North Carolina
State Building Code

Volume I
General Construction

1996 Edition

1996/1997 REVISIONS

(North Carolina Revisions To the 1994 Standard Building Code
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North Carolina Building Code Council

And

North Carolina Department of Insurance

Post Office Box 26387

Raleigh, North Carolina 27611

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PREFACE

The purpose of the Standard Building Code is to serve as a comprehensive regulatory document to guide decisions aimed at protecting the public's life, health and welfare in the built environment. This protection is provided through the adoption and enforcement, by state and local governments, of the performance-based provisions contained herein.

The use of performance-based requirements encourages the use of innovative building designs, materials and construction systems while at the same time recognizing the merits of the more traditional materials and systems. This concept promotes maximum flexibility in building design and construction as well as assuring a high degree of life safety.

The Standard Building Code incorporates, by reference, nationally recognized consensus standards for use in judging the performance of materials and systems. This provides for the equal treatment of both innovative and traditional materials and systems, provides for the efficient introduction of new materials into the construction process and assures a high level of consumer protection.

The Standard Building Code is intended to be adopted by reference through statute or ordinance and enforced by state and local governments, governmental agencies or other authorities having jurisdiction. Sample adopting legislation is printed in this document for that purpose. In preparation for adopting this code, the authority having jurisdiction should specifically consider including such items as inspection fees, permit fees and penalties or fines for noncompliance in the adopting legislation since these items vary considerably from one jurisdiction to another and cannot be effectively included in a model code.

The Standard Building Code was first adopted by the Southern Building Code Congress International in November of 1945 at the Annual Research Conference. Revised editions have been published since that time at approximate three-year intervals.

This Standard Building Code is dedicated to the organizations and individuals, including code officials, architects, engineers and industry representatives, who have volunteered their time and knowledge to make this the most comprehensive and up-to-date code available.

Solid vertical bars in the margin indicate North Carolina 1996 Revisions to the 1994 edition of the Standard Building Code.

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THE STANDARD CODES

Standard Amusement Device Code
Standard Building Code
Standard Existing Buildings Code
Standard Fire Prevention Code
Standard Gas Code
Standard Housing Code
Standard Mechanical Code
Standard Plumbing Code
Standard Swimming Pool Code
Standard Unsafe Building Abatement Code

CODE-RELATED PUBLICATIONS

Standard for Proscenium Curtains
Standard for Existing High Rise Buildings
Standard for Flood Plain Management
Standard for Soil Expansion
Standard for Sound Control
Standard for Textile Wall Covering Test
Standard for Roof Tile Test
Standard for Hurricane Resistant Residential Construction
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Standard Gas Code Commentary
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One and Two Family Dwelling Code Commentary

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RECOMMENDED PROCEDURES TO FOLLOW TO USE THE STANDARD BUILDING CODE

1. Determine Occupancy Classification of the structure. Select occupancy classification which most accurately fits the use of the building. (Chapter 3)

2. Determine actual physical properties of building.
   (a) Determine building area each floor. (Area definition Chapter 2)
   (b) Determine grade elevation for building. (Grade definition Chapter 2)
   (c) Determine building height in feet above grade. (Height definition Chapter 2)
   (d) Determine building height in stories. (Story definition Chapter 2)
   (e) Determine separation distance from exterior walls to assumed and common property lines. (Property line definition Chapter 2)
   (f) Determine percent of exterior openings per floor.

3. Determine minimum Type of Construction necessary to accommodate proposed structure. (Chapter 6)
   (a) Determine maximum allowable heights and floor areas for Types of Construction and Occupancy classification. (Table 500)
   (b) Check allowable height and area increases permitted. (Chapter 5)

4. Check detailed Occupancy requirements. (Chapter 4)

5. Check detailed Construction requirements.
   (a) Fire Protection of Structural Members (Chapter 6 and Table 600)
   (b) Fire Protection Requirements (Chapter 7 and Table 700)
   (c) Means of Egress Requirements (Chapter 10)
   (d) Special restrictions if in Fire District. (Appendix F. The provisions of Appendix F are applicable only where specifically adopted by ordinance.)

6. Review design as related to standards. (Chapters 16-26)

7. Check other requirements as necessary.
   (a) Construction projecting into public property (Chapter 32)
   (b) Elevators and conveying systems (Chapter 30)
   (c) Sprinklers, standpipes and alarm systems (Chapter 9)
   (d) Use of combustible materials on the interior (Chapter 8)
   (e) Roofs and roof structures (Chapter 15)
   (f) Light, ventilation and sanitation (Chapter 12)
   (g) Other

These steps are naturally varied in sequence by individual preferences; however, the first three are standard steps which should be followed in proper order to assist in design or review of buildings.

1994 STANDARD BUILDING CODE REORGANIZATION SUMMARY

The 1994 Standard Building Code has been reformatted into the common code format that was developed cooperatively by SBCCI, BOCA, ICBO, AIA and SFPE under the auspices of the Council of American Building Officials.

To aid previous users of the Standard Building Code, the following list shows the reorganization by listing the chapter/section of the 1991 edition and the corresponding chapter/section of the reformatted 1994 edition.

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101.6	Special Historic Buildings	3401.5 (deleted)
102	Powers and Duties of the Building Official	103 (deleted)
103	Permits	104 (deleted)
103.9	Certificates	106 (deleted)
103.10	Posting Floor Loads	106.4 (deleted)
104	Tests	107 (deleted)
105	Construction Board of Adjustment and Appeals	108 (deleted)
106	Severability	109 (deleted)
107	Violations and Penalties	110 (deleted)
CHAPTER 2 DEFINITIONS		Chapter 2
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	CHAPTER 4 CLASSIFICATION OF BUILDING BY OCCUPANCY	
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402	Height and Area	503
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403.3	Special Occupancy Separation	704.1.3
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404.2	Subclassifications	403.1.2
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404.5	Interior Finish	803.3.2 & 803.3.3
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CHAPTER 1

ADMINISTRATION

101 TITLE AND SCOPE

Provisions in the following chapters and sections shall constitute and be known and may be cited as the "North Carolina State Building Code, Volume I, General Construction," hereinafter referred to as "this Code." For Administration requirements, refer to the "North Carolina State Building Code, Volume I-A, Administration and Enforcement Requirements."

102 APPLICABILITY

The provisions of this Code shall apply to the construction, alteration, repair, equipment, use and occupancy, location, movement to another site, removal and demolition, or any appurtenances connected or attached to every building or structure.

103 EXCEPTIONS TO APPLICABILITY

The provisions of the code shall not apply to the following:

1. One and two family dwellings.
2. Buildings for the use of any farmer or his immediate family located outside the building regulation jurisdiction of any municipality when use of the building does not involve the health and safety of the public. If the operation of such can be considered a business endeavor, it shall meet the provisions of the technical codes.
   EXCEPTION: All buildings used for sleeping purposes shall conform to the provisions of the technical codes. All electric wiring of houses, buildings, or structures shall conform to the provisions of the North Carolina State Building Code, Volume IV - Electrical.
3. The design, construction, location, installation or operation of equipment for storing, handling, and transporting liquefied petroleum gases for fuel purposes up to the outlet of the first stage pressure regulator, and anhydrous ammonia or other liquid fertilizers.
4. The design, construction, location, installation or operation of equipment or facilities of a public utility, as defined in G.S. 62-3, or an electric or telephone membership corporation, including without limitation poles, towers, and other structures supporting electric or communication lines from the distribution network up to the meter location.
   NOTE: All buildings owned and operated by a public utility or an electric or telephone membership corporation shall meet the provisions of the code.
5. The Storage and Handling of Hazardous Chemicals Right to Know Act, North Carolina General Statute 95-173 – 95-318.

104 CROSS REFERENCE

For all cross references which specify the Standard Plumbing, Mechanical, Fire Prevention, Gas Codes, or NFiPA 70, the North Carolina editions shall be the code indicated.

105 POSTING OF FLOOR LOADS

105.1 Occupancy.

An existing or new building shall not be occupied for any purpose which will cause the floors thereof to be loaded beyond their safe capacity.

105.2 Storage and Factory-Industrial Occupancies.

It shall be the responsibility of the owner, agent, proprietor or occupant of Group S and Group F occupancies, or any occupancy where excessive floor loading is likely to occur, to employ an architect or professional engineer in computing the safe load capacity. All such computations shall be accompanied by an affidavit from the architect or professional engineer stating the safe allowable floor load on each floor in pounds per square foot uniformly distributed. The computations and affidavit shall be filed as a permanent record of the Inspection Department.

105.3 Signs Required.

In every building or part of a building used for storage, industrial or hazardous occupancy, the safe floor loads, as reviewed by the Building Official on the plan, shall be marked on plates of approved design which shall be supplied and securely affixed by the owner of the building in a conspicuous place in each story to which they relate. Such plates if lost, removed or defaced shall be replaced by the owner of the building.

CHAPTER 2

DEFINITIONS

201 GENERAL

201.1 Scope

For the purpose of this code, certain abbreviations, terms, phrases, words, and their derivatives, shall be construed as set forth in this chapter or the chapter to which they are unique.

201.2 Tense, Gender and Number

Words used in the present tense include the future. Words in the masculine gender include the feminine and neuter. The singular number includes the plural and the plural number includes the singular.

201.3 Words Not Defined

Words not defined herein shall have the meanings stated in the Standard Mechanical Code, Standard Plumbing Code, Standard Gas Code or Standard Fire Prevention Code. Words not defined in the Standard Codes shall have the meanings in Webster's Ninth New Collegiate Dictionary as revised.

202 DEFINITIONS

ACCESSIBLE - having access to but which first may require the removal of a panel, door or similar covering of the item described. See READILY ACCESSIBLE.

ADDITION - an extension or increase in floor area or height of a building or structure.

ALLEY - any public space or thoroughfare 20 ft (6096 mm) or less wide which has been dedicated or deeded for public use.

ALTER or ALTERATION - any change or modification in construction or occupancy.

AND/OR - in a choice of two code provisions, signifies that use of both provisions will satisfy the code requirement and use of either provision is acceptable also.

APARTMENT – See DWELLING UNIT.

APARTMENT HOUSE - any building or portion thereof used as a multiple dwelling for the purpose of providing three or more separate dwelling units which may share means of egress and other essential facilities.

APPLICABLE GOVERNING BODY - a city, county, state agency or other political government subdivision or entity authorized to administer and enforce the provisions of this Code, as adopted or amended.

APPROVED - approved by the building official or other authority having jurisdiction.

ARCHITECT - a duly registered and licensed architect.

ARCHITECTURAL TRIM - the ornamental or protective framing or edging around openings or at corners or eaves and other architectural elements attached to the exterior walls of buildings, usually of a color and material different from that of the adjacent wall surface, and serving no structural purpose.

AREA, BUILDING - the area included within surrounding exterior walls, or exterior walls and fire walls, exclusive of courts. The area of a building or portion of a building without surrounding walls shall be the usable area under the horizontal projection of the roof or floor above.

AREA, GROSS FLOOR - the area within the inside perimeter of the exterior walls with no deduction for corridors, stairs, closets, thickness of walls, columns or other features, exclusive of areas open and unobstructed to the sky.

AREA, NET FLOOR - the area actually occupied not including accessory unoccupied areas such as corridors, stairs, closets, thickness of walls, columns, toilet rooms, mechanical area or other features.

ASSEMBLY OCCUPANCY - defined in 304.

ATRIUM - a space, intended for occupancy within a building, extending vertically though the building and enclosed at the top.

AUTOMATIC - as applied to fire protection devices, is a device or system providing an emergency function without the necessity for human intervention and activated as a result of a predetermined temperature rise, rate of rise of temperature, or combustion products, such as incorporated in an automatic sprinkler system, automatic fire door, automatic fire shutter, or automatic fire vent.

AUTOMATIC FIRE-EXTINGUISHING SYSTEM - an approved system of devices and equipment which automatically detects a fire and discharges an approved fire-extinguishing agent onto or in the area of a fire.

AUTOMOTIVE SERVICE STATION - defined in 404.2.

AWNING - an architectural projection that provides weather protection, identity and/or decoration and is wholly supported by the building to which it is attached. An awning is comprised of a lightweight, rigid or retractable skeleton structure over which an approved cover is attached.

BALCONY, ASSEMBLY ROOM - that portion of the seating space of an assembly room, the lowest part of which is raised 4 ft (1219 mm) or more above the level of the main floor.

BASEMENT - any building story having a floor below grade.

BLEACHERS - tiered or stepped seating facilities without backrests.

BOILER - a heating appliance intended to supply hot water or steam.

BUILDING - any structure that encloses a space used for sheltering any occupancy. Each portion of a building separated from other portions by a fire wall shall be considered as a separate building.

BUILDING LINE - the line, established by law, beyond which the building shall not extend, except as specifically provided by law.

BUILDING OFFICIAL - the officer or other designated authority, or their duly authorized representative, charged with the administration and enforcement of this code.

BUSINESS OCCUPANCY - defined in 305.

CITY - See APPLICABLE GOVERNING BODY.

COMBUSTIBLE MATERIAL - a material which cannot be classified as noncombustible in accordance with that definition.

CONSTRUCTION TYPES -

Type I - Sec 603	Type IV - See 606
Type II - See 604	Type V - Sec 607
Type III - See 605	Type VI - See 608

CORRIDOR - a passageway into which compartments or rooms open and which is enclosed by partitions, other than partial partitions, and/or walls and a ceiling or a floor/roof deck above.

DEAD END - a hallway, corridor or space open to a corridor so arranged that it can be entered from an exit access corridor without passage through a door, but does not lead to an exit.

DEAD LOAD - the weight of all permanent construction, including walls, floors, roofs, ceilings, stairways, and fixed service equipment, plus the net effect of prestressing.

DORMITORY - a space in a unit where group sleeping accommodations are provided with or without meals for persons not members of the same family group, in one room or in a series of closely associated rooms under joint occupancy and single management, as in college dormitories, fraternity houses, military barracks, and ski lodges.

DWELLING - a building occupied exclusively for residential purposes by not more than two families, unless qualified otherwise in code text.

DWELLING UNIT - a single unit providing complete, independent living facilities for one or more persons including permanent provisions for living, sleeping, eating, cooking and sanitation.

EDUCATIONAL OCCUPANCY - defined in 306.

ENGINEER - a duly registered and licensed engineer.

EVALUATION REPORT - a report indicating compliance with the provisions of the Standard Building Code as analyzed by the Evaluation Committee of SBCCI PST & ESI.

EXIT - that portion of the means of egress which is separated from all other spaces of a building or structure by construction and opening protectives, as required for exits, to provide a protected way of travel to the exit discharge. Exits include exterior exit doors, separated exit stairs, exit passageways and horizontal exits.

EXIT ACCESS - that portion of a means of egress which leads to an entrance to an exit.

EXIT COURT - an outside space with building walls on three or more sides and open to the sky.

EXIT DISCHARGE - that portion of a means of egress between the termination of an exit and a public way.

FAMILY - one or more persons living together, whether related to each other by birth or not, and having common housekeeping facilities.

FARM BUILDINGS - structures, other than residences and structures appurtenant thereto, for on-farm use (barns, sheds, poultry houses, etc.).

FIRE DOOR - a door and its assembly, so constructed and assembled in place as to give the specified protection against the passage of fire.

FIRE RESISTANCE or FIRE RESISTANCE RATING - the period of time a building or building component maintains the ability to confine a fire or continues to perform a given structural function or both, as determined by tests prescribed in 701.2.

FIRE RETARDANT TREATED WOOD - any wood product which, when impregnated with chemicals by pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E 84, a flamespread index of 25 or less and show no evidence of significant progressive combustion when the test is continued for an additional 20 minute period. In addition, the flame front shall not progress more than 10 1/2 ft (3200 mm) beyond the center line of the burners at any time during the test. See 2301.8 for acceptance criteria for fire retardant treated wood.

FIRE WALL - a 4-hour fire resistant wall, having protective openings, which restricts the spread of fire and extends continuously from the foundation to or through the roof, with sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall.

FIREBLOCKING - barriers installed to resist the movement of flame and gases to other areas of a building through small concealed passages in building components such as floors, walls and stairs.

FLAMESPREAD - the propagation of flame over a surface.

FLAMESPREAD RATING - that numerical value assigned to a material tested in accordance with ASTM E 84.

FOOTBOARDS - that part of a raised seating facility other than an aisle or cross aisle upon which the occupant walks to reach a seat. Applies to reviewing stands, grandstands and bleachers.

GALLERY - that portion of the seating space of an assembly room having a seating capacity of more than ten located above a balcony.

GRADE - a reference plane representing the average of finished ground level adjoining the building at all exterior walls. When the finished ground level slopes away from the exterior walls, the reference plane shall be established by the lowest points within the area between the building and the lot line or between the building and a point 6 ft (1829 mm) from the building, whichever is closer to the building.

GRADE, LUMBER- the division of sawn lumber into quality classes with respect to its physical and mechanical properties as defined in published lumber manufacturer's standard grading rules.

GRANDSTANDS - tiered or stepped seating facilities.

GROUT - mixture of cementitious materials and aggregate to which sufficient water is added to produce pouring consistency without segregation of the constituents.

GUARDRAIL SYSTEM - a system of building components located near the open sides of elevated walking surfaces.

GYPSUM SHEATHING - a gypsum board used as a backing for exterior surface materials, manufactured with water-repellent paper and which may be manufactured with a water-resistant core, in accordance with ASTM C 79.

GYPSUM WALLBOARD - a gypsum board manufactured in accordance with ASTM C 36 used primarily as an interior surfacing for building structures.

GYPSUM WALLBOARD, TYPE X - a gypsum board specially manufactured to provide specific fire-resistant characteristics.

HABITABLE SPACE - a space in a structure for living, sleeping, eating or cooking. Bathrooms, toilet compartments, closets, halls, storage or utility space, and similar areas are not considered habitable space.

HANDRAIL - a horizontal or sloping rail grasped by hand for guidance or support.

HAZARD CONTENTS, HIGH - contents which are liable to burn with extreme rapidity or from which poisonous fumes or explosions are to be feared in case of fire.

HAZARD CONTENTS, LOW - contents of such low combustibility that no self-propagating fire therein can occur. The only probable danger requiring the use of emergency exits will be from panic, fumes, smoke, or fire from some external source.

HAZARD CONTENTS, ORDINARY - contents which are liable to burn with moderate rapidity or to generate a considerable volume of smoke but from which neither poisonous fumes nor explosions are to be feared in case of fire.

HAZARDOUS OCCUPANCY- defined in 308.

HEATING - see Chapter 28 and Standard Mechanical Code.

HEIGHT, BUILDING - the vertical distance from grade to the highest finished roof surface in the case of flat roofs or to a point at the average height of the highest roof having a pitch. Height of a building in stories includes basements, except as specifically provided for in 503.2.4.

HEIGHT, STORY - the vertical distance from top to top of two successive finished floor surfaces.

HEIGHT, WALL - the vertical distance to the top measured from the foundation wall, or from a girder or other intermediate support of such wall.

HORIZONTAL EXIT - way of passage from one building to an area of refuge in another building on approximately the same level, or a way of passage through or around a wall or partition to an area of refuge on approximately the same level in the same building, which affords safety from fire or smoke from an area of incidence and areas communicating therewith.

HORIZONTAL SEPARATION - the distance in feet measured from the building face to the closest interior lot line, to the centerline of a street, alley or public way, or to an imaginary line between two buildings on the same property.

HOTEL - any building containing six or more guest rooms intended or designed to be used, or which are used, rented or hired out to be occupied or which are occupied for sleeping purposes by guests.

INDUSTRIAL OCCUPANCY - defined in 307.

INSTITUTIONAL OCCUPANCY - defined in 309.

INTERIOR LOT LINE - See PROPERTY LINE, COMMON.

LABELED - devices, equipment or materials to which have been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the above labeled items and by whose label the manufacturer attests to compliance with applicable nationally recognized standards.

LINTEL - the member placed over an opening in a wall which supports the wall construction above.

LISTED - equipment or materials included in a list published by a nationally recognized testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets nationally recognized 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. The building official should utilize the system employed by the listing organization to identify a listed product

LIVE LOAD - the weight superimposed by the use and occupancy of the building, not including crane load, dead load, earthquake load, snow load, or wind load.

LOAD DURATION - the period of continuous application of a given load, or the aggregate of periods of intermittent applications of the same load.

LOT - a parcel of land considered as a unit.

MEANS OF EGRESS - a continuous and unobstructed way of exit travel from any point in a building or structure to a public way, consisting of three separate and distinct parts: (l) the way of exit access, (2) the exit, and (3) the way of exit discharge. A means of egress comprises the vertical and horizontal ways of travel and shall include the intervening room space, doors, corridors, passageways, balconies, stairs, ramps, enclosures, lobbies, horizontal exits, courts and yards. See EXIT and EXIT ACCESS.

MEZZANINE - one or more intermediate levels between the floor and ceiling of a story, meeting the requirements of 503.2.3.

MOTEL - See HOTEL.

MULTIPLE DWELLING - See APARTMENT HOUSE.

NONCOMBUSTIBLE BUILDING MATERIAL - a material which meets either of the following requirements:

1 . Materials which pass the test procedure set forth in ASTM E 136.

2. Materials having a structural base of noncombustible materials as defined in 1, with a surfacing not more than 1/8 inch (3.17 mm) thick which has a flamespread rating not greater than 50 when tested in accordance with ASTM E 84.

The term noncombustible does not apply to the flamespread characteristics of interior finish or trim materials. A material shall not be classed as noncombustible which is subject to increase in combustibility or flamespread rating beyond the limits herein established through the effects of age, moisture or other atmospheric conditions.

OCCUPANCY - the purpose for which a building, or part thereof, is used or intended to be used.

OCCUPANCY, MIXED - a building used for two or more occupancies classified in different occupancy groups.

OCCUPANT CONTENT - the actual number of total occupants permitted to occupy a floor area in accordance with the maximum capacity of the exits serving that floor area.

OCCUPANT LOAD - the calculated minimum number of persons for which the means of egress of a building or portion thereof is designed, based on Table 1003.1.

OCCUPIABLE ROOM - a room or enclosed space designed for human occupancy in which individuals congregate for amusement, educational or similar purposes, or in which occupants are engaged at labor; and which is equipped with means of egress, light, and ventilation facilities meeting the requirements of this code.

OPEN AIR GRANDSTANDS AND BLEACHERS - seating facilities which are located so that the side toward which the audience faces is unroofed and without an enclosing wall.

OWNER - any person, agent, firm or corporation having a legal or equitable interest in the property.

PARTITION - an interior wall, other than folding or portable, that subdivides spaces within any story, attic or basement of a building.

PARTITION, PARTIAL - a partition with a maximum height of 72 inches (1829 mm).

PERMANENT SEATING - seating facilities which remain at a location for more than 90 days. Applies to reviewing stands, grandstands and bleachers.

PERMIT - an official document or certificate issued by the building official authorizing performance of a specified activity.

PERSON - a natural person, his heirs, executors, administrator, or assigns, or a firm, partnership or corporation and its successors or assigns, or the agent of any of the aforesaid.

PLASTIC, APPROVED - a thermoplastic, thermosetting or reinforced plastic material which has self-ignition temperature 650°F (343°C) or greater when tested in accordance with ASTM D 1929, a smoke density rating no greater than 450 when tested in accordance with ASTM E 84 in the way intended for use, or a smoke density rating no greater than 75 when tested in the thickness intended for use by ASTM D 2843 and which meets one of the combustibility classifications listed below:

CC 1 - Plastic materials which have a burning extent of 1 inch (25.4 mm) or less when tested in nominal .060 inch (1.52 mm) thickness by ASTM D 635.

CC 2 - Plastic materials which have a burning rate of 2 1/2 inches (64 mm) per minute or less when tested in nominal .060 inch (1.52 mm) thickness by ASTM D 635 or in the thickness intended for use.

PLASTIC, GLASS FIBER REINFORCED - plastic reinforced with glass fiber having not less than 20% of glass fibers by weight.

PLASTIC, GLAZING - plastic materials which are glazed or set in frame or sash and not held by mechanical fasteners which pass through the glazing material.

PLATFORM, PERMANENT - a platform used within an area for more than 30 days.

PLATFORM, TEMPORARY - a platform used within an area for 30 days or less.

PLENUM - an air compartment or chamber to which one or more ducts are connected and which forms part of an air distribution system.

PROPERTY LINE, ASSUMED - the centerline of street where an exterior building wall faces a street, or an imaginary line between the exterior walls of two buildings on the same lot.

PROPERTY LINE, COMMON - a line dividing one lot from another.

PUBLIC SPACE - a legal open space on the premises, accessible to a public way or street, such as yards, courts or open spaces permanently devoted to public use, which abuts the premises and is permanently maintained accessible to the fire department and free of all encumbrances that might interfere with its use by the fire department.

PUBLIC WAY - any street, alley or other parcel of land open to the outside air, deeded, dedicated or otherwise permanently appropriated to the public for public use and having a clear and unobstructed width and height of not less than 10 ft (3048 mm).

READILY ACCESSIBLE - 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.

REPAIR - the reconstruction or renewal of any part of an existing building for the purpose of its maintenance.

RESIDENTIAL OCCUPANCY- defined in 311.

REVIEWING STANDS - elevated platforms accommodating not more than 50 persons. Seating facilities, if provided, are normally in the nature of loose chairs. Reviewing stands accommodating more than 50 persons are grandstand.

SAFE DISPERSAL AREA - an area which will accommodate a number of persons equal to the total capacity of the stand and building which it serves in such a manner that no person within the area need be closer than 50 ft (15.2 m) from the stand or building. Dispersal areas are based on an area of not less than 3 sq ft (0.28 m2) per person. Applies to reviewing stands, grandstands and bleachers.

SEISMIC LOAD - the forces superimposed on a building or structure by an earthquake.

SELF-CLOSING - as applied to a fire door or other opening, means normally closed and equipped with an approved device which will insure closing after having been opened for use.

SERVICE STATION - defined in 404.2.

SHAFT - a vertical opening extending through one or more stories of a building.

SHALL - as used in this code, is mandatory.

SMOKEPROOF ENCLOSURE - an exit consisting of a vestibule and continuous stairway enclosed from the highest point to the lowest point and designed so that the movement of products of combustion produced by a fire occurring in any part of the building into the smokeproof tower is limited.

SNOW LOAD - the forces superimposed on a building or structure resulting from the accumulation of snow.

SPRINKLERED - equipped with an approved automatic sprinkler system properly maintained.

STAIRWAY - one or more flights of stairs, either exterior or interior, with the necessary landings and platforms connecting them, to form a continuous and uninterrupted passage from one level to another in a building or structure.

STORY - that portion of a building included between the upper surface of a floor and upper surface of the floor or roof next above.

STREET - any public thoroughfare, street, avenue, boulevard, park or space more than 20 ft (6096 mm) wide which has been dedicated or deeded to the public for public use.

STREET LINE - a lot line dividing a lot from a street.

STRUCTURAL WORK OR ALTERATION - the installation or assembly of any new structural components, or any change to existing structural components, in a system, building, or structure.

STRUCTURE - that which is built or constructed.

TENANT - any person, agent, firm, corporation or division, who uses or occupies land, a building, or portion of a building by title, under a lease, by payment of rent, or who exercises limited control over the space.

TENANT SEPARATION - a partition or floor/ceiling assembly or both between tenants.

THEATER - a building, or part thereof, which contains an assembly hall with or without a stage which may be equipped with curtains and permanent stage scenery or mechanical equipment adaptable to the showing of plays, operas, motion pictures, performances, spectacles and similar forms of entertainment.

TOWNHOUSE - a single family dwelling constructed in a series or group of attached units with property lines separating each unit.

USABLE CRAWL SPACE - a crawl space designed to be used for equipment or storage.

VALUATION OR VALUE - when applied to a building, means the estimated cost to replace the building in kind.

VENEER - a facing attached to a wall for the purpose of providing ornamentation, protection, or insulation, but not counted as adding strength to the wall.

VERTICAL OPENING - an opening through a floor or roof.

WALL, BEARING - a wall supporting any vertical load in addition to its own weight.

WALL, CURTAIN - a nonbearing wall between columns or piers which is not supported by girders or beams, but is supported on the ground.

WALL, EXTERIOR - a wall, bearing or nonbearing, which is used as an enclosing wall for a building, other than a party wall or fire wall.

WALL, FOUNDATION - a wall below the first floor extending below the adjacent ground level and serving as support for a wall, pier, column or other structural part of a building.

WALL, NONBEARING - a wall which supports no vertical load other than its own weight.

WALL, PANEL - a nonbearing wall in skeleton or framed construction, built between columns or piers and wholly supported at each story.

WALL, PARAPET - that part of any wall entirely above the roof line.

WALL, PARTY - a fire wall on an interior lot line, used or adapted for joint service between two buildings.

WALL, RETAINING - a wall designed to prevent the lateral displacement of soil or other material.

WIND LOAD - the forces superimposed on a building or structure by the movement of an air mass at a specified velocity.

WRITING - includes printing and typewriting.

WRITTEN NOTICE - a notification in writing delivered in person to the individual or parties intended, or delivered at, or sent by certified or registered mail to the last residential or business address of legal record.

YARD - an unoccupied open space other than a court.

CHAPTER 3

OCCUPANCY CLASSIFICATION

301 GENERAL

301.1 Scope

Provisions of this chapter shall govern the classification of building occupancies.

301.2 Occupancy or Use Categories

Every new and existing building, structure or part thereof shall, for the purpose of this code, be classified according to its use, or occupancy as a building or structure of one of the following occupancy groups:

Group A	-Assembly (see 304)
Group B	-Business (see 305)
Group E	-Educational (see 306)
Group F	-Factory Industrial (see 307)
Group H	-Hazardous (see 308)
Group I	-Institutional (see 309)
Group M	-Mercantile (see 310)
Group R	-Residential (see 311)
Group S	-Storage (see 312)

301.3 Uncertain Classification

Each occupancy group is intended to include buildings as hereinafter defined and those of similar character or use. Wherever there is any uncertainty as to the classification of a building, the building official shall determine the classification within which it falls, according to the life safety and relative fire hazard involved.

302 DEFINITIONS

The following words and terms shall, for the purposes of this chapter and as stated elsewhere in this code, have the meanings shown herein. Refer to Chapter 2 for general definitions.

ROOMING HOUSE (Transient) – any building or portion thereof containing not more than five guest rooms, occupied by not more than five guests, where rent is paid and guests are transient.

ROOMING HOUSE (Not Transient) – any building or portion thereof containing guest rooms where rent is paid and guests are not transient.

303 MIXED OCCUPANCIES

303.1 Multiple Occupancies

A building that is used for two or more occupancies, classified within different occupancy groups, shall be considered a mixed occupancy building.

EXCEPTION: A building containing two or more occupancies, none of them Group H, may be considered a single occupancy when:

1. The required type of construction for the building is determined by applying the height and area limitations for each of the applicable occupancy groups to the entire building with the most restrictive type of construction requirements being applied, and
2. The entire building conforms with the most restrictive occupancy group fire protection requirements, as determined by Chapter 7 and 8, and

3. The entire building conforms with the most restrictive occupancy group sprinkler, standpipe and alarm system requirements, as determined by Chapter 9, and
4. All other requirements of this code are applied to each portion of the building based on the use of that space.

303.2 Height and Area

A mixed occupancy building shall be governed by the height and area limitations applying to the principal intended use. However each portion of the building shall conform to all other requirements of this code for the occupancy contained therein. Accessory occupancies shall not exceed the area limitation nor be located at a height greater than that permitted for such occupancy group in the type of construction being used.

304 ASSEMBLY OCCUPANCY- GROUP A

304.1 Scope

304.1.1 Group A occupancy is the use of a building or structure, or any portion thereof, for the gathering together of persons for purposes such as civic, social or religious functions or for recreation, or for food or drink consumption or awaiting transportation.

304.1.2 Group A occupancy shall include, among others, the following:

Amusement Park Buildings	Passenger Depots
Auditoriums	Public Assembly Halls
Churches	Recreation Halls
Dance Halls	Restaurants
Gymnasiums	Stadiums and Grandstands
Motion Picture Theaters	Tents for Assembly
Museums	Theaters for Stage Production

304.2 Subclassifications

304.2.1 Assembly occupancies shall be divided into two subclassifications as set forth in this section, both of which shall comply with the requirements for Group A occupancy unless otherwise specified:

1. A-1: Large Assembly shall include theaters and other places of assembly without a legitimate stage and with an occupant load of 1,000 or more persons. Large Assembly shall also include theaters and other places of assembly with a stage requiring proscenium opening protection and with an occupant load of 700 or more persons.
2. A-2: Small Assembly shall include theaters and other places of assembly with or without a stage requiring proscenium opening protection and with an occupant load of 100 or more persons, but with an occupant load less than designated for Large Assembly.

304.2.2 Assembly occupancies with an occupant load less than 100 persons shall be classified as Group B.

305 BUSINESS OCCUPANCY - GROUP B

305.1Scope

305.1.1 Group B occupancy is the use of a building or structure, or any portion thereof, for office, professional, or service type transactions including normal accessory storage and the keeping of records and accounts.

305.1.2 Group B occupancy shall include, among others, the following:

Animal hospitals, kennels, pound
Automobile and other motor vehicle showrooms
Automobile or other vehicle service stations
Banks (nonhazardous)
Barber shops
Beauty shops
Bowling alleys
Carwashes
Civic administration areas
Clinics – outpatient
Dry cleaning; pick-up and delivery stations and self-service
Educational occupancies above the 12th grade
Electronic data processing areas
Florist and nurseries
General post offices Greenhouses
Laboratories; testing and research
Laundries; pickup and delivery stations and self-service
Libraries (other than school)
Office buildings
Police stations
Print shops
Professional services; attorney, dentist, physician, engineer, etc.
Radio and television stations
Telephone exchanges

305.1.3 Assembly occupancies with an occupant load less than 100 persons shall be classified as Group B.

EXCEPTION: Provisions of 403.1.3. 403.2, 403.3, 1019.10, 1019.11 and 3103 shall apply to buildings used for assembly purposes, regardless of occupant load.

305.1.4 Dry cleaning establishments using solvents which are nonflammable or nonflammable at ordinary temperatures and only moderately flammable at higher temperatures (Class IV System) shall be classified as Group B occupancy.

306 EDUCATIONAL OCCUPANCY – GROUP E

306.1Scope

306.1.1 Group E occupancy is the use of a building or structure, or any portion thereof, by six or more persons at any one time for educational purposes through the 12th grade.

306.1.2 Child care facilities which accommodate children of any age who stay less than 24 hours per day shall be classified as Group E.

306.1.3 Parts of buildings used for the congregating or gathering of 100 or more persons in one room shall be classified as Group A occupancy, regardless of whether or not such gathering is of an educational or instructional nature.

306.1.4 Schools for business or vocational training shall be classified in the same occupancies and conform to the same requirements as the trade, vocation or business taught, provided the concentration of persons will not exceed that listed in 1003 for the occupancy classification used.

307 FACTORY-INDUSTRIAL OCCUPANCY - GROUP F

307.1 Scope

307.1.1 Group F occupancy is use of a building or structure, or any portion thereof, for assembling, disassembling, repairing, fabricating, finishing, manufacturing, packaging or processing operations that are not otherwise classified in this code.

307.1.2 Group F occupancy shall include, among others, the occupancies listed in this section, but does not include buildings used principally for any purpose involving highly combustible, flammable, or explosive products or materials. See 308.

Assembly Plant
Factory
Manufacturing Plant
Mill
Processing Plant

307.1.3 Portions of Group F occupancy involving highly combustible, flammable or explosive products or materials shall be properly ventilated, protected and separated from the remainder of the building in accordance with the appropriate NFiPA Standard or the entire building will be classified as Hazardous occupancy. See 308.

308 HAZARDOUS OCCUPANCY - GROUP H

308.1 Scope

Group H occupancy is the principal use of a building or structure, or any portion thereof, that involves the manufacturing, processing, generation, storage, or other use of hazardous materials in excess of the exempt quantities listed in this section.

308.2 Subclassification

308.2.1 Group H hazardous occupancies shall be divided into H1 through H4 according to the hazards presented by each material as described below:

Hl: Buildings or parts thereof used for the manufacturing, processing, generation or storage of materials which present a detonation hazard. Detonation hazards include explosives, blasting agents and fireworks, Class 4 liquid and solid oxidizers, unclassified detonatable organic peroxides, and Class 3 and 4 detonatable unstable (reactive) materials in excess of the amounts given in Table 308.2A.

H2: Buildings or parts thereof used for the manufacturing, processing, generation or storage of materials which present a deflagration hazard or a hazard from accelerated burning. Deflagration hazards include Class I, II and III-A flammable or combustible liquids in open containers or containers pressurized at more than 15 psi (103 kPa), combustible dusts stored in piles or within open containers, Class 3 liquid and solid oxidizers, Class I organic peroxides, solid, liquid and gaseous pyrophorics, Class 3 nondetonatable unstable (reactive) materials and flammable cryogenic fluids in excess of the amounts given in Table 308.2B.

H3: Buildings or parts thereof used for the manufacturing, processing, generation or storage of materials which readily support combustion or present a physical hazard. Physical hazards include Class I, II, and III flammable and combustible liquids in closed containers pressurized at 15 psi (103 kPa) or less, Level 2 and Level 3 aerosol products, flammable solids, Class 1 and 2 liquid and solid oxidizers, Class II, III, or IV organic peroxides, Class 1 and 2 unstable (reactive) materials, water reactive materials, and oxidizing cryogenic fluids in excess of the amounts given in Table 308.2C.

H4: Buildings or parts thereof used for the manufacturing, processing, generation or storage of materials which are health hazards. Health hazards include toxic and toxic compressed gases, highly toxic and toxic solids and liquids, corrosives, irritants, sensitizers, and other health hazard solids, liquids and gases in excess of the amounts given in Table 308.2D.

EXCEPTIONS TO 308.2.1:

1. The quantities of alcoholic beverages in retail sales uses are unlimited provided the liquids are packaged in individual containers not exceeding 1 gal (3.79 L).
2. The quantities of medicines, foodstuffs and cosmetics containing not more than 50% by volume of water miscible flammable liquids and with the remainder of the solution not being flammable are unlimited when packaged in containers not exceeding 1 gal (3.79 L).
3. Mercantile occupancies: Storage of flammable and combustible liquids shall be limited to quantities needed for display and normal merchandising purposes but shall not exceed the quantities permitted in the Standard Fire Prevention Code.
4. Explosives, Blasting Agents and Ammunition preempted by the requirements of Chapters 19 and 20 of the Standard Fire Prevention Code.
5. Refrigeration systems.

6. Storage, use and handling of pesticides and agricultural materials used for weed abatement, pest control, erosion control, soil amendments or similar application for use on the premises.
7. Materials contained within fuel tanks or batteries on automobiles.
8. Stationary batteries used for facility emergency power, uninterrupted power supply or telecommunication facilities, provided that the batteries are provided with safety venting caps and sufficient ventilation to produce a vapor-air mixture which is less than 25% of the lower explosive limit.
9. Control areas in accordance with 308.2.2.
10. Corrosives, irritants and sensitizers shall not include commonly used building materials.
11. Corrosives, irritants and sensitizers shall not include personal or household products in their original packaging for retail display.
12. Level 1 aerosol products shall be considered equivalent to a Class III commodity, as defined by NFiPA 30B and the Standard Fire Prevention Code.

308.2.2 Control areas containing hazardous material not exceeding the exempt quantities shall be permitted in all occupancies except assembly occupancies. The control area shall be separated by 1-hour fire resistant construction with 3/4-hour opening protection with self-closing or automatic closing device in accordance with 705.1.3.2.3. The maximum number of control areas per floor in multistory buildings shall be limited to four. The maximum number of control areas in any building shall be limited to ten. When control areas are on different floors but adjacent to each other, the floor/ceiling between these control areas shall have not less than 2-hour fire resistant construction. When the floor/ceiling assembly forms part of the separation, the separation walls of the control area shall extend from the floor below to the floor deck above.

308.2.3 When the stored amount of any hazardous material listed in tables 308.2A through 308.2D is exceeded in any one control area, such storage shall be within a room or building conforming to the code requirements for H1, H2, H3 or H4 occupancies.

308.2.4 Multiple Hazards. Materials representing hazards that are classified in one or more of the H occupancy subgroups shall conform to the code requirements for each of the use groups represented.

Table 308.2A
Exempt Quantities of H1 Materials

Condition	Explosives and Blasting Agents[1,6]		Liquid And Solid Oxidizers[2,3,4] (lbs) Class 4	Organic Peroxides[2,5] (lbs) UD	Unstable (Reactive) Materials (Detonatable)[2,5]			
					CLASS 3		CLASS 4	
	Solids (lbs)	Liquids (lbs)			Solids & Liquids (lbs)	Gases (cu ft)	Solids & Liquids (lbs)	Gases (cu ft)
unprotected by sprinklers or cabinet	0	0	0	0	5	50	0	0
within cabinet in unsprinklered building	0	0	0	0	10	100	0	0
In sprinklered building, not in cabinet	1	0.10	1	1	10	100	1	10
In sprinklered building, within cabinet	2	0.20	2	2	20	200	2	20

1 lb = 0.4536 kg
1 gal= 3.7854 L
1 cu ft = 0.02832 m^3

UD = Unclassified Detonatable.

Notes:

1. Storage of pyrotechnic special effect materials in motion picture, television, theatrical and group entertainment production when under permit amount as specified in Chapter 20 of the Standard Fire Prevention Code.
2. A conversion of 10 lbs/gal shall be used.
3. No exempt amounts are permitted in Group A, E, M, or R, or offices of Group B occupancies.
4. No exempt amounts are permitted in Group I occupancies or in classrooms or laboratories of Group B unless storage is within a hazardous material storage cabinet containing no other storage.
5. Except for laboratories in Group B occupancies, materials are not permitted in Group A, B, E, I, M and R occupancies.
6. Allowable quantities for retail display and storage are specified In Chapter 19 of the Standard Fire Prevention Code.

Table 308.2B
Exempt Quantities of H2 Materials

Conditions	Flammable and Combustible Liquids in Open Containers or Containers Pressurized at More Than 15 Psig (Gal)[1]						Combustible Dusts Stored In Piles Or Open Containers (lbs)	Liquid and Solid Oxidizers (lbs)[3,4]	Organic Peroxides (lbs)[3,5]	Pyrophoric Materials[3,5]		Unstable Reactives[5] (Nondetonatable)		
								Class 3	Class 1	Solid & Liquid (lbs)	Gases (cu ft)	Class 3		
	IA	IB	IC	IA[2] IB[2] IC[2]	II	IIIA						Solid & Liquid (lbs)	Gases (cu ft)	Flammable Crygenic Fluids (Gal)
unprotected by sprinklers or cabinet	30	60	90	120	120	330	125	10	5	0	0	5	50	45
within cabinet in unsprinklered building	60	120	180	240	240	660	250	20	10	0	0	10	100	45
in sprinklered building, not in cabinet	60	120	180	240	240	660	250	20	10	4	50	10	100	90
in sprinklered building, within cabinet	120	240	360	480	480	1,320	500	40	20	8	100	20	200	90

1 lb = 0.4536 kg
1 gal= 3.7854 L
1 cu ft = 0.02832 m^3

Notes:

1. For storage requirements see Chapter 9 of the Standard Fire Prevention Code.
2. Containing not more than the exempt amounts of Class lA, IB, IC, flammable liquids.
3. A conversion of 10 lbs/gal shall be used.
4. A maximum quantity of 200 lbs of solid or 20 gallons may be permitted in I, M, and A occupancies when necessary for maintenance purposes or operation of equipment.
5. Except for laboratories in Group B occupancies, materials not permitted in Group A, B, E, I, M and A occupancies.

Table 308.2C
Exempt Quantities of H3 Materials

Conditions	Flammable and Combustible Liquids in Closed Containers Pressurized at 15 Psig or Less (Gal)1 Class							Flammable Solids (lbs)[4]	Liquid & Solid Oxidizers (lbs)[3] Class		Organic Peroxides[3] (lbs) Class			Unstable Materials[3]				Water Reactive[3] (lbs) Class			Flammable or Oxidizing Cryogenic Fluids (Gals)
	IA	IB	IC	IA[2] IB[2] IC[2]	II	IIIA	IIIB		1	2	II	III	IV	Class 1 Solid & Liquid (lbs)	Gases (cu ft)	Class 2 Sold & Liquid (lbs)	Gases (cu ft)	1	2	3	
unprotected by sprinklers or cabinet	30	60	90	120	120	330	13,200	125	1,000	250	50	125	500	125	750	50	250	NL	50	5	45
within cabinet in unsprinklered building	60	120	180	240	240	660	26,400	250	2,000	500	100	250	1,000	250	1,500	100	500	NL	100	10	45
in sprinklered building, not in cabinet	60	120	180	240	240	660	NL	250	2,000	500	100	250	1,000	250	1,500	100	500	NL	100	10	90
in sprinklered building, within cabinet	120	240	360	480	480	1,320	NL	500	4,000	1,000	200	500	2,000	500	3,000	200	2,000	NL	200	20	90

1 lb = 0.4536 kg
1 gal= 3.7854 L
1 cu ft = 0.02832 m^3

Notes:

1. For storage requirements see Chapter 9 of the Standard Fire Prevention Code.
2. Containing not more than the exempt amounts of Class IA, IB, or IC flammable liquids.
3. A conversion of 10 lbs/gal shall be used.
4. For baled combustible fibers the exempt quantities shall be 1,000 cu ft, 2,000 cu ft, 2,000 cu ft and 4,000 cu ft for the respective conditions.

Table 308.2D
Exempt Quantities of H4 Materials

Conditions	Highly Toxic Gases1,2 (cu ft)	Toxic Compressed Gases1,2,4 (cu ft)	Highly Toxic and Toxic Solids and Liquids3 (lbs)		Corrosives, Irritants, Sensitizers, and Health Hazard Solids, Liquids, and Gases		
			Highly Toxic	Toxic	Solids (lbs)	Liquids (gals)	Gases (cu ft)
unprotected by sprinklers or cabinet	0	650	1	500	5,000	500	650
within cabinet in unsprinklered building	20	1,300	2	1,000	10,000	1,000	1,300
in sprinklered building, not in cabinet	0	1,300	2	1,000	10,000	1,000	1,300
in sprinklered building, within cabinet	40	2,600	4	2,000	20,000	2,000	2,600

1 lb = 0.4536 kg
1 gal= 3.7854 L
1 cu ft = 0.02832 m^3

Notes:

1. No exempt amounts are permitted in Group A, M, R and offices in Group B occupancies.
2. Except for cylinders not exceeding 20 cu ft stored within a gas storage cabinet or fume hood, no exempt amounts are permitted In Group E or I occupancies or in classrooms.
3. A conversion of 10 lbs/gal shall be used.
4. Compressed chlorine gas shall have an exempt amount of 810 cu ft.

309 INSTITUTIONAL OCCUPANCY - GROUP I

309.1 Group I Unrestrained Occupancy

Group I Unrestrained includes buildings or portions thereof used for medical, surgical, psychiatric, nursing, or custodial care on a 24 hour basis of six or more persons who are not capable of self-preservation and shall include among others:

Detoxification Facilities
Hospitals
Mental hospitals
Nursing homes (both intermediate care facilities and skilled nursing facilities).

Facilities such the above with five or less persons not ancillary to other uses shall be classified as a residential occupancy.

309.2 Group I Restrained Occupancy

Group I Restrained includes buildings or portions thereof which provide sleeping accommodations for six or more persons under some degree of restraint or security who are generally incapable of self-preservation due to security measures not under the occupant's control and shall include among others:

Correctional Institutions
Detention Centers
Jails
Reformatories

EXCEPTION: Group I Restrained qualifying for Use Condition 1 may be classified as a Group R occupancy.

310 MERCANTILE OCCUPANCY - GROUP M

310.1Scope

Group M occupancy is the use of a building or structure or any portion thereof, for the display and sale of merchandise including stocks of goods, wares or merchandise incidental to such purposes and accessible to the public and shall include, among others, the following:

Department stores
Drug stores
Markets
Retail stores
Sales rooms
Shopping centers
Wholesale stores (other than warehouses)

311 RESIDENTIAL OCCUPANCY - GROUP R

311.1 Scope

Group R occupancy is the use of a building or structure, or any portion thereof, for sleeping accommodations not classed as a Group I occupancy.

311.2 Subclassifications

Group R occupancies shall include, among others, the following:

R1 Residential occupancies where the occupants are primarily transient in nature including:

Boarding housing (transient)
Hotels
Motels

R2: Multiple dwellings where the occupants are primarily permanent in nature including:

Apartment houses
Convents
Fraternities and sororities
Monasteries
Rectories
Rooming houses (nontransient)
Dormitory facilities which accommodate six or more persons of more than 2 1/2 years of age who stay more than 24 hours.

R3: Residential occupancies including the following:

Child care facilities which accommodate five or less children of any age for any time period.
One and two family dwellings where the occupants are primarily permanent in nature and not classified a R1, R2, or I.
Rooming houses (transient).

312 STORAGE OCCUPANCY – GROUP S

312.1Scope

Group S occupancy is the principal use of a building or structure, or any portion thereof, for storage that is not classed as a Group H occupancy, including buildings or structures used for the purpose of sheltering animals. For buildings used for the storage of hazardous materials, see 308.

312.2 Subclassifications

312.2.1 S1 Moderate Hazard Storage shall include buildings used for the storage of combustible materials when not classified as S2 Low Hazard or Group H.

312.2.2 S2 Low Hazard Storage shall include buildings used for the storage of noncombustible materials such as products on wood pallets or in paper cartons without significant amounts of combustible wrappings. Such products may have a negligible amount of plastic trim such as knobs, handles, or film wrapping. S2 Low Hazard Storage shall include but not be limited to the following:

Beer or wine up to 12% alcohol in metal, glass or ceramic container
Cement in bags
Dairy products in nonwaxed coated paper containers
Dry cell batteries Dry inscctic1des Electric coils Electrical insulators Meats
Electrical motors
Empty cans
Fresh fruit and vegetable in nonplastic trays or containers
Foods in noncombustible containers
Frozen foods
Glass bottles, empty or filled with noncombustible liquids
Gypsum board
Inert Pigments
Metal cabinets
Metal desks with plastic tops and trim
Metal part
Mirrors
Oil filled and other types of distribution transformers
Stoves
Washers and dryers

312.2.3 Portions of Group S occupancy involving highly combustible, flammable or explosive products or materials shall be properly ventilated, protected and separated from the remainder of the building in accordance with the appropriate NFiPA Standard or the entire building will be classified as Group H occupancy.

CHAPTER 4

SPECIAL OCCUPANCY

401 GENERAL

401.1 Scope

Provisions of this chapter shall govern the design of buildings for specific occupancies as well as special occupancy types.

402 DEFINITIONS

The following words and terms shall, for the purposes of this chapter and as stated elsewhere in this code, have the meanings shown herein. Refer to Chapter 2 for general definitions.

DRY CLEANING - the process of removing dirt, grease, paints and other stains from wearing apparel, textiles, fabrics, rugs, or other materials by the use of nonaqueous liquids (solvents). It shall include the process of dyeing clothes or other fabrics or textiles in a solution of dye colors and nonaqueous liquid solvents.

DRY CLEANING SYSTEMS - dry cleaning plants or systems classified as follows:

Type I - those systems using Class I flammable liquid solvents having a flash point below 100°F (38°C).

Type II - those systems using Class II combustible liquid solvents having a flash point at or above 100°F (38°C) and below 140°F (60°C).

Type III - those systems using Class III combustible liquid solvents having a flash point at or above 140°F (60°C).

Type IV and Type V - those systems using Class IV nonflammable liquid solvents.

403 SPECIAL ASSEMBLY OCCUPANCIES

403.1General

403.1.1 Main Entrance. All buildings of Group A occupancy shall front directly upon at least one street or public space not less than 30 ft (9144 mm) wide, in which front shall be located a main entrance and exit of such building.

403.1.2 Occupant Content.

403.1.2.1 The area per occupant listed in Table 1003.1 shall not limit the occupant content of any floor area, providing the capacity of the exits serving that floor area is not exceeded. The occupant content shall be determined by the building official based on the egress width, in inches, for the spaces served, divided by the egress width per person as indicated in Table 1004. The occupant content shall not be more than the number determined by dividing the floor area by 5 sq ft (0.5 m2) per person.

403.1.2.2 Signs stating the maximum occupant content shall be conspicuously posted in each area of assembly, assembly room, auditorium or room used for a similar purpose. It shall be unlawful to remove or deface such notice or to permit more than this legal number of persons within such space or area. This number shall be determined by the building department based on this code.

403.1.2.3 Such signs shall read as follows:

OCCUPANT BY MORE THAN _____ PERSONS IS DANGEROUS AND UNLAWFUL.

_____ BUILDING OFFICIAL

403.1.3 Special Construction Requirements

403.1.3.1 Buildings of Group A - Large Assembly with a stage requiring proscenium opening protection shall be of Type I or II construction except that in auditoriums, ornamental wood, trusses and paneling may be of wood.

403.1.3.2 Buildings of Group A - Large Assembly without a stage requiring proscenium opening protection shall conform to the limitations of use prescribed in Table 500.

403.1.3.3 Buildings of Group A - Small Assembly shall conform to the limitations of use prescribed in Table 500.

403.1.3.4 Gymnasiums and similar occupancies may have running tracks constructed of wood or unprotected metal.

403.2 Stages and Platforms

403.2.1 Scope. Stages, platforms, sound stages and accessory spaces in assembly occupancies shall conform with the requirements of 403.2.

403.2.2 Definitions. For the purpose of this section, certain special terms are defined as follows:

FLYGALLERY - a raised floor area above a stage from which the movement of scenery and operation of other stage effects are controlled.

GRIDIRON - the structural framing over a stage supporting equipment for hanging or flying scenery and other stage effects.

PINRAIL - a rail on or above a stage through which belaying pins are inserted and to which lines are fastened.

PLATFORM - an area within a building used for entertainment or presentation wherein there are limited combustible materials or finishes.

PROSCENIUM WALL - the wall that separates the stage from the auditorium or house.

STAGE - a space within a building used for entertainment or presentations. Stage areas shall be measured to include the entire performance area and adjacent backstage and support areas not separated from the performance area by fire resistant rated construction. Stage height shall be measured from the lowest point on the stage floor to the highest point of the roof or floor deck above the stage.

403.2.3 Loads.

403.2.3.1 The design of platforms and stages shall comply with the requirements of Chapter 16. Provisions shall be made for the loads in 403.2.3.2 and Table 1604.1.

403.2.3.2 Assumed values for the following loads shall be clearly noted on construction documents submitted for approval:

Head block beams

Loft block beams

Gridiron, walk-on

Loading and fly galleries

Railings, channels or similar battens intended for mounting theatrical lighting

Pinrails and locking rails

403.2.4 Platform Construction.

403.2.4.1 Permanent platforms may be constructed of fire retardant treated wood for Types I, II, III, and IV construction where the platforms are not more than 30 inches (762 mm) above the main floor, and not more than 1/3of the room floor area and not more than 3,000 sq ft (279 m^2) in area. All other permanent platforms shall be constructed of materials as required for the type of construction of the building in which the permanent platform is located. When the space beneath the permanent platform is used for storage or any other purpose other than equipment, wiring or plumbing, the floor construction shall not be less than 1-hour fire resistant construction. When the space beneath the permanent platform is not used for any purpose other than equipment, wiring or plumbing, the underside of the permanent platform need not be protected.

403.2.4.2 Platforms installed for a period of not more than 30 days may be constructed of any materials permitted by the code. The space between the floor and the platform above shall only be used for plumbing and electrical wiring to platform equipment.

403.2.5 Stage Construction.

403.2.5.1 The minimum type of construction for stages shall be as required for the building as determined by the occupancy, area, and height except that the finish floor may be of wood in all types of construction.

403.2.5.2 All portions of a stage area with a stage height greater than 50 ft (15.2 m) shall be within an area separated from all other building areas by 2-hour fire resistant construction with protected openings except that the main opening in the proscenium wall used for viewing performances shall be provided with proscenium opening protection. The 2-hour fire resistant construction shall extend to the roof or floor deck above the auditorium.

403.2.5.3 Where permitted by the building construction type or where the stage is separated from all other areas as required in 403.2.5.2, the stage floor may be of unprotected noncombustible or heavy timber framing members with a minimum 1 1/2-inch (38.1 mm) thick wood deck.

403.2.5.4 Where a stage floor is required to have 1-hour fire resistance, the stage floor may be unprotected when the space below the stage is sprinklered throughout.

403.2.5.5 Where the stage height is 50 ft (15.2 m) or less, the stage area shall be separated from accessory spaces by 1-hour fire resistant construction with protected openings.

EXCEPTION: Control rooms and follow spot rooms may be open to the audience.

403.2.6 Accessory rooms. Dressing rooms, workshops, storerooms and other accessory spaces contiguous to stages shall be separated from each other and other building areas by 1-hour fire resistant construction and protected openings.

403.2.7 Ventilators. Emergency ventilation shall be provided for all stage areas greater than 1,000 sq ft (92.9 m^2) or with a stage height of greater than 50ft (15.2 m) to provide a means of removing smoke and combustion gases directly to the outside in the event of a fire.

Ventilation shall be by one or a combination of the following methods:

1. Smoke control: A means shall be provided to maintain the smoke level not less than 6 ft (1829 mm) above the highest level of assembly seating or above the top of the proscenium opening where a proscenium wall and opening protection is provided. The system shall be activated independently by each of the following: (1) Activation of the sprinkler system in the stage area and (2) by a manually operated switch at an approved location. The emergency ventilation system shall be connected to both normal and standby power. Fan power wiring and ducts shall be located and properly protected to assure a minimum 20 minutes of operation in the event of activation.

2. Roof vents: Two or more vents shall be located near the center of and above the highest part of the stage area. They shall be raised above the roof and provide a net free vent area equal to 5% of the stage area. Vents shall be constructed to open automatically by approved heat-activated devices. Supplemental means shall be provided for manual operation of the ventilator from the stage floor. Vents shall be labeled by an approved agency.

403.2.8 Proscenium Opening. The proscenium opening shall be protected by an approved fire curtain or an approved water curtain complying with NFiPA 13 (4-4.2.1). The fire curtain shall be designed to close automatically upon automatic detection of a fire and upon manual activation and shall resist the passage of flame and smoke for 20 minutes between the stage area and the audience area.

403.2.9 Gridiron, fly galleries and pinrails. Beams designed only for the attachment of portable or fixed theater equipment, gridirons, galleries and catwalks shall be constructed of materials consistent with the building type of construction and a fire resistance rating is not required.

EXCEPTION: Combustible materials shall be permitted for use as the floors of galleries and catwalks of all types of construction.

403.2.10 Flame Retardant Requirements. Combustible scenery of cloth, film, vegetation (dry), and similar effects shall meet the requirements of the Standard Fire Prevention Code. Foam plastics shall have a maximum heat release rate of 100 kW when tested in accordance with UL 1975.

403.3 Motion Picture Projection Rooms

403.3.1 The provisions of 403.3 shall apply where ribbon-type cellulose acetate or other safety film is used in conjunction with electric arc, xenon or other light source projection equipment which develops hazardous gases, dust or radiation. Where cellulose nitrate film is used, projection rooms shall be in compliance with the provisions of NFiPA 40, Chapter 6.

403.3.2 Every motion picture machine projecting film as mentioned in 403.3.1 shall be enclosed in a projection room. Appurtenant electrical equipment, such as rheostats, transformers and generators, may be within the projection room or in an adjacent room of equivalent construction.

403.3.3 There shall be posted on the outside of each projection room door and within the projection room itself a conspicuous sign with l-inch (25.4 mm) block letters stating: SAFETY FILM ONLY PERMITIED IN THIS ROOM.

403.3.4 Every projection room shall be of permanent construction consistent with the conjunction requirements for the type of building in which the projection room is located. Openings need not be protected.

403.3.5 The room shall have a floor area of not less than 80 sq ft (7.4 m^2) for a single machine, and at least 40 sq ft (3.7 m^2) for each additional machine. Each motion picture projector, floodlight, spotlight or similar piece of equipment shall have a clear working space not less than 30x30 inches (762x762 mm) on each side and at the rear thereof, but only one such space shall be required between two adjacent projectors.

403.3.6 The projection room and the rooms appurtenant thereto shall have a ceiling height of not less than 7 ft 6 in (2286 mm).

403.3.7 The aggregate of openings for projection equipment shall not exceed 25% of the area of the wall between the projection room and the auditorium or assemblage area. All such openings shall be provided with glass or other approved material so as to completely close the opening.

403.3.8 Projection booth ventilation shall be not less than indicated in 403.3.8.1 and 403.3.8.2.

403.3.8.1 Each projection room shall be provided with adequate air supply inlets so arranged as to provide well-distributed air throughout the room. Air inlet ducts shall provide an amount of air equivalent to the amount of air being exhausted by projection equipment. Air may be taken from the outside, from adjacent spaces within the building provided the volume and infiltration rate is sufficient, or from the building air conditioning system provided it is so arranged as to provide sufficient air when other systems are not in operation.

403.3.8.2 Projection booths may be exhausted through the lamp exhaust system. The lamp exhaust system shall be positively interconnected with the lamp so that the lamp will not operate unless there is the air flow required for the lamp. Exhaust air ducts shall terminate at the exterior of the building in such a location that the exhaust air cannot be readily recirculated into any air supply system. The projection room ventilation system may also serve appurtenant rooms such as the generator room and rewind room. Each projection machine shall be provided with an exhaust duct that will draw air from each lamp and exhaust it directly to the outside of the building. The lamp exhaust may serve to exhaust air from the projection room to provide room air circulation. Such ducts shall be of rigid materials, except for a flexible connector approved for the purpose. The projection lamp or projection room exhaust systems or both may be combined, but shall not be interconnected with any other exhaust or return system within the building.

403.3.9 A maximum of four containers of flammable liquids not greater than 16 oz (0.473 L) capacity and of a nonbreakable type may be permitted in each projection room.

403.4 Amusement Park Buildings

Amusement park buildings used as dining rooms, theaters, or for other purposes shall conform to the requirements of this code governing the particular use or occupancy.

403.5 Special Amusement Buildings

403.5.1 Scope. Special amusement buildings shall meet all the requirements of the appropriate assembly use group in addition to the requirements of 403.5. See 403.4.

EXCEPTION: Buildings or portions thereof that are essentially open to the outside air, such as buildings without walls or without a roof and arranged to prevent the accumulation of smoke in the building or structure, need not meet the requirements of 403.5.

403.5.2 Definitions. For the purpose of this section, certain special terms are defined as follows:

AMUSEMENT BUILDING, SPECIAL - any building or portion thereof , temporary, permanent or mobile used for amusement, entertainment, or educational purposes and which contains a device or system which conveys passengers or provides a walkway along, around, or over a course in any direction so arranged that the egress path is not readily apparent due to visual or audio distractions or is intentionally confounded or is not readily available due to the nature of the attraction or mode of conveyance through the building or structure.

403.5.3 Automatic Fire Detection System. An automatic fire detection system with smoke detectors shall be installed in all amusement buildings in conformance with 905.

EXCEPTION: In areas where the ambient conditions will cause a smoke detector to alarm, an approved alternate type of automatic fire detector shall be installed.

403.5.4 Sprinklers. All amusement buildings shall be provided throughout with an automatic sprinkler system in accordance with the standards listed in 903.2. When the special amusement building is temporary or mobile, the sprinkler water supply may be an approved temporary means.

EXCEPTION: An automatic sprinkler system is not required when the total floor area of a temporary special amusement building is less than 1,000 sq ft (93 m^2) and the travel distance from any point is less than 50 ft (15 m).

403.5.5 System Response.

403.5.5.1 The activation of the automatic fire detection system within a single protected area or the automatic sprinkler system shall automatically:

1. Cause illumination of the means of egress with light of not less than 1 foot-candle (10.8 lx) at the walking surface level, and
2. Stop any conflicting or confusing sounds and visual effects, and
3. Activate an approved directional exit marking that will become apparent in an emergency.

403.5.5.2 Activation of any single smoke detector, the automatic sprinkler system or any other automatic fire detection device shall immediately sound an alarm at the building at a constantly attended location from which emergency action can be initiated including the capability of manual initiation of 403.5.5.1(1) through 403.5.5.1(3).

403.5.5.3 A public address system installed in accordance with NFiPA 72 shall be provided and shall be audible throughout the entire amusement building.

403.5.6 Exit Illumination and Signs. Exit illumination and signs shall meet the requirements of 1016. Where mirrors, mazes or other designs are used that confound the means of egress path, approved low level exit signs and directional path markings shall be provided and located no more than 8 inches (203 mm) above the walking surface on or near the egress path.

403.6 Reviewing Stands, Grandstands And Bleachers

403.6.1 Scope. Reviewing stands, grandstands and bleachers shall conform to the provisions of this section. See 202 for definitions.

403.6.2 Grandstands and Bleachers.

403.6.2.1 Grandstands and bleachers may be of the types of construction permitted for Group A occupancy (no stage requiring proscenium opening protection) shown in Table 500. There shall not be more than three seating terraces or balconies in a single story.

EXCEPTION: Open air grandstands and bleachers of Type I, II, or IV construction shall not be limited in height or area.

403.6.2.2 When s paces under grandstands or bleachers are used for purposes other than toilet rooms, ticket booths less than 100 sq ft (9.29 m^2) in area, and open ramps or level exiting facilities, such spaces shall be separated by not less than 1-hour fire resistant construction.

403.6.2.3 The highest level of seat platforms of any grandstand or bleacher having a combustible structural frame of less than heavy timber sizes shall be not more than 20ft (6096 mm). See 605.

403.6.2.4 Combustible material may be used for seatboard, toeboards, bearing or base pads or footboards.

404 SPECIAL BUSINESS OCCUPANCIES

404.1 High Rise

Provisions for Group B high rise buildings are contained in 412.

404.2 Automotive Service Station

404.2.1 An automotive service station of Group B occupancy is a place of retail business at which outdoor automotive refueling is carried on using fixed dispensing equipment connected to storage tanks by a closed system of piping and/or at which goods and services generally required in the operation and maintenance of motor vehicles and fulfilling of motorist needs may also be available. The building consists of a sales office where automotive accessories and packaged automotive supplies may be kept or displayed. It may also include one or more service bays in which vehicle washing, lubrication and minor replacement, adjustment and repair services are rendered. An automobile service station building shall not have a basement, but may have open pits if such pits are continually ventilated. It may be of any construction type.

404.2.2 Canopies and their supports over pumps shall be of noncombustible materials, wood of Type III sizes, or of construction providing 1-hour fire resistance. Combustible materials used in or on a canopy shall be:

1. Shielded from the pumps by a noncombustible element of the canopy, or wood of Type III sizes, or
2. Approved plastics covered by an aluminum facing having a minimum thickness of 0.020 inch (0.51 mm) or corrosion-resistant steel having a minimum base metal thickness of 0.016 inch (0.41 mm). The approved plastic shall have a flamespread rating of 25 or less when tested in the form intended for use in accordance with ASTM E 84

404.2.3 Pumps or other dispensing devices shall be located a minimum of 10 ft (3048 mm) from a property line and from any building of Type VI construction. Pumps shall be located so the nozzle, with hose fully extended, shall not reach within 5 ft (1524 mm) of any building opening.

404.2.4 Pumps installed above grade shall be mounted on a concrete foundation and protected against vehicle damage by mounting on a concrete island or other approved collision protection. Subsurface pumps shall be installed in accordance with approved standards.

404.2.5 Storage and handling of flammable and combustible liquids shall be in accordance with the Standard Fire Prevention Code.

404.2.6 The pump motor shall be activated by a switch that cannot be energized until after the hose nozzle has been removed from its boot. The motor shall stop operating when the switch is de-energized upon replacement of the hose nozzle in its boot.

404.2.7 A clearly labeled, manually operated pump master switch shall be provided in an approved location, readily accessible to the station attendant.

404.3 Bowling Alleys

404.3.1 Where bowling pin finishing or refinishing operations are carried on, a separate building, or a separate room, constructed as specified herein, shall be provided. Finishing or refinishing operations shall comply with Chapter 11 of the Standard Fire Prevention Code.

404.3.1.1 Such a room shall be located at or above street level and shall have one or more windows opening to the outside of the building.

404.3.1.2 Walls and ceilings of such rooms shall have not less than 1-hour fire resistance. Floors shall be of concrete at least 2 inches (51 mm) thick or equivalent noncombustible protective material. Walls shall be liquid tight where they meet the floor.

404.3.1.3 Door openings shall be provided with noncombustible sills raised 6 inches (152 mm) above floor level and protected with approved fire door.

404.3.1.4 Shelving, containers, and all furnishings shall be of noncombustible material. Machinery shall be effectively grounded.

404.3.1.5 Ventilation sufficient to effect a complete change of air at least once every 3 minutes shall be provided.

404.4 Automotive Lubrication Service Facility

404.4.1 An automotive lubrication service facility of Group B occupancy is a place of retail business at which the periodic servicing of automotive equipment is accomplished by the removal and/or replacement of oils, fluids, filters, greases and minor parts necessary for the maintenance and upkeep of vehicles normally used for transportation on the public roads and highways. These facilities may include provisions for the tuning of engines.

404.4.2 An automotive lubrication service facility may have a basement or underfloor work and storage area whereby access may be gained to portions of vehicles being serviced through openings in the floor complying with 705.2.1.1. A basement or underfloor work area shall be continuously ventilated to the outside air by fans supplying not less than six air changes per hour.

404.4.3 Facilities dispensing gasoline or motor fuel shall meet the requirements of 404.2.

405 SPECIAL EDUCATIONAL OCCUPANCIES

405.1Special Protective Requirements

Where permanent motion picture projectors using cellulose nitrate film are installed, booths shall be provided, as set forth in 403.3.

405.2 Public Schools

Every heating appliance which produces an unprotected open flame shall be prohibited. Fossil fuel furnace rooms, fuel rooms, and boiler rooms shall be separated by 2 hour rated construction. Door openings shall be to the exterior and all penetrations to the interior of the building shall be protected.

405.3 Subdivision of Building Spaces

405.3.1 Educational buildings shall be subdivided into compartments by smoke barriers having a 1-hour fire resistance rating where:

1. The maximum area of a compartment, including the aggregate area of all floors having a common atmosphere, exceeds 30,000 sq. ft. (2,800m2); or
2. The length or width of the building exceeds 300 feet (91 m).

   EXCEPTIONS:

   1. Where all spaces normally subject to student occupancy have at least one door opening directly to the outside.
   2. Buildings that consist of only one story and are protected throughout by an approved, supervised automatic sprinkler system.

405.3.2 The maximum area of a smoke compartment shall not exceed 30,000 sq. ft. (2,800 m^2) with no dimension exceeding 300 feet (91 m).

EXCEPTION: In buildings protected throughout by a supervised, automatic sprinkler system, there is no maximum sized smoke compartment, provided that the floor is divided into a minimum of two smoke compartments.

406 SPECIAL FACTORY-INDUSTRIAL OCCUPANCIES

No requirements for special Group F buildings are currently contained in this code.

407 SPECIAL HAZARDOUS OCCUPANCIES

407.1 Special Requirements

407.1.1 General.

407.1.1.1 Storage, dispensing, handling and use of solid, liquid and gaseous hazardous materials shall be in accordance with this section and the Standard Fire Prevention Code.

407.1.1.2 An increase in the allowable areas or heights as set forth in Table 500 shall not be permitted when the principal use of the building or structure is a hazardous occupancy or the building or structure is classified as a hazardous occupancy.

407.1.2 Definitions. For the purpose of this section, certain special terms are defined as follows:

AEROSOL – a product that is dispensed from an aerosol container by a propellant and is categorized as follows:

Level 1 Aerosol Products - Aerosol products whose base contains up to 25% by weight of water miscible or water immiscible materials with a flash point of 500°F (260°C) or less.

Level 2 Aerosol Products - Aerosol products shall be classified as Level 2 where base products contain:

1. More than 25% by weight of water miscible materials with a flash point of 500°F (260°C) or less.
2. More than 25%, but no more than 55%, by weight of water immiscible materials with a flash point of 500°F (260°C) or less.

Level 3 Aerosol Products - Aerosol products shall be classified as Level 1 when containing:

1. Base products exceeding 55% by weight of water immiscible materials with a flash point of 500°F (260°C) or less, or
2. A flammable propellant that equals or exceeds 80% of the net weight of the container contents.

AEROSOL CONTAINER – metal cans, glass or plastic bottles designed to disperse an aerosol. Metal cans shall be limited to maximum size of 33.8 fl oz (1.0 L). Glass or plastic bottles shall be limited to a maximum size of 4 fl oz (0.128 L).

CEILING LIMIT - the maximum concentration of an airborne contaminant to which one may be exposed before the contaminant becomes a health hazard. The ceiling limits utilized are to be those published in OSHA 29 CFR 1910.1000.

COMBUSTIBLE FIBERS – any readily ignitable and free-burning fibers, such as cotton, sisal, henequen, ixtle, jute, hemp, tow, cocoa fibers, oakum, rags, waste, cloth, wastepaper, kapok, hay, straw, Spanish moss, excelsior, and other like materials.

CONTINUOUS GAS DETECTION SYSTEM – a gas detection system where the analytical instrument is maintained in continuous operation and sampling is performed without interruption or at intervals not to exceed 30 minutes.

CONTROL AREA – space within a building where the exempt amounts of hazardous materials may be stored, dispensed, used or handled.

CORROSIVE – a chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. A chemical is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described by the U .S. Department of Transportation in Appendix A to CFR 49 Part 173, it destroys or changes irreversibly the structure of the tissue at the site of contact following an exposure period of four hours. This term shall not refer to action on inanimate surfaces.

CYLINDER – a pressure vessel designed for pressures higher than 40 psi (276 kPa) and having a circular cross section. It does not include a portable tank, multi-unit tank car tank, cargo tank or tank car.

DEFLAGRATION – an exothermic reaction, such as the extremely rapid oxidation of a flammable dust or vapor in air, in which the reaction progresses through the unburned material at a rate less than the velocity of sound. A deflagration can have an explosive effect.

DETACHED STORAGE – storage in a separate building or in an outside area located away from all structures.

DETONATION – an exothermic reaction characterized by the presence of a shock wave in the material which established and maintains the reaction. The reaction zone progresses through the material at a rate greater than the velocity of sound. The principal heating mechanism is one of shock compression. Detonations have an explosive effect.

DISPENSING – the pouring or transferring of any material from a container, tank or similar vessel whereby vapors, dusts, fumes, mists or gases may be liberated to the atmosphere.

DUST – pulverized particles which, if mixed with air in the proper proportions, become explosive and may be ignited by a flame, spark or other source of ignition.

EMERGENCY RESPONSE RECOVERY KIT – a chlorine emergency kit designed to contain leaks in chlorine containers. A kit operates by containing valve leaks with hoods and gaskets or providing sealing devices for small holes in side walls. The kit shall be capable of containing all remaining chlorine in the cylinder.

EXCESS FLOW CONTROL – a fail-safe system designed to shut off flow due to a rupture in pressurized piping systems.

EXHAUSTED ENCLOSURE – power-ventilated equipment of varying dimensions and construction provided to enclose or accommodate a gas or vapor use or filling operation and to confine and limit the escape of gas or vapors and to exhaust them safely. The exhausted enclosure is not required to be totally enclosed.

EXPLOSION – an effect produced by the sudden violent expansion of gases, which may be accompanied by a shockwave or disruption, or both, of enclosing materials or structures. An explosion may result from:

1. chemical changes such as rapid oxidation, deflagration or detonation, decomposition of molecules and runaway polymerization (usually detonations);
2. physical changes (e.g., pressure tank ruptures); or
3. atomic changes (nuclear fission or fusion).

FLAMMABLE SOLID – a solid substance, other than one which is defined as a blasting agent or explosive, that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or as a result of retained heat from manufacture, or which has an ignition temperature below 212°F (100°C), or which burns so vigorously or persistently when ignited so as to create a serious hazard.

HAZARDOUS MATERIALS – those chemicals or substances which are physical hazards or health hazards as defined and classified in 407 whether the materials are in usable or waste condition.

HEALTH HAZARD – a classification of a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed persons. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes.

HIGHLY TOXIC MATERIAL – a material which produces a lethal dose or lethal concentration which falls within any of the following categories:

1. A chemical that has a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

2. A chemical that has a median lethal dose (LD_{50}) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
3. A chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

Mixtures of these materials with ordinary materials, such as water, may not warrant a classification of highly toxic. Any hazard evaluation which is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.

HIGHLY VOLATILE LIQUID – a liquid with a boiling point of less than 68°F (20°C).

IDLH (Immediately Dangerous to Life and Health) – a concentration of airborne contaminant, normally expressed in parts per million (ppm) or milligrams per cubic meter, which represents the maximum level from which one could escape within 30 minutes without any escape-impairing symptoms or irreversible health effects. This level is established by the National Institute of Occupational Safety and Health (NIOSH). If adequate data does not exist for precise establishment of IDLH data, an independent certified Industrial Hygienist, Industrial Toxicologist, or appropriate regulatory agency shall make such determination.

IMMISCIBLE – not capable of forming a solution or dispersion with another component.

IRRITANT – a chemical which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. A chemical is a skin irritant if, when tested on the intact skin of albino rabbits by the methods of CPSC 16 CFR 1500.41 for four hours exposure or by other appropriate techniques, it results in an empirical score of 5 or more. A chemical is an eye irritant if so determined under the procedure listed in CPSC 16 CFR 1500.42 or other appropriate techniques.

MISCIBLE – capable of forming a solution or dispersion with another component.

ORGANIC PEROXIDE – an organic compound that contains the bivalent-0-0-structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms have been replaced by an organic radical. Organic peroxides may present an explosion hazard (detonation or deflagration) or they may be shock sensitive. They may also decompose into various unstable compounds over an extended period of time.

OXIDIZER – a chemical other than a blasting agent or explosive that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

PERMISSIBLE EXPOSURE LIMIT (PEL) – the maximum permitted 8-hour time weighted average concentration of an airborne contaminant. The maximum permitted time weighted average exposures to be utilized are those published in OSHA 29 CFR 1910.1000.

PHYSICAL HAZARD – a classification of a chemical for which there is scientifically valid evidence that it is a combustible liquid, compressed gas, cryogenic, explosive, flammable gas, flammable liquid, flammable solid, organic peroxide, oxidizer, pyrophoric, unstable (reactive) or water reactive material.

PRIMARY CONTAINMENT – the first level of containment, i.e., the inside portion of that container which comes into immediate contact on its inner surface with the material being contained.

PROPELLANT – a liquified or compressed gas that expels the contents from an aerosol container when the valve is actuated.

PYROPHORIC – a chemical that will spontaneously ignite in air at or below a temperature of 130°F (54°C).

REACTIVE MATERIALS – those materials which can enter into a hazardous chemical reaction with other stable or unstable materials.

SECONDARY CONTAINMENT – the level of containment that is external to and separate from primary containment.

SECURE – safe from intrusion or contained separately to prevent mixing with other materials.

SENSITIZER – a chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

SEPARATE GAS STORAGE ROOM – a separate enclosed area which is part of or attached to a building and is utilized for the storage of toxic or highly toxic compressed or liquefied gases.

TANK– a vessel containing more than 60 gallons (227 L).

TANK, PORTABLE – any packaging over 60 U.S. gallons (227 L) capacity and designed primarily to be loaded into or on or temporarily attached to a transport vehicle or ship and equipped with skids, mounting or accessories to facilitate handling of the tank by mechanical means. It does not include any cylinder having less than a 1,000 lb (454 kg) water capacity, cargo tank, tank car tank or trailers carrying cylinders of over 1,000 lbs (454 kg) water capacity.

TANK, STATIONARY – any packaging designed primarily for stationary installations not intended for loading, unloading or attachment to a transport vehicle as part of its normal operation in the process of use. It does not include cylinders having less than 1,000 lb (454 kg) water capacity.

TOXIC MATERIAL – material which produces a lethal dose or a lethal concentration within any of the following categories:

1. A chemical or substance that has a median lethal dose (LD_{50}) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each .
2. A chemical or substance that has a median lethal dose (LD_{50}) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.
3. A chemical or substance that has a median lethal concentration (LC_{50}) in air more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

Mixtures of these materials with ordinary materials such as water may not warrant a classification of highly toxic. Any hazard evaluation which is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.

UNSTABLE (Reactive) MATERIALS – those materials, other than explosives, which in the pure state or as commercially produced will vigorously polymerize, decompose, condense or become self-reactive and undergo other violent chemical changes, including explosion, when exposed to heat, friction or shock, or in the absence of an inhibitor or in the presence of contaminants or in contact with noncompatible materials.

407.1.3 Automatic Protection Systems.

407.1.3.1 General. Indoor storage areas, storage buildings, and areas or rooms in which hazardous materials are dispensed or used shall be protected by an approved automatic sprinkler system. The design of the sprinkler system shall be not less than ordinary hazard, Group 3 in accordance with NFiPA 13. For areas of sprinkler operation of less than 3,000 sq ft (279 m^2) a density for 3,000 sq ft (279 m^2) shall be used.

EXCEPTIONS:

1. Detached storage buildings storing oxidizers and organic peroxides when meeting the separation distances and storage requirements of the Standard Fire Prevention Code.
2. Approved alternate automatic fire extinguishing systems may be used in indoor storage and dispensing rooms or areas.

407.1.3.2 Water Reactive Materials. Where Class 3 water reactive materials are stored in areas protected by an approved automatic sprinkler system, the materials shall be stored in closed, watertight container.

407.1.3.3 Highly Toxic and Toxic Compressed Gas. Gas cabinet and exhausted enclosures for the storage of cylinders shall be internally sprinklered. Alternate fire extinguishing systems shall not be permitted for either storage areas, gas cabinets, or exhausted enclosures. An automatic sprinkler system shall be provided for roof structures provided for the storage of highly toxic or toxic compressed gases.

EXCEPTION: Requirements for sprinkler systems shall not apply to compressed chlorine gas cylinders for water systems installed in buildings or rooms of Type I or Type II construction. No storage of combustible materials shall be allowed in the areas of chlorine storage

407.1.3.4 Highly Toxic Solids and Liquids. Exterior storage of highly toxic solids and liquids shall be in fire resistant containers or shall comply with one of the following:

1. The storage area shall be protected by an automatic, open head, deluge system of the type and density specified in NFiPA 13: or
2. Storage shall be located under a roof structure of noncombustible construction, with the area under the roof protected by an automatic fire extinguishing system.

407.1.3.5 Laboratory Fume Hoods. Laboratory fume hoods and spray booths where flammable materials are used shall be protected by an automatic sprinkler system

407.1.3.6 Vehicle Loading Racks and Exterior Storage. Flammable hazardous materials dispensing or use areas located within 50 ft (15.2 m) of either a storage area or building, and vehicle loading racks where flammable hazardous materials are dispensed, shall be protected by an approved automatic fire extinguishing system.

407.2 Storage and Dispensing Areas

407.2.1 General. This division shall apply to the storage and dispensing of hazardous materials in excess of the exempt amounts specified in Tables 308.2A through 308.2D.

EXCEPTIONS:

1. Hazardous materials regulated by other chapters in the Standard Fire Prevention Code unless specifically indicated in 407.4 through 407.17.
2. All indoor storage of liquid and solid oxidizers, organic peroxides, unstable (reactive) and water reactive materials shall be as specified in 407.4 through 407.17.

407.2.2 Explosion Venting or Explosion Suppression.

Indoor storage or dispensing areas and buildings shall be provided with explosion venting, equivalent explosion protective devices, explosion suppression systems, or barricades. Areas which are provided with explosion venting shall comply with the following:

1. Walls, ceilings and roofs exposing another occupancy or use shall be designed to resist a minimum internal pressure of 100 psf (4.79 kPa).
2. Explosion venting shall be permitted only in exterior walls or roofs or through specially designed shafts to the exterior of the building. Discharge shall be in the direction of least exposure and not into the interior of the building.
3. Venting shall be designed to prevent serious structural damage and the production of projectiles.
4. The aggregate clear vent relief area shall be governed by the pressure resistance of the nonrelieving portions of the building.
5. Vents shall be designed to relieve at a maximum internal pressure of 20 psf (958 Pa).
6. Venting devices shall discharge directly to the open air or to an unoccupied space not less than 50 ft (15 m) in width on the same lot.
7. Relieving devices shall be so located that the discharge end shall be not less than 10 ft (3048 mm) vertically and 20 ft (6096 mm) horizontally from window openings or exits in the same or adjoining buildings or structures.

EXCEPTIONS TO 407.2.2:

1. Storage areas and storage buildings storing Class 1, 2, or 3 oxidizers, Class II, III, or IV organic peroxides, highly toxic or toxic solids and liquids, corrosive materials, irritants, sensitizers or health hazard solids, liquids and gases.
2. When process vessels are designed to fully contain the worst case explosion anticipated within the vessel under process conditions considering the most likely failure.

407.2.3 Spill Control, Drainage, and Containment.

407.2.3.1 General. Rooms, buildings or areas used for the storage or dispensing of solid or liquid hazardous materials shall be provided with a means to control spillage and to contain or drain spillage and fire protection water discharged in the storage area. A means to control spillage shall be provided in open systems in which dispensing is done into containers exceeding 1 gal (3.79 L) capacity, or used in open containers or systems exceeding 5 gal (18.9 L) capacity, or in closed systems exceeding 55 gal (208.2 L) capacity.

EXCEPTION: Spill control, drainage, and containment shall not be required for the storage of highly toxic and toxic compressed gases or flammable solids.

407.2.3.2 Spill Control. Floors shall be recessed a minimum of 4 inches (102 mm) or shall be provided with a liquidtight, raised sill to a minimum height of 4 inches (102 mm) so as to prevent the flow of liquids to adjoining areas. When liquidtight sills are provided, they may be omitted at door openings with the installation of an open grate trench at door openings which connects to the room drainage system.

407.2.3.3 Drainage. The room, building or area shall be provided with a drainage system which directs the flow of liquids to an approved location, or provides secondary containment, and meets the following requirements:

l. Not less than a 1% floor slope to the drain shall be provided.
2. Drains from the area shall be sized to carry the automatic fire extinguishing system design flow rate over the system design area.
3. Materials of construction for the drainage system shall be compatible with the stored materials.

4. Incompatible hazardous materials shall have separate drain systems. Drain systems may be combined when incompatible hazardous materials have been rendered acceptable by an approved means.
5. Drainage of spillage and fire protection water may be directed to a neutralizer or treatment system. Such system shall comply with the following:
   1. The system shall be designed to handle the maximum worst case spill from the single largest container plus the volume of fire protection water from the system over the minimum design area for a period of 20 minutes.
   2. Overflow from the neutralizer or treatment system shall not be permitted.

407.2.3.4 Secondary Containment.

1. Secondary containment shall be provided in indoor storage rooms and areas containing liquid or solid oxidizers and organic peroxides. Secondary containment shall be provided in indoor and exterior storage of pyrophoric liquids, unstable materials, water reactive materials, highly toxic and toxic solids and liquids, corrosives, irritants, sensitizers and health hazard solids, liquids and gases. Secondary containment in closed system dispensing areas shall be provided when the aggregate of multiple tanks or containers exceeds 1,000 gals (3785 L). In open system dispensing areas, secondary containment shall be provided when the capacity of an individual container exceeds 55 gals (208.2 L) or the aggregate of multiple containers exceeds 100 gals (378.5 L).
2. Drains shall be directed to a containment system or other location designed as secondary containment for the hazardous material liquids and fire protection water; or the building, room or area shall be designed to provide secondary containment of hazardous material liquids and fire protection water through the use of recessed floors or liquidtight raised sills.
3. Secondary containment shall be designed to retain the spill from the largest single container plus the design flow rate of the automatic fire extinguishing system for the area of the room or area in which the storage is located or the system design area, whichever is smaller. The containment capacity shall be capable of containing the flow for a period of 20 minutes.
4. Overflow from the secondary containment system shall not be permitted.
5. If the storage area is open to rainfall, the secondary containment shall be designed to accommodate the volume of a 24-hour rainfall as determined by the 25 year storm. When curbs are used, provisions shall be made for draining accumulations of groundwater and rainwater. A visual monitoring method capable of detecting hazardous material leakage from the primary containment into the secondary containment shall be provided. Where secondary containment may be subject to the intrusion of water, a monitoring method for such water shall be provided. Whenever monitoring devices are provided, they shall be connected to distinct visual and audible alarms.

407.2.3.5 Underground Tanks. Underground tanks containing hazardous materials shall be located and protected in accordance with applicable chapters of the Standard Fire Prevention Code. Secondary containment shall be provided for all underground tanks.

407.2.4 Ventilation.

407.2.4.1 Indoor storage areas and storage buildings shall be provided with mechanical exhaust ventilation.

EXCEPTIONS:

1. Mechanical exhaust ventilation shall not be required for flammable solid storage areas.
2. Where natural ventilation can be shown to be acceptable for the materials as stored.

407.2.4.2 Exhaust ventilation systems shall comply with the following:

1. Installation shall be in accordance with the provisions of the Standard Mechanical Code.

2. Mechanical ventilation shall be at a rate of not less than 1 cfm per sq ft ($0.005 l/m^3/s/m^2$) of floor area over the storage area.
3. Systems shall operate continuously.
4. A manual shutoff control shall be provided outside the room adjacent to the access door into the room or in a location approved by the building official. The switch shall be of the break-glass type and shall be labeled VENTILATION SYSTEM EMERGENCY SHUTOFF.

   EXCEPTION: A manual shutoff control is not required when the ventilation system is equipped with a means for automatic shutdown of the system under fire conditions.
5. Exhaust ventilation shall be arranged to consider the density of the potential fumes or vapors released. For fumes or vapors that are heavier than air, exhaust shall be taken from a point within 12 inches (305 mm) of the floor.
6. The location of both the exhaust and inlet air openings shall be arranged to provide air movement across all portions of the floor or room to prevent the accumulation of vapors.
7. Exhaust ventilation shall not be recirculated within the room or building.

407.2.5 Alarm and Detection.

407.2.5.1 Emergency Alarm. A local manual fire alarm box or approved emergency signal device shall be installed outside of each interior egress door to a storage room. Activation of the fire alarm box or emergency signal device shall sound a local audible alarm. When solids, liquids or gases which have a degree of hazard rating in health, flammability or reactivity of 3 or 4 as ranked by NFiPA 704 are transported through exit or exit access corridor, there shall be an emergency telephone system, a local manual fire alarm box or an approved emergency signal device at not more than 150 ft (45.7m) intervals and at each exit doorway throughout the transport route. Activation of a telephone, fire alarm box or emergency signal device shall initiate a local audible alarm.

407.2.5.2 Smoke Detection. Activation of the detection system shall sound a local alarm. An approved smoke detection system installed in accordance with 905 shall be provided in:

1. Rooms or areas where highly toxic compressed gases, liquid or solid oxidizers, or unclassified detonable, Class I or Class II organic peroxides are stored.
2. Where Class III or Class IV organic peroxides are stored in quantities exceeding the exempt amounts specified in Table 407.2.5.

   EXCEPTION: A smoke detection system shall not be required in detached storage buildings, storing those oxidizers and organic peroxides listed above, if such buildings are provided with an automatic fire extinguishing system.

407.2.5.3 Supervision. When alarm, emergency signal, detection or automatic fire extinguishing systems are required, such systems shall be supervised by an approved central station, proprietary or remote station service or shall initiate an audible and visual signal at a constantly attended on-site location.

Table 407.2.5[1,2]
Exempt Amounts of Organic Peroxides (lb)

Condition	UD	I	II	III	IV
Unprotected by sprinklers or cabinets	0	5	50	125	500
Within cabinets in unsprinklered building	0	10	100	250	1,000
In sprinklered building, not in cabinet	1	10	100	250	1,000
In sprinklered building, within cabinet	2	20	200	500	2,000

1 lb = 0.4536 kg UD = Unclassified Detonatable

NOTES:

1. For organic peroxide liquids, a conversion of 10 lbs/gal shall be used.
2. Except for laboratories In Group B occupancies, organic peroxides are not permitted in Group A, B, E, I, M and R occupancies.

407.2.6 Floors.

407.2.6.1 General. Except for surfacing, floors of storage areas shall be impervious to the material stored.

407.2.6.2 Liquidtight Floor. Floors of storage areas shall be of liquidtight construction.

EXCEPTION: Areas storing explosives and blasting agents, highly toxic and toxic compressed gases, flammable solids, unstable gases, and cryogenics.

407.2.7 Weather Protection.

407.2.7.1 Insulated Roof. Roofs of liquid and solid oxidizers, organic peroxides, and unstable (reactive) material storage areas shall be insulated to maintain the permissible temperature range of the material stored.

407.2.7.2 Roof Structures. When roofs are provided for sheltering exterior hazardous material storage areas, such storage shall not be considered indoor storage when all of the following conditions are met:

1. Maximum size of roof structure areas shall not exceed 1,500 sq ft ($139m^2$).
2. Roof supports and walls shall not obstruct more than one side of the perimeter of the storage area.
3. The distance from the roof structure and the roof supports to buildings, property lines, streets, alleys, public ways or exits to a public way shall be not less than the distance required for an exterior hazardous material storage area without a roof.

407.2.8 Smoke and Heat Venting. Areas storing liquid and solid oxidizers, organic peroxides, unstable (reactive) materials or water reactive materials shall be provided with means to vent smoke and heat in a fire or other emergency. Smoke and heat venting shall be designed in accordance with Chapter 36 of the Standard Fire Prevention Code.

407.2.9 Electrical Wiring and Equipment.

407.2.9.1 General. Electrical wiring and equipment shall be installed in accordance with NFiPA 70.

407.2.9.2 Hazardous Locations. Electrical wiring and equipment for indoor and exterior storage areas for Unclassified Detonatable, Class I, II or III organic peroxides, and pyrophoric gases and liquids shall comply with the requirements for Class I, Division 2, Group D locations. The interior of any refrigerator or freezer cabinet used for the storage of Unclassified Detonatable, Class I, II or III organic peroxides shall comply with the requirements for Class I, Division l, Group D locations.

407.2.9.3 Static Accumulation. When processes or conditions exist where a flammable mixture may be ignited by static electricity, means shall be provided to prevent the accumulation of a static charge in accordance with NFiPA 77.

407.2.9.4 Standby Power. A standby system installed in accordance with NFiPA 70 shall be connected to the following:

1. mechanical ventilation systems,
2. treatment systems,
3. temperature controls,
4. alarm systems,
5. detection systems,
6. emergency illumination in accordance with 1016.1.2
7. other electrically operated systems.

   EXCEPTIONS:

   l. Areas storing Class 1 or 2 oxidizers, or Class III or IV organic peroxides.

   2. When highly toxic compressed gases or highly toxic, highly volatile liquids are used or dispensed, emergency power shall be provided in lieu of standby power on all required systems in accordance with NFiPA 70.

407.2.10 Identification. Visible hazard identification signs as specified in NFiPA 704 shall be placed at all entrances to locations where hazardous materials are stored, dispensed, used or handled in quantities in excess of the exempt amounts.

407.2.11 Security. Dispensing, use and handling areas shall be secured against unauthorized entry. Storage areas of highly toxic and toxic compressed gases shall also be secured against unauthorized entry.

407.3 Dispensing, Use And Handling

When the amount of hazardous materials dispensed or used in one control area exceeds that specified in Tables 407.3A and 407.3B, such dispensing or use shall either be located in a room or area constructed in accordance with the provisions for a hazardous occupancy or located in an exterior dispensing, use or handling area located in accordance with the exterior storage provisions of 407.4 through 407.17.

EXCEPTION: Hazardous materials regulated by the Standard Fire Prevention Code.

Table 407.3A
Exempt Amounts of Hazardous Materials: Physical Hazard
(Maximum Quantities Per Control Area[7])

Material	Class	Closed Systems			Open Systems	
		Solid lbs or (cu ft)	Liquid gal or (lbs)	Gas cu ft	Solid lbs or (cu ft)	Liquid gal or (lbs)
Combustible Liquid	II	---	120[1]	---	---	30[1]
	IIIA	---	330[1]	---	---	80[1]
	IIIB	---	13,200[2]	---	---	3,300[2]
Combustible Dust lbs/1000 cu ft		1[3]	---	---	1[3]	---
Combustible Fiber	Loose	(100)	---	---	(20)	---
	Baled	(1,000)	---	---	(200)	---
Cryogenics (Flammable or Oxidizing)		---	45[1]	---	---	10[1]
Explosives		1/4[4]	(1/4)[4]	---	1/4[4]	(1/4)[4]
Flammable Gas	Gaseous	---	---	750[1,5]	---	---
	Liquified	---	15[1,5]	---	---	---
Flammable Liquid	IA	---	30[1]	---	---	10[1]
	IB	---	60[1]	---	---	15[1]
	IC	---	90[1]	---	---	20[1]
Combination IA, IB, IC		---	120[1,6]	---	---	30[1,6]
Flammable Solid		25[1]	---	---	25[1]	---
Organic Peroxide	UD	1/4[4]	(1/4)[4]	---	1/4[4]	(1/4)[4]
	I	1[1]	(1)[1]	---	1[1]	(1)[1]
	II	50[1]	(50)[1]	---	10[1]	(10)[1]
	III	125[1]	(125)[1]	---	25[1]	(25)[1]
	IV	500[1]	(500)[1]	---	100[1]	(100)[1]
	V	NL	NL	---	NL	NL
Oxidizer	4	1/4[4]	(1/4)[4]	---	1/4[4]	(1/4)[4]
	3	2[1]	(2)[1]	---	2[1]	(2)[1]
	2	250[1]	(250)[1]	---	50[1]	(50)[1]
	1	1,000[1]	(1,000)[1]	---	200[1]	(200)[1]
Oxidizer-Gas	Gaseous	---	---	1,500[1,5]	---	---
	Liquified	---	15[1,5]	---	---	---
Pyrophoric		1[4]	(1)[4]	10[4,5]	0	0
Unstable (reactive)	4	1/4[4]	(1/4)[4]	2[4,5]	1/4[4]	(1/4)[4]
	3	1[1]	(1)[1]	10[1,5]	1[1]	(1)[1]
	2	50[1]	(50)[1]	250[1,5]	10[1]	(10)[1]
	1	125[2]	(125)[2]	750[1,5]	25[2]	(25)[2]
Water Reactive	3	5[1]	(5)[1]	---	1[1]	(1)[1]
	2	50[1]	(50)[1]	---	10[1]	(10)[1]
	1	125[2]	(125)[2]	---	25[2]	(25)[2]

1 lb = 0.4536 kg
1 gal= 3.7854 L
1 cu ft = 0.02832 m^3

- Not applicable.
NL = Not limited.
UD = Unclassified detonatable.

Notes:

1. The amount may be doubled in sprinklered buildings.
2. The quantities permitted in a sprinklered building are not limited.
3. A dust explosion potential is considered to exist if 1 lb or more of combustible dust per 1,000 cu ft of volume is normally in suspension or could be put into suspension in all or a portion of an enclosure, including dust inside pieces of equipment. This also includes combustible dust which accumulates on horizontal surfaces inside buildings or equipment and which could be put into suspension by an accident, sudden force, or small explosion.
4. Permitted in sprinklered buildings only. No amount is allowed in unsprinklered buildings.
5. The amount may be doubled when dispensed or used inside approved exhausted gas cabinets, exhausted enclosures, or fume hoods. When footnote 1 also applies, the increase for both footnotes may be applied.
6. Containing no more than the exempt amounts of Class IA, IB or IC flammable liquids.
7. The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

Table 407.3B
Exempt Amounts of Hazardous Materials: Health Hazard
(Maximum Quantities Per Control Area[5])

Material	Closed System			Open Systems	
	Solid lbs[1]	**Liquid** gal or (lbs)[1]	**Gas** cu ft[1]	**Solid** lbs[1]	**Liquid** gal or (lbs)[1]
Corrosive	5,000	500[2,3]	650[6,7]	1,000	100[3,7]
Highly Toxic	1	(1)	20[4]	1/4	(1/4)
Irritant	5,000	500	650[b]	1,000	100
Sensitizer	5,000	500	650[b]	1,000	100
Toxic	500	(500)	650[4,f]	125	(125)[f]
Other Health Hazards	5,000	500	650[5]	1,000	1,000

1 lb = 0.4536 kg

1 gal= 3.7854 L

1 cu ft = 0.02832 m^3

Notes:

1. The amount may be doubled in sprinklered buildings.
2. This amount may be doubled when dispensed or used in closed containers or systems. If the building is also sprinklered, the amount may be increased to a maximum of 2,000 gals.
3. Containment shall be provided and shall be arranged so that sprinkler discharge cannot overflow and mix materials which are not compatible.
4. Permitted only when stored in approved gas cabinets or exhausted enclosures.
5. The aggregate quantity in use and storage shall not exceed the quantity listed for storage.
6. The amount may be doubled when dispensed or used inside approved exhausted gas cabinets, exhausted enclosures, or fume hoods. When footnote 1 also applies, the increase for both footnotes may be applied.
7. Compressed chlorine gas shall have an exempt amount of 810 cu ft.

407.4 Explosives and Blasting Agents - Indoor Storage

Indoor storage of explosives and blasting agents shall be in accordance with 407 and Chapter 19 of the Standard Fire Prevention Code. Indoor storage of fireworks shall be in accordance with 407 and Chapter 20 of the Standard Fire Prevention Code.

407.5 Highly Toxic and Toxic Compressed Gases - Indoor Storage

407.5.1 General. Indoor storage of compressed gases shall be in accordance with the provisions of Chapter 15 of the Standard Fire Prevention Code. Storage of highly toxic or toxic compressed gases shall be in accordance with 407.

407.5.2 Emergency Power. Emergency power shall be provided in lieu of standby power for:

1. exhaust ventilation,
2. treatment systems,
3. gas detection systems,
4. emergency alarm systems, and
5. temperature control systems.

407.5.3 Gas Detection. A continuous gas detection system shall be provided to detect the presence of gas at or below the permissible exposure limit (PEL) or ceiling limit. The detection system shall initiate an alarm at or below the PEL and transmit a signal to a constantly attended control station. The alarm shall be both visual and audible and shall be designed to provide warning both inside and outside of the storage area. The audible alarm shall be distinct from all other alarms.

EXCEPTIONS:

l. Signal transmission to a constantly attended control station is not required when only one cylinder is stored.

2. A continuous gas detection system shall not be required for toxic gases when the physiological warning properties for the gas are at a level below the accepted PEL for the gas, as found in the NIOSH Publication No. 81-123. The gas detection system shall be capable of monitoring the room or area in which the gas is stored at or below the PEL or ceiling limit and the discharge from the treatment system at or below one-half the Immediately Dangerous To Life and Health (IDLH) limit.

407.5.4 Exhaust Ventilation.

407.5.4.1 Ventilated Area. Storage of cylinders shall be within ventilated gas cabinets, under exhaust hoods, within exhausted enclosures or within a ventilated separate gas storage room. Storage of portable and stationary tanks shall be within a separate ventilated room without other occupancy or use. If gas cabinets are provided, the room or area in which they are located shall have independent exhaust ventilation. Treatment systems for gas cabinets, exhaust hoods, exhausted enclosures and separate gas storage rooms shall be designed to remove the accidental release of gas to a treatment system.

407.5.4.2 Gas Cabinets. When gas cabinets are provided they shall be:

l. Operated at negative pressure in relation to the surrounding area.

2. Provided with self-closing limited access ports or noncombustible windows to give access to equipment controls. The average velocity of ventilation at the face of access ports or windows shall be not less than 200ft per minute (1.0 m/s) with a minimum of 150ft per minute (0.76 m/s) at any point of the access port or window.

3. Connected to a treatment system.

4. Provided with self-closing doors.

5. Constructed of not less than 0.105-inch (2.67 mm) steel.

407.5.4.3 Separate Gas Storage Rooms, Exhaust Hoods and Exhausted Enclosures. When provided they shall be designed to operate at a negative pressure in relation to the surrounding area and direct the exhaust ventilation to a treatment system.

407.5.5 Treatment Systems.

407.5.5.1 General. Treatment systems shall be used to process all exhaust discharged from gas cabinets, exhaust hoods, exhausted enclosures or separate gas storage rooms. Treatment systems shall be capable of reducing the concentration of the highly toxic or toxic gases to 1/2 IDLH at the point of discharge to the atmosphere.

407.5.5.2 Sizing. Treatment systems shall be sized to process the maximum worst case release of gas based on the maximum flow rate of release and the total quantity from the largest cylinder or tank utilized.

EXCEPTION: A cylinder containment device or system may be accepted in lieu of the treatment system for cylinder storage when approved by the fire official. Emergency response recovery kits may also be used for chlorine cylinders only.

407.5.6 Distance from Storage to Exposures. Exterior storage of highly toxic or toxic compressed gases shall comply with 407.5.6.1 and 407.5.6.2.

407.5.6.1 Distance Limitation to Exposures. Exterior storage of highly toxic or toxic compressed gases shall not be permitted within 75 ft (23 m) of a property line, street, alley, public way or exit to a public way, or building not associated with the manufacture or distribution of the gases, unless the storage is shielded by a structure having a minimum fire resistance rating of 2 hours and which interrupts the line of sight between the storage and the exposure. The shielding structure shall be at least 5 ft (1524 mm) from any exposure. The shielding structure shall have not more than two sides at approximately 90-degree (1.57 rad) directions, except that a third diagonal section may be used at the vertex.

407.5.6.2 Openings in Exposure Buildings. When the storage area is located closer than 75 ft (23 m) to a building not associated with the manufacture or distribution of the gases, openings into a building other than piping shall not be permitted above the height of the top of the shielding structure or within 50 ft (15 m) horizontally from the storage area whether or not shielded by a protective structure.

407.5.6.3 Air Intakes. The storage area shall not be permitted within 75 ft (23 m) of any air intakes to buildings.

407.5.7 Piping and Controls. Piping and controls on stationary tanks shall be in accordance with the following:

l. Pressure relief devices shall be vented to a treatment system designed in accordance with the provisions of 407.5.5.

2. Where filling or dispensing connections are provided, they shall be provided with a means of local exhaust. Such exhaust shall be designed to capture fumes and vapors. The exhaust shall be directed to a treatment system designed in accordance with the provisions of 407.5.5.

3. Stationary tanks shall be provided with a means of excess flow control on all tank inlet or outlet connections.

   EXCEPTIONS:

   1. Inlet connections that are designed to preclude backflow.
   2. Pressure relief devices.

407.5.8 Supply Piping. Supply piping and tubing for gases and liquids having a health hazard ranking of 3 or 4 in accordance with NFiPA 704 shall also comply with the following:

1. Connections in piping and tubing utilized for the transmission of highly toxic or toxic materials shall be protected by an exhausted enclosure if the material is a gas. If the material is a liquid the piping or tubing must be provided with a receptor for containment.

   EXCEPTION: Metallic piping or tubing with welded connections.

2. Piping and tubing shall not be located within the exit or exit access corridor or above areas not classified as Group H occupancies.

   EXCEPTION: Such piping and tubing may be installed within the space defined by the walls of exit or exit access and floor or roof above or in concealed space above other occupancies when installed in accordance with the provisions required for HPM facilities as specified in 408.

3. Where gases or liquids are carried in pressurized piping above 15 psi (103 kPa), excess flow control shall be provided. Where the piping originates from within a hazardous material storage room or area, the excess flow control shall be located within the storage room or area. Where the piping originates from a bulk source, the excess flow control shall be located as close to the bulk source as practical.

4. Readily accessible manual or automatic remotely activated fail-safe emergency shutoff valves shall be installed on supply piping and tubing at the point of use and at the tank, cylinder or bulk source.

407.5.9 Control of Leaking Cylinders. At least one gas cabinet, exhaust hood, exhausted enclosure, or leak containment device or system shall be provided for the handling of leaking cylinders. Cabinets, enclosures or hoods shall be located within or adjacent to exterior storage areas or within separate gas storage rooms used for cylinders.

EXCEPTION: An additional gas cabinet, containment device or system, exhaust hood, or exhausted enclosure need not be provided for leaking cylinders if all cylinders are stored within gas cabinets or exhausted enclosures or under exhaust hoods.

407.5.10 Local Exhaust for Leaking Portable Tanks. A means of local exhaust shall be provided to capture leaks from portable tanks. The local exhaust may consist of portable ducts or collection systems designed to be applied to the site of a leak in a valve or fitting on the tank. The local treatment system shall be connected to a treatment system as specified in 407.5.5. The local treatment system shall be provided within or immediately adjacent to exterior storage areas and within separate gas storage rooms used for portable or stationary tanks.

407.6 Flammable/Combustible Liquids - Indoor Storage

Indoor storage of flammable and combustible liquids shall be in accordance with Chapter 9 of the Standard Fire Prevention Code.

407.7 Flammable Solids

407.7.1 Indoor Storage. Indoor storage of flammable solids shall be in accordance with 407. Storage of combustible fibers shall be in accordance with the provisions of Chapter 33 of the Standard Fire Prevention Code. Storage of cellulose nitrate plastics shall be in accordance with the provisions of Chapter 23 of the Standard Fire Prevention Code.

407.7.2 Exterior Storage. Exterior storage of flammable solids shall be in accordance with this section. Storage of combustible fibers shall be in accordance with the provisions of Chapter 33 of the Standard Fire Prevention Code.

407.7.3 Distance from Storage to Exposures. Exterior storage of flammable solids shall not be permitted within 20 ft (6096 mm) of any building, property line, street, alley, public way, or exit to a public way.

EXCEPTION: An unpierced 2-hour fire resistant wall extending not less than 30 inches (762 mm) above and to the sides of the storage area may be provided in lieu of such distance.

407.7.4 Monitor Control Equipment. Monitor control equipment shall not be required.

407.8 Liquid and Solid Oxidizers

407.8.1 Indoor Storage. Indoor storage of liquid and solid oxidizers shall be in accordance with 407.

EXCEPTION: For mercantile display areas displaying nonflammable solid and nonflammable or noncombustible liquid Class l, 2 and 3 oxidizers, see Section 2201.8 of the Standard Fire Prevention Code.

407.8.2 Detached Storage. Storage of liquid and solid oxidizers in quantities in excess of those specified in Table 407.8.2 shall either be in a detached building used for no other purpose or in an exterior storage area. Detached storage buildings shall be single story, without basement or crawl space and of construction conforming to this code. Detached storage buildings are not required to be sprinklered when separation distances and storage arrangements are in accordance with NFiPA 43A.

Table 407.8.2
Required Detached Storage of Oxidizers

Class	Detached Storage Required When Amount Exceeds (tons)
1	No Requirement
2	2,000
3	1,200
4	Exempt Amount Specified in Table 308.2A

1 ton = 907.2 kg

407.8.3 Distance from Detached Storage Buildings to Exposures. Detached storage buildings shall be separated from other buildings, property lines, streets, alleys, public ways, or exits to public ways in accordance with Tables 407.8.3A and 407.8.3B.

Table 407.8.3A
Class 1, 2 or 3 Oxidizers
Separation of Detached Storage

	Minimum Distance (ft)	
Class	Unsprinklered	Sprinklered
1	Note 1	Note 1
2	50	35
3	75	50

1 ft = 0.305 m

Note:

1.Detached storage of class I liquid or solid oxidizers not required.

Table 407.8.3B
Class 4 Oxidizers
Separation of Detached Storage

Weight (lbs)	Minimum Distance (ft)
Less than 10	50
11 to 100	75
101 to 500	10
501 to 1,000	125
1,001 to 3,000	200
3,001 to 5,000	300
5,001 to 10,000	400
Over 10,000	As determined by the building official

1 lb = 0.4536 kg

1ft = 0.305 m

Note:

1. Detached storage of class I liquid or solid oxidizers not required.

407.8.4 Separation. Class 3 and Class 4 oxidizers shall be separated from other hazardous materials by not less than 1-hour fire resistant construction or stored in hazardous material storage cabinets. Detached storage buildings for Class 4 oxidizers shall be located a minimum of 50 ft (15 m) from all other hazardous materials storage.

407.9 Organic Peroxides

407.9.1 Indoor Storage. Indoor storage of organic peroxides shall be in accordance with this section.

EXCEPTION: Unclassified detonatable organic peroxides that are capable of detonation in their normal shipping containers under conditions of fire exposure shall be stored in accordance with the requirements of Chapter 19 of the Standard Fire Prevention Code.

407.9.2 Detached Storage. Storage of organic peroxides in quantities exceeding those specified in Table 407.9.2 shall be in a detached building used for no other purpose or in an exterior storage area. Detached storage buildings shall be single story, without basement or crawl space. Detached storage buildings are not required to be sprinklered when separation distances and storage arrangements are in accordance with NFiPA 43B.

Table 407.9.2
Required Detached Storage of Organic Peroxides

Class	Detached Storage Required When Amount Exceeds (tons)
UD	See Chapter 19 of the Standard Fire Prevention Code
I	Exempt Amount Specified in Table 308.2B
II	25
III	50
IV	No Requirement

1 ton= 907.2 kg UD= Unclassified detonatable

407.9.3 Distance from Detached Storage Buildings to Exposures. Detached storage buildings shall be separated from other buildings, property lines, streets, alleys, public ways, or exits to public ways in accordance with Table 407.9.3A. The separation distance between individual detached storage buildings or areas shall be in accordance with Table 407.9.3B.

Table 407.9.3A
Minimum Separation Distance of Detached Storage

Organic Peroxide	Minimum Storage Quantity (lbs) at Minimum Separation		
Class	50 ft	100 ft	150 ft
I	2,000	20,000	175,000
II	100,000	200,000	Unlimited
II	200,000	Unlimited	Unlimited
IV	Unlimited	Unlimited	Unlimited

1 ft= 0.305 m

Table 407.9.3B
Minimum Separation Distance
Between Individual Detached Storage Buildings or Areas

Class	Minimum Storage Quantity (lbs) at Minimum Separation		
	20 ft	75 ft	100 ft
I	2,000	20,000	175,000
II, III, IV	Note 1	Note 1	Note 1

1 ft = 0.305 m

Note:

1. When the amount of organic peroxide stored does not exceed the amount indicated in Table 407.9.3A, minimum separation shall be 20 ft; when the amount of organic peroxide stored exceeds the amount indicated in Table 407.9.3A, minimum separation shall be 50 ft.

407.9.4 Exterior Storage. Exterior storage of organic peroxides shall be in accordance with this section.

EXCEPTION: Unclassified detonatable organic peroxides that are capable of detonation in their normal shipping containers under fire conditions shall be stored in accordance with the requirements of Chapter 19 of the Standard Fire Prevention Code.

407.10 Pyrophoric Materials

407.10.1 Indoor Storage. Indoor storage of pyrophoric solids, liquids and gases shall be in accordance with 407.

407.10.2 Separation. Indoor storage of pyrophoric solids, liquids and gases shall be isolated from incompatible hazardous materials by 1-hour fire resistant walls with openings protected in accordance with the provisions of 705.1.

EXCEPTION: Storage in approved hazardous materials storage cabinets built in accordance with the provisions of the Standard Fire Prevention Code.

407.10.3 Exterior Storage. Exterior storage of pyrophoric solids, liquids and gases shall be in accordance with this section.

407.10.4 Distance from Storage to Exposures. The separation of pyrophoric solids and liquids from buildings, property lines, streets, alleys, public ways or exits to a public way shall be twice the separation required by Chapter 9 of the Standard Fire Prevention Code for Class IB flammable liquids. Separation of pyrophoric gases shall be a minimum of 50ft (15m).

407.11 Unstable (Reactive) Materials

407.11.1 Indoor Storage. Indoor storage of unstable (reactive) materials shall be in accordance with 407.

EXCEPTIONS:

1. Detonatable unstable (reactive) materials shall be stored in accordance with Chapter 19 of the Standard Fire Prevention Code.
2. For retail display of nonflammable solid and nonflammable and noncombustible liquid unstable (reactive) materials, see Section 2201.8 of the Standard Fire Prevention Code.

407.11.2 Detached Storage. Detached storage shall be provided when the amount of materials stored exceeds that specified in Table 407.11.2. Detached storage buildings shall be single story and without basement or crawl space.

Table 407.11.2
Required Detached Storage of Unstable (Reactive) Materials

	Detached Storage Required When Amount Exceeds	
Class	**Solids and Liquids (lbs)**	**Gases (cu ft)**
4	Exempt Amounts Specified in Table 308.2A	
3	2,000	2,000
2	50,000	10,000

1 lb = 0.4536 kg
1 cu ft = 0.02832 m^3

407.11.3 Exterior Storage. Exterior storage of unstable (reactive) materials shall be in accordance with this section.

407.11.4 Distance from Storage to Exposures. Exterior storage of unstable (reactive) materials shall not be permitted within 20 ft (6096 mm) of any building, property line, street, alley, public way or exit to a public way.

EXCEPTIONS:

1. An unpierced 2-hour fire resistant wall extending not less than 30 inches (762 mm) above and to the sides of the storage may be provided in lieu of such distance.
2. Unstable (reactive) materials which may detonate shall be located in accordance with the requirements of Chapter 19 of the Standard Fire Prevention Code.

407.12 Water Reactive Materials

407.12.1 Indoor Storage. Indoor storage of water reactive materials shall be in accordance with this section.

EXCEPTION: For retail display of nonflammable solid and nonflammable or noncombustible liquid water reactive materials, see Section 2201.8 of the Standard Fire Prevention Code.

407.12.2 Detached Storage. Detached storage shall be provided when the amount stored exceeds 2,000 lb (907 kg) of Class 3 material or 50,000 lb (22 680 kg) of Class 2 material. Detached storage buildings shall be single story and without basement or crawl space.

407.12.3 Waterproof Room. Rooms or areas used for the storage of water reactive materials shall be constructed to resist the penetration of water. Piping carrying water for other than approved automatic fire extinguishing systems shall not be permitted within such rooms or areas. Recessed floors are not permitted.

407.12.4 Exterior Storage. Exterior storage of water reactive materials shall be within tanks or closed, water tight containers and shall be in accordance with this section.

407.12.5 Distance from Storage to Exposures. Exterior storage of water reactive materials shall not be permitted within 20 ft (6096 mm) of any building, property line, street, alley, public way or exit to a public way.

EXCEPTIONS:

1. An unpierced 2-hour fire resistant wall extending not less than 30 inches (762 mm) above and to the sides of the storage area may be provided in lieu of such distance.
2. Class 3 water reactive materials shall not be permitted within 75 ft (23 m) of any building, property line, street, alley, public way or exit to a public way.

407.13 Cryogenic Fluids

Indoor storage of flammable or oxidizing cryogenic fluids shall be in accordance with this section and Chapter 18 of the Standard Fire Prevention Code.

407.14 Highly Toxic and Toxic Solids and Liquids

407.14.1 Indoor Storage. Indoor storage of highly toxic or toxic solids and liquids shall be in accordance with this section.

EXCEPTION: For retail display of nonflammable solid and nonflammable or noncombustible liquid highly toxic materials, see Section 2201.8 of the Standard Fire Prevention Code.

407.14.2 Treatment System. Treatment systems for the processing of highly toxic liquid vapors shall be provided for storage areas where a spill or other accidental release of such liquids can be expected to release highly toxic vapors. Treatment systems and other processing systems shall be installed in accordance with the Standard Mechanical Code. Emission control shall conform to the requirements of the local air quality authority.

407.14.3 Separation. Storage of highly toxic liquids and solids shall be isolated from other hazardous materials by 1-hour fire resistant construction or stored in approved hazardous materials storage cabinets.

407.14.4 Exterior Storage. Exterior storage of highly toxic or toxic solids and liquids shall be in accordance with this section and the Standard Fire Prevention Code. Storage of highly toxic liquids which liberate highly toxic vapors in the event of a spill or other accidental discharge shall not be permitted unless approved collection and treatment systems are provided. Emission control shall conform to the requirements of the local air quality authority.

407.14.5 Distance from Storage to Exposures. Exterior storage of highly toxic or toxic solids and liquids shall not be permitted within 20 ft (6096 mm) of any building, property line, street, alley, public way or exit to a public way.

EXCEPTION: An unpierced 2-hour fire resistant wall extending not less than 30 inches (762 mm) above and to the sides of the storage area may be provided in lieu of such distance.

407.15 Corrosives

407.15.1 Indoor Storage. Indoor storage of corrosive materials shall be in accordance with this section.

EXCEPTION: For retail display of nonflammable solid and nonflammable or noncombustible corrosive liquid, see Section 2201.8 of the Standard Fire Prevention Code.

407.15.2 Exterior Storage. Exterior storage of corrosive materials shall be in accordance with this section.

407.15.3 Distance from Storage to Exposures. Exterior storage of corrosive liquids shall not be permitted within 20 ft (6096 mm) of any building, property line, street, alley, public way or exit to a public way.

EXCEPTION: An unpierced 2-hour fire resistant wall extending not less than 30 inches (762 mm) above and to the side of the storage area may be provided in lieu of such distance.

407.16 Irritants, Sensitizers, Other Health Hazard Solids, Liquids and Gases

407.16.1 Indoor Storage. Indoor storage of irritants, sensitizers or other health hazard solids, liquids, and gases shall be in accordance with this section.

EXCEPTION: For retail display of other health hazard materials which are nonflammable solid and noncombustible or nonflammable liquid, see Section 2201.8 of the Standard Fire Prevention Code.

407.16.2 Exterior Storage. Exterior storage of irritants, sensitizers or other health hazard solids, liquids, and gases shall be in accordance with this section.

407.16.3 Distance from Storage to Exposures. Exterior storage of irritants, sensitizers or other health hazard solids, liquids, and gases shall not be permitted within 20 ft (6096 mm) of any building, property line, street, alley, public way or exit to a public way.

EXCEPTION: An unpierced 2-hour fire resistant wall extending not less than 30 inches (762 mm) above and to the sides of the storage area may be provided in lieu of such distance.

407.16.4 Storage Conditions. Exterior storage of irritants, sensitizers or other health hazard solids and liquids shall be separated into piles not larger than 2,500 cu ft (71 m^3). Aisle widths between piles shall be not less than one-half the height of the piles or 10 ft (3048 mm), whichever is greater.

407.17 Dry Cleaning Plants

407.17.1 Type I Systems. Dry cleaning plants or systems utilizing Class I solvents shall be prohibited.

407.17.2 Type II Systems. Type II systems shall be located in buildings conforming with the provisions for a Group H2 or H3 occupancy.

407.17.3 Type III, IV, and V Systems. Type III, IV and V systems shall be classified as a Group B occupancy.

407.17.4 General.

407.17.4.1 Dry cleaning operations shall be restricted to the lowest floor of a building but shall not be located on any floor below grade. Operations incidental to the dry cleaning business such as laundering, pressing, and ironing may be in a communicating building or located on the same floor with the dry cleaning plant, provided the dry cleaning operations are separated therefrom by 2-hour fire resistant construction.

407.17.4.2 Door openings on stairs or elevators leading from a dry cleaning area to a basement, or opening into a room having openings or stairs to basements, shall be provided with sills or ramps raised at least 4 inches (102 mm). Approved self-closing fire doors shall be provided at such openings. Enclosures shall be of construction equivalent to the floor construction but having a rating of not less than 1-hour fire resistance.

407.17.4.3 Rooms in which articles are hung up to dry shall be separated from the rest of the building by 2-hour fire resistant construction. If the drying room is in a separate building, it shall conform in all respects to the provisions for that type of occupancy.

407.17.4.4 A mechanical system of ventilation shall be installed in dry cleaning areas and drying rooms conforming to the provisions of the Standard Mechanical Code. The mechanical system of ventilation shall have sufficient capacity to insure complete and continuous change of air in accordance with the provisions of the Standard Mechanical Code and shall be provided with means for remote control. The system shall operate automatically when any dry cleaning equipment is in use.

408 HAZARDOUS PRODUCTION MATERIAL FACILITIES

408.1 General

408.1.1 Scope. The provisions of this section shall apply to buildings and structures using HPM, such as semiconductor fabrication facilities and areas of comparable research and development. Except as specifically required by this section, such buildings shall comply with the applicable requirements of this code. The specific code provisions of 503.4.1, 704.1.1 and 1005.3.2, and Tables 500 and 704.1 applicable to Group H, Hazardous Occupancies, shall not apply unless stated herein.

408.1.2 Automatic Sprinkler System. An approved automatic sprinkler system shall be provided throughout all buildings containing HPM facilities in accordance with 903.2, 903.7.4 and 903.8.

408.1.3 Stairways. All stairways shall be enclosed in accordance with 1006.1.1.

408.2 Definitions

For the purpose of this section, certain special terms are defined as follows:

HAZARDOUS PRODUCTION MATERIAL (HPM) – a solid, liquid or gas that has a degree of hazard rating in health, flammability or reactivity of 3 or 4 as ranked by NFiPA 704 and which is used directly in research, laboratory or production processes which have, as their end product, materials which are not hazardous.

HPM EMERGENCY CONTROL STATION – an approved location on the premises of an HPM Facility where signals from emergency equipment are received.

HPM SEPARATE INSIDE STORAGE ROOM – a room used for the storage of hazardous production material in containers, tanks, drums or other means, separated from other occupancies. Such rooms include:

HPM INSIDE ROOM – a hazardous production material storage room totally enclosed within a building and having no exterior walls.

HPM CUTOFF ROOM – a hazardous production material storage room within a building and having at least one exterior wall.

HPM SERVICE CORRIDOR – a fully enclosed passage used for transporting hazardous production material from an HPM separate inside storage room or the exterior of the building to the perimeter wall of the fabrication area, and for purposes other than required exiting.

408.3 Fabrication Areas

408.3.1 General. A fabrication area is an area in which there are processes involving hazardous production materials and includes ancillary rooms or areas such as dressing rooms and offices that are supplemental to those processes.

408.3.2 Allowable Height, Stories and Area. The allowable height, number of stories and building areas permitted for buildings and structures used for facilities using hazardous production material shall not exceed the limits set forth in Table 408.3.2.

Table 408.3.2
Allowable Heights and Building Areas For Hazardous Production Material Facllltles[1, 2, 3]
(Allowable building area is shown In thousands of square feet per floor.)

	TYPE OF CONSTRUCTION								
	TYPE I	TYPE II	TYPE III	TYPE IV		TYPE V		TYPE VI	
				1-Hr	Unprot.	1-Hr	Unprot.	1-Hr	Unprot.
Max. No. of Stories	3	3	3	3	3	3	3	1	1
Max. Height (feet)	55	55	55	55	55	55	55	50	40
Area: Multistory	UA	UA	63.0	63.0	42.0	45.0	30.0		
One story only	UA	UA	94.5	94.5	63.0	67.5	45.0	45.0	30.0

1 ft = 0.305 m
1 sq ft = 0.0929 m2

UA = Unlimited Area

Notes:

1. The increases permitted in 503.3 shall apply.
2. The provisions of 503.4.1 and Table 500 shall not apply.
3. The area limitations are based on the building facing on one street of public space not less than 30ft wide.

408.3.3 Area of Fabrication. The size of a fabrication area shall be determined by the density of the HPM in that space. The density of the HPM shall not exceed that specified in Table 408.3.3A. The total quantity of HPM permitted shall be based on the densities in Table 408.3.3A or the quantities in Table 408.3.3B, whichever is the larger amount.

Table 408.3.3A

Permitted Quantities of Hazardous Production Material In a Single Hazardous Production Material Facility Density Bases[1,3]

State	Units	Flammable	Oxidizer	Corrosive
solid	lbs/sq ft	0.001	0.003	0.003
liquid	gal/sq ft	0.04[2]	0.03	0.08
gas	cf/sq ft	1.250	1.250	3.00

1 lb/sq ft = 4.882 kg/m^2
1 ga/sq ft = 40.747 /m^2
1 cf/sq ft = 0.305 m^3/m^2

Notes:

1. Hazardous production material within piping shall not be included in the calculated amount.
2. The maximum permitted quantities of flammable and combustible liquids shall not exceed the following quantities:
   Class (IA) + (IB) + (IC) (Combination flammable liquids) 0.025
   however, Class IA shall not exceed 0.0025
   Class II 0.01
   Class IIIA 0.02
3. Highly toxic material, highly toxic and toxic gases shall be limited by the maximum quantities specified in Table 408.3.3B.

Table 408.3.3B
Permitted Quantities of Hazardous Production Material
In a Single Fabrication Area[2]

Materials	Maximum Quantity
Flammable liquids	
Class IA	90 gal
Class IB	180 gal
Class IC	270 gal
Combination flammable liquids	360 gal[1]
Combustible liquids	
Class II	360 gal
Class IIIA	750 gal
Flammable gases	9,000 cu ft at normal temperature and pressure
Liquified flammable gases	180 gal
Flammable solids	1,500 lbs
Corrosive liquids	165 gal
Oxidizing material – gases	18,000 cu ft
Oxidizing material – liquids	150 gal
Oxidizing material – solids	1,500 lbs
Organic peroxides	30 lbs
Highly toxic material, highly toxic and toxic gases	Included in the aggregate for flammables as noted above.

1 lb = 0.4536 kg
1 gal = 3.7854 L
1 cu ft = 0.02832 m^3

Notes:

1. Containing not more than the exempt amounts of Class IA, IB, IC flammable liquids.
2. When the amount of hazardous material in a building is less than one-third of the maximum quantity contained in this table, 301.3 shall be used to establish the appropriate occupancy.

408.3.4 Separation.

408.3.4.1 Fabrication areas shall be separated from each other, from exit access corridors and from other parts of the building by not less than 1-hour fire resistant construction in compliance with 701.2, with not less than 3/4 hour opening protectives.

408.3.4.2 The fire resistance of construction separating a fabrication area from an HPM cutoff room shall have a fire rating of not less than 2 hours with the openings protected by self-closing doors having a fire resistance rating of not less than 1 1/2 hours.

408.3.4.3 Floor forming part of the required separation shall be liquidtight.

408.3.5 Floors. Floors within fabrication areas shall be of noncombustible construction. Unprotected openings through the floor of fabrication areas are permitted when the interconnected levels are used solely for mechanical equipment directly related to such fabrication area.

A fabrication area may have mechanical, duct and piping penetrations which extend through not more than two floors within that fabrication area. Penetrations shall be effectively sealed to prevent air flow at the floor level. The fabrication area, including the areas through which ductwork and piping extend, shall be considered a single conditioned space.

408.3.6 Ventilation.

408.3.6.1 General. Ventilation systems shall comply with the Standard Mechanical Code except as otherwise provided herein. Ventilation, including recirculated air, shall be provided throughout the fabrication area at the rate of not less than 1 cfm per sq ft (0.0051 m^3/sf m^2) of floor area.

408.3.6.2 Interconnection. The exhaust system of one fabrication area shall not connect to another exhaust system outside that fabrication area within the building. The return air system from one fabrication area shall not connect to any other system.

408.3.6.3 Smoke Detectors. Smoke detectors shall be installed in the recirculating airstream and shall initiate a signal at the emergency control station.

408.3.6.4 Shutoff Switches. Automatic shutoffs are not required to be installed on air-moving equipment. A manually operated remote switch to shut off the fabrication area supply or recirculating air system, or both, shall be provided at an approved location outside the fabrication area.

408.3.7 Gas Detection. When HPM gas is used or dispensed and the physiological warning properties for the gas are at a higher level than the accepted permissible exposure limit for the gas, a continuous gas-monitoring system shall be provided to detect the presence of a short-term hazard condition. When dispensing occurs with the possibility of generating flammable gases or vapors in quantities exceeding 20% of the lower explosive limit, a continuous gas-monitoring system shall be provided. The monitoring system shall be connected to the emergency control station.

408.3.8 Transporting Hazardous Production Material. HPM shall be transported to fabrication areas through enclosed piping or tubing systems that comply with 408.7 through HPM service corridors or in exit access corridors as permitted in the exception in 408.4. The handling or transporting of HPM within HPM service corridors shall comply with the Standard Fire Prevention Code.

408.3.9 Means of Egress. There shall be not less than two egress doors from all portions of an HPM facility having a floor area of 200 sq ft (18.6 m^2) or more regardless of the number of occupants within the room or space. All doors shall swing in the direction of egress.

408.3.10 Electrical. Electrical equipment and devices within the fabrication area shall comply with NFiPA 70. The requirements for hazardous locations need not be applied when the average air change is at least 4 cfm per sq ft (0.02 $m^3/s/m^2$) of floor area and when the number of air changes at any location is not less than 3 cfm per sq ft (0.015 $m^3/s/m^2$).

408.4 Exit Access Corridors

408.4.1 Exit access corridors shall be separated from fabrication areas as specified in 408.3.4. Exit access corridors shall not be used for transporting HPM except as provided herein and in 408.7.2.

EXCEPTION: In existing HPM Facilities, when there are alterations or modifications to existing fabrication areas, the transportation of HPM in exit access corridors shall be permitted when all the following requirements are met:

l. Corridors adjacent to the fabrication area under alteration shall comply with 408.3.4 and Table 700 for the length of the common wall of the corridor and the fabrication area, and for the distance along the exit access corridor to the point of entry of HPM into the exit access corridor serving that fabrication area.

2. There shall be no openings between an exit access corridor and an HPM storage cabinet in a fabrication area unless 1-hour fire doors are installed between the exit access corridor and the cabinet; the cabinet is enclosed with 1-hour fire resistant construction and the cabinet is internally fire sprinklered.

408.5 HPM Service Corridors

408.5.1 General. HPM service corridors shall be considered as part of the HPM Facility.

408.5.2 Separation. HPM service corridors shall be separated from exit access corridors as required by 408.3.4.

408.5.3 Ventilation. HPM service corridors shall be mechanically ventilated as required by 408.3.6.

408.5.4 Means of Egress. There shall be not less than two egress doors from an HPM service corridor. Not more than one-half of the required means of egress shall be into the fabrication area. Doors from HPM service corridors shall be self-closing and swing in the direction of egress.

408.5.5 Travel Distance. The maximum distance of travel from any point in an HPM service corridor to an exterior exit door, horizontal exit, exit access corridor, enclosed stairway or door into a fabrication area shall not exceed 75ft (23m). Dead ends shall not exceed 4ft (1219 mm) in length.

408.5.6 Alarms. Alarms shall be provided as required in 408.6.6.

408.6 Storage of Hazardous Production Material

408.6.1 General. Rooms used for the storage of HPM in quantities greater than that set forth in Table 408.3.3B, except for that permitted within a fabrication area, shall comply with the provisions of NFiPA 30 provided that the area of an HPM cutoff room shall not exceed 6,000 sq ft (557.4 m^2).

408.6.2 Location Within Building. When HPM cutoff rooms are provided, they shall be not less than 30 feet (9144 mm) from property lot lines and street lines.

408.6.3 Hazardous Production Material Drainage Systems. Drainage systems shall be provided to direct liquid leakage and fire protection water to a safe location away from the building, any important valve or adjoining property. HPM flammable liquid drains shall be separated from other HPM liquid drains. Other HPM liquids in drains that are not compatible shall be separated from each other, provided that they are permitted to be combined when they have been rendered acceptable for discharge by an approved means into the public sewers.

408.6.4 Means of Egress. There shall be two egress doors from an HPM separate inside storage room when the rooms exceed 200 sq ft (18.6 m^2) in area. When two means of egress are required from HPM cutoff rooms, one shall be directly to the outside of the building. All storage room egress doors shall be self-closing and swing in the direction of egress.

408.6.5 Ventilation. Exhaust ventilation shall be provided in accordance with 408.3.6 for all categories of HPM.

408.6.6 Emergency Alarm. An emergency telephone system or local manual alarm pull station shall be installed outside of each interior egress door from HPM cutoff rooms. The signal shall be relayed to the emergency control station and a local signaling device provided.

408.6.7 Electrical. HPM cutoff rooms containing flammable liquids or gases shall be classified as Class I, Division 1 hazardous locations in accordance with NFiPA 70.

408.7 Piping And Tubing

408.7.1 General. HPM piping and tubing shall comply with this section and shall be installed in accordance with ANSI B31.3. Piping and tubing systems shall be metallic unless the material being transported is incompatible with such system. Systems supplying gaseous HPM, having a Health Hazard of 3 or 4 as ranked by NFiPA 704, shall be welded throughout, except for connections, valves and fittings, which are within an exhausted enclosure. HPM supply piping or tubing in HPM service corridors shall be exposed to view.

408.7.2 Installation in Exit Corridors and Above Other Occupancies. Hazardous Production Material shall not be located within exit access corridors or above areas not containing HPM Facilities except as permitted by this section. HPM piping and tubing may be installed within the space defined by the walls of exit access corridors and the floor or roof above or in concealed spaces above other occupancies under the following conditions:

1. Automatic sprinklers shall be installed within the space unless the space is less than 6 inches (152 mm) in least dimension.
2. Ventilation at not less than six air changes per hour shall be provided. The space shall not be used to convey air from any other area.
3. All HPM supply piping and tubing and HPM nonmetallic waste lines shall be separated from the exit access corridor and from any other occupancy other than an HPM Facility by construction having a fire resistance rating of not less than 1 hour as permitted for walls or partitions. When gypsum wallboard is used, joints on the piping side of the enclosure need not be taped, provided the joints occur over framing members. Access openings into the enclosure shall be protected by approved fire opening protectives.
4. When the piping or tubing is used to transport HPM liquids, a receptor shall be installed below such piping or tubing. The receptor shall be designed to collect any discharge or leakage and drain it to an approved location. The 1 hour enclosure required by item 3 herein shall not be used as part of the receptor.
5. Readily accessible manual or automatic remotely activated fail-safe emergency shutoff valves shall be installed on piping and tubing other than waste lines at branch connections into the fabrication area and at entries into exit access corridors.
6. Where HPM supply gas is carried in pressurized piping, a fail-safe system for excess flow control shall shut off flow due to rupture in the piping.
7. Electrical wiring and equipment located in the piping space shall be approved for Class I, Division 2 Hazardous Locations in accordance with NFiPA 70.
8. Gas detection shall be provided in accordance with 408.3.7.

EXCEPTIONS to Items 1 Through 8:

1. Transverse crossings of the corridors by supply piping coaxially enclosed within a ferrous pipe or tube for the width of the corridor are permitted.
2. An enclosed pipe or tube open to an HPM facility is permitted.

408.7.3 Identification. Piping, tubing and HPM waste lines shall be identified in accordance with ANSI A13.1 to indicate the material being transported.

409 SPECIAL INSTITUTIONAL OCCUPANCIES

409.1 Group I Unrestrained Occupancies

409.1.1 General

409.1.1.1 Group I Unrestrained buildings shall be provided with an approved automatic wet pipe sprinkler system. Smoke compartments containing patient rooms shall be protected throughout with listed quick response sprinklers.

EXCEPTION: Standard sprinklers may be used where patient sleeping rooms are protected with a smoke detector complying with the requirements of UL 217 or UL 268 permanently connected to house current. Such detectors shall provide a visual display on the corridor side of each patient sleeping room and shall provide an audible and visible alarm at the nursing station attending that room. Such detector and related devices may be combined with the nursing call system and the total system need not be electrically supervised.

409.1.2 Smoke Barriers.

409.1.2.1 Smoke barriers shall be provided to subdivide every story used by patients for sleeping or treatment into at least two smoke compartments. Egress shall be provided from each smoke compartment without returning through the compartment from which egress originated. The maximum area of each smoke compartment shall not be more than 22,500 sq ft (2090.3 m^2), with a travel distance from any point to a smoke barrier door in a publicly accessible area not to exceed 200 ft (61 m). At least 30 net sq ft (2.79 m^2) per patient shall be provided within the aggregate area of corridors, patient rooms, treatment rooms, lounge or dining areas and other similar spaces on each side of the smoke barrier for the total number of patients in adjoining compartments. On stories not housing bed and litter patients, at least 6 sq ft (0.56 m^2) per occupant shall be provided on each side of the smoke barrier for the total number of occupants in adjoining compartments.

409.1.2.2 For smoke barrier fire resistance requirements, see 704.2.2.2. For smoke barrier opening protectives, see 705.1.

409.1.2.3 Doorways separating corridor in adjoining smoke compartments shall be equipped with either horizontal sliding doors conforming with 1012.4 or a pair of swinging type doors, each swinging in a direction opposite from the other, and the minimum clear width of each door shall be 44 inches (1118 mm) for hospital corridors and 32 inches (813 mm) for residential custodial care institutions. Other doors in smoke barrier shall be swinging type of required width or horizontal sliding doors conforming with 1012.4.

409.1.2.4 Doors in smoke barriers shall have a fire resistance rating of 20 minutes except as required in 409 1.5 or when used as an exit or for enclosure of a vertical opening. Double egress corridor doors shall have, and other doors shall be permitted to have, vision panels of 1/4-inch (6.4 mm) labeled wire glass mounted in steel frames. The glass area shall be limited to 1296 sq in (0.84 m^2) for each door. The door shall close the opening with only the clearance necessary for proper operation under self-closing, and shall be without undercuts, louvers or grilles. Rabbets or astragals are required at the meeting edges of double egress doors, and stops are required on the head and jambs of all doors in smoke barriers. Positive latching devices are not required on double egress corridor doors, and center mullions are prohibited.

EXCEPTION Protection at the meeting edges of doors and stops at the head and sides of door frames may be omitted in buildings equipped with an approved engineered smoke control system. The engineered smoke control system shall respond automatically preventing the transfer of smoke across the barrier.

409.1.2.5 Doors in smoke barriers shall be self-closing or shall be provided with door hold open devices of the fail-safe type which shall release the doors causing them to close upon the actuation of smoke detectors installed in accordance with 905 as well as upon the application of a maximum manual pull of 50 lb (222 N) against the hold open device.

409.1.2.6 HVAC systems penetrating a smoke barrier shall be fully ducted.

409.1.3 Corridors.

409.1.3.1 Exit access corridor partitions shall be constructed of materials permitted by this code for the type of construction used and shall not be required to have a fire resistance rating. Such partitions shall comply with 1604.5 and shall be designed to resist the passage of smoke. If these partitions are to be terminated at the ceiling membrane, the ceiling membrane shall also be designed to resist the passage of smoke.

409.1.3.2 Waiting areas may be open to the corridor, provided:

1. The aggregate area of waiting areas in each smoke compartment does not exceed 600 sq ft (55.7 m^2), and
2. Each area is located to permit direct visual supervision by the facility staff, and
3. Each area is equipped with an automatic smoke detector system installed in accordance with 905, and
4. Each area is arranged not to obstruct access to required exits.

409.1.3.3 Spaces may be unlimited in size and open to the corridor provided:

1. The spaces are not used for patient sleeping rooms, treatment rooms, hazardous areas or special use areas listed in 409.1.5, and
2. Each space is located to permit direct visual supervision by the facility staff, and
3. The space and corridors which the space open onto in the same smoke compartment are protected by an automatic smoke detection system installed in accordance with 905, and
4. The space is arranged not to obstruct access to required exits.

409.1.3.4 Space for doctors' and nurses' charting and communication areas may be open to the corridor.

409.1.3.5 All corridors shall be continuous to the exits and separated from all other use areas.

409.1.4 Corridor Doors.

409.1.4.1 Doors in corridor partitions need not have a fire resistance rating but shall be designed to resist the passage of smoke. Doors shall be equipped with positive latching. Roller latches shall be prohibited.

EXCEPTION: Doors required to be rated by 409.1.5, exit doors, and rated shaft enclosure doors.

409.1.4.2 Locking devices which restrict access to rooms from the corridor and which are operable only by staff from the corridor side shall not restrict egress from the room except for mental health patient rooms.

409.1.5 Protection from Hazardous Areas. Hazardous areas listed in Table 409.1.5 shall be separated/protected as shown. All doors shall be self-closing or automatic closing by smoke detection. Where nonfire-rated separation is permitted, the hazardous area shall be separated from the remainder of the building by partitions constructed of materials consistent with the building type of construction and capable of resisting the passage of smoke. The partitions shall extend from the floor to the underside of a fire resistance rated floor/ceiling or roof /ceiling assembly or to the floor/roof deck above.

Table 409.1.5
Protection From Hazardous Areas

Area	Separation/Protection
Boiler and heater rooms Physical plant maintenance shop Laundries greater than 100 sq ft Soiled linen room Storage rooms more than 100sq ft storing combustible material Trash collection rooms	1-hour / 3/4-hour doors
Employee locker room Gift/retail shop Handcraft shops Kitchens Storage room more than 50 sq ft in area but not more than 100 sq ft in area storing combustible material	Nonfire-rated separation / Smoke resistant doors
Laboratories and paint shops employing hazardous materials in quantities less than that which would cause classification as an H use	1-hour / 3/4-hour doors, Control room per 308.2.2

1 sq ft = 0.0929 m^2

409.1.6 Building Fire Protective Signaling Systems. A fire protective signaling system shall be activated by manual fire alarm boxes, by sprinkler activation and by smoke detection required in 409.1.3.2 and 409.1.3.3.

409.1.7 Fire Department Notification. The fire protective signaling system shall be arranged to transmit an alarm to the fire department via any of the following means.

1. Approved central station system in accordance with NFiPA 71 or
2. Approved proprietary, auxiliary or remote station system in accordance with NFiPA 72.

409.1.8 Supervision. The sprinkler system shall be supervised in accordance with 903.8.

409.1.9 Fixed Furnishings Tests. Fixed furnishings shall comply with the requirements in Chapter 43 of the Standard Fire Prevention Code.

409.2 Group I Restrained Occupancies

409.2.1 General.

409.2.1.1 Portions of Group I Restrained which may be classified as a different occupancy group shall meet the corresponding requirements of this code for such occupancies. Where security operations necessitate the locking of required means of egress, provisions shall be made for the release of occupants during all times of use.

409.2.1.2 Sections of Group I Restrained occupancies may be classified as other occupancies if they meet the following conditions:

1. They are not intended to serve residents for purpose of housing, customary access or means of egress.
2. They are separated from Group I Restrained occupancies by construction meeting the occupancy separation requirements of 704.1.

409.2.1.3 All means of egress that traverse other use areas shall conform to requirements of this code for Group I Restrained occupancies.

EXCEPTION: It is permissible to exit through a horizontal exit into other contiguous occupancies which do not conform to Group I Restrained occupancy egress provisions but which do comply with requirements set forth in the appropriate occupancy, as long as the occupancy is not a high hazard use.

409.2.1.4 Occupancies, not related to Group I Restrained, classified as containing high hazard contents shall not be permitted in buildings housing Group I Restrained occupancies.

409.2.2 Definitions. For the purpose of this section, certain special terms are defined as follows:

SALLYPORT (Security Vestibule) – a compartment provided with two or more doors where the intended purpose is to prevent continuous and unobstructed passage by allowing the release of only one door at a time.

RESIDENTIAL HOUSING AREAS – includes sleeping areas and any contiguous day room, group activity space or other common spaces for customary access of residents.

409.2.3 Subclassification Of Occupancy. Group I Restrained shall be categorized as one of the Use Conditions in 1024.2.2.

409.2.4 Minimum Construction Requirements. The height and area of buildings containing a Group I Restrained occupancy shall be limited in accordance with Table 500.

409.2.5 Occupant Load.

409.2.5.1 The minimum occupant load for which means of egress shall be provided for any floor shall be the maximum number of persons intended to occupy that floor, but not less than that projected by calculations using the tabular values of 1003.1.

409.2.5.2 For resident housing areas the minimum occupant load shall be based upon 120 sq ft (11.1 m^2) per occupant using gross floor area.

409.2.6 Means or Egress. Means of egress requirements shall be as provided in Chapter 10.

409.2.7 Protection or Vertical Openings.

409.2.7.1 Any vertical opening between stories shall be enclosed in accordance with 705.2 except as provided here.

409.2.7.2 Atriums complying with 414 shall be permitted in buildings protected throughout by automatic sprinklers.

409.2.7.3 Multilevel residential housing areas are permitted without enclosure protection between levels provided all the following conditions are met:

1. The entire normally occupied area so interconnected is sufficiently open and unobstructed so that supervisory personnel can observe the area.
2. Exit capacity is sufficient to provide simultaneous egress from all floor levels for all the occupants of such interconnected levels.
3. The height between the highest and lowest finished floor levels does not exceed 13 ft (3962 mm).

   EXCEPTION TO CONDITION 3: In buildings protected by an approved automatic sprinkler system, the height between the highest and lowest finished floor levels shall not exceed 23 ft (7010 mm). Each story shall have at least one-half of its required exit capacity provided by exits leading directly out of that story, without occupants having to traverse another story within the interconnected area.

409.2.8 Protection from Specific Uses.

409.2.8.1 Specific use areas shall be separated from other areas of Group I Restrained buildings in accordance with the requirements of Table 409.2.8.

Table 409.2.8
Specific Use Areas Within Group I Restrained

Area	Separation/Protection
Boiler and heater rooms Paint shops employing hazardous substances and materials in quantities less than that which would cause classification as Group H Physical plant maintenance shop	2-hour, or 1 hour and automatic sprinklers
Laundries greater than 100 sq ft Storage rooms more than 100 sq ft Trash collection rooms Padded cells	1 hour and automatic sprinklers
Employee locker rooms Handcraft shops Kitchens Storage rooms more than 50 sq ft in area but not more than 100 sq ft in area	1 hour, or automatic sprinklers with separation walls

1 sq ft = 0.0929 m^2

409.2.8.2 Where the separation walls around specific use areas are not required by Table 409.2.8 to have a fire resistance rating, they shall be constructed of materials consistent with the building type of construction and shall be capable of resisting the passage of smoke. The separation walls shall extend from the floor to the underside of a fire resistance rated floor/ceiling or roof/ceiling assembly or to the floor/roof deck above. All doors shall be self-closing or automatic-closing upon detection of smoke.

409.2.8.3 Cooking facilities shall be protected in accordance with the Standard Mechanical Code.

409.2.9 Interior Finish.

409.2.9.1 Interior finish of walls and ceilings in corridors, exits and any space not separated from corridors and exits by a partition capable of retarding the passage of smoke shall be Class A. All other areas shall be in accordance with 803.3.

409.2.9.2 Interior floor finish shall be in accordance with 803.7.

409.2.10 Fire Protective Signaling Systems.

409.2.10.1 A fire protective signaling system shall be provided in accordance with NFiPA 72.

EXCEPTIONS:

1. Manual fire alarm boxes may be locked provided that staff is present within the subject area when occupied and has keys readily available to unlock the boxes.
2. Manual fire alarm boxes may be located in a staff location provided that the staff location is manned when the building is occupied and has direct supervision of the sleeping area.

409.2.10.2 Initiation of the fire protective signaling system shall be by manual means and by automatic means of any required detection device.

409.2.10.3 Operation of any alarm initiating device shall automatically, without delay, accomplish general alarm indication and control functions. Prealarm (presignal) systems are prohibited.

EXCEPTION: Any required smoke detectors may be arranged to alarm at a constantly attended location only and are not required to accomplish general alarm indication.

409.2.11 Fire Department Notification. The fire protective signaling system shall be arranged to transmit an alarm to the fire department via any of the following means:

1. Approved central station system in accordance with NFiPA 71 or
2. Approved proprietary, auxiliary, or remote station system in accordance with NFiPA 72.

EXCEPTION: Smoke detectors may be arranged to alarm locally and at a constantly attended location only and are not required to accomplish general alarm nor be connected to the fire department.

409.2.12 Automatic Fire Detection. An approved automatic fire detection system with smoke detectors shall be installed in accordance with NFiPA 72 and NFiPA 72E throughout all resident housing areas, including sleeping areas and any contiguous day room, group activity space, or other common spaces for customary access of residents.

EXCEPTIONS:

1. Smoke detectors shall not be required in sleeping rooms with four or fewer occupants in buildings protected throughout with an approved automatic sprinkler system.
2. Other arrangements and positioning of smoke detectors may be used to prevent damage or tampering or for other purposes provided the function of detecting any fire is fulfilled and the siting of detectors is such that the speed of detection will be equivalent to that provided by the spacing and arrangements described in NFiPA 72E. This may include the location of detectors in exhaust ducts from cells, behind grills, or in other locations. The equivalent performance of the design shall be approved by the building official.

409.2.13 Extinguishing Requirements.

409.2.13.1 When required by Table 500, facilities shall be protected throughout by an approved automatic sprinkler system in accordance with NFiPA 13.

409.2.13.2 Where exceptions are stated in the provisions of this code (including those specified in 409.2.15) for Group I Restrained equipped with an approved automatic extinguishing system, and where such systems are required, the system shall be in complete accordance with NFiPA 13 for systems in light hazard occupancies and shall be electrically interconnected with the fire alarm system.

409.2.13.3 The sprinkler system shall be electrically supervised in accordance with 903.8.

409.2.13.4 The sprinkler piping, serving no more than six sprinklers for any isolated hazardous area, may be connected directly to a domestic water supply system having a capacity sufficient to provide 0.15 gpm per sq ft (0.0001 $m^3/s/m^2$) of floor area through the entire enclosed area. An indicating shutoff valve shall be installed in an accessible location between the sprinkler and the connection to the domestic water supply. For sprinkler requirements for hazardous areas, see 409.2.8.

409.2.13.5 Portable fire extinguishers shall be provided in accordance with NFiPA 10.

EXCEPTIONS:

1. Access to portable fire extinguishers may be locked.
2. Portable fire extinguishers may be located at staff locations only.

409.2.14 Smoke Barriers.

409.2.14.1 Smoke barriers shall be provided to divide every story used by residents for sleeping, or any other story having an occupancy load of 50 or more persons, into at least two compartments.

EXCEPTION: Spaces having direct exit to one of the following fulfill the requirements for subdivision of such spaces, provided the locking arrangements of doors involved meet the requirements for doors at the compartment barrier for the use condition involved:

1. a public way, or

2. a building separated from the resident housing area by 2-hour fire resistance or 50ft (15.2 m) of open space, or
3. an enclosed area having a holding space 50 ft (15.2 m) from the housing area that provides 6 sq ft (0.56 m2) or more of refuge area per person (resident, staff, visitors, etc.) that may be present at the time of the fire.

409.2.14.2 Where required, smoke barriers shall:

1. Limit the housing to a maximum of 200 residents in any smoke compartment, and
2. Limit the travel distance to a door in a smoke barrier from any room door required as exit access to 100 ft (30.5 m) and from any point in a room to 150ft (45.7 m).

   EXCEPTION: The travel distance may be increased by 50ft (15.2 m) in buildings protected by an approved automatic sprinkler system.

409.2.14.3 Smoke barriers shall be constructed in accordance with 704.2.2.1.1.

409.2.14.4 At least 6 net sq ft (0.56 m^2) per occupant shall be provided on each side of the smoke barrier for the total number of occupants in adjoining compartments. This space shall be readily available whenever the occupants are moved across the smoke barrier in a fire emergency.

409.2.14.5 Doors in smoke barriers shall swing in the direction of egress. In those applications where egress may be in either direction, a pair of swinging doors shall be provided. Center mullions are permitted. The minimum clear width of exit in the direction of exit travel shall be 32 inches (813 mm).

EXCEPTION: Doors in a smoke barrier may be of the power operated horizontal sliding type provided the force to slide the door to its fully open position does not exceed 50 lb (222 N) with a perpendicular force against the door of 50 lb (222 N). The door shall be reasonably tight fitting.

409.2.14.6 Doors in smoke barriers shall comply with 705.1.3.2.2 and shall be self-closing or automatic-closing by actuation of smoke detectors installed in accordance with NFiPA 72E. Swinging doors shall be self-latching. Powered horizontal sliding doors shall automatically return to the closed position within 15 seconds after opening, even if the close switch is not activated.

409.2.14.7 Doors in smoke barriers shall conform with the requirements for doors in means of egress as specified in 1024.2.8 and 1024.2.9 and shall have locking and release arrangements according to the use condition as follows:

1. For Use Condition 1 (Free Egress) and 2 (Zoned Egress) there shall be no locks or other arrangements to prevent free egress through the doors in the smoke barriers.
2. For Use Condition 3 (Zoned Impeded Egress) and 4 (Impeded Egress) the doors may be locked to prevent free egress provided there is remote release control conforming with the requirements for such control as specified in 1024.2.9.
3. For Use Condition 5 (Contained) the doors in smoke barriers may be locked with a key provided the keying arrangements meets the requirements specified for locked egress doors in 1024.2.9.

409.2.14.8 Vision panels of approved transparent wired glass not exceeding 1296 sq in (0.84 m^2) with steel frames shall be provided in each door in a smoke barrier.

409.2.14.9 An approved damper designed to resist the passage of smoke shall be provided at each point a duct penetrates a required smoke barrier. The damper shall close upon detection of smoke.

EXCEPTION: Buildings designed with an engineered smoke control system approved by the building official need not comply with this requirement.

409.2.15 Subdivision of Resident Housing Areas. Any individual cell, dormitory, or other space where residents are housed shall be separated from all other spaces by substantial construction of noncombustible materials in accordance with Table 409.2.15.

Table 409.2.15
Separation Required For Resident Housing Areas[1,2,3,4]

Feature	Use 2		Use 3				Use 4				Use 5	
	NS	AS	NS		AS		NS	AS			NS	AS
Room to Room Separation	NR	NR	NR		NR		ST	NR			FR(1/2)	ST
Room Face to Corridor Separation	ST	NR	ST		NR		ST	NR			FR	ST
Room Face to Common Space Separation	NR	NR	NR ≤50 ft[5]	ST >50 ft[5]	NR ≤50 ft[5]	ST >50 ft[5]	ST	NR ≤50 ft[5]	ST >50 ft[5]		FR	ST
Common Space to Corridor Separation	FR	NR	FR		NR		FR	NR			FR	ST
Total Openings in Solid Room Face	120 sq in		120 sq in				120 sq in				120 sq in closable from inside or 120 sq in w/smoke control	

1 in^2 = 645.16 mm^2

AS = Protected by automatic sprinklers
NS = Not protected by automatic sprinklers
NR = No requirement
ST = Smoketight
FR = Fire Rated – 1-hour
FR(1/2) = Fire Rated – 1/2-hour

Notes:

1. Doors in openings in partitions required to be fire resistant by this chart in other than required enclosures of exits or hazardous areas shall be substantial doors of construction that will resist fire for at least 20 minutes. Wire glass or minimum 45-minute fire-rated glazing vision panels are permitted. Latches and door closers are not required on cell doors.
2. Doors in openings in partitions required to be smoketight by the chart shall be substantial doors, of construction that will resist the passage of smoke. Latches and door closers are not required on cell doors.
3. "Total Openings in Solid Room Face" includes all openings (undercuts, food passes, grills, etc.), the total of which will not exceed 120 sq in. All openings shall be 36 inches or less above the floor.
4. Under Use Condition 2, 3, or 4, a space housing not more than 16 persons and subdivided by open construction (any combination of grating doors and grating walls or solid walls) may be considered one room. The perimeter walls of such space shall be of smoketight construction. Smoke detection shall be provided in such space. Under Use Condition 4, common walls between sleeping areas within the space shall be smoketight and grating doors and fronts may be used.
5. This is the travel distance through the common space to the exit access corridor.

409.2.16 Windowless Buildings.

409.2.16.1 For the purpose of this section a windowless building or portion of a building is one with nonopenable windows, windows not readily breakable, or with no windows.

409.2.16.2 Windowless buildings shall be provided with vent openings, smoke shafts, or an engineered smoke control system approved by the building official to provide ventilation, mechanical or natural, for each windowless smoke compartment.

409.2.17 Building Services.

409.2.17.1 Alarms, emergency communication systems and the illumination of generator set locations shall be as described for the Life Safety Branch in NFiPA 70.

409.2.17.2 Portable space heating devices are prohibited. Any heating device other than a central heating plant shall be so designed and installed that combustible material will not be ignited by it or its appurtenances. If fuel-fired, such heating devices shall be chimney or vent connected, shall take air for combustion directly from outside, and shall be so designed and installed to provide for complete separation of the combustion system from the atmosphere of the occupied area. The heating system shall have safety devices to immediately stop the flow of fuel and shut down the equipment in case of either excessive temperatures or ignition failure.

EXCEPTION: Approved suspended unit heaters may be used in locations other than means of egress and sleeping areas provided such heaters are located high enough to be out of the reach of persons using the area and provided they are vent connected and equipped with the safety devices called for above.

409.2.17.3 Combustion and ventilation air for boiler, incinerator or heater rooms shall be taken directly from and discharged directly to the outside air.

409.2.17.4 Trash chutes, incinerators and laundry chutes shall comply with the provisions of NFiPA 82.

1. Any trash chute or linen chute, including pneumatic rubbish and linen systems, shall be provided with automatic extinguishing protection installed in accordance with NFiPA 13.
2. Any trash chute shall discharge into a trash collecting room used for no other purpose and protected in accordance with NFiPA 82.
3. No incinerator shall be directly flue-fed nor shall any floor chute directly connect with the combustion chamber.

409.2.18 Emergency and Standby Power and Light.

409.2.18.1 A permanently installed battery or standby engine driven power generation system conforming to NFiPA 70 shall be provided to serve essential emergency operation. It shall be equipped to automatically start upon failure of the normal electrical service, and within 10 seconds of the loss of power to automatically transfer circuits required for essential emergency operations. The system shall have an on-premises fuel supply sufficient for at least 2 hours of continuous operation at full demand load; equipment fueled by pipeline natural gas may be utilized if acceptable to the building official. System supervision devices and a manual start feature shall be provided in the facilities with a rated capacity of 48 or greater. Prisons shall have a fuel supply sufficient for 24 hours.

409.2.18.2 The following loads are classified as essential emergency operations:

1. Emergency egress illumination in accordance with 1016.
2. Exit sign illumination.
3. All power and lighting circuits in Central Control.
4. Lighting at each staff station.
5. All required communication and signal systems, including facility telephone lines.
6. Automatic fire detection and fire protective signaling systems.
7. Power for electric door operation and lock release.
8. Fire pumps where required.
9. All equipment required to provide smoke control.

409.2.18.3 Normal and standby power shall be so arranged to minimize the simultaneous interruption of power by a single act including the opening of a switch.

409.2.19 Fire Access Openings. Openings for fire department use in 903.5 and 1405 are not required.

410 SPECIAL RESIDENTIAL OCCUPANCIES

410.1 General

410.1.1 Additional provisions for R3 occupancies are contained in Appendix C. Those provisions are applicable only where specifically included in the adopting ordinance.

410.1.2 Provisions for Group R high rise buildings are contained in 412.

410.2 Special Provisions For Type VI Group R2 Buildings

410.2.1 For buildings two stories or more in height, there shall be at least one window meeting Section 1005.4 or balcony accessible to fire service personnel. The window or balcony shall provide emergency ladder access from finished grade which is no more than 15% maximum slope for a distance of 12 feet from the building wall.

410.2.2 All exterior attached storage rooms shall have a minimum of 1/2 inch fire rated gypsum wallboard on ceilings and all interior walls (taping and mudding not required).

410.2.3 Soffit surface shall be constructed of noncombustible materials or exterior fire retardant treated lumber. No soffit openings shall be permitted above an unprotected opening to a point l foot to each side of unprotected openings.

410.2.4 With a single exit as permitted in 1026.1, all exitway wall and roof/ceiling assemblies shall be constructed as follows:

1. The separation wall between the unit and the exitway shall have a fire resistance rating of at least 1-hour, with fire exposure from either side.
2. All wall and ceiling surfaces of the exitway shall be constructed with noncombustible materials or fire retardant treated lumber.
3. All construction within an exitway, including decking, structural members and stairways, shall be of noncombustible materials or fire retardant treated lumber.

NOTE: Fire retardant treated lumber shall be weather protected by a roof covering.

410.2.5 For sprinklered buildings (see 903.7.6) with exitways provided with complete sprinkler protection using NFiPA 13R hydraulic and coverage requirements, installed to prevent freezing of piping and accessories, the following provisions are allowed:

1. The exitway protection listed in 410.2.4, shall be waived.
2. The limitation of 1026.1.1(1) shall be 40 feet.
3. The limitations of 1026.1.1(2) and 1026.1.1(3) shall be waived.
4. The maximum building height listed in 1026.1.1(4) shall be two stories above the level of exit discharge.
5. The protection of wall openings listed in 705 shall be waived.

411 SPECIAL STORAGE OCCUPANCIES

411.1General

411.1.1 Refer to Chapter 36 of the Standard Fire Prevention Code for provisions on storage of high-piled combustible material and high-rack storage systems.

411.1.2 The storage, location, and ventilation requirements for storage batteries shall comply with NFiPA 70, Article 480.

411.2 Automobile Parking Garages

411.2.1 Automobile parking garages shall be classified as either open, as defined in 411.3, or enclosed and shall meet the appropriate criteria of 411.3 or 411.4.

411.2.2 The clear height of each floor level in vehicle and pedestrian traffic area shall not be less than 7ft (2134 mm).

411.2.3 Pedestrian guardrails shall be provided in accordance with 1015 at all exterior and interior vertical openings on all floor and roof areas where automobiles are parked or moved and when the vertical distance to the ground or surface directly below exceeds 3 ft (914 mm). Such parking areas shall also be provided with exterior or interior walls or impact guardrails, except at pedestrian or vehicular accesses, designed in accordance with 1608.2.3. Impact guardrails not less than 2 ft (607 mm) high shall be placed at the ends of drive lanes, at the end of parking spaces at the perimeter of the structure and at the end of parking spaces where the difference in adjacent floor elevation is greater than 1 ft (305 mm).

411.2.4 Automobile ramps shall not be considered as providing required exit facilities. Enclosed ramps shall be in accordance with the exit requirements of Chapter 10.

411.2.5 Parking surfaces shall be of concrete or similar noncombustible and nonabsorbent materials.

EXCEPTION: Asphalt parking surfaces are permitted at ground level.

411.2.6 Automobile parking garages shall be separated from other occupancies in accordance with 704.

EXCEPTION: Separation is not required between a Group R3 building and an attached garage.

411.2.7 Connection of an automobile parking garage with any room in which there is a fuel-fired appliance shall be by means of a doorway with a raised sill at least 8 inches (203 mm) above the garage floor or through a vestibule providing two door separation.

411.2.8 Openings from a parking garage directly into a room used for sleeping purposes shall not be permitted.

411.2.9 Garages of Type VI construction shall be permitted for use only for dead storage or display of automobiles.

EXCEPTION: Garages not exceeding 850 sq ft (79 m^2) and used for the storage of not more than four automobiles or trucks of 1 ton (907.2 kg) or less capacity.

411.3 Open Parking Garages

411.3.1 Open automobile parking garages with roof parking may be constructed to the allowable heights and areas specified in Table 411.3.1. To be considered open, the garage shall meet the requirements of 411.3.2, 411.3.3 and 411.3.4.

411.3.2 The exterior and interior walls of the garage shall be designed in accordance with one of the following:

1. At least 50% of the clear height between floors shall be open to the atmosphere for the full length of at least two exterior walls, excluding required stair and elevator walls and structural columns. Interior wall lines and column lines shall be at least 20% open and uniformly distributed, or
2. The exterior walls of the structure shall have uniformly distributed openings on two or more sides totaling no less than 40% of the building perimeter. The area of such openings in the exterior walls on each level shall be at least 20% of the total perimeter wall area of each level. Interior wall lines and column lines shall be at least 20% open and uniformly distributed.

411.3.3 The distance from any point on any floor level to an open exterior wall facing on a street, or to other permanently maintained open space at least 20 ft (6096 mm) wide extending full width to a street, shall not exceed 200 ft (61 m).

411.3.4 Garages within 10ft (3048 mm) of a common property or building line shall be provided with an enclosure wall along the line of not less than 1-hour fire resistance without openings therein, except door openings meeting the requirements of 705.1.3 shall be permitted.

Table 411.3.1
Open Automobile Parking Garages Allowable Heights and Areas

Construction Type	Sq Ft Per Floor	Allowable Height
Type I	No Limit	No Limit
Type II	No Limit	No Limit
Type III	30,000	4 stories or 40 ft
Type IV	400,000	8 stories of 75 ft

1ft= 0.305 m
1 sq ft = 0.0929 m^2

411.4 Enclosed Parking Garages

411.4.1 Enclosed automobile parking garages and portions thereof which do not meet the definition of open parking garages shall be limited to the allowable heights and areas specified in Table 500 for Group S buildings. Roof parking is permitted.

411.4.2 A mechanical ventilation system for the removal of the products of combustion shall be provided in enclosed automobile parking garages. The mechanical system shall be capable of providing at least 6 air changes per hour for each level. Under normal use the ventilation of the enclosed automobile parking garage shall comply with the ventilation requirements of 411.5.

EXCEPTION: A mechanical ventilation system shall not be required in garages used for the storage of no more than four automobiles or trucks of 1 ton (907.2 kg) maximum capacity and not exceeding 850 sq ft (79 m^2).

411.5 Repair Garages

411.5.1 A repair garage is any building or part thereof which is used for painting, body and fender work, engine overhauling or other major repair of motor vehicles.

EXCEPTION: This occupancy shall not include automotive service stations, as defined in 404.2.

411.5.2 Garages of Type VI construction may be used only for dead storage and display of automobiles.

411.5.3 A repair garage shall not be located within, or attached to, a building occupied for any other purpose, unless separated from the other occupancies as prescribed in 704. Such separation shall be continuous and unpierced, except for doors leading to salesrooms, or offices, operated in connection with such garages, provided such openings are approved by the building official as being required or essential, and provided such openings are equipped with self-closing fire doors conforming to the requirements of 705.1.

411.5.4 Repair garages shall be continuously ventilated by a mechanical system with positive means for both inlet and exhaust of at least 0.75 cfm per sq ft (0.0038 $m^3/s/m^2$) of floor area, controlled from a location close to the entrance door.

411.5.5 Garage floors shall be of concrete or similar noncombustible and nonabsorbent materials.

411.5.6 Heating equipment, other than unit heaters suspended at least 8 ft (2438 mm) above the garage floor, shall be placed in another room separated by 2-hour fire resistant construction. Entrance shall be from the outside or by means of a doorway with sill raised at least 8 inches (203 mm) above the garage floor level or through a vestibule providing two doorway separations.

411.6 Parking Lots

Open sheds or canopies may be erected not to exceed two-thirds the area of the lot, provided such construction is not less than that required for Type IV construction, and that all such construction meets the approval of the building official.

411.7 Aircraft Hangars

411.7.1 Aircraft hangars may be of any type of construction. Exterior walls that are located within 30ft (9144 mm) and facing common property lines or the opposite side of a public street or thoroughfare shall provide not less than 2-hour fire resistance.

411.7.2 The floor areas of hangars shall not exceed those permitted for Group S in Table 500 as modified.

411.7.3 Where hangars have basements, the floor over the basement shall be of Type I construction and shall be made tight against seepage of water, oil or vapors. There shall be no opening or communication between basement and hangar. Access to basement shall be from outside only.

411.7.4 Floors shall be graded and drained to prevent water or gasoline from remaining on the floor. Floor drains shall discharge through an oil separator to the sewer or to an outside vented sump.

411.7.5 Heating equipment other than unit heaters suspended at least 10 ft (3048 mm) above the upper surface of wings or engine enclosures of the highest aircraft which may be housed in the hangar and at least 8 ft (2438 mm) above the floor in shops, offices, and other sections of the hangar communicating with storage or service areas shall be placed in a separate room cut off by 2-hour fire resistant construction. Entrance shall be from the outside or by means of a doorway with a sill raised at least 8 inches (203 mm) above the hangar floor level or through a vestibule providing two door separation.

411.7.6 The process of "doping," involving use of a volatile flammable solvent, or of painting, shall be carried on in a separate detached building equipped with automatic sprinkler equipment in accordance with 903.

411.7.7 Aircraft hangars shall be provided with fire suppression as required in NFiPA 409.

EXCEPTION: Group II hangars storing private aircraft without major maintenance or overhaul are exempt from foam suppression requirements.

411.7.8 Residential Aircraft Hangars.

411.7.8.1 Residential aircraft hangars as defined in 411.7.8.2 shall comply with 411.7 8.3 through 411.7.8.7.

411.7.8.2 Definitions.

RESIDENTIAL AIRCRAFT HANGAR – an accessory building less than 2,000 sq ft (186 m^2) in area, constructed on a one or two family residential property where aircraft of the owner is stored. Such use will be considered as a residential accessory use incidental to the dwelling.

411.7.8.3 A hangar may be attached to a dwelling when separated by walls having a fire resistance rating of not less than 1 hour. Such separation shall be continuous from foundation to the underside of the roof and unpierced except for doors leading to the dwelling unit. All doors into the dwelling unit must be equipped with self-closing devices and conform to the requirements of 705.1 with at least a 4-inch (102 mm) noncombustible raised sill.

411.7.8.4 A hangar shall provide two means of egress. One of the doors into the dwelling shall be considered as meeting only one of the two means of egress.

411.7.8.5 At least one approved smoke detector shall be installed within the hangar and shall be hardwired into the residential smoke alarm or other sounding device to provide an alarm which will be audible in all sleeping areas of the dwelling.

411.7.8.6 All mechanical and DWV systems installed within the hangar shall be independent of the systems installed within the dwelling. Building sewer lines may connect outside the structures.

EXCEPTION: smoke detector wiring and feed for electrical subpanels in the hangar.

411.7.8.7 Hangars shall not exceed 2,000 sq ft (185.8 m^2) in area and 20 ft (6096 mm) in height.

411.8 Helistops

411.8.1 Helistops may be erected on buildings or other locations when they are constructed in accordance with this section.

411.8.2 The touchdown or landing area for helicopters of less than 3,500 lb (1588 kg) shall be a minimum of 20 ft (6096 mm) in length and width. The touchdown area shall be surrounded on all sides by a clear area having a minimum average width at roof level of 15 ft (4572 mm) but with no width less than 5 ft (1524 mm).

411.8.3 Helicopter landing areas and the supports thereof on the roof of a building shall be noncombustible construction. Landing areas shall be designed to confine any flammable liquid spillage to the landing area itself and provision shall be made to drain such spillage away from any exit or stairway serving the helicopter landing area or from a structure housing such exit or stairway.

411.8.4 For means of egress requirements for helistops, see 1027.1.2.

411.9 Coal Pockets

Coal pockets, and other similar structures, shall be constructed of steel, concrete, or other noncombustible material, or of lumber sizes which meet the requirements of Type III construction.

411.10 Greenhouses

411.10.1 Greenhouses constructed totally of noncombustible materials and used exclusively for the cultivation of live plants may be unlimited in area.

411.10.2 Greenhouses more than 35ft (10.7 m) high shall have a noncombustible structural frame. Greenhouses not over 400 sq ft (37.2 m^2) in area and not over 15 ft (4572 mm) high shall be considered accessory structures and may be of any construction, except that a greenhouse with wood frame construction shall be located not less than 5 ft (1524 mm) from an adjoining structure or property line.

411.10.3 Refer to Table 1610.1 for deflection limits.

411.10.4 Greenhouses used exclusively for the cultivation of live plants and with no access to the general public shall be considered to represent a low hazard to human life for purposes of establishing the importance factor, I, in ASCE 7, Section 7, and the use factor in ASCE, Section 6.

411.11 Farm Buildings

Farm buildings shall include those structures, other than residences and structures appurtenant thereto, for on-farm use (barns, sheds, poultry houses, etc.). Refer to Table 1610.1 for deflection limits.

412 SPECIAL PROVISIONS FOR HIGH RISE BUILDINGS

412.1 General Requirements

412.1.1 Scope. The provisions of this section apply to all buildings in which the highest occupied floor is more than 75 feet above the highest firefighting vehicle apparatus access area.

412.1.2 Minimum Construction. Construction shall be of Type I or Type II in accordance with Tables 500 and 600. For Business, Mercantile, and Residential occupancies, Type II construction may be used where Type I construction may be required by Table 500.

412.1.3 Fire Fighting Vehicle Apparatus Access Area. Fire fighting vehicle apparatus, access shall be provided adjacent to and parallel to each building. A clear unobstructed access area not less than 36 ft wide shall be provided. The edge of the access area closest to the building shall be at least 10 ft from the building wall but not more than 35 ft from the building wall. The length of the access area shall be at least 25% of the perimeter of the building or one entire side of the building, whichever is less. No parking or other obstructions are permitted in a 20 ft wide strip nearest the building. Public streets and sidewalks meeting these requirements may be used for this area.

412.1.4 A minimum of one window or openable identified access panel per floor shall be provided on the access side of the building to provide emergency access. The window or panel shall have a minimum area of 20 sq ft with a minimum height of 48 inches and a minimum width of 36 inches. When an openable panel is provided, it shall be identified on both the interior and exterior sides of the building. Access windows or panels are not required to floors which are more than 100 ft above the fire fighting vehicle apparatus access area

412.1.5 Fire Department Equipment Area. A clear unobstructed staging area shall be provided for each building. The area shall be located on the same level as the return point of the primary emergency elevator within 75 clear unobstructed feet of a building entrance door serving this level. The building entrance door shall be located within 75 ft of the primary emergency elevator. This door may be the same door required by 412.8.1. When more suitable for fire department operations, the staging area may be located within 75 ft of the Fire Department building connection when approved by the Building Official. The staging area shall be a minimum of 36 ft wide by 75 ft long. Thirty-three percent of this area may be used as normal parking space. The staging area may be the same area required in 412 1.3 if all of the other requirements of this section are met.

412.1.6 Support Base. The fire apparatus access and staging area shall have a base equivalent to six inches of crusher run unwashed stone mix compacted to 95% compaction. An equivalent support base designed by a Professional Engineer is acceptable. The support base shall be capable of supporting the firefighting apparatus of the municipality having jurisdiction.

412.1.7 High Rise Requirements Preemptive. All high rise buildings shall comply with the requirements of applicable Sections of the North Carolina State Building Code, Volume 1 - General Construction, Volume II - Plumbing, Volume III - Mechanical, Volume IV - Electrical, Volume V - Fire Prevention, and Volume VI - Gas. When there is a conflict, the provisions of this section shall apply unless expressly stated otherwise.

412.1.8 Central References for High Rise Requirements. The designer shall provide a central reference sheet indicating sheet numbers and specifications sections which provide a summary of the description of the operation and schematic drawings of required mechanical and electrical *"life safety equipment"*. Information as to how they propose to comply with the provisions of this section shall also be included. This information shall be submitted with preliminary plans.

412.1.9 Maintaining Fire Resistive Integrity of Floors and Walls. Plans for all buildings shall indicate the tested assembly fire resistive design numbers or clearly indicate the approved reference from which the fire resistive rated assemblies were obtained or calculated. Penetrations of rated walls, partitions and floors by cables, cable trays, conduits, ducts and pipes shall be firestopped with a material which has been tested and listed as complying with the F rating of ASTM E 814 or UL 1479 as suitable for this purpose or other materials which have been demonstrated to withstand ASTM-E 119 fire conditions without permitting the passage of flame and hot gases sufficient to ignite cotton waste for a time period of at least equal to the fire resistance rating of the penetrated assembly. Details shall be provided to indicate how the required structural and fire resistive integrity is maintained at these penetrations. Details shall be provided to indicate how the fire integrity will be maintained where floors abut or intersect exterior walls.

412.1.10 Materials in Concealed Spaces. For the purpose of this section, concealed spaces are those spaces which are not visible from the occupied space. Such spaces are normally cavities of walls, partitions, ceiling/floor and ceiling/roof assemblies and shafts. Materials used within concealed spaces shall conform with the following requirement: (Note: Exposed materials shall meet the requirements of Table 412.7 and shall be considered as part of the trim and other incidental finish permitted by Section 704.)

1. These materials shall meet one of the following requirements:
   a. Qualifies as noncombustible in accordance with the requirements of part (l) of the definition of noncombustible material contained in 202, or
   b. The materials are located within an assembly, which has been tested with the materials incorporated therein and listed by a nationally recognized testing laboratory as complying with ASTM E 119, or
   c. The materials have a maximum flame spread rating of 25 and a maximum smoke developed rating of 50 when tested and Listed in accordance with ASTM E 84.
2. This section does not apply to materials encased by and embedded in concrete or masonry with a minimum cover of 2 inches or to materials located in noncombustible enclosures.
3. Penetration of floor slab within a floor assembly may be permitted with such materials which do not meet the definition of noncombustible provided such penetration meets the F rating requirements of UL 1479 or ASTM E 814.
4. Except as noted in 412.1.10(5), non-metallic piping materials, other than that used for acid waste systems, which do not meet the requirements of 412.1.10(1) shall not be used.
5. Flame retardant non-metallic piping materials classified as self-extinguishing group one by ASTM D 635 may be used for acid waste drainage and vent systems. Non-metallic vertical piping extending more than one floor level shall be located in a 2-hour fire rated shaft with horizontal penetrations fire stopped in accordance with 412.1.9.
6. Exhaust ducts (metallic and non-metallic) conveying corrosive vapors and extending more than one floor level shall be located In a continuous 2 hour fire rated shaft with no openings into other floors. Fire dampers are not required where ducts enter the shaft.

412.1.11 Design of Life Safety Equipment. All electrical, mechanical, central alarm and communications systems, smoke control measures and sprinkler systems as hereinafter specified shall be designed and sealed by a Professional Engineer in the State of North Carolina in accordance with Chapter 89(C) of the General Statutes.

412.1.12 Filing of Field Test Reports on Life Safety Equipment. The Professional Engineer performing the design for the electrical, mechanical and sprinkler systems shall file test results with the Building Official that such systems have been tested to indicate that as installed, they function in accordance with the standards specified in this section and according to design criteria.

412.1.13 Portions of a building of Type II Construction adjacent and connecting to a high rise building in which the top occupied floor does not exceed 75 ft above firefighting apparatus access area are exempt from this section, subject to the following provisions:

1. Adjacent portions shall be separated from high rise portions by 2-hour rated walls. A high rise portion of a building shall not be supported by any portion of a building which does not meet the requirements of this section.
2. Any required exit from the high rise portion which passes through the low rise portion shall be separated from the low rise portion by 2-hour fire rated construction.
3. When a floor or additional floors are added to an existing building, the entire building shall comply with the provisions of this section if the addition reclassifies the building as high rise.

412.1.14 No hazardous occupancy is permitted in buildings classified as high rise.

412.1.15 Section 418 and 1021.1 requires rooms used for day care nurseries, kindergarten or first grade students to be located on the floor of exit discharge and that rooms used by second grade pupils be located not more than one story above the floor of exit discharge.

412.2 Smoke Control

412.2.1 Smokeproof Stairs. All required exit stairways shall be smokeproof in accordance with 1005.5.

EXCEPTION: A maximum of 50% of the stair may be pressurized in accordance with 412.2.1.1 and 412.2.1.2. Access to the pressurized stair by way of a vestibule or an open exterior balcony is not required.

412.2.1.1 Stairways Serving Floors Above the Lowest Exit Level. Stairways serving floors above the lowest exit level shall comply with the following:

1. A vent or door located at or near the lowest exit level shall be provided. The vent or door shall open automatically upon start-up of the shaft pressurization fan.
2. The vent or door shall have a net openable area of 0.5 sq ft for every door opening into the stairshaft, but not less than 20 sq ft.
3. The vent or door shall open directly to the outside or an exit corridor that has a similar opening to the outdoors.
4. Equipment capable of providing an outside air supply of 15,000 CFM plus 200 CFM for every door opening into the shaft shall be provided.
5. When the height of shaft exceeds 225 ft, a pressure relief damper shall be provided at the top of the shaft. The damper shall be controlled by a static pressure regulator activated by the supply fan circuit. The regulator shall be connected to the emergency electrical power supply system. The regulator shall be set to limit the static pressure at the top of the shaft to a maximum of 2 psf.
6. See Section 1005.5.9.

412.2.1.2 Stairways Serving Floors Below the Lowest Exit. Stairways serving floors below the lowest exit level shall comply with the following:

1. A vent or door complying with 412.2.1.1(1), 412.2.1.1(2) and 412.2.1.1(3) shall be provided except the opening shall be at top of shaft.
2. If a common shaft is used for upper and lower floors, the shaft serving lower floors shall be separated from upper floor shaft at lowest exit floor with 2-hour fire rated construction.
3. Equipment capable of providing an outside air supply of 1,000 CFM per floor served by the shaft shall be provided.
4. See Section 1005.5.9.

412.2.2 All elevator shafts shall be pressurized so that, during a period of two hours after the start of a fire, they will not contain more than 1 percent by volume of contaminated air from the fire floor, assuming an outdoor temperature equal to the January design temperature on a 97 1/2 percent basis according to ASHRAE Guide. Pressurizing equipment (fans and ductwork) when located inside the building shall be located in 2 hour fire rated construction. Ventilation of the hoistway is not required when the hoistway is pressurized. Elevators which do not serve more than three floors are not required to be pressurized. See Figure 412.2 for elevator shaft air requirements.

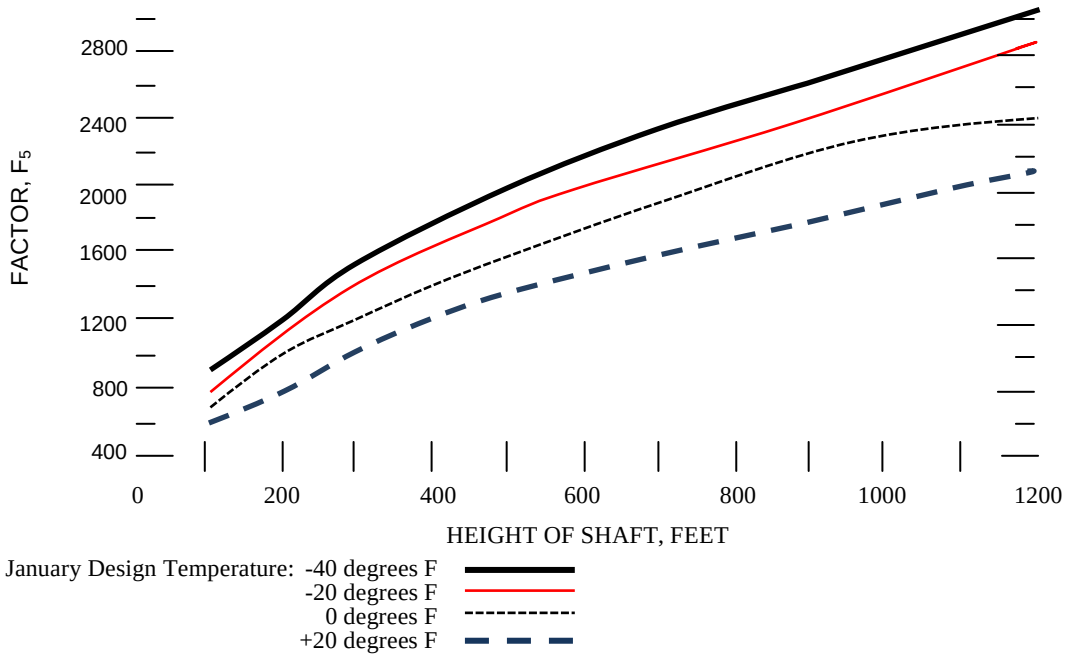


FIGURE 412.2
FACTOR FOR AIR SUPPLY TO AN ELEVATOR SHAFT

Notes to Figure 412.2

1. Air supply to each elevator shaft in cubic feet per minute
   $= F^5 \ (0.25d^5 = 0.0014a^5)$
   where
   F^5 is factor obtained from Figure 412.2
   d^5 is the total number of doors having a perimeter not more than 20 ft. that open into the elevator shaft.
   a^5 is the area of enclosing walls of the shaft in square feet
2. If the perimeter of a door exceeds 20 ft the value of d' must be increased in direct proportion to the increase in the perimeter.
3. A double leaf door is counted as 2 doors in this formula.
4. If the enclosing walls of the shaft are of monolithic concrete or of unit masonry plastered on one side, the value of a^5 may be halved.
5. If an elevator shaft is provided with vestibules on each floor, the enclosing walls considered in this formula may be taken as including those of the vestibules if it leads to an economy in air supply requirements. In this case d^5 refers to doors between the vestibules and the floor areas, and doors between the elevator shaft and the vestibules do not enter into the calculation.

412.3 Sprinklers And Standpipes

412.3.1 All buildings shall be provided with an approved sprinkler system in accordance with NFiPA 13, standpipes in accordance with NFiPA 14, and 412.3.1.1 thru 412.3.1 .4. See Section 901.5 for rooms and areas which are exempted from having sprinkler heads.

EXCEPTION: Parking structures complying with Section 411.3.2(2) when of Type I or Type II construction and which are within buildings or occupancies referenced in Section 411.3.1 (Business, Mercantile or Residential) are not required to be provided with automatic sprinkler protection.

412.3.1.1 The sprinkler system shall be equipped with a water flow and supervisory signal system that will transmit automatically a signal directly to the Fire Department or to an independent signal monitoring service satisfactory to the Fire Department upon flow of water.

NOTE: Refer to Table 1004 for 50% increase in travel distance for exits for sprinklered buildings and to Chapter 9 for other code references for sprinklered buildings. This increase does not apply to deadend limits.

412.3.1.2 Supervised shut off valves (tamper-proof switches) and water flow devices shall be provided at every branch sprinkler connection to a vertical riser on each floor. System to transmit signal shall be electrically supervised or by a digital dialer with automatic periodic confirmation.

412.3.1.3 Standpipes for fire department use shall be provided in each required exit stairwell. Two fire department connections per standpipe shall be provided at each floor level. One connection shall be located within the exit stairwell. The other connection shall be located on the interior of the building, within 5 ft of the stairwell door. The connections shall be 2 1/2 inches in diameter with threads that match the local fire department threads. Fire hose for connections is optional; however, when supplied, shall be a maximum of 1 1/2-inch in size.

412.3.1.4 The minimum water supply for a combined sprinkler and standpipe system for a light hazard occupancy shall be 500 gpm. The minimum water supply for other buildings shall be 1000 gpm. The supply shall be sufficient to maintain a residual pressure of 65 psi at the topmost outlet of each standpipe with 500 gpm flowing from the topmost outlet of the most remote standpipe and 250 gpm flowing from the topmost outlet of each of the other standpipes up to a maximum flow of 2500 gpm flowing.

412.3.2 A preaction sprinkler system, fixed water spray protection covers, carbon dioxide, or halon flooding systems may be used in areas having equipment or activities which are sensitive to water. When more than 1/3 of a floor is protected with a carbon dioxide or halon flooding system, the area shall also be protected with a system complying with NFiPA 13. High temperature sprinkler heads may be used with this system.

412.4 Smoke Venting

Natural or mechanical ventilation methods for the removal of products of combustion shall be provided in every story of buildings and shall comply with 412.4.1, 412.4.2, or 412.4.3.

412.4.1 In the exterior walls, fixed windows with tempered glass only, or panels or windows which can be opened from the interior without the use of special devices shall be provided. Such venting facilities shall be provided at the rate of 20 sq ft per 50 lineal feet of exterior wall in each story and distributed around the perimeter at not more than 50 foot intervals. Such panels and their controls shall be clearly identified. When a building has less than two exterior walls, one of the systems in 412.4.2 or 412.4.3 shall be used for venting.

412.4.2 The mechanical air handling equipment may be designed to accomplish smoke venting. Under fire conditions, the system shall maintain 6 air changes per hour on the fire floor.

412.4.3 One or more vertical shafts meeting the following:

1. Have an opening or openings into each floor with an aggregate area of not less than that obtained from Table 412.4A. Leakage characteristics of the shaft shall be determined by Table 412.4B. Damper leakage shall be determined by Table 412.4C.
2. The cross sectional area of the shaft shall be equivalent to the total area of all openings determined in (1) above.

3. Top of openings shall not be more than 10 inches below the ceiling. Openings may be above ceiling if the ceiling freely allows passage of air.
4. Openings shall be equipped with a 1 1/2 hour rated and listed motor operated fire damper. A smoke detector shall be located adjacent to each opening. Dampers shall be able to be manually opened from a remote location such as a stair shaft, floor immediately below or central control room. Dampers shall open automatically only when activated by the smoke detector located near the opening.
5. Be separated from the remainder of the building by 2 hour fire resistive construction.
6. Have a dampered opening to the outdoors at the top. Area of opening shall be equal to cross sectional area of shaft. Damper shall open automatically on signal from any smoke detector or fire alarm.
7. Opening shall terminate at least 3 ft above roof surface.
8. Shaft shall contain no combustible materials, fuel lines, utilities, or other services.

TABLE 412.4A

MINIMUM SIZE IN SQUARE FEET OF VENT OPENING[1,2] INTO SMOKE SHAFT FROM EACH FLOOR AREA

Floor Area Sq. Ft.	Leakage[2] Area		Building Height, Ft. 60	120	240	360	480	600	720	840	960
2,000		1.0	1.1	1.3	1.5	1.6	1.8	1.9	2.0	2.1	
5,000		2.2	2.5	2.9	3.2	3.5	3.8	4.0	4.2	4.4	
10,000		4.3	4.8	5.4	5.9	6.4	6.8	7.2	7.5	7.8	
20,000		8.3	9.1	10.1	10.9	11.7	12.4	13.0	13.6	14.1	
30,000	0%	12.2	13.4	14.7	15.6	16.8	17.6	18.4	19.2	19.9	
40,000		16.1	17.5	19.1	20.3	21.7	22.7	23.7	24.7	25.5	
50,000		20.0	21.7	23.5	24.8	26.5	27.6	28.8	30.0	31.0	
60,000		23.9	25.8	27.8	29.3	31.2	32.5	33.9	35.2	36.2	
2,000		1.0	1.2	1.5	1.9	2.3	2.8	3.5	4.4	5.7	
5,000		2.3	2.7	3.4	4.1	4.9	5.8	7.0	8.5	10.6	
10,000		4.4	5.1	6.2	7.3	8.7	10.2	12.1	14.5	17.6	
20,000		8.5	9.8	11.6	13.5	15.8	18.3	21.3	25.2	30.0	
30,000	1%	12.6	14.3	16.8	19.3	22.5	25.8	30.0	35.1	41.4	
40,000		16.7	18.8	21.9	25.1	29.0	33.2	38.3	44.5	52.3	
50,000		20.7	23.2	27.0	30.7	35.4	40.3	46.4	53.8	62.9	
60,000		24.8	27.7	32.0	36.2	41.7	47.4	54.3	62.8	73.2	
2,000		1.0	1.3	1.8	2.5	3.8	6.2	13.3	48.8	961.7	
5,000		2.4	2.9	4.0	5.3	7.6	11.6	21.7	64.0	1011.4	
10,000		4.6	5.5	7.3	9.5	13.2	19.4	33.6	862	1087.8	
20,000		8.8	10.5	13.5	17.4	23.5	33.4	54.7	125.3	1235.4	
30,000	2%	13.1	15.4	19.6	24.9	33.3	464	74.1	160.7	1378.0	
40,000		17.3	20.2	25.6	32.2	42.7	59.0	92.7	194.6	1509.7	
50,000		21.5	25.0	31.4	39.5	52.0	71.3	110.5	226.0	1642.5	
60,000		25.7	29.7	37.3	46.6	61.1	83.4	128.2	258.4	1768.0	
2,000		1.1	1.4	2.2	3.8	9.1	72.8				
5,000		2.5	3.1	4.7	7.7	16.2	93.8				
10,000		4.7	5.9	8.7	13.5	26.6	124.8				
20,000		9.2	11.3	16.1	24.3	45.4	180.2				
30,000	3%	13.6	16.5	23.3	34.6	63.0	230.9				
40,000		17.9	21.8	30.4	44.7	80.1	279.3				
50,000		22.3	26.9	37.3	54.6	96.6	326.5				
60,000		26.6	32.1	44.2	64.4	112.9	372.2				
2,000		1.1	1.5	2.8	7.2	265.0					
5,000		2.5	3.4	5.9	13.6	309.7					
10,000		4.9	6.4	10.7	23.1	378.7					
20,000		9.5	12.2	19.8	40.4	504.7					
30,000	4%	14.1	17.9	28.6	56.9	622.0					
40,000		18.6	23.5	37.2	72.9	732.8					
50,000		23.1	29.1	45.7	88.7	841.0					
60,000		27.6	34.7	54.2	104.2	944.6					
2,000		1.1	1.6	3.7	35.0						
5,000		2.6	3.7	7.7	52.8						
10,000		5.1	6.9	13.9	79.0						
20,000		9.9	13.3	25.6	126.2						
30,000	5%	14.6	19.5	36.8	170.5						
40,000		19.3	25.6	47.8	213.2						
50,000		24.0	31.7	58.7	254.8						
60,000		28.7	37.7	69.5	295.3						

1. The minimum size of vent opening into a smoke shaft is obtained from Table 412.4A for a smoke shaft depending on the floor area and total leakage area of smoke shaft walls and dampers. This total leakage area may be estimated where cross-sectional area of smoke shaft, opening into shaft and opening to the outdoors at the top of the shaft are equal by adding the leakage areas for shaft wall obtained from Table 412.4B and for dampered openings obtained from Table 412.4C.
2. Leakage area is the total of the leakage area of smoke shaft wall obtained from Table 412.4B and the leakage area of dampered opening in smoke shafts obtained from Table 412.4C.

TABLE 412.4B

LEAKAGE AREA OF SMOKE SHAFT WALL

Wall Construction	Leakage Area as a Per Cent of Damper Area
Monolithic concrete	0.5
Masonry wall unplastered	1.5
Masonry wall plastered	0.5
Gypsum wallboard on steel studs	1.0

TABLE 412.4C

LEAKAGE AREA OF DAMPERED OPENINGS IN SMOKE SHAFT

Type of Damper	Leakage Area as a Per Cent of Damper Area[1]
Curtain fire damper	2.5
Single-blade fire damper	3.5
Multi-blade fire damper	4.5

1. Values include allowance for 0.5 per cent leakage between frame and wall construction.

412.5 Requirements For Connecting Buildings

Where a high rise building is connected to any other building, measures shall be taken to limit the movement of contaminated air from one building into another during a fire by venting a connecting vestibule directly outside or by pressurizing the vestibule. See Figures 412.5A and 412.5B for vestibule air supply requirements.

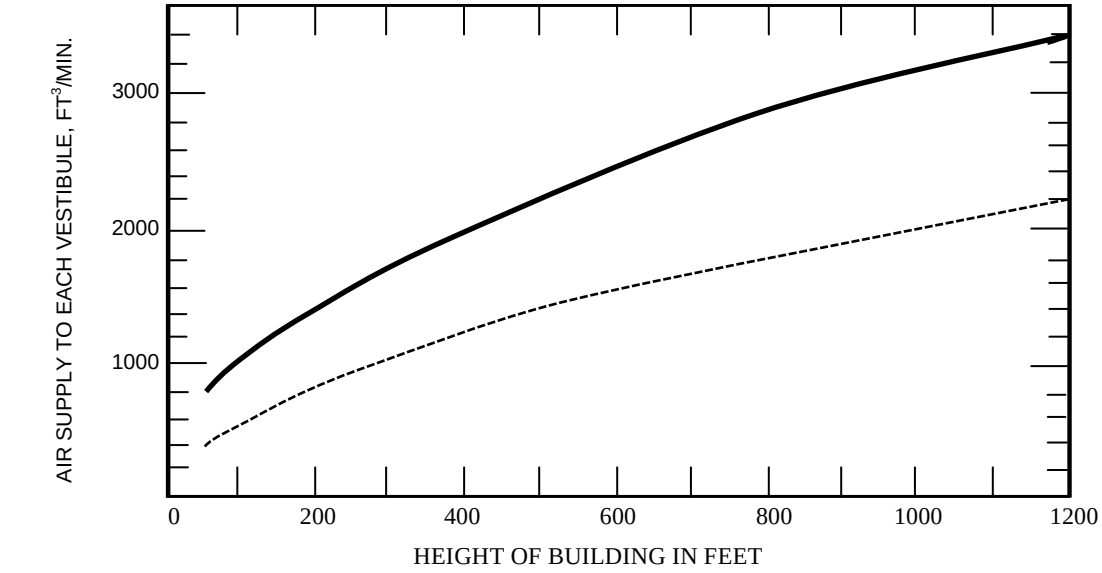


FIGURE 412.5A
AIR SUPPLY TO VESTIBULE IN A DIVIDED BUILDING

Notes to Figure 412.5A

1. Curve A shows the air supply to each vestibule in cubic feet per minute for a vestibule that has 4 doors (or two double doors) each door having a perimeter of not more than 20 ft between the vestibule and the floor areas in either side of the building.
2. Curve B shows the air supply to each vestibule in cubic feet per minute for a vestibule that has 2 single doors each door having a perimeter of not more than 20 ft between the vestibule and the floor areas on either side of the building.
3. If the perimeter of a door exceeds 20 ft the air supply must be increased in direct proportion to the increase in the perimeter.

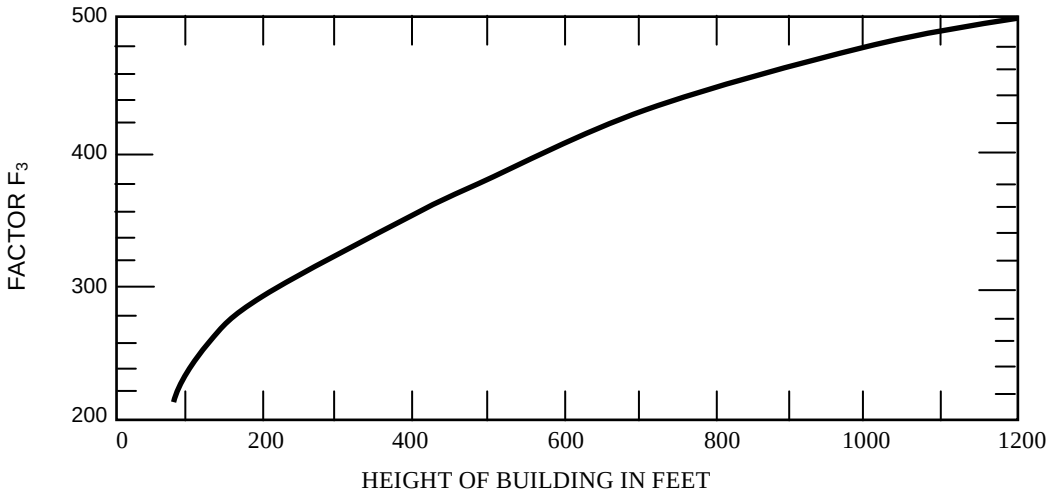


FIGURE 412.5B
FACTOR FOR MECHANICAL AIR SUPPLY TO A VESTIBULE

Notes to Figure 506.5B

1. Air supply to each vestibule in cubic feet per minute

$$= F_3 d + 150e + 200s$$

where
F_3 is a factor obtained from Figure 506.5B.
d = the number of doors having a perimeter not more than 20 ft. between each vestibule and a floor area.
e = the number of doors having a perimeter not more than 20 ft. between each vestibule and an elevator shaft.
s = the number of doors having a perimeter not more than 20 ft. between each vestibule and a stair shaft.

2. If the perimeter of a door exceeds 20 ft. the value of d, e or s must be increased in direct proportion to the increase in the perimeter.
3. A double leaf door is counted as 2 doors.

412.6 Elevators

412.6.1 Standards. All elevators for high rise buildings shall comply with the "Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks," ANSI A17.1

412.6.2 Additional Requirements for Controls and Pressurization of Hoistways. In addition to conforming to the ANSI A17.1, 412.6.2.1 thru 412.6.2.7 shall be met.

412.6.2.1 Elevator Lobby Separation. All public elevators on all floors except those separated from the mam building with exterior walkways shall open into usable elevator lobbies which are separated from the remainder of the building by one hour fire resistive construction with 3/4 hour fire rated doors. The main floor elevator lobby separation may be omitted.

412.6.2.2 Smoke Detectors in Elevator Lobbies. Each interior or enclosed elevator lobby or elevator entrance area shall be provided with an approved and listed supervised smoke detector located within 15 ft of the elevator doors. Upon activation, this smoke detector only, when located on any floor except the main floor, shall cause all operable automatic elevators serving that common lobby to start automatically and return non-stop to the fire department access floor lobby. Smoke detectors located in the fire department access floor lobby only, when activated, shall cause these elevators to return non-stop to a designated alternate smoke-free lobby connected to an approved means of egress. In addition to smoke detectors, each single elevator or group of elevators serving a common lobby shall be provided with a key operated switch [A17.1b-211.3(a) as described in ANSI A17.1b-211.3a] located at the main floor lobby. Activation of this switch shall cause all elevators to return non-stop to the fire department access floor lobby only. After the elevators have returned to the fire department access or alternate floor, they shall remain at that floor and shall be individually available for emergency service operation as described in ANSI A17.1b. Rule 211.3(a)(4)(5)(6). When the elevator or group of elevators are in an emergency power mode of operation, the automatic return to the fire department access or alternate floor shall conform to the sequential operation as provided in this section. After all cars have returned to the fire department access or alternate floor while on emergency power, a minimum of one car in each pressurized hoist way shall remain available for emergency operation.

412.6.2.3 Signs in Lobbies. Each elevator lobby shall have an illuminated sign which is readable at all times and which flashes on and off to illuminate a device which indicates "EMERGENCY-USE THE EXIT STAIRS" when any elevator lobby smoke detector is activated. The signs on all floors served by that group of elevators shall flash. The phrase shall be red on a white background in color and be a minimum of 1/2 inch block letters.

412.6.2.4 Machine Protection. Elevator hoistways shall not be vented into an elevator machine room.

412.6.2.5 Primary Emergency Elevator. At least one passenger elevator car in each building serving all floors shall have minimum clear inside car dimensions of 4 ft 3 inches wide by 6 ft 8 inches front to back with a minimum clear door opening width of 42 inches on the narrow side. Elevators otherwise designed to provide equivalent access to accommodate an ambulance stretcher (minimum size 24 inches x 76 inches) in its horizontal position may be installed in accordance with Table 506.6. This elevator shall be identified as the "Primary Emergency Elevator" with signs both outside and inside the elevator. The identified "Primary Emergency Elevator" shall be capable of providing transportation from all floor levels to the fire department access floor level. When a building is provided with elevators in which all elevators do not serve all floors (i.e., 1-10 and 11-20), one primary emergency elevator serving each height section and having a landing at the fire department access floor may be provided. The use of a transfer floor to permit passengers from an upper floor section to reach the exit level is not permitted.

TABLE 412.6

Capacity	Clear	Clear	Door Opening		
Lbs	Width	Depth	S/Slide	2-Speed	Center Opening
2500	6’-8”	4’-3”	42”	42”	
3000	6’-8”	4’-7”	42”	42”	
3500	6’-8”	5’-3”	42”	42”	
4000	7’-8”	5’-3”			48”

Note: These combinations of car sizes and door openings accommodates a 24" x 76" ambulance type stretcher in the horizontal position.

412.6.2.6 Sequential and Selective Operation. Upon the loss of normal power, elevators shall begin an automatic sequential operation of one elevator at a time on the emergency power source. A control switch shall be provided in the central control room having a contact position for each elevator and an automatic position. When on the automatic position, the elevators will be automatically sequenced to the fire department access floor and the primary emergency elevator and one other designated elevator will remain operational on emergency power. The individual contact positions of this switch will enable other cars to be selected to operate on emergency power should the primary emergency and/or other designated elevator become inoperable.

412.6.2.7 Protection of Hoistways from Top Floor to Street Floor. Where it is necessary to change elevators to reach any floor, the system shall be designed so that not more than one change of elevator is required when traveling from a street floor to any floor in the building. Pressurization of the hoistways required above would include pressurization in the top and bottom level hoistways and the transfer lobby. The primary emergency elevator is not allowed to have a transfer floor. See 3003.1.3 for access openings required for bottom level hoistways.

412.7 1nteriorFinish

The interior finish for all walls, partitions, and ceilings including all rooms or space, service spaces and elevator lobbies of high rise buildings shall have a flame spread rating and smoke developed classification conforming to ASTM E 84 and Table 412.7.

TABLE 412.7
INTERIOR FINISH

Location	Maximum Flame [1] [2] [4] Spread Rating		Maximum Smoke Developed Classification	
	Wall [3] Surface	Ceiling [3] Surface	Wall Surface	Ceiling Surface
Exit stairways, Vestibules to Exit stairs & exit corridors	A	A	50	50
Corridors providing access to exit except within stairs	B	B	100	50
Elevator cars and lobbies	A	A	100	100
Assembly Rooms	A	A	50	50
Other rooms or spaces	B	B	100	100

1. Wall and ceiling covering materials listed in accordance with ASTM E 84 shall be grouped in the following classes according to their flame spread rating:
   Class A Interior Finish - Flame Spread 0-25
   Class B Interior Finish - Flame Spread 26-75
   Class C Interior Finish - Flame Spread 76-200
2. Trim, millwork and doors within any room have a flame spread rating not exceeding 200, provided they do not exceed 10 percent of the area of the wall or ceiling of the room in which they occur.
3. The flame spread rating required in this table for wall and ceiling finishes applies to the surface finish and in the case of carpet it applies also to the underlayment. Wall and ceiling covering materials listed by Underwriters' Laboratories in accordance with ASTM E 84 shall comply with these requirements.
4. All noncombustible materials conforming with part 1 and 2 of definition of noncombustible shall have a flame spread rating of less than 25 even though they may be painted with ordinary house paint.

NOTE: For carpet used as a floor finish, see 803.7.

412.8 Central Control Room

412.8.1 All high rise buildings shall have a Central Control Room located on the same level as the fire department access level. This room shall contain a minimum of 100 sq ft of clear floor area or l/10 of 1% of the total building area, whichever is greater, up to a maximum clear area of 300 sq ft. This room shall be separated from the remainder of the building by 2-hour resistive construction. The location of this room shall be readily accessible to fire department personnel directly through an exterior door and an interior door leading to the remainder of the building. The Central Control Room shall contain the following:

1. The fire alarm and public address system panels.
2. Emergency communication panel to automatically transmit manual and automatic alarm signals to the Fire Department either directly or through a signal monitoring system.
3. Fire detection and alarm system annunciator panels to indicate the type of signal and the floor zone from which the fire alarm is received.
4. Sprinkler valve and waterflow detector display panels.
5. Means to sound an audible and visual fire alarm signal when any fire alarm, waterflow alarm or detection device is activated and a switch to silence the audible signal causing a visual signal to indicate that the audible signal has been silenced.
6. Means to manually and selectively actuate the fire alarm devices the building and to silence them after they have operated initially for not less than 1 minute and to indicate by a visual signal that the fire alarm has been silenced.
7. Status indicators and manual override controls for air handling systems used for smoke control.
8. Controls for manually starting and stopping the emergency power supply.
9. Control switch to select the elevator to run on emergency power.
10. Elevator car position indicator for each elevator.
11. Voice communication systems in accordance with 412.9.
12. Means to close fire rated doors leading to stairways, and elevator lobbies, and door in smoke barrier partitions automatically on receipt of an alarm signal, if these are normally held open, unless this is effected automatically by proprietary smoke, fire detection, or sprinkler system control equipment.
13. Controls for unlocking simultaneously all stairway doors which are locked leading into building from the stairway side on each floor.

412.8.2 The Central Control Room shall be available to the Fire Department at all times.

412.8.3 Control rooms in buildings exceeding 250 ft in height shall be provided with 24 hour continuously occupied surveillance or a lock box accessible to the Fire Department.

412.9 Communication

412.9.1 All buildings shall be provided with a one-way voice communication system complying with NFiPA 72. It shall operate from the Central Control Room and shall be established on a selective or general basis to the following terminal areas and designed to be clearly heard by all occupants of these areas:

1. Exit stairways
2. Rooms and tenant spaces exceeding 1000 sq ft in area.
3. All units in Group R occupancies.

412.9.2 Two Way System. A two-way voice communication system complying with NFiPA 72 for use by both firefighters and occupants shall be provided. It shall operate between the Central Control Room and every elevator lobby, each entry to an enclosed exit stairway and in required exit corridors. Telephone Jacks are not acceptable as a means of communication.

412.9.3 The two way elevator voice communication system shall be incorporated in this system. Telephone jacks are not an acceptable means of communication.

412.9.4 The communication system shall be designed so that in the event of one circuit or speaker being damaged or out of service, the remainder of the system shall continue to be operable.

412.9.5 The system shall include provision for silencing the fire alarm devices when the loudspeakers are in use, but only after the fire alarm devices have operated initially for not less than 1 minute.

412.10 Emergency Electrical Power Supply

412.10.1 All conductors furnishing electrical power and control circuits to all required emergency equipment and systems shall be installed in a 2-hour fire rated enclosure or structural element which does not contain any combustible materials. Such protection shall begin at the source of the emergency electrical power or origin of control circuit and extend to the floor level on which the emergency equipment is located. Electrical and control circuits from the rated enclosure to emergency equipment served, shall be located above the level of sprinkler protection. Vertical runs located below the level of sprinkler protection shall be installed in a rated wall or partition, except that portion of the run in the vicinity of the equipment necessary to facilitate connection.

412.10.2 Emergency Generator Capacity. An approved emergency generator, located outside the building at ground level or in a 2-hour rated enclosure properly ventilated to the outside shall be provided. The emergency generator shall be capable of operating under a full load for at least 2 hours. It shall be designed to automatically switch over in the event of failure of the normal source of power or to be operated manually for emergency power for:

1. Fans for pressurizing stairs, stairway shafts and smokeproof vestibules.
2. Fans for pressurizing elevator shafts.
3. Equipment for mechanical ventilation systems when used to remove products of combustion.
4. Every public elevator in a building, assuming only the primary emergency elevator and one other passenger elevator will operate at a time. When more than one primary emergency elevator is provided, emergency power shall permit the operation of the primary emergency elevators and one other passenger elevator for each height section.
5. Fire Pumps – Water supply for firefighting when the supply is dependent on electrical power supplied to the building.
6. Emergency lighting, exit and elevator lighting.
7. Emergency Alarms and Communication Systems – Power supply for fire alarm, fire detection, voice communication systems and central alarm and control facility.
8. Motor operated fire dampers and air relief dampers in smoke shafts.

412.10.3 Automatic Transfer. Provision shall be made for automatic transfer to emergency power in not more than ten seconds for emergency lighting, exit and elevator lighting and emergency alarms and communication systems.

412.10.4 The emergency generator location shall be such that manual starting or servicing can be readily accomplished in case of need during an emergency. The generator shall not be separated from the Central Control Room by more than two floor levels. The emergency generator shall be located above regulatory flood level.

412.11 Maintenance Of Emergency Systems

It shall be the duty and responsibility of the owner of all high rise buildings to maintain all fire detection, fire control, smoke movement and venting systems as required by 506, and similar emergency systems in proper operating condition at all times. Annual certification of full-test and inspections of all systems shall be provided annually to the Fire Department.

412.12 Smoke Detection And Manual Fire Alarm Systems

412.12.1 In all high rise buildings an electrically supervised smoke and fire alarm system complying with NFiPA 72 shall be installed when 24 hour surveillance is provided. When 24 hour surveillance is not provided, systems shall comply with NFiPA 72.

412.12.2 At least one approved smoke detector capable of detecting visible and invisible products of combustion shall be installed as follows:

1. In every mechanical equipment, electrical, telephone, elevator equipment, or similar room. Thermal/rate of rise detectors may be installed in boiler rooms. Smoke detectors located in elevator equipment rooms when activated shall cause all elevators in that equipment room to return to the fire department access floor in accordance with 412.6.2.2.
2. Each opening where a return plenum or return branch duct connects to a vertical shaft.
3. In the return air duct system before fresh air intake and relief air opening of every air conditioning and mechanical ventilation system serving any floor other than the floor on which the equipment is located.
4. In the supply duct downstream of filters in system larger than 2000 CFM.
5. In every interior elevator lobby.
6. In other locations as required by other sections of this code.

412.12.3 The actuation of any detector or other initiation device shall activate the alarm system and cause such other operations as are necessary to prevent the recirculation of smoke and any other functions required by this code.

412.12.4 Audible and visual alarm devices shall be provided. Audible devices shall be located to be effectively heard in all occupied areas of the building.

412.12.5 Manual pull stations shall be located in every elevator lobby, adjacent to each door into an exit stair, and not more than 150 ft horizontally from every door to an occupied space.

412.12.6 The system shall be designed to report a fire on an annunciator panel in the Central Control Room by building zone and type of alarm. Fire alarm zones shall not include more than one floor or more than one smoke zone per floor.

412.12.7 Audible and visual signal shall be activated throughout the floor on which the initiating device is located, and may optionally be activated on other floors or throughout the building.

412.13 Interior Partitions

412.13.1 In all high rise buildings, all interior partitions including demountable partitions shall be framed and surfaced with materials which qualify as noncombustible in accordance with requirements of Part (1) and (2) of definition of noncombustible contained in 202. Surface finish materials may be applied to such partitions provided they meet the flame spread ratings specified in 412.7.

412.13.2 All Group B office building partitions required to be of 1-hour fire resistive construction may be of noncombustible construction without a fire resistive time period. Openings in exit corridor walls serving more than 200 people shall be protected by tight-fitting, self-closing, automatic latching solid core wood or noncombustible doors that need not have a fire resistive period. This exception shall not apply to the elevator lobby protection or stairways and vertical shafts.

412.14 Special Exit Requirements

412.14.1 Stairway Door Locks. All stairway doors which can be locked to prohibit access from the stairway into a floor from the stairway side shall have the capability of being unlocked simultaneously without unlatching upon a signal from the Central Control Room.

412.14.2 Outside Emergency Communication. Emergency telephone or emergency signal device audible on the outside of the building and outside the stairway shall be provided at not less than every third floor in each required stairway.

412.14.3 Stairs to Roofs. All required exit stairways shall extend through and to the roof except where the roof slope is greater than one in four. Roof hatches are not permitted.

412.15 Gaseous Fuel Systems

412.15.1 Natural and LP gas fuel systems operating at a maximum of 20 psi may be installed to serve high rise buildings.

412.15.2 Main gas meters shall be located outside the building. At each main gas meter, a manual shutoff valve shall be provided.

412.15.3 The main supply piping, when located in the interior of a building, shall be located in a two hour fire rated vertical shaft. The shaft shall be vented to the outside at the top. The minimum free area of the ventilation opening in square inches shall be 1/2 the maximum pressure in the piping times the largest nominal diameter of the pipe or 1/2 the cross sectional area of the shaft, whichever is greater. When more than one gas piping system is located in the shaft, the free area for each system shall be calculated and the largest area shall be used. Piping penetrating the shaft wall shall be sleeved and sealed. The shaft shall contain gas piping only.

412.15.4 The entire gas piping system shall be air tested to 100 psig for one hour with no drop in pressure.

412.15.5 Gas piping operating above 1/2 psi but not exceeding 20 psi, shall be schedule 40 steel pipe with welded joints. For sizes below 2 inches, joints shall be socket welded. For sizes 2 inches and larger, joints shall be either beveled and butt welded or socket welded. Piping and tubing complying with the NC State Building Code, Volume VI - Gas, may be used for connecting the system to appliances and equipment in occupied spaces when the operating pressure in that section of the system does not exceed 1/2 psi.

412.15.6 Branch supply lines may operate at a maximum pressure of 2 psi. Branch lines shall have a pressure reducing valve, service meter, and manual shutoff valve located immediately adjacent to the shaft. The service meter shall be located in a ventilated room or breezeway accessible and acceptable to the serving gas supplier. When located in a room, suitable gravity or mechanical ventilation shall be provided to prevent a buildup of gas vapor to an explosive level in case of a gas leak. Pressure reducing valves shall be vented into the shaft or to the outside.

412.16 Outside Air

412.16.1 When outside air is mechanically introduced into a building as a smoke control measure the point or points of intake shall be located to minimize the possibility of contamination by combustion products. When the air intake is above the first floor level, a minimum of two remote intakes located on different sides of the building shall be provided. Controls shall be provided in the Central Control Room to manually select the smoke intake.

412.16.2 A single outside air intake located on the roof a minimum of 10 ft from the edge of the roof is acceptable.

413 COVERED MALL BUILDINGS

413.1 Scope

The provisions of 413 shall apply to buildings or structures defined in 413.2 as covered mall buildings, except when approved by the building official. The following uses need not comply with the provisions of 413:

1. Terminals for transportation facilities.
2. Foyers and lobbies of hotel, apartment and office buildings.

413.2 Definitions

For the purpose of this section, certain special terms are defined as follows:

ANCHOR STORE – an exterior perimeter department store or major merchandising center having direct access to a mall but having all required exits independent of a mall.

COVERED MALL BUILDING – a single building three stories or less in height enclosing a number of tenants and occupancies such as anchor stores, retail, drinking and dining establishments, entertainment and amusement facilities, offices and other similar uses wherein two or more tenants have a main entrance into one or more malls.

GROSS LEASABLE AREA – the total floor area designed for tenant occupancy and exclusive use. The area of tenant occupancy is measured from the center lines of joint partitions to the outside of the tenant walls. All tenant areas, including areas used for storage, shall be included in calculating gross leasable area.

MALL – a roofed or covered common pedestrian area within a covered mall building which serves as access for two or more tenants.

413.3 Tenant Separation

413.3.1 Each tenant shall be separated from adjoining tenants by 1-hour fire resistant partitions and floor/ceiling assemblies. The partitions shall be constructed tight against the floor or roof deck above. Separation is not required between a tenant space and mall.

413.3.2 Portions of the covered mall building separated by property lines need not comply with exterior wall requirements in Table 600 at the common property line. A wall at a common property line shall not be considered a party wall.

413.4 Exits

413.4.1 Exit requirements shall be based on the occupant load for the gross leasable area of the covered mall building, excluding anchor stores, assuming all portions including individual tenant spaces and the mall to be occupied at the same time, determined by one of the following:

1. Divide the gross leasable area by 30 for covered mall buildings containing up to 150,000 sq ft (13 935 m^2) of gross leasable area.
2. Divide the gross leasable area by 40 for covered mall buildings containing between 150,001 and 350,000 sq ft (13 936 and 32 515 m^2) of gross leasable area.
3. Divide the gross leasable area by 50 for covered mall buildings containing more than 350,000 sq ft (32 516 m^2) of gross leasable area.

413.4.2 The occupant load of anchor stores opening into the mall shall be based on other provisions of this code and need not be included in computing the total number of occupants for the mall.

413.4.3 The maximum distance of travel from any point within a mall to the exterior, an exit enclosure, a horizontal exit or an exit passageway shall not exceed 200ft (61 m).

413.4.4 Each individual occupancy within the covered mall building shall be provided with exits in accordance with other provisions of this code. Travel distance may be measured to the entrance of the tenant space to the mall.

413.4.5 Egress From Tenant Space.

413.4.5.1 One-half of the required units of exit width for tenant spaces connected to a mall shall lead to the outside by means other than through the mall.

EXCEPTION: One egress door shall be permitted for tenant spaces 2,250 sq ft (209 m^2) or less in area with a travel distance from any point in the space to a mall entrance of 75 ft (22.9 m) maximum.

413.4.5.2 Where exit passageways provide the secondary exit from a tenant space, doors to the passageway shall be 1-hour fire doors. Such doors shall be self-closing and be so maintained or shall be automatic-closing by smoke detection. Storage is prohibited in exit passageways which are also used for service to the tenants. Such passageways shall be posted with conspicuous signs prohibiting storage.

413.4.5.3 Tenant spaces requiring more than one exit may use for egress an adjoining or intervening room which provides a direct, obvious and unobstructed means of travel to an exit, provided the egress does not pass through restrooms, kitchens, closets or spaces used for similar purposes.

413.4.5.4 Where a tenant space is located at the intersection of two malls or has exposure on two different malls, such tenant space when in excess of 2,250 sq ft (209 m^2) in area shall have at least two separate egress doors, both of which may lead through the malls, providing the egress doors are located as remote from each other as practical.

413.4.6 Egress Width.

413.4.6.1 The total egress width from a covered mall building shall be sufficient to accommodate the entire calculated occupant load exclusive of the anchor stores.

413.4.6.2 The minimum egress width from a mall shall be 66 inches (1676 mm).

413.4.6.3 The aggregate required egress width shall be divided approximately equally around the mall.

413.4.7 Anchor Stores. Anchor stores shall provide the required number and width of exits directly to the exterior. The occupant load of anchor stores opening into the mall shall not be included in determining exit requirements for the mall.

413.4.8 Dead End Length. The dead end length of a mall shall not exceed twice its width.

413.5 Mall Width

413.5.1 The minimum width of the mall shall be 20 ft (6096 mm).

413.5.2 There shall be a minimum of 10 ft (3048 mm) clear exit width to a height of 8 ft (2438 mm) between any projection of a tenant space bordering the mall to the nearest kiosk, vending machine, bench, display opening, or other obstruction to exit travel.

413.6 Types of Construction

The area of any covered mall building, including anchor stores, of Types I, II, III, and IV construction shall not be limited provided the building is surrounded on all sides by a permanent open space of not less than 60 ft (18.3 m).

413.7 Occupancy

413.7.1 Covered mall buildings shall be classified as Group M occupancies and may contain accessory uses consisting of Group A, B, E, or R occupancies. Individual accessory uses within a covered mall building shall not exceed the sprinklered area limitation and shall not be located at a height greater than that permitted for such occupancy group in the type of construction being used. The aggregate area of all accessory uses within a covered mall building shall not exceed 25% of the gross leasable area.

413.7.2 Occupancy separations between different occupancies in adjacent tenant spaces shall be 1-hour fire resistant construction. Occupancy separations are not required within a single tenant space, nor to separate occupancies from a mall.

413.7.3 Group A - Large Assembly occupancies shall be located in the covered mall building so that their main entrance is immediately adjacent to a principal entrance to the mall.

413.8 Automatic Fire Sprinkler Systems

The covered mall building shall be provided with an automatic fire sprinkler system conforming to the provisions of NFiPA 13. In addition to these provisions, the automatic fire sprinkler system shall comply with the following:

1. All automatic fire sprinkler system control valves shall be supervised in accordance with 903.8.
2. The automatic fire suppression system shall be complete and operative throughout all occupied space in the covered mall building prior to occupancy of any of the tenant spaces. Unoccupied tenant space shall be similarly protected unless provided with approved alternate protection.

413.9 Hose Connections

413.9.1 There shall be a fire department hose outlet connected to a water supply capable of delivering 250 gpm (15.8 L/s) at each of the following locations:

1. Within the mall at the entrance to an exit passage or exit corridor.
2. At each floor level landing within enclosed stairways opening directly onto the mall.
3. Adjacent to principle exterior entrances to the mall.

413.9.2 Hose outlets shall be installed to comply with the requirements of NFiPA 14 with regard to materials, installation methods and testing.

EXCEPTIONS:

l. Risers and laterals of dry standpipe systems not located within an enclosed stairway need not be protected by a degree of fire resistance equal to that required for vertical enclosures in the covered mall building.
2. In buildings where more than one standpipe is provided, they need not be interconnected.
3. Piping may be hydraulically sized.

413.10 Smoke Control Requirements

413.10.1 The purpose of smoke control is to restrict movement of smoke to the general area of fire origin and to maintain means of egress in a usable condition.

413.10.2 Smoke detectors shall be provided within the return air portion of an air conditioning system in accordance with the Standard Mechanical Code. Actuation of either a smoke detector or the sprinkler system shall cause the air supply to the air conditioning zone in which the fire occurs to shut down.

413.10.3 The mall shall have smoke removal capability installed in or near the roof. Such facility may be either natural or mechanical.

413.10.4 Before the systems are accepted by the building official, they shall be tested in his presence to confirm that they are operating in compliance with the requirements of 413.10.

413.11 Public Address System

When a public address system is provided, the system shall be made accessible to and usable by the fire department.

413.12 Fire Department Access to Equipment

Rooms containing controls for air conditioning systems, sprinkler risers and valves, or other fire detection, suppression or control elements shall be identified for the use of the fire department.

413.13 Plastic Panels and Plastic Signs

Within every store or level and from side wall to side wall of each tenant space or mall, approved plastic panels and plastic signs shall be limited as follows:

1. They shall not exceed 20% of the wall area facing the mall.
2. They shall not exceed a height of 36 inches (914 mm) except that if the sign is vertical then the height shall not exceed 96 inches (2438 mm) and the width shall not exceed 36 inches (914 mm).
3. They shall be located a minimum distance of 18 inches (457 mm) from adjacent tenants.
4. All edges and backs shall be fully encased in metal.

413.14 Standby Power and Light

A standby power and light system shall be provided in accordance with 412.7.

414 ATRIUMS

414.1 General

Vertical openings may be unenclosed in all buildings other than Group H when meeting the requirements of this section. Stair enclosures, utility chases, elevator hoistways and escalators shall not be classified as an atrium.

414.2 Use

The floor of the atrium shall not be used for other than low fire hazard uses and only approved materials and decorations may be used in the atrium space.

EXCEPTION: The atrium floor area may be used for any approved use when the individual space is provided with an automatic fire suppression system.

414.3 Automatic Sprinkler Protection

An approved automatic sprinkler system shall be installed throughout the entire building.

EXCEPTIONS:

1. That area of a building adjacent to or above the atrium need not be sprinklered provided that portion of the building is separated from the atrium portion by fire separations corresponding to Table 600 but in no case less than a 2-hour fire resistant separation.
2. When the ceiling of the atrium is more than 55ft (16.8 m) above the floor, sprinkler protection at the ceiling of the atrium may be omitted when approved by the building official.

414.4 Smoke Control

414.4.1 A smoke control system shall be designed to control the migration of products of combustion in the atrium space. Upon detection of a fire, the system shall shut down the air supply to the fire floor and the return air from all nonfire floors. Any other approved design which will achieve the same level of smoke control as described in this section may be used in lieu of these requirements.

414.4.2 In atriums 55 ft (16.8 m) or less in height with a volume of 600,000 cu ft (16 992 m^3) or less, a smoke exhaust system shall be located at the ceiling of the atrium. Such systems shall exhaust 40,000 cfm (18.9 m^3/s). When the volume of the atrium exceeds 600,000 cu ft (16 992 m^3) the exhaust system shall be sized to provide a minimum of four air changes per hour.

414.4.3 Supply air inlets may be provided at the lowest level of the atrium. These inlets shall be sized to provide 75% of the exhaust.

414.4.4 For purposes of this section, the volume of the atrium shall include all spaces not separated from the atrium as provided in 414.5.

414.4.5 When the height of the atrium exceeds 55 ft (16.8 m), an exhaust system shall be provided as required in 414.4.2; however, supply air shall be introduced mechanically from the floor of the atrium and shall be directed vertically at the exhaust outlet above. The capacity of the supply shall be 75% of the exhaust.

414.4.6 Manual controls shall be provided for the atrium smoke control system. When the smoke control system in other than the atrium is provided by mechanical ventilation in accordance with 414.8, manual controls shall also be provided as described above for the atrium system. The manual controls shall be provided in a location approved by the building official.

414.5 Enclosure of Atriums

Atrium spaces shall be separated from adjacent spaces by a 1-hour fire separation wall. A glass wall forming a smoke partition may be used in lieu of the required fire separation wall where automatic sprinklers are spaced 6 ft (1829 mm) or less along both sides of the separation wall, or on the room side only if there is not a walkway on the atrium side, and not more than 1 ft (305 mm) away from the glass and so designed that the entire surface of the glass is wet upon activation of the sprinkler system. The glass shall be installed either:

1. In a gasketed frame so installed that the framing system may deflect without breaking (loading) the glass before the sprinkler system operates, or
2. As a glass block wall assembly in accordance with 2112 and the listing for a 3/4-hour fire resistance rating.

EXCEPTION: The adjacent spaces of any three floors of the atrium shall not be required to be separated from the atrium; however, such spaces shall be included when computing the volume of the atrium.

414.6 Automatic Fire Detection

414.6.1 In addition to such smoke detection as may be required by the Standard Mechanical Code, smoke detectors shall be installed at the following locations:

1. When spot-type detectors are used they shall be installed at the atrium ceiling spaced in accordance with their listing, on the underside of projections into the atrium spaced in accordance with their listing, and around the perimeter of the atrium opening on all floors open to the atrium. These detectors shall be spaced no more than 30 ft (9144 mm) on center and shall be located within 15 ft (4572 mm) of the atrium opening.
2. When projected beam-type smoke detection is used, it shall be installed and spaced in accordance with its listing.

414.6.2 The actuation of two spot-type detectors or a single beam-type detector shall activate the atrium smoke removal system. The actuation of any one detector shall cause an alarm to be sounded at a constantly attended location. All smoke detectors shall be accessible for maintenance and testing.

414.7 Standby Power

All equipment required to provide smoke control shall be connected to a standby power system in accordance with 412.10.

414.8 Smoke Control in Other Than the Atrium

In any building containing an atrium, occupied space that does not open directly to the atrium shall be designed to provide natural or mechanical ventilation in accordance with 412.4.

414.9 Acceptance Of Smoke Control System

Before the certificate of occupancy is issued, the smoke control system shall be tested by an approved independent agency to show compliance with the requirements of this section.

414.10 Inspections

The smoke removal and control systems shall be tested by an approved inspection agency or by the owner or his representative when so approved. Such inspections shall be made every six months and a log of the tests shall be kept by the inspection agency. The log shall be on the premises and available for examination.

414.11 Interior Finish

The interior finish of walls and ceilings of the atrium shall not exceed Class B with no reduction in class for sprinkler protection.

415 UNDERGROUND BUILDINGS

415.1General

The provisions of this section apply to all building spaces having a floor level used for human occupancy more than 30ft (9144 mm) or more than one story below the lowest level of exit discharge.

EXCEPTIONS:

1. One and two family dwellings, sprinklered in accordance with NFiPA 13D.
2. Parking garages with automatic fire suppression systems in compliance with 415.3.
3. Fixed guideway transit systems.
4. Grandstands.
5. When the lowest story is the only story which would qualify the building as an underground building and has an area not exceeding 1,500 sq ft (139.4 m^2) and has an occupant load less than 10.

415.2 Construction Requirements

The underground portion of the building shall be of Type I or Type II construction.

415.3 Automatic Fire Sprinkler System

The highest level of exit discharge serving the underground portions of the building and all levels below shall be provided with an automatic fire sprinkler system installed in compliance with NFiPA 13. All waterflow switches and control valves shall be supervised in accordance with 903.8.

415.4 Compartmentation

415.4.1 A building having a floor level more than 60ft (18.3 m) below the lowest level of exit discharge shall be divided into a minimum of 2 compartments of approximately equal size. Such compartmentation shall extend through the highest level of exit discharge serving the underground portions of the building and all levels below.

EXCEPTION: The lowest story need not be compartmented when the area does not exceed 1,500 sq ft (139.4 m^2) and has an occupant load of less than 10.

415.4.2 The separation between the two compartments shall be of minimum 1-hour fire resistant wall construction which shall extend from floor slab to floor deck above. Openings between the two compartments shall be limited to plumbing and electrical piping and conduit with the space around the penetrations tightly caulked to inhibit the passage of smoke and toxic gases and to doorways protected by door assemblies which are automatic closing by smoke detection. The door assembly shall have a minimum 3/4-hour C label rating as determined by ASTM E 152 and shall be provided with gasketing and a drop sill to minimize smoke leakage. Where provided each compartment shall have an air supply and exhaust system independent of the other compartments.

415.4.3 When elevators are provided, each compartment shall have direct access to an elevator. Where an elevator serves more than one compartment, an elevator lobby shall be provided and shall be separated from each compartment by 1-hour fire resistant construction and a 3/4-hour C label door which is automatic-closing by smoke detection. Such doors shall be gasketed and have a drop sill.

415.5 Smoke Exhaust System

415.5.1 Where compartmentation is required, each compartment shall have an independent, automatically activated smoke exhaust system capable of manual operation. The system shall have an air supply and smoke exhaust capability which will provide a minimum of six air changes per hour.

415.5.2 At least one approved smoke detector suitable for the intended use shall be installed in accordance with NFiPA 72E in:

1. Mechanical equipment, electrical, transformer, telephone equipment, elevator machine, or similar rooms.
2. Elevator lobbies.
3. The main return and exhaust air plenum of each air conditioning system serving more than one story and located in a serviceable area downstream of the last duct inlet.
4. Each connection to a vertical duct or riser serving two or more floors from return air ducts or plenums of heating, ventilating and air conditioning systems, except that in Group R occupancies, an approved smoke detector may be used in each return air riser carrying not more than 5,000 cfm (2.36 m^3/s) and serving not more than 10 air inlet openings.

415.5.3 The smoke exhaust system shall be operated in the compartment of origin by the following independently of each other:

1. Two cross-zoned smoke detectors within a single protected area or a single smoke detector monitored by an alarm verification zone or an approved equivalent method.
2. The automatic fire sprinkler system.
3. Manual controls that are readily accessible to the fire department.

415.5.4 Activation of the smoke exhaust system shall activate an audible alarm at a constantly attended location.

415.6 Fire Protective Signaling System

A fire protective signaling system is required throughout the building when the lowest level of a building is more than 60ft (18.3 m) below the lowest level of exit discharge and shall be installed in accordance with NFiPA 72 and shall be activated in accordance with 905.1.6 by the following:

1. Smoke detectors required by 415.5.2(1) and 415.5.2(2).
2. The automatic fire sprinkler system.
3. Manual fire alarm box.

415.7 Voice Communication

415.7.1 A public address system which may also serve as an alarm system shall be provided which shall be capable of transmitting voice communications to the highest level of exit discharge serving the underground portions of the building and all levels below.

415.7.2 When a fire protective signaling system is required, a public address system is required.

415.7.3 When the occupancy in the underground portion is required to have a fire protective signaling system, the public address system shall be a voice alarm signaling system installed in accordance with NFiPA 72.

415.8 Exits

415.8.1 Each story shall be provided with a minimum of two exits. When compartmentation is required by 415.4, each compartment shall have a minimum of one exit and shall also have an exit access doorway into the adjoining compartment.

415.8.2 Every required stairway serving floor levels more than 30ft (9144 mm) below its level of exit discharge shall comply with the requirements for a smokeproof enclosure.

415.9 Standby Power

415.9.1 A standby power generation system conforming to NFiPA 70 shall be provided. The system shall be equipped with suitable means for automatically starting the generator set upon failure of the normal electrical service and for automatic transfer and operation of electrical functions.

415.9.2 An on-premises fuel supply sufficient for not less than 2 hours full demand operation of the system shall be provided.

415.9.3 Standby Power Loads. The following loads are classified as standby power loads. The transition time from the instant of failure of normal power to emergency power shall not exceed 60 seconds. The standby power load shall be sized to supply the following.

1. Smoke management system.
2. Smokeproof enclosure.
3. Fire pumps.
4. One elevator to serve all floors with the capability of transferring power to any elevator.
5. Emergency power loads.

415.10 Emergency Power Loads

415.10.1 The following loads are classified as emergency power loads:

1. Voice alarm signaling system.
2. Fire protective signaling systems.
3. Automatic fire detection systems.
4. Elevator car lighting.
5. Egress lighting and exit sign illumination.

415.10.2 The transition time from the instant of failure of normal power to emergency power shall not exceed 10 seconds.

415.10.3 All emergency power loads shall be capable of being transferred to the standby power system.

415.11 Standpipes

A 2-1/2-inch (64 mm) standpipe hose connection shall be located at each floor level, at every exit stairway, and on each side of the wall adjacent to the exit opening of a horizontal exit.

416 DRYING ROOMS

416.1 Construction

Drying rooms or dry kilns located within a building shall be constructed entirely of noncombustible materials where used or intended to be used at temperatures exceeding $125^{O}F$ ($52\ ^{O}C$). If enclosure is of metal, it shall be insulated from all combustible material by not less than a 12-inch (305 mm) air space or an approved insulation. All drying rooms shall have approved ventilation.

416.2 Heating Pipes

Heating pipes, not located overhead, shall be shielded to maintain not less than 2 inches (51 mm) clearance between them and the contents

417 COMPUTER/DATA PROCESSING EQUIPMENT ROOMS

Computer/data processing equipment rooms shall comply with the requirements of NFiPA 75

418 DAY CARE STANDARDS

418.1 Family Day Care Homes. Any family day care, new or existing, keeping between 3 and 5 preschool age children and no more than 3 school age children who are unrelated to the operator shall meet the following requirements:

1. Meet N.C. State Building Code, Volume VII - Residential or be a manufactured home bearing a third party inspection label certifying compliance with the Federal Manufactured Home Construction Safety Standards or certifying compliance with construction Standards adopted and enforced by the State of North Carolina. Homes shall be installed in accordance with the North Carolina Manufactured/Mobile Home Regulations, published by the NC Department of Insurance.

   EXCEPTION: Single wide manufactured homes will be limited to a maximum of 3 preschool age children (not more than 2 may be two years of age or less) and 2 school age children.
2. All children shall be kept on the ground level with an exit at grade.
3. All homes shall be equipped with an electrically operated smoke detector with battery backup, or one electrically operated and one battery operated detector located next to each other.
4. All homes shall be provided with at least one five pound 2-A: 10-B: C Type extinguisher readily accessible for every 2500 square feet of floor area.
5. Fuel burning space heaters, fireplaces and floor furnaces which are listed and are provided with a protective screen attached securely with substantial supports that will prevent accidental burning of the children will be allowed. However, unvented fuel burning heaters and portable electric heaters of all types are prohibited.

418.2 Large Day Care Homes. Large day care homes as defined by the state agency having jurisdiction and which are normally occupied as a residence shall meet the following requirements:

1. The building must meet N.C. State Building Code, Volume VII - Residential.
2. All walls and ceilings in rooms which are used for day care purposes and are part of the existing path shall have surface of noncombustible construction (plaster or gypsum wallboard).
3. Each room used for day care purposes shall have access to two remotely located outside doors. Access from the room door to the remotely located outside exits shall not have a deadend distance of more than 20 feet measured from the room door used by the children to a point at which two separate means of egress can be provided.

   EXCEPTION: Rooms which have an exterior door leading directly to the outside and is located no more than 48" above finished grade.
4. These facilities shall be provided with a manual fire alarm device. The manual fire alarm device shall be readily visible to all occupants and be audible throughout the day care facility and have a district sound which can be distinguished as an emergency signal (examples: freon horn, cow bell, electrically operated bell or an approved fire alarm in accordance with Chapter 9.
5. All unoccupied spaces, such as basements, workshops and fossil fuel fired furnace rooms must be provided with approved labeled automatic smoke and/or heat detectors.
6. The spaces to be used shall have ventilation meeting the requirements of 1203.
7. Fuel burning space heaters, fireplaces and floor furnaces which are listed and are provided with a protective screen attached securely with substantial supports that will prevent accidental burning of the children will be allowed. However, unvented fuel burner heaters and portable electric heaters of all types are prohibited.

418.3 Day Care Centers. All small, medium and large day care centers as defined by the State agency having jurisdiction shall be classified as Education Occupancy.

EXCEPTION: Small, medium and large Day Care Centers which serve children less than 3 years of age and do not provide doors directly to the outside shall be classified as Institutional Occupancy.

418.3.2 Daycare facilities shall have smoke detectors installed in accordance with 905.2.6.

418.4 Special Care Facilities (Existing Prior to 12-13-88)

418.4.1 Special Care Facilities are defined as being those that house children first grade and under in age for periods four hours and less and are not required by the State Day Care Licensing Law to be licensed.

418.4.2 All rooms used as nurseries, kindergartens or special care facilities caring for children less than 3 years of age for any period of time shall be located on the floor of exit discharge.

418.4.3 Buildings of one hour protected Type V and VI construction and a maximum of 2 stories in height may house children three years of age and older on the second floor if the following conditions are met:

1. Equipped with a smoke detection system wired into an approved central station, and;
2. Have two independent and remote exits from each floor, and;
3. Have a fire exit plan in effect and fire drills being practiced.

   EXCEPTION: In lieu of these conditions, a direct exit from each room located on the second floor used to house children 3 years old and older may be provided. This exit shall be covered from the second floor to grade to provide minimum protection from the weather.

419 RESIDENTIAL CARE FACILITIES

419.1 Classification. Buildings in which more than three people are harbored for medical, charitable or other care or treatment shall be classified as Residential Care Facilities. The State Agency having jurisdiction shall classify the facility as a Residential Care Home, Small Residential Care Facility, Small Non-Ambulatory Care Facility, or Large Residential Care Facility.

419.2. Residential Care Homes. Homes keeping no more than six ambulatory adults or six unrestrained ambulatory children who are able to respond and evacuate the facility without assistance, determined by the State Agency having jurisdiction to be licensable shall be classified as Residential (N.C. State Building Code, Volume VII-Residential).

419.2.1 Each normally occupied story of the facility shall have two remotely located exits.

419.2.2 Smoke detectors shall be provided on all levels per the North Carolina State Building Code, Volume IV-Electrical.

419.2.3 Interior wall and ceiling finish shall be class C. Fire retardant paints shall be renewed at such intervals as necessary to maintain the required finish rating.

419.2.4 Unvented fuel-fire heaters and portable electric heaters shall not be used.

419.3 Small Residential Care Facilities. When determined by the State Agency having jurisdiction to be licensable shall be classified as Single Family Residential (Volume VII).

1. Residential Care Facilities keeping no more than six adults or six unrestrained children with no more than three who are unable to respond and evacuate without assistance.
2. Residential Care Facilities keeping no more than five adults or five children who are unable to respond and evacuate without assistance, when certifiable for Medicaid reimbursement , and when staffed 24-hours per day with at least two staff awake at all times.
3. Residential Care Facilities keeping no more than nine ambulatory retarded or similarly developmentally disabled adults who are able to respond and evacuate without assistance.
4. Residential Care Facilities keeping no more than nine children who are dependent, neglected, abandoned, destitute, orphaned, delinquent, or separated temporarily from their parents.

419.3.1 The building shall be of one-hour fire resistant construction or sprinklered in accordance with NFiPA 13R Sprinklers, if provided, shall be installed in all areas except attics, crawl spaces, and floor/ceiling spaces. The extinguishing system shall be electrically connected directly to an approved central station facility.

419.3.2 The building shall not exceed either 3000 square feet in area (per story) or two stories in height. Attics and basements used as habitable space shall be counted as stories.

419.3.3 Each normally occupied story of the facility shall have two remotely located exits.

419.3.4 Facility exit stairways shall be either exterior unenclosed or interior enclosed on each level with one-hour fire resistant construction and a 20-minute labeled door. Other interior stairways shall be enclosed on one floor level with one-hour fire resistant walls and a 20-minute labeled door.

419.3.5 Smoke detectors shall be provided on all levels per the North Carolina State Building Code, Volume IV-Electrical. Heat detectors shall be installed in all attic spaces.

419.3.6 Any hazardous area (see Institutional - Unrestrained) shall be enclosed with one-hour fire resistant construction and a 20-minute labeled door.

419.3.7 A building fire alarm system shall be provided in accordance with NFiPA 72. Provision shall be made to activate the internal evacuation alarm at all required exits.

419.3.8 Interior wall and ceiling finish shall be gypsum wallboard or plaster.

419.3.9 Unvented fuel-fire heaters, floor furnaces, and portable electric heaters shall not be used.

419.3.10 Occupants younger than six-years of age shall sleep on the level of exit discharge with adult supervision.

419.3.11 Every facility shall formulate an evacuation plan (in cooperation with the local fire department) for the protection of all persons in the event of fire and for their evacuation to areas of refuge and from the building when necessary.

419.4 Small Non-Ambulatory Care Facilities. Facilities keeping no more than six adults or six children who are unable to respond and evacuate without assistance, when determined by the State Agency having jurisdiction to be licensable shall comply with the requirements for Small Residential Care Facilities.

419.4.1 The building shall be of one-hour fire resistant construction and sprinklered in accordance with NFiPA 13R. Sprinklers shall be installed in all areas except attics, crawl spaces, and floor/ceiling spaces. The extinguishing system shall be electrically connected directly to an approved central station facility.

419.5 Large Residential Care Facilities. Facilities keeping no more than twelve residents, when determined by the State Agency having jurisdiction to be licensable shall be classified as Group R, Residential (N. C. State Building Code, Volume 1-General Construction).

419.5.1 The building shall be of one-hour fire resistant construction, sprinklered in accordance with NFiPA 13R, and limited to one story in height. Sprinklers shall be installed in all areas except attics, crawl spaces, and floor/ceiling spaces. The extinguishing system shall be electrically connected directly to an approved central station facility.

419.5.2 The facility shall have two remotely located exits.

419.5.3 All doorways subject to use by residents shall have a clear width of not less than 32-inches when the door is in the open position.

419.5.4 Required corridors, ramps, and passageways shall have a clear width of not less than 6-feet when serving as part of the means of egress from resident areas.

419.5.5 Buildings may have spaces open to the corridor without visual supervision by the facility staff, provided:

1. Each area does not exceed 250-sq. ft., and
2. The spaces are not used for resident sleeping rooms, treatment rooms, or hazardous areas, and
3. The area is equipped with an electrically supervised automatic smoke detection system, and
4. Not more than one such area is permitted, and
5. The area is arranged not to obstruct access to required exits.

419.5.6 Doors in corridor partitions need not have a fire resistance rating but shall be designed to resist the passage of smoke. Doors shall be equipped with approved latches that will keep the door tightly closed. All doors except those to patient sleeping rooms shall be self-closing or automatic closing by smoke detection.

419.5.7 Corridors shall be provided with approved smoke detectors connected to the building fire alarm system.

419.5.8 Any hazardous area (see Institutional-Unrestrained) shall be enclosed with one-hour fire resistant construction and 45-minute, "C"-labeled doors.

419.5.9 A building fire alarm system shall be provided in accordance with NFiPA 72. Provision shall be made to activate the internal evacuation alarm at all required exits.

419.5.10 Every facility shall formulate an evacuation plan (in cooperation with the local fire department) for the protection of all persons in the event of fire and for their evacuation to areas of refuge and from the building when necessary.

420 SPECIAL OCCUPANCY REQUIREMENTS

420.1 Scope

This Section shall apply to all exhibition facilities.

EXIBITION FACILITY – is a building or part thereof for which the use is the displaying of manufactured products, furniture, home furnishing accessories, and like items, primarily for the purpose of obtaining sales to wholesalers, retailers, or other dealers.

420.2 General Requirements and Exceptions

All exhibition facility, including all display spaces, shall be subject to the provision of this code for specific use group and type of construction, except in the following specific cases:

A wall or partition that separates an exit access from a display space may have a fire resistance rating of less than one (1) hour, regardless of the occupancy load that the corridor serves, if the exhibition facility and the display areas meet the following requirements:

1. The exhibition facility, including all display spaces, is equipped throughout with an approved automatic sprinkler system in accordance with Section 901.
2. The wall or partition that separates the display spaces from the exit access is of a minimum of fire-retardant treated wood, noncombustible construction or 1 hour rated construction and if glass is used in the wall or partition, it shall be of 1/4" fully tempered glass or 1/4" labeled wire glass.
3. The exit access shall be a minimum of 10 ft in width. For exhibition facilities used for events such as; flea markets, gun shows, and craft shows, aisles shall be a minimum of 8 ft in width. Aisles at the end of the display areas shall be of sufficient width to accommodate the occupant load for the area served. Cross aisles serving as exit access shall have sufficient width to accommodate the occupant load.
4. For any areas used for other than display, see Section 303.1 for occupancy separation requirements.

CHAPTER 5

GENERAL BUILDING LIMITATIONS

501 GENERAL

501.1Scope

Provisions of this chapter shall govern the height and area of buildings.

502 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter2.

503 HEIGHT AND AREA

503.1Application

503.1.1 For the purpose of this code, "height" and "area," as applied to a building, has the meaning designated in Chapter 2.

503.1.2 The height and area for buildings or structures of the different types of construction shall be governed by the intended occupancy or use of the building, as provided for in this chapter and shall not exceed the limits set forth in Table 500 except as modified in 503.2 and 503.3 and the specific use provisions of this chapter. For the purpose of this code, each part of a building or structure included within fire walls shall be considered a separate building.

EXCEPTION: A building permitted to be unlimited in area by 503.4.1 shall be permitted to have interior fire walls.

503.1.3 A building heretofore erected shall not be extended to exceed the allowable floor area set forth in this chapter, governed by the occupancy and type of construction. A building heretofore lawfully erected, which exceeds such area, may be extended horizontally, provided such extension does not exceed the area prescribed and provided such extension is separated from the existing building by a fire wall as set forth in 503.1.2.

503.2 Height Modifications

503.2.1 Rooftop Structures. Church spires, chimneys, tanks and supports, aerial supports, parapet walls not over 4ft (1219 mm) high, bulkheads and penthouses used solely to enclose stairways, tanks, elevator machinery or shafts, or ventilation or air-conditioning apparatus, need not be considered in determining the highest point of the building, provided that the highest point shall be taken to be the highest point of the roof of the highest penthouse when the aggregate area of all penthouses and other roof structures exceeds one-third of the area of the roof upon which they stand. See 1503, 1504, 1505 and 1506.

503.2.2 Parking Under Group R. Where a one story automobile parking garage, enclosed or open of Type I or II construction, or open of Type III construction, with grade entrance, is provided under a building of Group R occupancy, the number of stories to be used in determining the minimum type of construction may be measured from the floor above such parking area. The floor/ceiling assembly between the parking garage and the Group R occupancy above shall comply with the type of construction required for the parking garage and shall also provide a fire resistance rating not less than the occupancy separation required in 704.1.1.

503.2.3 Mezzanines. A mezzanine shall not be counted as a story when it meets the following requirements:

503.2.3.1 The construction of a mezzanine shall be consistent with the type of materials and fire resistance ratings required for the building in which it is constructed.

503.2.3.2 The total area of mezzanines within a room shall not exceed one third that of the room or space in which they are located. Enclosed space under a mezzanine shall not be included in a determination of the size of the room or space in which the mezzanine is located.

503.2.3.3 All portions of a mezzanine shall be open and unobstructed to the room in which it is located except for walls not more than 42 inches (1067 mm) high, columns and posts.

EXCEPTIONS:

1. Mezzanines or portions thereof need not be open to the room in which they are located, provided the occupant load of the aggregate area of the enclosed space does not exceed 10.
2. In sprinklered buildings, a mezzanine having two or more means of egress need not open into the room in which it is located, if at least one of the means of egress provides direct access to an exit at the mezzanine level.

503.2.3.4 Means of egress shall be in accordance with 1005.6.

503.2.4 Basements. A basement of a building shall not count as a story, when applying Table 500 for allowable building height, if the upper surface of the first floor above such basement complies with all of the following:

1. is less than 7 ft (2134 mm) above grade,
2. is less than 7 ft (2134 mm) above finished ground level for more than 50 percent of the perimeter of a building, and
3. is less than 12 ft (3658 mm) above finished ground level around the entire building perimeter.

503.2.5 Group A and E Basements. Group A and Group E basements used as classrooms or assembly rooms shall be counted as a story.

503.2.6 Special Unlimited Height.

503.2.6.1 The height of Group B, Group M and Group R occupancies of Type II construction shall not be limited, provided the fire resistance of all columns shall be not less than 3 hours and the other structural members including floors shall be not less than that shown in Chapter 6, but in no case less than 2 hours except that roofs and their supporting beams, girders, trusses and arches shall be not less than 1-1/2 hours.

503.2.6.2 For unlimited height open air grandstands and bleachers, see 403.6.2.1.

503.3 General Area Modifications

503.3.1 The exceptions and requirements of 503.3 and 503.4 shall modify unsprinklered areas permitted by Table 500 and the specific use provisions of this chapter.

503.3.2 Where streets or public spaces, or horizontal separation from property lines of total width of not less than 30ft (9144 mm), or 30ft (9144 mm) between buildings on commonly owned property, extend along the building perimeter, except for hazardous occupancies, the areas permitted by Table 500 may be increased as follows:

$$I = 4/3[100\ (F/P - 0.25)]$$

Where
- I = Percent increase of unsprinklered areas in Table 500
- F = Building perimeter which fronts on streets, public spaces or horizontal separation not less than 30 ft (9144 mm) wide
- P = Total perimeter of building

503.3.3 For both an unsprinklered building and a sprinklered building, the percent increase is multiplied by the unsprinklered area permitted in Table 500 for the type of construction of the building, and the resulting area increase is added to either the sprinklered or unsprinklered areas in Table 500. When there are no unsprinklered areas permitted for the building in Table 500, an unsprinklered area can be computed for use in this section. The corresponding unsprinklered areas are computed as one-third of the sprinklered area for one story only and as one-half of the sprinklered area for multi-stories.

503.4 Occupancy Area Modifications

503.4.1 The area of a one story building of Group B, Group F, Group M, or Group S occupancy shall not be limited provided the building is equipped with an approved automatic sprinkler system throughout, in accordance with 903, or other automatic extinguishing systems as approved by the building official, and is surrounded on all sides by a permanent open space of not less than 60 ft (18 m). High-piled combustible storage shall be protected in accordance with Chapter 36 of the Standard Fire Prevention Code.

EXCEPTIONS:

1. Where water may cause or increase a fire, other fire extinguishing systems shall be required in rooms or buildings used for the manufacture or storage of hazardous materials including but not limited to, aluminum powder, calcium carbide, calcium phosphate, metallic sodium and potassium, quicklime, magnesium powder and sodium peroxide.
2. In Group F and Group S occupancies where noncombustible products are manufactured or stored, such as metal processing and manufacturing plants, and metal products are not stored in combustible wrappings, containers or palletized, the sprinkler system may be omitted upon approval of the building official.

503.4.2 The area of a one story building of Type IV construction used for Group E occupancy shall not be limited provided the building is equipped throughout with an approved automatic sprinkler system in accordance with 903, is surrounded on all sides by a permanent open space of not less than 60 ft (18.3 m), and is provided with 1-hour fire resistant smokestop partitions dividing the building into areas not to exceed 30,000 sq ft (2787 m^2) in floor area.

503.4.3 One story Group A buildings without a stage requiring proscenium opening protection of Type V 1-hour, IV or III construction which are surrounded on all sides by a permanent open space of not less than 60 ft (18.2 m), are provided with an approved automatic sprinkler system, and the assembly floor is located at, or within 21 inches (533 mm) of street or grade level and all exits meet the street or grade level by ramps having a slope not exceeding 1:10 shall not be limited in area.

503.4.4 Where there are no balconies or galleries in Group A - Large Assemblies without a stage requiring proscenium opening protection or in Group A - Small Assembly with or without a stage requiring proscenium opening protection, and the assembly floor is located at or within 21 inches (533 mm) of street or grade level and all exits meet the street or grade level by ramps having a slope not exceeding 1:10, the maximum allowable areas of Type III , IV and V construction may be increased 50% over the unsprinklered areas specified in Table 500. This increase may be added to the area increase permitted by 503.3.2.

503.4.5 One story buildings used for participation sports such as tennis, skating and similar activities, limited in occupant content to those participating in the sports activity, and with no spectator seating permitted, may be unlimited in area when of Types III, IV and V construction and are surrounded on all sides by not less than 30 ft (9144 mm) of permanent open space.

503.4.6 When used as a place of worship, the allowable areas for Group A - Small Assembly without a stage requiring proscenium opening protection may be increased 33 1/3% over the unsprinklered areas specified in Table 500. This increase may be added to the area increase permitted by 503.3.2.

503.4.7 The area of a one story Group E Type III, IV or V building may be increased 100% over the unsprinklered areas specified in Table 500 if the building is surrounded on all sides by a permanent open space of not less than 60 ft (18.3 m), and there are not less than two exits provided from each classroom, one of which opens directly to the exterior of the building. This increase may be added to the area increase permitted by 503.3.2.

503.4.8 The permanent open space of 60ft (18.3 m) required in 503.4.1, 503.4.2, 503.4.3 and 503.4.7 shall be permitted to be reduced to not less than 40 ft (12.2 m) provided all of the following requirements are met:

1. The reduced open space shall not be allowed for more than 75% of the perimeter of the building.
2. The exterior wall facing the reduced open space shall have minimum fire resistance rating of 3 hours.
3. All openings in the exterior wall, facing the reduced open space, shall have opening protectives with a fire resistance rating of 3 hours.

503.4.9 Group A area modification: Open air grandstands and bleachers, see 403.6.2.1.

503.4.10 Group M area modifications: covered mall buildings see 413.6.

503.4.11 Group S area modifications:

l. Aircraft hangars see 411.7.2.

2. Automobile parking garages see 411.3.

504 BUILDINGS LOCATED ON THE SAME LOT

Where the exterior walls of two or more buildings located on the same lot face one another, and one of the walls is not constructed as required for a fire wall, a property line shall be assumed between them. The fire resistance requirements for such facing walls and for the protection of openings therein shall be the same as required by this code for walls and openings facing an assumed property line, as provided in Table 600.

EXCEPTION: Fire resistance separation shall not be required between a dwelling and its detached private garage.

505 BUILDINGS LOCATED WITHIN A FIRE DISTRICT

Additional provisions for buildings located within a fire district are contained in Appendix F. Those provisions are applicable only where specifically included in the adopting ordinance.

TABLE 500 – ALLOWABLE HEIGHTS IND BUILDING AREAS

Lower case letters in table refer to Notes following table.
Height for types of construction is limited to the number of stories and height in feet shown.
Allowable building area (determined by definition of "Area, Building") is shown in thousands of square feet per floor.

TYPE CONSTRUCTION	I		II		III		IV 1-Hour		IV Unprot.		V 1-Hour		V Unprot.		VI 1-Hour		VI Unprot.	
Maximum Height in Feet:	**No Limit**		**80'**		**65'**		**65'**		**55'**		**65'**		**55'**		**50'**		**40'**	
OCCUPANCY	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**
		j	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**
A-1 ASSEMBLY LARGI (stage requiring proscenium opening protection) a,b																		
Max. No. of Stories	NL	NL	NL	NL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area: Multistory	UA	UA	UA	UA														
One Story only	UA	UA	UA	UA														
A-1 ASSEMBLY LARGI (no stage requiring proscenium opening protection) a,b																		
Max. No. of Stories	NL	NL	NL	NL	1	1	1	1	1	1	1	1	1	1	0	0	0	0
Area: Multistory	UA	UA	UA	UA														
One Story only	UA	UA	UA	UA	12.0	36.0	12.0	36.0	8.0	24.0	12.0	36.0	8.0	24.0				
A-2 ASSEMBLY SMALI (stage requiring proscenium opening protection) a,b																		
Max. No. of Stories	NL	NL	NL	NL	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Area: Multistory	UA	UA	UA	UA														
One Story only	UA	UA	UA	UA	10.0	30.0	10.0	30.0	6.0	18.0	10.0	30.0	6.0	18.0	4.5	13.5	3.0	9.0
A-2 ASSEMBLY SMALI (no stage requiring proscenium opening protection) a,b																		
Max. No. of Stories	NL	NL	NL	NL	2	2	2	2	2	2	2	2	2	2	1	1	1	1
Area: Multistory	UA	UA	UA	UA	12.0	24.0	12.0	24.0	8.0	16.0	12.0	24.0	8.0	16.0				
One Story only	UA	UA	UA	UA	12.0	36.0	12.0	36.0	8.0	24.0	12.0	36.0	8.0	24.0	7.5	22.5	5.0	15.0
B BUSINESS a,b																		
Max. No. of Stories	NL	NL	NL	NL	5	5	5	5	2	5	5	5	2	5	2	2	2	2
Area: Multistory	UA	UA	UA	UA	25.5	51.0	25.5	51.0	17.0	34.0	21.0	42.0	14.0	28.0	13.5	27.0	9.0	18.0
One Story only	UA	UA	UA	UA	25.5	76.5	25.5	76.5	17.0	51.0	21.0	63.0	14.0	42.0	13.5	40.5	9.0	27.0
E EDUCATIONAL a,b																		
Max. No. of Stories	NL	NL	NL	NL	2	2	2	2	1	1	2	2	1	1	2	2	1	1
Area: Multistory	UA	UA	UA	UA	18.0	36.0	18.0	36.0			18.0	36.0			12.0	24.0		
One Story only	UA	UA	UA	UA	18.0	54.0	18.0	54.0	12.0	36.0	18.0	54.0	12.0	36.0	12.0	36.0	8.0	24.0
F FACTORY-INDUSTRIAL a,b,g																		
Max. No. of Stories:	NL	NL	NL	NL	3	6	2	4	2	4	2	4	2	4	1	1	1	1
Area: Multi-story:	UA	UA	UA	UA	31.5	63.0	31.5	63.0	21.0	42.0	22.5	45.0	15.0	30.0				
One Story only	UA	UA	UA	UA	31.5	94.5	31.5	94.5	21.0	63.0	22.5	67.5	15.0	45.0	15.0	45.0	10.0	30.0

1 ft = 0.305 m
1 sq ft = 0.0929 m^2

TABLE 500 – ALLOWABLE HEIGHTS IND BUILDING AREAS *(Continued)*

Lower case letters in table refer to Notes following table.
Height for types of construction is limited to the number of stories and height in feet shown.
Allowable building area (determined by definition of "Area, Building") is shown in thousands of square feet per floor.

TYPE CONSTRUCTION	I		II		III		IV 1-Hour		IV Unprot.		V 1-Hour		V Unprot.		VI 1-Hour		VI Unprot.	
Maximum Height in Feet:	**No Limit**		**80'**		**65'**		**65'**		**55'**		**65'**		**55'**		**50'**		**40'**	
OCCUPANCY	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**
		j	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**
H-1 HAZARDOUS c																		
Max. No. of Stories	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0	0
Area: Multistory																		
One Story only		15.0		12.0		7.5		7.5		5.0		7.5						
H-2 HAZARDOUS c																		
Max. No. of Stories	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0
Area: Multistory																		
One Story only		15.0		12.0		7.5		7.5		5.0		7.5		4.0		2.5		
H-3 HAZARDOUS c																		
Max. No. of Stories	0	4	0	3	0	2	0	2	0	1	0	2	0	1	0	1	0	0
Area: Multistory		30.0		20.0		10.0		10.0				10.0						
One Story only		30.0		20.0		10.0		10.0		7.5		10.0		7.5		4.0		
H-4 HAZARDOUS c																		
Max. No. of Stories	0	NL	0	6	0	3	0	4	0	4	0	4	0	4	0	1	0	1
Area: Multistory		UA		UA		48.0		48.0		32.0		48.0		32.0				
One Story only		UA		UA		72.0		72.0		48.0		72.0		48.0		27.0		18.0
I INSTITUTIONAL-RESTRAINED b							i											
Max. No. of Stories	NL	NL	NL	NL	0	2	2	3	0	2	0	3	0	2	0	3	0	2
Area: Multistory	UA	UA	UA	UA		24.0	15.0	30.0		20.0		21.0		14.0		15.0		10.0
One Story only	UA	UA	UA	UA		36.0	15.0	45.0		30.0		31.5		21.0		22.5		15.0
I INSTITUTIONAL-UNRESTRAINED b																		
Max. No. of Stories	0	NL	0	NL	0	2	0	3	0	1	0	1	0	0	0	1	0	0
Area: Multistory		UA		UA		24.0		30.0										
One Story only		UA		UA		36.0		45.0		30.0		31.5				22.5		
M MERCANTILE a,b	f		f		f		f		f		f		f		f		f	
Max. No. of Stories	NL	NL	NL	NL	5	5	5	5	2	5	5	5	2	5	2	5	2	2
Area: Multistory	15.0	UA	15.0	UA	13.5	27.0	13.5	27.0	9.0	18.0	13.5	27.0	9.0	18.0	9.0	18.0	6.0	12.0
One Story only	15.0	UA	15.0	UA	13.5	40.5	13.5	40.5	9.0	27.0	13.5	40.5	9.0	27.0	9.0	27.0	6.0	18.0

1 ft = 0.305 m
1 sq ft = 0.0929 m^2

TABLE 500 – ALLOWABLE HEIGHTS IND BUILDING AREAS *(Continued)*

Lower case letters in table refer to Notes following table.
Height for types of construction is limited to the number of stories and height in feet shown.
Allowable building area (determined by definition of "Area, Building") is shown in thousands of square feet per floor.

TYPE CONSTRUCTION	I		II		III		IV 1-Hour		IV Unprot.		V 1-Hour		V Unprot.		VI 1-Hour		VI Unprot.	
Maximum Height in Feet:	**No Limit**		**80'**		**65'**		**65'**		**55'**		**65'**		**55'**		**50'**		**40'**	
OCCUPANCY	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**	**uns**	**spr**
		j	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**	**h**	**j**
R RESIDENTIAL a,b,d																	k	
Max. No. of Stories	NL	NL	NL	NL	3	3	5	5	2	5	5	5	2	5	3	3	2	2
Area: Multistory	UA	UA	UA	UA	18.0	36.0	18.0	36.0	12.0	24.0	18.0	36.0	12.0	24.0	10.5	21.0	7.0	14.0
One Story only	UA	UA	UA	UA	18.0	54.0	18.0	54.0	12.0	36.0	18.0	54.0	12.0	36.0	10.5	31.5	7.0	21.0
S STORAGE a,b,e,g																		
Max. No. of Stories	NL	NL	6	6	2	6	2	4	2	4	2	4	2	4	1	1	1	1
Area: Multistory	UA	UA	30.0	60.0	24.0	48.0	24.0	48.0	16.0	32.0	24.0	48.0	16.0	32.0				
One Story only	UA	UA	30.0	90.0	24.0	72.0	24.0	72.0	16.0	48.0	24.0	72.0	16.0	48.0	9.0	27.0	6.0	18.0

1 ft = 0.305 m
1 sq ft = 0.0929 m^2

Notes:

a. For height modifications and limitations by occupancy, see:
1. Mezzanines 503.2.3
2. Basements 503.2.4
3. Assembly-Basements 503.2.5
4. Business 503.2.6
5. Educational-Basements 503.2.5
6. Mercantile 503.2.6
7. Residential 503.2.2, 503.2.6

b. For area modifications and limitations by occupancy see:
1. Area increase for separation (All occupancies except H) 503.3.2
2. Assembly 503.4.3, 503.4.4, 503.4.5, 503.4.6, 503.4.8
3. Business 503.4.1, 503.4.8
4. Educational 503.4.2, 503.4.7
5. Factory-Industrial 503.4.1, 503.4.8
6. Mercantile 503.4.1, 503.4.8, 503.4.10
7. Storage 503.4.1, 503.4.8, 503.4.11

c. Modifications in height and area shall not be permitted in Group H occupancies.

d. See 903.7.5 and 903.7.6 for height limitations of unsprinklered R1 and R2 occupancies. Height and area increases in 503.2 are not permitted for NFPA 13R systems installed as an option in 903.7.6.

e. See 411.3.1 for allowable height and floor areas of Open Automobile Parking Structures.

TABLE 500 NOTES *(continued)*

f. Total area for unsprinklered Group M occupancies after increase permitted by 503.3 shall not exceed 15,000 sq ft.
g. Height in feet not applicable to Group S and Group F occupancies.
h. When all portions of buildings are sprinklered in accordance with the standards listed in 903.2, the height of buildings listed under this column may be increased one story. A general area increase provided for in 503.3.2 may be applied before using footnote h.
i. Automatic sprinkler protection required throughout all buildings where Use Condition 5 is used. See 409.2.3 and 1024.2.2.
j. When all portions of buildings are sprinklered in accordance with the standards listed in 903.2, the allowable heights and areas of buildings shall be as listed under this column.
k. See 903.7.6.

CHAPTER 6

CONSTRUCTION TYPES

601 GENERAL

601.1 Scope

Provisions of this chapter shall govern the classification of construction type by materials and fire resistance of its elements and the use of more than one construction type in a building.

601.2 Classification by Type of Construction

601.2.1 Every building shall be classified by the building official into one of the types of construction as set forth in this section.

Type I
Type II
Type III
Type IV
  1-Hour Protected
  Unprotected
Type V
  1-Hour Protected
  Unprotected
Type VI
  1-Hour Protected
  Unprotected

601.2.2 Materials for any one of the six types of construction may be used as specified in Table 600, or as permitted in this chapter.

601.3 Fire Resistance Requirements

601.3.1 All fire resistance requirements are expressed in terms of the number of hours of satisfactory performance in accordance with ASTM E 119.

601.3.2 Construction required to have a fire resistance rating shall be supported by construction of equal or greater fire resistance.

EXCEPTION: In Types IV Unprotected, V Unprotected and VI Unprotected construction, structural elements supporting exit access corridor walls and tenant separation walls of not more than 1-hour fire resistance need not be rated provided a fire resistance rating is not required by other provisions of this code.

601.4 Materials and Construction Approved for Fire Resistance

601.4.1 The degree of fire resistance and the materials, assemblies, and constructions providing such resistance shall be defined in Chapter 7 of this code, except that other materials, assemblies, and constructions shall be approved, provided test data of a recognized engineering or testing laboratory are submitted, establishing that they develop the required fire resistance rating under tests made in accordance with ASTM E 119 or based on calculations and accepted engineering practice as set forth in 709.

601.4.2 Where structural requirements necessitate assemblies providing greater fire resistance than specified in this chapter, such structural requirements shall govern.

602 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

603 TYPE I CONSTRUCTION

Type I is construction in which the structural members including exterior walls, interior bearing walls, columns, beams, girders, trusses, arches, floors, and roofs are of noncombustible materials and are protected so as to have fire resistance not less than that specified for the structural elements as specified in Table 600. For interior nonbearing partition requirements, see 704.2. For provisions governing combustibles in concealed spaces, see 707.

604 TYPE II CONSTRUCTION

Type II is construction in which the structural members including exterior walls, interior bearing walls, columns, beams, girders, trusses, arches, floors and roofs are of noncombustible materials and are protected so as to have fire resistance not less than that specified for the structural elements as specified in Table 600. For interior nonbearing partition requirements see 704.2. For provisions governing combustibles in concealed spaces, see 707.

605 TYPE III CONSTRUCTION

605.1 General

Type III is construction in which fire resistance is attained by the sizes of heavy timber members (sawn or glued laminated) being not less than indicated in this section, or by providing fire resistance not less than 1 hour where materials other than wood of heavy timber sizes are used; by the avoidance of concealed spaces under floors and roofs; by the use of approved fastenings, construction details and adhesives for structural members; and by providing the required degree of fire resistance in exterior and interior walls.

605.2 Columns

605.2.1 Wood columns may be sawn or glued laminated and shall be not less than 8 inches nominal in any dimension when supporting floor loads, and not less than 6 inches nominal wide and 8 inches nominal deep when supporting roof and ceiling loads only.

605.2.2 Columns shall be continuous or superimposed throughout all stories by means of reinforced concrete or metal caps with brackets, or shall be connected by properly designed steel or iron caps, with pintles and base plates, or by timber splice plates affixed to the columns by means of metal connectors housed within the contact faces, or by other approved methods.

605.3 Floor Framing

605.3.1 Beams and girders of wood may be sawn or glued laminated and shall be not less than 6 inches nominal wide and not less than 10 inches nominal deep.

605.3.2 Framed or glued laminated arches which spring from the floor line and support floor loads shall be not less than 8 inches nominal in any dimension.

605.3.3 Framed timber trusses supporting floor loads shall have members of not less than 8 inches nominal in any dimension.

605.4 Roof Framing

605.4.1 Framed or glued laminated arches for roof construction which spring from the floor line and do not support floor loads shall have members not less than 6 inches nominal wide and 8 inches nominal deep for the lower half of the height and not less than 6 inches nominal in any dimension for the upper half of the height.

605.4.2 Framed or glued laminated arches for roof construction which spring from the top of walls or wall abutments, framed timber trusses and other roof framing which do not support floor loads, shall have members not less than 4 inches nominal wide and not less than 6 inches nominal deep. Spaced members may be composed of two or more pieces not less than 3 inches nominal thick when blocked solidly throughout their intervening spaces or when such spaces are tightly closed by a continuous wood cover plate of not less than 2 inches nominal thick, secured to the underside of the members. Splice plates shall be no less than 3 inches nominal thick. When protected by approved automatic sprinklers under the roof deck, such framing members shall be not less than 3 inches nominal wide.

605.5 Construction Details

605.5.1 Wall plate boxes of self-releasing type, or approved hangers, shall be provided where beams and girders enter masonry. An air space of 1/2 inch (12.7 mm) shall be provided at the top, ends and sides of the member unless approved durable or treated wood is used.

605.5.2 Girders and beams shall be closely fitted around columns and adjoining ends shall be cross-tied to each other, or inter-tied by caps or ties, to transfer horizontal loads across the joint. Wood bolsters may be placed on tops of columns which support roof loads only.

605.5.3 Where intermediate beams are used to support floors, they shall rest on top of the girders, or shall be supported by ledgers or blocks securely fastened to the sides of the girders, or they may be supported by approved metal hangers into which the ends of the beams shall be fitted closely.

605.5.4 Columns, beams, girders, arches and trusses of material other than wood shall have a fire resistance rating of not less than 1 hour.

605.5.5 Wood beams and girders supported by walls required to have a fire resistance rating of 2 hours or more shall have not less than 4 inches (102 mm) of solid masonry between their ends and the outside face of the wall, and between adjacent beams.

605.5.6 Adequate roof anchorage shall be provided.

605.6 Floor Decks

Floors shall be without concealed spaces. They shall be of sawn or glued laminated plank, splined, or tongue-and-grooved, not less than 3 inches nominal thick, or of planks not less than 4 inches nominal wide set on edge and well-spiked together. The planks shall be laid so that no continuous line of joints will occur except at points of support and they shall not be spiked to supporting girders. Planks shall be covered with 1 inch nominal tongue-and-groove flooring laid crosswise or diagonally or with 15/32 inch (11.9 mm) wood structural panels. Planks and flooring shall not extend closer than 1/2 inch (12.7 mm) to walls to provide an expansion joint, and the joint shall be covered at top or bottom.

605.7 Roof Decks

Roofs shall be without concealed spaces and roof decks shall be sawn or glued laminated, splined or tongue and grooved plank, not less than 2 inches nominal thick, or of planks not less than 3 inches nominal wide, set on edge and spiked together as required for floors, or of 1 1/8-inch (29 mm) tongue and grooved wood structural panels bonded with exterior glue. Other types of decking may be used when approved by the building official.

605.8 Walls

605.8.1 Bearing portions of exterior and interior walls shall be of approved noncombustible materials and shall provide fire resistance ratings in accordance with Table 600.

605.8.2 Nonbearing portions of exterior walls shall be of approved noncombustible materials and shall provide fire resistance ratings in accordance with Table 600.

EXCEPTION: Where a horizontal separation of at least 20ft (6096 mm) is provided, wood columns, arches, beams and roof decks conforming to heavy timber sizes may be used externally.

606 TYPE IV CONSTRUCTION

Type IV is construction in which the structural members including exterior walls, interior bearing walls, columns, beams, girders, trusses, arches, floors, and roofs are of noncombustible materials. Type IV construction may be protected or unprotected. Fire resistance requirements for structural elements of Type IV construction shall be as specified in Table 600. For provisions governing combustibles in concealed spaces, see 707.

607 TYPE V CONSTRUCTION

Type V is construction in which the exterior bearing and nonbearing walls are of noncombustible material and have fire resistance not less than that specified in Table 600; bearing portions of interior walls are of material permitted in Table 600, and have fire resistance not less than that specified in Table 600; and beams, girders, trusses, arches, floors, roofs, and interior framing are wholly or partly of wood or other approved materials and have fire resistance not less than that specified in Table 600. Type V construction may be either protected or unprotected. Fire resistance requirements for structural elements of Type V construction shall be as specified in Table 600.

608 TYPE VI CONSTRUCTION

Type VI is construction in which the exterior bearing and nonbearing walls and partitions, beams, girders, trusses, arches, floors, and roofs and their supports are wholly or partly of wood or other approved materials. Type VI construction may be either protected or unprotected. Fire resistance requirements for structural elements of Type VI construction shall be as specified in Table 600.

609 PARTITIONS

609.1 Bearing walls shall comply with the provisions of Chapter 6, but shall provide not less than the degree of fire resistance specified in Table 600.

609.2 Nonbearing partitions shall conform to 609.2.1 through 609.2.4 and have the fire resistance specified in Table 700 except as specified elsewhere in this code.

609.2.1 Type I and Type II Construction. Partitions shall be constructed of noncombustible materials.

EXCEPTIONS:

1. Framing members may be of fire retardant treated wood.
2. Pocket doors and their frames may be of wood.

609.2.2 Type III Construction. Partitions may be of any material permitted by this code.

609.2.3 Type IV Construction. Partitions shall be constructed of noncombustible materials except that framing members of fire retardant treated wood may be used and pocket doors and their frames may be of wood. Partitions in one story buildings only may be of any material permitted by this code. Partitions in fully sprinklered buildings, regardless of height, may be of any material permitted by this code.

609.2.4 Type V and Type VI Construction. Partitions may be of any material permitted by this code.

610 MIXED TYPES OF CONSTRUCTION

610.1 Area Limitations

Where two or more types of construction not separated by fire walls occur in the same building, the area of the entire building shall not exceed the least area permitted based on occupancy for the types of construction used in the building.

610.2 Height Limitations

Where two or more types of construction occur in the same building, the height of the entire building shall not exceed the least height permitted based on the occupancy for the types of construction used in the building.

610.3 Open Parking Structures

Open parking structures which comply with 411.3 may be constructed beneath other occupancies in buildings of mixed types of construction in accordance with the following:

1. The height and area of the open parking structure shall not exceed that permitted by Table 411.3.1 for the type of construction of the open parking structure.
2. The total height of the structure shall not exceed that allowed for its primary occupancy in accordance with 303 and Table 500.
3. The fire resistance of structural members within the open parking structure that support any part of the building above the open parking structure shall have the same or greater fire resistance as the supported type of construction. This provision applies to all columns; beams, girders, and trusses directly connected to the columns; and all other structural members which directly brace the columns.
4. The entire structure shall be of noncombustible construction.
5. Occupancy separations shall be maintained in accordance with 704.1.
6. All exits for the upper occupancy shall be protected to the exterior of the building in accordance with Chapter 10.

Table 600
Fire Resistance Ratings
Required Fire Resistance in Hours

STRUCTURAL ELEMENTS	Type I	Type II	Type III	Type IV		Type V		Type VI	
				1-Hour Protected	Unprotected	1-Hour Protected	Unprotected	1-Hour Protected	Unprotected
PARTY AND FIRE WALLS (a)	4	4	4	4	4	4	4	4	4
INTERIOR BEARING WALLS	(l)								
Support columns, other bearing walls or more than on floor	4	3	2	1	NC	1(h)	0(h)	1	0
Support one floor only	3	2	1	1	NC	1	0	1	0
Support one roof only	3	2	1	1	NC	1	0	1	0
INTERIOR NONBEARING PARTITIONS	See 704.1, 704.2 and 705.2								
COLUMNS	(l)		See 605						
Supporting other columns or more than one floor	4	3	H(d)	1	NC	1	0	1	0
Supporting one floor only	3	2	H(d)	1	NC	1	0	1	0
Support one roof only	3	2	H(d)	1	NC	1	0	1	0
BEAMS, GIRDERS, TRUSSES & ARCHES	(l)		See 605						
Supporting other columns or more than one floor	4	3	H(d)	1	NC	1	0	1	0
Supporting one floor only	3	2	H(d)	1	NC	1	0	1	0
Support one roof only	1 1/2(e,p)	1(e,f,p)	H(d)	1(e,p)	NC(e)	1	0	1	0
FLOORS & FLOOR/CEILING	(l)		See 605	(n)	(n,o)	(n)	(m,n,o)		(o)
CONSTRUCTION	3	2	H(o)	1	NC	1	0	1	0
ROOF & ROOF/CEILING			See 605						
CONSTRUCTION (g)	1 1/2(e,p)	1(e,f,p)	H(d)	1(e,p)	NC(e)	1	0	1	0
EXTERIOR BEARING WALLS and gable ends of roof (g,i,j)	(% indicates percent of protected and unprotected wall openings permitted. See 705.1.1 for protection requirements)								
Horizontal separation (distance from common property line or assumed property line).									
0 ft to 3 ft (c)	4(0%)	3(0%)	3(0%)(b)	2(0%)	1(0%)	3(0%)(b)	3(0%)(b)	1(0%)	1(0%)
over 3 ft to 10 ft (c)	4(10%)	3(10%)	2(10%)(b)	1(10%)	1(10%)	2(10%)(b)	2(10%)(b)	1(20%)	0(20%)
over 10 ft to 20 ft (c)	4(20%)	3(20%)	2(20%)(b)	1(20%)	NC(20%)	2(20%)(b)	2(20%)(b)	1(40%)	0(40%)
over 20 ft to 30 ft	4(40%)	3(40%)	1(40%)	1(40%)	NC(40%)	1(40%)	1(40%)	1(60%)	0(60%)
over 30 ft (k)	4(NL)	3(NL)	1(NL)	1(NL)	NC(NL)	1(NL)	1(NL)	1(NL)	0(NL)
EXTERIOR NONBEARING WALLS and gable ends of roof (g,i,j)	(% indicates percent of protected and unprotected wall openings permitted. See 705.1.1 for protection requirements)								
Horizontal separation (distance from common property line or assumed property line).									
0 ft to 3 ft (c)	3(0%)	3(0%)	3(0%)(b)	2(0%)	1(0%)	3(0%)(b)	3(0%)(b)	1(0%)	1(0%)
over 3 ft to 10 ft (c)	2(10%)	2(10%)	2(10%)(b)	1(10%)	1(10%)	2(10%)(b)	2(10%)(b)	1(20%)	0(20%)
over 10 ft to 20 ft (c)	2(20%)	2(20%)	2(20%)(b)	1(20%)	NC(20%)	2(20%)(b)	2(20%)(b)	1(40%)	0(40%)
over 20 ft to 30 ft	1(40%)	1(40%)	1(40%)	NC(40%)	NC(40%)	1(40%)	1(40%)	0(60%)	0(60%)
over 30 ft (k)	NC(NL)	NC(NL)	NC(NL)	NC(NL)	NC(NL)	NC(NL)	NC(NL)	0(NL)	0(NL)

Notes:

a. See 704.5 for extension of party walls and fire walls.

b. See 704.5for parapets.

c. See 705 for protection of wall openings.

d. Where horizontal separation of 20 ft or more is provided, wood columns, arches, beams, and roof deck conforming to heavy timber sizes may be used externally.

e. In buildings not over two stories approved fire retardant treated wood may be used.

f. In one story buildings, structural members of heavy timber sizes may be used as an alternate to unprotected structural roof members. Stadiums, field houses and arenas with heavy timber wood dome roofs are permitted. An approved automatic sprinkler system shall be installed in those areas where 20 ft clearance to the floor or balcony below is not provided.

g. See 1503 for penthouses and roof structures.

h. The use of combustible construction for interior bearing partitions shall be limited to the support of not more than two floors and a roof.

i. Exterior walls shall be fire tested In accordance with 601.3. The fire resistance requirements for exterior walls with 5 ft or less horizontal separation shall be based upon both Interior and exterior fire exposure. The fire resistance requirements for exterior walls with more than 5 ft horizontal separation shall be based upon Interior fire exposure only.

j. Where Appendix F is specifically included in the adopting ordinance, see F102.2.6 for fire resistance requirements for exterior walls of Type IV buildings in Fire District.

k. Walls or panels shall be of noncombustible material or fire retardant treated wood, except for Type VI construction.

l. For Group A - Large Assembly, Group A- Small Assembly, Group B, Group E, Group F, Group R occupancies and Automobile Parking Structures, occupancies of Type I construction, partitions, columns, trusses, girders, beams, and floors may be reduced by 1 hour if the building is equipped with an automatic sprinkler system throughout, but no component or assembly may be less than 1 hour.

m. Group A - Large Assembly (no stage requiring proscenium opening protection) and Group A - Small Assembly occupancies of Type V Unprotected construction shall have 1 hour fire resistant floors over any crawl space or basement.

n. For Group B and Group M occupancies of Type IV or Type V construction, when five or more stories in height a 2 hour fire resistant floor shall be required over the basement.

o. For unsprinklered Group E occupancies of Type III, Type IV Unprotected, Type V Unprotected or Type VI Unprotected, floors located immediately above useable space in basements shall have a fire resistant rating of not less than 1 hour.

p. In buildings of Group A, B, E, and R occupancies, fire resistance may be omitted where structural members support a roof only and are 20 ft or more clear above any floor or balcony.

CHAPTER 7

FIRE RESISTANT MATERIALS AND CONSTRUCTION

701 GENERAL

701.1 Scope

Provisions of this chapter shall govern the fire resistant materials and assemblies used for structural fire resistance and fire resistant separation of adjacent spaces, including construction, opening protectives, penetrations, fireblocking and drafstopping.

701.2 Tests

701.2.1 Fire resistance requirements of this code are based on fire resistance ratings. Materials, thicknesses, and assemblies which have successfully performed under tests made by a recognized laboratory in accordance with the requirements of ASTM E 119 or based on calculations and accepted engineering practice as set forth in 709 shall be accepted by the building official for specific ratings.

EXCEPTION: In determining the fire resistance rating of exterior bearing walls, compliance with ASTM E 119 criteria for unexposed surface temperature rise ignition of cotton waste due to passage of flame or gases is required only for a period of time corresponding to the required fir resistance rating of an exterior, nonbearing wall with the same horizontal separation distance, and in a building of the same type construction. When the fire resistance rating determined in accordance with this exception exceeds the fire resistance rating determined in accordance with ASTM E 119, the fire exposure time period, water pressure and application duration criteria for the hose stream test of ASTM E 119 shall be based upon the fire resistance rating determined in accordance with this exception.

701.2.2 When insulation or other materials which may change the capacity for heat dissipation are added to or subtracted from fire resistant roof or ceiling assemblies whose fire ratings are listed in this code or listed in reference documents, fire test results or other substantiating data shall be submitted to the building official to show that the required fire resistance time period is not reduced.

701.2.3 Thicknesses established by fire tests shall be construed as establishing minimum requirements for fire resistance only, and shall not preclude the application of other requirements of this code where consideration of strength, durability or stability require greater thicknesses.

701.3 Column Fire Resistance

Where columns require a fire resistance rating, the entire column, including its connection beams or girders, shall be protected. Where the column extends through a ceiling, fire resistance of the column shall be continuous from top of the floor through the ceiling space to the underside of the floor deck above, except as provided in Table 600, Note p, or other such provisions of this code.

701.4 Fire Resistance References

701.4.1 To meet the fire resistance requirements of this code, it shall be determined that materials, constructions and assemblies of construction materials have successfully performed under accepted tests as prescribed in 701.2.

701.4.2 Appropriate fire resistant materials, constructions and assemblies of constructions as listed in 709.7 and the following publications may be accepted as if herein listed:

FM Specification Tested Products Guide

GA Fire Resistance Design Manual

SBCCI PST & ESI Evaluation Report Listing

UL Fire Resistance Directory

Test by National Bureau of Standards.

Listings Book by Warnock Hersey International.

The Omega Point Laboratories Director of Listed Building Products, Materials, and Assemblies.

Fire Testing Certification of the Department of Fire Technology at Southwest Research Institute.

Prestressed Concrete Institute Manual 124-77.

Prestressed Concrete Institute Manual for the Design of Hollow Core Slabs (1985).

PFS Corporation to Test and List Building Assemblies and Components to ASTM E-84, ASTM E 119, and ASTM E 152.

701.4.3 Other fire resistance ratings may be accepted by the building official on evidence of compliance with 701.2.

701.5 Exceptions To Fire Resistance

701.5.1 Elevator Frames. Structural members of frames for elevators will not be required to have the fire resistance required for structural steel, provided such members are erected within an enclosure of the prescribed fire resistance rating. See 705.2.

701.5.2 Lintel Protection. Lintels over openings in walls shall be protected to provide a fire resistance rating at least equal to that required for beams, except that fire resistance may be omitted from the bottom flange of lintels, shelf angles and plates not a part of the structural frame or with a span of 6 ft (1829 mm) or less.

701.5.3 Unusable Space. In 1-hour fire resistant construction, the ceiling may be omitted over unusable crawl space and flooring may be omitted when unusable attic space occurs above.

702 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

703 MATERIALS FOR FIRE RESISTANCE

703.1 Scope

Materials prescribed herein for fire resistance shall conform with the requirements of this chapter.

703.2 Brick

Brick shall be laid in Type M, S, N or 0 mortar. Solid clay and shale brick shall conform to ASTM C 216 or ASTM C 62. Hollow clay and shale brick shall conform to ASTM C 652. Concrete brick shall conform to ASTM C 55. Sand-lime brick shall conform to ASTM C 73. Ceramic glazed structural facing tile and facing brick shall conform to ASTM C 126.

703.3 Clay or Shale Tile

Hollow clay or shale tile shall be laid in Type M, S, N, 0 or gypsum mortar. Clay or shale tile used in nonbearing partitions and for fire resistance shall meet the requirements of ASTM C 56. Clay or shale tile used in exterior walls and in all loadbearing walls shall comply with the requirements of ASTM C 34 and ASTM C 212.

703.4 Gypsum

703.4.1 Poured gypsum used for fire resistance and floor and roof construction shall contain not more than 12 1/2% of wood chips, shavings or fiber, measured in a dry condition, as a percentage by weight of the dry mix. Gypsum mortar shall be composed of one part gypsum and not more than three parts clean, sharp, well-graded sand, by weight.

703.4.2 Fibered plaster may be used where unsanded or neat gypsum plaster is prescribed.

703.4.3 All plaster mixes for sanded gypsum plasters shall be measured by dry weight.

703.4.4 When gypsum plaster is used with an aggregate, the proportions shall be as required in 2504.

703.5 Gypsum Lath, Wallboard and Sheathing Board

703.5.1 Gypsum lath shall comply with the provisions of ASTM C 37.

703.5.2 Gypsum lath shall be nailed to wood studs or joists in all constructions required to be fire resistant, with 1 1/8-inch (29 mm), 13 ga, 19/64-inch (7.5 mm) flat head blued nails at intervals not exceeding 4 inches (102 mm) on centers (five nails per lath for support of 16-inch (406 mm) lath) or equivalent attachment.

703.5.3 Gypsum wallboard shall comply with the provisions of ASTM C 36.

703.5.4 Gypsum sheathing board shall comply with the provisions of ASTM C 79.

703.5.5 Gypsum veneer base shall comply with the provisions of ASTM C 588.

703.5.6 Gypsum veneer plaster shall comply with the provisions of ASTM C 587.

703.5.7 Exterior gypsum soffit board shall comply with the provisions of ASTM C 931.

703.5.8 Water resistant gypsum backing board shall comply with the provisions of ASTM C 630.

703.6 Metal or Wire Lath

703.6.1 Metal lath shall comply with the provisions of ASTM C 847. Wherever metal lath or wire lath and plaster are used as required protection against the spread of fire, the weight of lath shall be not less than 2.5 lb per sq yd (1.4 kg/m^2) when used in vertical position, and not less than 2.75 lb per sq yd (1.5 kg/m^2) when used in horizontal position. Wire lath shall not be lighter than 2 1/2 meshes per inch, or equivalent.

703.6.2 Weight tags shall be left on all metal lath or wire lath until inspected and approved by the building official.

703.6.3 Metal lath for ceilings below wood joists in construction which is required to be fire resistant shall be attached with 1 1/2-inch (38 mm), 11 ga, 7/16-inch (11.1 mm) head barbed roofing nails spaced at intervals not to exceed 6 inches (152 mm) on centers, or equivalent attachment.

703.6.4 Welded wire lath shall comply with the provisions of ASTM C 933.

703.6.5 Woven wire lath shall comply with ASTM C 1032.

703.7 Concrete Block

Concrete masonry units used in exterior walls and in all walls or partitions shall comply with ASTM C 90 and C 129.

703.8 Vermiculite

Vermiculite, when used as an aggregate with plaster, shall conform in particle size to ASTM C 35. The weight of vermiculite shall be not less than 6 pcf (96 kg/m^3) nor more than 10 pcf (160 kg/m^3) as determined by measurement in a cubic-foot box, using the shoveling procedure as outlined in ASTM C 29.

703.9 Perlite

Perlite, when used as an aggregate with plaster, shall conform in particle size to ASTM C 35. The weight of perlite shall be not less than 7 1/2 pcf (120 kg/m^3) nor more than 15 pcf (240 kg/m^3), as determined by measurement in a cubic-foot box, using the shoveling procedure as outlined in ASTM C 29.

703.10 Glass Block

Glass block shall be labeled to conform to ASTM E 163 or UL 9.

704 FIRE RESISTANT SEPARATIONS

704.1 Occupancy Separation Requirements

704.1.1 The minimum fire resistance of construction separating any two occupancies in a building of mixed occupancy shall be the higher rating required for the occupancies being separated, as specified in Table 704.1.

Table 704.1
Occupancy Separation Requirements

Large or Small Assembly	2 hour
Business	1 hour
Educational	2 hour
Factory-Industrial	2 hour
Hazardous	See 704.1.4
Institutional	2 hour
Mercantile	1 hour
Residential	1 hour
Storage, Moderate Hazard S1	3 hour
Storage, Low Hazard S2	2 hour
Automobile Parking Garages[1]	1 hour
Automobile Repair Garages	2 hour

Note:
1. See 411.2.6 for exceptions.

704.1.2 Accessory Occupancies

704.1.2.1 Portions of buildings used as accessory offices or for customary nonhazardous uses necessary for transacting the principal business in Group S and Group F occupancies need not be separated from the principal use. Group F occupancies producing, using or storing low hazard products listed in 312.2.2 need not be considered mixed occupancies. Height and area will be governed by the principal intended use.

704.1.2.2 The following occupancies need not be separated from the uses to which they are accessory:

1. A kitchen in a Group A occupancy does not constitute a mixed occupancy. A fire resistant separation is not required.
2. Assembly rooms having a floor area of not over 750 sq ft (70 m^2).

3. Administrative and clerical offices and similar rooms which, in area per story, do not exceed 25% of the story area of the major use when not related to Group H occupancies.

   EXCEPTION: Accessory uses in Group F and S occupancies conforming to 704.1.2.1.

4. Rooms or spaces used for customary storage of nonhazardous materials in Group A, Group B, Group E, Group F, Group M, and Group R, which in aggregate do not exceed one-third of the major occupancy floor area in which they are located.

704.1.2.3 A 1-hour occupancy separation shall be permitted in assembly rooms greater than 750 sq ft (70m^2) but less than 2,000 sq ft (186 m^2) in area when all of the following are met:

1. The occupant content does not exceed 300 persons calculated in accordance with Table 1003.1.
2. The assembly room does not constitute the major occupancy classification of the building.
3. The assembly room is not associated with a hazardous or Group S1 occupancy.
4. The assembly room is not associated with a kitchen.
5. The assembly room is not a theater or restaurant.

704.1.3 Special Occupancy Separations.

704.1.3.1 Assembly and Educational. Fire resistance separation shall not be required between Sunday school rooms and a church auditorium of Group A - Small Assembly occupancy, and between classrooms in day schools and auditoriums, gymnasiums, cafeterias, and libraries of small assembly occupancy, which are used only as accessory uses to the education occupancy.

704.1.3.2 Automobile Parking Garages. A separation between an automobile parking garage used exclusively for the storage of passenger vehicles that will accommodate not more than nine passengers and any other occupancy having a rating of 2 hours or more in Table 704.1 shall be 2 hours.

704.1.3.3 Boiler and Machinery Rooms

704.1.3.3.1 Every central heating boiler as defined in the Standard Mechanical Code, installed in any building other than a one or two family dwelling or Group F, shall be separated from the rest of the building by not less than 1-hour fire resistant construction.

704.1.3.3.2 A central heating boiler installed in a Group A or H occupancy shall be separated from the rest of the building by construction having a fire resistance rating of not less than 2 hours.

704.1.3.3.3 Steam Boilers. Every steam boiler carrying more than 15 psi (103 kPa) pressure with a rating in excess of 10 boiler horsepower (98 kW) installed in a building other than one of Group F occupancy, shall be located in a separate room or compartment, shall not be located under a means of egress and shall be separated from the rest of the building by construction having at least 2-hour fire resistance. This rating may be reduced in accordance with the hazard existing when in the opinion of the building official it is desirable to provide for explosion venting upward.

704.1.3.3.4 Refrigerant System Machinery Rooms. Where required by the Standard Mechanical Code due to refrigerant type, amount, system classification and occupancy, a Level 2 machinery room shall be of noncombustible construction. A minimum of 1-hour construction shall separate the machinery room from other occupied spaces. A minimum of 3/4 hour C-labeled doors shall be used when separating from other occupancies.

704.1.4 Hazardous Occupancies.

704.1.4.1 The separation of a hazardous occupancy from other occupancies shall be in accordance with Table 704.1.4.

Table 704.1.4
Hazardous Occupancy Separation Requirements

Occupancy	H1	H2	H3	H4
A	NP	4	4	4
B	NP	2	2	1
E	NP	4	4	4
F	NP	2	1	1
H1	----	NP	NP	NP
H2	NP	----	1	2
H3	NP	1	----	1
H4	NP	2	1	----
I	NP	4	4	4
M	NP	2	2	2
R1,2,3	NP	4	4	4
S1,2	NP	2	2	2

Note:
NP = H1 occupancies not permitted to be attached to other occupancies or other H subclassifications.

704.1.4.2 The separation of a hazardous occupancy subclassification shall only apply to storage areas.

704.1.4.3 Building areas intended for the use, processing, manufacture or generation of materials having different hazard classifications, all of them being Group H, need not be separated further within the confines of the Group H occupancy provided the requirements for each hazard are met.

704.1.4.4 Accessory areas, other than assembly occupancies, that do not exceed 10% of the allowable area for the hazardous occupancy subclassification in Table 500 and that do not exceed 1,500 sq ft (139 m^2) shall not be required to comply with 704.1. Where accessory areas are separated from hazardous occupancies by partitions, the partitions shall be not less than 1-hour fire resistant construction with an opening protection rating not less than 3/4-hour. Opening protection shall be either self-closing or automatic-closing in accordance with 705.1.3.2.3.

704.2 Interior Wall and Partition Fire Separation Requirements

704.2.1 General.

704.2.1.1 This section shall apply to the fire separation requirements of interior walls and partitions for the various occupancies and types of construction. Partitions of higher fire resistance rating required by other sections of this code may also serve to meet the requirements of this section.

704.2.1.2 All partitions enclosing vertical openings such as stairways, utility shafts and elevator shafts which are required to have a fire resistance rating shall extend from floor to floor or floor to roof. These walls shall be continuous through all concealed spaces such as the space above a suspended ceiling. The supporting structure shall have a fire resistance rating equal to or greater than the fire resistance rating required for the vertical enclosure. Where the openings are offset at intermediate floors, the offset and floor construction shall be of construction having a fire resistance of not less than that required for the enclosing partitions.

704.2.1.3 All other partitions required to have a fire resistance rating shall extend from the top of the floor below to the ceiling above and shall be securely attached thereto. Where said ceiling is not a part of an assembly having a fire resistance rating at least equal to that required for the partition, the partition shall be constructed tight against the floor or roof deck above. The design of the partitions or ceilings and any openings shall be such as to prevent spread of smoke to the corridor.

704.2.1.4 View panels in 1-hour fire resistant partitions shall be limited to either 1/4 inch (6.4 mm) thick labeled wire glass assemblies installed in steel frames or labeled glass block panels installed in steel channels. The wired glass shall be limited to 1,296 sq in (0.84 m^2) with no dimension greater than 54 inches (1372 mm). The glass block shall be limited to 120 sq ft (11.1 m^2) with no dimension greater than 12 ft (3658 mm). Neither assembly shall exceed 25% of the wall area separating each tenant space from the corridor.

704.2.1.5 Corridor partitions, smokestop partition s, horizontal exit partitions, exit enclosures, and fire rated walls required to have protected openings shall be effectively and permanently identified with signs or stenciling in a manner acceptable to the authority having jurisdiction. Such identification shall be above any decorative ceiling and in concealed spaces. Suggested wording, FIRE AND SMOKE BARRIER PROTECT ALL OPENINGS.

704.2.2 Partition Requirements By Occupancy.

704.2.2.1 Group I Restrained.

704.2.2.1.1 Any required smoke barrier shall be continuous from outside wall to outside wall, from floor slab to floor slab or roof deck, from smoke barrier to smoke barrier, or a combination thereof, including continuity through all concealed spaces such as those found above suspended ceilings; however, smoke barriers are not required in interstitial spaces designed and constructed with ceilings equivalent to smoke barriers. Barriers shall be of 0.10 inch (2.5 mm) thick steel or of 1-hour construction. Fixed wired glass vision panels shall be permitted in such barriers provided they do not individually exceed an area of 1,296 sq in (0.84 m^2) and are mounted in steel frames. There is no restriction on the total number of such panels in any barrier.

704.2.2.1.2 All interior partitions in Type I and Type II construction shall be of noncombustible construction.

704.2.2.2 Group I Unrestrained. Smoke barriers hall have a minimum of 1-hour fire resistance. Such partitions shall form an effective membrane continuous from outside wall to outside wall and from floor slab to floor slab or roof deck thereby including continuity through all concealed spaces, such as those found above suspended ceilings, and including interstitial structural and mechanical spaces.

EXCEPTION: Smoke barriers are not required in interstitial spaces when such spaces are designed and constructed with ceilings that provide resistance to the passage of smoke equivalent to that provided by smoke barriers.

704.2.2.3 Group R Residential. Nonfire-rated partitions may be constructed within one and two family dwellings and within individual dwelling units unless required by Table 600. The tenant separation in a two family dwelling shall comply with 704.3.

704.2.3 Partitions Within Tenant Space.

704.2.3.1 Partitions dividing portions of stores, offices or similar places occupied by one tenant only, which do not establish an exit access corridor serving an occupant load of 30 persons or more, and partial partitions, may be temporary or permanent and constructed in accordance with 609 without fire resistance, provided that:

1. Their location is restricted by their method of construction or by means of permanent tracks, guides or other approved methods.
2. Flammability shall be limited to materials having an interior finish classification as set forth in Table 803.3 for rooms or areas.

704.2.3.2 Group B building exit access corridors are not required to be rated on any single tenant floor or in any single tenant space.

704.3 Tenant Fire Separation

704.3.1 In a building or portion of a building of a single occupancy classification, when enclosed spaces are provided for separate tenants, such spaces shall be separated by not less than 1-hour fire resistance.

EXCEPTION: In buildings of Group B and Group S occupancies, non-fire-rated partitions may be used to separate tenants provided no area between partitions rated at 1 hour or more exceeds 3,000 sq ft (278.7 m^2).

704.3.2 In buildings with usable crawl spaces, tenant separation walls required to have a fire resistance rating shall extend from the underside of the floor to the ground below. A suitable foundation shall be provided at grade level.

EXCEPTION: The wall need not be extended when the floor above the crawl space has a minimum 1-hour fire resistance rating.

704.4 Townhouse Fire Separation

Each townhouse shall be considered a separate building and shall be separated from adjoining townhouses by a party wall complying with the North Carolina State Building Code, Volume VII-Residential.

704.5 Fire Wall Extensions and Parapets

704.5.1 Fire Wall Extensions.

704.5.1.1 Party walls and fire walls shall extend not less than 3ft (914 mm) above the roof.

EXCEPTION: Fire walls shall not be required to extend above the roof where the roof is:

1. Noncombustible in Types I, II and IV construction, or,
2. Noncombustible or fire retardant treated wood for an area within 40 ft (12.2 m) of each side of the wall in Types III, V and VI construction.

704.5.1.2 Party walls and fire walls shall extend not less than 18 inches (457 mm) past exterior intersecting walls of combustible construction or exterior noncombustible walls with combustible projections or veneers. The party or fire wall shall extend not less than 18 inches (457 mm) past any combustible projection or veneer. Party walls or fire walls shall extend to the inside facing of the exterior surface of noncombustible construction.

704.5.1.3 All fire walls shall be in accordance with the requirements of NCMA-TEK Bulletin 95 or equivalency in brick or poured concrete or other nationally recognized tested systems.

704.5.2 Parapet Walls.

In Type III and Type V Construction, exterior walls shall extend not less than 18 inches (457 mm) above the roof.

EXCEPTIONS:

1. Walls located more than 15 ft (4.57 m) from a common property line or centerline of a public way.
2. Where the roof slopes more than 4:12 from the back of the exterior wall.

705 PROTECTION OF OPENINGS

705.1 Protection or Wall Openings

705.1.1 Protection or Openings in Exterior Walls.

705.1.1.1 The provisions of 705.1.1 do not apply to Group R3 occupancies.

705.1.1.2 Every exterior wall within 15 ft (4572 mm) of a property line shall be equipped with approved opening protectives:

EXCEPTIONS:

1. Exterior walls not required by Table 600 to have a fire resistance rating.
2 Show windows fronting on a street or public space.
3. Open parking structures meeting the requirements of 411.3.

705.1.1.3 Where openings in an exterior wall are above and within 5 ft (1524 mm) laterally of an opening of the story below, such openings shall be separated by an approved noncombustible flame barrier extending 30 inches (762 mm) beyond the exterior wall in the plane of the floor or by approved vertical flame barriers not less than 3 ft (914 mm) high measured vertically above the top of the lower opening. Such flame barriers are not required when a complete approved automatic sprinkler system is installed.

705.1.1.4 Fresh air intakes shall be protected against exterior fire exposure by means of approved fire doors, dampers, or other suitable protection in accordance with the degree of exposure hazard.

705.1.2 Protection of Openings in Interior Walls.

705.1.2.1 Openings in walls and partitions, except in one and two family dwellings, shall be protected in accordance with Table 700.

705.1.2.2 Fire dampers shall comply with the requirements of UL 555 and shall bear the label of an approved testing agency. Fire dampers shall be classified and identified for use in either:

1. Static systems that automatically shut down in the event of fire.
2. Dynamic systems that operate in the event of fire.

705.1.2.3 Fire dampers shall be installed in accordance with the manufacturer's installation instructions in the following locations:

1. Ducts penetrating walls or partitions having a fire resistance rating of 1 hour or more.
2. Ducts penetrating shaft walls having a fire resistance rating of 1 hour or more.

705.1.2.4 Fire dampers are not required under the following conditions:

1. In duct systems serving only one story and used only for exhaust of air to the outside and not penetrating a wall or partition having a required fire resistance rating of 2 hours or more or passing entirely through the enclosure for a vertical shaft.
2. Where branch ducts connect to return risers in which the air flow is upward and subducts at least 22 inches (559 mm) long are carried up inside the riser at each inlet.
3. In duct systems of any duct material or combinations thereof allowed by Chapter 6 of the Standard Mechanical Code penetrating 1-hour walls or partitions, where the duct penetrating the rated wall or partition meets the following minimum requirements:
    1. the duct shall not exceed 100 sq inch (0.06 m^2),
    2. the duct shall be of 0.0217 inch (0.55 mm) minimum steel,
    3. the duct shall continue with no duct openings for not less than 5 ft (1.5 m) from the rated wall, and
    4. the duct shall be installed above a ceiling.

    When wall registers occur at the rated wall, a fire damper shall be provided.
4. See Section 610 of the Standard Mechanical Code for additional exceptions.

705.1.2.5 Unless the air system is designed to provide smoke control or pressurization functions during a fire emergency, smoke dampers with listed operators shall be installed at all duct penetrations of required smoke barriers.

705.1.2.6 Transfer grilles, whether equipped with fusible link-operated dampers or not shall not be used in smoke barriers. See Section 610.3 of the Standard Mechanical Code.

705.1.2.7 Where a fire resistant wall is required due to type of construction only, opening protectives are not required.

705.1.3 Approved Types of Fire Windows, Doors and Shutters.

705.1.3.1 Wall openings required to be protected shall be protected by approved listed and labeled fire doors, windows and shutters and their accompanying hardware, including all frames, closing devices, anchorage and sills, in accordance with the requirements of NFiPA 80, except as otherwise specified in this code.

705.1.3.2 Openings are classified in accordance with the character and location of the wall in which they are situated. Fire protection ratings for products intended to comply with this section shall be as determined and reported by a nationally recognized testing agency in accordance with ASTM E 152 or ASTM E 163. All such products shall bear an approved label. In each of the following classes, the minimum fire protection ratings are shown.

705.1.3.2.1 Fire doors are classified as 3 hour (A), 1 1/2 hour (B), 1 hour (B), 3/4 hour (C), 1 1/2 hour (D), 3/4 hour (E) or 20 minutes. The letter designation indicates the classification of opening in a wall or partition assembly for which a door is considered suitable and the relative importance of the door in preventing the spread of fire. These designations are described as follows:

1. Class A - openings in walls that divide a single building into fire areas or fire walls separating buildings.
2. Class B - openings in enclosures of vertical communications through buildings. They are also suitable for certain other openings in walls or partitions.
3. Class C - openings in walls or partitions between rooms and corridors or hallways, except as provided in 705.1.3.2.2 for 20 minute doors.
4. Class D & E - openings in exterior walls subject to severe and moderate fire exposure from outside of the building respectively.

705.1.3.2.2 Unless otherwise specified, door assemblies in walls required to have a fire resistance rating of 1-hour or less shall have a fire resistance rating of 20 minutes when tested in accordance with ASTM E 152 without the hose stream.

EXCEPTION: For Group I Unrestrained, corridor doors shall be in accordance with 409.1.4.

705.1.3.2.3 All doors in smoke barriers, horizontal exits, stairway enclosures and other doors opening between rooms and fire-rated exit access corridors shall be self-closing and so maintained or shall be provided with approved door holding devices of the fail-safe type which will release the door causing it to close when activated by approved listed smoke detectors. When doors are automatic-closing by smoke detection, there shall be not more than a 10-second delay before the door starts to close after the smoke detector is actuated.

EXCEPTION: Doors from classrooms in Group E occupancies, opening directly into a 1-hour rated corridor, may be installed without self-closing devices.

705.1.3.3 The maximum size of fire doors shall not exceed that specified in Appendix C, NFiPA 80.

705.1.3.4 For 1 1/2 hour (B) and 1 hour (B) doors used in stairway enclosures the average temperature developed on the unexposed side shall not exceed 450°F (232°C) at the end of 30 minutes of standard fire test exposure.

705.1.3.5 Fire doors shall be equipped with an approved closer. See 1009.2.2 for doors in horizontal exits.

EXCEPTION: Doors located in common walls separating guest rooms in Group R1 hotels and motels may be installed without automatic or self-closing devices.

705.1.3.6 l/4-inch (6.4 mm) thick wired glass labeled for fire protection purposes may be used in approved opening protectives with the maximum sizes shown in Table 705.1 .3.6. Other glazing materials which have been tested and labeled to indicate the type of opening to be protected for fire protection purposes may be used in approved opening protectives in accordance with their listing with the maximum sizes tested. For requirements for safety glazing see 2405.

Table 705.1.3.6
Limiting Size of Wired Glass Panels[1,2,3]

Rating, Opening	Max. Area (sq in)	Max. Height (in)	Max. Width (in)
3 hour, Class A door	0	0	0
1 & 1-1/2 hour, Class B doors	100	33	12
3/4 hour, Class C door	1,296	54	54
1-1/2 hour, Class D door	0	0	0
3/4 hour, Class E door	1,296	54	54

1 in = 25.4 mm

1 in^2 = 645.16 mm^2

Notes:

1. The glass shall be well-embedded in putty, and all exposed joints between the metal and glass shall be struck and pointed.
2. Devices used to view through fire doors rated at 1-1/2 hours or less shall be labeled.
3. Wired glass in 20 minute doors shall be limited to the amount of glass tested in a door.

705.1.4 Fire Shutters.

705.1.4.1 When equipped with fire shutters of the swinging type, at least one in every three openings facing a street in each story shall have such shutters arranged to be readily opened from the outside. Distinguishing marks shall be provided on such shutters.

705.1.4.2 Fire shutters of the rolling type shall be carefully counterbalanced and so arranged that they can be readily opened from the outside.

705.1.5 Opening Protection in Stairway Enclosures.

Opening protectives in stairway shafts are limited to self-closing or smoke actuated, automatic-closing, fire door assemblies. If smoke actuated closures close one door, all doors serving that stairway shall close.

Table 700
Minimum Fire Resistance of Walls, Partitions And Opening Protectives[1] (hrs)

Component	Walls and Partitions	Opening Protectives
SHAFT ENCLOSURES (including stairways, exits & elevators)		
4 or more stories	2	1-1/2 B
Less than 4 stories	1[2]	1 B[2]
All refuse chutes	2	1-1/2 B
WALLS AND PARTITIONS		
fire walls[3]	4	3 A
within tenant space	See 704.2.3	
tenant space (see also 704.3)	1	3/4 C
horizontal exit	2	1-1/2 B
exit access corridors[4,5]	1	20 min
smoke barriers	See 409.1.2	
refuse and laundry chute access rooms	1	3/4 C
incinerator rooms	2	1-1/2 B
refuse and laundry chute termination rooms	1	3/4 C
hazardous occupancy control areas	1	3/4 C
high rise buildings	See 412	
covered mall buildings	See 413	
assembly buildings	See Note 2	
bathrooms & restrooms	See Note 6	
OCCUPANCY SEPARATIONS[7]	Required Fire Resistance	
	4	3 A
	3	3 A
	2	1-1/2 B
	1	3/4 C
EXTERIOR WALLS[8]	All	3/4 E

Notes:

1. Table 600 may require greater fire resistance of walls to insure structural stability.
2. All exits and stairways in Group A and H occupancies shall be 2 hours with 1-1/2 hour B door assemblies.
3. See also 503.1.2
4. See 704.2.3
5. See 409 for sprinklered Group I – buildings.

705.2 Protection of Floor Openings

705.2.1 General Requirements.

705.2.1.1 Protection of floor openings shall be provided in accordance with these provisions to prevent the spread of fire from story to story.

705.2.1.2 For protection of stairways, see 1006. For protection of elevators, see 3003.1.

705.2.1.3 For protection of pipe, conduit, cable, wire, tube, duct and vent penetrations of fire resistance rated floors, roofs, ceilings, and shaft enclosures, see 705.4.

705.2.1.4 Duct Penetrations.

705.2.1.4.1 Fire dampers shall be installed in accordance with the manufacturer's installation instructions in ducts penetrating only one floor of a building requiring the protection of vertical openings when the duct is not protected by a shaft enclosure described in Section 610.3 of the Standard Mechanical Code.

705.2.1.4.2 Fire dampers shall comply with the requirements of UL 555 and shall bear the label of an approved testing agency. Fire dampers shall be classified and identified for use in either:

1. Static systems that automatically shut down in the event of fire.
2. Dynamic systems that operate in the event of fire.

705.2.2 Shaft Enclosures. All openings through a floor and penetrations through a floor shall be protected by a shaft enclosure in accordance with 705.2.3.

EXCEPTIONS:

1. A shaft enclosure is not required for openings totally within a dwelling unit and connecting four stories or less.
2. A shaft enclosure is not required for a floor opening which
    1. is not part of the required means of egress, and
    2. is not concealed within the building construction, and
    3. does not connect more than two stories, and
    4. does not connect with a stairway or escalator serving other floors, and
    5. is not open to any corridors in Group I and R Occupancies or to corridors on nonsprinklered floors in other occupancies, and
    6. is separated from floor openings serving other floors by construction conforming with required shaft enclosures.
3. A shaft enclosure is not required for penetrations by pipe, tube, conduit, wire, cable, duct and vents protected in accordance with 705.3.1.4 or 705.4.4.
4. A shaft enclosure is not required for floor openings complying with the special provisions for covered malls or atriums.
5. A shaft enclosure is not required for approved masonry chimneys where annular space protection is provided at each floor level in accordance with 705.4.6.
6. A shaft enclosure is not required for floor openings in an open parking garage.
7. A shaft enclosure is not required for floor openings between a mezzanine and the floor below.
8. A shaft enclosure is not required in fully sprinklered buildings for an escalator opening protected in accordance with one of the following alternatives:

Alternative A - (1) The area of the floor opening between stories shall not exceed twice the horizontal projected area of the escalator, and

(2) Draft curtains and special sprinkler head locations shall meet the requirements of NFiPA 13, and

(3) In other than Group B and M occupancies the escalator openings shall not connect more than four stories, or

Alternative B - The opening is protected by approved power operated automatic shutters at every floor opening. The shutters shall be of noncombustible construction and have a fire resistance rating of not less than 1 1/2 hours. The shutter shall close immediately upon the automatic detection of smoke by an approved device and shall completely shut off the floor opening. The escalator shall stop when the shutter begins to close. The shutter shall operate at a speed of not more than 30 feet per minute (0.152 m/s) and shall be equipped with a sensitive leading edge to arrest its progress when in contact with any obstacle, and to continue its progress after release.

705.2.3 Shaft Enclosure Construction.

705.2.3.1 Fire Resistance. The fire resistance rating of shaft enclosures shall be in accordance with Table 700 and not less than the floor assembly penetrated, but the rating need not exceed 2 hours.

705.2.3.2 Construction Type. Shaft enclosures shall be of noncombustible materials in Types I, II, and IV construction and may be of combustible materials in Types III, V, and VI construction.

705.2.3.3 Enclosure at Bottom. Shafts which do not extend to the bottom of the building or structure shall be enclosed at the lowest level with construction of the same fire resistance as the lowest floor through which the shaft passes, but not less than the rating required for the shaft enclosure, or shall terminate in a room having a use related to the purpose of the shaft. The room shall be separated from the remainder of the building by construction having a fire resistance rating and opening protectives at least equal to the protection required for the shaft enclosure. For shafts containing refuse or laundry chutes, see 705.2.4.

EXCEPTIONS:

1. Fire resistant separation of the room is not required provided there are no openings in or penetrations through the shaft enclosure to the interior of the building except at the bottom of the shaft. The bottom of the shaft shall be closed off around the penetrating items with materials permitted by the code for draftstops, or the room shall be provided with an approved automatic sprinkler system.
2. Fire resistance separation of the room is not required and the bottom of the shaft may be open provided there are no combustibles in the shaft and there are no other openings or penetrations through the shaft enclosure to the interior of the building.

705.2.3.4 Enclosure at Top.

705.2.3.4.1 A shaft that does not extend to or through the underside of the roof deck of the building shall be enclosed at the top with construction of the same fire resistance as the topmost floor penetrated by the shaft, but not less than the rating required for the shaft enclosure.

705.2.3.4.2 When a shaft extends through a roof, the shaft enclosure shall extend at least 36 inches (914 mm) above the highest part of the roof that is within 5 ft (1524 mm) of the opening. The enclosure wall or combination of enclosure wall and guardrail shall be at least 42 inches (1066 mm) high.

EXCEPTION: When a shaft extends through a noncombustible roof, a noncombustible guardrail at least 42 inches (1066 mm) high may be used around the opening instead or a wall.

705.2.3.5 Openings in Shaft Enclosures. Openings in shaft enclosures shall

be permitted when limited to those necessary for the purposes of the shaft. Permitted openings in shaft enclosures shall be protected with opening protectives having a fire resistance in accordance with Table 700.

705.2.4 Special Provisions for Refuse and Laundry Chutes.

705.2.4.1 General Refuse and laundry chutes, access and termination rooms, and incinerator rooms shall be constructed 10 accordance with 705.2.4.2 through 705.2.4.6.

EXCEPTION: Group R3 occupancies.

705.2.4.2 Refuse and Laundry Chute Enclosures. A shaft containing a refuse or laundry chute shall be used for no other purpose and shall be protected by a shaft enclosure in accordance with 705.2.3. Refuse chute material shall be noncombustible meeting Part I of the definition for noncombustible. All openings into the shaft enclosure, including those from access rooms and termination rooms, shall be protected in accordance with Table 700. Such opening protectives shall be self-closing or automatic- closing upon detection of smoke, except that the opening protective between the shaft and the termination room may be closed by a heat-activated device.

705.2.4.3 Refuse and Laundry Chute Access Rooms. Access openings for refuse and laundry chutes shall be located in rooms or compartments completely enclosed by construction and opening protectives in accordance with Table 700. Access openings to refuse and laundry chutes shall not be located in exit access corridors or exit enclosures.

705.2.4.4 Termination Room. Refuse and laundry chutes shall discharge into an enclosed termination room completely separated from the remainder of the building by construction and opening protectives in accordance with Table 700. Refuse chutes shall not terminate in an incinerator room.

705.2.4.5 Incinerator Room. Incinerators shall be enclosed within a room separated from the remainder of the building by construction and opening protectives in accordance with Table 700.

705.2.4.6 Automatic Sprinklers. An approved automatic sprinkler system shall be installed at the top and at alternate floor levels in refuse and laundry chutes and in the termination and incinerator rooms.

705.3 Fireblocking and Draftstopping

705.3.1 Fireblocking.

705.3.1.1 Fireblocking shall be provided in all walls and partitions to cut off all concealed draft openings both horizontal and vertical and to form a fire barrier between floors and between the upper floor and the roof space. See also 2305.1.

705.3.1.2 Fireblocking shall not be covered or concealed until inspected by the building official.

705.3.1.3 Walls and stud partitions shall be fireblocked at floors, ceilings and roofs. Fireblocking in noncombustible partitions shall not be required at the ceiling for suspended ceiling systems. Fireblocking shall consist of approved noncombustible materials unless otherwise specified in this code. Material shall be securely fastened in place.

705.3.1.4 The annular space around pipes, tubes, conduits, wires, cables and vents shall be protected in accordance with 705.4.

705.3.1.5 Chimneys shall be fireblocked an accordance with 2113, 2305, and 2804.

705.3.1.6 Any openings between the edge of a floor deck and an exterior wall shall be sealed using an approved material or assembly of materials designed and tested for this purpose. The material shall remain in place, sealing the opening, for a time period at least equal to the required fire resistance rating of the floor deck.

705.3.2 Draftstopping.

Enclosed attic and floor spaces formed of combustible construction shall be divided in accordance with 2305.

705.4 Penetrations of Fire Resistant Assemblies

705.4.1 General: Plans for all buildings shall indicate the tested assembly fire resistive design numbers or clearly indicate the approved reference from which the fire resistive rated assemblies were obtained or calculated. Penetrations of fire rated walls and partitions listed in Table 700 and fire rated floors by cables, cable trays, conduits, and pipes shall be firestopped by a system(s) or device(s) which has been tested and listed as complying with ASTM E-814 when conducted under a minimum positive pressure differential of 0.01 inch of water. The system(s) or device(s) shall be installed in accordance with the conditions of their listing and shall have an F rating at least equivalent to the rating of the assembly being penetrated.

EXCEPTION: Pipes and conduit up to 4 inch nominal diameter may penetrate:

1. Concrete floor membrane if firestopped with approved materials installed the full depth of the membrane. The annular space surrounding the penetrating item(s) shall not exceed 1 1/2 inches.
2. Walls, partitions and shaft enclosures constructed of concrete or masonry if firestopped with approved materials installed the full depth of the wall. The annular space surrounding the penetrating item(s) shall not exceed 1 1/2 inches.
3. Other fire rated assemblies where the annular space is filled with material complying with 701.2.3 and the opening does not exceed 100 square inches.

705.4.1.1 Approved annular space firestop materials for these systems are concrete, mortar or nonshrink grout, or other materials which have been demonstrated to withstand ASTM E 119 fire conditions without permitting the passage of flame and hot gases sufficient to ignite cotton waste for a time period at least equal to the fire resistance rating of the penetrated assembly.

705.4.1.2 When walls, floors and partitions are required to have a minimum 1 hour or greater fire resistance rating, cabinets, bathroom components, lighting and other fixtures shall be so installed such that the required fire resistance wall not be reduced.

EXCEPTION: Fixtures which are listed for such installation are permitted.

705.4.1.3 Insulation and coverings on penetrating items shall not pass through the assembly unless these materials have been tested as part of the through penetration assembly.

705.4.1.4 Penetrations of nonrated walls, partitions and floors of noncombustible construction shall be firestopped with noncombustible materials.

705.4.1.5 Penetrations of nonrated walls, partitions and floors of combustible construction shall be firestopped with materials equivalent to two inches of wood.

705.4.2 Definitions. For the purpose of this section, certain special terms are defined as follows:

THROUGH-PENETRATION FIRESTOP SYSTEM – a system installed to prevent, for a prescribed time period, the passage of flame, heat and hot gases through openings, which penetrate an entire fire resistant assembly in order to accommodate cables, cable trays, conduits, tubing, pipes or similar items.

705.4.3 Electrical Boxes. Openings in assemblies of 2 hours or less, for metallic electrical boxes not exceeding 16 sq inches (0.010 m^2) are permitted provided the area of such openings does not aggregate more than 100 sq in (0.06 m^2) for any 100 sq ft (9 m^2) of fire resistant wall area or shaft enclosure wall area. The wallboard face must be cut so that the clearance from the electrical box does not exceed 1/8 inch (3.2 mm). Outlet boxes on opposite sides of the fire resistant wall or shaft enclosure shall be separated by a horizontal distance of not less than 24 inches (610 mm).

EXCEPTION: Openings in assemblies of 2 hours or less, for nonmetallic electrical boxes, are permitted provided such boxes are listed for use in fire resistant assemblies and are installed in accordance with their listing.

705.4.4 Ducts. Ducts may penetrate fire resistant walls provided the duct penetrations are protected with approved fire dampers. Fire dampers used for protection of duct penetrations shall be installed in accordance with their listing.

EXCEPTION: Duct penetrations in accordance with 705.1.2 and 705.2.1.4.

705.4.5 Walls, Floors and Partitions. When walls, floors and partitions are required to have a minimum 1 hour or greater fire resistance rating, cabinets, bathroom components, lighting and other fixtures shall be so installed such that the required fire resistance will not be reduced.

EXCEPTIONS:

1. Fixtures which are listed for such installation arc permitted.
2. One electrical box not exceeding 16 square inches (407 mm) in area is permitted for light fixtures in such ceilings, in each 90 square feet of ceiling area.
3. Holes in fire resisting ceilings, for automatic sprinkler heads or other fire extinguishing or smoke detection system components are permitted.

705.4.6 Column Protection

Where columns require a fire resistance rating, the entire column, including its connections to beams or girders, shall be protected. Where the column extends through a ceiling, fire protection of' the column shall be continuous from the top of the floor through the ceiling space to the underside of the floor deck above, except as provided in Table 600, Note p or other such provisions of this Code.

706 COMBUSTIBLES IN FIRE RATED ASSEMBLIES

706.1 Plumbing, Electrical and Air Handling Systems in Fire Rated Assemblies

In Type I and Type II construction, materials used for piping, conduit raceways or duct systems which do not qualify as noncombustible in accordance with the requirements of part 1 of the definition of noncombustible material contained in 202 shall neither:

1. penetrate any assembly which is required to have a fire resistance rating unless such materials and methods of penetration have been tested in accordance with 705.4, nor
2. be concealed within any assembly which is required to have a fire resistance rating unless enclosed by or totally embedded within noncombustible materials or unless such materials and methods have been tested in accordance with 701.2.

707 COMBUSTIBLES IN CONCEALED SPACES

707.1 Concealed Spaces in Types I, II and IV Construction

Combustibles shall not be permitted in concealed spaces of Types I, II, or IV construction.

EXCEPTIONS:

1. Materials complying with 609.1.2 of the Standard Mechanical Code.
2. Class A interior finish materials.
3. Fire retardant treated wood used in accordance with Table 600 and wood used in accordance with 609.
4. Floor finish complying with 803.6.
5. Conduit or raceway systems complying with 706.
6. Foam plastic insulation complying with 2603.
7. Thermal insulation materials complying with 708.
8. Combustible piping within partitions or enclosed shafts installed in accordance with the provision of this code. Combustible piping may also be used within concealed ceiling spaces when approved.

707.2 Combustibles in Plenums

The use of combustible materials in plenums shall be restricted in accordance with the Standard Mechanical Code.

708 THERMAL INSULATING MATERIALS

708.1 General

Insulating materials, including facings such as vapor retarders and breather papers, similar coverings, and all layers of single and multilayer reflective foil insulations, shall comply with the requirements of this section. Where a flamespread rating or a smoke developed rating is specified in this section, such rating shall be determined in accordance with the ASTM E 84. Any material which is subject to an increase in flamespread rating or smoke developed rating beyond the limits herein established through the effects of age, moisture, or other atmospheric conditions, shall not be permitted.

708.2 Concealed Installation

708.2.1 Insulating materials, when concealed as installed, in buildings of any type construction, shall have a flamespread rating of not more than 75 and a smoke developed rating of not more than 450.

708.2.2 When such materials are installed in concealed spaces in buildings of Type III, Type V or Type VI construction, the flamespread and smoke developed limitations do not apply to facings, coverings, and layers of reflective foil insulation that are installed behind and in substantial contact with the unexposed surface of the ceiling, wall or floor finish.

708.3 Exposed Installation

Insulating materials when exposed as installed in buildings of any type construction shall have a flamespread rating of not more than 25 and a smoke developed rating of not more than 450.

708.4 Loose-Fill Insulation

Loose-fill insulation materials, which cannot be mounted in the ASTM E 84 apparatus without a screen or artificial supports, shall comply with the flamespread and smoke developed limits of 708.2 and 708.3 when tested in accordance with CAN 4-S102.2-M83.

708.5 Roof Insulation

The use of combustible roof insulation not complying with 708.2 or 708.3 shall be permitted in any type construction provided it is covered with approved roof coverings directly applied thereto.

708.6 Duct Insulation

Duct linings and coverings shall conform to the appropriate requirements of the Standard Mechanical Code.

708.7 Foam Plastics

Foam plastics shall comply with 2603.

708.8 Cellulose Fiber Thermal Insulation

Cellulose fiber thermal insulation shall be tested in accordance with and shall comply with the requirements of 708.1 through 708.3, CPSC 16 CFR, Parts 1209 and 1404, and ASTM C 739. Each package of such insulating material shall be clearly labeled as meeting the requirements of the CPSC and ASTM Standards.

709 CALCULATED FIRE RESISTANCE

709.1 General

709.1.1 Scope. These provisions contain procedures by which the fire resistance of specific materials or combinations of materials can be established by calculations. These procedures apply only to the information contained in this section and shall not be otherwise used.

709.1.2 Definitions. For the purpose of this section, certain special terms are defined as follows:

CARBONATE AGGREGATE CONCRETE – concrete made with aggregates consisting mainly of calcium or magnesium carbonate, e.g., limestone or dolomite.

CELLULAR CONCRETE – lightweight insulating concrete made by mixing a preformed foam with Portland cement slurry and having a dry unit weight of approximately 30 pcf (480 kg/m^3).

CERAMIC FIBER BLANKET – a mineral wool insulation material made of alumina-silica fibers and weighing 4 to 10 pcf (64 to 160 kg/m^3).

GLASS FIBER BOARD – fibrous glass roof insulation consisting of inorganic glass fibers formed into rigid boards using a binder. The board has a top surface faced with asphalt and kraft reinforced with glass fiber.

LIGHTWEIGHT AGGREGATE CONCRETE – concrete made with aggregates of expanded clay, shale, slag, or slate or sintered fly ash, and weighing 85 to 115 pcf (1360 to 1840 kg/m^3).

MINERAL BOARD – a rigid felted thermal insulation board consisting of either felted mineral fiber or cellular beads of expanded aggregate formed into flat rectangular units.

PERLITE CONCRETE – a lightweight insulating concrete having a dry unit weight of approximately 30 pcf (480 kg/m^3) made with perlite concrete aggregate. Perlite aggregate is produced from a volcanic rock which, when heated, expands to form a glass-like material of cellular structure.

SAND-LIGHTWEIGHT CONCRETE – concrete made with a combination of expanded clay, shale, slag, or slate or sintered fly ash and natural sand. Its unit weight is generally between 105 and 120 pcf (1680 and 19 1920 kg/m^3).

SILICEOUS AGGREGATE CONCRETE – concrete made with normal weight aggregates consisting mainly of silica or compounds other than calcium or magnesium carbonate.

VERMICULITE CONCRETE – a lightweight insulating concrete made with vermiculite concrete aggregate which is laminated micaceous material produced by expanding the ore at high temperatures. When added to a portland cement slurry the resulting concrete has a dry unit weight of approximately 30 pcf (480 kg/m^3).

709.2 Concrete Assemblies

709.2.1 Concrete Walls.

709.2.1.1 Cast-In-Place Or Precast Walls.

709.2.1.1.1 The minimum equivalent thicknesses of cast-in-place or precast concrete walls for fire resistance ratings of 1 hour to 4 hours are shown in Table 709.2.1.1. For solid walls with flat vertical surfaces, the equivalent thickness is the same as the thickness. The values in Table 709.2.1.1 apply to plain, reinforced, or prestressed concrete walls.

Table 709.2.1.1
Minimum Equivalent Thickness (in) of Cast-In-Place Or Precast Concrete Walls, Loadbearing Or Nonloadbearing

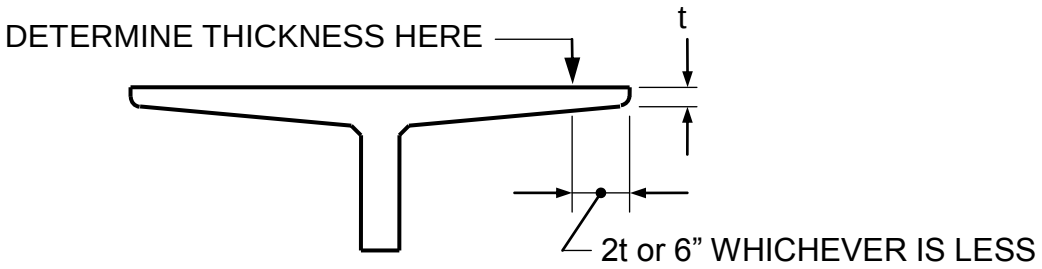
	Minimum Slab Thickness (in) For Fire Resistance Rating of				
Concrete Type	**1 hr**	**1 1/2 hr**	**2 hr**	**3 hr**	**4 hr**
Siliceous	3.5	4.3	5.0	6.2	7.0
Carbonate	3.2	4.0	4.6	5.7	6.6
Sand-Lightweight	2.7	3.3	3.8	4.6	5.4
Lightweight	2.5	3.1	3.6	4.4	5.1

1 in – 25.4 mm

709.2.1.1.2 For hollow-core precast concrete wall panels in which the cores are of constant cross section throughout the length, the equivalent thickness may be calculated by dividing the net cross-sectional area (the gross cross-section minus the area of the cores) of the panel by its width.

709.2.1.1.3 Where all of the core spaces of hollow-core wall panels are filled with loose-fill material, such as expanded shale, clay, or slag, or vermiculite or perlite, the fire resistance rating of the wall is the same as that of a solid wall of the same concrete type and of the same overall thickness.

709.2.1.1.4 The thickness of panels with tapered cross sections shall be that determined at a distance 2t or 6 inches (152 mm), whichever is less, from the point of minimum thickness, where t is the minimum thickness.

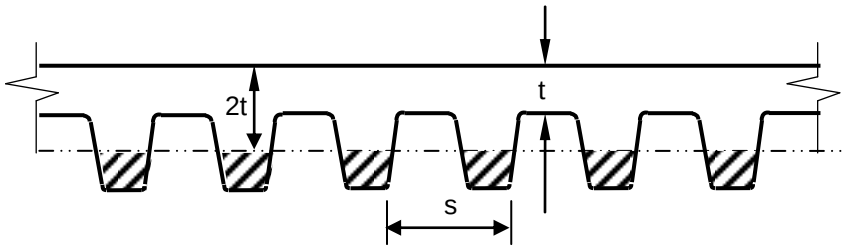


709.2.1.1.5 The equivalent thickness of panels with ribbed or undulating surfaces shall be determined by one of the following expressions:

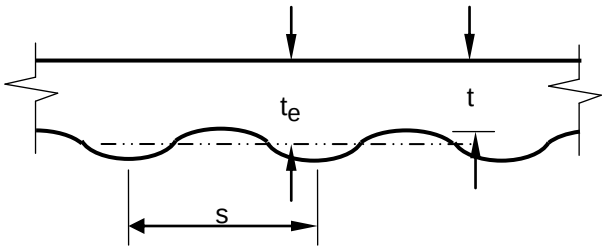
for $s \geq 4t$, the thickness to be used shall be t;
for $s \leq 2t$, the thickness to be used shall be t_e;
for $4t > s > 2t$, the thickness to be used shall be

$$t + \left(\frac{4t}{s} - 1\right)(t_e - t)$$

where s = spacing of ribs or undulations
t = minimum thickness
t_e = equivalent thickness of the panel calculated as the net cross-sectional area of the panel divided by the width, in which the maximum thickness used in the calculation shall not exceed 2t.



NEGLECT SHADED AREA IN CALCULATION OF EQUIVALENT THICKNESS



709.2.1.2 Multi-Wythe Walls.

709.2.1.2.1 For walls which consist of two wythes of different types of concrete the fire resistance ratings may be determined from Figure 709.2.1.2.

709.2.1.2.2 The fire resistance rating for wall panels consisting of two or more wythes may be determined by the formula:

$$R = (R_1^{0.59} + R_2^{0.59} + \ldots + R_n^{0.59})^{1.7} \qquad \text{(Eq. 709.2.1.2)}$$

where R = the fire endurance of the assembly, minutes
and R_1, R_2 and R_n = the fire endurances of the individual wythes, minutes.
Values of $R_n^{0.59}$ for use in Eq. 709.2.1.2 are given in Table 709.2.1.2.

709.2.1.2.3 The fire resistance ratings of precast concrete wall panels consisting of a layer of foam plastic insulation sandwiched between two wythes of concrete may be determined by use of Eq. 709.2.1.2. Foam plastic insulation with a total thickness of less than 1 inch (25 mm) shall be disregarded. The R_n value for thickness of foam plastic insulation of 1 inch or greater, for use in the calculation, is 5 minutes; therefore $R_n^{0.59} = 2.5$.

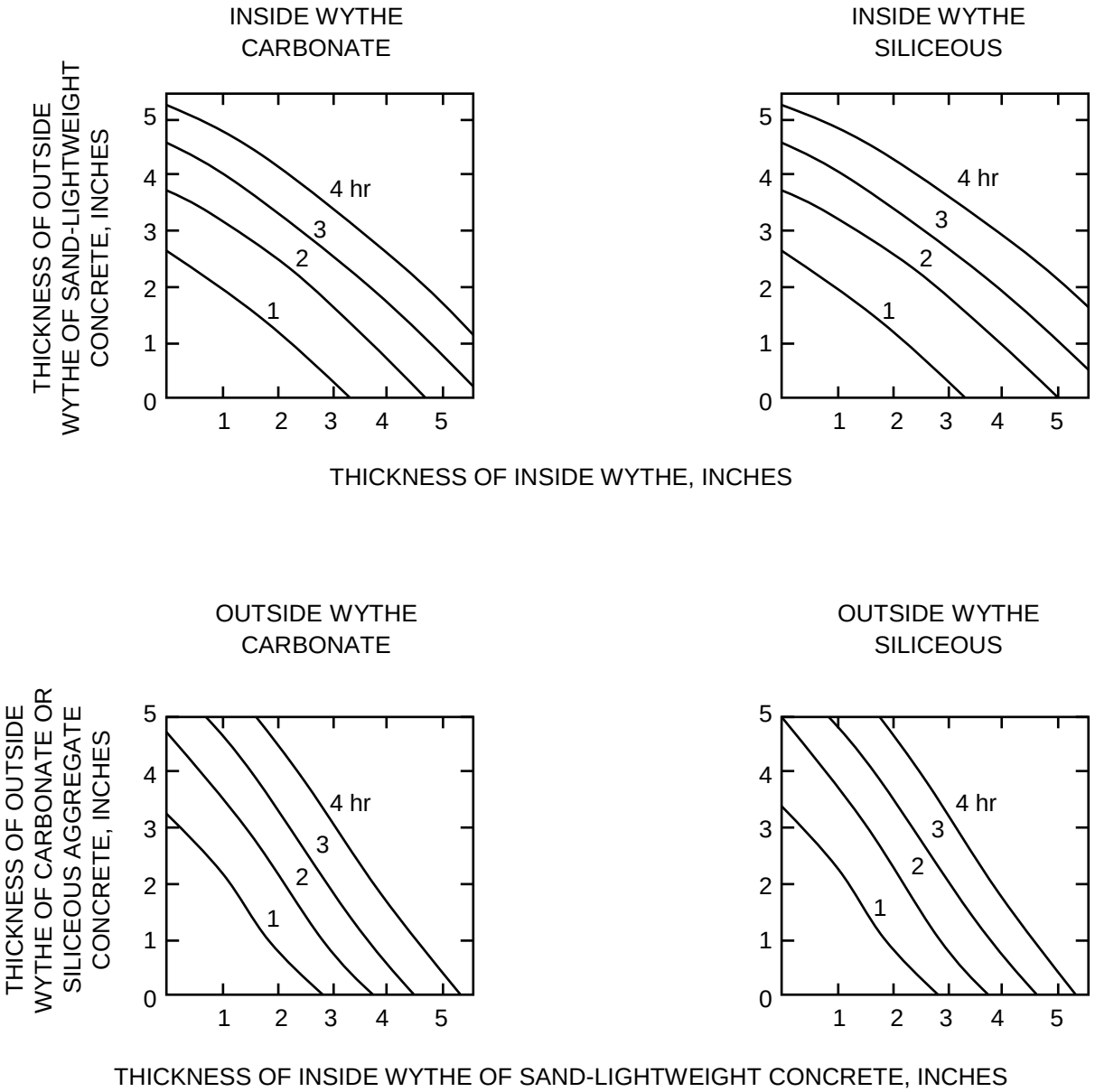


Figure 709.2.1.2
Fire Resistance Ratings of Two-Wythe Concrete Walls

Table 709.2.1.2
Values of $R_n^{0.59}$ For Use In Eq. 709.2.1.2

Type of Material	Thickness of Material											
	1-1/2 in	2 in	2-1/2 in	3 in	3-1/2 in	4 in	4-1/2 in	5	5-1/2 in	6 in	6-1/2 in	7 in
Siliceous aggregate concrete	5.3	6.5	8.1	9.5	11.3	13.0	14.9	16.9	18.8	20.7	22.8	25.1
Carbonate aggregate concrete	5.5	7.1	8.9	10.4	12.0	14.0	16.2	18.1	20.3	21.9	24.7	27.2[3]
Sand-lightweight concrete	6.5	8.2	10.5	12.8	15.5	18.1	20.7	23.3	26.0[3]	Note 3	Note 3	Note 3
Lightweight concrete	6.6	8.8	11.2	13.7	16.5	19.1	21.9	24.7	27.8[3]	Note 3	Note 3	Note 3
Insulating concrete[1]	9.3	13.3	16.6	18.3	23.1	26.5[3]	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3
Air Space[2]	----	----	----	----	----	----	----	----	----	----	----	----

1 in = 25.4 mm

Notes:

1. Dry unit weight of 35 pcf (560.6 kg/m^3) or less and consisting of cellular, perlite, or vermiculite concrete.
2. The $R_n^{0.59}$ value for one 1/2" to 3-1/2" air space is 3.3. The $R_n^{0.59}$ value for two 1/2" to 3-1/2" air spaces is 6.7.
3. The fire resistance rating for this thickness exceeds 4 hours.

R, minutes	$R^{0.59}$
60	11.20
120	16.85
180	21.41
240	25.37

709.2.1.3 Joints Between Precast Wall Panels.

709.2.1.3.1 Joints between precast concrete wall panels which are not insulated as required by this section shall be considered as openings in walls. Uninsulated joints shall be included in determining the percentage of openings permitted by Table 600. Where openings are not permitted or are required by this code to be protected, the provisions of this section shall be used to determine the amount of joint insulation required. Insulated joints shall not be considered openings for purposes of determining compliance with allowable percentage of openings in Table 600.

709.2.1.3.2 Figure 709.2.1.3 shows thicknesses of ceramic fiber blankets to be used to insulate joints between precast concrete wall panels for various panel thicknesses and for joint widths of 3/8 inch (9.5 mm) and 1 inch (25.4 mm) for fire resistance rating of 1 hour to 4 hours. For joint widths between 3/8 inch (9.5 mm) and 1 inch (25.4 mm), the thickness of ceramic fiber blanket may be determined by direct interpolation. Other tested and labeled materials may be used in place of ceramic fiber blankets.

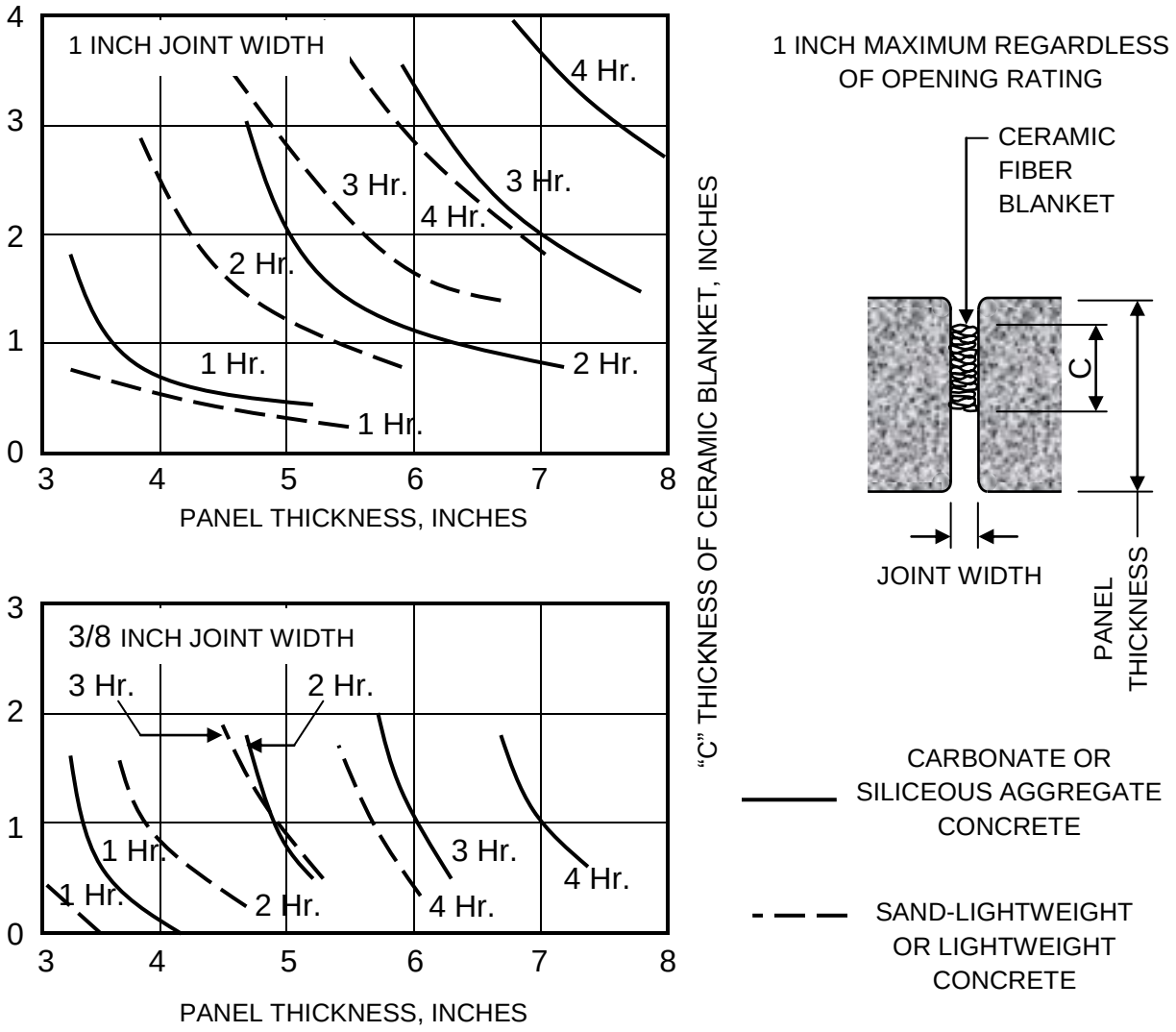


Figure 709.2.1.3
Ceramic Fiber Joint Protection

709.2.1.4 Walls with Gypsum Wallboard or Plaster Finishes.

709.2.1.4.1 The fire resistance rating of cast-in-place or precast concrete walls with finishes of gypsum wallboard or plaster applied to one or both sides may be calculated in accordance with the provisions of this section.

709.2.1.4.2 Where the finish of gypsum wallboard or plaster is applied to the nonfire-exposed side of the wall, the contribution of the finish to the total fire resistance rating shall be determined as follows: The thickness of the finish shall first be corrected by multiplying the actual thickness of the finish by the applicable factor determined from Table 709.2.1.4A based on the type of aggregate in the concrete. The corrected thickness of finish shall then be added to the actual thickness or equivalent thickness of concrete and fire resistance rating of the concrete and finish determined from Table 709.2.1.1, Figure 709.2.1.2, or Table 709.2.1.2.

709.2.1.4.3 Where gypsum wallboard or plaster is applied to the fire-exposed side of the wall, the contribution of the finish to the total fire resistance rating shall be determined as follows: The time assigned to the finish as established by Table 709.2.1.4B shall be added to the fire resistance rating determined from Table 709.2.1.1 or Figure 709.2.1.2, or Table 709.2.1.2 for the concrete alone, or to the rating determined in 709.2.1.4.2 for the concrete and finish on the nonfire-exposed side.

709.2.1.4.4 For a wall having no finish on one side or having different types or thicknesses of finish on each side, the calculation procedures of 709.2.1.4.2 and 709.2.1.4.3 shall be performed twice, i.e., assume that either side of the wall may be the fire-exposed side. The fire resistance rating of the wall shall not exceed the lower of the two values.

EXCEPTION: For exterior wall with more than 5 ft (1524 mm) of horizontal separation, the fire shall be assumed to occur on the interior side only.

709.2.1.4.5 When the finish applied to a concrete wall contributes to the fire resistance rating, the concrete alone shall provide not less than one-half the total required fire resistance rating.

709.2.1.4.6 Finishes on concrete walls which are assumed to contribute to the total fire resistance rating of the wall shall comply with the installation requirements of 709.3.1.6.

Table 709.2.1.4A
Multiple Factor for Finishes on Nonfire-Exposed Side of Wall

	Type of Aggregate Used in Concrete or Concrete Masonry			
	Concrete: Siliceous or Carbonate	**Concrete: Sand-Light-Weight**	**Concrete: Lightweight**	
Type of Finish Applied to Wall	**Concrete Masonry: Siliceous or Calcareous Gravel**	**Concrete Masonry: Limestone, Cinders or Unexpanded Slag**	**Concrete Masonry: Expanded Shale, Clay or Slate**	**Concrete Masonry: Pumice, or Expanded Slag**
Portland Cement-Sand Plaster	1.00	0.75[1]	0.75[1]	0.50[1]
Gypsum-Sand Plaster or Gypsum Wallboard	1.25	1.00	1.00	1.00
Gypsum-Vermiculite or Perlite Plaster	1.75	1.50	1.25	1.25

Note:

1. For Portland cement-sand plaster 5/8 inch (15.9 mm) or less in thickness and applied directly to the concrete masonry on the nonfire-exposed side of the wall, the multiplying factor shall be 1.00.

Table 709.2.1.4B
Time Assigned to Finish Materials on Fire-Exposed Side of Wall

Finish Description	Time, (min.)
Gypsum Wallboard	
3/8 in	10
1/2 in	15
5/8 in	30
2 layers of 3/8 in	25
1 layer 3/8 in, 1 layer 1/2 in	35
2 layers 1/2 in	40
Type X Gypsum Wallboard	
1/2 in	25
5/8 in	40
Portland cement-sand plaster applied directly to concrete masonry	See Note 1
Portland cement-sand plaster on metal lath	
3/4 in	20
7/8 in	25
1 in	30
Gypsum sand plaster on 3/8 in gypsum lath	
1/2 in	35
5/8 in	40
3/4 in	50
Gypsum sand plaster on metal lath	
3/4 in	50
7/8 in	60
1 in	80

Note:

1. The actual thickness or Portland cement-sand plaster, provided it is 5/8 inch (15.9 mm) or less in thickness, may be included in determining the equivalent thickness of the masonry for use in Table 709.3.1.

Table 709.2.2.1
Minimum Slab Thickness (in)

Concrete Type	Fire Resistance Rating				
	1 hr	1-1/2 hr	2 hr	3 hr	4 hr
Siliceous	3.5	4.3	5.0	6.2	7.0
Carbonate	3.2	4.0	4.6	5.7	6.6
Sand-Lightweight	2.7	3.3	3.8	4.6	5.4
Lightweight	2.5	3.1	3.6	4.4	5.1

1 in = 25.4 mm

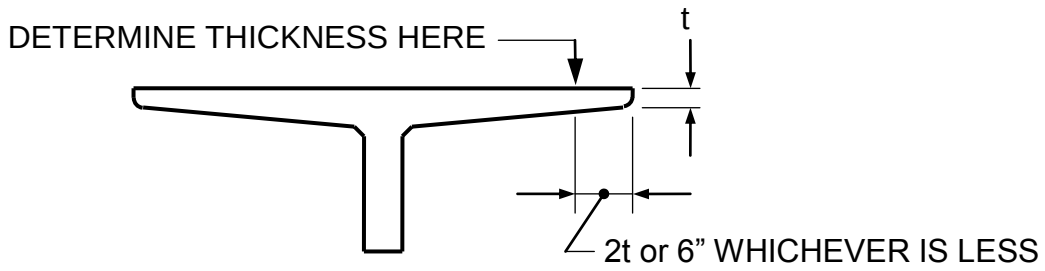
709.2.2 Concrete Floor and Roof Slabs.

709.2.2.1 Reinforced and Prestressed Floors and Roofs.

709.2.2.1.1 The minimum thicknesses of reinforced and prestressed concrete floor or roof slabs for fire resistance ratings of 1 hour to 4 hours are shown in Table 709.2.2.1.

709.2.2.1.2 For hollow-core prestressed concrete slabs in which the cores are of consistent cross section through the length, the equivalent thickness may be obtained by dividing the net cross-sectional area of the slab including grout in the joints, by its width.

709.2.2.1.3 The thickness of slabs with sloping soffits shall be determined at a distance 2t or 6 inches (152 mm), whichever is less, from the point of minimum thickness, where t is the minimum thickness.



709.2.2.1.4 The thickness of slabs with ribbed or undulating soffits shall be determined by one of the following expressions, whichever is applicable.

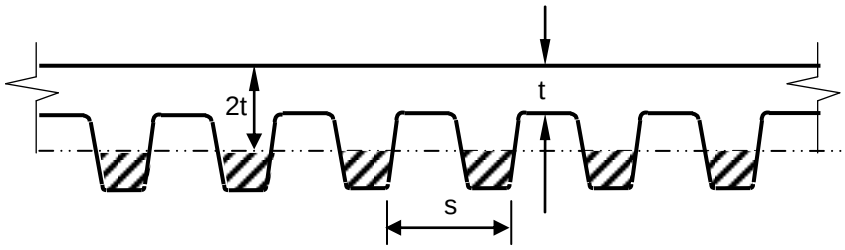
for $s \geq 4t$, the thickness to be used shall be t;
for $s \leq 2t$, the thickness to be used shall be t_e;
for $4t > s > 2t$, the thickness to be used shall be

$$t + \left(\frac{4t}{s} - 1\right)(t_e - t)$$

where s = spacing of ribs or undulations

t = minimum thickness

t_e = equivalent thickness of the slab calculated as the net area of the slab divided by the width, in which the maximum thickness used in the calculation shall not exceed 2t.



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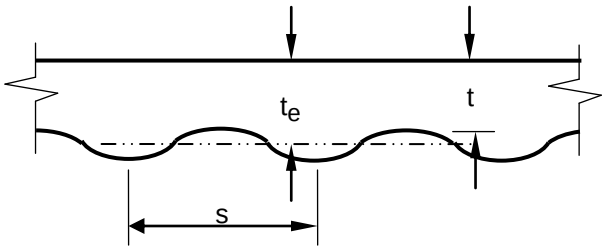
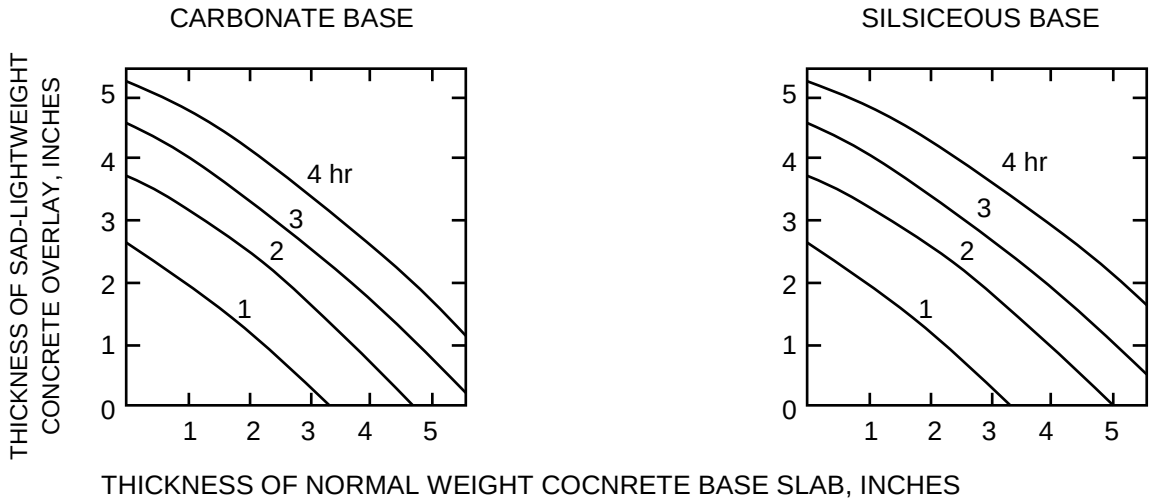


709.2.2.2 Multicourse Floors and Roofs.

709.2.2.2.1 Figure 709.2.2A gives information on the fire resistance ratings of floors which consist of a base slab of concrete with a topping (overlap) of a different type of concrete.

709.2.2.2.2 Figure 709.2.2B gives information on the fire resistance ratings of roofs which consist of a base slab of concrete with a topping (overlay) of an insulating concrete or with an insulating board and built-up roofing.

1. For the transfer of heat, three-ply built-up roofing contributes 10 minutes to the fire resistance rating; thus, 10 minutes can be added to concrete assemblies such as those shown in Figure 709.2.2B (a), (b) and (c), but not to those shown in Figure 709.2.2B (d) and (e).



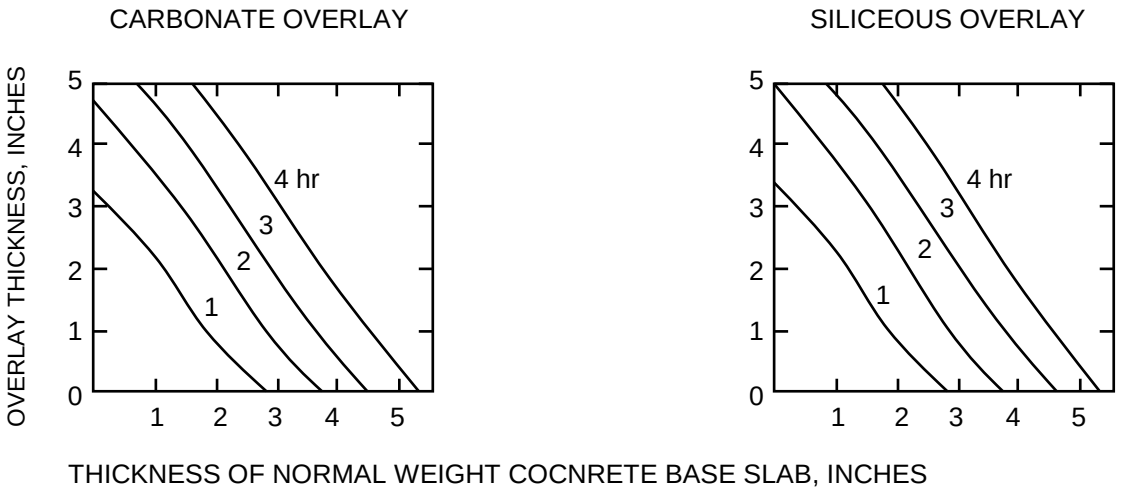


Figure 709.2.2A
Fire Resistance for Two-Course Concrete Floors

1 in = 25.4 mm

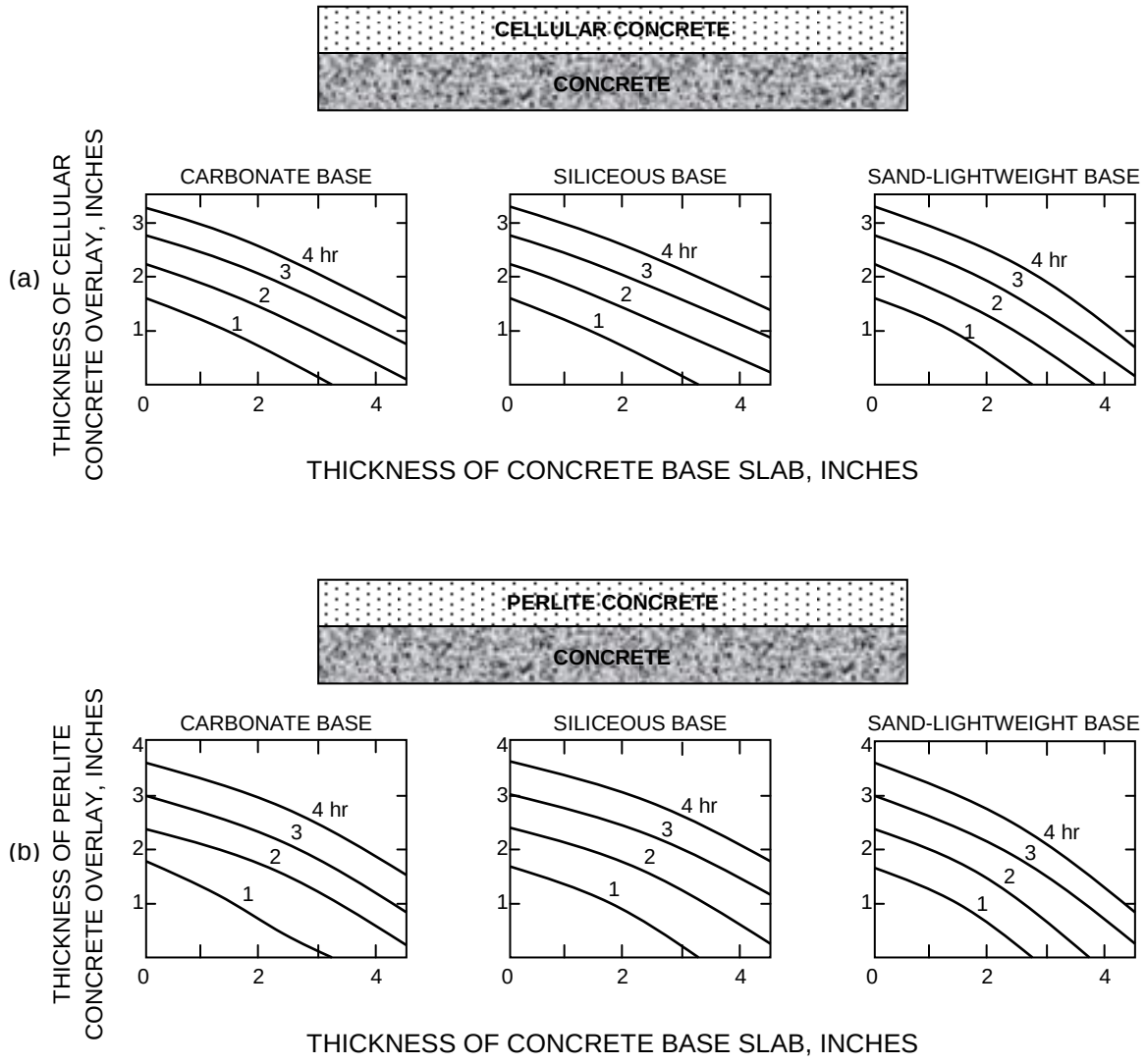
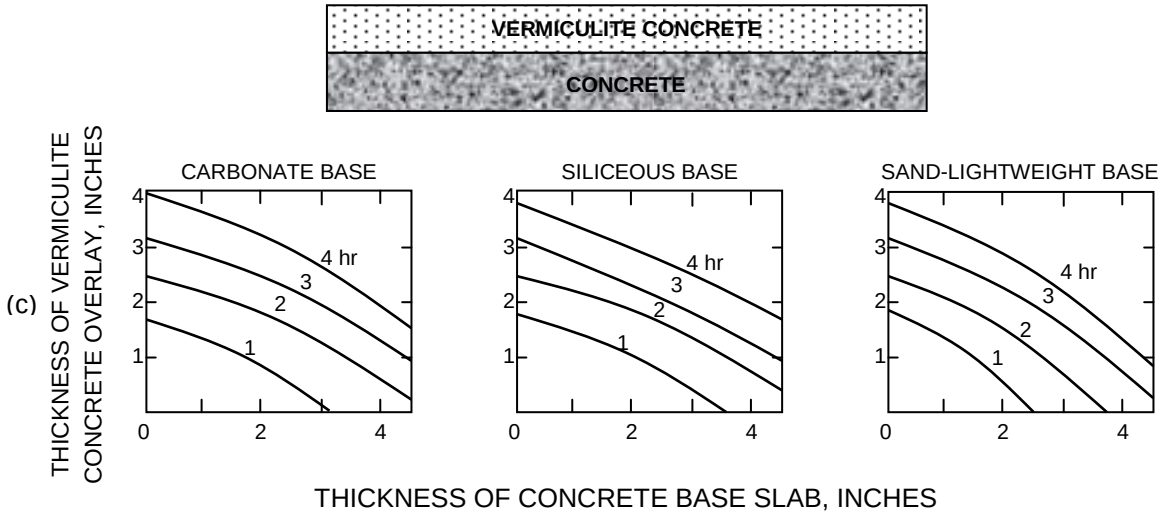


Figure 709.2.2B
Fire Resistance Ratings for Concrete Floor Assemblies

1 in = 25.4 mm



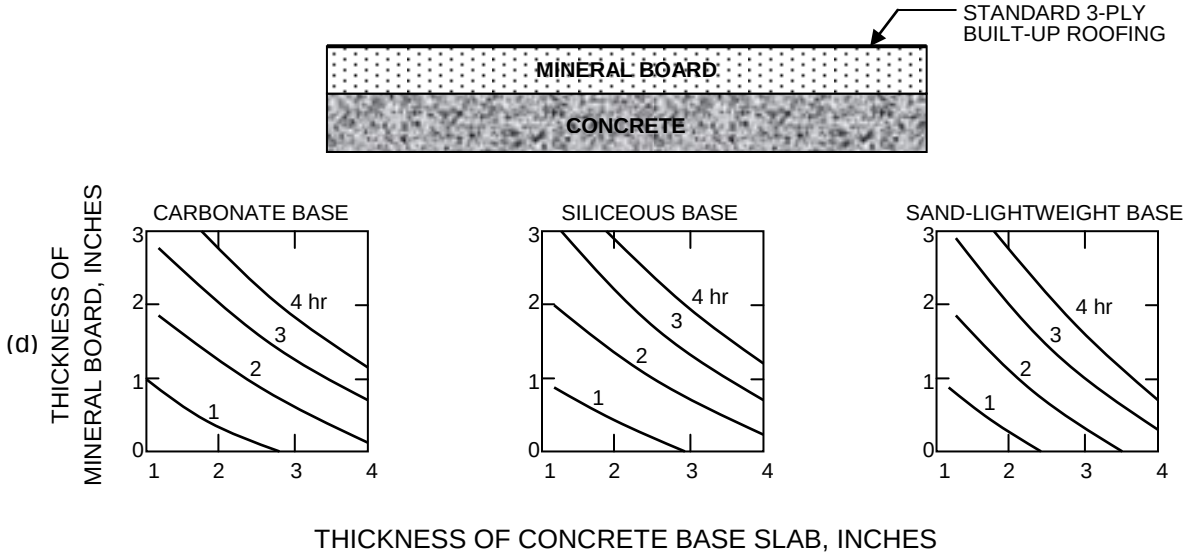


Figure 709.2.2B *(continued)*
Fire Resistance Ratings for Concrete Floor Assemblies

1 in = 25.4 mm

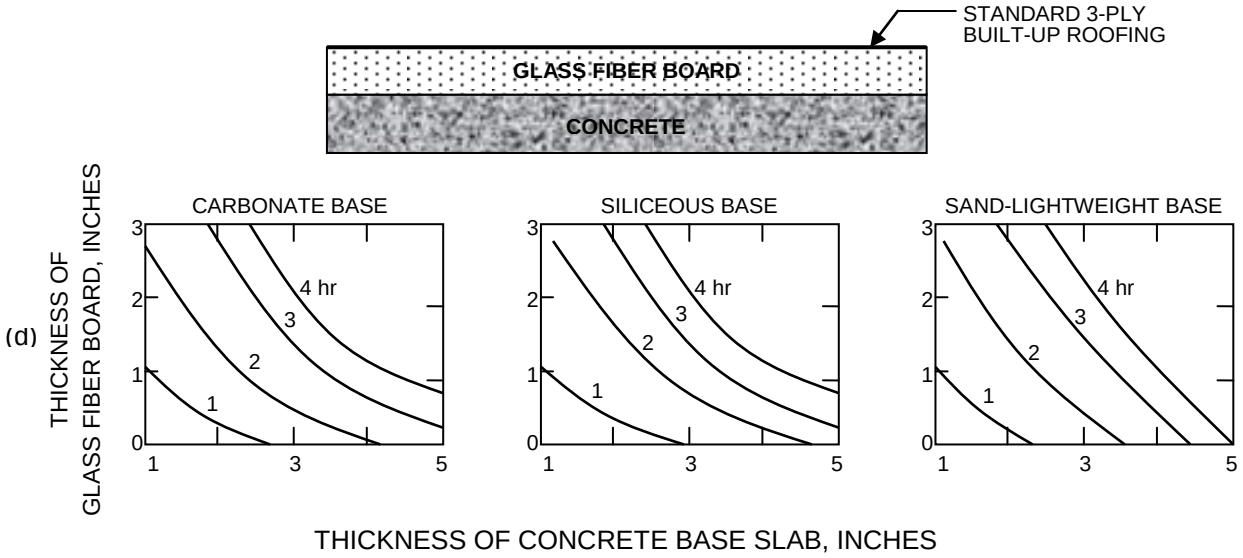


Figure 709.2.2B *(continued)*
Fire Resistance Ratings for Concrete Floor Assemblies

1 in = 25.4 mm

709.2.2.3 Joints in Precast Slabs. Joints between adjacent precast concrete slabs may be ignored in calculating the slab thickness provided that a concrete topping at least 1 inch (25.4 mm) thick is used. Where no concrete topping is used, joints must be grouted to a depth of at least one-third the slab thickness at the joint, but not less than 1 inch (25.4 mm), or the joints must be made fire resistant by other approved methods.

709.2.3 Concrete Cover Over Reinforcement.

709.2.3.1 Slab Cover. The minimum thickness of concrete cover to the positive moment reinforcement is given in Table 709.2.3A for reinforced concrete and Table 709.2.3B for prestressed concrete. These tables are applicable for solid or hollow-core one-way or two-way slabs with flat undersurfaces. Slabs may be cast-in-place or precast. For precast prestressed concrete not covered elsewhere, the procedures contained in PCI Design for Fire Resistance of Precast Prestressed Concrete shall be acceptable.

Table 709.2.3A
Cover Thickness for Reinforced Concrete Floor or Roof Slabs (in)

Concrete Aggregate Type	Fire Resistance Rating									
	Restrained[1]					Unrestrained[1]				
	1 hr	1-1/2 hr	2 hr	3 hr	4 hr	1 hr	1-1/2 hr	2 hr	3 hr	4 hr
Siliceous	3/4	3/4	3/4	3/4	3/4	3/4	3/4	1	1-1/4	1-5/8
Carbonate	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	1-1/4	1-1/4
Sand-Light-weight or Lightweight	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	1-1/4	1-1/4

1 in = 25.4 mm

Note:

1. See Table 709.2.3E for guidance on restrained and unrestrained assemblies.

Table 709.2.3B
Cover Thickness for Prestressed Concrete Floor or Roof Slabs (in)

Concrete Aggregate Type	Fire Resistance Rating									
	Restrained[1]					Unrestrained[1]				
	1 hr	1-1/2 hr	2 hr	3 hr	4 hr	1 hr	1-1/2 hr	2 hr	3 hr	4 hr
Siliceous	3/4	3/4	3/4	3/4	3/4	1-1/8	1-3/4	1-3/4	2-3/8	2-3/4
Carbonate	3/4	3/4	3/4	3/4	3/4	1	1-3/8	1-5/8	2-1/8	2-1/4
Sand-Light-weight or Lightweight	3/4	3/4	3/4	3/4	3/4	1	1-3/8	1-1/2	2	2-1/4

1 in = 25.4 mm

Note:

1. See Table 709.2.3E for guidance on restrained and unrestrained assemblies.

709.2.3.2 Reinforced Beam Cover. The minimum thickness of concrete cover to the positive moment reinforcement (bottom steel) for reinforced concrete beams is shown in Table 709.2.3C for fire resistance ratings of 1 hour to 4 hours.

Table 709.2.3C
Minimum Cover for Main Reinforcing Bars of Reinforced Concrete Beams[3]
(Applicable to All Types of Structural Concrete)

Restrained or Unrestrained[1]	Beam Width[2] (in)	Fire Resistance Rating				
		1 hr	1-1/2 hr	2 hr	3 hr	4 hr
Restrained	5	3/4	3/4	3/4	1[1]	1-1/4[1]
	7	3/4	3/4	3/4	3/4	3/4
	≥10	3/4	3/4	3/4	3/4	3/4
Unrestrained	7	3/4	1	1-1/4	---	---
	5	3/4	3/4	3/4	1-3/4	3
	≥10	3/4	3/4	3/4	1	1-3/4

1 in = 25.4 mm

Note:

1. See Table 709.2.3E for guidance on restrained and unrestrained assemblies. Tabulated values for restrained assemblies apply to beams spaced more than 4 ft on centers. For restrained beams spaced 4 ft or less on centers, minimum cover of 3/4 inch is adequate for ratings of 4 hr or less.
2. For Beam widths between the tabulated values, the minimum cover thickness can be determined by direct interpolation.
3. The cover for an individual reinforcing bar is the minimum thickness of concrete between the surface of the bar and the fire-exposed surface of the beam. For beams in which several bars are used, the cover for corner bars used in the calculation shall be reduced to one-half of the actual value. The cover for an individual bar must be not less than one-half of the value given in Table 709.2.3C nor less than 3/4 inch.

709.2.3.3 Prestressed Beam Cover. The minimum thickness of concrete cover in the positive moment prestressing tendons (bottom steel) for prestressed concrete beams is shown in Table 709.2.3D for fire resistance rating of 1 hour to 4 hours.

Table 709.2.3D
Minimum Cover for Prestressed Concrete Beams[4,6,7]

Restrained or Unrestrained[1]	Concrete Aggregate Type[2]	Beam Width[3] (in)	Fire Resistance Rating				
			1 hr	1-1/2 hr	2 hr	3 hr	4 hr
Restrained	Carb or Sil	8	1-1/2	1-1/2	1-1/2	1-3/4[1]	2-1/2[1]
	Carb or Sil	≥12	1-1/2	1-1/2	1-1/2	1-1/2	1-7/8[1]
	Sand LW	8	1-1/2	1-1/2	1-1/2	1-1/2	2[1]
	Sand LW	≥12	1-1/2	1-1/2	1-1/2	1-1/2	1-5/8[1]
Unrestrained	Carb or Sil	8	1-1/2	1-3/4	2-1/2	5[5]	---
	Carb or Sil	≥12	1-1/2	1-1/2	1-7/8	2-1/2	3
	Sand LW	8	1-1/2	1-1/2	2	3-1/4	---
	Sand LW	≥12	1-1/2	1-1/2	1-5/8	2	2-1/2

1 in = 25.4 mm

Notes:

1. See Table 709.2.3E for guidance on restrained and unrestrained assemblies. Tabulated values for restrained assemblies apply to beams spaced more than 4 ft (1219 mm) on centers. For restrained beams spaced 4 ft (1219 mm) or less on centers, minimum cover of 3/4 inch (19 mm) is adequate for ratings of 4 hr or less.
2. Carb = carbonate aggregate concrete; Sil = siliceous aggregate concrete; Sand LW = sand-lightweight concrete.
3. For beam widths between 8 inches (203 mm) and 12 inches (305 mm), minimum cover thickness can be determined by direct interpolation.
4. The cover for an individual tendon is the minimum thickness of concrete between the surface of the tendon and the fire-exposed surface of the beam, except that for ungrouted ducts the assumed cover thickness is the minimum thickness of concrete between the surface of the duct and the surface of the beam. For beams in which several tendons are used, the cover is assumed to be the average of the minimum cover of individual tendons, where the minimum cover for corner tendons used in the calculation shall be reduced to one-half of the actual value. The cover for an individual tendon must be not less than one-half of the value given in Table 709.2.3D nor less than 1 inch (25.4 mm).
5. Not practical for 8 inches (203 mm) wide beam but shown for purposes of interpolation.
6. For precast prestressed concrete not covered elsewhere, the procedures contained in PCI Design for Fire Resistance of Precast Prestressed Concrete shall be acceptable.
7. The minimum cover for nonprestressed reinforcing in prestressed concrete beams shall be determined in accordance with the provisions of Table 709.2.3C.

Table 709.2.3E
Construction Classification, Restrained and Unrestrained

Unrestrained	
Bearing	Single span and simply supported end spans of multiple bays such as concrete slabs or precast units[1]
Restrained	
Wall bearing:	Interior spans of multiple bays: (1) Cast-in-place concrete slab systems (2) Precast concrete where the potential thermal expansion is resisted by adjacent construction[2]
Concrete framing:	(1) Beams securely fastened to the framing members (2) All types of cast-in-place floor or roof systems (such as beam-and-slabs) where the floor or roof system is cast with the framing members (3) Interior and exterior spans of precast systems with cast-in-place joints resulting in restrained equivalent to that which would exist in condition 1, concrete framing. (4) All types of prefabricated floor or roof systems where the structural members are secured to such systems and the potential thermal expansion of the floor or roof systems is resisted by the framing systems of the adjoining floor or roof construction[2]

Notes:

1. Floor and roof systems can be considered restrained when they are tied into walls with or without tie beams, the walls being designed and detailed to resist thermal thrust from the floor or roof system.
2. For example, resistance to potential thermal expansion is considered to be achieved when:
   (1) Continuous structural concrete topping is used,
   (2) The space between the ends of precast units or between the ends of units and the vertical face of supports is filled with concrete or mortar, and
   (3) The space between the ends of precast units and the vertical face of supports, or between the ends of solid or hollow-core slab units does not exceed 0.25% of the length for normal weight concrete members or 0.1% of the length for structural lightweight concrete members.

709.2.4 Concrete Columns.

709.2.4.1 Minimum Size. Table 709.2.4A and 709.2.4B show the minimum overall dimensions of reinforced concrete columns for fire resistance ratings of 1 hour to 4 hours.

Table 709.2.4A
Minimum Dimensions (in) of Concrete Columns

Types of Concrete	Fire Resistance Rating				
	1 hr	1-1/2 hr	2 hr	3 hr	4 hr
Siliceous	8	8	10	12	14
Carbonate	8	8	10	11	12
Sand-Lightweight	8	8	9	10.5	12

1 in = 25.4 mm

Table 709.2.4B
Minimum Dimensions (in) of Concrete Columns With Fire Exposure Conditions on Two Parallel Side[1]

Types of Concrete	Fire Resistance Rating				
	1 hr	1-1/2 hr	2 hr	3 hr	4 hr
Siliceous	8	8	8	8	10
Carbonate	8	8	8	8	10
Sand-Lightweight	8	8	8	8	10

1 in = 25.4 mm

Note:

1. The minimum dimensions are acceptable for rectangular columns with a fire exposure condition on 3 or 4 sides provided each of two parallel sides of the column are at least 36 inches in length.

709.2.4.2 Minimum Cover For R/C Columns. The minimum cover to the main longitudinal reinforcement in columns for fire resistance ratings of 1 hour, 1 1/2 hours, 2 hours and 3 hours shall be 1 1/2 inches (38 mm); for 4 hours the minimum cover to the main longitudinal reinforcement shall be 2 inches (51 mm) for siliceous aggregate concrete and 1 1/2 inches (38 mm) for carbonate aggregate concrete or sand-lightweight concrete.

709.2.4.3 Precast Cover Units For Steel Columns. See 709.5.1.4.

709.3 Concrete Masonry

709.3.1 Concrete Masonry Walls.

709.3.1.1 The fire resistance rating of walls and partitions constructed of concrete masonry units shall be determined from Table 709.3.1. The rating shall be based on the equivalent thickness of the masonry and type of aggregate used.

709.3.1.2 Where plaster or gypsum wallboard is applied to the nonfire-exposed side of the wall, the contribution of the finish to the total fire resistance rating shall be determined as follows: The thickness of gypsum wallboard or plaster shall be corrected by multiplying the actual thickness of the finish by applicable factor determined from Table 709.2.1.4A. This corrected thickness of finish shall be added to the equivalent thickness of masonry and the fire resistance rating of the masonry and finish determined from Table 709.3.1.

709.3.1.3 Where plaster or gypsum wallboard is applied to the fire-exposed side of the wall, the contribution of the finish to the total fire resistance rating shall be determined as follows: The time assigned to the finish as established by Table 709.2.1.4B shall be added to the fire resistance rating determined in 709.3.1.1 for the masonry alone, or in 709.3.1.2 for the masonry and finish on the nonfire-exposed side.

709.3.1.4 For a wall having no finish on one side or having different types or thicknesses of finish on each side, the calculation procedures of this section shall be performed twice, i.e., assume that either side may be the fire-exposed side of the wall. The fire resistance rating of the wall shall not exceed the lower of the two values calculated.

EXCEPTION: For exterior walls with more than 5 ft (1524 mm) of horizontal separation, the fire shall be assumed to occur on the interior side only.

709.3.1.5 When the finish applied to a concrete masonry wall contributes to the fire resistance rating, the masonry alone shall provide not less than one-half the total required fire resistance rating.

709.3.1.6 Installation of finishes shall be as follows:

1. Gypsum wallboard and gypsum lath applied to concrete masonry or concrete walls shall be secured to wood or steel furring members spaced not more than 16 inches (406 mm) o.c.
2. Gypsum wallboard shall be installed with the long dimension parallel to the furring members and shall have all joints finished.
3. Other aspects of the installation of finishes shall comply with the applicable provisions of Chapter 7 and Chapter 25.

709.3.2 Filled Core Spaces. Where all the core spaces of hollow or solid masonry are filled with loose-fill material, such as vermiculite, perlite, or expanded shale, clay, slate or slag, the equivalent thickness of the masonry shall be assumed to be the actual wall thickness.

Table 709.3.1
Minimum Equivalent Thickness[1] (in) of Bearing Or Nonbearing Concrete Masonry Walls[2,3,4]

	Fire Resistance Rating (hours)														
Types of Aggregate	**0.50**	**0.75**	**1**	**1.25**	**1.50**	**1.75**	**2**	**2.25**	**2.50**	**2.75**	**3**	**3.25**	**3.50**	**3.75**	**4**
Pumice or Expanded Slag	1.5	1.9	2.1	2.5	2.7	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.5	4.7
Expanded Shale, Clay or Slate	1.8	2.2	2.6	2.9	3.3	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	4.9	5.1
Limestone, Cinders, or Unexpanded Slag	1.9	2.3	2.7	3.1	3.4	3.7	4.0	4.3	4.5	4.8	5.0	5.2	5.5	5.7	5.9
Calcareous Gravel	2.0	2.4	2.8	3.2	3.6	3.9	4.2	4.5	4.8	5.0	5.3	5.5	5.8	6.0	6.2
Siliceous Gravel	2.1	2.6	3.0	3.5	3.9	4.2	4.5	4.8	5.1	5.4	5.7	6.0	6.2	6.5	6.7

1 in = 25.4 mm

Note:

1. Equivalent thickness is the average thickness of the solid material in the unit. Determine the equivalent thickness in accordance with ASTM C 140.
2. Values between those shown in the table can be determined by direct interpolation.
3. Where combustible members are framed into the wall, the thickness of solid material between the end of each member and the opposite face of the wall, or between members set in from opposite sides, shall not be less than 93% of the thickness shown in the table.
4. Requirements of ASTM C 55, C 73 or C 90 shall apply.

709.3.3 Multiwythe Masonry Walls. The fire resistance rating of wall assemblies constructed of multiple wythes of masonry materials may be based upon the fire resistance rating period of each wythe and the continuous air space between each wythe in accordance with the following formula:

$$R_A = (R_1^{0.59} + R_2^{0.59} + \ldots + R_n^{0.59} + A_1 + A_2 + \ldots + A_n)^{1.7} \qquad \text{(EQ. 709.3.3)}$$

Where:

R_A = Fire endurance rating of the assembly, hours

$R_1, R_2, ..., R_n$ = Fire endurance rating of wythes for 1, 2, ...n (hours), respectively

$A_1, A_2, ..., A_n$ = 0.30, factor for each continuous air space for 1, 2, ...n, respectively, having a depth of 1/2 inch (12.7 mm) or more between wythes.

709.3.4 Concrete Masonry Lintels. Fire resistance ratings for concrete masonry lintels shall be determined based upon the nominal thickness of the lintel and the minimum thickness of concrete masonry or concrete, or any combination thereof, covering the main reinforcing bars, as determined according to Table 709.3.4, or by approved alternate methods.

Table 709.3.4
Minimum Cover (in) on Main Reinforcing Bars
For Reinforced Concrete Masonry Lintels

	Fire Resistance Rating			
Lintel Thickness (in) Nominal	**1 hr**	**2 hr**	**3 hr**	**4 hr**
6	1	1-1/4	---	---
8	1	1	1-3/4	3
10 or more	1	1	1	1-3/4

1 in = 25.4 mm

709.3.5 Concrete Masonry Columns. Concrete masonry columns shall be designed (and reinforced) in accordance with applicable requirements of this code. The fire resistance rating shall be determined based upon the least plan dimension of the column in accordance with Table 709.3.5 or by approved alternate methods.

Table 709.3.5
Minimum Dimension (in) of Concrete Masonry Columns

Fire Resistance Rating			
1 hr	**2 hr**	**3 hr**	**4 hr**
8	10	12	14

1 in = 25.4 mm

709.4 Brick and Tile Masonry

709.4.1 Clay Masonry Walls.

709.4.1.1 The fire resistance ratings of walls or partitions constructed of clay masonry units shall be determined from Table 709.4.1A, 709.4.1B or 709.4.1C.

709.4.1.2 Where plaster is applied to the wall, the total fire resistive rating shall be determined by the formula:

$$R = (R_n^{0.59} + pl)^{1.7} \qquad \text{(Eq. 709.4.1.2)}$$

where R = the fire endurance of the assembly, minutes;
R_n =the fire endurance of the individual wall, minutes;
and pl = coefficient for thickness of plaster.

Values for $R_n^{0.59}$ for use in Eq. 709.4.1.2 are given in Table 709.4.1D. Coefficients for thickness of plaster shall be selected from Table 709.4.1E based on the actual thickness of plaster applied to the wall or partition and whether one or two sides of the wall are plastered.

709.4.1.3 Where a continuous air space separates multiple wythes of the wall or partition, the total fire resistance rating shall be determined by the formula:

$$R = (R_1^{0.59} + R_2^{0.59} + \ldots + R_n^{0.59} + as)^{1.7} \qquad \text{(Eq. 709.4.1.3)}$$

where R = the fire endurance of the assembly, minutes;
$R_1, R_2, ..., R_n$ = the fire endurance of the individual wythes, minutes;
and as = coefficient for continuous air space.

Values for $R_n^{0.59}$ for use in Eq. 709.4.1.3 are given in Table 709.4.1 D. Coefficients for the thickness of a 1/2 inch to 3 1/2 inch (12.7 to 89 mm) continuous air space separating two individual wythes shall be 0.3 for one continuous air space or 0.66 for two continuous air spaces.

709.4.1.4 For a wall having no finish on one side or having different types or thicknesses of finish on each side, the calculation procedures of this section shall be performed twice, i.e., assume that either side may be the fire-exposed side of the wall. The fire resistance of the wall shall not exceed the lower of the two values determined.

EXCEPTION: For exterior walls with more than 5 ft (1524 mm) of horizontal separation, the fire shall be assumed to occur on the interior side only.

709.4.2 Hollow Clay Masonry Walls. The fire resistance rating for hollow clay masonry walls and partitions may be determined from Table 709.4.2 based on the equivalent thickness of the hollow clay masonry units. The fire resistance rating determined from Table 709.4.2 may be used in the calculated fire resistance rating procedures in 709.4.1 or 709.4.3.

709.4.3 Multiwythe Walls.

709.4.3.1 The fire resistance rating for walls or partitions consisting of two or more dissimilar wythes may be determined by the formula:

$$R = (R_1^{0.59} + R_2^{0.59} + \ldots + R_n^{0.59})^{1.7} \qquad \text{(Eq. 709.4.3)}$$

where R = the fire endurance of the assembly, minutes;
$R_1, R_2, ..., R_n$ = the fire endurance of the individual wythes, minutes;

Values for $R_n^{0.59}$ for use in Eq. 709.4.3 are given in Table 709.4.1D.

709.4.3.2 For walls which consist of two or more wythes of different materials (concrete or concrete masonry units) in combination with clay masonry units, the fire resistance rating of the different materials may be determined from Table 709.2.1.1 for concrete; Table 709.3.1 for concrete masonry units or Table 709.4.1A, 709.4.1B or 709.4.1C for clay and tile masonry units.

Table 709.4.1A
Fire Resistance Periods of Bearing and Nonbearing Clay Brick Masonry Walls or Partitions[1,2]

Wall or Partition Assembly (minimum nominal thickness)	Member Framed into Wall or Partition	
	Combustible (minutes)	Noncombustible (minutes)
CLAY OR SHALE, SOLID		
4 in brick	---	75
6 in brick	---	153
8 in brick	120	240
12 in brick	240	---
CLAY OR SHALE, HOLLOW		
8 in brick		
71% solid	120	180
60% solid, cells filled with loose-fill insulation	---	240
12 in brick		
64% solid	---	240
CLAY OR SHALE, ROLOCK		
8 in Hollow Rolok	60	150
12 in Hollow Rolok	180	240
8 in Hollow Rolok Bak	---	240
CAVITY WALLS, CLAY OR SHALE		
8 in wall two 3-inch (actual) brick withes separated by 2-inch air space; masonry joint reinforcement spaced 16 in o.c. vertically	---	180
9 in wall two nominal 4-inch withes separated by 2-inch air space; 1/4-inch metal ties for each 3 sq ft of wall area	60[2]	240
CLAY OR SHALE BRICK, METAL FURRING CHANNELS		
5 in wall 4-inch nominal brick (75% solid) backed with a hat-shaped metal furring channel 3/4-inch thick formed from 0.021-inch sheet metal attached to brick wall on 24-inch centers with approved fasteners; and 1/2-inch Type X gypsum board attached to the metal furring strips with 1-inch long Type S screws spaced 8 inches on center.	---	120
HOLLOW CLAY TILE, BRICK FACING		
8 in wall 4-inch units (40% solid)[3] plus 4-inch solid brick	60	210
12 in wall 8-inch units (40% solid)[3] plus 4-inch solid brick	120	240

1 in = 25.4 mm

Note:

1. Units shall comply with the requirements of ASTM C 62, C 126, C 216 or C652.
2. A 9-inch wall has a 120-minute rating if the hollow spaces near combustible members are filled with fire resistance materials for the full thickness of the wall and for at least 4 inches above and below and between the combustible members.
3. Units shall comply with the requirements of ASTM C 34.

Table 709.4.1B
Fire Resistance Periods of Bearing and Nonbearing Clay Tile Masonry Walls or Partitions[1]

Wall or Partition Assembly (minimum nominal thickness)	Member Framed into Wall or Partition	
	Combustible (minutes)	Noncombustible (minutes)
HOLLOW CLAY TILE		
8-inch unit		
2 cells in wall thickness, 40% solid	45	75
2 cells in wall thickness, 43% solid	45	90
2 cells in wall thickness, 46% solid	60	105
2 cells in wall thickness, 49% solid	75	120
3 or 4 cells in wall thickness, 40% solid	45	105
3 or 4 cells in wall thickness, 43% solid	45	120
3 or 4 cells in wall thickness, 48% solid	60	150
3 or 4 cells in wall thickness, 53% solid	75	180
12-inch unit		
3 cells in wall thickness, 40% solid	120	150
3 cells in wall thickness, 45% solid	150	180
3 cells in wall thickness, 49% solid	180	210
12-inch unit		
2 units with 3 or 4 cells in wall thickness, 40% solid	120	210
2 units with 3 or 4 cells in wall thickness, 45% solid	150	240
2 units with 3 or 4 cells in wall thickness, 53% solid	180	240
16-inch unit		
2 or 3 units with 4 or 5 cells in wall thickness, 40% solid	240	240
STRUCTURAL CLAY TILE		
4-inch unit		
1 cells in wall thickness, 40% solid[2,3]	---	75
1 cells in wall thickness, 40% solid[3,4]	---	75
6-inch unit		
1 cell in wall thickness, 30% solid[2,3]	---	120
1 cell in wall thickness, 30% solid[3,4]	---	120
3 cells in wall thickness, 45% solid[4]	---	60
HOLLOW STRUCTURAL CLAY TILE		
8-inch unit		
2 cells in wall thickness, 40% solid	45	75
2 cells in wall thickness, 49% solid	75	120
2 cells in wall thickness, 46% solid	60	105
2 or 4 cells in wall thickness, 53% solid	75	180
12-inch unit		
3 cells in wall thickness, 40% solid	120	150
3 cells in wall thickness, 45% solid	150	180
3 cells in wall thickness, 49% solid	180	210
12-inch unit		
2 units with 3 cells in wall thickness, 40% solid	120	210
2 units with 3 or 4 cells in wall thickness, 45% solid	150	240
16-inch unit		
2 units with 4 cells in wall thickness, 43% solid	240	240
2 or 3 units with 4 or 5 cells in wall thickness, 40% solid	240	240

1 in = 25.4 mm

Notes:
1. Units shall comply with the requirements of ASTM C 34, C 56, C 212 or 530.
2. Ratings are for dense hard-burned clay shale.
3. Cells filled with tile, stone, slag, cinders or sand mixed with mortar.
4. Ratings are for medium-burned clay tile.

Table 709.4.1C
Fire Resistance Periods of Bearing Steel Framed Brick Veneer Walls or Partitions

Wall or Partition Assembly	Plaster Side Exposed (hr)	Brick Faced Side Exposed (hr)
Outside facing of steel studs: 1/2-in wood fiberboard sheathing next to studs, 3/4-in air space formed with 3/4 x 1-5/8-in wood strips placed over the fiberboard and secured to the studs; metal or wire lath nailed to such strips, 3-3/4-in brick veneer held in place by filling 3/4-in air space between the brick and the lath with mortar. Inside facing of studs: 3/4-in unsanded gypsum plaster on metal or wire lath attached to 5/16-in wood strips secured to edges of the studs.	1-1/2	4
Outside facing of steel studs: 1-in insulation board sheathing attached to studs, 1-in air space, and 3-3/4-inch brick veneer attached to steel frame with metal ties every 5th course. Inside facing of studs: 7/8-inch sanded gypsum plaster (1:2 mix) applied on metal or wire lath attached directly to the studs.	1-1/2	4
Same as above except use 7/8-in vermiculite-gypsum plaster or 1-in sanded gypsum plaster (1:2 mix) applied to metal or wire.	2	4
Outside facing steel studs: 1/2-in gypsum sheathing board, attached to studs, and 3-3/4-in brick veneer attached to steel frame with metal ties every 5th course. Inside facing of studs: 1/2-in sanded gypsum plaster (1:2 mix) applied to 1/2-in perforated gypsum lath securely attached to studs and having strips of metal lath 3-in wide applied to all horizontal joints of gypsum.	2	4

1 in = 25.4 mm

Table 709.4.1D
Values of $R_n^{0.59}$
(For Use in Eq. 709.4.1.2, 709.4.1.3 or 709.4.3)

R, minutes	$R_n^{0.59}$
60	11.20
120	16.85
180	21.41
240	25.37

Table 709.4.1E
Coefficient for Plaster[1]

Thickness of plaster, inches	One Side	Two Side
1/2 (12/7 mm)	0.3	0.6
5/8 (15.9 mm)	0.37	0.75
3/4 (19.1 mm)	0.45	0.90

Note:
1. Values listed in table are for 1:3 sanded gypsum plaster.

Table 709.4.2
Minimum Equivalent Thickness[1] (in) of Bearing or Nonbearing Clay Masonry Walls[2,3]

	Fire Resistance Rating			
Type of Material	**1 hr**	**2 hr**	**3 hr**	**4 hr**
Hollow brick[4] of clay or shale, not filled	2.3	3.4	4.3	5.0
Hollow brick[4] of clay or shale, grouted or filled with perlite, vermiculite, or expanded shale aggregate	3.0	4.4	5.5	6.6

1 in = 25.4 mm

Notes:
1. Equivalent thickness is the average thickness of the solid material in the wall. It may be found by taking the total volume of a wall unit, subtracting the volume of the core spaces and dividing this by the area of the exposed face of the unit.
2. Values between those shown in the table can be determined by direct interpolation.
3. Where combustible members are framed in the wall, the thickness of solid material between the end of each member and the opposite face of the wall, or between members set in from opposite sides, shall be not less than 93% of the thickness shown in the table.
4. Requirements of ASTM C 652 shall apply.

709.5 Steel Assemblies

709.5.1 Structural Steel Columns.

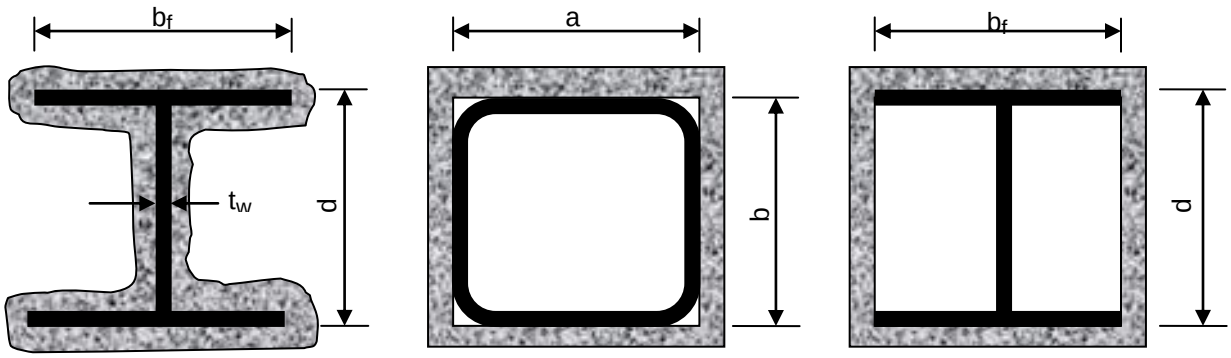
709.5.1.1 General.

709.5.1.1.1 These procedures establish a basis for determining the fire resistance of column assemblies as a function of the thickness of fire resistant material and, the weight, W and heated perimeter D of steel columns. As used in these sections, W is the average weight of a structural steel column in pounds per linear foot. The heated perimeter D is the inside perimeter of the fire resistant material in inches as illustrated in Figure 709.5.1A.

709.5.1.1.2 The application of these procedures shall be limited to column assemblies in which the fire resistant material is not designed to carry any of the load acting on the column.

709.5.1.1.3 In the absence of substantiating fire endurance test results, ducts, conduit, piping, and similar mechanical, electrical, and plumbing installations shall not be embedded in any required fire resistant materials.

709.5.1.1.4 Table 709.5.1 A contains weight to heated perimeter ratios (W/D) for both contour and box fire resistant protection profiles, for the wide flange shapes most often used as columns. For different fire resistant profiles or column cross sections, the weight to heated perimeter ratios (W/D) shall be determined in accordance with the definitions given in this section.



$D = 4b_f + 2d - 2t_w$ $D = 2(a + b)$ $D = 2(b_f + d)$

Figure 709.5.1A
Determination of the Heated Perimeter
Of Structural Steel Columns

1 in = 25.mm

Table 709.5.1A
W/D Ratios for Steel Columns

Structural Shape	Contour Profile	Box Profile	Structural Shape	Contour Profile	Box Profile
W14 x 233	2.49	3.65	W10 x 112	1.78	2.57
x 211	2.28	3.35	x 100	1.61	2.33
x 193	2.10	3.09	x 88	1.43	2.08
x 176	1.93	2.85	x 77	1.26	1.85
x 159	1.75	2.60	x 68	1.13	1.66
x 145	1.61	2.39	x 60	1.00	1.48
x 132	1.52	2.25	x 54	0.91	1.34
x 120	1.39	2.06	x 49	0.83	1.23
x 109	1.27	1.88	x 45	0.87	1.24
x 99	1.16	1.72	x 39	0.76	1.09
x 90	1.06	1.58	x 33	0.65	0.93
x 82	1.20	1.68			
x 74	1.09	1.53	W8 x 67	1.34	1.94
x 68	1.01	1.41	x 58	1.18	1.71
x 61	0.91	1.28	x 48	0.99	1.44
x 53	0.89	1.21	x 40	0.83	1.23
x 48	0.81	1.10	x 35	0.73	1.08
x 43	0.73	0.99	x 31	0.65	0.97
			x 28	0.67	0.96
W12 x 190	2.46	3.51	x 24	0.58	0.83
x 170	2.22	3.20	x 21	0.57	0.77
x 152	2.01	2.90	x 18	0.49	0.67
x 136	1.82	2.63			
x 120	1.62	2.36	W6 x 25	0.69	1.00
x 106	1.44	2.11	x 20	0.56	0.82
x 96	1.32	1.93	x 16	0.57	0.78
x 87	1.20	1.76	x 15	0.42	0.63
x 79	1.10	1.61	x 12	0.43	0.60
x 72	1.00	1.48	x 9	0.33	0.46
x 65	0.91	1.35			
x 58	0.91	1.31	W5 x 19	0.64	0.93
x 53	0.84	1.20	x 16	0.54	0.80
x 50	0.89	1.23			
x 45	0.81	1.12	W4 x 13	0.54	0.79
x 40	0.72	1.00			

1 plf/in = 0.059 kg/m/mm

709.5.1.2 Gypsum Wallboard Protection.

709.5.1.2.1 The fire resistance of structural steel columns with weight to heated perimeter ratio (W/D) less than or equal to 3.65 and which are protected with Type X gypsum wallboard may be determined from the following expression:

$$R = 130 \left[\frac{h\,(W'/D)}{2} \right]^{0.75}$$

Where R = fire resistance(minutes),
h = total thickness of gypsum wallboard (inches),
D = heated perimeter of the structural steel column (inches), and
W' = total weight of the structural steel column and gypsum wallboard protection (pounds per linear foot).
0r, W' = W + 50hD/144

709.5.1.2.2 The gypsum wallboard shall be supported as illustrated in either Figure 709.5.1B for fire resistance ratings of 4 hours or less, or Figure 709.5.1C for fire resistance ratings of 3 hours or less.

709.5.1.2.3 The fire resistance of structural steel columns can be determined from Figure 709.5.1D for various thicknesses of gypsum wallboard as a function of the weight to heated perimeter ratio (W/D) of the column. For structural steel columns with weight to heated perimeter ratios (W/D) greater than 3.65, the thickness of gypsum wallboard required for specified fire resistance ratings shall be the same as the thickness determined for a W14x233 wide flange shape.

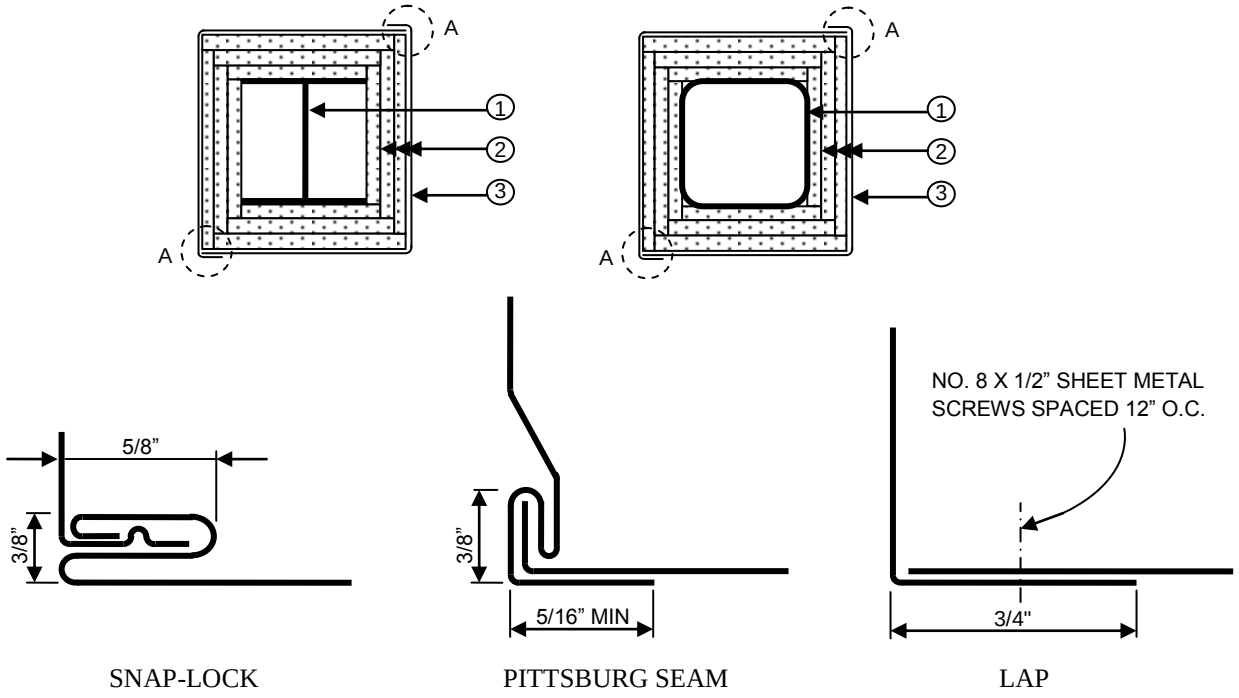


Figure 709.5.1B
Gypsum Wallboard Protected Structural Steel
Columns with Sheet Steel Column Covers

1 in = 25.4 mm)

NOTES:

1. Structural steel column, either wide flange or tubular shapes.
2. Type X gypsum wallboard in accordance with ASTM C 36. For single layer applications the wallboard shall be applied vertically with no horizontal joints. For multiple layer application, horizontal joints are permitted at a minimum spacing of 8ft (2438 mm) provided that the joints in successive layers are staggered at least 12 inches (305 mm). The total required thickness of wallboard shall be determined on the basis of the specified fire resistance rating and the weight to heated perimeter ratio (W/D) of the column. For fire resistance ratings of 2 hours or less, one of the required layers of gypsum wallboard may be applied to the exterior of the sheet steel column covers with 1 inch (25.4 mm) long Type S screws spaced 1 inch (25.4 mm) from the wallboard edge and 8 inches (203 mm) on center. For such installations, 0.0149 inch (0.378 mm) minimum thickness galvanized steel corner beads with 1 1/2-inch (38 mm) legs shall be attached to the wallboard with Type S screws spaced 12 inches (305 mm) on center.
3. For fire resistance ratings of 3 hours or less, the column covers shall be fabricated from 0.0239 inch (0.607 mm) minimum thickness galvanized or stainless steel. For 4 hour fire resistance ratings, the column covers shall be fabricated from 0.0239 inch (0.607 mm) minimum thickness stainless steel. The column covers shall be erected with the Snap Lock or Pittsburgh joint details.

   For fire resistance ratings of 2 hours or less, column covers fabricated from 0.0269 inch minimum thickness galvanized or stainless steel may be erected with lap joints. The lap joints may be located anywhere around the perimeter of the column cover. The lap joints shall be secured with 1/2 inch (12.7 mm) long No. 8 sheet metal screws spaced 12 inches (305 mm) on center.

   The column covers shall be provided with a minimum expansion clearance of 1/8 inch per linear foot (10.4 mm/m) between the ends of the cover and any restraining construction.

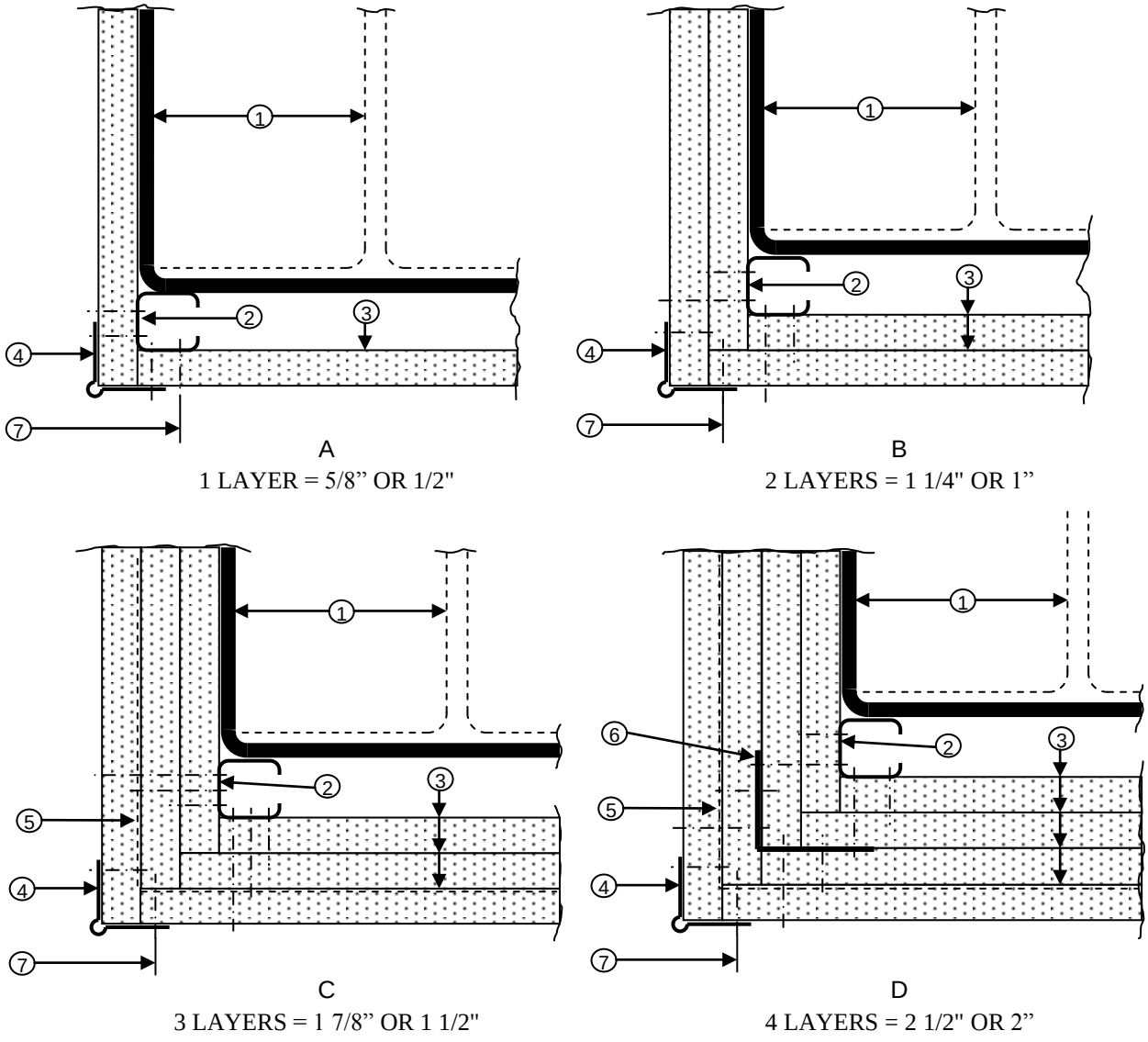


Figure 709.5.1C
Gypsum Wallboard Protected Structural Steel Columns with Steel Stud/Screw Attachment System

1 in = 25.4 mm

Notes:

1. Structural steel column, either wide flange or tubular shapes.
2. 1 5/8 inch (41.3 mm) deep studs fabricated from 0.0179 inch (0.46 mm) minimum thickness galvanized steel with 1 5/16 or 1 7/16 inch (33.3 or 36.5 mm) legs. The length of the steel studs shall be 1/2 inch(12.7 mm) less than the height of the assembly.
3. Type X gypsum wallboard in accordance with ASTM C 36. For single layer applications, the wallboard shall be applied vertically with no horizontal joints. For multiple layer applications, horizontal joints are permitted at a minimum spacing of 8ft (2438 mm) provided that the joints in successive layers are staggered at least 12 inches (305.mm). The total required thickness of wallboard shall be determined on the basis of the specified fire resistance rating and the weight-to-heated-perimeter ratio (W/D) of the column.
4. Galvanized 0.0149 inch (0.378 mm) minimum thickness steel corner beads with 1 1/2 inch (38.1 mm) legs attached to the wallboard with 1 inch (25.4 mm) long, Type S screws spaced 12 inches (305 mm) on center.
5. No. 18 SWG steel tie wires spaced 24 inches (610 mm) on center.
6. Sheet metal angles with 2 inch legs fabricated from 0.0209 inch (0.531 mm) minimum thickness galvanized steel.
7. Type S screws 1 inch (25.4 mm) long shall be used for attaching the first layer of wallboard to the steel studs and the third layer to the sheet metal angles at 24 inches (610 mm) on center. Type S screws 1 3/4 inches (44.5 mm) long shall be used for attaching the second layer of wallboard to the steel studs and the fourth layer to the sheet metal angles at 12 inches (305 mm) on center. Type S screws 2 1/4 inches (57.2 mm) long shall be used for attaching the third layer of wallboard to the steel studs at 12 inches (305 mm) on center.

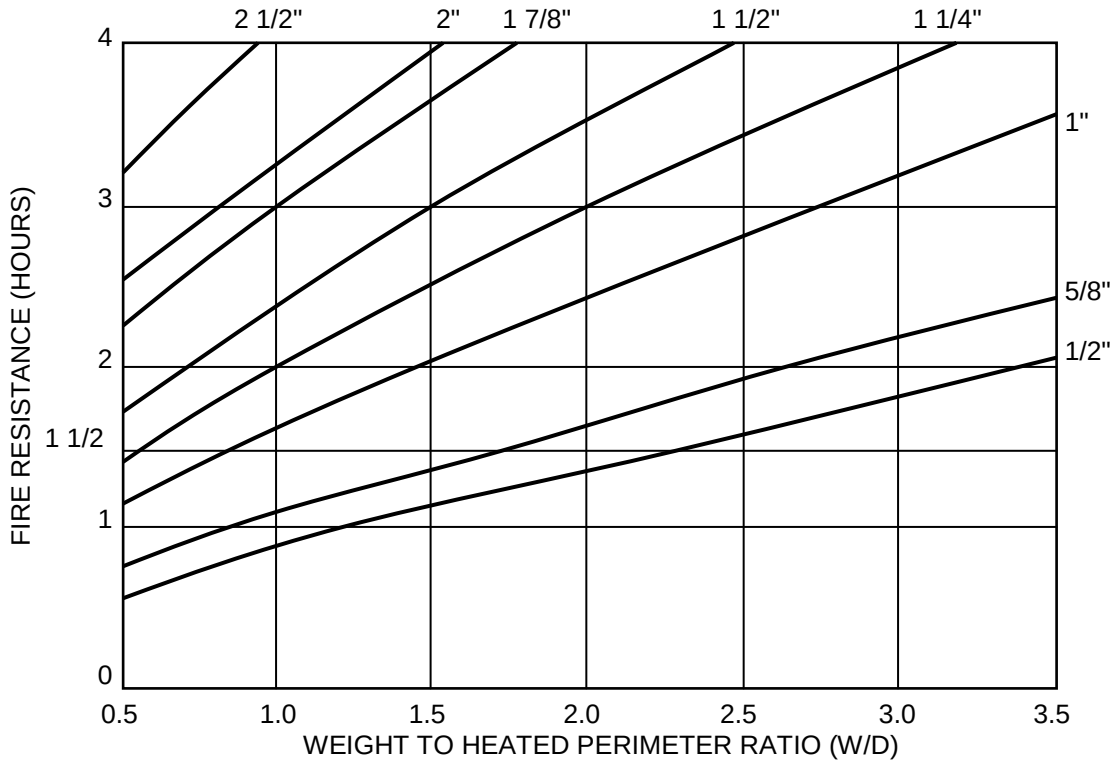


Figure 709.5.1D
Fire Resistance of Structural Steel Columns[1] Protected with Various Thickness of Type X Gypsum Wallboard

1 in = 25.4 mm

1 plf/in = 0.059 kg/m/mm

NOTE:

The W/D ratios for typical wide flange columns are listed in Table 709.5.1A. For other column shapes, the W/D ratios shall be determined in accordance with 709.5.1.1.

709.5.1.3 Spray-Applied Fire Resistant Materials.

709.5.1.3.1 The fire resistance of wide flange structural steel columns protected with spray-applied fire resistant materials, as illustrated in Figure 709.5.1E, may be determined from the following expression:

$$R = [C_1 (W/D) + C_2] h$$

Where R = fire resistance (minutes),
h = thickness of spray-applied fire resistant material (inches),
D = heated perimeter of the structural steel column (inches),
C_1 and C_2 = material-dependent constants, and
W = weight of structural steel column (pounds per linear foot)

709.5.1.3.2 The material-dependent constants, C_1 and C_2, shall be determined for specific fire resistant materials on the basis of standard fire endurance tests in accordance with 701. Unless evidence is submitted to the building official substantiating a broader application, this expression shall be limited to determining the fire resistance of structural steel columns with weight to heated perimeter ratios (W/D) between the largest and smallest columns for which standard fire endurance test results are available.

709.5.1.3.3 Spray-applied fire resistant materials shall be identified by density and thickness required for a given fire resistance rating.

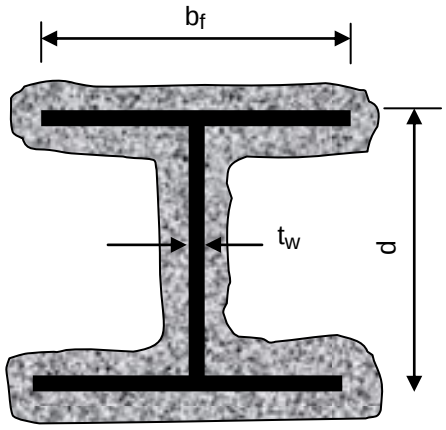


Figure 709.5.1E
Wide Flange Structural Steel Columns with Spray-Applied Fire Resistant Materials

709.5.1.4 Concrete Protected Columns.

709.5.1.4.1 The fire resistance of structural steel columns protected with concrete, as illustrated in Figure 709.5.1F (a) and (b), may be determined from the following expression:

$$R = R_0 (1 + 0.03m)$$

Where $R_0 = 10 (W/D)^{0.7} + 17 (h^{1.6}/k_c{}^{0.2}) (1 + 26 (H/p_c c_c h (L + h))^{0.8})$

As used in these expressions:

R = fire endurance at equilibrium moisture conditions (minutes)
R_o = fire endurance at zero moisture content (minutes)
m = equilibrium moisture content of the concrete by volume (percent)
W = average Weight of the steel column (pounds per linear foot)
D = heated perimeter of the steel column (inches)
h = thickness of the concrete cover (inches)
k_c = ambient temperature thermal conductivity of the concrete (Btu/hr ft ^{O}F)
H = ambient temperature thermal capacity of the steel column = .11W (Btu/ft ^{O}F)
p_c = concrete density (pounds per cubic foot)
c_c = ambient temperature specific heat of concrete (Btu/lb ^{O}F)
L = interior dimension of one side of a square concrete box protection (inches)

709.5.1.4.2 For wide flange steel columns completely encased in concrete with all re-entrant spaces filled (Figure 709.5.1 F(c)), the thermal capacity of the concrete within the re-entrant spaces may be added to the thermal capacity of the steel column, as follows:

$$H = 0.11W + (p_c c_c/144)(b_f d - A_s)$$

Where b_f = flange width of the steel column (inches),
d = depth of the steel column (inches), and
A_s = cross sectional area of the steel column (sq in).

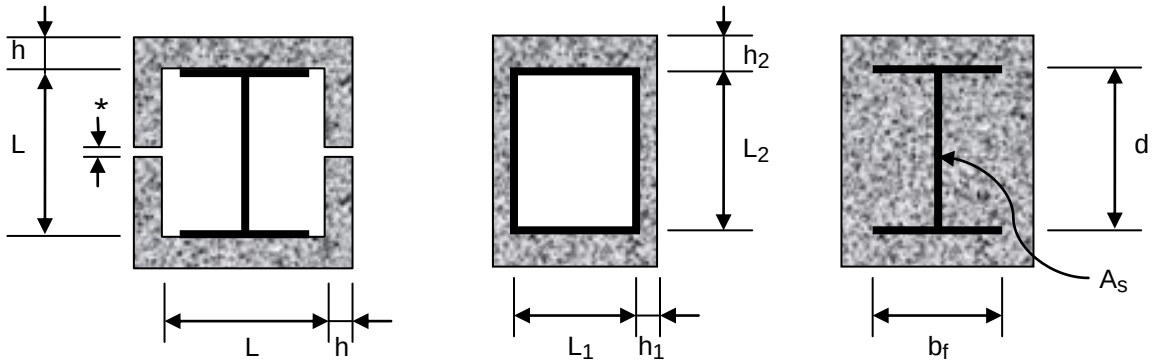
709.5.1.4.3 If specific data on the properties of concrete is not available, the values given in Table 709.5.1B may be used.

TABLE 709.5.1B
PROPERTIES OF CONCRETE

	Normal Weight Concrete	Structural Lightweight Concrete
Thermal conductivity (k_c)	0.95 Btu/hr ft ^{O}F (1.644 W/(m*K))	0.35 Btu/hr ft ^{O}F (0.606 W/(m*K))
Specific heat (c_c)	0.20 Btu/lb ^{O}F (837.4 J/(kg*K))	0.20 Btu/lb ^{O}F (837.4 J/(kg*K))
Density (p_c)	145 pcf (2322.7 kg/m^3)	110 pcf (1762.0 kg/m^3)
Equilibrium (free) moisture content (m) by volume	4%	5%

709.5.1.4.4 For structural steel columns encased in concrete with all re-entrant spaces filled (Figure 709.5.1 F(c)), Tables 709.5.1C and 709.5.1D give the thickness of concrete cover required for various fire resistance ratings for typical wide flange sections. The thicknesses of concrete given in these tables also apply to structural steel columns larger than those listed.

709.5.1.4.5 For structural steel columns protected with precast concrete column covers as shown in Figure 709.5.1 F(a), Table 709.5.1E gives the thickness of the column covers required for various fire resistance ratings for typical wide flange shapes. The thicknesses of concrete given in these tables also apply to structural steel columns larger than those listed.



(a) PRECAST CONCRETE COLUMN COVERS

(b) CONCRETE ENCASED STRUCTURAL TUBE

(c) CONCRETE ENCASED WIDE FLANGE SHAPE

FIGURE 709.5.1F
CONCRETE PROTECTED STRUCTURAL STEEL COLUMNS [1]

Notes

1. When the inside perimeter of the concrete protection is not square, L shall be taken as the average of L_1 and L_2. When the thickness of concrete cover is not constant, h shall be taken as the average of h_1 and h_2.
2. Joints shall be protected with a minimum 1 inch (25.4 mm) thickness of ceramic fiber blanket but in no case less than one-half the thickness of the column cover (See 709.2.1.3).

Table 709.5.1C
Minimum Cover (In) for Steel Columns Encased in Normal Weight Concrete[1]
(Figure 709.5.1F(c))

<table>
<tr><th rowspan="2">Structural Shape</th><th colspan="5">Fire Resistance Rating (Hours)</th></tr>
<tr><th>1</th><th>1 1/2</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>W14 X233</td><td rowspan="6">1</td><td rowspan="4">1</td><td rowspan="2">1</td><td rowspan="2">1 1/2</td><td>2</td></tr>
<tr><td>X176</td><td rowspan="3">2 1/2</td></tr>
<tr><td>X132</td><td rowspan="3">1</td><td rowspan="3">2</td></tr>
<tr><td>X 90</td><td rowspan="3">1 1/2</td></tr>
<tr><td>X 61</td><td rowspan="3">3</td></tr>
<tr><td>X 48</td></tr>
<tr><td>X 43</td><td>1 1/2</td><td>2 1/2</td></tr>
<tr><td>W12 X152</td><td rowspan="4">1</td><td rowspan="3">1</td><td>1</td><td rowspan="3">2</td><td rowspan="2">2 1/2</td></tr>
<tr><td>X 96</td><td rowspan="3">1 1/2</td></tr>
<tr><td>X 65</td><td rowspan="3">3</td></tr>
<tr><td>X 50</td><td>1 1/2</td><td rowspan="2">2 1/2</td></tr>
<tr><td>X 40</td><td colspan="3"></td></tr>
<tr><td>W10 X 88</td><td>1</td><td rowspan="4">1 1/2</td><td rowspan="3">1 1/2</td><td>2</td><td rowspan="2">3</td></tr>
<tr><td>X 49</td><td rowspan="3">1</td><td rowspan="3">2 1/2</td></tr>
<tr><td>X 45</td><td rowspan="2">3 1/2</td></tr>
<tr><td>X 39</td><td rowspan="2">2</td></tr>
<tr><td>X 33</td></tr>
<tr><td>W8 X 67</td><td rowspan="6">1</td><td>1</td><td rowspan="3">1 1/2</td><td rowspan="3">2 1/2</td><td>3</td></tr>
<tr><td>X 58</td><td>1 1/2</td><td rowspan="2">3 1/2</td></tr>
<tr><td>X 48</td><td rowspan="4">2</td></tr>
<tr><td>X 31</td><td rowspan="3">1 1/2</td><td rowspan="3">3</td></tr>
<tr><td>X 21</td><td rowspan="2">4</td></tr>
<tr><td>X 18</td></tr>
<tr><td>W6 X 25</td><td rowspan="4">1</td><td rowspan="2">1 1/2</td><td rowspan="2">2</td><td rowspan="4">3</td><td>3 1/2</td></tr>
<tr><td>X 20</td><td rowspan="4">4</td></tr>
<tr><td>X 16</td><td rowspan="3">2</td><td rowspan="3">2 1/2</td></tr>
<tr><td>X 15</td></tr>
<tr><td>X 9</td><td>1 1/2</td><td colspan="2"></td><td>3 1/2</td></tr>
</table>

1 in = 25.4 mm

Note:

1. The tabulated thicknesses are based upon the assumed properties of normal weight concrete given in Table 709.5.1B.

Table 709.5.1D
Minimum Cover (In) for Steel Columns Encased in Structural Lightweight Concrete[1]
(Figure 709.5.1F(c))

<table>
<tr><th rowspan="2">Structural Shape</th><th colspan="5">Fire Resistance Rating (Hours)</th></tr>
<tr><th>1</th><th>1 1/2</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>W14 X233</td><td rowspan="5">1</td><td rowspan="5">1</td><td rowspan="4">1</td><td>1</td><td rowspan="2">1 1/2</td></tr>
<tr><td>X193</td><td rowspan="3">1 1/2</td></tr>
<tr><td>X 74</td><td>2</td></tr>
<tr><td>X 61</td><td rowspan="2">2 1/2</td></tr>
<tr><td>X 43</td><td>1 1/2</td><td>2</td></tr>
<tr><td>W12 X 65</td><td rowspan="3">1</td><td rowspan="3">1</td><td rowspan="2">1</td><td>1 1/2</td><td>2</td></tr>
<tr><td>X 53</td><td rowspan="2">2</td><td rowspan="2">2 1/2</td></tr>
<tr><td>X 40</td><td>1 1/2</td></tr>
<tr><td>W10 X112</td><td rowspan="3">1</td><td rowspan="3">1</td><td rowspan="2">1</td><td rowspan="2">1 1/2</td><td rowspan="2">2</td></tr>
<tr><td>X 88</td></tr>
<tr><td>X 60</td><td rowspan="2">2</td><td rowspan="2">2 1/2</td></tr>
<tr><td>X 33</td><td>1 1/2</td></tr>
<tr><td>W8 X 35</td><td rowspan="3">1</td><td rowspan="2">1</td><td rowspan="3">1 1/2</td><td rowspan="2">2</td><td>2 1/2</td></tr>
<tr><td>X 28</td><td rowspan="2">3</td></tr>
<tr><td>X 24</td><td rowspan="2">2 1/2</td></tr>
<tr><td>X 18</td><td>1 1/2</td></tr>
</table>

1 in = 25.4 mm

Note:

1. The tabulated thicknesses are based upon the assumed properties of structural leightweight concrete given in Table 709.5.1B.

Table 709.5.1E
Minimum Cover (In) for Steel Columns In Normal Weight Precast Covers[1]
(Figure 709.5.1F(a))

<table>
<tr><th rowspan="2">Structural Shape</th><th colspan="5">Fire Resistance Rating (Hours)</th></tr>
<tr><th>1</th><th>1 1/2</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>W14 X233</td><td rowspan="8">1 1/2</td><td rowspan="4">1 1/2</td><td rowspan="2">1 1/2</td><td rowspan="3">2 1/2</td><td>3</td></tr>
<tr><td>X211</td><td rowspan="3">3 1/2</td></tr>
<tr><td>X176</td><td rowspan="3">2</td></tr>
<tr><td>X145</td><td rowspan="3">3</td></tr>
<tr><td>X109</td><td rowspan="3">4</td></tr>
<tr><td>X 99</td><td rowspan="3">2</td><td rowspan="3">2 1/2</td></tr>
<tr><td>X 61</td><td rowspan="2">3 1/2</td></tr>
<tr><td>X 43</td><td>4 1/2</td></tr>
<tr><td>W12 X190</td><td rowspan="8">1 1/2</td><td rowspan="4">1 1/2</td><td>1 1/2</td><td rowspan="2">2 1/2</td><td rowspan="2">3 1/2</td></tr>
<tr><td>X152</td><td rowspan="3">2</td></tr>
<tr><td>X120</td><td rowspan="3">3</td></tr>
<tr><td>X 96</td><td rowspan="3">4</td></tr>
<tr><td>X 87</td><td rowspan="3">2</td><td rowspan="3">2 1/2</td></tr>
<tr><td>X 58</td><td rowspan="2">3 1/2</td></tr>
<tr><td>X 40</td><td>4 1/2</td></tr>
<tr><td>W10 X112</td><td rowspan="5">1 1/2</td><td rowspan="2">1 1/2</td><td rowspan="2">2</td><td rowspan="3">3</td><td>3 1/2</td></tr>
<tr><td>X 88</td><td rowspan="3">4</td></tr>
<tr><td>X 77</td><td rowspan="3">2</td><td rowspan="3">2 1/2</td></tr>
<tr><td>X 54</td><td rowspan="2">3 1/2</td></tr>
<tr><td>X 33</td><td>4 1/2</td></tr>
<tr><td>W8 X 67</td><td rowspan="5">1 1/2</td><td>1 1/2</td><td>2</td><td>3</td><td rowspan="3">4</td></tr>
<tr><td>X 58</td><td rowspan="3">2</td><td rowspan="3">2 1/2</td><td rowspan="3">3 1/2</td></tr>
<tr><td>X 48</td></tr>
<tr><td>X 28</td><td rowspan="3">4 1/2</td></tr>
<tr><td>X 21</td><td rowspan="2">2 1/2</td><td rowspan="2">3</td></tr>
<tr><td>X 18</td><td>4</td></tr>
<tr><td>W6 X 25</td><td rowspan="4">1 1/2</td><td>2</td><td>2 1/2</td><td rowspan="2">3 1/2</td><td rowspan="3">4 1/2</td></tr>
<tr><td>X 20</td><td rowspan="4">2 1/2</td><td rowspan="4">3</td></tr>
<tr><td>X 16</td><td rowspan="3">4</td></tr>
<tr><td>X 12</td><td rowspan="2">2</td></tr>
<tr><td>X 9</td><td>5</td></tr>
</table>

1 in = 25.4 mm

Note:

1. The tabulated thicknesses are based upon the assumed properties of normal weight concrete given in Table 709.5.1B.

Table 709.5.1F
Minimum Cover (In) for Steel Columns In Structural Lightweight Precast Covers[1]
(Figure 709.5.1F(a))

<table>
<tr><th rowspan="2">Structural Shape</th><th colspan="5">Fire Resistance Rating (Hours)</th></tr>
<tr><th>1</th><th>1 1/2</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>W14 X233</td><td rowspan="7">1 1/2</td><td rowspan="7">1 1/2</td><td rowspan="4">1 1/2</td><td rowspan="2">2</td><td rowspan="2">2 1/2</td></tr>
<tr><td>X176</td></tr>
<tr><td>X145</td><td rowspan="4">2 1/2</td><td rowspan="3">3</td></tr>
<tr><td>X132</td></tr>
<tr><td>X109</td><td rowspan="3">2</td></tr>
<tr><td>X 99</td><td rowspan="2">3 1/2</td></tr>
<tr><td>X 68</td></tr>
<tr><td>X 43</td><td>3</td></tr>
<tr><td>W12 X190</td><td rowspan="7">1 1/2</td><td rowspan="7">1 1/2</td><td rowspan="4">1 1/2</td><td rowspan="2">2</td><td rowspan="2">2 1/2</td></tr>
<tr><td>X152</td></tr>
<tr><td>X136</td><td rowspan="4">2 1/2</td><td rowspan="3">3</td></tr>
<tr><td>X 106</td></tr>
<tr><td>X 96</td><td rowspan="3">2</td></tr>
<tr><td>X 87</td><td rowspan="2">3 1/2</td></tr>
<tr><td>X 65</td></tr>
<tr><td>X 40</td><td>3</td></tr>
<tr><td>W10 X112</td><td rowspan="7">1 1/2</td><td rowspan="6">1 1/2</td><td rowspan="3">1 1/2</td><td>2</td><td rowspan="3">3</td></tr>
<tr><td>X100</td><td rowspan="4">2 1/2</td></tr>
<tr><td>X 88</td><td rowspan="4">2</td></tr>
<tr><td>X 77</td><td rowspan="3">3 1/2</td></tr>
<tr><td>X 60</td><td rowspan="3">3</td></tr>
<tr><td>X 39</td></tr>
<tr><td>X 33</td><td>2</td></tr>
<tr><td>W8 X 67</td><td rowspan="4">1 1/2</td><td rowspan="3">1 1/2</td><td>1 1/2</td><td rowspan="2">2 1/2</td><td>3</td></tr>
<tr><td>X 48</td><td rowspan="3">2</td><td rowspan="3">3 1/2</td></tr>
<tr><td>X 35</td><td rowspan="3">3</td></tr>
<tr><td>X 28</td><td rowspan="2">2</td></tr>
<tr><td>X 18</td><td>2 1/2</td><td>4</td></tr>
<tr><td>W6 X 25</td><td rowspan="3">1 1/2</td><td rowspan="3">2</td><td>2</td><td rowspan="2">3</td><td>3 1/2</td></tr>
<tr><td>X 15</td><td rowspan="2">2 1/2</td><td rowspan="2">4</td></tr>
<tr><td>X 9</td><td>3 1/2</td></tr>
</table>

1 in = 25.4 mm

Note:

1. The tabulated thicknesses are based upon the assumed properties of structural lightweight concrete given in Table 709.5.1B.

709.5.1.4.6 The fire resistance of structural steel columns protected with concrete masonry units as illustrated in Figure 709.5.1G, may be determined from the following expression:

$$R_o = 2.282\ (A_s/P_s)^{0.7} + \{15.2\ (T_e^{1.6}/K^{0.2})\ \}\ x\ [1.0 + 42.7\ \{\ (A_s/rT_e)\ /\ (L + T_e)\ \}^{0.8}]$$

Where:

R_o = fire resistance rating of steel column at zero moisture content (hours).
A_s = cross-sectional area of steel column (sq ft).
T_e = equivalent thickness of concrete masonry protection (ft).
p = inner perimeter of concrete masonry protection (ft).
P_s = heated perimeter of steel column (ft) = 2d + 4w
d = depth of steel column (ft).
w = width of steel column flange (ft).
r = density of concrete masonry (pcf)
K = ambient thermal conductivity of concrete masonry (Btu/hr/ft ^{O}F).
L = p/4 for square perimeter (ft)

Refer to Note at Figure 709.5.1G for calculation of rectangular box protection: T_e = h

If specific data on the properties of concrete masonry is not available, the values in Table 709.5.1G may be used:

Table 709.5.1G
Properties of Concrete Masonry Units

Density (r) Lb/ft^3	Thermal Conductivity (K) BTU/hr/ft. ^{O}F
80	0.207
85	0.228
90	0.252
95	0.278
100	0.308
105	0.340
110	0.376
115	0.416
120	0.459
125	0.508
130	0.561
135	0.620
140	0.685
145	0.758
150	0.837

1 lb/ft^3 = 16.0185 kg/m^3
1 BTU/hr/ft x ^{O}F = 1.731 W/(m x K)

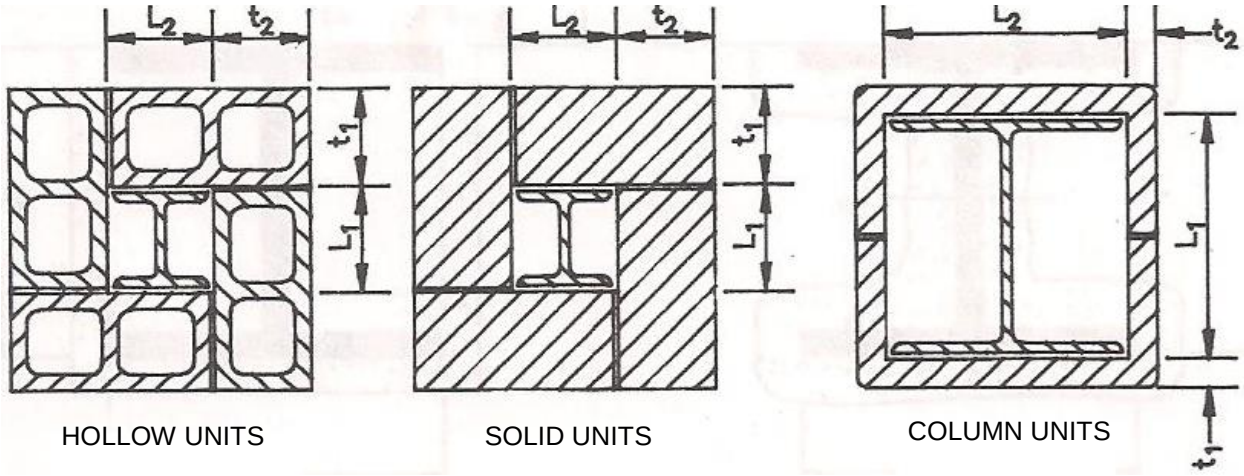


Figure 709.5.1G
Concrete Masonry Protected
Structural Steel Columns[1]

Note:

1. The dimension L in the fire resistance equation shall be the average of L_1 and L_2. The dimension h in the fire resistance equation shall be based on the equivalent thickness of the concrete masonry unit. For solid concrete masonry, h equals the lesser of t_1 or t_2. For hollow concrete masonry, h equals the lesser of t_1 or t_2, times the percent solid of the unit expressed as a decimal.

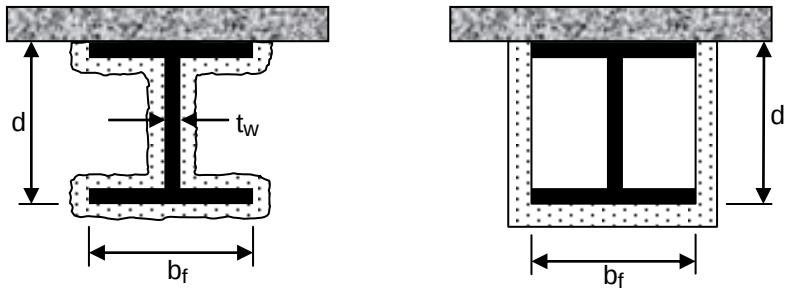
709.5.2 Structural Steel Beams and Girders.

709.5.2.1 Determination of Fire Resistance.

709.5.2.1.1 These procedures establish a basis for determining the fire resistance of structural steel beams and girders which differ in size from that specified in approved fire resistant assemblies as a function of the thickness of fire resistant material and the weight (W) and heated perimeter (D) of the beam or girder. As used in these sections, W is the average weight of a structural steel member in pounds per linear foot. The heated perimeter, D, is the inside perimeter of the fire resistant material in inches as illustrated in Figure 709.5.2.

709.5.2.1.2 The weight to heated perimeter ratios (W/D), for both contour and box fire resistant protection profiles, for the wide flange shapes most often used as beams or girders are given in Table 709.5.2. For different shapes, the weight to heated perimeter ratios (W/D) shall be determined in accordance with the definitions given in this section.

709.5.2.1.3 Except as provided for in 709.5.2.2, structural steel beams in approved fire resistant assemblies shall be considered the minimum permissible size. Other beam or girder shapes may be substituted provided that the weight to heated perimeter ratio (W/D) of the substitute beam is equal to or greater than that of the beam specified in the approved assembly.



$D = 3b_f + 2d - 2t_w$ $D = 2d + b_f$

Figure 709.5.2
Determination of the Heated Perimeters of Structural Steel Beams and Girders

Table 709.5.2
Weighty to Heated Perimeter Ratios (W/D)
For Typical Wide Flange Beam and Girder Shapes

Structural Shape	Contour Profile	Box Profile	Structural Shape	Contour Profile	Box Profile
W36 X300	2.47	3.33	W24 X 84	1.13	1.47
X280	2.31	3.12	X 76	1.03	1.34
X260	2.16	2.92	X 68	0.92	1.21
X245	2.04	2.76	X 62	0.92	1.14
X230	1.92	2.61	X 55	0.82	1.02
X210	1.94	2.45			
X194	1.80	2.28	W21 X147	1.83	2.60
X182	1.69	2.15	X132	1.66	2.35
X170	1.59	2.01	X122	1.54	2.19
X160	1.50	1.90	X111	1.41	2.01
X150	1.41	1.79	X101	1.29	1.84
X135	1.28	1.63	X 93	1.38	1.80
			X 83	1.24	1.62
W33 X241	2.11	2.86	X 73	1.10	1.44
X221	1.94	2.64	X 68	1.03	1.35
X201	1.78	2.42	X 62	0.94	1.23
X152	1.51	1.94	X 57	0.93	1.17
X141	1.41	1.80	X 50	0.83	1.04
X130	1.31	1.67	X 44	0.73	0.92
X118	1.19	1.53			
			W18 X119	1.69	2.42
W30 X211	2.00	2.74	X106	1.52	2.18
X191	1.82	2.50	X 97	1.39	2.01
X173	1.66	2.28	X 86	1.24	1.80
X132	1.45	1.85	X 76	1.11	1.60
X124	1.37	1.75	X 71	1.21	1.59
X116	1.28	1.65	X 65	1.11	1.47
X108	1.20	1.54	X 60	1.03	1.36
X 99	1.10	1.42	X 55	0.95	1.26
			X 50	0.87	1.15
W27 X178	1.85	2.55	X 46	0.86	1.09
X161	1.68	2.33	X 40	0.75	0.96
X146	1.53	2.12	X 35	0.66	0.85
X114	1.36	1.76			
X102	1.23	1.59	W16 X100	1.56	2.25
X 94	1.13	1.47	X 89	1.40	2.03
X 84	1.02	1.33	X 77	1.22	1.78
			X 67	1.07	1.56
W24 X162	1.85	2.57	X 57	1.07	1.43
X146	1.68	2.34	X 50	0.94	1.26
X 131	1.52	2.12	X 45	0.85	1.15
X117	1.36	1.91	X 40	0.76	1.03
X104	1.22	1.71	X 36	0.69	0.93
X 94	1.26	1.63	X 31	0.65	0.83

Table 709.5.2 (Continued)
Weight to Heated Perimeter Ratios (W/D)
For Typical Wide Flange Beam and Girder Shapes

Structural Shape	Contour Profile	Box Profile	Structural Shape	Contour Profile	Box Profile
W16 X 26	0.55	0.70	W10 X 68	1.35	2.20
			X 60	1.20	1.97
W14 X132	1.83	3.00	X 54	1.09	1.79
X120	1.67	2.75	X 49	0.99	1.64
X109	1.53	2.52	X 45	1.03	1.59
X 99	1.39	2.31	X 39	0.94	1.40
X 90	1.27	2.11	X 33	0.77	1.20
X 82	1.41	2.12	X 30	0.79	1.12
X 74	1.28	1.93	X 26	0.69	0.98
X 68	1.19	1.78	X 22	0.59	0.84
X 61	1.07	1.61	X 19	0.59	0.78
X 53	1.03	1.48	X 17	0.54	0.70
X 48	0.94	1.35	X 15	0.48	0.63
X 43	0.85	1.22	X 12	0.38	0.51
X 38	0.79	1.09			
X 34	0.71	0.98	W8 X 67	1.61	2.55
X 30	0.63	0.87	X 58	1.41	2.26
X 26	0.61	0.79	X 48	1.18	1.91
X 22	0.52	0.68	X 40	1.00	1.63
			X 35	0.88	1.44
W12 X 87	1.44	2.34	X 31	0.79	1.29
X 79	1.32	2.14	X 28	0.80	1.24
X 72	1.20	1.97	X 24	0.69	1.07
X 65	1.09	1.79	X 21	0.66	0.96
X 58	1.08	1.69	X 18	0.57	0.84
X 53	0.99	1.55	X 15	0.54	0.74
X 50	1.04	1.54	X 13	0.47	0.65
X 45	0.95	1.40	X 10	0.37	0.51
X 40	0.85	1.25			
X 35	0.79	1.11	W6 X 25	0.82	1.33
X 30	0.69	0.96	X 20	0.67	1.09
X 26	0.60	0.84	X 16	0.66	0.96
X 22	0.61	0.77	C 15	0.51	0.83
X 19	0.53	0.67	X 12	0.51	0.75
X 16	0.45	0.57	X 9	0.39	0.57
X 14	0.40	0.50			
			W5 X 19	0.76	1.24
W10 X112	2.14	3.38	X 16	0.65	1.07
X100	1.93	3.07			
X 88	1.72	2.75	W4 X 13	0.65	1.05
X 77	1.52	2.45			

709.5.2.2 Spray-Applied Fire Protection

709.5.2.2.1 The provisions in this section apply to structural steel beams and girders protected with spray applied cementitious or mineral fiber materials. Larger or smaller beam and girder shapes may be substituted for beams specified in approved fire resistant assemblies provided that the thickness of fire protection material is adjusted in accordance with the following expression:

$$h_2 = \left[\frac{W_1 / D_1 + 0.60}{W_2 / D_2 + 0.60} \right] h_1$$

Where h = thickness of spray-applied fire protection in inches,
W = weight of the structural steel beam or girder in pounds per linear foot, and
D = heated perimeter of the structural steel beam or girder in inches.

Subscript 1 refers to the beam and fire protection thickness in the approved assembly.

Subscript 2 refers to the substitute beam or girder and the required thickness of fire protection material.

709.5.2.2.2 The equation in 709.5.2.2.1 is limited to beams with a weight to heated perimeter ratio (W/D) of 0.37 or greater. The minimum thickness of protection shall not be less than 3/8 inch (9.5 mm).

709.5.2.3 Structural Steel Trusses. The fire resistance of structural steel trusses protected with cementitious or mineral fiber materials spray-applied to each of the individual truss elements may be determined in accordance with this section. The thickness of protection shall be determined in accordance with 709.5.1.3. The weight to heated perimeter ratio (W/D) of truss elements which can be simultaneously exposed to fire on all sides shall be determined on the same basis as columns, as specified in 709.5.1.1. The weight to heated perimeter ratio (W/D) of truss elements which directly support floor or roof construction shall be determined on the same basis as beams and girders, as specified in 709.5.2.1.

709.5.2.4 Determining Conditions of Restraint. Floor and roof assemblies and individual beams in buildings shall be considered restrained when their surrounding or supporting structure is capable of resisting substantial thermal expansion throughout the range of anticipated elevated temperatures. Construction not complying with this definition is assumed to be free to rotate and expand and shall therefore be considered as unrestrained.

709.6 Wood Assemblies

709.6.1 General.

709.6.1.1 This section contains procedures for calculating the fire resistance ratings of walls, floor/ceiling and roof/ceiling assemblies based in part on the standard method of testing referenced in 701.

709.6.1.2 Fire resistance ratings calculated using the procedures in this section shall be used only for 1-hour rated assemblies.

709.6.1.3 When dissimilar membranes are used on a wall assembly, the calculation shall be made from the least fire resistant (weaker) side.

709.6.2 Walls, Floors and Roofs.

709.6.2.1 These procedures apply to both loadbearing and nonloadbearing assemblies.

709.6.2.2 The fire resistance rating of a wood framed assembly is equal to the sum of the time assigned to the membrane on the fire-exposed side, the time assigned to the framing members and the time assigned for additional contribution by other protective measures such as insulation. The membrane on the unexposed side shall not be included in determining the fire resistance of the assembly.

709.6.2.3 Table 709.6.2A gives the time assigned membranes on the fire-exposed side.

709.6.2.4 For an exterior wall having more than 5 ft (1524 mm) of horizontal separation, the wall is assigned a rating dependent on the interior membrane and the framing as described in Tables 709.6.2A and 709.6.2B. The membrane on the outside or nonfire-exposed side of exterior walls having more than 5 ft (1524 mm) of horizontal separation may consist of sheathing, sheathing paper, and siding as described in Table 709.6.2C.

709.6.2.5 In the case of a floor or roof, the standard test provides only for testing for fire exposure from below. Except as noted in 701.5.3, floor or roof assemblies of wood framing shall have an upper membrane consisting of a subfloor and finish floor conforming to Table 709.6.2D or any other membrane that has a contribution to fire resistance of at least 15 minutes in Table 709.6.2A.

709.6.2.6 Table 709.6.2E gives the time increments that can be added to the fire resistance when glass fiber rockwool or slag mineral wool insulation is incorporated in the assembly.

709.6.2.7 Fastening of wood framed assemblies and the fastening of membranes to the wood framing members shall be done in accordance with Table 2306.1 and 2504.4.1.

Table 709.6.2A
Time Assigned to Wallboard Membranes[1,2]

Description of Finish	Time, Min.
3/8-inch plywood bonded with exterior glue	5
15/32-inch plywood bonded with exterior glue	10
19/32-inch plywood bonded with exterior glue	15
3/8-inch gypsum wallboard	10
1/2-inch gypsum wallboard	15
5/8-inch gypsum wallboard	30
1/2-inch type X gypsum wallboard	25
5/8-inch type X gypsum wallboard	40
Double 3/8-inch gypsum wallboard	25
1/2 + 3/8-inch gypsum wallboard	35
Double 1/2-inch gypsum wallboard	40

1 in = 25.4 mm

Notes:

1. These values apply only when membranes are installed on framing members which are spaced 16 inches o.c.
2. Gypsum wallboard installed over framing or furring shall be installed so that all edges are supported, except 5/8-inch Type X gypsum wallboard may be installed horizontally with the horizontal joints staggered 24 inches each side and unsupported but finished.
3. On wood framed floor/ceiling or roof/ceiling assemblies, gypsum board shall be installed with the long dimension perpendicular to framing members and shall have all joints finished.

Table 709.6.2B
Time Assigned for Contribution of Wood Frame[1,2]

Description of Finish	Time Assigned to Frame, Min.
Wood studs 16 inches o.c.	20
Wood floor and roof joists 16 inches o.c.	10

1. This table does not apply to studs or joists spaced more than 16" o.c (406 mm).
2. All studs shall be nominal 2x4 and all joists shall have a nominal thickness of at least 2 inches (51 mm).
3. Allowable spans for joists shall be determined in accordance with 2307.3.1 and 2309.3.1.

Table 709.6.2C
Membrane[1] on Exterior Face of Wood Stud Walls

Sheathing	Paper	Exterior Finish
5/8-in T & G lumber		Lumber siding
5/16-in exterior glue plywood	Sheathing paper	Wood shingles and shakes
1/2-in gypsum wallboard		1/4-in wood structural panels exterior type
5/8-in gypsum wallboard		1/4-in hardboard
1/2-in fiberboard		Metal siding
		Stucco on metal lath
		Masonry veneer
None		3/8-in exterior grade wood structural panels

1 in = 25.4 mm

Notes:

1. Any combination of sheathing, paper and exterior finish listed may be used.

Table 709.6.2D
Flooring or Roofing Over Wood Framing[1]

Assembly	Structural Members	Subfloor or Roof Deck	Finish Flooring or Roofing
Floor	Wood	15/32-in. wood structural panels or 11/16-in T&G softwood	Hardwood or softwood flooring on building paper. Resilient flooring, parquet floor felted-synthetic-fiber floor coverings, carpeting, or ceramic tile on 3/8-in thick panel-type underlay. Ceramic Tile on 1 1/4-in mortar bed.
Roof	Wood	15/32-in wood structural panels or 11/16-in T&G softwood	Finish roofing material with or without insulation

1 in = 25.4 mm

Notes:

1. This table applies only to wood joist construction. It is not applicable to wood truss construction.

TABLE 709.6.2E
TIME ASSIGNED FOR ADDITIONAL PROTECTION

Description of Additional Protection	Fire Resistance, Min.
Add to the fire resistance rating of wood stud walls if the spaces between the studs are completely filled with glass fiber mineral wool batts weighing not less than 2 lb/cu ft (0.6 lb/sq ft of wall surface) or rockwool or slag mineral wool batts weighing not less than 3.3 lb/cu ft (1 lb/sq ft of wall surface).	15

1 lb/cu ft = 16.0185 kg/m^3

709.6.3 Design Of Fire-Resistant Exposed Wood Members

709.6.3.1 The fire resistance rating, in minutes, of timber beams and columns with a minimum nominal dimension of 6 inches is equal to:

Beams: (1) 2.54Zb (4 - 2(b/d)) for beams which may be exposed to fire on four sides.
(2) 2.54Zb (4 - (b/d)) for beams which may be exposed to fire on three sides,

Columns: (3) 2.54Zd (3 - (d/b)) for columns which may be exposed to fire on four sides.
(4) 2.54Zd (3 - (d/2b)) for columns which may be exposed to fire on three sides.

Where: b = the breadth (width) of a beam or larger side of a column before exposure to fire, inches.
d = the depth of a beam or smaller side of a column before exposure to fire, inches.
Z = load factor, based on Figure 709.6.3A

709.6.3.2 Formula (4) above applies only where the unexposed face represents the smaller side of the column. If a column is recessed into a wall, its full dimension shall be used for the purpose of these calculations.

709.6.3.3 Allowable loads on beams and columns are determined using design values given in Design Values for Wood Construction, a supplement to the National Design Specification for Wood Construction.

709.6.3.4 Where minimum 1-hour fire resistance is required, connectors and fasteners shall be protected from fire exposure by 1 1/2 inches (38 mm) of wood, or other approved covering or coating for a 1-hour rating. Typical details for commonly used fasteners and connectors are shown in AITC Technical Note No.7.

709.6.3.5 Wood members are limited to dimensions of 6 inches nominal or greater. Glued laminated timber beams utilize standard laminating combinations except that a core lamination is removed. The tension zone is moved inward and the equivalent of an extra nominal 2-inch thick outer tension lamination is added.

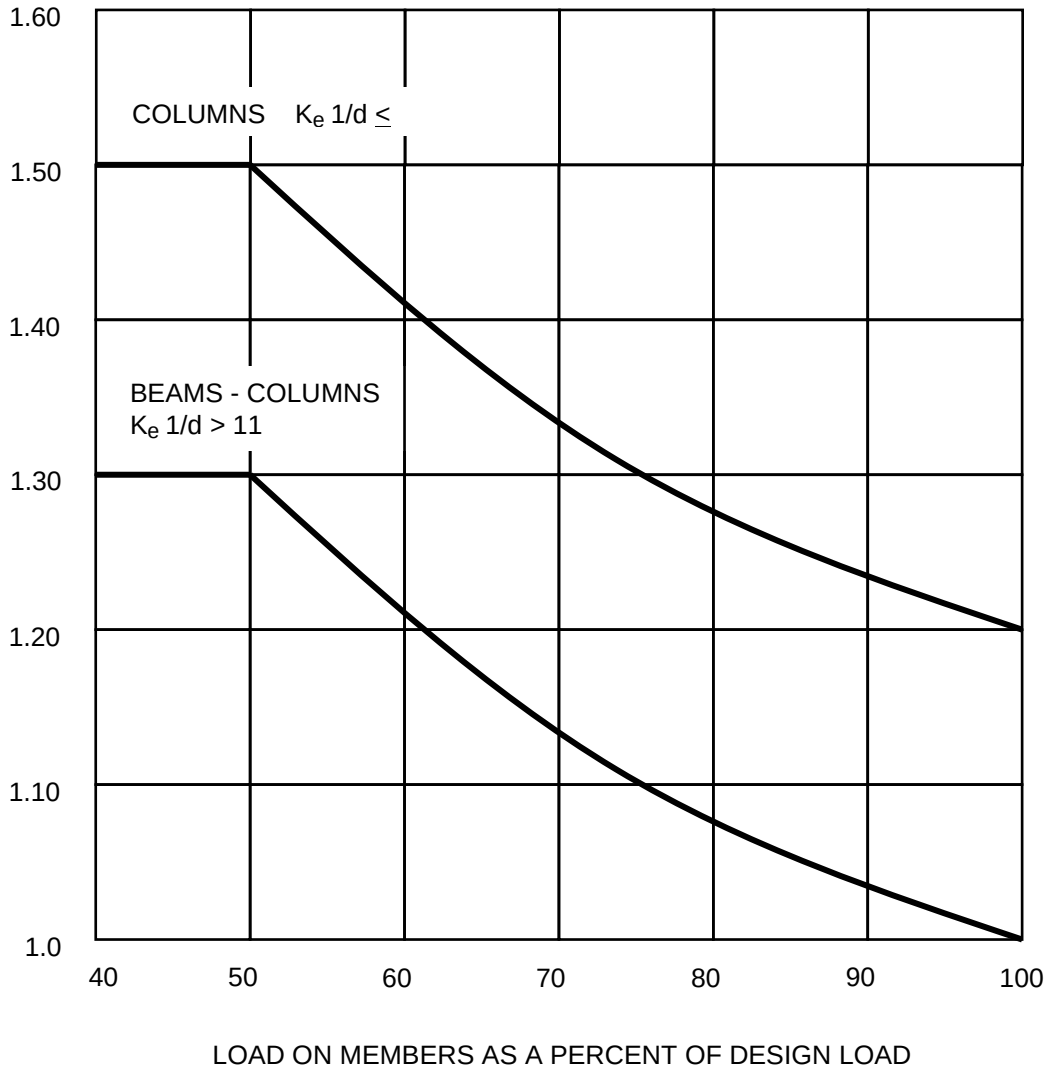


Figure 709.6.3A
Load Factor

K_e = the effective length factor as noted in Figure 709.6.3B.
l = the unsupported length of columns, inches.

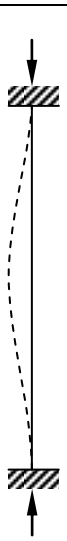
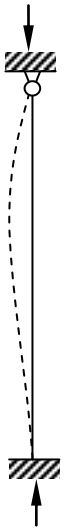
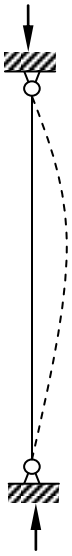
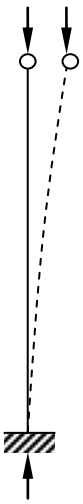
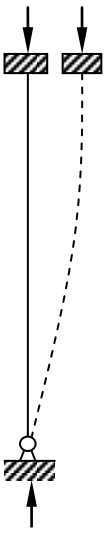
BUCKLING MODES						
THEORETICAL K_e VALUE	0.5	0.7	1.0	1.0	2.0	2.0
RECOMMENDED DESIGN K_e WHEN IDEAL CONDITIONS APPROXIMATED	0.65	0.80	1.2	1.0	2.10	2.4
END CONDITION CODE		ROTATION FIXED, TRANSLATION FIXED				
		ROTATION FREE, TRANSLATION FIXED				
		ROTATION FIXED, TRANSLATION FREE				
		ROTATION FREE, TRANSLATION FREE				

Figure 709.6.3B
Effective Length Factors

709.7 Other Reference Documents

Refer to 701.4.2 and NBS BMS 71, NBS Fire Tests of Building Columns, and NBS TRBM-44 for fire resistance ratings of materials and assemblies.

CHAPTER 8

INTERIOR FINISHES

801 GENERAL

802.1 Scope

Provisions of this chapter shall govern the use of materials as interior finishes by limiting the allowable flamespread and smoke development based on location and occupancy classification.

802 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

803 RESTRICTIONS ON INTERIOR FINISHES

803.1 General

803.1.1 Combustible materials may be used as a finish for ceilings, floors and other interior surfaces of buildings as provided in this section. Show windows in the first story of buildings may be of wood or of unprotected metal framing.

803.1.2 Interior finish shall mean the exposed interior surfaces of buildings including, but not limited to, fixed or movable walls and partitions, columns, and ceilings, interior wainscoting, paneling or other finish applied structurally or for decoration, acoustical correction, surface insulation, structural fire resistance or similar purposes. 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 (0.9 mm) thick cemented to the surface of walls or ceilings, when these materials have flamespread characteristics no greater than paper of this thickness cemented to a noncombustible or fire retardant treated wood backing.

803.2 Classification

Interior finish materials other than those applied to floors shall be classified in accordance with ASTM E 84. Such interior finish materials shall be grouped in the following classes in accordance with their flamespread and smoke development:

1. Class A Interior Finish. Flamespread 0-25, Smoke Developed 0-450. Any element thereof when so tested shall not continue to propagate fire.
2. Class B Interior Finish. Flamespread 26-75, Smoke Developed 0-450.
3. Class C Interior Finish. Flamespread 76-200, Smoke Developed 0-450.

803.3 Interior Finish Requirements Based on Occupancy

803.3.1 The minimum flamespread classification of interior finish other than floor finish and floor coverings shall be based on the use or occupancy as set forth in Table 803.3.

EXCEPTIONS:

1. Except in Group I occupancies and in enclosed vertical exits, Class C interior finish material may be used in access to exits and other spaces as wainscoting extending not more than 48 inches (1219 mm) above the floor and for tack and bulletin boards covering not more than 5% of the gross wall area of the room. In Group I occupancies, Class B interior finish material may be used in access to exits as wainscoting extending not more than 48 inches (1219 mm) above the floor.
2. The exposed faces of Type III structural members, including decking and planking, where otherwise permitted by this code, are excluded from flamespread requirements.

Table 803.3
Minimum Interior Finish Classification

Occupancy	Unsprinklered			Sprinklered		
	Exits[1]	Exit Access	Other Spaces	Exits[1]	Exit Access	Other Spaces
A	A	A	B	B	C	C
B	B	B	C	C	C	C
E	A	B	C	B	C	C
F	C	C	C	C	C	C
H	Sprinklers required			B	C	C
I Restrained	A	A	C	A	A	C
I Unrestrained	Sprinklers required			B	B	B[3]
M	B	B	C	C	C	C
R[2]	B	B	C	C	C	C
S	C	C	C	C	C	C

Notes:

1. In vertical exitways of buildings three stories or less in height of other than Group I Restrained, the interior finish may be Class B for unsprinklered buildings and Class C for sprinklered buildings.
2. Class C interior finish materials may be used within a dwelling unit.
3. Rooms with 4 or less persons require Class C interior finish.

803.3.2 For churches or places of worship, nothing in this section shall prevent the use of wood for ornamental purposes, trusses, paneling, or chancel furnishing.

803.3.3 Imitation leather or other material, consisting of, or coated with a pyroxylin or similarly hazardous base, shall not be used in Group A occupancies.

803.4 Foam Plastics

Foam plastics shall not be used as interior finish.

EXCEPTION: Foam plastic trim, defined as picture molds, chair rails, baseboards, handrails, ceiling beams, door trim and window trim shall be permitted to be used provided:

1. The minimum density is 20 lb/cu ft (320 kg/m^3).
2. The maximum thickness of the trim is 1/2 inch (12.7 mm) and the maximum width is 4 inches (102 mm).
3. The trim constitutes no more than 10% of the area of any wall or ceiling.
4. The flamespread rating does not exceed 75 when tested per ASTM E 84. The smoke developed rating is not limited.

803.5 Carpet on Walls and Ceilings

803.5.1 Textile materials having a napped, tufted, looped, woven , nonwoven, or similar surface may be used as interior finish on ceilings only when said materials have a flamespread rating of 25 or less in accordance with ASTM E 84.

803.5.2 Textile wall coverings, including materials such as those having a napped, tufted, looped, nonwoven, woven or similar surface, shall comply with one of the following:

1. Textile wallcoverings shall have a flamespread rating of 25 or less in accordance with ASTM E 84 and shall be protected by automatic sprinklers, or

2. Textile wallcoverings shall meet the acceptance criteria of SBCCI Standard Test Method for Evaluating Room Fire Growth Contribution of Textile Wallcovering when tested using the product mounting system, including adhesive, of actual use.

803.6 Floor Finish

803.6.1 In buildings of Type I or Type II construction, floor finish, if of combustible material, shall be applied directly upon the floor construction, except that a floor finish of wood, linoleum, rubber, tile or cork may be secured to a subfloor of wood. Where wood sleepers are used for laying wood floors or subfloors in such buildings, they shall be fireblocked so that there will not be an open space extending under any permanent partition. Where wood sleepers are used and the space between the floor slab and the underside of the floor or subfloor is more than 2 l/2 inches (64 mm), such space shall be filled with noncombustible material so that such space is not more than 2 1/2 inches (64 mm).

803.6.2 Combustible insulating boards may be used for sound deadening or insulating of floors, except that in buildings required to be of Type I or Type II construction, such insulating board shall not be more than 1/2 inch (12.7 mm) thick and cemented directly to the floor slab or secured to wood sleepers fireblocked as called for above and covered with approved finish flooring.

803.7 Floor Covering

803.7.1 Finished floors or floor covering materials of a traditional type, such as wood, vinyl, linoleum, terrazzo and other resilient floor covering materials, are exempt from the requirements of this section. Carpet type floor coverings shall be tested as proposed for use including underlayment.

803.7.2 Carpet materials used on floors of exit access corridors and enclosed exits in other than Group I occupancies shall satisfactorily withstand a minimum critical radiant flux of 0.22 watts/sq cm when tested in accordance with the NFiPA 253.

EXCEPTION: Buildings equipped with an approved automatic sprinkler system.

803.7.3 Interior floor finish materials used on floors of exit access corridors and enclosed exits in Group I occupancies shall satisfactorily withstand a minimum critical radiant flux of 0.45 watts/sq cm when tested in accordance with the NFiPA 253.

803.7.4 All carpet required by this code to meet critical radiant flux limits established by NFiPA 253 shall have been tested by an approved laboratory. A copy of the test report representing the style shall be provided to the building official upon request. The test report shall identify the carpet by manufacturer or supplier and style name and shall be representative of the current construction of the carpet.

803.7.5 The carpet shall be identified by a hang tag or other suitable method as to identify manufacturer or supplier and style and shall indicate the critical radiant flux level.

803.8 Application of Interior Finish

803.8.1 When walls and ceilings are required by any provision in this code to be of fire resistant, noncombustible, or fire retardant treated wood construction and the finish material is applied to furring strips not exceeding 1 3/4-inch (44 mm) thick applied directly against such surfaces, the intervening spaces between such furring strips shall be filled with inorganic or Class A materials or shall be fireblocked not to exceed 8 ft (2438 mm) in any direction.

803.8.2 Where walls and ceilings are required to be of fire resistant, noncombustible, or fire retardant treated wood construction and walls are set out or ceilings are dropped distances greater than specified in 803.8.1, Class A finish materials shall be used except where the finish materials are protected on both sides by automatic fire extinguishing systems or are attached to a noncombustible or fire retardant treated wood backing or to furring strips installed as specified in 803.8.1. The hangers and assembly members of such dropped ceilings that are below the main ceiling line shall be of noncombustible or fire retardant treated wood materials.

803.8.3 Wall and ceiling finish materials of all Class A, B or C materials, as permitted, may be installed directly against the wood decking or planking of heavy timber construction or to wood furring strips applied directly to the wood decking or planking installed and firestopped as specified in 803.8.1.

803.8.4 Interior finish materials shall be cemented or otherwise fastened in place so that they will not readily become detached when subjected to room temperatures of 300°F (149°C) for 25 minutes.

803.9 Interior Plastic Signs

Applications using approved plastic interior signs shall comply with 2604.15. Applications using approved plastic interior signs in covered mall buildings shall comply with 413.13.

804 ACOUTICAL CEILING SYSTEMS

804.1 General

The quality, design, fabrication and erection of metal suspension systems for acoustical tile and lay-in panel ceilings in buildings or structures shall conform to good engineering practice, the provisions of this chapter and other applicable requirements of this code.

804.2 Materials and Installation

804.2.1 Acoustical materials complying with the interior finish requirements of 803 shall be installed in accordance with the manufacturer's recommendations and applicable provisions for applying interior finish.

804.2.2 Suspended acoustical ceiling systems shall be installed in accordance with the provisions of ASTM C 635 and ASTM C 636.

804.2.3 Acoustical ceiling systems which are part of a fire resistant construction shall be installed in the same manner used in the assembly tested and shall comply with the provisions of 701 of this code. If the weight of lay-in ceiling panels, used as a part of fire resistant floor/ceiling or roof/ceiling assemblies, is not adequate to resist an upward force of 1 psf (48 Pa), wire or other approved devices shall be installed above the panels to prevent upward displacement under such upward force.

CHAPTER 9

FIRE PROTECTION SYSTEMS

901 GENERAL

901.1 Scope

Provisions of this chapter shall govern the application, design, installation, testing and maintenance of automatic sprinklers, standpipes and fire alarms. For the purpose of this code, sprinkler systems meeting the following standards shall be considered meeting sprinkler requirements of this Code:

1. NFiPA 13D for townhouses.
2. NFiPA 13R for Group R1 and Group R2.
3. NFiPA 13 for all other buildings.

902 DEFINITIONS

The following words and terms shall, for the purposes of this chapter and as stated elsewhere in this code, have the meanings shown herein. Refer to Chapter 2 for general definitions.

ALARM INDICATING APPLIANCE – an electro-mechanical appliance that converts energy into audible or visible form for perception as an alarm signal.

FIRE ALARM BOX, MANUAL – a manually operated, alarm initiating device that activates a fire protective signaling system.

FIRE DETECTION SYSTEM, AUTOMATIC – a fire protective signaling system containing automatic detecting devices that activate a fire alarm signal.

FIRE PROTECTIVE SIGNALING SYSTEM – electrically operated circuits, instruments, and devices, together with the necessary electrical energy, designed to transmit alarms, supervisory, and trouble signals necessary for the protection of life and property.

SMOKE DETECTOR – an approved listed detector sensing either visible or invisible particles of combustion.

SMOKE DETECTOR, MULTIPLE-STATION – single-station smoke detectors which are capable of being interconnected such that actuation of one causes all integral or separate audible alarms to operate.

SMOKE DETECTOR, SINGLE-STATION – an assembly incorporating the detector, control equipment and alarm sounding device in one unit, which is operated from a power supply either in the unit, or obtained at the point of installation.

STANDPIPE – an arrangement of piping, valves, hose outlets and allied equipment installed in a building or structure with outlets located in such a manner that water can be discharged through hose and nozzles for the purpose of extinguishing a fire. Standpipes are classified as either one of four types as follows:

Class I – for use by fire departments and those trained in handling heavy fire streams (2 1/2-inch (64 mm) hose).

Class II – for use primarily by the building occupants until the arrival of the fire department (1 1/2-inch (38 mm) hose).

Class III – for use by either fire departments and those trained in handling heavy hose streams (2 1/2-inch (64 mm) hose) or by the building occupants (1 1/2-inch (38 mm) hose).

Combined Systems – one where the water piping serves both 2 1/2-inch (64 mm) outlet for fire department use and outlets for automatic sprinklers.

STANDPIPE, DRY – a system having no permanent water supply. A filled standpipe having a small water supply connection to keep the piping full but requiring water to be pumped into the system shall be considered a dry standpipe.

STANDPIPE, WET – a system having supply valve open and water pressure maintained at all times.

903 SPRINKLERS

903.1 Approved Equipment and Layout

Only approved sprinklers and devices shall be used in automatic sprinkler systems and the complete layout of the system shall be submitted to the building official for approval before installation.

903.2 Requirements

Every automatic sprinkler system required by this code shall conform to NFiPA 13, (as modified by NFiPA 231 and NFiPA 231C, except that a single water supply of adequate pressure, capacity and reliability, equal to the primary supply required by those standards, may be permitted by the building official). Automatic sprinkler systems installed in lieu of or as an alternate to other requirements, as permitted by this code, shall be considered required systems and shall comply with NFiPA 13.

903.3 Material

Piping shall be as specified in NFiPA 13, 13D, or 13R.

903.4 Hose Threads

All hose threads in connections shall be uniform with that used by the fire department of the applicable governing body.

903.5 General

Approved automatic sprinkler equipment meeting the requirements of 903 shall be installed in buildings as follows:

1. Basements having floor areas exceeding 2,500 sq ft (232 m^2)when used as workshops or for manufacture, repair, sale or storage of combustible materials or when used as lounges or nightclubs regardless of the size. See 503.4.1, Exception 2.
2. In buildings which do not have suitable access, as set forth in 1405, to each story above grade on at least one accessible side of the building. Openings which are glazed with security glazing designed to withstand breakage shall not be considered as access openings.
3. See Chapter 36, Standard Fire Prevention Code.
4. See 407.3.1, 411.7.6 and 411.7.7.
5. Spray finishing booth, area or room shall comply with Chapter 10 of the Standard Fire Prevention Code.

903.6 Garages

Approved automatic sprinkler systems shall be provided in the following garages:

1. Enclosed parking garages over 65 ft (19.8 m) high and exceeding 10,000 sq ft (929 m^2) per floor.
2. Repair garages two stories or more high, and exceeding 10,000 sq ft (929 m^2) in a single floor area.
3. One story repair garages exceeding 15,000 sq ft (1394 m^2).

4. Basement garages or repair garages in a basement.

   EXCEPTION: Group R3 occupancies.

5. Garages used for the storage of commercial trucks and having an area exceeding 5,000 sq ft (465 m^2).
6. Bus garages when used as passenger terminals for four or more buses or when used for bus storage or loading of four or more buses.

903.7 Other Occupancy Sprinkler Requirements

903.7.1 Group M. An approved automatic sprinkler system shall be provided in stores and similar occupancies where stocks of combustible materials are on display for public sale and where the story floor area exceeds 15,000 sq ft (1394 m^2).

903.7.2 Group A

901.7.2.1 An approved automatic sprinkler system shall be provided in Group A-1 occupancies over areas which could be used for the display, sale or storage of combustible materials when such display, sale or storage floor area exceeds 15,000 sq ft (1394 m^2).

903.7.2.2 Stages shall be provided with an approved automatic sprinkler system. Such sprinklers shall be provided throughout the stage and in dressing rooms, workshops, storerooms, and other accessory spaces contiguous to such stages.

EXCEPTIONS:

1. Sprinklers are not required where stages are 1,000 sq ft (93 m^2) or less in area and 50 ft (15.2 m) or less in height and curtains, scenery, or other combustible hangings are not retractable vertically. Combustible hangings shall be limited to a single main curtain, borders, legs, and a single backdrop.
2. Sprinklers are not required under stage areas less than 4ft (1219 mm) in clear height used exclusively for chair or table storage and lined on the inside with 5/8 inch (15.9 mm) Type X gypsum wallboard or approved equal.

903.7.3 High-Piled Combustible Stock. An approved automatic sprinkler system shall be provided throughout buildings required to have sprinkler protection by Chapter 36 of the Standard Fire Prevention Code.

EXCEPTION: Automatic sprinkler systems may be provided only in the storage area of the building when the storage is separated from the remainder of the building by a minimum 2-hour fire resistant separation.

903.7.4 Hazardous Production Material (HPM) Facility. An approved automatic sprinkler system shall be provided throughout buildings containing Group H (HPM) facilities as defined in 408, shall be designed in accordance with NFiPA 13 and not less than that required for the special fire hazard areas shown in Table 903.7.4.

Table 903.7.4
Hazardous Production Material Facilities
Special Fire Hazard Area Requirements

Location	NFiPA Hazard Group
Fabrication Areas	Ordinary Hazard Group 2
HPM Service Corridors	Ordinary Hazard Group 2
HPM Separate Inside Storage Rooms Without Dispensing	Ordinary Hazard Group 2
HPM Separate Inside Storage Rooms With Dispensing	Extra Hazard Group 2
Exit Access Corridors	Ordinary Hazard Group 2

903.7.5 Group R1 - Residential Occupancy. An approved automatic sprinkler system shall be provided throughout Group R1 occupancies three or more stories in height.

EXCEPTIONS: An automatic sprinkler system shall not be required when exterior exitway stairs complying with 1006.2 are provided for guest rooms.

903.7.6 Group R 2 - Residential Occupancy. An approved automatic sprinkler system shall be provided throughout Group R2 occupancies three or more stories in height.

EXCEPTIONS:

1. Three story buildings which are not required to have an automatic sprinkler system by other provisions of the code and provided with exterior exitway stairs complying with 1006.2.
2. An automatic sprinkler system complying with NFiPA 13R shall be permitted for buildings not exceeding four stories in height.

903.8 Supervision

903.8.1 Where an automatic sprinkler system is provided either as a requirement or as an alternate to another requirement of this code, the system shall be supervised by one of the following methods:

1. Approved central station system in accordance with NFiPA 72;
2. Approved proprietary or remote central station system, or an approved supervisory service in accordance with NFiPA 72 which will cause the actuation of an audible appliance at a constantly attended location.

   EXCEPTION: Supervisory facilities in accordance with 903.8 shall not be required for extinguishing systems in R-2 occupancies.

903.8.2 In HPM Facilities, as defined in 408, all valves shall be provided with supervisory tamper switches. In addition to the requirement of 903.8.1, the closing of a valve shall activate an audible and visual signal at the emergency control station.

903.8.3 When a building fire protective signaling system is provided, actuation of the sprinkler system shall cause the building alarm to sound.

903.9 Group R2 Multi-family Dwellings

903.9.1Townhouses

903.9.1.1 Townhouses provided with an automatic sprinkler system complying with NFiPA 13D installed to prevent freezing of piping and accessories with a local water flow alarm and approved fire department connection on each unit, shall be accepted as meeting all the requirements of this Code for sprinklered buildings.

903.9.1.2 The separation between townhouses listed in 704.4 shall be reduced to one hour.

903.9.2 R-2 Type VI Unprotected Sprinklered Buildings

903.9.2.1 The provisions of Section 503.3 shall not apply.

903.9.2.2 Building story height listed in Table 500 mat be increased to three stories. For single exit provisions, see 410.2.5.

903.9.2.3 The tenant separations required by 704.3.1 and all walls and ceilings shall be a minimum of 1/2 inch fire rated gypsum wallboard.

EXCEPTION: Interior non-load bearing walls may be constructed of any material permitted by this code.

903.9.2.4 The finish grade required for emergency access listed in Section 410.2.1 shall be waived.

903.9.2.5 The exterior storage room protection listed in Section 410.2.2 shall be waived when the storage room is sprinklered.

903.9.2.6 The soffit protection listed in Section 410.2.3 shall be waived.

903.9.2.7 The two levels above grade limitation for a sleeping room on a mezzanine listed in Section 1005.6.3(4) will be increased to 4 levels above grade, provided a window in compliance with 1005.4.2 and 1005.4.3 and a smoke detector connected to the main level smoke detector(s) are provided.

904 STANDPIPES

904.1 Approval

904.1.1 Unless otherwise provided herein, standpipe system design, installation and testing requirements shall comply with NFiPA 14.

904.1.2 The complete layout of the standpipe and hose system shall be submitted to the building official and/or fire official before installation.

904.2 Type of System

Standpipe systems shall be one of the following types:

1. Wet standpipe system having supply valve open and water pressure maintained at all times.
2. Dry standpipe system so arranged through the use of approved devices as to admit water to the system automatically by opening a hose valve.
3. Dry standpipe system arranged to admit water to the system through manual operation of approved remote control devices located at each hose station.

904.3 Where Required

904.3.1 Standpipes shall be provided in all buildings in which the highest floor is greater than 30 ft (9144 mm) above the lowest level of fire department vehicle access.

EXCEPTION: Standpipes are not required in Group R3 buildings.

904.3.2 Stages greater than 1,000 sq ft (93 m^2) in area shall be provided with a standpipe on each side of the stage.

904.3.3 Covered malls shall be provided with standpipe connections in accordance with 413.9.

904.3.4 Standpipes shall be provided in public assembly halls more than 5,000 sq ft (165 m^2) in area used for exhibition or display purposes.

904.3.5 Standpipes shall be provided in nonsprinklered Group A buildings having an occupant load exceeding 1,000 persons.

904.3.6 Standpipes shall be provided in buildings in which the highest floor is 30 ft (9144 mm) or less above the lowest level of fire department vehicle access and exceeding 10,000 sq ft (929 m^2) in area per story when any portion of the building's interior area is more than 200ft (61 m) of travel from the nearest point of fire department vehicle access.

EXCEPTIONS:

1. Standpipes are not required in Group R2 with 8 units or less, R3 and S2 occupancies.
2. Standpipes are not required in buildings protected throughout with automatic sprinkler installed in accordance with NFiPA 13.

904.4 Class and Type System

904.4.1 Standpipes required by 904.3.1 and 904.3.5 shall be Class I wet standpipes.

EXCEPTIONS·

1. Buildings without approved automatic sprinkler protection shall be permitted to use any Class I standpipe system listed in 904.2 if the highest floor surface used for human occupancy is 75 ft (22.9 m) or less above the lowest level of fire department vehicle access.
2. Buildings protected with an approved automatic sprinkler system shall be permitted to use any Class I standpipe system listed in 904.2 if the highest floor surface used for human occupancy is 75 ft (22.9 m) or less above the lowest level of fire department vehicle access.

904.4.2 Standpipes required by 904.3.2 shall be Class I or Class III wet standpipes.

904.4.3 Standpipes required by 904.3.4 shall be Class I or Class II wet standpipes.

904.4.4 Standpipes required by 904.3.6 shall be Class I dry filled standpipes having a small water supply connection to keep the piping full but requiring water to be pumped into the system for firefighting purposes or any Class I standpipe permitted by 904.2.

904.4.5 In buildings requiring standpipes in accordance with 904.3, dry standpipes may be installed when in the opinion of the building official and the fire official, a constant and automatic water supply is not necessary.

904.5 Hose Connection Location

Hose connections for standpipes shall be in accordance with NFiPA 14.

904.6 Standpipes During Construction

See 3311.3 for requirements.

904.7 Supervisory Facilities

Where a building fire protective signaling system is provided, the closing of any standpipe water supply valve including any valves associated with a fire pump installation shall cause an audible supervisory signal to sound at the fire alarm annunciator or at a constantly attended location. If the building does not have a fire protective signaling system, locks shall be provided on all valves and shall be of a type acceptable to the building official.

904.8 Water Supply

904.8.1 Standpipe piping may be used to supply water for automatic sprinkler systems.

904.8.2 For nonsprinklered buildings, and sprinklered buildings having floor surfaces used for human occupancy located more than 75 ft (22 9 m) above the lowest level of fire department vehicle access, the water supply shall meet the requirements of NFiPA 14.

904.8.3 For sprinklered buildings having floor surfaces used for human occupancy located 75 ft (22.9 m) or less above the lowest level of fire department vehicle access, required water supply shall meet minimum water pressure requirements of NFiPA 13 and shall be:

1. 500 GPM (31.6 L/s) for light hazard occupancy as defined in NFiPA 13.
2. 1,000 GPM (63.1 L/s) for ordinary hazard occupancy as defined in NFiPA 13.
3. In no case shall the water supply be less than the automatic sprinkler demand including hose stream allowance.

904.9 Signs

If control valves are located in a separate room, a sign shall be provided on the entrance door. The lettering shall be a contrasting color at least 4 inches (102 mm) high and shall read, STANDPIPE CONTROL VALVE.

905 FIRE ALARMS

905.1 Manual Fire Alarm Systems

905.1.1 A fire protective signaling system in accordance with NFiPA 72 shall be installed in all of the following occupancies:

Group A having an occupant load of 300 persons or more.

Group B having an occupant load of 500 or more persons or more than 100 persons above or below the street floor.

Group E.

EXCEPTION: Individual one room classrooms.

Group F industrial occupancies having a total capacity of 100 or more persons or 25 or more persons above or below the level of exit discharge.

Group H.

Group I.

Group M having an occupant load of 500 or more persons or more than 100 persons above or below the level of exit discharge.

Group R

R1 occupancies having accommodations for more than 15 guests.

R2 – Apartment houses four or more stories in height, and dormitories or rooming houses having more than 15 sleeping accommodations.

EXCEPTION: Where each guest room has a direct exit to the outside of the building and the building is three stories or less in height.

905.1.2 Manual fire alarm boxes shall be located not more than 5 ft (1524 mm) from the entrance to each exit. Except in Group I occupancies and hazardous material storage areas, the manual fire alarm boxes required in 905.1 may be omitted in buildings equipped with an automatic fire detection or automatic sprinkler system covering all areas. Actuation of the automatic fire detection or automatic sprinkler system shall activate the fire protective signaling system. Provisions shall be made to manually activate the fire protection signaling system at a minimum of one centrally located station.

905.1.3 Each floor shall be zoned separately. No one zone may exceed 15,000 sq ft (1394 m^2). A zone indicator panel shall be located at grade level at the normal point of fire department access or at a constantly attended building security control center.

EXCEPTION Automatic sprinkler system zones shall not exceed the area permitted by NFiPA 13.

905.1.4 Alarm indicating appliances listed for the purpose shall be provided. Visible and audible alarm indicating appliances shall be provided in occupancies housing the hearing impaired. Audible alarm indicating appliances shall provide a distinctive sound which shall not be used for any purpose other than that of a fire alarm. Such devices shall provide a sound pressure level of 15 dBA above the average ambient sound level in every occupied space within the building. The minimum sound pressure levels shall be: 70 dBA in buildings of Group R occupancy, 90 dBA in mechanical equipment rooms; and 60 dBA in all other occupancy classifications. The maximum sound pressure level for audible alarm indicating appliances shall not exceed 130 dBA at the minimum hearing distance from the audible appliance. Visible alarm indicating appliances, where required, shall be so located as to notify all occupants in every occupied space within the building.

905.1.5 Upon completion of the fire protective signaling system, all alarm initiating devices and circuits, alarm indicating appliances and circuits, supervisory signal initiating devices and circuits, signaling line circuits, and primary and secondary power supplies shall be subjected to a 100% acceptance test in accordance with NFiPA 72.

905.1.6 The alarm indicating appliances shall be automatically activated by all of the following where provided:

1. Smoke detectors, other than single-station smoke detectors, as required by 905.2. Activation of the fire protective signaling system by smoke detectors shall be by either two cross-zoned smoke detectors within a single protected area or a single smoke detector monitored by an alarm verification zone or an approved equivalent method;
2. Sprinkler water-flow devices;
3. Manual fire alarm boxes; and
4. Other approved types of automatic fire detection device suppression systems.

905.1.7 Required fire protective signaling system shall include visible alarm indicating appliances in public and common areas.

905.2 Automatic Fire Detection

905.2.1 An approved single-station or multiple-station smoke detectors shall be installed in accordance with NFiPA 72 within every dwelling and every dwelling unit within an apartment house, condominium or townhouse, and every guest or sleeping room in a motel, hotel or dormitory. Where more than one detector is required to be installed within an individual dwelling unit, the detections shall be wired in such a manner that the actuation of one alarm will actuate all of the alarms in the individual unit.

905.2.2 In dwellings and dwelling units, a smoke detector shall be mounted on the ceiling or wall at a point centrally located in the corridor or area giving access to each group of rooms used for sleeping purposes. Where the dwelling or dwelling unit contains more than one story, detectors are required on each story including basements, but not including uninhabitable attics, and shall be located in close proximity to the stairway leading to the floor above.

905.2.3 In dwelling units with split levels and without an intervening door between the adjacent levels, a smoke detector installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full story below the upper level.

905.2.4 Smoke detectors connected to a fire protective signaling alarm system shall be installed in accordance with NFiPA 72.

905.2.5 In dwelling and dwelling units, smoke detectors shall be hardwired into an AC electrical power source in all new construction. A monitored battery power source shall be permitted in existing construction.

905.2.6 All Group R buildings shall have installed in all interior enclosed exit access corridors approved listed smoke detection devices. Such smoke detection devices shall be installed in accordance with the requirements of NFPA 72.

905.2.6.1 Buildings which have corridors 75 feet or more in length, or which are more than two stories high, must be provided with a smoke detection system to be electrically interconnected to the fire protective signaling system when required by Section 905. These detectors must be tested and listed in accordance with ANSI/UL 268.

905.2.6.2 One and two story buildings with corridors less than 75 feet in length may utilize the single station device approved for dwellings but if two or more detectors are required, they must be interconnected. These detectors must be tested and listed in accordance with ANSI/UL 217. They shall be powered from the electrical system via a permanent connection as specified in the North Carolina State Building Code, Volume IV-Electrical.

CHAPTER 10

MEANS OF EGRESS

1001 GENERAL

1001.1Scope

1001.1.1 Provisions of this chapter shall govern the design, construction, and arrangement of elements to provide a safe means of egress from buildings and structures.

1001.1.2 In every building hereafter erected, means of egress shall comply with the minimum requirements of this chapter.

1001.1.3 Means of egress shall consist of continuous and unobstructed paths of travel to the exterior of a building. Means of egress shall not be permitted through kitchens, closets, restrooms and similar areas nor through adjacent tenant spaces.

EXCEPTION: Means of egress shall be permitted through a kitchen area serving adjoining rooms constituting part of the same dwelling unit or guest room.

1001.1.4 When unusually hazardous conditions exist, the building official may require additional means of egress to assure the safety of the occupants.

1001.2 Alterations

A building shall not hereafter be altered so as to reduce the capacity of the means of egress to less than required by this chapter nor shall any change of occupancy be made in any building unless such building conforms with the requirements of this chapter.

1001.3 Exit Construction

Stairways, ramps and passageways used for required exits shall be of noncombustible construction except where otherwise specifically permitted by 1007, 1010, and 1013.

1002 DEFINITIONS

The following words and terms shall, for the purposes of this chapter and as stated elsewhere in this code, have the meanings shown herein. Refer to Chapter 2 for general definitions.

ALTERNATING TREAD STAIRWAY – a stairway having a series of steps between 50° (0.87 rad) and 70° (1.22 rad) from horizontal, usually attached to a center support rail in an alternating manner so that the user never has both feet at the same level at the Same time. The initial tread of the stairway begins at the same elevation as the platform, landing or floor surface.

DOOR, BALANCED – a door equipped with double-pivoted hardware so designed as to cause a semicounterbalanced swing action when opening.

ILLUMINATION UNIFORMITY RATIO – the illumination uniformity ratio as determined by the following formula:

Maximum illumination at any point divided by minimum illumination at any point.

PANIC HARDWARE – a door latching assembly incorporating a device which releases the latch upon the application of a force in the direction of exit travel.

1003 OCCUPANT LOAD AND MEANS OF EGRESS CAPACITY

1003.1 Occupant Load

1003.1.1 For determining the means of egress required, the minimum number of persons for any floor area shall in no case be taken less than specified in Table 1003.1.

1003.1.2 The occupant load of any occupancy may be determined in accordance with 1003.1 when the necessary aisles and means of egress are provided as approved by the building official. An aisle, egress and seating diagram shall be provided to the building official to substantiate the occupant load.

Table 1003.1
Minimum Occupant Load

Use	Area per Occupant[2,3] (sq ft)
Assembly without fixed seats	
Concentrated (includes among others, auditoriums, churches, dance floors, lodge rooms, reviewing stands, stadiums)	7 net
Waiting Space	3 net
Unconcentrated (including among others conference rooms, exhibit rooms, gymnasiums, lounges, skating rinks)	15 net
Assembly with fixed seats	Note 1
Bowling alleys, allow 5 persons for each alley, including 15ft of runway, and other spaces in accordance with appropriate listing herein	7 net
Business areas	100 gross
Courtrooms other than fixed seating areas	40 net
Educational (Including Educational Uses Above the 12th Grade)	
Classroom areas	20 net
Shops and other vocational areas	50 net
Industrial areas	100 gross
Institutional	
Sleeping areas	120 gross
Inpatient treatment and ancillary areas	240 gross
Outpatient area	100 gross
Residential housing areas	120 gross
Library	
Reading rooms	50 net
Stack area	100 gross
Malls	Section 413
Mercantile	
Basement and grade floor areas open to public	30 gross
Areas on other floors open to public	60 gross
Storage, stock, shipping area not open to public	300 gross
Parking garage	200 gross
Residential	200 gross
Restaurants (without fixed seats)	15 net
Restaurants (with fixed seats)	Note 1
Storage area, mechanical	300 gross

1. The occupant load for an assembly area having fixed seats installed shall be determined by the number of fixed seats. Capacity of seats without dividing arms shall equal one person per 18 in (457 mm). For booths, one person per 24 in (610 mm).

2. See 202 for definitions of gross and net floor areas.

3. The occupant load of floor areas of the building shall be computed on the basis of the specific occupancy classification of the building. Where mixed occupancies occur, the occupant load of each occupancy area shall be computed on the basis of that specific occupancy.

1003.2 Measurement of Means of Egress

1003.2.1 The width of the means of egress shall be determined from occupants served in accordance with Table 1004.

1003.2.2 The width shall be measured in the clear at its narrowest point. Handrails may project 3 1/2 inches (89 mm) and door jambs 1 inch (25.4 mm) on each side of the measured width; however, the clear width of doorways shall not be reduced.

1003.2.3 Objects projecting from walls with their leading edges between 27 and 80 inches (686 and 2032 mm) above the finished floor shall protrude no more than 4 inches (102 mm) into walks, corridors, passageways, or aisles. Free-standing objects mounted on posts or pylons may overhang 12 inches (305 mm) maximum from 27 to 80 inches (686 and 2032 mm) above the ground or finished floor.

1003.2.4 There shall be a minimum headroom of 6 ft 8 inches (2032 mm), excluding stops, from the walking surface to the lowest part of any structural member, fixture or furnishing.

EXCEPTION: Sloping ceilings permitted by 1203.2.

1003.3 Capacity of Means of Egress

1003.3.1 The width of the means of egress shall be not less than the required capacity based on occupant load from Table 1003.1.

1003.3.2 The capacity of exit stairways constructed in accordance with 1007 shall be not less than the minimum required herein. Exit stairways shall be permitted to be used as a required exit from all floors which they serve. If, for example, three stairways are required to serve the third floor of a building and a like number are required for the second floor, the total number of stairways required shall be three, not six, and the capacity of the stairway shall be determined by the floor having the highest occupant load and not the total occupant load of the building.

1003.3.3 The required capacity of an exit access corridor shall be defined as the occupant load using the corridor for exit access divided by the required number of exits to which the corridor connects, but not less than the required capacity of the exit element to which the corridor leads.

1003.3.4 The aggregate width of passageways, aisles or corridors serving as access to exits shall be at least equal to the required width of the exit. Where all travel to any exit is along the same access to the exit, the width of the access shall be at least equal to the exit. Where there are several accesses to an exit, each shall have a width suitable for the travel which it may be called on to accommodate.

1003.3.5 When exits serve more than one floor, only the occupant load of each floor, considered individually, need be used in computing the required capacity of the exits at that floor. At no point along the exit path may the exit width be decreased. When an exit from an upper floor and a lower floor converge at an intermediate floor, the capacity of the exit from the intermediate floor shall be not less than the sum of the required capacities of such upper and lower floors.

1003.3.6 The minimum width of exitway access corridors shall be in accordance with Table 1004.

1003.3.7 Exit access corridors shall have fire resistance ratings as specified in Table 700.

1003.4 Elevators, Escalators, and Moving Walks

Elevators, escalators and moving walks shall not be used as a component of a required means of egress.

EXCEPTION: Elevators shall be permitted to be used as an accessible means of egress for the purpose of providing egress for people with physical disabilities only when permitted by 1004.3.

1004 ARRANGEMENT AND NUMBER OF EXITS

1004.1 Arrangement of Exits

1004.1.1 Exits shall be so located that the distance from the most remote point in the floor area, room or space served by them to the nearest exit, measured along the line of travel, shall be not more than the travel distance specified in Table 1004.

1004.1.2 Where two or more exits or exit access doors are required, at least two of the exits or exit access doors shall be placed a distance apart equal to not less than one half of the length of the maximum overall diagonal dimension of the building or area to be served measured in a straight line between such exits or exit access doors. The two exits or exit access doors shall be so located and constructed to minimize the possibility that both may be blocked by any one fire or other emergency condition.

EXCEPTION: When exit enclosures are provided as a portion of the required exit and are interconnected by a corridor conforming to the requirements for 1-hour rated construction, the exit separation may be measured along a direct line of travel within the corridor.

1004.1.3 Where open stairways or ramps are permitted as part of the path of travel to required exits, such as between mezzanines, balconies and the floor below, the travel distance shall include:

1. The distance to reach the stair or ramp.
2. The line of travel on a stair measured in the plane of the stair nosing.
3. The distance from the end of the stair or ramp to the exit.

1004.1.4 In one story Group F and Group S buildings equipped with automatic heat and smoke vents complying with this section and sprinklered, the travel distance may be increased to 400 ft (122 m). Smoke and heat vents shall be constructed and installed in a manner approved by the building official.

1004.1.4.1 Smoke and heat vents shall open automatically by activation of a heat responsive device rated at l00°F to 220°F (38°C to l04°C) above ambient. The releasing mechanism shall be capable of operation such that the vent will be fully open when the vent is exposed to a time-temperature gradient that reaches an air temperature of 500°F (260°C) within 5 minutes. Vents shall be capable of being opened by an approved manual operation.

1004.1.4.2 Curtain boards shall be provided to subdivide a vented building. Curtain boards shall be constructed of material that will resist the passage of smoke and consistent with the building type of construction. Curtain boards location and depth shall comply with Table 1004.1.4.

EXCEPTION: When a smoke and heat venting system complies with the guidelines of NFiPA 204M.

1004.1.4.3 Maximum spacing of roof vents and vent area shall comply with Table 1004.1.4.

EXCEPTION: When a smoke and heat venting system complies with the guidelines of NFiPA 204M.

Table 1004
Travel Distance, Dead-End Length, Exit and Means of Egress Width

Occupancy Classification	Maximum Travel Dist. To Exit (ft)		Maximum Dead End Corridor Length (ft)	Egress Width Per Person Served (in)		Minimum Corridor/ Aisle Width (in)	Minimum Clear Op'g Of Exit Doors (in)	Minimum Stair Width[10] (in)
	Insprk.	Sprk.		Level[12]	Stairs			
Group A	200	250	20	0.2	0.37[14]	44[1,10]	32	44
Group B	200	250	20	0.2	0.37[14]	44[10]	32	44
Group E	200	250	20	0.2	0.37[14]	72[2]	32	44
Group F	200	250[7]	20	0.2	0.37[14]	44[10]	32	44
Group H	NP	100[13]	20	0.4	0.7	44[10]	32	44
Group I Restrained	Varies[11]	Varies[11]	20	0.2	0.37[14]	48	32	44
Group I Unrestrained	150	200	20	0.2	0.37[14]	44[3]	36[9]	44
Group M	200	250	20	0.2	0.37[14]	44[4,10]	32	44
Group R	200	250	20[8]	0.2	0.37[14]	44[5,10]	32	44
Group S	200[6]	250[6,7]	20	0.2	0.37[14]	44[10]	32	44

1 in = 25.4 mm

1 ft = 0.305 m

1. See 1019.10.2.
2. For occupant loads less than 100 persons, 44 inches may be used.
3. 96 inches shall be provided in areas requiring the movement of beds.
4. Sec 413 for covered mall buildings.
5. 36 inches shall be permitted within dwelling units.
6. Maximum travel distance shall be increased to 300 ft if unsprinklered and 400 ft if sprinklered for Group S2 occupancies and open parking structures constructed per 411.
7. See 1004.1.4 for exceptions.
8. See 1026.1.1 for exceptions.
9. 44 inches required in areas requiring movement of beds.
10. 36 inches acceptable if stair or corridor serves occupancy load of less than 50.
11. See 1024.2.6.
12. Applies to ramps, doors and corridors.
13. For HPM Facilities, as defined in 408, the maximum travel distance shall be 100 ft.
14. Use 0.3 for stairs having tread depths 11 inches or greater and riser heights between 4 inches minimum and 7 inches maximum.

Table 1004.1.4
Roof Vent Size and Spacing for Increased Travel Distance in Group F and S

Occupancy	Hazard Classification[1]	Vent Height H[2]	Minimum Curtain Board Depth[3]	Maximum Area Formed by Curtain Boards (sq ft)	Vent Area to Floor Area Ratio	Maximum Spacing of Vent Centers	Maximum Distance From Wall or Curtain Board	Maximum Distance Between Curtain Boards
F	--	--	0.2H (4 ft min.)	50,000	1:100	120 ft	60 ft	8H but ≤250 ft
S	I through IV	20 ft or less	6 ft	10,000	1:100	100 ft	60 ft	8H
S	I through IV	Over 20 ft to 40ft	6 ft	8,000	1:75	100 ft	55 ft	8H but ≤250 ft
S	I through IV	20 ft or less	4 ft	3,000	1:75	100 ft	55 ft	8H
S	I through IV	Over 20 ft to 40ft	4 ft	3,000	1:50	100 ft	50 ft	8H but ≤250 ft
S	V	20 ft or less	6 ft	6,000	1:50	100 ft	50 ft	8H
S	V	Over 20 ft to 30ft	6 ft	6,000	1:40	90 ft	45 ft	8H
S	V	30 ft or more	4 ft	2,000	1:30	75 ft	40 ft	8H but ≤100 ft

1. See Chapter 36 of the Standard Fire Prevention Code for classification of Contents Class I thru IV. Class V commodities are products which represent special fire hazards beyond those of Class I, II, III or IV, such as aerosols, foamed plastic, PVC, polyurethane, polystyrene, and asphalt paper.
2. H is the height of the vent above the floor.
3. The depth if the curtain board shall be measured from the bottom of the vent. The bottom of the curtain board shall be level.

1004.2 Minimum Number of Exits

1004.2.1 There shall be not less than two approved independent exits, accessible to each tenant area, serving every story, except in Group R3 occupancies and as modified in 1018.

1004.2.2 The minimum number of exits for all occupancies, except as modified by 1018, based on occupant load, shall be as follows:

Minimum Number of Exits	Occupancy Load per Story
2	1 - 500
3	501 – 1,000
4	more than 1,000

1004.2.3 Sufficient exit facilities shall be provided so that the aggregate capacity of all such exits, determined in accordance with this chapter, shall be not less than the occupant load as determined from 1003.1.

1004.2.4 Is shall be unlawful to occupy any part of a building by a greater number of persons than that for which means of egress capacity, as prescribed in this chapter, has been provided.

1004.3 Accessible Means of Egress

See Chapter 11.

1005 SPECIAL EXIT REQUIREMENTS.

1005.1 Boiler, Incinerator, Furnace Rooms

Except in one and two family dwellings, two egress doors shall be provided from all boiler, incinerator, and furnace rooms that exceed 500 sq ft (46 m^2) in area, and the largest installed piece of fuel-fired equipment exceeds 400,000 Btu (117 kW) input capacity. Egress doors shall be separated by horizontal distance not less than one-half the maximum horizontal dimensions of the room. A 6-inch (152 mm) sill (dike) shall be provided where oil fire equipment is used. Interior openings between a Group H Hazardous occupancy and a boiler, incinerator, furnace or similar room shall not be permitted. Maximum distance of travel to an egress door shall not exceed 50ft (15m).

1005.2 Dead-End Pockets or Hallways

Exits and exit access shall be so arranged that dead-end pockets or hallways in excess of 20 ft (6096 mm) long shall not occur.

1005.3 Exit Access Corridors

1005.3.1 It shall be prohibited to use exit access corridors separated from building use areas by fire-rated partitions and providing access to exit, for return or exhaust from adjoining air conditioned spaces through louvers or other devices mounted in corridor doors, partitions, or ceilings.

1005.3.2 Except in Group I or Group R occupancies, 1005.3.1 may be waived by the building official, providing corridors are equipped with approved smoke detectors arranged to automatically stop supply, return and exhaust and close louvers or other devices mounted within the corridors doors, partitions, or ceilings.

1005.4 Emergency Egress Openings

1005.4.1 Every sleeping room on the first and second story of Group R occupancies shall have at least one operable exterior window or exterior door approved for emergency egress or rescue. The units must be operable from the inside to a full clear opening without the use of separate tools or key. Where windows are provided as a means of egress or rescue, they shall have a sill height of not more than 44 inches (1118 mm) above the floor.

1005.4.2 The minimum net clear opening height dimension shall be 22 inches (559 mm). The minimum net clear opening width dimension shall be 20 inches (508 mm). The net clear opening area shall in no case be less than 4 sq ft (0.37 m^2).

1005.4.3 Each egress window from sleeping rooms must have a minimum total glass area of not less than 5 sq ft (0.47 m^2) in the case of a ground floor window and not less than 5.7 sq ft (0.53 m^2) in the case of a second story window.

1005.5 Smokeproof Enclosures

1005.5.1 Where the floor surface of any story is located more than 75 ft (23 m) above the lowest level of fire department vehicle access, each of the required exits for the building shall be a smokeproof enclosure.

1005.5.2 A minimum 2-hour fire resistant construction shall be used for smokeproof enclosures. In each case openings into the required 2-hour construction shall be limited to those needed for maintenance and operation and shall be protected by self-closing 1 1/2-hour fire resistance rated devices. The supporting frame shall be protected as set forth in Chapter 6.

1005.5.3 Group B buildings exceeding 15,000 sq ft (1395 m^2) per floor and complying with the area of refuge (compartmentation) option described in 412.9 are exempt from smokeproof enclosure requirements.

1005.5.4 Stairs in smokeproof enclosures shall be of noncombustible construction.

1005.5.5 A smokeproof enclosure shall exit into a public way or into an exit passageway, yard, open court or open space having direct access to a public way. The exit passageway shall be without other openings and shall have walls, floors, and ceiling of 2-hour fire resistance.

1005.5.6 A stairway in a smokeproof enclosure shall not continue below the grade level unless an approved barrier is provided at the ground level to prevent persons from accidentally continuing into the basement.

1005.5.7 Access to the stairway shall be by way of a vestibule or by way of an open exterior balcony of noncombustible materials.

1005.5.8 Smokeproof Enclosures by Natural Ventilation.

1005.5.8.1 Where a vestibule is provided, the door assembly into the vestibule shall have a 1 1/2-hour fire resistance rating and the door assembly from the vestibule to the stairs shall have not less than a 20 minute fire resistance rating. The doors shall have closing devices a specified in 1005.5.9.10. Wired glass 1/4 inch (6.4 mm) thick may be installed not to exceed 100 sq in (0.065 m^2) with neither dimension exceeding 12 inches (305 mm).

1005.5.8.2 The vestibule hall have a minimum of 16 sq ft (1.49 m^2) of opening, in a wall facing an exterior court, yard or public way at least 20 ft (6096 mm) wide. The vestibule shall be a minimum of 44 inches (1118 mm) wide and 72 inches (1829 mm) in the direction of travel.

1005.5.8.3 Where access to the stairway is by means of an open exterior balcony, the door assembly to the stairway shall have a 1 1/2-hour fire resistance rating. Doors shall have closing devices as specified in 1005.5.9.10.

1005.5.9 Smokeproof Enclosures by Mechanical Ventilation.

1005.5.9.1 Stair pressurization systems shall be independent of other building ventilation systems.

1005.5.9.2 Equipment and ductwork for stair pressurization shall comply with one of the following:

1. Be located exterior to the building and be directly connected to the stairway or connected to the stairway by ductwork enclosed in 2-hour construction.
2. Be located within the stair enclosure with intake or exhaust air directed to the outside or through ductwork in 2-hour construction.
3. Be located within the building if separated from the remainder of the building, including other mechanical equipment, with 2-hour construction.

1005.5.9.3 The door from the building into the vestibule shall have a 1 1/2-hour fire resistance rating and have closing devices as specified in 705.1.3.2.3. The door from the vestibule to the stairway shall have a minimum 20 minute fire resistance rating and have closing devices as specified in 705.1.3.2.3. Wired glass, if provided, shall not exceed 100 sq in (0.065 m^2) and shall be set in a steel frame. The door shall be provided with a drop sill or other provision to minimize air leakage.

1005.5.9.4 Where access to the stairway is by means of an open exterior balcony, the door assembly to the stairway shall have a 1 1/2-hour fire resistance rating. Doors shall have closing devices as specified in 1005.5.9.10.

1005.5.9.5 The vestibule shall have a minimum dimension of 44 inches (1118 mm) wide and 72 inches (1829 mm) in direction of exit travel.

1005.5.9.6 The vestibule shall be provided with not less than one air change per minute and the exhaust shall be 150% of the supply. Supply air shall enter and exhaust air shall discharge from the vestibule through separate, tightly constructed ducts used only for that purpose. Supply air shall enter the vestibule within 6 inches (152 mm) of the floor level. The top of the exhaust register shall be located at the top of the smoke trap but no more than 6 inches (152 mm) down from the top of the trap and shall be entirely within the smoke trap area. Doors, when in the open position, shall not obstruct duct openings. Duct openings may be provided with controlling dampers if needed, to meet the design requirements but are not otherwise required.

1005.5.9.7 For buildings where such air changes would result in excessively large duct and blower requirements, a specially engineered system may be used. Such an engineered system shall provide 2,500 cfm (1.2 m^3/s) exhaust from a vestibule when in emergency operation and shall be sized to handle three vestibules simultaneously. The smoke detector located outside each vestibule shall release to open the supply and exhaust duct dampers in that affected vestibule.

1005.5.9.8 The vestibule ceiling shall be at least 20 inches (508 mm) higher than the door opening into the vestibule to serve as a smoke and heat trap and to provide an upward moving air column. The 20-inch (508 mm) height requirement may be reduced proportionally if the minimum vestibule size described in 1005.5.9.5 is enlarged so as to maintain the same volume in the smoke trap area above the door when justified by design and test. In any case, minimum ceiling height shall not be less than 7 ft 6 in (2286 mm).

1005.5.9.9 The stair shaft shall be provided with mechanical supply and exhaust air. There shall be a minimum of 2,500 cfm (1.2 m^3/s) discharge through a dampered relief opening or an exhaust fan at the top of the stair shaft. The supply shall be sufficient to provide a minimum positive pressure of 0.05-inch water column (12.5 Pa) in addition to the maximum anticipated stack pressure, relative to other parts of the building measured with all doors closed. The combined positive pressure shall not exceed 0.35-inch water column (87 Pa). The air supply shall be taken directly from outside of the building. The stair pressure shall be static pressures measured at the level of discharge from the stair.

EXCEPTION: The minimum positive pressure shall be increased to 0.15-inch water column (37 Pa) in an unsprinklered building.

1005.5.9.10 The activation of the ventilating equipment shall be initiated by a smoke detector installed outside the vestibule door in an approved location. When the closing device for the stair shaft and vestibule doors is activated by smoke detection or power failure, the closing devices on all doors in the smokeproof enclosure at all levels shall be activated and the mechanical equipment shall operate at the levels specified in items 1005.5.9.6 and 1005.5.9.9.

1005.6 Mezzanines

1005.6.1 Two means of egress shall be provided from any mezzanine with an occupant load or travel distance to an exit or to a point where there is a choice of more than one means of egress which exceeds that shown in Table 1005.6.

Table 1005.6
Single Exit Criteria for Mezzanines

Use	Occupant Load	Maximum Travel Distance
Assembly	50	75 feet
Business	30	75 feet
Court Rooms	50	75 feet
Educational		
Classroom	50	75 feet
Shops and vocational	50	75 feet
Industrial	50	75 feet
Institutional		
Sleeping area	6	75 feet
In-patient treatment areas	10	75 feet
Outpatient treatment areas	10	75 feet
Library		
Reading rooms	50	75 feet
Stack area	30	75 feet
Mercantile		
Basement/grade levels	50	75 feet
Other floors	50	75 feet
Stock, storage & shipping	10	75 feet
Parking garages	30	75 feet
Residential		
Dwellings	10	75 feet
Hotels & apartments	10	75 feet
Dormitories	10	75 feet
Hazardous	3	25 feet[1]
Storage	30	100 feet

1 ft = 0.305 m

Notes:

1. Maximum area with one exit or exit access door shall be 200 sq ft

1005.6.2 If any required means of egress is through the room below, the occupant load of the mezzanine shall be added to the occupant load of the room in which it is located.

1005.6.3 Egress stairways from mezzanines shall conform with the requirements of 1007. They may be open and may descend to the floor of the room in which they are located when all the following conditions are met:

1. The pace beneath the mezzanine is totally open and unencumbered by partitioned rooms or spaces.

   EXCEPTION: The space beneath the mezzanine may be enclosed provided the enclosed space is protected throughout with a smoke detection system in accordance with NFiPA 72 which sounds an alarm in the mezzanine.

2. Deleted.
3. The occupant load of the mezzanine is added to the occupant load of the story or room in which it is located for purposes of determining the egress requirements of such story or room.
4. The mezzanine is not occupied for sleeping purposes, unless there are exterior windows accessible to the mezzanine and located not more than two stories above grade.

1005.7 Burglar Bars

Each sleeping room or room with a required exit door in a residential occupancy that has burglar bars installed shall have at least one emergency egress window or door that is operable from the inside without the use of a key, tool, special knowledge, or effort.

1006 STAIRWAY PROTECTION

1006.1 Enclosed Stairways

1006.1.1 Exit stairways between floors shall be enclosed in or separated by fire resistant construction in accordance with 705.2 and Table 700.

EXCEPTIONS·

1. Stairways serving and contained within a dwelling, dwelling unit, or hotel suite.
2. Exterior stairways conforming to 1006.2.
3. In open automobile parking garages when the stair is on an open side, as defined in 411.3.2.
4. In open parking garages, having all sides open.

1006.1.2 Except in one and two family dwellings, basement stairways located under stairways from upper stories shall be completely enclosed by construction providing fire resistance not less than required for the stair enclosure above the basement but in no case less than 1-hour fire resistance.

1006.1.3 A stairway enclosure shall not be used for any purpose other than means of egress. Openings in exit enclosures other than unexposed exterior openings shall be limited to those necessary for exit access to the enclosure from normally occupiable or habitable rooms and for egress from the enclosure.

1006.1.3.1 Penetrations into and openings through a stairway enclosure assembly are prohibited except for required exit door, ductwork and equipment necessary for independent stair pressurization, sprinkler piping, standpipes, metallic hot and cold water and condensate piping, and electrical conduit serving the stairway and terminating at a steel box not exceeding 16 sq in (0.010 m^2). Such penetrations shall be protected in accordance with 705.4. There shall be no penetrations or communicating openings, whether protected or not, between adjacent stair enclosures.

1006.1.3.2 Exterior walls of an enclosed stairway shall comply with the requirements of Table 600 for exterior walls. Where nonrated walls or unprotected openings are used to enclose the exterior of the stairway, the building exterior walls within 10 ft (3048 mm) horizontally of the non-rated wall or unprotected opening shall be constructed as required for stairway enclosures, including opening protectives, but need not exceed 1-hour fire resistance with 3/4-hour opening protective. This construction shall extend vertically from the ground to a point 10 ft (3048 mm) above the topmost landing of the stairway or to the roof line, whichever is lower.

1006.1.4 The space under a stairway may be used if it is separated from the stairway by fire resistant construction as required by 1006.1.

EXCEPTION: Separation is not required from those stairways exempted from enclosure in 1006.1.1.

1006.2 Exterior Exitway Stairs

1006.2.1 Exterior stairways conforming to the requirements for interior stairways in all respects, except as to enclosures and except as herein specifically modified, may be accepted as an element of a required means of egress in buildings not exceeding six stories or 75 ft (22.9 m) in height for other than Group E and I Unrestrained buildings.

1006.2.2 Exterior stairways shall be permitted where at least one door from each tenant opens onto a roofed-over open porch or balcony served by at least two stairways so located as to provide a choice of independent, unobstructed means of egress directly to the ground, except a single stairway shall be allowed when a single exit is permitted by 1020, 1025, 1026, and 1027. Such porches and stairways shall comply with the requirements for interior exitway stairway as specified in 1007 and 1014. Porches and balconies shall be not less than 4 1/2 ft (1372 mm) wide. The stairways shall be located so that the entrances and all portions of the stairways on each level are a distance apart equal to not less than one half of the length of the maximum overall diagonal dimension of the building or area to be served measured in a straight line between such stairways. The maximum travel distance from any tenant space to the nearest stairway shall be as specified in Table 1004. Porches and stairways shall be located at least 10 ft (3048 mm) from adjacent property lines and from other buildings on the same lot, unless openings in such buildings are protected by 3/4 hour fire resistant doors or windows.

1006.2.3 Handrails and guardrails shall be as specified in 1007.5 and 1015 respectively.

1006.2.4 Exterior stairs shall be separated from the interior of the building by walls with a fire resistance rating of not less than 1 hour, with fixed or self-closing opening protectives as required for enclosed stairs. This protection shall extend vertically from the ground to a point 10 ft (3048 mm) above the topmost landing or the roof line, whichever is lower, and horizontally 10 ft (3048 mm) from each side of the stairway. Openings within the 10 ft (3048 mm) horizontal extension of the protected walls beyond the stairway shall be equipped with fixed 3/4-hour assemblies.

EXCEPTIONS:

1. Exterior stairways may be unprotected when serving an exterior exit access balcony which has two exterior stairways, remotely located as required in 1006.2.2.
2. Such protection is not required in two story buildings where there is a second exit remotely located as required in 1006.2.2.

1006.2.5 All required exterior stairways shall be located so as to lead directly to a street or open space with direct access to a street. When located on the rear of the building such stairways may lead through a passageway at grade complying with 1010.

1006.2.6 Exterior stairways shall not project beyond the street lot line.

1007 STAIRWAY CONSTRUCTION

1007.1 General

1007.1.1 Exterior and interior exit stairways shall be constructed of noncombustible materials throughout in the following buildings:

1. All buildings of Type I and of Type II construction.
2. All Group A-1 and Group I buildings.
3. All Group A-2 and Group E buildings three stories or more in height.
4. All other buildings three stories or more in height or occupied by more than 40 persons above or below the first story at street or grade level, except one and two family dwellings and buildings of Type VI construction.

1007.1.2 Stairways located in a required fire resistant enclosure shall have closed risers. All other stairways shall be permitted to have open risers.

1007.1.3 Interior stairs constructed of wood, except those with open risers, shall be fireblocked as specified in 705.3.

1007.1.4 Closets shall not be located beneath stairs unless such stairs are protected as required by 1006.1.

EXCEPTION: Protection is not required for those stairways exempted from enclosure in 1006.1.1.

1007.1.5 The underside of interior stairways, if of combustible construction, shall be protected to provide not less than 1-hour fire resistance.

EXCEPTION: When located within a dwelling unit.

1007.1.6 Enclosed exit stairways that continue beyond the floor of discharge shall be interrupted at the floor of discharge by partitions, doors or other effective means.

EXCEPTION: Stairs that continue one-half story beyond the level of exit discharge need not be interrupted by physical barriers where the exit discharge is clearly obvious.

1007.2 Not Used

1007.3 Treads and Risers

1007.3.1 Treads and risers of stairs shall be so proportioned that the sum of two risers and a tread, exclusive of projection of nosing, is not less than 24 inches (610 mm) nor more than 25 inches (635 mm). The height of riser shall not exceed 7 3/4 inches (197 mm), and treads, exclusive of nosing, shall be not less than 9 inches (229 mm) wide.

EXCEPTION: Special stairs in 1007.8.

1007.3.2 Every tread less than 10 inches (254 mm) wide shall have a nosing, or effective projection, of approximately 1 inch (25.4 mm) over the level immediately below that tread.

1007.3.3 Tread depth shall be measured horizontally between the vertical planes of the foremost projection of adjacent treads and at a right angle to the tread's leading edge.

EXCEPTION: Tread depth of special stairs in 1007.8 shall be measured on a line perpendicular to the centerline of tread.

1007.3.4 Treads shall be of uniform depth and risers of uniform height in any stairway between two floors. There shall be no variation exceeding 3/16 inch (4.8 mm) in the depth of adjacent treads or in the height of adjacent risers and the tolerance between the largest and smallest riser or between the largest and smallest tread shall not exceed 3/8 inch (9.5 mm) in any flight. The uniformity of winders and other tapered treads, complying with 1007.8.1, 1007.8.2, and 1007.8.3 shall be measured at consistent distances from the narrower end of the treads.

EXCEPTION: Where the bottom or top riser adjoins a sloping public way, walk or driveway having an established grade and serving as a landing, a variation in height of the riser of not more than 3 inches (76 mm) for every 3 ft (914 mm) of stairway width is permitted.

1007.4 Landings

1007.4.1 A flight of stairs shall not have a vertical rise of more than 12 ft (3658 mm) between floors or landings.

1007.4.2 The width of landings shall be not less than the width of stairways they serve. Every landing shall have a minimum dimension measured in the direction of travel equal to the width of the stairway. Such dimension need not exceed 4 ft (1219 mm) when the stair has a straight run.

1007.4.3 Stairway landings shall have guardrails as specified in 1015 on any open and unenclosed edges.

EXCEPTION: The top element of a guardrail at the inside open or unenclosed edge of any intermediate landing where the stairs reverse direction may be at the same height as the stairway handrails when the horizontal distance between the stair flights is 1 ft (305 mm) or less and when a continuous handrail as specified in 1007.5 is provided.

1007.5 Handrails

1007.5.1 Stairways having four or more risers above a floor or finished ground level, shall be equipped with handrails located not less than 30 (762 mm) nor more than 38 inches (965 mm) above the leading edge of a tread.

EXCEPTIONS:

1. Handrails that form part of a guardrail may be 42 inches (1067 mm) high.
2. As required for Group I Unrestrained in 1024.1.4.

1007.5.2 Stairways shall have handrails on each side.

EXCEPTIONS:

1. Aisle stairs provided with a center handrail need not have additional handrails.
2. Stairs within dwelling units, spiral stairs and aisle stairs serving seating only on one side may have a handrail on one side only.

1007.5.3 Handrails shall have either a circular cross section with a diameter of 1 1/4 inches (32 mm) to 2 inches (51 mm), or a noncircular cross section with a perimeter dimension of at least 4 inches (102 mm) but not more than 6 1/4 inches (159 mm) and a largest cross section dimension not exceeding 2 1/4 inches (57 mm). Edges shall have a minimum radius of 1/8 inch (3 mm).

1007.5.4 Gripping surfaces shall be continuous, without interruption by newel posts or other obstructions.

1007.5.5 Where a wall or guardrail exists, handrails shall extend at least 12 inches (305 mm) beyond the top riser and at least 12 inches (305 mm) plus the depth of one tread beyond the bottom riser. At the bottom, the handrail shall continue to slope for a distance of the depth of one tread from the bottom riser; the remainder of the extension shall be horizontal.

EXCEPTION: Handrails within a dwelling unit.

1007.5.6 Clear space between handrail and wall shall be a minimum of 1 1/2 inches (38 mm).

1007.5.7 When the required width of a flight of stairs exceeds 88 inches (2235 mm), one or more intermediate handrails, continuous between landings, substantially supported and terminating at the upper end in newels or standards, shall be provided and there shall be not more than 88 inches (2235 mm) between such adjacent handrails.

1007.5.8 Handrails, where required along open-sided flights of stairs, shall be of construction adequate in strength, durability and attachment for their purpose as prescribed in 1608.2. They shall include intermediate rails or ornamental patterns such that a 6-inch (152 mm) diameter sphere cannot pass through any openings.

EXCEPTIONS:

1. Openings between intermediate rails shall be permitted for specific occupancy groups as described in 1018.
2. Stairways which are part of or connected to the facilities described in 1026.4.2, and not more than 6ft (1829 mm) above the grade below shall be required to have only one intermediate railing located between 14 and 18 inches (356 and 457 mm) above the leading edge of the tread.

1007.5.9 On monumental stairs, handrails shall be located along the most direct path of egress travel.

1007.6 Width

1007.6.1 Stairs shall be clear of all obstructions except projections not exceeding 3 1/2 inches (89 mm) at or below handrail height on each side.

1007.6.2 Width of stairs shall not decrease in the direction of exit travel.

1007.6.3 The minimum width of any stair serving as a means of egress shall be in accordance with Table 1004.

1007.7 Headroom

Stairs shall have a minimum headroom clearance of 6 ft 8 inches (2032 mm) measured vertically from a line connecting the edge of the nosings. Such headroom shall be continuous above the stair to the point where the line intersects the landing below, one tread depth beyond the bottom riser. This minimum shall be maintained the full width of the stair and landing.

1007.8 Special Stairs

1007.8.1 Winders shall have a minimum tread depth of 6 inches (152 mm) at the narrow edge and shall have a minimum tread depth of 11 inches (279 mm) at a point 12 inches (305 mm) from the narrow edge. Winders shall be permitted to be used as a component in the means of egress within a dwelling unit.

1007.8.2 Spiral stairways shall be permitted to be used as a component in the means of egress within dwelling units and from a mezzanine not more than 250 sq ft (23 m2) and serving not more than five occupants. A spiral stairway shall have a 7 l/2-inch (190 mm) minimum clear tread depth at a point 12 inches (305 mm) from the narrow edge. The risers shall be sufficient to provide a headroom of 6 ft 6 in (1981 mm) minimum, but riser height shall not be more than 9 1/2 inches (114 mm). The minimum stairway width shall be 26 inches (660 mm).

1007.8.3 Circular stairways shall be permitted to be used as a component in the means of egress providing the minimum depth of tread is not less than 11 inches (279 mm) measured 12 inches (305 mm) from the smaller radius, and the smaller radius is not less than twice the width of the stairway. In Group R3 Occupancies, circular stairs may have a minimum tread depth of 9 inches (229 mm) with 1 inch (25.4 mm) of nosing, and the smaller radius may be less than twice the width of the stairway.

1007.8.4 Alternating tread stairways shall have a minimum projected tread exclusive of nosing of 8 1/2 inches (216 mm) within a minimum total tread depth of 10 1/2 inches (267 mm). The rise to the next alternating tread surface shall be a maximum of 8 inches (203 mm). Distance between handrails shall be a minimum of 17 inches (432 mm) and a maximum of 24 inches (610 mm). A minimum distance of 6 inches (152 mm) shall be provided between the stair handrail and any other object. A minimum of 12 inches (305 mm) shall be provided between the stair handrails of adjacent alternating tread stairways.

1007.8.5 Alternating tread stairways meeting the requirements of 1007.8.4 shall be permitted to be used as a component in a means of egress from a mezzanine of not more than 250 sq ft (23 m^2) in area serving not more than five occupants in F, H, I, within dwelling units of R 2 and R3, and S occupancies.

1008 ACCESS TO ROOF

Buildings four stories or more in height, except those with a roof slope greater than 4:12, shall be provided with a stairway to the roof. Such stairway shall be marked at street and floor levels with a sign indicating that it continues to the roof. Where roofs are used for roof gardens or for other purposes, stairways shall be provided as required for such use or occupancy.

1009 HORIZONTAL EXITS

1009.1 General

1009.1.1 Horizontal exits shall not comprise more than one half of the required exits from any building or floor area and shall not serve as the only exit. The walls of horizontal exits shall have a fire resistance rating of 2 hours using materials dependent on the type of construction.

EXCEPTION: Horizontal exits comprising more than one half of the required exits shall be permitted in accordance with 1024.1.1 and 1024.2.7.

1009.1.2 Ramps meeting the requirements of 1013 shall be used where there is a difference of level between connected areas.

1009.1.3 The area into which a horizontal exit leads shall be provided with exits adequate to meet the requirements of this chapter, but not including the added capacity imposed by persons entering it through horizontal exits from another area. At least one of its exits shall lead directly to the exterior.

1009.2 Doors

1009.2.1 The width of horizontal exits shall be not less than required for exit doorways. The exit capacity of horizontal exits shall be as specified in 1003.3.

1009.2.2 All fire doors in horizontal exits shall be self-closing or automatically closing when activated by a smoke detector. All opening protectives in horizontal exits shall be consistent with the fire resistance rating of the wall with a minimum 1 1/2-hour rating.

1009.2.3 Doors in horizontal exits shall be kept unlocked and unobstructed.

1009.3 Capacity of Refuge Area

The refuge area of a horizontal exit shall be either public areas or spaces occupied by the same tenant and each such area of refuge shall be adequate to house the total occupant load of both connected areas. The capacity of areas of refuge shall be computed on a net floor area allowance of 3 sq ft (0.28 m^2) for each occupant to be accommodated therein, not including areas of stairs, elevators and other shafts or courts.

EXCEPTION: Area for Group I shall be computed in accordance with 1024.1.1.2 and 1024.2.7.2.

1010 EXIT DISCHARGE

1010.1 General

1010.1.1 Unless directly connected to a public way or to a space leading to a public way, required exits shall be connected to an exit court, exit passageway, lobby or vestibule leading to a public way.

1010.1.2 The minimum width of such courts, passageways, lobbies and vestibules shall be 44 inches (1118 mm) but not less than the required width of the exits to which they are connected. There shall be no reduction of width in the direction of exit travel.

1010.1.3 The minimum clear ceiling height shall be 8 ft (2438 mm).

1010.1.4 The slope of the floor of exit discharge elements shall not exceed 1:12.

1010.2 Exit Courts

Exit courts 10 ft (3048 mm) or less in width shall have a minimum fire resistance rating of 1 hour with 3/4-hour opening protectives.

1010.3 Exit Passageways

Exit passageways shall be constructed in accordance with 704.2.1.2, 1006.1.3, and 1006.1.3.1, with a fire resistance rating equivalent to shaft enclosures in Table 700.

EXCEPTIONS: A maximum 50% of the required number of exits and 50% of the required exit capacity shall be permitted to discharge through areas on the level of exit discharge provided all the following are met:

1. Such exits discharge to a free and unobstructed way to the exterior of the building, such way being readily visible and identifiable from the point of discharge at the exit, and
2. The entire area is separated from areas below by construction having a fire resistance rating not less than that required for the exit enclosure, and
3. The area is protected throughout by an approved automatic sprinkler system, and
4. Any other portion of the level of discharge with access to the area of discharge is protected throughout by an approved automatic sprinkler system or separated from the area of discharge in accordance with requirements for the enclosure of exitways.

1010.4 Vestibules

An exit may discharge into an interior vestibule which meets the following criteria:

1. The depth from the exterior of the building is not greater than 10 ft (3048 mm) and the length is not greater than 20 ft (6096 mm), and
2. The vestibule is separated from the remainder of the level of exit discharge by construction providing protection equivalent to that provided by 1/4-inch (6 mm) thick labeled wired glass in steel frames.

1011 FIRE ESCAPES

1011.1 General

1011.1.1 Fire escapes shall not be permitted except as approved by the building official for existing buildings when more adequate exit facilities cannot be provided. Fire escapes shall not provide more than 50% of the required exit capacity.

1011.1.2 When located on the front of the building and projecting beyond the building line, the lowest landing shall be not less than 7 (2134 mm) nor more than 12 ft (3658 mm) above grade, equipped with a counterbalanced stairway to the street. In alleyways and thoroughfares less than 30ft (9144 mm) wide, the clearance under the lowest landing shall be not less than 12 ft (3658 mm).

1011.2 Design

1011.2.1 The fire escape shall be designed to support a live load of 100 psf (4.8 kPa) and shall be constructed of steel or other approved noncombustible materials. Fire escapes may be constructed of wood not less than 2 inches (51 mm) thick on buildings of Type VI construction.

1011.2.2 Stairs shall be at least 22 inches (559 mm) wide with risers not more and treads not less than 8 inches (203 mm) and with landings at foot of stairs not less than 40 inches (1016 mm) wide by 36 inches (914 mm) long, located not more than 8 inches (203 mm) below the access window or door.

1011.2.3 All openings located within 10 ft (3048 mm) of fire escapes shall be protected with approved opening protectives of at least 3/4-hour fire resistance.

EXCEPTION: Fire escape ladders as set forth in 1011.3.

1011.3 Fire Escape Ladder Devices

A self-contained fire escape ladder device may be used when authorized by the building official in Group R Occupancies not exceeding five stories, when said device conforms to the following:

1. The exit ladder serves an occupant load of 10 or less, or a single dwelling unit or guest room.
2. The access is adjacent to an opening as specified for emergency egress or rescue from a balcony. The exit ladder shall not pass in front of any building opening at or below the unit being served.

3. The exit ladder shall be so installed that the descending face is adjacent to the building wall and each ladder device shall be offset or staggered not less than 24 inches (610 mm) from the ladder above.
4. The availability of the activation device for the exit ladder is accessible only from the opening on the balcony served.
5. An alarm sounds when the exit ladder is activated.

1012 DOORS

1012.1 General

1012.1.1 Egress doors used as an exit door shall provide a clear opening of not less than the widths shown in Table 1004. The maximum leaf width of the door shall not exceed 48 inches (1219 mm). Egress doors used in the exit access shall provide a clear opening of not less than 32 inches (813 mm) wide.

EXCEPTIONS:

1. Resident sleeping room doors within Group I Restrained occupancies.
2. Storage closets less than 10 sq ft (0.93 m^2) in area.
3. Revolving doors.
4. Interior egress door within a dwelling unit which is not required to be adaptable or accessible.

1012.1.2 Egress doors shall be side swinging type. Doors shall swing in the direction of egress for the following:

1. when serving an occupant load of 50 or more, or,
2. when serving a high hazard occupancy.

The following prescribed maximum forces applied to the latch side shall perform their respective functions:

1. A 15 lb (67 N) force shall release a latch.
2. A 30 lb (133 N) force shall set door in motion.
3. A 15 lb (67 N) force shall swing door fully open.

EXCEPTIONS TO 1012.1.2:

1. As permitted for specific occupancies in 1018.
2. Revolving doors conforming with 1012.3.
3. Horizontal sliding doors conforming with 1012.4 when used in elevator lobbies, or areas of refuge set forth in 1004.3.5, or smoke barriers, or any room or space, other than Group H, with an occupant load of less than 50.

1012.1.3 Every room or tenant space shall be provided with a minimum of one means of egress. Every room or tenant space which has an occupant load of 50 or more persons or in which the travel distance from the most remote point to the entrance to the exit access from the room or tenant space exceeds 75 ft (23 m) shall have not less than two egress doors.

EXCEPTION: Doors in an HPM Facility shall comply with 408.3.9.

1012.1.4 The floor surface on both sides of a door shall be at the same elevation. The floor surface over which the door swings shall extend from the door in the closed position a distance equal to the door width. Thresholds at doorways shall not exceed 3/4 inch (19.1 mm) in height for exterior sliding doors or 1/2 inch (12.7 mm) for other doors. Raised thresholds and floor level changes greater than 1/4 inch (6.4 mm) at doorways shall be beveled with a slope no greater than 1:2.

EXCEPTIONS:

1. Exterior doors not on an accessible route as defined in 1102.
2. Variations in elevation due to differences in finish materials, but not more than 1/2 inch (12.7 mm).
3. Doorways complying with 1012.1.6.

1012.1.5 Doors opening onto exit stairs or other approved exits shall not obstruct the travel along any required exit. Doors opening onto exit access corridors or onto a landing shall not reduce the corridor width or the landing width to less than one-half the required width during the opening process. When fully open, the door shall not project more than 7 inches (178 mm) into the required width of a corridor or a landing.

1012.1.6 Exit doorways shall not open immediately upon a flight of stairs. A landing of at least the width of the door shall be provided, which is the same elevation as the finished floor from which it is exiting.

1012.1.7 In Group R3 occupancies, a landing shall be provided on the exterior side of all egress door openings. Landing width shall be no less than the width of the door it serves and the depth shall be not less than 36 inches (914 mm). The landing may be one step lower than the inside floor level but not more than 7 inches (178 mm) lower.

1012.1.8 Required exit doors shall be openable from the inside without the use of a key, tool, special knowledge or effort. Manually operated flush bolts or surface bolts are prohibited. All hardware must be direct acting requiring no more than one operation. Double cylinder dead bolts, requiring a key for operation on both sides, are prohibited on required means of egress doors unless the locking device is provided with a key which cannot be removed when the door is locked from the inside.

1012.1.9 For required width of doorways serving exit stairways and the exit capacity of doorways, see 1003.2 and 1003.3.

1012.1.10 Special locking arrangements shall be permitted in accordance with 1012.6 for the applicable occupancy and 1018.

1012.2 Power Operated Doors

1012.2.1 Where required doors are operated by power which is activated by a photo-electric device, floor mat, wall switches or other approved device as well as doors with power assisted manual operation, the design, installation and maintenance shall be such that, in the event of power failure, the door may be manually opened to permit exit travel. These doors shall be openable as is required for other nonpower operable doors.

1012.2.2 Power operating sliding doors may be used provided the sliding leaf is equipped with an emergency swing (panic release) feature.

EXCEPTION: Horizontal sliding doors conforming with 1012.4.

1012.2.3 Power operated doors shall comply with ANSI/BHMA A156.10.

1012.3 Revolving Doors

1012.3.1 Each revolving door shall be capable of collapsing into a book-fold position with parallel egress paths providing an aggregate width of 36 inches (914 mm).

1012.3.2 A revolving door shall not be located within 10ft (3048 mm) of the foot of or top of stairs or escalators or the entrance or exit of a moving walk. A dispersal area shall be provided between the stairs or escalators or either end of the moving walk and the revolving doors.

1012.3.3 The turning speed of a revolving door shall not exceed the maximum permitted by Table 1012.3.3.

Table 1012.3.3
Maximum Speed For Revolving Doors

Inside Diameter (ft and in)	Power-Driven Type Speed Control (rpm)	Manual Type Speed Control (rpm)
6-6	11	12
7-0	10	11
7-6	9	11
8-0	9	10
8-6	8	9
9-0	8	9
9-6	7	8
10-0	7	8

1012.3.4 Each revolving door shall have a conforming side-hinged swinging door in the same wall as the revolving door and within 10ft (3048 mm).

EXCEPTION: A revolving door may be used without an adjacent swinging door for street floor elevator lobbies if a stairway, escalator or door from other parts of the building does not discharge through the lobby and the lobby does not have any occupancy or use other than as a means of travel between elevators and street.

1012.3.5 A revolving door to be credited as a component of a means of egress shall comply with 1012.3.1 through 1012.3.4 and the following conditions:

1. Revolving doors shall not be given credit for more than 50 of the required exit capacity.
2. Each revolving door shall be credited with no more than 50 persons capacity.
3. Each revolving door shall be capable of being collapsed when a force of not more than 130 lb (578 N) is applied within 3 inches (76 mm) of the outer edge of a wing.

1012.3.6 A revolving door not used as a component of a means of egress shall have a collapsing force of not more than 180 lb (801 N)

EXCEPTION: A revolv1ng door may have a collapsing force set in excess of 180 lb (801 N) if the collapsing force is reduced to not more than 130 lb (578 N) when at least one of the following is satisfied:

1. There is a power failure or power is removed to the device holding the wings in position.
2. There is an actuation of the automatic sprinkler system when such system is provided.
3. There is an actuation of a smoke detection system which is installed to provide coverage in all areas within the building which are within 75 ft (23 m) of the revolving doors.
4. There is the actuation of a manual control switch which reduces the holding force to below the 130 lb (578 N) level. Such switch shall be in an approved location and shall be clearly identified.

1012.4 Horizontal Sliding Doors

Approved and listed horizontal sliding doors complying with the following conditions may be used in a means of egress when specifically permitted by this code.

1. The doors shall be power operated and shall be capable of being operated manually in the event of power failure, and
2. The doors shall be openable by a simple method from both sides without special knowledge or effort, and
3. The force required to operate the door shall not exceed 30 lb (133 N) to set the door in motion and 15 lb (67 N) to close the door or open it to the minimum required width, and

4. The door shall be openable with a force not to exceed 15 lb (67 N) when a force of 250 lb (1112 N) is applied perpendicular to the door adjacent to the operating device, and
5. The door assembly shall comply with the applicable fire protection rating and, when rated, shall be self-closing or automatic-closing by smoke detection, shall be installed in accordance with NFiPA 80, and shall comply with 705.1.3, and
6. The door assembly shall have an integrated standby power supply, and
7. The door assembly power supply shall be electrically supervised.

1012.5 Special Doorway Requirements

A door, when opening or when fully open, shall not project beyond the building line. See Chapter 32.

1012.6 Special Locking Arrangements

1012.6.1 Except in Group A occupancies, doors in buildings protected throughout by an approved supervised automatic smoke detection system or automatic sprinkler system may be equipped with approved, listed, locking devices which shall:

1. Unlock upon actuation of the approved supervised automatic smoke detection system, automatic fire detection system or automatic sprinkler system, and/or
2. Unlock upon loss of power controlling the locking device, and in all cases
3. Initiate an irreversible process which will unlock the door within 15 seconds whenever a force of not more than 15 lb (67 N) is applied to the door or releasing device and not relock until the door has been opened. Once the irreversible process has started, it shall activate a signal in the vicinity of the door for assuring those attempting to exit that the system is functional. The Building Official may approve a delay not to exceed 30 seconds provided that reasonable life safety is assured.

   EXCEPTION:

   Independent standby power is acceptable as long as the supervised automatic smoke detection system, automatic fire detection system, or automatic sprinkler system, when activated, has precedence over the standby power and unlocks the door. If a non-emergency situation occurs such as a power outage, the door shall be allowed to remain locked until the detection system(s) operate, provided that the power outage does not disable these detection systems. If any of the detection systems are disabled in any way, standby power controlling the locking devices will be interrupted.
4. In addition to 1 and 2 above, and as an alternative to 3 above, for Institutional Occupancy, a special locking system of electromagnetic locks may be utilized when all of the following requirements are met:
   A. These type locks may be used only in wards and wings or other portions of the facility which require security provisions for the protection of its patients.
   B. These systems may be used provided not more than one such system is located in any egress path.
   C. A wiring diagram and system components location map shall be provided under glass adjacent to the fire alarm panel.
   D. An on/off emergency release switch(es) must be capable of interrupting power to all magnetically or electronically locked doors in the facility. Release switch(es) shall be located and properly identified at each nursing station and any other control station which are manned 24 hours.
   E. An additional emergency release switch shall be provided for each locked door and located within 3 ft of the door.

F. Any required emergency release switch shall interrupt the power to the locking device(s) and shall not depend on relays or other devices to cause the interruption of power. If any required emergency release switch is of the locking type, all staff must carry emergency release switch keys. Additional convenience release devices may be provided.

G. Section 1012.6.2 does not apply when this option is used.

5. Each special locking installation shall be approved by the appropriate fire and building inspection authority prior to installation, after installation, and prior to initial use and reviewed periodically thereafter.

1012.6.2 Signs shall be provided on the door adjacent to the release device which read: PUSH. THIS DOOR WILL OPEN IN 15 SECONDS. ALARM WILL SOUND. Sign letters shall be at least 1 inch (25.4 mm) high.

1012.6.3 Emergency lighting shall be provided at the door.

1012.7 Access-Controlled Egress Doors

The entrance doors in a means of egress in Group B, M, R1 or R2 buildings and entrance doors to tenant spaces of Groups B, M, R1 and R2 are permitted to be equipped with an approved entrance and egress access control system which meets all of the following:

1. An approved listed releasing sensor/device, either mechanical or electrical, shall be provided on the egress side arranged to detect an occupant attempting to gain egress. The doors shall be arranged to unlock by a signal from or loss of power to the releasing sensor/device.
2. Loss of power to that part of the access control system which locks the doors shall automatically unlock the doors.
3. The doors shall be arranged to unlock from a manual unlocking device for emergency unlock purposes only. Manual unlocking devices shall be located 40 to 48 inches (1016 to 1219 mm) vertically above the floor and within 5 feet (1524 mm) of the secured doors. Ready access shall be provided to the manual unlocking device and the device shall be clearly identified by a sign. When operated, the manual unlocking device shall result in direct interruption of power to the lock, independent of the access control system electronics. Upon activation of the manual unlocking device, the doors shall remain unlocked for a minimum of 30 seconds
4. Activation of the building fire protective signaling system automatic sprinkler or smoke detection systems, if provided, shall automatically unlock the doors. The doors shall remain unlocked until the signaling systems have been reset.
5. Entrance doors in Group B or M shall not be secured from the egress side during periods that the building is open to the general public.
6. Entrance doors in buildings having a mechanical means of egress in conjunction with an electric strike shall be latched when not energized.
7. Independent standby power, if provided, is acceptable on doors having immediate egress upon activation with a listed releasing sensor/device and, if provided, tie in with the supervised automatic smoke/fire detection or automatic sprinkler system as described in 1012.6.1 (Exception A).

1013 RAMPS

1013.1 General

Where changes in elevations exist in exit access corridors, exits and exit outlets, ramps shall be used when the difference in elevation is 12 inches (305 mm) or less. Ramps in the means of egress shall conform to 1013.2 through 1013.8.

1013.2 Slope

Maximum slope in the direction of travel shall be 1:12. Maximum cross slope shall be 1:48.

EXCEPTIONS:

1. Maximum slope in direction of travel shall be 1:8 for a 3-inch (76 mm) rise maximum and 1:10 for a 6-inch (152 mm) rise maximum.
2. Aisles in Group A occupancies. See 1019.

1013.3 Rise

Maximum rise for a single ramp run shall be 30 inches (762 mm).

EXCEPTION: Aisles in Group A occupancies.

1013.4 Landings

Ramps shall have landings at the top, bottom and at doors opening onto the ramp. Slope of landings shall not be steeper than 1:48.

1013.5 Handrails

Ramps steeper than 1:20 shall be provided with handrails along both sides of a ramp segment and shall conform with the requirements in 1007.5.3, 1007.5.4 and 1007.5.6. If handrails are not continuous, they shall extend at least 12 inches (305 mm) beyond the top and bottom of the ramp segment and shall be parallel with the floor or ground surface. Handrails shall be not less than 34 inches (864 mm) nor more than 38 inches (965 mm) above the ramp surface.

EXCEPTIONS:

1. Handrails are not required when the total rise is 6 inches (152 mm) or less.
2. Aisles in Group A occupancies. See 1019.

1013.6 Drop-Offs

Ramps and landings with drop-offs at the sides shall have a curb with a minimum 4-inch (102 mm) height, wall, railing or a guardrail.

1013.7 Slip Resistance

Ramps shall have a slip resistant surface.

1013.8 Water Accumulation

Exterior ramps and landings shall be designed so water will not accumulate on their surfaces.

1014 BALCONIES, PORCHES, GALLERIES

1014.1 General

1014.1.1 Any exterior balcony, porch, or gallery may serve as a means of egress if it complies with all the requirements as to width, arrangement, headroom and travel distance and materials of construction that are specified in this chapter for means of egress and provided it complies with the requirements of the following paragraphs of 1014.

EXCEPTION: Protection of openings in the building walls opening onto exterior balconies is not required, unless regulated by 1006.2.4.

1014.1.2 All porches, balconies, raised floor surfaces or landings located more than 30 inches (762 mm) above the floor or grade below shall have guardrails as specified in 1015.

1014.1.3 Balconies or other open spaces serving as a means of egress shall be maintained as a required path of travel without obstruction so as to maintain the required minimum width of exit travel.

1014.1.4 Exterior balconies used as an exit access from buildings four or more stories in height shall be of noncombustible construction. See 1404.2 and 1404.3 for fire protection requirements of balconies not used as a means of egress.

1014.1.5 See 3206 for projections over public property.

1015 GUARDRAILS

1015.1 General

All unenclosed floor and roof openings, open and glazed sides of landings and ramps, balconies or porches which are more than 30 inches (762 mm) above finished ground level or a floor below shall be protected by a guardrail. Guardrails shall form a vertical protective barrier not less than 42 inches (I067 mm) high. Open guardrails shall have intermediate rails or ornamental pattern such that a 6-inch (152 mm) diameter sphere cannot pass through any opening. A bottom rail or curb shall be provided that will reject the passage of a 2-inch (51 mm) diameter sphere. Construction of guardrails shall be adequate in strength, durability and attachment for their purpose as described in 1608.2.

EXCEPTIONS:

1. Guardrails are not required on the loading side of loading docks.
2. Guardrails shall be permitted in conformance with requirements for specific occupancies in 1018.

1015.2 Glass

Glass guardrail components shall comply with 2405.5.

1016 EXIT ILLUMINATION AND SIGNS

1016.1 Means of Egress Illumination

1016.1.1 Means of egress shall be illuminated at all times that the building is occupied, with light of not less than 1 foot-candle (11 lx) intensity at the floor level, except theaters which shall have not less than 1/5 foot-candle (2 lx) in aisles. For purposes of illumination, means of egress shall consist only of the exits and aisles, corridors, passageways, ramps, escalators and lobbies leading to the exits.

1016.1.2 An independent and separate source of emergency power shall be provided for means of egress illumination in occupancies with the occupant load listed in Table 1016. Such emergency power shall be automatically actuated and emergency illumination provided for a period of 1 1/2 hours in the event of failure of normal lighting. Emergency lighting facilities shall be arranged to provide initial illumination that is not less than an average of 1 foot-candle (11 lx) and a minimum at any point of 0.2 foot-candle (2 lx) measured along the path of egress at the floor level. Measurements shall be taken at intervals of 2 ft 0 inches (305 mm) between light sources. Illumination levels may decline to 0.6 foot-candle (6 lx) average and a minimum at any point of 0.1 foot-candle (1 lx) at the end of the emergency lighting duration. A maximum illumination uniformity ratio of 40:1 shall not be exceeded.

EXCEPTION: The decline in the illumination level does not apply to occupancy Groups H and I or to Group B and R high rise.

1016.2 Exit Signs

1016.2.1 Exits shall be marked by an approved sign readily visible from any direction of exit access. Access to exits shall be marked by readily visible signs in all cases where the exit or way to reach it is not immediately visible to the occupants. Sign placement shall be such that no point in the exit access is more than 100 ft (30 m) from the nearest visible sign. Every exit sign shall be suitably illuminated by a reliable light source. Externally and internally illuminated signs shall be visible in both the normal and emergency lighting mode.

1016.2.2 All exit and directional signs shall have letters at least 6 inches (152 mm) high with a minimum stroke of 3/4 inch (19 mm). The word "EXIT" shall have letters having a width not less than 2 inches (51 mm) except the letter "I" and the minimum spacing between letters shall be not less than 3/8 inch (10 mm). Signs larger than the minimum established in this paragraph shall have letter widths, strokes and spacing in proportion to their height. Each door to an exit stairway shall have tactile signage that states EXIT and complies with CABO/ANSI A117.1.

EXCEPTION: Group R3 occupancies.

1016.2.3 Externally illuminated signs shall be illuminated by not less than 5 foot-candles (54 lx) and shall employ a contrast ratio of not less than 0.5.

1016.2.3.1 The visibility of an internally illuminated sign shall be the equivalent of an externally illuminated sign. The 0.5 contrast ratio shall be derived from luminance measurements obtained in units of foot-lamberts (cd/m). Approved self-luminous or electroluminescent signs which operate in the 5,000 to 6,000 angstrom (5 x 10- to 6 x 10 -m) range and which provide evenly illuminated letters shall have a luminance of not less than 0.06 foot-lamberts (0.21 cd/m).

1016.2.3.2 All exit signs for egress elements shall be provided an emergency source of power in accordance with 1016.1.2.

EXCEPTION: Approved self-luminous signs.

1016.2.3.3 Where a main entrance serves as an exit and is visible to the occupants, an exit sign is not required over the main entrance door.

1016.2.4 Where exit lights or signs or the exits themselves are not visible from the exit approach, directional signs indicating the way of egress shall be provided. The level at which there is direct exit to the exterior shall also be clearly indicated.

1016.2.5 An independent and separate source of power shall be provided for exit signs in occupancies at the occupant load listed in Table 1016.

1016.2.6 Signs installed as projections from a wall or ceiling within the means of egress shall provide vertical clearance no less than 7 ft (2134 mm) from the walking surface.

Table 1016
Special Power for Exit Signs and Illumination

Occupancy	Minimum Occupant Load
Group A	All
Group I	All
Group H	All[1]
Group R	Greater than 100
Group B & M	Greater than 150
Group E	Greater than 300

Note:

1. Individual rooms 500 sq ft (46.5 m^2) or less in mixed occupancy and buildings 500 sq ft (46.5 m^2) or less are exempted.

1016.3 Stair Identification

An approved sign shall be located at each floor level landing in all enclosed stairways of buildings four or more stories in height. The sign shall indicate the floor level and the availability of roof access from that stairway and an identification of the stairway. The sign shall also state the floor level of and direction to exit discharge. The sign shall be located approximately 5 ft (1524 mm) above the floor landing in a position which is readily visible when the door is in the open or closed position.

1017 EXIT OBSTRUCTIONS

Where floor space is occupied by tables, chairs or other movable furniture, aisles not less than 36 inches (914 mm) clear width shall be maintained to provide ready access to egress doors.

1018 SPECIAL EGRESS REQUIREMENTS BY OCCUPANCY

The general requirements of Chapter 10 apply to all occupancies except as modified for specific occupancies in accordance with 1019 through 1027.

1019 ASSEMBLY

1019.1 Means of Egress Capacity

1019.1.1 The minimum aggregate width of main entrance doorways for Group A Assembly Occupancies shall be sufficient to accommodate 50% of the occupant load. Each level of a Group A, Assembly Occupancy shall have access to a main exit and shall be provided with additional exits of sufficient width to accommodate one-half of the total occupant load served by that level.

1019.2 Foyers and Lobbies

1019.2.1 In every Group A - Large Assembly occupancy, a foyer consisting of a space at a main entrance of the auditorium or place of assembly shall be provided. Such foyer, if not directly connected to a public street by all the main entrances or exits, shall have a straight and unobstructed corridor or passage to every such main entrance and exit.

1019.2.2 The width of a foyer at any point shall be not less than the combined width of aisles, stairways, and passageways tributary thereto.

1019.2.3 In theaters and similar Group A occupancies, where persons are admitted to the building at times when seats are not available and are allowed to wait in a lobby or similar space, such use of lobby or similar space shall not encroach upon the required clear width of exits. Such waiting areas shall be separated from the required exitways by substantial permanent partitions or by fixed rigid railings not less than 42 inches (1067 mm) high.

1019.3 Interior Balcony and Gallery

1019.3.1 Means of Egress. For balconies or galleries of Group A occupancies having a seating capacity of over 50, at least two means of egress shall be provided, one from each side of every balcony or gallery, leading directly to a street or exit court.

1019.3.2 Two means of egress shall be required from theater balconies when the occupancy exceeds 50.

1019.3.3 Enclosure and Capacity. All interior stairways and other vertical openings shall be enclosed and protected as provided in this chapter, except that stairs may be open between balcony and main assembly floor in occupancies such as theaters, churches and auditoriums. The means of egress capacity required for balconies or galleries shall be determined on the same basis as those required for the occupancy use.

1019.3.4 Travel Distance. The maximum travel distance for balcony or gallery from any seat to an exit shall be determined on the same basis as the building occupancy.

1019.4 Stages

1019.4.1 Where two means of egress are required, they shall be separate with at least one means of egress on each side of the stage.

1019.4.2 The means of egress from lighting and access catwalks, galleries and gridirons shall meet the requirements for Group F occupancies.

EXCEPTIONS:

1. A minimum width of 22 inches (559 mm) shall be permitted for lighting and access catwalks.
2. A second means of egress is not required from these areas where a means of escape to a floor or to a roof is provided. Ladders, alternating tread stairs, or spiral stairs shall be permitted in the means of escape.

1019.4.3 Each tier of dressing rooms shall be provided with two exits.

1019.4.4 Stairways from stage and dressing rooms need not be enclosed.

1019.5 Tents

Tent exits, aisles, seating, etc., shall conform with the requirements of the Standard Fire Prevention Code. All exits shall be kept free and clear of obstructions while the tent is occupied by the public.

1019.6 Projection Rooms

The projection room shall be provided with not less than one exit having a minimum opening of not less than 30 inches (762 mm) wide and 80 inches (2032 mm) high.

1019.7 Doors

1019.7.1 A key locking device may be used from the egress side on the main exterior exit doors on Group A-2 having an occupancy of 300 or less, subject to the following:

1. There is a readily visible durable sign on or adjacent to the door stating: THIS EXIT TO REMAIN UNLOCKED WHEN THIS BUILDING IS OCCUPIED. The sign shall be in letters no less than 1 inch (25.4 m) high on a contrasting background.
2. The locking device must be of a type that will be readily distinguishable as locked.
3. The main exit door is a single door or one pair of doors.
4. When unlocked, the door or both leaves of the pair must be free. The use of the key locking device may be revoked by the building official for due cause.

1019.7.2 Each door in a means of egress from an area of Group A occupancy may be provided with a latch or lock only if it is panic hardware or fire exit hardware, which releases when pressure of no more than 15 lb (67 N) is applied to the releasing devices in the direction of the exit travel. Such releasing devices may be bars or panels extending not less than one-half the width of the door and placed at heights suitable for the service required, but not less than 30 (762 mm) nor more than 44 inches (1118 mm) above the floor. Whenever panic hardware is used on a labeled fire door, the panic hardware shall be labeled as fire exit hardware.

1019.7.3 If balanced doors are used and panic hardware is required, the panic hardware shall be of the pushpad type and the pad shall not extend more than one-half the width of the door measured from the latch side.

1019.8 Stairway Construction

1019.8.1 In buildings of Group A occupancy, flights of less than three risers shall not be used in stairways, interior or exterior, passageways, aisles, at entrance or elsewhere in connection with required exits. To overcome lesser differences in level, gradients not exceeding 1:8 may be used. See 1019.10 for additional aisle and stair information in assembly occupancies.

1019.8.2 Aisles in Group A occupancies with a gradient exceeding 1:8 shall consist of a series of risers and treads extending across the full width of the aisles and shall be illuminated. Such aisles shall comply with 1019.8.2.1 through 1019.8.2.3.

1019.8.2.1 Tread depths shall be a minimum of 11 inches (279 mm) and be uniform within each aisle.

EXCEPTIONS:

1. Nonuniformities shall not exceed 3/16 inch (4.8 mm) between adjacent treads.
2. Where seating is on stepped platforms, one tread in each seat platform may have a greater width to accommodate access to seats.

1019.8.2.2 On aisle stairs where the gradient must be the same as the gradient of adjoining seating areas, the riser height shall be not less than 4 inches (102 mm) nor more than 8 inches (203 mm) and it shall be uniform within each flight.

EXCEPTION: Riser height may be nonuniform but only to the extent necessitated by changes in the gradient of the adjoining seating area to maintain adequate sightlines. Where nonuniformities exceed 3/16 inch (4.8 mm) between adjacent risers, the exact location of such nonuniformities shall be indicated with a distinctive marking stripe on each tread at the nosing or leading edge adjacent to the nonuniform risers.

1019.8.2.3 A contrasting marking stripe shall be provided on each tread at the nosing or leading edge such that the location of each tread is readily apparent when viewed in descent. Such stripe shall be a minimum of 1 inch (25.4 mm) wide and a maximum of 2 inches (51 mm) wide.

EXCEPTION: The marking stripe may be omitted where tread surfaces are such that the location of each tread is readily apparent when viewed in descent.

1019.9 Guardrails

1019.9.1 Assembly aisles located more than 30 inches (762 mm) above the floor or grade below shall have guardrails in accordance with 1015.

1019.9.2 Where an elevation change of 30 inches (762 mm) or less occurs between an aisle parallel to the seats (cross aisle) and the adjacent floor or grade below, guardrails not less than 26 inches (660 mm) above the aisle floor shall be provided.

EXCEPTION: Where the backs of seats on the front of the cross aisle project 24 inches (610 mm) or more above the adjacent floor of the aisle, a guardrail need not be provided.

1019.9.3 Guardrails on a balcony, loge or gallery immediately in front of the first row of fixed seats and which are not at the end of an aisle shall be not less than 26 inches (660 mm) high. Guardrails 42 inches (1067 mm) high and the width of the aisle shall be located at the front edge of a balcony, loge or gallery where the aisle terminates. When the slope of the aisle is less than 1:8, the guardrail may be 36 inches (914 mm) high where the aisle terminates.

1019.9.4 Guardrails are not required on the audience side of stages, raised platforms, and other raised floor areas such as runways, ramps and side stages used for entertainment or presentations.

1019.9.5 Permanent guardrails are not required at vertical openings in the performance area of stages.

1019.9.6 Guardrails are not required where the side of an elevated walking surface is to be open for the normal functioning of special lighting or for access and use of other special equipment.

1019.10 Assembly Aisles and Seating

1019.10.1 General.

1019.10.1.1 Provisions in 1019.10 shall apply to all assembly aisles and seating except for special provisions relating to seating for reviewing stands, grandstands, and bleachers.

1019.10.1.2 Every portion of any building which contains seats, tables, displays, equipment, or other material shall be provided with aisles leading to exits.

1019.10.2 Aisle Width.

1019.10.2.1 Aisle width shall provide sufficient egress capacity for the number of persons accommodated by the catchment area served by the aisle. See 1019.10.4. The catchment area served by an aisle is that portion of the total space that is naturally served by that section of the aisle. In establishing catchment areas the assumption shall be made that there is a balanced use of all means of egress, with the number of persons in proportion to egress capacity.

1019.10.2.2 Where aisles converge to form a single path of egress travel, the required egress capacity of that path shall be not less than the combined required capacity of the converging aisles.

1019.10.2.3 Those portions of aisles, where egress is possible in either of two directions, shall be uniform in required width.

1019.10.2.4 In all balconies and galleries having more than 20 rows of seats, there shall be provided a crossaisle not less than 4ft (1219 mm) wide leading directly to an exit.

1019.10.2.5 The minimum clear width of aisles shall:

1. 48 inches (1219 mm) for stairs having seating on each side.
2. 36 inches (914 mm) for stair having seating on only one side.
3. 23 inches (584 mm) between a stair handrail or guardrail and seating when the aisle is subdivided by a handrail. See 1007.5.
4. 42 inches (1067 mm) for level or ramped aisles having seating on both sides.
5. 36 inches (152 mm) for level or ramped aisles having seating only on one side.
6. 23 inches (584 mm) between a stair handrail and seating when an aisle does not serve more than five rows on one side.

1019.10.2.6 The minimum clear width of aisles in existing buildings shall be in accordance with 3402.

1019.10.3 Clear Width of Rows.

1019.10.3.1 Where seating rows have 14 or fewer seats, the row minimum clear width shall be not less than 12 inches (305 mm) measured as the clear horizontal distance from the back of the row ahead and the nearest projection of the row behind. Where chairs have automatic or self-rising seats, the measurement shall be made with seats in the raised position. Where any chair in the row does not have an automatic or self-rising seat, the measurements shall be made with the seat in the down position. For seats with folding tablet arms, row spacing shall be determined with the tablet arm down.

1019.10.3.2 For rows of seating served by aisles or doorways at both ends there shall be no more than 100 seats per row and the row minimum clear width of 12 inches (305 mm) shall be increased by 0.3 inch (7.6 mm) for every additional seat beyond 14, but the minimum clear width need not exceed 22 inches (559 mm).

1019.10.3.3 For rows of seating served by an aisle or doorway at one end only, minimum clear width of 12 inches (305 mm) between rows shall be increased by 0.6 inch (15.2 mm) for every additional seat beyond seven, but the minimum clear width need not exceed 22 inches (559 mm).

1019.10.3.4 For rows of seating served by an aisle or doorway on one end only, the path of travel shall not exceed 30ft (9144 mm) from any seat to a point where a person has a choice of two path of travel to two exits.

1019.10.4 Means of Egress Capacity. The width of aisles and other means of egress shall provide sufficient capacity in accordance with the following formulas where clear width is measured to walls, edges of seating and tread edges except for permitted projections:

1. At least 0.3 inch (7.6 mm) of width for each person served shall be provided on stairs having riser height 7 inches (178 mm) or less and tread depths 11 inches (279 mm) or greater, measured horizontally between tread nosings.
2. At least 0.005 inches (0.127 mm) of additional stair width for each person shall be provided for each 0.10 inch (2.5 mm) of riser height above 7 inches (178 mm).
3. Where egress requires stair descent, at least 0.075 inch (1.9 mm) of additional width for each person shall be provided on those portions of stair width having no handrail within a horizontal distance of 30 inches (762 mm).
4. Level or ramped means of egress, with slopes less than 1:8, shall have at least 0.22 inch (5.6 mm) of clear width for each person served.
5. Doorways shall have at least 0.2 inch (5.1 mm) of clear width per person served.

1019.10.5 Travel Distance. Exits and aisles shall be so located that the travel distance to an exit door shall not be greater than 200 ft (61 m) measured along the line of travel. Travel distance may be increased to 250 ft (76 m) in sprinklered buildings.

1019.10.6 Aisle Slope. Aisles shall not have a slope of more than 1:8.

1019.10.7 Aisle Termination.

1019.10.7.1 Dead-end aisles which terminate only at one end with a cross aisle, foyer, doorway or vomitory giving access to an exit, shall be not greater than 20ft (6096 mm) long.

EXCEPTION: A longer dead-end aisle is permitted where seats served by the dead-end aisle are not more than 24 seats from another aisle, measured along a row of seats having a minimum clear width of 12 inches (305 mm) plus 0.6 inch (15.2 mm) for each additional seat above seven in the row.

1019.10.7.2 Each end of a cross aisle shall terminate at an aisle, foyer, doorway or vomitory giving access to an exit.

1019.10.8 Aisle Obstructions. There shall be no obstructions in the required width of aisles except for handrails as provided in 1007.5 and 1019.10.2.5.

1019.10.9 Seat Stability. In places of assembly used regularly for theatrical or similar performances, or for the display of motion pictures, the seats shall be securely fastened to the floor. In restaurants, cafeterias, gymnasiums and similar multipurpose places of assembly, the seats shall not be required to be fastened to the floor. All other Group A occupancies seating more than 200 persons shall have seats fastened to the floor. All seats in balconies or galleries shall be secured to the floor except that in railed-in enclosures, boxes, or loges, with level floors and having no more than 14 seats, the seat need not be fastened to the floor, or have separating arms.

1019.10.10 Other Provisions. Other stair and ramp provisions are found in 1007 and 1013.

1019.11 Grandstands, Bleachers and Reviewing Stands

1019.11.1 General.

1019.11.1.1 Scope. These provisions shall apply to buildings or structures of an assembly occupancy which provides permanent, temporary or portable seating facilities.

1019.11.1.2 Definitions. For the purpose of this section, certain special terms are defined as follows:

AISLE ACCESSWAY – that portion of an exit access that leads to an aisle.

SMOKE-PROTECTED ASSEM BLY SEATING – seating served by a means of egress that is not subject to smoke accumulation within or under a structure.

1019.11.2 Smoke-Protected Assembly Seating.

1019.11.2.1 The lowest portion of the roof shall not be less than 15 ft (4572 mm) above the highest aisle or aisle accessway.

1019.11.2.2 All enclosed areas shall be equipped with an approved automatic sprinkler system.

EXCEPTIONS:

1. The floor area used for performances or entertainment is restricted to low fire hazard use and the roof is more than 50 ft (15 m) above the floor level.
2. Press boxes and storage facilities less than 1,000 sq ft (93 m^2) in outdoor seating facilities when all seating and means of egress are essentially open to the outside.

1019.11.2.3 All means of egress shall be provided with smoke actuated ventilation or natural ventilation designed to maintain the smoke level at least 6 ft (1829 mm) above the floor of the means of egress.

1019.11.3 Travel Distance. The travel distance shall comply with Table 1004. The distance shall be measured along the line of travel to an exit. Where aisles are required, the distance shall be measured along the aisles and aisle accessway without travel over or on the seats.

EXCEPTIONS:

1. Smoke-protected assembly seating - The travel distance from each seat to the nearest entrance to a vomitory or concourse shall not exceed 200 ft (61 m). The travel distance from the entrance to the vomitory or concourse to a stair, ramp or walk on the exterior of the building shall not exceed 200 ft (61 m).
2. Outdoor assembly seating - The travel distance from each seat to the building exterior shall not exceed 400 f t (122 m). The travel distance shall not be limited in facilities of Type I or II construction.

1019.11.4 Aisles. Aisles shall be provided in all seating facilities except that an aisle may be omitted when all of the following conditions exist:

1. Seats are without backrests.
2. The rise from row to row does not exceed 6 inches (152 mm) per row.
3. The row spacing does not exceed 28 inches (711 mm) unless the seat boards and footboards are at the same elevation.

4. The number of rows does not exceed 16 rows in height.
5. The first seating board is not more than 12 inches (305 mm) above the ground or floor below or a cross aisle.
6. Seat boards have a continuous flat surface.
7. Seat boards provide a walking surface with a minimum width of 11 inches (279 mm).
8. Egress from seating is not restricted by rails, guards or other obstructions.

1019.11.5 Aisle Width.

1019.11.5.1 Aisle width shall provide sufficient egress capacity for the number of persons accommodated by the catchment area served by the aisle. The catchment area served by an aisle is that portion of the total space that is naturally served by that section of the aisle. In establishing catchment areas, the assumption shall be made that there is a balanced use of all means of egress, with the number of persons in proportion to egress capacity.

1019.11.5.2 When bench-type seating is used, the number of persons shall be based on one person for each 18 inches (457 mm) of length of the bench.

1019.11.5.3 Where aisles converge to form a single path of egress travel, the required egress capacity of that path shall be not less than the combined required capacity of the converging aisles.

1019.11.5.4 Where egress is possible in either of two directions, aisles shall be uniform in required width.

1019.11.5.5 The minimum clear width of aisles shall be:

1. 48 inches (1219 mm) for stairs having seating on each side.
2. 36 inches (914 mm) for stairs having seating on only one side.
3. 23 inches (584 mm) between a stair handrail or guardrail and seating when the aisle is subdivided by a handrail.
4. 42 inches (1067 mm) for level or ramped aisles having seating on both sides.
5. 36 inches (914 mm) for level or ramped aisles having seating only on one side.
6. 23 inches (584 mm) between a stair handrail and seating when an aisle does not serve more than 5 rows on one side.

1019.11.5.6 The minimum clear width of aisles in existing buildings shall be in accordance with 3402.

1019.11.6 Aisle Termination.

1019.11.6.1 Aisles shall terminate at an aisle, foyer, doorway or vomitory giving access to an exit.

EXCEPTION: Dead-end aisles terminating at a cross aisle, foyer, doorway or vomitory giving access to an exit at only one end and meeting any of the following conditions shall be permitted:

1. Where dead-end aisles do not exceed 20 ft (6096 mm).
2. Where there are not more than 24 seats between aisles. The aisle accessway serving those seats shall have a minimum clear width of 12 inches (305 mm) plus 0.6 inch (15.2 mm) for each additional seat above seven in the row.
3. For smoke-protected assembly seating where there are not more than 40 seats between aisles. The aisle accessway serving those seats shall have a clear minimum width of 12 inches (305 mm) plus 0.3 inch (7.6 mm) for each additional seat above seven in the row.
4. For smoke-protected assembly seating, dead ends in vertical aisles do not exceed a distance of 21 rows.

5. When seats are without backrests, dead ends in vertical aisles do not exceed a distance of 16 rows.

1019.11.6.2 Each end of a cross aisle shall terminate at an aisle, foyer, doorway or vomitory giving access to an exit.

1019.11.7 Aisle Walking Surfaces. Aisles with a slope not exceeding 1:8 shall consist of a ramp having a slip resistant walking surface. Aisles with a slope exceeding 1:8 shall consist of a series of risers and treads extending across the full width of aisles and complying with the following requirements.

1. Tread depths shall be a minimum of 11 inches (279 mm) and be uniform within each aisle.

   EXCEPTION: Nonuniformities shall not exceed 3/16 inch (4.8 mm) between adjacent treads.

2. On aisle stairs where the slope must be the same as the slope of adjoining seating areas, the riser height shall be not less than 4 inches (102 mm) nor more than 8 inches (203 mm) and it shall be uniform within each flight. Riser heights not exceeding 9 inches (229 mm) shall be permitted where they are necessitated by the slope of adjacent seating areas to maintain sightlines.

   EXCEPTION: Riser height may be nonuniform but only to the extent necessitated by changes in the slope of the adjoining seating area to maintain adequate sightlines. Where nonuniformities exceed 3/16 inch (4.8 mm) between adjacent risers, the exact location of such nonuniformities shall be indicated with a distinctive marking stripe on each tread at the nosing or leading edge adjacent to the nonuniform risers.

3. A contrasting marking stripe shall be provided on each tread at the nosing or leading edge such that the location of each tread is readily apparent when viewed in descent. Such stripe shall be a minimum of 1 inch (25.4 mm) wide and a maximum of 2 inches (51 mm) wide.

   EXCEPTION: The marking stripe may be omitted where tread surfaces are such that the location of each tread is readily apparent when viewed in descent.

1019.11.8 Aisle Handrails.

1019.11.8.1 Ramped aisles having a slope exceeding 1:15 and aisle stairs shall be provided with handrails located either at the side or within the aisle width.

EXCEPTI ONS:

1. Handrails are not required for ramped aisles having a slope not exceeding 1:8 and having seating on both sides.
2. Handrails are not required if, at the side of the aisle, there is a guardrail that complies with graspability requirements for handrails.

1019.11.8.2 Where there is seating on both sides of the aisle, handrails located within the aisle shall be discontinuous with gaps or breaks at intervals not exceeding 5 rows to facilitate access to seating and to permit crossing from one side of the aisle to the other. These gaps or breaks shall have a clear width of at least 22 inches (559 mm) and not greater than 36 inches (914 mm), measured horizontally, and the handrail shall have rounded terminations or bends.

1019.11.8.3 Where handrails are provided in the middle of aisle stairs, there shall be an additional, intermediate handrail located approximately 12 inches (305 mm) below the main handrail.

1019.11.9 Rows.

1019.11.9.1 Seating rows shall have aisle accessways with minimum clear width measured in accordance with 1019.11.9.2 and increased, for row length, in accordance with 1019.11.9.3 and 1019.11.9.4.

1019.11.9.2 The minimum clear width of aisle accessways shall be not less than 12 inches (305 mm) measured as the clear horizontal distance from the back of the row or guardrail ahead and the nearest projection of the row behind. Where chairs have automatic or self-rising seats, the measurement shall be made with seats in the raised position. Where any chair in the row does not have an automatic or self-rising seat, the measurement shall be made with the seat in the down position.

1019.11.9.3 For rows of seats served by aisles or doorways at both ends, there shall be no more than 100 seats per row and the minimum clear width of 12 inches (305 mm) for aisle accessways shall be increased by 0.3 inch (7.6 mm) for every additional seat beyond 14, but the minimum clear width need not exceed 22 inches (559 mm).

EXCEPTION: For smoke-protected assembly seating the row length limits, beyond which the aisle accessway minimum clear width of 12 inches (305 mm) must be increased, shall be in accordance with Table 1019.11.9.3.

Table 1019.11.9.3
Smoke-Protected Assembly Seating
12-Inch Aisle Accessway Row Length Limits

Total No. of Seats In the Space	No. of Seats Per Row Permitted to Have a Minimum 12-inch (305 mm) Clear Width Aisle Accessway	
	Aisle or Doorway At Both Ends of Rows	Aisle or Doorway At One End of Row
<4,000	14	7
4,000	15	7
7,000	16	8
10,000	17	8
13,000	18	9
16,000	19	9
19,000	20	10
>22,000	21	11

1019.11.9.4 For rows of seats served by an aisle or doorway at one end only, the aisle accessway minimum clear width of 12 inches (305 mm) shall be increased by 0.6 inch (15.2 mm) for every additional seat beyond seven, but the minimum clear width need not exceed 22 inches (559 mm).

EXCEPTION: See exception to 1019.11.9.3.

1019.11.9.5 For rows of seats served by an aisle or doorway on one end only, the path of travel shall not exceed 30 ft (9144 mm) from any seat to a point where a person has a choice of two directions of egress travel.

EXCEPTION: For smoke-protected assembly seating, the path of travel shall not exceed 50 ft (15m) from any seat to a point where a person has a choice of two directions of egress travel.

1019.11.10 Capacity of Means of Egress.

1019.11.10.1 The minimum clear width of aisles and other means of egress shall comply with 1019.11.10.2 in the case without smoke-protected assembly seating and with 1019.11.10.3 in the case of smoke-protected assembly seating. The clear width shall be measured to intermediate handrails, edges of seating, tread edges and walls.

EXCEPTION: Outdoor assembly seating otherwise complying with the requirements for smoke-protected seating shall have means of egress capacities determined by either the provisions of 1019.11.10.3 or 1019.11.10.4.

1019.11.10.2 Without smoke-protected assembly seating. The minimum clear width of aisles and other means of egress shall provide sufficient capacity in accordance with the following:

1. At least 0.3 inch (7.6 mm) of width for each person served shall be provided on stairs having riser heights 7 inches (178 mm) or less and tread depths 11 inches (279 mm) or greater, measured horizontally between tread nosings.
2. At least 0.005 inch (0.127 mm) of additional stair width for each person shall be provided for each 0.10 inch (2.5 mm) of riser height above 7 inches (178 mm).
3. Where egress requires stair descent, at least 0.075 inch (1.9 mm) of additional width for each person shall be provided on those portions of stair width having no handrail within a horizontal distance of 30 inches (762 mm).
4. Level or ramped means of egress with slopes not exceeding 1:10 shall have at least 0.2 inch (5.1 mm) of clear width for each person served. Ramps with slopes exceeding 1:10 shall have at least 0.22 inch (5.6 mm) of clear width per person.
5. Doorways shall have at least 0.2 inch (5.1 mm) of clear width per person served.

1019.11.10.3 Smoke-protected assembly seating. The minimum clear width of aisles and other means of egress for smoke-protected assembly seating shall provide sufficient capacity in accordance with the following table. The number of seats specified shall be within a single assembly space and interpolation shall be permitted between the specific values shown.

Table 1019.11.10.3
Minimum Egress Widths For Smoke-Protected Assembly Seating

	Inches of Clear Width Per Seat Served			
Number of Seats in Space	**Stairs With Handrails[1] Within 30 Inches**	**Stairs Without Handrail[1] Within 30 Inches**	**Passageway, Doorways, And Ramps Not Steeper Than 1:10**	**Ramps Steeper Than 1:10**
≤2,000	0.300	0.375	0.200	0.220
5,000	0.200	0.250	0.150	0.165
10,000	0.130	0.163	0.100	0.110
15,000	0.096	0.120	0.070	0.077
20,000	0.076	0.095	0.056	0.066
≥25,000	0.060	0.075	0.044	0.048

1 in = 25.4 mm

Notes:

1. If risers exceed 7 inches in height, the minimum clear width of stairs determined from the table shall be multiplied by factor A where A = 1 + (Riser height - 7.0) / 5.

1019.11.10.4 Outdoor Smoke-Protected Assembly Seating. The minimum clear width of aisles and other means of egress, in inches, shall be not less than the total occupant load served by the egress element multiplied by 0.08 when the egress is by stair and multiplied by 0.06 when the egress by ramps, corridors, tunnels or vomitories.

1019.11.11 Guardrails. Guardrails shall be located along open-sided walking surfaces and elevated seating facilities which are located more than 30 inches (762 mm) above the floor or ground below. Guardrails shall be not less than 42 inches (1067 mm) in height measured vertically above the leading edge of the tread, adjacent walking surface or adjacent seatboards.

EXCEPTION: Guardrails at the front row of seats, which are not located at the end of an aisle and where there is no cross aisle, may have a height of not less than 26 inches (660 mm).

1019.11.12 Bleacher Footboards. Bleacher footboards shall be provided for all rows of seats above the third row or beginning at such a point where the seating plank is more than 2 ft (610 mm) above the ground or floor below. When the same platform is used for both seating and footrests, footrests are not required, provided each level or platform is not less than 24 inches (610 mm) wide. When projected on a horizontal plane, there shall be no horizontal gaps exceeding 1/4 inch (6.4 mm) between footboards and seatboards. At aisles, there shall be no horizontal gaps exceeding 1/4 inch (6.4 mm) between footboards.

1020 BUSINESS

1020.1 Single Exit

A single exit is permitted in Group B occupancies when meeting the following conditions:

1. Maximum two stories in height.
2. Each floor area served by that exit does not exceed 3,500 sq ft (325 m^2)
3. There are no more than 40 persons above the street floor as determined by Table 1003.1.
4. The maximum distance of travel to the exit does not exceed 75ft (23m).

1020.2 Locking

A key locking device may be used from the egress side on the main exterior exit door on Group B, occupancies subject to the following:

1. There is a readily visible durable sign on or adjacent to the door stating: THIS EXIT TO REMAIN UNLOCKED WHEN THIS BU ILDING IS OCCUPIED. The sign shall be in letters no less than 1 inch (25.4 mm) high on a contrasting background.
2. The locking device must be of a type that will be readily distinguishable as locked.
3. The main exit door is a single door or one pair of doors.
4. When unlocked, the door or both leaves of the pair must be free. The use of the key locking device may be revoked by the building off1cial for due cause.

1021 EDUCATIONAL

1021.1 Special Exit Requirement

1021.1.1 Rooms used for first grade children and younger shall be located on the floor of exit discharge. Rooms used for second grade children shall not be located more than one story above the floor of exit discharge.

1021.1.2 Every room or space used for classroom or other educational purposes or normally subject to student occupancy shall have at least one outside window for emergency rescue and ventilation. Such window shall be openable from the inside without the use of tools and shall provide a clear opening of not less than 20 in. (50.8 cm) in width, 24 in. (61 cm) in height, and 5.7 sq. ft. (0.53 m^2) in area. The bottom of the opening shall be not more than 32 in. (81 cm) above the floor for grade 5 and younger pupils and 44 in. (112 cm) above the floor for grades 6 through 12. The clear opening shall permit a rectangular solid, with a minimum width and height that provides the required 5.7 sq. ft. (0.53 m^2) opening and a minimum depth of 20 in. (50.8 cm) to pass fully through the opening.

EXCEPTIONS:

1. In buildings protected throughout by an approved, automatic sprinkler system.
2. Where the room or space has a door leading directly to the outside of the building.

3. In rooms located higher than three stories above grade, the openable clear height, width, and area of the window shall be permitted to be modified to the dimensions necessary for ventilation.
4. Where the room or space complies with the following:
   a. Doors open directly to a corridor with exit access in one direction and provide access through adjacent classrooms or directly to a separate smoke compartment with exit access in the other direction, and
   b. The compartments are separated by smoke barriers having a 1 hour fire resistance rating with self-closing or automatic closing doors, and
   c. The length of travel to exits along such paths shall not exceed 150ft. (45 m), and
   d. Each communicating door shall be identified, and
   e. No locking device shall be allowed on the communicating doors.

1021.2 Panic and Fire Exit Hardware

1021.2.1 Each door in a means of egress from an area of Group E occupancy having an occupant load of 100 or more may be provided with a latch or lock only if it is panic hardware or fire exit hardware, which releases when a force of no more than 15 lb (67 N) is applied to the releasing devices in the direction of the exit travel. Such releasing devices may be bars or panels extending not less than one-half the width of the door and placed at heights suitable for the service required, but not less than 30 (762 mm) nor more than 44 inches (1118 mm) above the floor. Whenever panic hardware is used on a labeled fire door, the panic hardware shall be labeled as fire exit hardware.

1021.2.2 If balanced doors are used and panic hardware is required, the panic hardware shall be of the pushpad type and the pad shall not extend more than one-half the width of the door measured from the latch side.

1022 FACTORY-INDUSTRIAL

1022.1 Travel Distance

For allowable increase in travel distance, see 1004.1.4.

1022.2 Doors

Egress doors shall conform to the requirements of 1012.1.2 except in factory areas with an occupant load of 10 or less.

1022.3 Locks

A key locking device may be used from the egress side on the main exterior exit door on Group F occupancies subject to the following:

1. There is a readily visible durable sign on or adjacent to the door stating: THIS EXIT TO REMAIN UNLOCKED WHEN THIS BUILDING IS OCCUPIED. The sign shall be in letters no less than 1 inch (25.4 mm) high on a contrasting background.
2. The locking device must be of a type that will be readily distinguishable as locked.
3. The main door is a single door or one pair of doors.
4. When unlocked, the door or both leaves of the pair must be free. The use of the key locking device may be revoked by the building official for due cause.

1022.4 Handrails and Guardrails

Handrails and guardrails shall be installed in accordance with 1007.5 and 1015.

EXCEPTION: In areas not accessible to the public in Group F, the clear distance between rails measured at right angles to the rails shall not exceed 21 inches (533 mm).

1023 HAZARDOUS

1023.1 Doors

All egress doors in Group H occupancies shall swing in the direction of exit travel.

1023.2 Handrails and Guardrails

Handrails and guardrails shall be installed in accordance with 1007.5 and 1015.

EXCEPTION: In areas not accessible to the public in Group H, the clear distance between rails measured at right angles to the rails shall not exceed 21 inches (533 mm).

1024 INSTITUTIONAL

1024.1 Group I Unrestrained Occupancy

1024.1.1 Horizontal Exits.

1024.1.1.1 Horizontal exits meeting the requirement of 1009 may comprise two-thirds the required exits from any building or floor area in Group I Unrestrained occupancies.

1024.1.1.2 The capacity of areas of refuge shall be computed in accordance with 1009 and the area for each occupant as follows:

1. 30q ft (2.8 m^2) per patient for hospitals and nursing homes.
2. 15 sq ft (1.4 m^2) per resident for ambulatory Group I Unrestrained uses.
3. 6 sq ft (0.6 m^2) per occupant on stories not housing bed or litter patients in Group I Unrestrained uses.
4. 3 sq ft (0.3 m^2) per occupant in all other cases.

1024.1.2 Doors and Corridors.

1024.1.2.1 Doors shall be not less than 44 inches (1118 mm) clear width in the following:

1. doorways to areas housing bedridden patients
2. doorways between patient rooms and exits
3. exterior exit doorways.

EXCEPTION: Exit doors not subject to use for patient care shall be not less than 36 inches (914 mm) clear width.

1024.1.2.2 Corridors, ramps, or passageways shall be a minimum of 8 ft (2438 mm) clear width in the following:

1. all areas occupied by patients
2. all means of egress from patient areas.

1024.1.3 Locks. Patient rooms or tenant space egress doors in Group I occupancies shall not be lockable except in places of restraint or detention. See 1012.6.

1024.1.4 Handrails. All stairs or changes in grade in hospitals, nursing homes, convalescent homes and similar occupancies shall be equipped with handrails located not less than 30 (762 mm) nor more than 38 inches, (965 mm) above the leading edge of a tread.

EXCEPTION: Handrails that form part of a guardrail may be 42 inches (1067 mm) high.

1024.1.5 Institutional Illumination. Each building housing a Group I Unrestrained occupancy equipped with or requiring the use of life support systems shall have illumination for the means of egress and emergency lighting equipment supplied by the life safety branch of the electrical system described in Chapter 3, NFiPA 99.

1024.1.6 Smokeproof Enclosure. The smokeproof enclosure required by 1005.5 may be omitted when all required exit stairways are pressurized in accordance with 412.11(5).

1024.2 Group I Restrained Occupancy

1024.2.1 Mixed Use. Refer to 409.2.1 for means of egress requirements for areas classified as a different occupancy and traversing other use areas.

1024.2.2 Subclassification of Occupancy.

1024.2.2.1 Group I Restrained shall be categorized as one of the following Use Conditions:

1. **Use Condition 1 - Free Egress**

   Free movement is allowed from sleeping areas, and other spaces where access or occupancy is permitted to the exterior by means of egress meeting the requirements of this code. Group I Restrained qualifying for Use Condition 1 may be classified as a Group R occupancy. See 309.2.

2. **Use Condition 2 - Zoned Egress**

   Free movement is allowed from sleeping areas and any other occupied smoke compartment to one or more other smoke compartments.

3. **Use Condition 3 - Zoned Impeded Egress**

   Free movement is allowed within individual smoke compartments, such as within a residential unit comprised of individual sleeping rooms and group activity space, with egress impeded by remote control release of means of egress from such smoke compartment to another smoke compartment.

4. **Use Condition 4 - Impeded Egress**

   Free movement is restricted from an occupied space. Remote controlled release is provided to permit movement from all sleeping rooms, activity spaces and other occupied areas within the smoke compartment and to other smoke compartments.

5. **Use Condition 5 - Contained**

   Free movement is restricted from an occupied space. Staff controlled manual release at each door is provided to permit movement from all sleeping rooms, activity spaces and other occupied areas within the smoke compartment and to other smoke compartments.

1024.2.2.2 To be classified as Use Condition 3 or 4, the arrangement, accessibility and security of the release mechanism used for emergency egress shall be such that with the minimum available staff, at any time, lock mechanisms can be released within two minutes.

1024.2.3 Capacity of Means of Egress. The capacity of any required means of egress shall be based on the provisions of 1003.2 and 1003.3.

1024.2.4 Number of Exits.

1024.2.4.1 A minimum of two exits located remote from each other shall be accessible from each floor, fire compartment, or smoke compartment of the building.

1024.2.4.2 At least one of the required exits shall be accessible from each fire compartment and each required smoke compartment into which residents may be moved in a fire emergency with the exits so arranged that egress shall not require the occupants to return through the compartment from which egress originates.

1024.2.5 Arrangement of Means of Egress.

1024.2.5.1 Every sleeping room shall have a door leading directly to an exit access corridor.

EXCEPTIONS

1. If there is an exit door opening directly to the outside from the room at the ground level.

2. One adjacent room, such as a day room or group activity space, may intervene. Where individual occupant sleeping rooms adjoin a day room or group activity space which is utilized for access to an exitway, such sleeping rooms may open directly to the day space and may be separated in elevation by up to a full story height.

1024.2.5.2 All exits may discharge through the level of exit discharge. The requirements of 1010 may be waived provided that not more than 50% of the exits discharge into a single fire compartment.

1024.2.5.3 Exits may discharge into a fenced or walled courtyard. Enclosed yards or courts shall be of sufficient size to accommodate all occupants, a minimum of 50ft (15 m) from the building with a net area of 15 sq ft (1.4 m^2) per person.

1024.2.5.4 No exit or exit access shall contain a corridor, hallway or aisle having a pocket or dead end exceeding 50 ft (15 m) for Use Conditions 2, 3, 4 and 20 ft (6096 mm) for Use Condition 5.

1024.2.5.5 The distance which must be traversed before two separate and distinct paths of travel to two exits are available shall not exceed 50 ft (15 m).

EXCEPTION: 100 ft (30 m) shall be permitted in buildings completely protected by an approved automatic sprinkler system.

1024.2.5.6 A sallyport may be permitted in a means of egress where there are provisions for continuous and unobstructed passage through the sallyport during an emergency exit condition.

1024.2.5.7 A1sles, corridors, and ramps required for access or exit shall be at least 4 ft (1219 mm) wide.

1024.2.6 Measurement of Travel Distance to Exits. Travel distance shall be determined in accordance with 1004, but shall not exceed:

1. 100 ft (30m) between any room door required as exit access and an exit.
2. 150 ft (46 m) between any point in a room and an exit.
3. 50 ft (15 m) between any point in a sleeping room and the door of that room.

EXCEPTION: The travel distance above may be increased by 50ft (15 m) in rooms other than sleeping rooms when the building is protected throughout by an approved automatic sprinkler system or smoke control system.

1024.2.7 Horizontal Exits.

1024.2.7.1 Horizontal exits may comprise 100% of the exits required. At least 6 sq ft (0.6 m^2) of accessible space per occupant shall be provided on each side of the horizontal exit for the total number of people in adjoining compartments. Every fire compartment for which credit is allowed in connection with a horizontal exit shall not be required to have a stairway or door leading directly outside, provided the adjoining fire compartments have stairways or doors leading directly outside.

1024.2.7.2 The capacity of areas of refuge shall be computed in accordance with 1009 and the area for each occupant as follows:

1. 6 sq ft (0.6 m^2) per occupant for Group I Restrained uses
2. 3 sq ft (0.3 m^2) per occupant in all other cases.

1024.2.8 Doors.

1024.2.8.1 Egress doors shall conform to the requirements of 1012.1.2 except in Group I Restrained when used as a place of detention.

1024.2.8.2 Doors to resident sleeping rooms shall be at least 28-inch (711 mm) clear width.

1024.2.8.3 Doors in a means of egress may be of the horizontal sliding type provided the force to slide the door to its fully open position does not exceed 50 lb (222 N) with a perpendicular force against the door of 50 lb (222 N).

1024.2.9 Locks.

1024.2.9.1 Locking devices may be used in Group I Restrained occupancies.

1024.2.9.2 Doors may be locked in accordance with the applicable use condition.

1024.2.9.3 Doors from areas of refuge to the exterior may be locked with key lock in lieu of locking methods described in 1024.2.9.5. The keys to unlock such doors shall be available at all times and the locks shall be operable from both sides of the door.

1024.2.9.4 Any remote release in a means of egress shall be provided with reliable means of operation, remote from the resident living areas, to release locks on all required doors.

EXCEPTION: Provisions for remote unlocking in Use Conditions 3 and 4 may be waived provided not more than ten locks are necessary to be unlocked in order to move all occupants from one smoke compartment to an area of refuge within 3 minutes. The opening of all necessary locks shall be accomplished with no more than two separate keys. This exception shall not be used for smoke barrier doors serving a smoke compartment containing more than 20 persons.

1024.2.9.5 All remote release operated doors shall be provided with a redundant means of operation as follows:

1. Power operated sliding doors or power operated locks shall be so constructed that in the event of power failure a manual mechanical means to release and open the doors is provided at each door.
2. Mechanically operated sliding doors or mechanically operated locks shall be provided with a manual mechanical means to release and open the door at the door.

1024.2.9.6 Emergency power shall be provided for all electrically power operated sliding doors and power operated locks. Automatic transfer from the normal power service shall be accomplished within 10 seconds and operate under full load conditions for at least 1 1/2 hours.

EXCEPTION: This provision is not applicable for facilities with ten locks or less complying with the exception in 1024.2.9.4.

1024.2.9.7 Doors remotely unlocked under emergency conditions shall not automatically relock when closed unless specific action is taken at the remote location to enable doors to relock.

1024.2.10 Stairs.

1024.2.10.1 Spiral stairs meeting the requirements of 1007.8.2 are permitted for access to and between staff locations.

1024.2.10.2 Alternating tread stairways meeting the requirements of 1007.8.4 are permitted for access to and between staff locations.

1024.2.10.3 Solid risers, intermediate handrails, latticework or similar facilities required by 1007.1.2 and 1007.5.8 which would interfere with visual supervision of residents are not required.

1024.2.11 Handrails and Guardrails. Handrails and guardrails shall be installed in accordance with 1007.5 and 1015.

EXCEPTION: In areas not accessible to the public in Group I Restrained, the clear distance between rails measured at right angle to the rails shall not exceed 21 inches (533 mm).

1024.2.12 Illumination and Marking of Means of Egress

1024.2.12.1 Illumination shall be in accordance with 1016.

1024.2.12.2 Emergency lighting shall be provided in accordance with 1016.1.2.

1024.2.12.3 Exit marking shall be provided in areas accessible to the public in accordance with 1016.2.

EXCEPTION: Exit signs may be omitted in sleeping room areas.

1025 MERCANTILE

1025.1 Single Exit

A single exit is permitted in Group M occupancies when meeting the following conditions:

1. One story maximum.
2. The floor area does not exceed 2,250 sq ft (209 m^2).
3. The maximum distance of travel to the exit does not exceed 50 ft (15 m).

1025.2 Locks

A key locking device may be used from the egress side on the main exterior exit doors in Group M occupancies subject to the following:

1. There is a readily visible durable sign on or adjacent to the door stating: THIS EXIT TO REMAIN UNLOCKED WHEN THIS BUILDING IS OCCUPIED. The sign shall be in letters no less than 1 inch (25.4 mm) high on a contrasting background.
2. The locking device must be of a type that will be readily distinguishable as locked.
3. The main exit door is a single door or one pair of doors.
4. When unlocked, the door or both leaves of the pair must be free. The use of the key locking device may be revoked by the building official for due cause.

1025.3 Security Doors

Motor operated horizontal sliding or vertical rolling security grilles or doors may be used in a required means of egress in Group M occupancies subject to all of the following:

1. They must remain secured in the full open position when the space is occupied by the general public.
2. The doors or grilles shall be openable from within the space without the use of any special knowledge or effort.
3. Two or more means of egress are required and not more than half of the means of egress may be equipped with these type doors.
4. Security doors must unlock and open upon activation of an approved supervised automatic smoke detection system or automatic sprinkler system
5. Doors and grilles shall not be brought to a totally closed position when the space is occupied by more than 10 employees.

1026 RESIDENTIAL

1026.1 Single Exit

1026.1.1 In Group R1 and R2 occupancies one common exit is permitted provided all of the following conditions are met:

1. Maximum distance of travel to reach the exit or stairs from the entrance door to any dwelling unit shall not exceed 30 feet (9144 mm).
2. Maximum number of dwelling units served by the exit shall not exceed four per floor.
3. Maximum gross area of the dwelling units served by the exit shall not exceed 3,500 sq ft (325 m^2) per floor.
4. Maximum building height shall be one story above the level of exit discharge.

1026.1.2 A single exit is permitted in R3 occupancies.

1026.2 Doors

Egress doors shall conform to the requirements of 1012.1.2, except doors within a dwelling or dwelling unit need not be side swinging type unless such doors open onto common corridors, common balconies or are required exits.

1026.3 Locks

A night latch, deadbolt or security device may be used on exit doors from a dwelling unit, hotel guest room or suite provided such devices are openable from the inside without the use of a key, tool, special knowledge or effort and the device is mounted at a height not to exceed 48 inches (1219 mm) above the finished floor.

1026.4 Guardrails

1026.4.1 Guardrails for dwellings and within individual dwelling units or guest rooms shall be a minimum of 36 inches (914 mm) high.

1026.4.2 For one and two family dwellings, only one intermediate rail located between 14 and 18 inches (356 mm and 457 mm) above floor level shall be required between the top of the guardrail and the floor level of boat docks, piers, landings, decks on beach fronts and dune walk overs, providing the floor or deck level is not more than 6 ft (1829 mm) above the mean high water level or average grade of the beach, dune or ground below. No guardrail shall be required on that portion of a boat dock used for docking a boat.

1026.4.3 A bottom rail or curb is not required on guardrails within dwellings or dwelling units.

1027 STORAGE

1027.1 Number of exits

1027.1.1 Single Exit. A single exit is permitted in Group S occupancies when meeting the following conditions.

1. One story maximum
2. The floor area does not exceed 2,500 sq ft (232 m^2).
3. The maximum distance of travel to the exit does not exceed 50 ft (15 m).

1027.1.2 Helistops. Exits and stairways from helistops shall comply with the provisions of this chapter, except that all landing areas located on buildings or structures shall have two or more exits. For landing platforms or roof areas less than 60 ft (18 m) long, or less than 2,000 sq ft (186 m^2) in area, the second exit may be a fire escape or ladder leading to the floor below.

1027.2 Travel Distance

For allowable increase in travel distance, see 1004.1.4.

1027.3Doors

Egress doors shall conform to the requirements of 1012.1.2 except in automobile parking garages and storage areas with an occupant load of 10 or less.

1027.4 Locks

A key locking device may be used from the egress side on the main exterior exit doors in Group S occupancies subject to the following:

1. There is a readily visible durable sign on or adjacent to the door stating: THIS EXIT TO REMAIN UNLOCKED WHEN THIS BUILDING IS OCCUPIED. The sign shall be in letters no less than 1 inch (25.4 mm) high on a contrasting background.
2. The locking device must be of a type that will be readily distinguishable as locked.
3. The main exit door is a single door or one pair of doors.

4. When unlocked, the door or both leaves of the pair must be free. The use of the key locking device may be revoked by the building official for due cause.

1027.5 Handrails and Guardrails

Handrails and guardrails shall be installed in accordance with 1007.5 and 1015.

EXCEPTION: In areas not accessible to the public in Group S, the clear distance between rails measured at right angles to the rails shall not exceed 21 inches (533 mm).

CHAPTER 11

ACCESSIBILITY FOR PEOPLE WITH PHYSICAL DISABILITIES

1101 GENERAL

Accessibility provisions for people with physical disabilities are located in the North Carolina State Building Code, Volume 1C – Accessibility.

CHAPTER 12

INTERIOR ENVIRONMENT

1201 GENERAL

1201.1Scope

Provisions of this chapter shall govern light, ventilation, sanitation and rodent-proofing of buildings.

1202 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter2.

1203 LIGHT AND VENTILATION

1203.1 Minimum Requirements

1203.1.1 Every habitable room of buildings hereafter erected shall have one or more windows, unless otherwise specifically provided herein, to afford adequate light and ventilation. The requirements specified in this section shall be considered as minimum requirements supplementary to all state laws regulating light and ventilation.

1203.1.2 Where windows are required such windows shall open on a street, public space, yard, or approved open space that will afford adequate air and light. Required windows shall be so constructed that when fully opened, the total open space shall be not less than one-half the required window area.

EXCEPTIONS: Operable windows shall not be required in:

1. Group I occupancies equipped with an engineered smoke control system.
2. Group B and Group R high-rise buildings equipped with smoke control complying with 412.5.

1203.1.3 Attics not used for habitational purposes shall have provisions for the emission of excess heat.

1203.1.4 Except as otherwise provided herein, required windows shall have glazed openings of clear glass of area not less than 8% of the floor area of the room served by them with the following exceptions:

1. Storage room windows shall have an area not less than 5% of the floor area.
2. Obscure glass, glass blocks and similar glazed panels that admit less light than clear glass shall have area increased to admit amount of light equivalent to the above requirement.

1203.1.5 Skylights, vents, louvers or mechanical ventilation may be substituted for windows when approved by the building official, provided adequate light and ventilation is provided to meet the requirements of this chapter.

1203.1.6 Rooms where by reason of use or occupancy, dust fumes, gases, vapors, odors or other hazardous, obnoxious, or injurious impurities exist shall be provided with adequate additional ventilation to insure safe and healthful conditions.

1203.2 Room Dimensions

1203.2.1 Occupiable rooms and habitable spaces shall have a ceiling height of not less than 7 ft 6 inches (2286 mm). Corridors, bathrooms, toilet rooms, kitchens, storage rooms and laundry rooms shall be permitted to have a ceiling height of not less than 7 ft (2134 mm).

1203.2.2 If any room in a building has a sloping ceiling, the prescribed ceiling height for the room is required in only one-half the area thereof. No portion of the room measuring less than 5 ft (1524 mm) from the finished floor to the finished ceiling shall be included in any computation of the minimum area thereof.

1203.2.3 lf any room has a furred ceiling, the prescribed ceiling height is required in one-third of the area thereof, but in no case shall the height of the furred ceiling be less than 7 ft (2134 mm).

1203.2.4 Every dwelling unit shall have at least one room which shall have not less than 150 sq ft (13.9 m^2) of the net floor area. Other habitable rooms except kitchens shall have a net floor area of not less than 70 sq ft (6.5 m^2).

1203.2.5 No habitable room other than a kitchen shall be less than 7 ft (2134 mm) in any dimension.

1203.3 Alcoves

1203.3.1 An alcove opening off a habitable room may be included as part of that room in determining the window area required, provided that a portion of the common wall between the habitable room and the alcove is open and unobstructed.

1203.3.2 For the purpose of determining light and ventilation requirements, any room may be considered as a portion of an adjoining room when 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 or 25 sq ft (2.3 m^2), whichever is greater.

EXCEPTION: The limit on one-half the area of the common wall does not apply to existing buildings.

1203.4 Toilets

1203.4.1 Toilet rooms shall not open directly into a room used for the preparation of food for service to the public.

1203.4.2 Every toilet room shall have windows as specified for habitable rooms providing in no case less than 3 sq ft (0.28 m^2) of open space, or shall have approved equivalent mechanical ventilation.

1203.5 Mechanical Ventilation

Where mechanical ventilation is to be provided, the system design shall have the capability to provide ventilation in accordance with ASHRAE 62.

1204 SANITATION

1204.1 Fixtures

The quality, number and type of fixtures and the number and division of facilities shall be determined by the Standard Plumbing Code.

1204.2 Surrounding Materials

The walls and floors of all public rest rooms shall be lined with nonabsorbent material to a height of 4 ft (1219 mm) above the floor.

1204.3 Showers

Shower compartments shall have floors and walls constructed of smooth, corrosion resistant and nonabsorbent water resistant materials to a height of not less than 70 inches (1778 mm) above the compartment floor at the drain.

1204.4 Joints

Built-in tubs with showers shall have waterproofed joints between the tub and water resistant wall.

1205 RODENT-PROOFING

1205.1 Occupancy

1205.1.1 General. Every building in which feed, foodstuff or food is stored, prepared, processed, served or sold, shall be made, maintained or built of rodent-proof construction by the owner, tenant, or occupant in accordance with the provisions of this section. This section applies particularly to the following occupancies:

Group A – Large Assembly Restaurants

Group B – Cafes or Restaurants

(Curb Markets see 1205.3.)

Group F – Slaughter Houses

Group S – Storage

1205.1.2 Existing Or New Buildings.

1205.1.2.1 Foundation wall ventilator openings shall be covered for their height and width with perforated sheet metal plates not less than 0.070 inch (1.8 mm) thick or with expanded sheet metal not less than 0.047 inch (1.2 mm) thick or with cast iron grills or gratings, or with hardware cloth of 0.035 in (0.89 mm) wire or heavier. The openings therein shall not exceed 1/2 inch (12.7 mm).

1205.1.2.2 Foundation and exterior wall openings (except those used for doors and screened windows), such as those openings around pipes, electric cables, conduits, openings due to deteriorated walls, broken masonry or concrete, shall be protected against the passage of rodents by closing such openings with cement mortar, concrete masonry or noncorrodible metal.

1205.1.2.3 Exposed edges of the lower 10 inches (254 mm) of wooden doors, door sills and jambs serving as rear or side entrances into business buildings from the ground or basement floors, and other doors accessible to rats shall be protected against gnawing by covering doors, door sills and jambs with solid sheet metal not less than 0.024 inch (0.61 mm) thick.

1205.1.2.4 Doors on which metal protection has been applied shall be hinged so as to be freeswinging. When closed, doors shall fit snugly so that the maximum clearance between any door, door jambs and sills shall not be greater than 3/8 inch (9.5 mm).

1205.1.2.5 Door jambs and sills constructed of metal, concrete, masonry, stone or cement mortar will be acceptable without metal protection specified in 1205.1.2.3.

1205.1.2.6 Windows and other openings for the purpose of light or ventilation located in exterior walls within 2 ft (610 mm) above the existing ground level immediately below such opening shall be covered for their entire height and width, including frame, with wire cloth of at least 0.035 in (0.89 mm) wire having a mesh not larger than 1/2 inch (12.7 mm).

1205.1.2.7 Windows and other openings for the purpose of light and ventilation in the exterior walls not covered in 1205.1 .2.6, accessible to rodents by way of exposed pipes, wires, conduits, and other appurtenances, shall be covered with wire cloth of at least 0.035 in (0.89 mm) wire. In lieu of wire cloth covering, said pipes, wires, conduits and other appurtenances shall be blocked from rodent usage by installing solid sheet metal guards 0.024 inch (0.61 mm) thick or heavier. Guards shall be fitted snugly around pipes, wires, conduit or other appurtenances. In addition, they shall be fastened securely to and shall extend perpendicularly from the exterior wall for a minimum distance of 12 inches (305 mm) beyond and on either side of pipe, wire, conduit or appurtenance.

1205.2 Construction

1205.2.1 Concrete Floors. New buildings with concrete floors shall be constructed with no intervening space between the edge of the floor slab and building walls. All openings in the floor slab shall be properly protected against the passage of rodents.

1205.2.2 Pier and Wood Construction.

1205.2.2.1 New buildings constructed on piers having wooden floor sills less than 12 inches (305 mm) above the surface of the ground shall have the intervening space between the floor sills and ground protected against the passage of rodents by installing a solid masonry or concrete curtain wall around the entire perimeter of the building and extending said curtain wall to a depth of not less than 24 inches (610 mm) below the surface of the ground level and fastened securely to the exterior wall of the building.

1205.2.2.1.1 Where curtain walls are not desirable, ground floors of wood construction may be replaced with concrete not less than 4 inches (102 mm) thick with the exterior wall protected for a height of 24 inches (61 0 mm) above the concrete floor with masonry, concrete or solid sheet metal 0.024-inch (0.61 mm) thick or heavier. Exterior wall protection shall be securely tied into the concrete floor at all points.

1205.2.2.2 Buildings constructed on piers having wooden floor sills more than 12 inches (305 mm) above ground level, shall have the intervening spaces between floor sills and ground protected against the passage of rodents by installing curtain walls in accordance with 1205.2.2.1, or protecting said building against the passage of rodents by installing solid sheet metal collars 0.024-inch (0.61 mm) thick or heavier at top of each pier and snugly around each pipe, cable, wire, conduit or other utility service passing through wooden ground floor. Metal collars shall be not less than 8 inches (203 mm) greater in diameter than the pier, pipe, cable, wire, conduit or other utility service and shall be securely fastened underneath the wooden floor. All other openings in wooden ground floors through which rodents may gain entrance into double walls or the interior of business buildings, such as openings that may exist in floors at double walls above floor sills, shall be closed with 0.024-inch (0.61 mm) thick or heavier solid sheet metal or 0.0625 inch (1.59 mm) wire or heavier wire cloth of 1/2-inch (12.7 mm) mesh or with concrete or masonry.

1205.3 Curb or Farmer's Market

Floors of curb or farmer's markets in which fruit or vegetables are exposed and offered for sale shall be paved with 4 inches (102 mm) of concrete for the entire surface area of the market. The floor shall be protected by a curtain wall of concrete or masonry not less than 4 inches (102 mm) thick, hermetically sealed to the surface pavement, and extending not less than 24 inches (610 mm) below the ground surface. Curtain walls shall be extended around the entire perimeter of the floor pavement. Display racks, stands, or platforms on which fruit or vegetables are stored or offered for sale shall be of sufficient height that all such fruit or vegetables shall be kept at a distance of not less than 18 inches (457 mm) above the floor pavement and so constructed that rodents cannot harbor in or under such racks.

CHAPTER 13

ENERGY CONSERVATION

1301 ALL BUILDINGS

1301.1 General

All buildings shall use the prescriptive criteria of this code or the North Carolina State Building Code, Volume X - Energy. The following matrix illustrates the building types which can use this chapter and the types which must use Volume X - Energy.

Matrix showing which path to use to meet the Energy Code requirements

Building Construction Type	Building Thermal Envelope	Electrical Systems and Equipment	Lighting Systems and Equipment	Mechanical Systems and Equipment	Service Systems and Equipment
I	X[1]	X	X	X	X
II	X	X	X	X	X
III	X	X	X	X	X
IV	13[2] or X	X	X	X	X
V	13 or X	X	X	X	X
VI	13 or X	13[3] or X	13[3] or X	13[3] or X	13[3] or X

X[1] = North Carolina State Building Code, Volume X – Energy.

13[2] = North Carolina State Building Code, Volume I – General Construction, Chapter 13.

13[3] = Systems located within dwelling units of apartments or condominiums.

For the purpose of this chapter, seven thermal zones are established as shown in Figure 1301 and Table 1301.1.

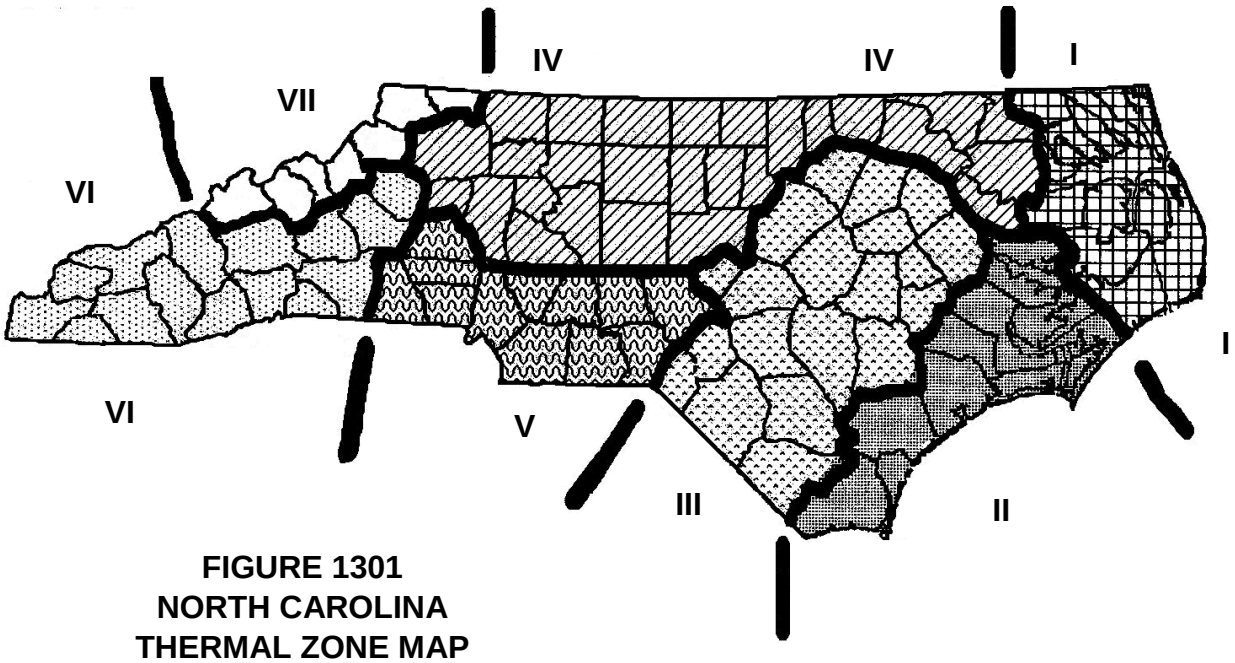


FIGURE 1301
NORTH CAROLINA
THERMAL ZONE MAP

TABLE 1301.1

ZONE I								
Camden	Currituck	Dare	Gates	Hyde	Pasquotank	Perquimans	Tyrrell	Washington
Chowan								
ZONE II								
Beaufort	Brunswick	Carteret	Craven	Jones	New Hanover	Onslow	Pamlico	Pender
ZONE III								
Bladen	Duplin	Green	Hoke	Lee	Nash	Robeson	Scotland	Wayne
Columbus	Edgecombe	Harnett	Johnston	Lenoir	Pitt	Sampson	Wake	Wilson
Cumberland	Franklin							
ZONE IV								
Alamance	Caswell	Davie	Granville	Hertford	Northampton	Randolph	Stokes	Warren
Alexander	Chatham	Durham	Guilford	Iredell	Orange	Rockingham	Surry	Wilkes
Bertie	Davidson	Forsyth	Halifax	Martin	Person	Rowan	Vance	Yadkin
ZONE V								
Anson	Catawba	Gaston	Mecklenburg	Montgomery	Moore	Richmond	Stanley	Union
Cabarrus	Cleveland	Lincoln						
ZONE VI								
Burke	Caldwell	Clay	Haywood	Jackson	McDowell	Rutherford	Swain	Transylvania
Buncombe	Cherokee	Graham	Henderson	Macon	Polk			
ZONE VII								
	Alleghany	Ashe	Avery	Madison	Mitchell	Yancey	Watauga	

1301.2 Installation of Materials

1301.2.1 It is imperative that close attention be paid to workmanship in the installation of the materials specified if the full benefits of these requirements are to be realized.

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 retarder 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.

1301.2.2 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.

1301.2.3 For unfaced blankets and rolls, the manufacturer shall furnish sufficient identifying markings to indicate the insulation R-Value.

1301.2.4 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 devices or equipment.

1301.2.5 All slab-on-grade floors within the heated or cooled space shall be insulated around the perimeter of the floor exposed to the outside with rigid insulation specifically designed and recommended by the Manufacturer for this type application. Foam plastic insulation shall be installed in accordance with 2603.8. A two (2) inch inspection gap shall be left between the top of the insulation and the bottom of the wall or wood siding so that termite tunnels may be detected. Any heat loss due to required inspection gap or treatment gap shall be disregarded. The insulation shall be installed as follows:

1. Insulation shall be installed downward to the bottom of a floating slab then horizontally beneath the slab for a total distance as specified in the Energy Code.
2. Insulation shall be installed downward to the bottom of a monolithic slab, then horizontally away from the slab for a total distance as specified in the Energy Code.
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.

1301.3 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, weather stripped or otherwise sealed in an approved manner.

1301.4 Trade-off Calculations

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 a 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.

1301.5 Compliance Forms

1301.5.1 A Prescriptive Compliance Worksheet(s) shall be furnished to the inspection department for the required inspections listed in Volume 1A - Administrative and Enforcement Requirements.

1301.5.2 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.

1301.5.3 When a design professional prepares plans or specifications for a building, the design professional shall inspect the work done and shall issue a certificate of compliance with the insulation and energy utilization standards of this code to the local inspection department and to the owner as required by General Statute 143-151.33.

1302 PRESCRIPTIVE CRITERIA FOR APARTMENTS AND CONDOMINIUMS

1302.1 General

Three requirements apply to all new apartments or condominiums consisting of three (3) or more dwelling units that are three (3) stories or less above grade and are heated and/or cooled regardless of the type of fuel used (electric, oil, gas, or wood).

1302.2 Minimum R-Value for Walls

1302.2.1 All wood stud 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 1302.4.
4. Metal stud walls shall use trade off calculations in accordance with Section 1301.4 and Table 1302.2a and b.

1302.2.2 All walls common to separate dwelling units shall be insulated so that the entire assembly (through the cavity section) will have a total R-Value of not less than R-13.

Table 1302.2a
Parallel Path Correction Factors
Metal Framed Walls with Studs 16 Ga. or Lighter

Spacing of Members	Spacing of Framing in.	Cavity Insulation R-Value	Correction Factor Fc	Equivalent Resistance Re
2 x 4	16 O.C.	R-11	0.50	R-5.0
		R-13	0.46	R-6.0
		R-15	0.43	R-6.4
2 x 4	24 O.C.	R-11	0.60	R-6.6
		R-13	0.55	R-7.2
		R-15	0.52	R-7.8
2 x 6	16 O.C.	R-19	0.37	R-7.1
		R-21	0.35	R-7.4
2 x 6	12 O. C	R-19	0.45	R-8.6
		R-21	0.43	R-9.0
2 x 8	16 O.C.	R-25	0.31	R-7.8
2 x 8	24 O.C.	R-25	0.38	R-9.6

Table 1302.2b
Parallel Path Correction Factors
Metal Roof Trusses Spaced 4 Ft o.c. or Greater That Penetrate the Insulation

Effective Framing/ Cavity R-Value	Correction Factor Fc	Equivalent Resistance Re*
R-0	1.00	R-0
R-5	0.96	R-4.8
R-10	0.92	R-9.2
R-15	0.88	R-13.2
R-20	0.85	R-17.0
R-25	0.81	R-20.3
R-30	0.79	R-23.7
R-35	0.76	R-26.6
R-40	0.73	R-29.2
R-45	0.71	R-32.0
R-50	0.69	R-34.5
R-55	0.67	R-36.0

* Based on 0.66-mch-diameter cross members every one foot.

1302.3 Minimum R-Value for Ceilings

1302.3.1 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 1301.4.

1302.3.2 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 10 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.)

1302.3.3 When soffit vents are installed, adequate baffling of the vent opening shall be provided to deflect the incoming air above the surface of the material and shall be installed at the soffit. Baffles shall be in place at the lime of inspection.

1302.3.4 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 this code.

1302.3.5 All ceiling/floor assemblies common to separate dwelling units shall be insulated so that the entire assembly (through the cavity section) will have a total R Value of not less than R-13.

1302.4 Minimum R-Value for Floors

1302.4.1 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.

1302.4.2 All slab-on-grade floors within the heated or cooled space shall be insulated around the perimeter of the floor exposed to the outside with rigid insulation having a minimum R-Value of R-5.0 and specifically designed and recommended by the manufacturer for this type application.

Exception: In the Special Mountains Region (Alleghany, Ashe, Avery, Madison, Mitchell, Watauga, and Yancey Counties), a minimum R-Value of R-7.0 is required.

1302.4.3 Insulation may be omitted from floors where the crawl space is used as a plenum floor system as defined in North Carolina State Building Code, Volume III - Mechanical. The foundation wall shall be insulated as specified in Section 1302.2.

1302.5 Exterior Doors and Windows

1302.5.1 All unglazed doors within the heated or cooled space exposed to the exterior shall have a minimum R-Value of R-1.66.

1302.5.2 All doors with glass units shall be in accordance with Table 1302.5.

1302.5.3 All window units shall be in accordance with Table 1302.5.

TABLE 1302.5
GLASS DOORS AND WINDOW UNITS [1,4]

% Openings[2]	Minimum Glazing	Typical R-Value[5]
≤ 13%	Single glazed & storm window, or double glazed	1.90
> 13 < 20%	Double glazed with Low-E[3] or triple glazed	2.70
≥ 20%	Double glazed with Low-E & Argon gas	3.50

Notes:

1. Includes sky lights. Skylights shall not exceed 1% of gross heated floor area per dwelling unit.
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 1301.4 only. Higher R-Values may be used in the trade-off calculations when certified by an approved testing laboratory.

1302.6 Electric Systems and Equipment. Electric systems and equipment located in common areas (such as clubhouses, interior corridors, stairways, etc.) and exterior to the individual dwelling units shall meet the provisions of the North Carolina State Building Code, Volume X - Energy.

1302.7 Lighting Systems and Equipment. Lighting systems and equipment located in common areas and exterior to the individual dwelling units shall meet the provisions of the North Carolina State Building Code, Volume X - Energy.

1302.8 Building Mechanical Systems and Equipment. Building mechanical systems and equipment located in common areas and exterior to the individual dwelling unit shall meet the provisions of the North Carolina State Building Code, Volume X - Energy.

1302.9 Building Service Systems and Equipment. Building service systems and equipment located in common areas and exterior to the individual dwelling units shall meet the provisions of the North Carolina State Building Code, Volume X - Energy.

1303 PRESCRIPTIVE CRITERIA FOR COMMERCIAL AND OTHER RESIDENTIAL BUILDINGS

1303.1 General

The thermal envelope requirements of this section shall apply to all commercial and residential buildings other than apartments and condominiums.

Exception: Type VI buildings (wood frame), 3 stories or less in height shall be constructed using the thermal envelope requirements of Section 1302. All other system requirements shall be in accordance with Section 1303.

Using Table 1301.1 and Figure 1301, determine the Thermal Zone for which the proposed building is to be located. Use this Thermal Zone, to determine the prescriptive requirements in Sections 1303.2 - 1303.5. If any of the U-values listed in Tables 1303.2 - 1303.5 are exceeded, then calculations in accordance with the North Carolina State Building Code, Volume X - Energy shall be provided.

1303.2 Minimum Value for Walls

The prescriptive values for walls are listed in Table 1303.2.

TABLE 1303.2
PRESCRIPTIVE WALL VALUES

Thermal Zone	Max. U-Value of Exterior Opaque Walls	Below Grade (R Min)	Max. U-Value of Walls Adjacent to Unconditioned Space
I	0.152	6	0.234
II	0.160	6	0.248
III	0.127	8	0.189
IV	0.121	8	0.184
V	0.130	8	0.175
VI	0.112	8	0.169
VII	0.088	10	0.126

1303.3 Minimum Value for Ceilings

The prescriptive values for ceilings are listed in Table 1303.3.

TABLE 1303.3
PRESCRIPTIVE ROOF VALUES

Thermal Zone	Max. U-Value of Roof
I	0.077
II	0.075
III	0.066
IV	0.068
V	0.066
VI	0.070
VII	0.055

1303.4 Minimum R-Value for Floors

The prescriptive values for floors are listed in Table 1303.4.

TABLE 1303.4
PRESCRIPTIVE FLOOR VALUES

Thermal Zone	Floor Over unconditioned space (U Max)	Slab on Grade (24" Min[1])	
		Vertical	Horizontal
I	0.105	4	4
II	0.112	4	4
III	0.085	7	12
IV	0.081	7	12
V	0.077	7	13
VI	0.073	7	13
VII	0.048	8	17

Note:
1. Increase by +2 for heated slab.

1303.5 Exterior Doors and Windows

The Maximum % of openings for doors and windows are listed in Table 1303.5.

TABLE 1303.5
MAXIMUM % OF DOORS & WINDOWS[1]

Thermal Zone	Max. % of wall openings[2]
I	16
II	15
III	14
IV	14
V	12
VI	17
VII	17

Notes:
1. The maximum U-value for any window assembly shall be 0.81.
2. Maximum % of exterior wall.

1303.6 Electric Systems and Equipment. Electrical systems and equipment shall meet the provisions of the North Carolina State Building Code, Volume X - Energy.

1303.7 Lighting Systems and Equipment. Lighting systems and equipment shall meet the provisions of the North Carolina State Building Code, Volume X - Energy.

1303.8 Building Mechanical Systems and Equipment. Building mechanical systems and equipment shall meet the provisions of the North Carolina State Building Code, Volume X - Energy.

1303.9 Building Service Systems and Equipment. Building service systems and equipment shall meet the provisions of the North Carolina State Building Code, Volume X- Energy.

CHAPTER 14

EXTERIOR WALL COVERING

1401 GENERAL

1401.1 Scope

Provisions of this chapter shall govern the construction of exterior veneered walls, architectural trim, balconies and bay windows, and openings for fire department access.

1402 DEFINITIONS

This chapter contains no unique definitions. For definitions specific to masonry see 2102. For general definitions, see Chapter 2.

1403 VENEERED WALLS

1403.1 General

1403.1.1 Veneer refers to a facing of brick, tile, concrete, masonry units, metal, including metal coated with porcelain enamel, glass, wood or similar material securely attached to a wall for the purpose of providing ornamentation, protection, or insulation but not so bonded as to exert a common reaction under load.

1403.1.2 Veneer shall not be assumed to support any load other than its own weight, neither shall it be assumed to add to the strength of the wall.

1403.1.3 Veneered walls shall provide weather protection for the building at the walls.

1403.1.4 Flashing shall be provided as necessary to prevent the entrance of water at openings in or projections through veneered walls. Flashing shall be provided at intersections of veneered walls of different materials unless such materials provide a self-flashing joint and at other points subject to the entrance of water. Caulking shall be provided where such flashing is determined by the building official to be impractical.

1403.1.4.1 Flashing and weepholes as outlined in 2111.1.3 shall be located in the first course of masonry above finished ground level above the foundation wall or slab, and other points of support, including structural floors, shelf angles and lintels when anchored veneers are designed in accordance with 1403.2.4, 1403.2.5 and 1403.2.6.

1403.2 Anchored Masonry Veneer

1403.2.1 Anchored veneer is veneer secured with approved mechanical fasteners to an approved backing. All masonry units, mortar and metal accessories used in anchored veneer walls shall meet the physical requirements of Chapter 21. Anchored veneer units shall be not less than 1 5/8 inches (41 mm) in actual thickness for solid masonry units and not less than 2 5/8 inches (67 mm) in actual thickness for hollow masonry units.

1403.2.2 Support.

1403.2.2.1 The weight of anchored veneer shall be vertically supported on footings, foundation walls or other approved noncombustible structural supports. Wood foundations meeting the requirements of 1804.8 are permitted to vertically support anchored veneer.

1403.2.2.2 Anchored veneer supported laterally by wood frame shall be limited to a maximum height of 30 ft (9144 mm). Anchored veneer installed more than 30 ft (9144 mm) in height above the noncombustible foundation or support shall be laterally supported by noncombustible structural framing. The structural framing shall horizontally support the weight of veneer at least at the initial 30 ft (9144 mm) height and at each story height thereafter.

EXCEPTION: These height restrictions may be increased for noncombustible structural framing when special design techniques, approved by the building official, are used in construction.

1403.2.3 Noncombustible lintels and noncombustible supports shall be provided over all openings where the anchored veneer is not self-supporting. The deflections of all structural lintels and horizontal supports for reinforced masonry required by 1403.2.2 and 1403.2.3 shall not exceed 1/600 of the span or 0.3 inch (7.62 mm).

1403.2.4 Masonry veneer anchored to wood framing shall be attached with corrosion-resistant corrugated sheet metal and shall be not less than 0.029 inch (0.74 mm) by 7/8 inch (22.2 mm) wide or corrosion-resistant ties of strand wire and shall not be less than No. 9 wire gage (3.76 mm) wire with ends of the wire bent to a 90° (1.6 rad) angle to form a hook not less than 2 inches (51 mm) long. The metal ties shall be embedded in the mortar joint a minimum of one-half the veneer thickness. Each metal tie shall support not more than 3 sq ft (0.28 m^2) of wall area with a maximum spacing of 16 inches (406 mm) vertically and 32 inches (813 mm) horizontally. When anchored veneer is applied over wood frame, the studs shall be spaced a maximum of 24 inches (610 mm) on center horizontally and be faced with sheathing materials as specified in Table 2308.2.2B or insulation board on both sides. The minimum thickness of the sheathing material or insulation board installed on each side of the studs shall be 1/2 inch (12.7 mm). A 1 inch (25.4 mm) minimum air space shall be maintained between the anchored veneer and the exterior face of the sheathing material or insulation board. Moisture protection shall be provided as required by 2303.3.

1403.2.5 Masonry veneer anchored to corrosion-resistant steel framing shall be attached with corrosion-resistant ties of strand wire and shall be not less than 0.148-inch (3.76 mm) (No. 9 W&M ga) wire with the ends of the wire bent to a 90° (1.6 rad) angle to form a hook not less than 2 inches (51 mm) long. The wire ties shall be embedded in the mortar joint a minimum of one-half the veneer thickness. Each metal tie shall support not more than 3 sq ft (0.28 m^2) of wall area with a maximum spacing of 16 inches (406 mm) vertically and 32 inches (813 mm) horizontally. When anchored veneer is applied over steel framing, the studs shall be spaced a maximum of 24 inches (610 mm) on center horizontally and be faced with sheathing materials as specified in Table 2308.2.2B or insulation board on both sides. The minimum thickness of the sheathing material or insulation board installed on each side of the steel framing shall be 1/2 inch (12.7 mm). A 1 inch (25.4 mm) minimum air space shall be maintained between the anchored veneer and the exterior face of the sheathing material or insulation board. Moisture protection shall be provided as required by 2303.3.

1403.2.6 Masonry veneer anchored to masonry or concrete walls shall be attached with corrosion-resistant corrugated sheet metal and shall be not less than 0.029 inch (0.74 mm) by 7/8 inch (22.2 mm) wide or corrosion-resistant ties of strand wire and shall be not less than No.9 gage wire (3.76 mm) with ends of the wire bent to a 90° (1.6 rad) angle to form a hook not less than 2 inches (51 mm) long. The metal ties shall be embedded in the mortar joint a minimum of one-half the veneer thickness. Each metal tie shall support not more than 3 sq ft (0.28 m^2) of wall area with a maximum spacing of 16 inches (406 mm) vertically and 32 inches (813 mm) horizontally. A 1 inch (25.4 mm) minimum air space shall be maintained between the anchored veneer and the supporting masonry or concrete walls.

1403.2.7 Stone veneer units not exceeding 10 inches (254 mm) in thickness may be anchored directly to masonry, concrete or to stud construction by one of the following methods:

1. With concrete or masonry backing, anchor ties shall be not less than 0.1055 in (2.68 mm) corrosion-resistant wire, or approved equal, formed beyond the base of the backing. The legs of the loops shall be not less than 6 inches (152 mm) in length bent at right angles and laid in the mortar joint and spaced so that the eyes or loops are 12 inches (305 mm) maximum on center in both directions. There shall be provided not less than a 0.1055 in (2.68 mm) corrosion-resistant wire tie, or approved equal, threaded through the exposed loops for every 2 sq ft (0.2 m^2) of stone veneer. This tie shall be a loop having legs not less than 15 inches (381 mm) in length bent so that it will lie in the stone veneer mortar joint. The last 2 inches (51 mm) of each wire leg shall have a right angle bend. One inch (25.4 mm) minimum thickness of cement grout shall be placed between the backing and the stone veneer.
2. With stud backing, a 2-inch by 2-inch (51 by 51 mm) 0.0625 in (1.59 mm) corrosion-resistant wire mesh with two layers of waterproof paper backing shall be applied directly to wood studs spaced a maximum of 16 inches (406 mm) on center. On studs the mesh shall be attached with 2-inch (51 mm) long corrosion-resistant steel wire furring nails at 4 inches (102 mm) on center providing a minimum 1 1/8-inch (29 mm) penetration into each stud and with 8d common nails at 8 inches (203 mm) on center into top and bottom plates. The corrosion-resistant wire mesh may be attached to steel studs with equivalent wire ties. There shall be not less than a 0.1055 in (2.68 mm) corrosion-resistant wire, or approved equal, looped through the mesh for every 2 sq ft (0.2 m^2) of stone veneer. This tie shall be a loop having legs not less than 15 inches (381 mm) in length, so bent that it will lie in the stone veneer mortar joint. The last 2 inches (51 mm) of each wire leg shall have a right angle bend. One-inch (25.4 mm) minimum thickness of cement grout shall be placed between the backing and the stone veneer.

1403.2.8 Slab-type veneer units not exceeding 2 inches (51 mm) in thickness may be anchored directly to masonry, concrete or stud construction. For veneer units of marble, travertine, granite or other stone units of slab form, ties of corrosion-resistant dowels in drilled holes located in the middle third of the edge of the units spaced a maximum of 24 inches (610 m) apart around the periphery of each unit with not less than four ties per veneer unit. Units shall not exceed 20 sq ft (1.9 m^2) in area.

If the dowels are not tight fitting, the holes may be drilled not more than 1/16 inch (1.6 mm) larger in diameter than the dowel with the hole countersunk to a diameter and depth equal to twice the diameter of the dowel in order to provide a tight fitting key of cement mortar at the dowel locations when the mortar in the joint has set. All veneer ties shall be corrosion-resistant metal capable of resisting in tension or compression a force equal to two times the weight of the attached veneer.

If made of sheet metal, veneer ties shall be not smaller in area than 0.0336 x 1 inch (0.853 x 25.4 mm) or, if made of wire, not smaller in diameter than 0.1483 in (3.76 mm) wire.

1403.2.9 Anchored terra cotta or ceramic units not less than 1 5/8 inches (41 mm) thick may be anchored directly to masonry, concrete or stud construction. Tied terra cotta or ceramic veneer units shall be not less than 1 5/8 inches (41 mm) thick with projecting dovetail webs on the back surface spaced approximately 8 inches (203 mm) on center. The facing shall be tied to the backing wall with corrosion-resistant metal anchors of not less than No. 8 ga wire installed at the top of each piece in horizontal bed joints not less than 12 inches (305 mm) nor more than 18 inches (457 mm) on center; these anchors shall be secured to 1/4-inch (6.4 mm) corrosion-resistant pencil rods which pass through the vertical aligned loop anchors in the backing wall. The veneer ties shall have sufficient strength to support the full weight of the veneer in tension. The facing shall be set with not less than a 2-inch (51 mm) space from the backing wall and the space shall be filled solidly with portland cement grout and pea gravel. Immediately prior to setting, the backing wall and the facing shall be drenched with clean water and shall be distinctly damp when the grout is poured.

1403.3 Adhered Masonry Veneer

1403.3.1 Adhered veneer is a veneer secured and supported through the adhesion of an approved bonding material applied to an approved backing. All masonry units used in adhered veneer walls shall meet the physical requirements of Chapter 21. Adhered veneer units shall be less than 1 5/8 inches (41 mm) thick and the units shall not be assumed to support any superimposed loads. With the exception of ceramic tile, adhered veneer and its backing shall be designed to provide a bond to the supporting element sufficient to withstand a shearing stress of 50 psi (345 kPa) after curing 28 days.

1403.3.2 Backing permitted for adhered veneer shall be continuous and may be of any material permitted by this code. The backing shall have surfaces prepared to secure and support the imposed loads of the adhered veneer.

1403.3.3 Exterior adhered veneer shall not be attached to wood frame construction at a point more than 30 ft (9144 mm) in height above the noncombustible foundation. The 30 ft (9144 mm) limit may be increased when special design techniques, approved by the building official, are used in construction.

1403.3.4 Adhered veneer units shall not exceed 36 inches (914 mm) in the greatest dimension nor more than 720 sq inches (0.5 m^2) in total area and shall not weigh more than 15 psf (718 Pa) unless approved by the building official.

EXCEPTION: Adhered veneer units weighing less than 3 psf (144 Pa) shall not be limited in dimension or area.

1403.3.5 Adhered veneer units may be adhered directly to the backing by one of the following methods:

1. A paste of neat portland cement shall be brushed on the backing and the back of the veneer unit. Type S mortar then shall be applied to the backing and the veneer unit. Sufficient mortar shall be used to create a slight excess to be forced out the edges of the units. The units shall be tapped into place so as to completely fill the space between the units and the backing. The resulting thickness of mortar in back of the units shall be not less than 1/2 inch (12.7 mm) nor more than 1 1/4 inches (32 mm).
2. Units of masonry, stone or terra cotta, not over 1 inch (25.4 mm) in thickness shall be restricted to 81 sq in (0.05 m^2) in area unless the back side of each unit is ground or box screeded to true up any deviation from plane. Those units not over 2 x 2 x 3/8 inches (5l x 51 x 9.5 mm) in size may be adhered by means of portland cement. Backing may be of masonry, concrete or portland cement plaster on metal lath. Metal lath shall be fastened to the supports in accordance with the requirements of Chapter 25. Mortar as described in Table 1403.3 shall be applied to the backing as a setting bed. The setting bed shall be a minimum of 3/8 inch (9.5 mm) thick and a maximum of 3/4 inch (19.1 mm) thick. A paste of neat portland cement or half portland cement and half graded sand shall be applied to the back of the exterior veneer units and to the setting bed and the veneer pressed and tapped into place to provide complete coverage between the mortar bed and veneer unit. A portland cement grout shall be used to point the veneer.

Table 1403.3
Adhered Veneer Setting Mortar

Wall Area	Coat	Volume Type 1 Portland Cement	Volume Type S Hydrated Lime	Volume Sand		Maximum Thickness of Coat (in)	Minimum Interval Between Coats
				Dry	Damp		
Over 10 sq ft	Scratch	1	1/2	4	5	3/8	24 hrs
		1	0	3	4	3/8	24 hrs
Over 10 sq ft	Float or leveling	1	1/2	4	5	3/4	24 hrs
		1	1	6	7	3/4	24 hrs
10 sq ft or less	Scratch and float	1	1/2	2 1/2	3	3/8	24 hrs

1 in= 25.4 mm
1 sq ft = 0.0929 m^2

1403.3.6 Adhered veneer units of ceramic tile shall be bonded to the backing as provided in 2104.10.

1403.3.7 Adhered veneer over wood frame shall be backed by solid sheathing covered with waterproof building paper except where the sheathing is water repellent.

1403.4 Metal Veneers

1403.4.1 Metal veneers may be formed metal not less than 0.0149 inch (0.38 mm) (28 ga). Aluminum siding shall conform to AAMA 1402.

1403.4.2 Exterior metal veneer shall be securely attached to the supporting masonry or framing members with corrosion-resistant fastenings, metal ties or by other approved devices or methods. The spacing of the fastenings or ties shall not exceed 24 inches (610 mm) either vertically or horizontally, but where units exceed 4 sq ft (0.4 m^2) in area there shall be not less than four attachments per unit. The metal attachments shall have a cross-sectional area not less than provided by No. 9 gage wire (3.76 mm). Such attachments and their supports shall be capable of resisting a horizontal force equal to the wind loads specified in this code, but in no case less than 20 psf (958 Pa).

1403.4.3 Metal supports for exterior metal veneer shall be protected by painting, galvanizing, or by other equivalent coating or treatment. Wood studs, furring strips, or other wood supports for exterior metal veneer shall be approved pressure treated wood or protected as required in 2303.3.

1403.4.4 All joints and edges in metal veneer that are exposed to the weather shall be caulked or painted with durable waterproofing material, or shall be protected by other means to prevent penetration of moisture.

1403.4.5 Masonry backup shall not be required for metal veneer except as is necessary to meet the fire resistance requirements of this code.

1403.4.6 Metal veneers fastened to supporting elements which are not a part of the grounded metal framing of a building shall be made electrically continuous by contact or interconnection of individual units and shall be effectively grounded. The conductor used to ground the veneer shall have no greater resistance than the conductor used to ground the electrical system within the building. Where a metal veneer is applied to a building with no electrical wiring system, grounding shall be required only if determined to be necessary by the building official.

1403.5 Glass Veneer

1403.5.1 The area of a single section of thin exterior structural glass veneer shall not exceed 10 sq ft (0.93 m^2) where it is not more than 15 ft (4572 mm) above the level of the sidewalk or grade level directly below, and shall not exceed 6 sq ft (0.56 m^2) where it is more than 15 ft (4572 mm) above that level.

1403.5.2 The length or height of any section of thin exterior structural glass veneer shall not exceed 48 inches (1219 mm).

1403.5.3 The thickness of thin exterior structural glass veneer shall be not less than 11/32 inch (8.7 mm).

1403.5.4 Thin exterior structural glass veneer shall be set only after backing is thoroughly dry and after application of an approved bond coat applied uniformly over the entire surface of the backing so as to effectively seal the surface. Glass shall be set in place with an approved mastic cement in sufficient quantity so that at least 50% of the area of each glass unit is directly bonded to the backing by mastic not less than 1/4 inch (6.4 mm) thick and not more than 5/8 inch (15.9 mm) thick. Bond coat and mastic shall preferably be from the same manufacturer and shall bond firmly together.

1403.5.5 Where glass extends to sidewalk surface, each section shall rest in an approved metal molding, and set at least 1/4 inch (6.4 mm) above the highest point of the sidewalk. The space between the molding and the sidewalk shall be thoroughly caulked and made watertight.

1403.5.6 Joints.

1403.5.6.1 Unless otherwise specifically approved by the building official, all abutting edges of thin exterior structural glass veneer shall be ground square. Mitered joints shall not be used except when specifically approved for wide angles.

1403.5.6.2 All joints shall be uniformly buttered with an approved jointing compound and all horizontal joints shall be held to not less than 1/16 inch (1.6 mm) by an approved nonrigid substance or device.

1403.5.6.3 Where thin exterior structural glass veneer abuts nonresilient material at sides or top, expansion joints not less than 1/4 inch (6.4 mm) wide shall be provided.

1403.5.7 When thin exterior structural glass veneer is installed above the level of the top of a bulkhead facing, or at a level more than 36 inches (914 mm) above the sidewalk level, the mastic cement binding shall be supplemented with approved nonferrous metal shelf angles located in the horizontal joints in every course. Such shelf angles shall be not less than 0.0478-inch (1.2 mm) thick and not less than 2 inches (51 mm) long and shall be spaced at approved intervals, with not less than two angles for each glass unit. Shelf angles shall be secured to the wall or backing with expansion bolts, toggle bolts, or by other approved methods.

1403.5.8 Mechanical Fastenings.

1403.5.8.1 All thin exterior structural glass veneer installed above the level of the heads of snow windows and all such veneer installed more than 12 ft (3658 mm) above sidewalk level shall, in addition to the mastic cement and shelf angles, be held in place by the use of fastenings at each vertical or horizontal edge, or at the four corners of each glass unit.

1403.5.8.2 Fastenings shall be secured to the wall or backing with expansion bolts, toggle bolts, or by other methods.

1403.5.8.3 Fastenings shall be so designed as to hold the glass veneer in a vertical plane independently of the mastic cement. Shelf angles providing both support and fastenings may be used.

1403.5.9 Exposed edges of thin exterior structural glass veneer shall be flashed with overlapping corrosion-resistant metal flashing and caulked with a waterproof compound in a manner to effectively prevent the entrance of moisture between the glass veneer and the backing.

1403.6 Wood

1403.6.1 Wood siding patterns known as rustic drop siding or shiplap shall have an average thickness in place of not less than 19/32 inch (15.1 mm) and shall have a minimum thickness of not less than 3/8 inch (9.5 mm). Bevel siding shall have a minimum thickness measured at the butt section of not less than 7/16 inch (11.1 mm) and a tip thickness of not less than 3/16 inch (4.8 mm). Siding of lesser dimensions may be used provided such wall covering is placed over sheathing which conforms to the provisions of 2308.2.

1403.6.2 Board siding applied vertically shall be nailed to horizontal nailing strips or blocking set 24 inches (610 mm) on center. The nails shall penetrate 1 1/2 inches (38 mm) into studs, blocking, studs or blocking and sheathing combined, or nailing strips.

1403.6.3 Wood shakes and shingles shall be applied in accordance with the CSSB Design and Application Manual for Exterior and Interior Walls.

1403.6.4 Wood structural panels shall be of the exterior type and shall have a thickness of 3/8 inch (9.5 mm), except as provided in Table 2308.1D. All wood structural panel joints shall be backed solidly with nailing pieces not less than 2 inches (51 mm) wide, unless wood, wood structural panel or particleboard sheathing is used, or otherwise made waterproof as required in 2303.3.

EXCEPTION: The framework is not required to be protected in accordance with 2303.3 when the joints are protected by a continuous wood batt, caulking, flashing or vertical or horizontal shiplap.

1403.6.5 Fiberboard siding shall be medium density not less than 1/2 inch (12.7 mm) nominal thickness.

1403.6.6 Hardboard siding s hall conform with the requirements of ANSI/AHA A135.4, ANSI/AHA A135.5 or ANSI/AHA A135.6 and shall be identified as to classification.

1403.6.7 Particleboard siding used for covering the exterior of outside walls shall be of the Exterior Type 2-M grades conforming to ANSI A208.1. Particleboard panel siding shall be installed in accordance with Table 2306.1 and Table 1403.6. Nails shall be spaced not less than 3/8 inch (9.5 mm) from edges and ends. Joints shall occur over framing members unless particleboard panel siding is applied over 5/8-inch (15.9 mm) net wood sheathing or 15/32-inch (11.9 mm) plywood or 1/2-inch (12.7 mm) particleboard sheathing. The framework shall be protected as required in 2303.3.

EXCEPTION: The framework is not required to be protected in accordance with 2303.3 when the joints are protected with a continuous wood batt, caulking, flashing or vertical or horizontal shiplap.

Table 1403.6
Allowable Spans For Exposed Particleboard Panel Siding

		Minimum Thickness (Inches)		
Grade	Stud Spacing (in)	Siding Direct to Studs	Siding Continuous Support	Exterior Ceilings and Soffits Direct to Support
2-M-W	16	3/8	5/16	5/16
	24	1/2	5/16	3/8
2-M-1 and 2-M-2	16	5/8	3/8	---
	24	3/4	3/8	---

1 in = 25.4 mm

1403.6.8 Wood veneers on exterior wall panels of types I, II, III, IV, and V construction shall comply with 1403.6.8.1 and 1403.6.8.2.

1403.6.8.1 Wood veneers of not less than 1-inch (25.4 mm) nominal thickness, 7/16-inch (11.1 mm) exterior hardboard siding or 3/8-inch (9.5 mm) exterior type wood structural panels or particleboard may be used on exterior walls when all the following conditions are met:

1. The wall to which the veneer is attached faces a street or permanent open space of 30 ft (9144 mm) or more wide.
2. The veneer does not exceed two stories in height, measured from grade, except where fire retardant treated for exterior use, it may be four stories in height.
3. The veneer is attached to or furred from a noncombustible backing of the fire resistance required by other provisions of this chapter.
4. Where open or spaced wood veneers (without concealed spaces) are used, they shall not project more than 24 inches (610 mm) from the building wall.

1403.6.8.2 Where the wood veneer is furred from the wall and forms a solid surface, the distance between the back of the veneer and the wall shall not exceed 1 5/8 inch (41 mm) and the space thereby created shall be fireblocked in accordance with 2305 and arranged so that there will be no open space exceeding 100 sq ft (9.3 m^2). Where wood furring strips are used, they shall be of approved wood of natural decay resistance or pressure treated wood.

1403.7 Asbestos Shingles

Asbestos shingles attached to sheathing other than wood, plywood or 2-M-W particleboard shall be secured with approved mechanically bonding nails or by corrosion-resistant common nails on shingle nailing boards securely nailed to each stud with two 8d nails, except that asbestos shingles may be attached directly to fiberboard nail base sheathing with corrosion-resistant annular grooved nails. Asbestos shingles shall have a minimum thickness of 5/32 inch (4 mm).

1403.8 Stucco

Stucco or exterior plaster shall conform to requirements of 2504.

1403.9 Rigid Vinyl

1403.9.1 Rigid vinyl siding shall conform with the requirements of ASTM D 3679 and is limited to Type VI construction.

1403.9.2 Provisions for exterior plastic veneers other than rigid vinyl are found in 2604.9.

1404 ARCHITECTURAL TRIM, BALCONIES, BAY WINDOWS

1404.1 Architectural Trim

1404.1.1 Architectural trim on buildings of Type I, II and IV construction not more than three stories or 40 ft (12.2 m) high may be of Type VI construction, and may be of Type VI construction on all buildings of Type III, V, and VI construction. Trim shall be secured to the wall with metal or other approved brackets or fasteners. When architectural trim is located along the top of exterior walls, it shall be completely backed by the exterior wall and shall not extend over the top of exterior walls.

1404.1.2 For projection over public property, see 3206.

1404.2 Balconies and Bay Windows

Balconies not used as required exits and bay windows shall conform to the type of construction required for the building to which they are attached, except that exterior fire retardant treated wood is permitted on buildings three stories or less for Type I and II exterior walls.

1404.3 Combustible Projections

Combustible projections from walls located where protection of openings is required shall be 1-hour fire resistant or heavy timber construction. Projections shall not extend more than 12 inches (305 mm) into the areas where openings are prohibited.

1405 FIRE DEPARTMENT ACCESS IN EXTERIOR WALLS

1405.1 General

Exterior walls shall have access openings for fire department use serving each story above grade on an accessible side of the building up to a height of 75 ft (22.9 m). Such access openings shall be a minimum of 32 inches (813 mm) wide and 48 inches (1219 mm) high and with the bottom of the opening not more than 32 inches (813 mm) above the floor.

EXCEPTION: Fire department access to high-piled combustible storage and high-rack storage systems shall be in accordance with Chapter 36 of the Standard Fire Prevention Code.

1405.2 Spacing

Openings shall be so spaced that there will be one opening in each 50 ft (15.2 m) of exterior wall on an accessible side of the building.

EXCEPTION: Buildings equipped with an automatic sprinkler system throughout in accordance with NFiPA 13 shall have access panels as set forth for each 200 ft (61 m) of wall.

1405.3 Identification

Where complying access openings are not apparent, they shall have distinctive markings for identification.

1405.4 Obstructions

Access openings shall open into a fire aisle within the building and no shelving, loose or fixed, no containers or equipment of any description, nor any loose merchandise shall be placed so as to block aisleways.

CHAPTER 15

ROOFS AND ROOF STRUCTURES

1501 GENERAL

1501.1Scope

Provisions of this chapter shall govern the construction of roof structures and the materials, application, installation, wind resistance, and fire resistance of roof coverings.

1502 DEFINITIONS

The following words and terms shall, for the purposes of this chapter and as stated elsewhere in this code, have the meanings shown herein. Refer to Chapter 2 for general definitions.

PENTHOUSE – an enclosed structure above the roof of a building, other than a roof structure or bulkhead, occupying not more than one-third of the roof area.

ROOF COVERING SYSTEM – a system designed to provide weather protection and resistance to design loads. The system may consist of two components, roof covering and roof deck, or a single component serving as both the roof covering and the roof deck. The roof covering provide the weather protection and the roof deck provides the structural support for the design loads.

ROOF STRUCTURE – an enclosed structure on or above the roof of any part of a building.

SCUPPER – an opening in a wall or parapet that allows water to drain from a roof.

1503 PENTHOUSE – TYPE ROOF STRUCTURES

1503.1Height and Area

1503.1.1 A penthouse or other projection above the roof in structures of other than Type I construction shall not exceed 28 ft (8534 mm) above the roof when used as an enclosure for tanks or for elevators which run to the roof and in all other cases shall not extend more than 12 ft (3658 mm) above the roof.

1503.1.2 The aggregate area of all penthouses and other roof structures shall not exceed one-third the area of the supporting roof.

1503.1.3 A penthouse, bulkhead, or any other similar projection above the roof shall not be used for purposes other than shelter of mechanical equipment or shelter of vertical shaft openings in the roof. Penthouses or bulkheads used for purposes other than permitted by this section shall conform to the requirements of this code for an additional story.

1503.2 Type of Construction

1503.2.1 Roof structures shall be constructed with walls, floors, and roof as required for the main portion of the building.

EXCEPTIONS:

1. On buildings of Type I and Type II construction, the exterior walls and roofs of penthouses which are more than 5 ft (1524 mm) and less than 20 ft (6096 mm) from a common property line shall be of at least 1-hour noncombustible construction. Walls and roofs which are over 20ft (6096 mm) from a common property line may be of noncombustible construction. All interior framing and walls shall be noncombustible construction.

2. On buildings of Type III, IV, and V construction, the exterior walls and roofs of penthouses which are more than 5 ft (1524 mm) and less than 20ft (6096 mm) from a common property line shall be at least 1-hour construction. Walls which are over 20 ft (6096 mm) from a common property line may be of heavy timber construction or noncombustible construction. Roof s may be of wood frame construction. All interior framing and walls shall be heavy timber construction or noncombustible construction.
3. Enclosures housing only mechanical equipment and located at least 20 ft (6096 mm) from adjacent property lines may be of unprotected noncombustible construction.
4. On one story buildings, unroofed mechanical equipment screens, fences or similar enclosures may be of combustible construction when located at least 20 ft (6096 mm) from adjacent property lines and when not exceeding 4 ft (1219 mm) in height above the roof surface.
5. Dormers shall be of the same type of construction as the roof on which they are placed, or of the exterior walls of the building.

1503.2.2 The restrictions of this section shall not prohibit the placing of wood flagpoles or similar structures on the roof of any building.

1504 TANKS

1504.1 Tanks Exceeding 500 Gal (2m^3)

1504.1.1 Tanks of more than 500 gal (2 m^3) capacity placed in or on a building shall be supported on masonry, reinforced concrete or steel construction, except that portion of the supporting structure which is above the roof of the building may be of heavy timbers, provided that when such construction is within the building it shall be as required for Type I construction.

1504.1.1.1 Such tanks shall have in the bottom or on the side near the bottom, a pipe or outlet, fitted with a suitable quick opening valve for discharging the contents in an emergency through an adequate drain.

1504.1.1.2 Such tanks shall not be placed over nor near a line of stairs or an elevator shaft, unless there is a solid roof or floor underneath the tank.

1504.2 Unenclosed Roof Tanks

All unenclosed roof tanks shall have covers sloping toward the outer edges.

1505 COOLING TOWERS

Cooling towers in excess of 250 sq ft (23.2 m^2) in base area or in excess of 15ft (4572 mm) high when located on buildings more than 50ft (15.2 m) high shall be of noncombustible construction, except that drip boards may be of wood not less than 1 inch (25.4 mm) nominal thickness and the enclosing framework may be of wood, if covered on the exterior of the tower with noncombustible material. Cooling towers shall not exceed one-third of the supporting roof area.

1506 OTHER ROOF STRUCTURES

1506.1 Type of Construction

1506.1.1 Minimum Type I or II Construction. Any tower, spire, dome or cupola shall be of a type of construction not less in fire resistance rating than required for the building to which it is attached except that any such tower, spire, dome or cupola which exceeds 60 ft (18.3 m) in height above grade, and all construction upon which it is supported, shall be of Type I or Type II construction when the area at any horizontal section of such tower, spire, dome, or cupola exceeds 200 sq ft (18.6 m^2) or when it is used for any purpose other than a belfry or an architectural embellishment.

1506.1.2 Minimum Noncombustible Construction.

1506.1.2.1 Any tower, spire, dome or cupola which exceeds 25 ft (7620 mm) in height above the highest point at which it comes in contact with the roof, or which exceeds 200 sq ft (18.6 m^2) in area at any horizontal section, or which is intended to be used for any purpose other than a belfry or architectural embellishment, shall be entirely constructed of and supported by noncombustible materials. Such structures shall be separated from the building below by construction having a fire resistance rating of not less than 1 1/2 hours and, if access doors are provided, such doors shall be of an approved fire resistant type.

1506.1.2.2 Structures, except aerial supports 12 ft (3658 mm) high or less, flag poles, water tanks and cooling towers, placed above the roof of any building more than 50 ft (15.2 m) in height, shall be of noncombustible material and shall be supported by construction of noncombustible material.

1506.2 Towers and Spires

Towers and spires when enclosed shall have exterior walls as required for the building to which they are attached. The roof covering of spires shall be of a class of roof covering, as required for the main roof of the rest of the structure.

1507 PARAPET WALLS

1507.1 Framing

Parapet walls shall be designed as provided in this section.

1507.2 Coping

All parapet walls shall be properly coped with noncombustible, weatherproof materials of a width no less than the thickness of the parapet wall.

1507.3 Flashing

Proper flashings shall be installed in such a manner as to prevent moisture entering the wall through the joints in the coping, through moisture permeable material, at intersections with the roof plane or at parapet wall penetrations.

1507.4 Scuppers

1507.4.1 Where required for roof drainage, a scupper shall be placed level with the roof surface in a wall or parapet. The scupper shall be located as determined by the slope and the contributing area of the roof. The exterior facing or lining of a scupper, if metal, shall be the same as valley lining material required by 1509 for the particular type of covering specified for the building. For other type materials follow manufacturer's specifications.

1507.4.2 A scupper shall be sized in accordance with Chapter 11 of the Standard Plumbing Code.

1507.4.3 When other means of drainage of overflow water is not provided, overflow scuppers shall be placed in walls or parapets not less than 2 inches (51 mm) nor more than 4 inches (102 mm) above the roof deck and shall be located as close as practical to required vertical leaders or downspouts or wall and parapet scuppers. An overflow scupper shall be sized in accordance with Chapter 11 of the Standard Plumbing Code.

1508 GUTTERS AND LEADERS

Gutters and leaders placed on the outside of buildings other than one or two family dwellings, private garages, and buildings of Type VI construction, shall be of noncombustible material or a minimum Schedule 40 plastic pipe. See Chapter 11 of the Standard Plumbing Code for the sizing of vertical leaders and horizontal storm drains.

1509 ROOF COVERINGS

1509.1 General

1509.1.1 Scope. The requirements set forth in this section shall be construed as minimum requirements and shall apply to the application and installation of roof covering materials specified herein, excluding pre-engineered steel buildings. Roof coverings shall be applied in accordance with this chapter and/or meet manufacturer's recommendations. It should also be noted that this chapter does not deal with the minimum design loads of roofing materials. Those requirements, with which all roofing systems must comply, are covered in 1606.

1509.1.2 Covering.

1509.1.2.1 Roof coverings shall provide weather protection for the building at the roof.

1509.1.2.2 All roof coverings shall be applied to a solid or closely fitted deck, except where the roof covering is specifically designed to be applied to spaced supports

1509.1.2.3 Low slope roofs shall be designed for a minimum 1/4 inch/ft (20.8 mm/m) slope unless specific water retaining roof materials are to be installed.

1509.1.3 Insulation.

1509.1.3.1 The use of above deck thermal insulation is permitted on top of both the roof deck and the roof membrane provided such insulation is covered with an approved covering applied directly thereto in accordance with manufacturer's recommendations.

1509.1.3.2 A minimum of 1/2-inch (12.7 mm) insulation shall be installed over metal decking when a roof covering is installed subject to the manufacturer's flute span table.

1509.1.4 Fasteners.

1509.1.4.1 Nails, clips or similar fastening devices shall be hot dipped galvanized, stainless steel, nonferrous metal, or other suitable corrosion- resistant material.

1509.1.4.2 Fasteners for wood shingles and shakes shall conform with the requirements of 1509.8.5.1 and 1509.8.6.1.

1509.1.4.3 The composition flashing shall be mechanically attached using suitable manufacturer-approved fasteners spaced a maximum of 8 inches (203 mm) on center and 1 inch (25.4 mm) minimum from the top edge of flashing sheet.

1509.1.4.4 Tin caps shall be not less than 1 5/8 inches (41 mm) in diameter and a minimum of 0.0134 in (0.34 mm) thick sheet metal.

1509.1.4.5 Caphead nails shall be a minimum 1 inch (25.4 mm) long annular threaded 12 gage (2.66 mm) wire nail with a head not less than 1 inch (25.4 mm) in diameter.

1509.1.5 Composition Flashing. Composition base flashing should extend a minimum of 8 inches (203 mm) nominal above the roof line. When using such flashing, wood or fiber cants must be provided at any 90° (1.57 rad) angle created by rectangular curbs or projections. Wood nailers should be provided on all prefabricated curbs.

1509.1.6 Mechanical Units. For new construction, mechanical units mounted on pipe standards or curbs beneath which roofing materials will extend must be mounted to a height sufficiently above the roof to allow room to install the roof system and to make repairs beneath the unit. Heavy loads, such as large mechanical units, shall not be rolled over the completed membrane as they may cause damage to the roof. A failure in horizontal shear between the membrane, insulation or deck from these loads may result in future splitting of the roof.

1509.1.7 Flashing. Flashing shall be placed around openings and extensions of mechanical appliances or equipment through the roof and otherwise as necessary to provide adequate drainage.

1509.2 Fire Resistance Classification

1509.2.1 General. Roof coverings shall be divided into the classes defined below. All Class A, B and C roof coverings required to be listed by this section shall be tested in accordance with ASTM E 108. In addition, fire retardant treated wood roof coverings shall be tested in accordance with ASTM D 2898. All roof coverings shall be installed in accordance with 1509 or other approved nationally recognized standards.

1509.2.2 Class A Roof Coverings. Class A roof coverings shall include brick, concrete, slate, tile, or assemblies listed and identified as Class A by an approved testing laboratory, inspection agency, or product evaluation organization.

1509.2.3 Class B Roof Coverings. Class B roof coverings shall include corrugated steel sheets, galvanized steel sheets, galvanized steel shingles, sheet copper galvanized iron or assemblies listed and identified as Class B by an approved testing laboratory, inspection agency, or product evaluation organization.

1509.2.4 Class C Roof Coverings. Class C roof coverings shall include the assemblies listed and identified as Class C by an approved testing laboratory, inspection agency, or product evaluation organization.

1509.2.5 Requirements for Roofs. Roofs on buildings shall have Class A, Class B or Class C roof coverings, as specified herein. Unclassified wood shingles or shakes may be used as provided in 1509.8. Private detached garages, carports and farm buildings as defined in 411.11 are not regulated by this section.

1509.3 Wind Loads and Wind Resistance

1509.3.1 Wind loads on roof decks and other structural members supporting roof coverings are specified in 1606.

1509.3.2 Roof systems with built-up, modified bitumen, fully adhered or mechanically attached single-ply, metal panels, or other types of membrane roof coverings shall be designed to withstand the appropriate wind loads prescribed in 1606.

1509.3.3 Ballasted single-ply roof system coverings shall be designed in accordance with ANSI/RMA/SPRI RP-4.

1509.3.4 Asphalt shingles shall have self-seal strips or shall be interlocking, and shall have the type and minimum number of fasteners recommended by the manufacturer.

1509.3.5 Self-seal asphalt strip shingles shall have a minimum of six fasteners per shingle when the roof is in one of the following categories:

1. The basic wind speed is 90 mph (40.2 m/s) or greater and the eave is 20 ft (6096 mm) or higher above grade.
2. The basic wind speed is 90 mph (40.2 m/s) or greater and the Use Factor in Table 1606 is 1.15.
3. The basic wind speed is 100 mph (44.7 m/s) or greater.

1509.4 Asphalt Shingles

1509.4.1 General.

1509.4.1.1 The installation of asphalt shingles used as a roof covering shall comply with the requirements of this section.

1509.4.1.2 Shingle application shall be as specified in the manufacturer's published application instructions.

1509.4.2 Application.

1509.4.2.1 2:12 pitch up to 4:12 pitch: Underlayment shall be two layers of type 15 asphalt saturated, nonperforated felt applied in the following manner. Apply a 19-inch (483 mm) strip of type 15 asphalt saturated, shingle underlayment felt parallel with and starting at the eaves, fastened sufficiently to hold in place. Starting at the eave, apply 36-inch (914 mm) wide sheets of underlayment overlapping successive sheets 19 inches (483 mm) and fastened sufficiently to hold in place. Where January mean temperatures are 30°F (- 10C) or less, coat full width of the 19-inch (483 mm) laps from the eave to a point 24 inches (610 mm) from the inside of the exterior wall line of the building with asphalt based roofing cement.

1509.4.2.2 4:12 pitch to 20:12 pitch: Underlayment shall be type 15 asphalt saturated, nonperforated felt applied shingle fashion, parallel to and starting from the eave and lapped 2 inches (51 mm), fastened only as necessary to hold in place.

1509.4.2.3 Asphalt shingles shall be fastened along the rake. Asphalt shingles shall be fastened and cemented at all valleys, rakes, penetrations, and all vertical projections. Eaves must be cemented or the metal eave drip shall be installed under the felt.

1509.4.2.4 Fasteners shall penetrate through the roofing material and at least 3/4 inch (19 mm) into or through the roof sheathing.

1509.4.2.5 When slopes exceed 20:12, special methods of fastening are required. Follow manufacturer's printed instructions.

1509.5 Mineral Fiber Shingles

1509.5.1 For a minimum slope of 3:12 up to 4 1/2:12, underlayment shall be a minimum of one layer type 30 asphalt saturated felt nailed and one layer of type 15 asphalt saturated felt laid with hot asphalt or cold applied cement solid mopped.

1509.5.2 For slopes of 4 1/2:12 and greater, underlayment shall be one layer of type 30 asphalt saturated felt.

1509.5.3 Application shall be in accordance with the recommendations of the manufacturer.

1509.6 Slate Shingles

1509.6.1 Slate shingles shall only be used on slopes of 4:12 or greater.

1509.6.2 Underlay shall be one layer of type 30 asphalt saturated felt.

1509.6.3 Maximum exposure shall be calculated using the formula: E = (L-H)/2 where L is the shingle length, and H is the shingle headlap (e.g., for an 18-inch (457 mm) shingle with a 3-inch (76 mm) headlap, (18-3)/2 = 7 1/2-inch (191 mm) exposure).

1509.6.4 Minimum headlap of the shingles shall be in accordance with Table 1509.6.

Table 1509.6
Slate Shingle Headlap

Roof Slope	Minimum (inches)
4:12 to < 8:12	4 (102 mm)
8:12 to < 20:12	3 (76 mm)
20:12 and greater	2 (51 mm)

1509.7 Concrete and Clay Roof Tile

1509.7.1 General.

1509.7.1.1 Each roof tile shall have a permanent manufacturer's identification mark.

1509.7.1.2 The tile manufacturer's written application specifications shall be available and shall include but not be limited to the following:

l. The tile's placement and spacing,
2. Amount, and placement of mortar,
3. Underlayment,
4. Slope requirement,
5. Fasteners and their placement necessary to comply with requirements of Chapter 16.

1509.7.1.3 Roof tile shall be in accordance with the physical test requirements as follows:

1. Except for an overlapping lip, tile shall have a minimum thickness of not less than 1/2 inch (12.7 mm) for barrel tile and 3/8 inch (9.5 mm) for shingle tile.
2. Barrel tile shall be test loaded by being supported on sand 2 inches (51 mm) deep in a sand box 4 inches (102 mm) wider than the width of the tile. Shingle tile shall be tested using cloth tubes parallel to the edge of the tile. Sand tubes shall be 2-inch (51 mm) diameter loosely filled with dry 40/60 silicon and shall be placed under the edge of the tile with a center-to-center distance equal to the width of the tile. A test load shall be applied on a 3-inch (76 mm) square steel plate being on a sandbag set at the center of the tile. The breaking load of any average breaking load of 5 shingle tiles shall not be less than 250 lbs (1110 N). The average breaking load of 5 barrel tiles shall be not less than 300 lbs (1330 N).
3. Roof tiles shall absorb not more than 12% of the dry weight of the tile during a 24-hour immersion test.
4. Roof tiles shall meet or exceed the requirements of ASTM C 666 for freeze/thaw requirements.

1509.7.1.4 The substrate to which tile is to be installed shall be uniform, smooth, clean, and dry. Neither underlayment nor tiles shall be installed on wet, frozen, or icy surfaces.

1509.7.1.5 Underlayment materials used shall be in accordance with the following minimum standards.

1509.7.1.5.1 Single-ply system. (Mechanically fastened systems only)

1. Organic Type II (#30) having a minimum weight of 26 lbs (12 kg) per roll.
2. Organic Type I (#43 base sheet) having a minimum weight of 37 lbs (17 kg) per roll.
3. #90 mineral surface roll roofing having a minimum weight of 74 lbs (34 kg) per roll.

1509.7.1.5.2 Two-ply system. (Cemented and mechanically fastened systems)

1. Organic Type I (#30) having a minimum weight of 26 lbs (12 kg) per roll.
2. #90 mineral surface roll roofing having a minimum weight of 74 lbs (34 kg) per roll.

1509.7.1.5.3 Membrane materials shall comply with the following minimum standards.

1. Organic. Conforming to ASTM D 173, asphalt impregnated membrane, a minimum of 3 inches (76 mm) wide.
2. Inorganic. Conforming to ASTM D 1668, asphalt impregnated fiberglass membrane, a minimum of 3 inches (76 mm) wide.

1509.7.1.5.4 Fasteners shall be in accordance with the following:

1. Nails shall be corrosion-resistant minimum hotdipped galvanized or approved equal of sufficient length to properly penetrate the deck a minimum of 3/4 inch (19 mm) or through the thickness of the deck, whichever is less.
2. Caphead nails.
3. Staples shall be corrosion-resistant minimum, 7/16-inch (12 mm) crown.
4. Tin caps shall be in accordance with 1509.1.4.4.
5. Storm clips shall be applied in accordance with manufacturer's recommendations.

1509.7.1.5.5 Metal flashing shall be a minimum 26 ga (0.455 mm) G 90 corrosion-resistant metal conforming to ASTM A 525 and A 90 or minimum 16 oz (4.9 kg/m^2) copper conforming to ASTM B 370 or approved equal.

1509.7.1.5.6 Adhesive/Sealant shall be in accordance with the following:

1. Asphalt plastic roof cement shall conform to ASTM D 2822, Type II. Nonrunning, heavy body material composed of asphalt and other mineral ingredients.
2. Cold applied liquid roof coating shall conform to ASTM D 3019, Type II.
3. Structural bonding adhesive shall conform to ASTM C 557 or ASTM D 3498.
4. Hot steep asphalt shall conform to ASTM D 312.

1509.7.1.5.7 Mortar components shall be in accordance with the following:

1. Cements
   Blended cement shall conform to ASTM C 91, Type M.
   Portland cement shall conform to ASTM C 150, Type I.
   Masonry cement shall conform to ASTM C 91, Type M.
2. Sand shall conform to ASTM C 144, uniformly graded, clean, and free from organic materials.

1509.7.1.5.8 Mortar mixes shall conform to type M in accordance with 2104.7.

1509.7.1.5.9 Mortar flow 110± 5% shall conform to ASTM C 230 flow table.

1509.7.1.5.10 Eave Closure shall be one of the following installed according to manufacturer's recommendations.

1. Prefabricated EPDM synthetic rubber conforming to ASTM D 1056.
2. Prefabricated minimum 26 ga (0.455 mm) corrosion-resistant metal eave closure.
3. Mortar for mineral surface roll roofing.

1509.7.1.5.11 Lumber shall be in accordance with the following:

l. Fasteners which penetrate fire retardant treated wood and pressure treated wood shall comply with 2306.3.
2. Sheathing shall comply with 2301.4.
3. Nailer boards shall be pressure treated wood.

1509.7.2 Cement Applied Tile.

1509.7.2.1 Subroof Application Two-ply underlayment - pitches 2 1/2:12 and greater.

1509.7.2.1.1 Base Ply. Starting at the eave edge, one course of Type 30 roofing felt shall be applied horizontally along the roof line lapping the end joints a minimum of 4 inches (102 mm), tin-capped and secured with nails, staples or caphead nails a maximum of 12 inches (305 mm) o.c. in field and 12 inches (305 mm) on all headlaps with a weave pattern at all valleys. Each succeeding course shall be applied in the same manner allowing a minimum 2-inch (51 mm) headlap. All hips and ridges shall be overlapped a minimum of 6 inches (152 mm).

1509.7.2.1.2 Drip edge metal shall be nailed or stapled along and directly on top of the #30 felt at the eave, fastened 6 inches (152 mm) o.c. and 1/2 inch (12.7 mm) from the top flange. All joints shall be lapped a minimum of 2 inches (51 mm) continuing from the eave up the rake/gable in the same manner.

1509.7.2.1.3 Valleys shall be nailed within 1 inch (25.4 mm) of the metal edges, a maximum 6 inches (152 mm) o.c. with joints lapped a minimum of 6 inches (152 mm). Plastic roof cement shall be applied between the laps. Valleys shall meet the following requirements.

1. Standard valley shall be a minimum of 16 inches (407 mm) in width.
2. Preformed closed valley shall be a minimum of 16 inches (407 mm) in width with a center diverter.

3. Preformed open valley shall be a minimum of 16 inches (407 mm) in width with twin center diverters.

1509.7.2.1.4 Flashing and counter flashings at wall abutments. An "L" metal shall be installed flush to the base of walls over the #30 felt and nailed within 1 inch (25.4 mm) of the metal edges. Joints shall be lapped a minimum of 4 inches (102 mm) and plastic roof cement applied between the laps. Work shall start at the lower portion and work upward to insure watertightness. The top edge of the vertical flange shall be sealed, covering all nail penetrations with plastic roof cement and membrane. If counter flashing is to be installed, the top flange of the base flashing shall be lapped a minimum of 3 inches (76 mm). The metal shall be nailed within 1 inch (25.4 mm) of the metal edge a minimum of 6 inches (152 mm) o.c. or set into reglets and thoroughly caulked. Joints shall be lapped a minimum of 3 inches (76 mm) and plastic roof cement applied between laps.

1509.7.2.1.5 Standard skylights, chimneys, etc. shall be installed in accordance with regular flashing installation procedures.

1509.7.2.1.6 Plastic roof cement shall be applied around the base of the protrusion and on the bottom side of the metal flanges sealing the unit base flashing to the deck. All sides of the base flashing shall be nailed within l inch (25.4 mm) of the edge to secure the base flush to the deck.

1509.7.2.1.7 Top Ply. Starting at the eave edge, #90 roll roofing shall be applied horizontally along the roof line over the base ply lapping the end joints a minimum of 6 inches (152 mm). Hot asphalt shall be applied between the plies of roofing felt so that no felt touches felt. Cold applied or plastic roof cement shall be permitted to be substituted for hot asphalt for pitches above 6:12. Felt shall be backnailed using tin caps and roofing nails or caphead nails a maximum of 12 inches (305 mm) o.c. and a minimum 1 inch (25.4 mm) from the top edge of the felt. Each succeeding course shall be applied in the same manner, allowing a minimum 4-inch (102 mm) headlap. Hip and ridges shall be overlapped a minimum of 6 inches (152 mm) with a weave pattern in valleys or trimmed a maximum of 4 inches (102 mm) past nail penetrations. When preformed valley metal is used, the edge of the #90 felt shall be sealed with plastic roof cement and membrane. All metal flashings and roof protrusions shall be hot mopped or cold applied. Felt overhanging at eaves and gables shall be trimmed. Fishmouths shall be cut and sealed with plastic roof cement and membrane. Plastic roof cement or hot asphalt shall be applied along the edge of the felt wherever it meets wall bases.

1509.7.2.2 Tile Installation.

1509.7.2.2.1 Clay tile to be set in mortar shall be wetted prior to setting in mortar bed.

1509.7.2.2.2 Eave treatment shall be one of the following:

1. Prefabricated Eave Closure. Closure strip shall be installed along the eave according to the manufacturer's recommendation.
2. Metal Eave Closure. Closure strip shall be installed along the eave according to the manufacturer's recommendation.
3. Thickbutt Tile. Thickbutt tile shall be installed along the eave according to the manufacturer's recommendation.
4. Mortar Eave Closure. Starting at the lower left-hand comer (facing down roof), the first course of tile shall be installed with the eave edge of tile elevated with mortar, pointed and provided with a weephole flush with the deck to allow drainage and ventilation.
5. Fascia. Raised fascia/wood starter strip. #30 felt shall be installed in accordance with 1509.7.2.1. Fascia board shall be installed approximately 1 1/2 inch (38 mm) above the roof deck or a 2x2 wood starter strip installed at the roof edge. A tapered cant strip shall be installed behind the fascia/starter strip to support metal flashing and mortar. Antiponding metal flashing of sufficient width to insure positive drainage over fascia/starter strip shall be installed. The top edge of flange shall be nailed to the roof.

1509.7.2.2.3 The first course of tile shall be installed starting at the lower left-hand comer (facing down roof). All tile shall overhang the drip edge evenly along entire course and at same height when using mortar to elevate first course.

1509.7.2.2.4 Low Profile, High Profile and Flat Tile. Tile shall be set in a bed of Type M mortar. A full 10-inch (254 mm) minimum length mason trowel full of mortar (approximately 4 to 5 lbs (1.8 to 2.3 kg) dry weight) shall be installed vertically under the pan/flat portion of tile. When the tile has more than one pan/flat portion, the mortar shall be placed under the pan closest to the underlock of the previously installed tile. For flat tile, mortar shall be placed adjacent to the underlock of the previously installed tile. Mortar shall be placed from the head of the tile in the previous course to within 2 to 4 inches (51 to 102 mm) of the head of the tile being set. Mortar shall not be placed under the lugs, the head of the tile, nor onto the underlock of the adjacent tile. A half-starter/finisher tile shall be used for proper staggering of the tile courses when using the staggered/cross bond method of installation. Tile shall be set in stepped course fashion or in a horizontal and/or vertical fashion when utilizing the straight bond method. Succeeding courses of field tile shall be laid in the same manner. The bed of mortar shall make contact with the head of the lower course of tile and the underside of the tile being set.

1509.7.2.2.5 Two-piece barrel tile. A 10-inch (254 mm) mason's trowel full of mortar (approximately 4 to 5 lb (1.8 to 2.3 kg) dry weight) shall be applied vertically over the chalk line and under the center of each pan with the narrow end facing down the roof. Mortar shall be placed so as to make a 2-tile bond between the pan being set and the pan below in the previous course. A bed of mortar shall be placed along the inside edges of the pans and the covers set with the wide end facing down the roof. Mortar shall be pointed to the next acceptable straight edge finish, with good strong contact along the edges. Succeeding courses of field tile shall be laid in the same manner. The bed of mortar shall make contact with the head of the lower course of tile and the underside of the tile being set.

1509.7.2.2.6 Fastening shall be in accordance with the following:

l. Steep Roof Pitch Installations. For pitches 4:12 and above, the eave course shall be fastened with one nail in addition to the mortar. For pitches 6:12 up to and including 7:12, every third tile in every fifth course shall be fastened with one nail in addition to the mortar. Plastic cement shall be applied to seal all nail penetrations. For pitches above 7:12, every tile shall be nailed in addition to the application of mortar.

2. Elevation Requirements. Tile installed 55 ft (17 m) above grade or greater shall be fastened with a minimum of two hot dipped galvanized nails in addition to the mortar.

1509.7.2.2.7 Hip and ridge tiles shall be set in a continuous bed of mortar lapping the tile a minimum of 1 inch (25.4 mm). Mortar should be pointed and finished to match the tile surface. Hip starter tiles shall be one of the following:

1. Prefabricated hip starter.
2. Mitered tile as hip starter to match eave lines.
3. Standard hip tile as starter.

1509.7.2.2.8 Pressure treated nailer boards should be installed per manufacturer's recommendations where required for steep roof pitch installation, for use with hip or ridge, and/or two-piece barrel tile.

1509.7.2.2.9 Rake treatment shall be one of the following methods:

1. Rake Tile. The first rake tile shall be installed to the exposed length of the first course of field tile. The factory finish end of the tile should be installed toward the eave. The rake tile shall be nailed with a minimum of two hot dipped galvanized nails of sufficient length to penetrate the framing a minimum of 3/4 inch (19 mm). Each succeeding rake tile shall be abutted to the nose of field tile above, maintaining a constant headlap and pointed with mortar to match the tile surface along the inside edge.

2. Rush Finish. A mortar bed shall be placed along the roof edge and the field tile set in mortar flush with the edge and pointed smooth to a straight edge finish.

1509.7.2.2.10 At wall abutments, tile shall be installed adjacent to the wall and voids filled with mortar and finished to match the tile surface.

1509.7.2.2.11 Valleys shall be one of the following:

1. Closed Valley. Tile shall be mitered to meet at the center of the valley or mitered to form a straight border on either side of the water diverter.
2. Open Valley. Tile shall be mitered to form a straight border on either side of the two water diverters. A bed of mortar shall be placed a minimum of 2 inches (51 mm) from the valley center. Tile shall be mitered to form a straight border and pointed to match the tile surface. A minimum of one 2x4 shall be placed on edge down the center of the valley. A continuous bed of mortar shall be applied along the edge of the 2x4. The tile shall be installed a minimum of 1 inch to a minimum of 4 inches (25 to 102 mm) from the 2x4. A line of mortar shall be consistent through the valley. The mortar shall be smoothed and formed to match the tile contour. After initial set, the 2x4 shall be removed and the mortar pointed to match the tile surface.

1509.7.2.2.12 Tile shall be installed to accommodate all roof penetrations. Voids shall be filled with mortar and pointed to match the tile surface.

1509.7.2.2.13 Acrylic sealer shall be applied to exposed mortar in accordance with the manufacturer's recommendation.

1509.7.2.2.14 In a cemented application, an average nonadherence of no more than one tile in ten is allowable.

1509.7.3 Mechanically Fastened Tile-Subroof Application. Subroof application shall be in accordance with one of the methods described in 1509.7.3.1, 1509.7.3.2 or 1509.7.3.3.

1509.7.3.1 Method 1: Single-ply underlayment, minimum 4:12 pitch (Not Sealed). This method utilizes preformed metal flashing, minimum 2-inch (51 mm) paper head lap, 6-inch (152 mm) side lap and minimum 3-inch (76 mm) tile head lap. Paper laps or nail penetrations of tile need not be sealed when using this method.

1509.7.3.1.1 Drip edge metal shall be nailed or stapled along and directly on top of sheathing 6 inches (152 mm) o.c. and 1/2 inch (12.7 mm) from top flange. All joints shall be lapped a minimum of 3 inches (76 mm). Fastening of drip edge may be decreased when additional fastenings will be used during application of underlayment and/or eave closure.

1509.7.3.1.2 Underlayment. A 36-inch (914 mm) side strip of underlayment (sweat sheet) shall be applied down the center of the valley, tin-capped and fastened with nails, staples, or caphead nails a maximum 24 inches (610 mm) o.c. along the edge of the sheet. Starting at the eave edge, one course of underlayment should be applied horizontally along roof line with end joints lapped a minimum of 6 inches (152 mm), tin-capped and fastened with nails, staples, or caphead nails a maximum 36 inches (914 mm) o.c. along top edge of the sheet. Each succeeding course shall be applied in same manner allowing a minimum 2 inches (51 mm) headlap, tin-capped and fastened with nails, staples, or caphead nails approximately 12 inches (305 mm) o.c. at the headlap with a weave pattern at all valleys. All hips and ridges shall be overlapped a minimum of 6 inches (152 mm). Underlayment should extend a maximum 4 inches (102 mm) up abutting walls and other protrusions. Underlayment shall be fastened a minimum of 12 inches (305 mm) o.c. at eave.

1509.7.3.1.3 Rake Treatment shall be one of the following:

1. Underlayment wrapped gable (not recommended for flush finish). Trim tile shall be installed. Underlayment shall extend beyond the rake and be folded down onto the fascia on a barge board, tin-capped, and fastened with nails, staples, or caphead nails a maximum 6 inches (152 mm) o.c.

2. Metal drip edged gable. Drip edge metal shall be nailed or stapled along and directly on top of underlayment 6 inches (152 mm) o.c. and 1/2 inch (12.7 mm) in from the top flange. All joints shall be lapped a minimum of 3 inches (76 mm). Metal shall continue from the eave up the rake.

1509.7.3.1.4 Valleys shall be in accordance with the following:

1. Preformed closed valley. Valley shall be a minimum 16 inches (407 mm) wide with a minimum 2 1/2 inch (64 mm) high center diverter and with minimum 1 inch (25.4 mm) metal edge returns. All joints shall be lapped a minimum of 6 inches (152 mm). A coating or separator sheet for corrosion resistance shall be installed when using any ferrous metals.
2. Preformed open valley. Valley shall be a minimum 16 inches (407 mm) wide with a minimum 2 1/2 inch (64 mm) high twin center diverter and with minimum 1 inch (25.4 mm) metal edge returns. All joints shall be lapped a minimum of 6 inches (152 mm). A coating or separator sheet for corrosion resistance shall be installed when using any ferrous metals.
3. Valleys shall be secured with clips fabricated from the same material 24 inches (610 mm) o.c. One-inch (25.4 mm) metal edge returns shall be clipped to either deck or batten strip with roofing nails through a metal strap. Metal shall be trimmed and a lead soaker installed at all valley/ridge junctions. Lead should be turned up 1 inch (25.4 mm) to create water diverter.
4. Valleys terminating onto the roof plane shall be installed in accordance with regular valley flashing installation procedures. An 18x18 inch (457 x 457 mm) lead soaker skirt shall be applied underneath the eave end of the valley to carry water off of the valley back onto the field tile.

1509.7.3.1.5 Flashing and counter flashings at wall abutments. Preformed metal wall tray shall be installed flush to base of walls over underlayment. Work shall be started at lower portion to insure watertightness. Flashing shall be secured with clips on the horizontal metal flange 24 inches (610 mm) o.c. A 1-inch (25.4 mm) metal edge diverter shall be clipped to the deck/batten strip with a roofing nail through a metal strap. The vertical metal flange shall be nailed within 1 inch (25.4 mm) of the metal edge. Joints shall be lapped a minimum of 4 inches (102 mm) and a coating or separator sheet for corrosion resistance applied when using ferrous metals. The entire edge of the vertical metal flange shall be sealed. Where counter flashing is installed, the top flange of base flashing shall be lapped a minimum of 3 inches (76 mm). Metal shall be nailed within l inch (25.4 mm) of the metal edge a minimum of 6 inches (152 mm) o.c. or set into reglets and thoroughly caulked. Joints shall be lapped a minimum of 3 inches (76 mm) and plastic roof cement/sealant applied between laps. All head/apron flashing shall be installed on top of the tile. The deck flange shall conform to the pitch of the roof and extend a minimum of 4 inches (102 mm) onto the field tile. Flashing shall be installed to either channel water to the eave under the tile or redirect water back on top of the field tile.

1509.7.3.1.6 Curb Mounted Skylights, Hood Vents, Turbines. A cricket shall be installed on the ridge side of any curb greater than 48 inches (1219 mm) wide. A minimum 12-inch (305 mm) width of lead shall be installed at the eave end of curb, trimmed as necessary to insure water shedding capabilities on top of the field tile. It shall be secured with roofing nails 6 inches (152 mm) o.c., with nails covered by the skylight/hood vent flange. Lead shall be continued on both sides of the curb working up toward ridge, trimmed as necessary to insure water shedding capabilities onto the field tile. It shall be secured with roofing nails 6 inches (152 mm) o.c. The ridge end of the curb shall be installed with a minimum of 24 inch (610 mm) width of lead extending over the course of tile abutting the top of the curb and under the second course of tile at the top of the curb or lead shall be extended under both courses of the tile at the top of curb. Lead shall be folded to create a 1-inch (25.4 mm) water diverter at the top and sides of the 24-inch (610 mm) lead saddle. All nail penetrations, lead/skylight or hood vent joints shall be sealed with approved sealant or caulk.

1509.7.3.1.7 Prefabricated curbed skylights shall be installed in accordance with skylight manufacturer's recommendations for nail-on tile system skylights.

1509.7.3.1.8 Chimneys and Wall Abutments Terminating Onto Roof Plane. A minimum 12-inch (305 mm) width of lead shall be installed at the eave end of the protrusion, trimmed as necessary to insure water shedding capabilities on top of the field tile. It shall be secured with roofing nails a maximum 6 inches (152 mm) o.c., 1 inch (25.4 mm) from the vertical flange. A wall pan flashing with a minimum 1-inch (25.4 mm) water diverter along sides of the chimney/wall abutments shall be installed, trimmed and folded at the ridge end of side flashing. The wall pan flashing shall terminate a minimum of 8 inches (203 mm) from the eave end of the protrusion. Prior to securement, a lead saddle to carry water from wall pan flashing on top of the field tile shall be applied. The pan flashing shall be sealed to the lead saddle and secured with roofing nails a maximum 6 inches (152 mm) o.c., 1 inch (25 mm) from the vertical flange. A metal saddle shall be installed at the ridge end of the chimney using preformed corrosion- resistant metal or lead, trimmed and folded to insure water shedding capabilities onto the side pan flashing. It shall be secured with roofing nails a maximum 6 inches (152 mm) o.c., 1 inch (25.4 mm) from the vertical flange. The vertical flange shall be sealed with plastic cement/sealant. On flat tile installations, rigid corrosion-resistant metal shall be permitted to be substituted for lead flashing at the chimney/wall abutment and eave end.

1509.7.3.1.9 Pipe stacks shall be sealed with plastic cement. An 18-inch (457 mm) skirt lead stack shall be installed over the last field tile cut, previously installed. The lead shall extend under the course of tile above the pipe stack course and be sealed with approved sealant/caulk. On flat tile installations, rigid corrosion-resistant metal shall be permitted to be substituted for lead.

1509.7.3.2 Method 2: Single-ply underlayment, minimum 4:12 pitch (Sealed). This system utilizes standard metal flashings, minimum 43# base sheet with a sealed minimum 2-inch (51 mm) paper head lap, sealed 6-inch (152 mm) side lap, and minimum 2-inch (51 mm) tile head lap. All tile nail penetrations shall be sealed with plastic cement.

1509.7.3.2.1 Drip edge metal shall be nailed or stapled along and directly on top of sheathing, fastened a minimum 6 inches (152 mm) o.c. and 1/2 inch (12.7 mm) from the top flange. All joints shall be lapped a minimum of 3 inches (76 mm) and sealed along the entire length of top edge of eave drip with plastic cement. Securement of the drip edge may be decreased when additional securement will be used during application of the underlayment, and/or metal/rubber eave closure.

1509. 7.3.2.2 Underlayment. A 36-inch (914 mm) wide strip of underlayment (sweat sheet) shall be applied down the center of the valley, tin-capped and secured with nails, staples, or caphead nails a maximum 24 inches (610 mm) o.c. along the edge of the sheet. Starting at the eave edge, one course of underlayment shall be applied horizontally along roof line with the end joints lapped a minimum of 6 inches (152 mm). End laps shall be sealed with plastic cement. Underlayment shall be tin-capped and secured with nails, staples, or caphead nails a maximum 12 inches (305 mm) o.c. along the top edge of sheet. The entire length of top edge of underlayment shall be sealed, covering all tin-caps or caphead nails with plastic cement. Each succeeding course shall be applied in the same manner allowing a minimum 2 inch (51 mm) headlap, insuring a weave pattern at all valleys. Hips and ridges shall be overlapped a minimum of 6 inches (152 mm). Underlayment shall be trimmed at all wall bases.

1509.7.3.2.3 Rake Treatment. Drip edge metal should be nailed or stapled along and directly on top of the underlayment, fastened 6 inches (152 mm) o.c. and 1/2 inch (12.7 mm) from the top flange. All joints shall be lapped a minimum of 3 inches (76 mm). Metal shall continue from eave up rake/gable. The entire edge of the metal flange shall be sealed, covering all nail penetrations with plastic cement and membrane.

1509.7.3.2.4 Valleys shall be nailed within 1 inch (25.4 mm) of the metal edge a maximum 6 inches (152 mm) o.c. Metal joints shall be lapped a minimum of 6 inches (152 mm) with plastic roof cement applied between laps. The entire edge of the metal flange shall be sealed, covering all nail penetrations with plastic cement and membrane. Valleys shall be one of the following:

1. Standard. Material shall be a minimum of 16 inches (407 mm) in width.
2. Preformed Closed Valley. Material shall be a minimum of 16 inches (407 mm) in width with a minimum 2 1/2-inch (64 mm) high center diverter.
3. Preformed Open Valley. Material shall be a minimum of 16 inches (407 mm) in width with minimum 2 1/2-inch (64 mm) high twin center diverters.

1509.7.3.2.5 Flashings and Counter Flashings at Wall Abutments. "L" metal flashings shall be installed flush to base of walls over the underlayment, nailed within 1 inch (25.4 mm) of the metal edge. The horizontal flange shall be nailed a maximum 6 inches (152 mm) o.c. Joints shall be lapped a minimum 4 inches (102 mm) and plastic roof cement applied between laps. Flashing shall start at the lower portion and work up the roof to insure water shedding capabilities of all metal laps. The entire edge of the metal flange shall be sealed, covering all nail penetrations with plastic roof cement and membrane. If counterflashing is installed, the top flange of base flashing shall be lapped a minimum of 3 inches (76 mm). Metal shall be nailed within 1 inch (25.4 mm) of the metal edge a minimum of 6 inches (152 mm) o.c. or set into reglets (secured properly) and thoroughly caulked. Joints shall be lapped a minimum of 3 inches (76 mm) with plastic roof cement applied between laps. All head/apron flashing shall be installed on top of the underlayment, conforming to the pitch of the roof and extending a minimum of 4 inches (102 mm) onto the deck. Metal edge shall be sealed with plastic cement and membrane.

1509.7.3.2.6 Standard skylights, chimneys, etc. shall be installed in accordance with regular flashing installation procedures.

1509.7.3.2.7 Pipes, turbines, vents, etc. Plastic roof cement shall be applied around the base of protrusion and on the bottom side of metal flanges, sealing the unit base flashing to the underlayment. All sides of base flashing shall be nailed and secured within 1 inch (25.4 mm) of the edge. Base shall be flush to the deck. The edge of the metal flanges shall be sealed, covering all nail penetrations with plastic roof cement and membrane.

1509.7.3.3 Method 3: Two-ply Underlayment - Pitches 3:12 and Greater. This system utilizes standard metal flashings, minimum #30 dry-in sheet, tin-capped, hot mopped minimum 74 lb (34 kg) mineral surfaced roll roofing, and a minimum 2-inch (51 mm) tile headlap. Plastic cement shall be applied at all tile nail penetrations except for pitches 6:12 and above.

1509.7.3.3.1 Base Ply. Starting at the eave edge, one course of #30 roofing felt shall be applied horizontally along the roof line, lapping end joints a minimum of 4 inches (102 mm). #30 felt should be nailed and secured with nails, staples, or caphead nails, a maximum of 12 inches (305 mm) o.c. in the field with 12 inches (305 mm) headlaps, insuring a weave pattern at the valleys. Each succeeding course shall be applied in the same manner allowing a minimum 2-inch (51 mm) headlap. All hips and ridges shall be overlapped a minimum of 6 inches (152 mm).

1509.7.3.3.2 Drip edge metal shall be nailed and stapled along and directly on top of the #30 felt at the eave, fastened a maximum 6 inches (152 mm) o.c. and 1/2 inch (12.7 mm) from the top flange. All joints shall be lapped a minimum of 3 inches (76 mm). Metal shall continue from eave up rake/gable in same manner.

1509.7.3.3.3 Valleys. Metal shall be nailed within 1 inch (25.4 mm) of the metal edges, a maximum of 6 inches (152 mm) o.c. Metal joints shall be lapped a minimum of 6 inches (152 mm). Plastic roof cement shall be applied between the laps. Valleys shall be one of the following:

1. Standard. Material shall be a minimum of 16 inches (407 mm) in width.

2. Preformed Closed Valley. Material shall be a minimum of 16 inches (407 mm) in width with a minimum 2 1/2 inches (64 mm) high center diverter.
3. Preformed Open Valley. Material shall be a minimum of 16-inch (407 mm) in width with a minimum 2 1/2-inch (64 mm) high twin center diverters.

1509.7.3.3.4 Flashing and counter flashings at wall abutments. "L" metal shall be installed flush to the base of walls over the #30 felt and nailed within 1 inch (25.4 mm) of the metal edges. Joint s shall be lapped a minimum of 4 inches (102 mm) with plastic roof cement applied between the laps , starting at the lower portion and working up to insure watertightness. The top edge of the vertical flange shall be sealed, covering all nail penetrations with plastic roof cement and membrane. If counter flashing is installed, the top flange of base flashing shall be lapped a minimum of 3 inches (76 mm). Metal shall be nailed within 1 inch (25.4 mm) of metal edge a minimum of 6 inches (152 mm) o.c. or set into reglets (secured properly) and thoroughly caulked. Joints shall be lapped a minimum of 3 inches (76 mm) and plastic roof cement shall be applied between laps. All head/apron flashing shall be installed on top of the mineral surface roll roofing. The deck flange should conform to the pitch of the roof and extend a minimum of 4 inches (102 mm) onto the deck.

1509.7.3.3.5 Standard skylights, chimneys, and other projections shall be installed in accordance with regular flashing installation procedures.

1509.7.3.3.6 Pipes, turbines, vents, and other penetrations. Plastic roof cement shall be applied around the base of the protrusion and on the bottom side of the metal flanges, sealing the unit base flashing to the deck. All sides of base flashing shall be nailed and secured within 1 inch of the edge, making certain the base is flush to deck.

1509.7.3.3.7 Top Ply. Starting at the eave edge, #90 roll roofing shall be applied horizontally along the roof line over the base ply, lapping the end joints a minimum of 6 inches (152 mm). Hot asphalt shall be applied between the plies of roofing felt so that no felt touches felt. For pitches above 6:12, cold applied or plastic roof cement shall be permitted. The ply shall then be backnailed, using tin cap and roofing nails or caphead nails, a maximum of 12 inches (305 mm) o.c., and a minimum 1 inch (25.4 mm) from the top edge of the felt. Each succeeding course shall be applied in the same manner, allowing a minimum 4-inch (102 mm) headlap. Hips and ridges shall be lapped a minimum of 6 inches (152 mm), insuring a weave pattern in the valley or trim, a maximum of 4 inches (102 mm) past nail penetrations. When preformed valley metal is used, the edge of #90 felt shall be sealed with plastic roof cement and membrane. All metal flashings and roof protrusions shall be hot mopped or cold applied in order to insure weathertightness. Any felt overhanging at eave and gable shall be trimmed. Fishmouths shall be cut and sealed with plastic roof cement and membrane. Plastic roof cement or hot asphalt shall be applied along the edge of the felt wherever it meets wall bases.

1509.7.4 Mechanically Fastened Tile - Tile Installation. (Low Profile, High Profile and Flat Tile)

1509.7.4.1 Installation shall be in accordance with one of the following systems:

1. Batten installation. Battens are optional up to 7:12 pitch. Refer to manufacturer's recommendations for pitches 7:12 or greater. For pitches below 6:12, 4 ft (1219 mm) battens or shims with moisture resistant 1/4 inch (6.4 mm) nominal lath or strips of decay resistant material, such as asphalt cap sheet or asphalt shingle should be used. The top edge of the batten shall be installed to a horizontal line, fastening and securing a maximum of 24 inches (610 mm) o.c. using a minimum 8d corrosion-resistant nail. Preformed metal with 1 inch (25.4 mm) edge returns shall be used with a batten installation. A 1/2 inch (12.7 mm) space shall be left between the batten ends and between the battens and metal edges.
2. Direct deck installation. For use on pitches 4:12 and greater. Apply in accordance with manufacturer's recommendations.

1509.7.4.2 Eave treatment shall be one of the following:

1. Prefabricated Eave Closure. Closure strip shall be installed along the eave according to manufacturer's recommendations.
2. Metal Eave Closure. Closure strip shall be installed along the eave according to manufacturer's recommendations.
3. Raised Fascia/Wood Starter Strip. Fascia board shall be installed approximately 1 1/2 inches (38 mm) above the roof deck or a 2x2 wood starter strip installed at the roof edge. When using drip edge, an 8 inch (203 mm) tapered cant strip shall be installed at the eave behind the fascia and/or starter strip to support the metal flashing. Antiponding metal flashing of sufficient width to insure positive drainage over fascia/starter strip shall be installed. The top edge of the flange shall be nailed onto the roof. Underlayment shall be applied in accordance with 1509.7.3.1, 1509.7.3.2 and 1509.7.3.3. The use of storm clips shall be made in accordance with manufacturer's recommendations.

1509.7.4.3 The first course of tile shall be installed starting at lower left-hand corner (facing down roof). All tile shall overhang the drip edge evenly along entire course. Tile shall be fastened according to manufacturer's recommendations. Tile shall be cut/broken for proper staggering of tile courses when using the staggered/cross bond method of installation. Tile shall be set in stepped course fashion or in a horizontal and/or vertical fashion when the straight bond method is used. Succeeding courses of field tile shall be laid in the same manner, fastened according to manufacturer's recommendations. Field tile shall be cut/broken to form a straight edge at the center of the hip/ridge. For pitches less than 6:12 applied tile in accordance with 1509.7.3.2 and 1509.7.3.3, plastic cement shall be applied at all tile nail penetrations.

1509.7.4.4 Hip and ridge tiles shall be set in a continuous bed of mortar, lapping tile a minimum of 1 inch (25.4 mm). The bed of mortar shall not protrude into the center of the hip or ridge junction. A minimum 1 inch (25.4 mm) of the field tile shall extend beyond bed of mortar. Plastic cement or sealant shall be applied between the laps at ridge when installed in accordance with 1509.7.3.1. Mortar shall be pointed and finished to match the tile surface. Weepholes flush with the field tile shall be applied at the ridge when installed in accordance with 1509.7.3.1 only. Hip starters shall be one of the following:

1. Prefabricated hip starter.
2. Tile shall be mitered as a hip starter to match the eave lines.
3. Standard hip tiles shall be used as a starter.

1509.7.4.5 Nailer boards shall be installed in accordance with manufacturer's recommendations and shall be fastened with corrosion-resistant nails of sufficient length to penetrate a minimum 3/4 inch (19.1 mm) or through the deck, whichever is less.

1509.7.4.6 Rake treatment shall be in accordance with 1509.7.4.6.1, 1509.7.4.6.2, or 1509.7.4.6.3.

1509.7.4.6.1 Rake Tile. First rake tile shall be installed to the exposed length of the first course of field tile with the factory finish end of tile toward the eave. The rake tile shall be nailed with a minimum of two hot dipped galvanized nails of sufficient length to penetrate the framing a minimum of 3/4 inch (19 mm). Each succeeding rake tile shall be abutted to the nose of the field tile above, maintaining a constant headlap.

1509.7.4.6.2 Flush finish shall be one of the following:

1. Metal finish. A prefabricated gable metal with a minimum 1-inch (25.4 mm) water return shall be installed, fastened by clipping a maximum 24 inches (610 mm) o.c.
2. Mortar finish. (For use only with 2-ply sealed underlayment systems.) A mortar bed shall be placed along the roof edge and pointed smooth to a straight edge finish.

1509.7.4.6.3 For rake tile application at finishing end requiring special consideration to provide proper drainage, refer to manufacturer's recommendations.

1509.7.4.7 At wall abutments, tile shall be cut to fit a maximum 3/4 inch (19.1 mm) to base of walls. Point-up mortar shall not be permitted when installed in accordance with 1509.7.3.1.

1509.7.4.8 Valleys shall be one of the following:

1. Closed Valley. Tile shall be mitered to meet at the center of the valley and to form a straight border on either side of the water diverter.
2. Open Valley. Tile shall be mitered to form straight border on either side of two water diverters. For roll valley metal installation only, a bed of mortar shall be placed a minimum of 2 inches (51 mm) on both sides of the center of the valley. Tile shall be mitered to form a straight border and pointed to match the tile surface.

1509.7.4.9 Tile shall be cut to fit close to plumbing stack. Voids should be filled with mortar and pointed to match the tile surface when using underlayment system 1509.7.3.2 or 1509.7.3.3. For underlayment system 1509.7.3.1, see 1509.7.3.1.9.

1509.8 Wood Shingles and Shakes

1509.8.1 Where Permitted. Wood shingles and shakes shall be permitted as roof coverings on buildings that comply with all of the following restrictions:

1. The building is outside the Fire District, and
2. Building height is three stories or less, and
3. Building area is 9,000 sq ft (836m^2) or less, and
4. The building is located not less than 6 ft (1829 mm) from the property line.

1509.8.2 Materials.

1509.8.2.1 Wood shingles and shakes used as roof covering shall comply with the requirements of 1509.8 and shall be one of the materials listed in Table 1509.8.2.

Table 1509.8.2
Wood Shingle and Shake Material Requirements

Material	Minimum Grades	Applicable Grading Rules
Wood shingles of naturally durable wood	1, 2, or 3	CSSB
Wood shakes of naturally durable wood	1	CSSB
Tapersawn shakes of naturally durable wood	1 or 2	CSSB
Preservative treated shakes and shingles of naturally durable wood	1	CSSB
Fire retardant treated shakes and shingles of naturally durable wood	1	CSSB
Preservative treated tapersawn shakes of Southern Yellow Pine treated in accordance with AWPA Standard C2	1 or 2	TFS

TFS = Forest Products Laboratory of the Texas Forest Service

CSSB = Cedar Shakes and Shingle Bureau

1509.8.2.2 Wood shingles and shakes used as roof coverings on buildings shall be limited to the following materials:

1. Wood shingles of naturally durable wood shall be No. 1, 2, or 3 grades, and hip and ridge units shall be No. 1 or 2 grades. Shingles and hip and ridge units shall be manufactured in accordance with the grading rules of the Cedar Shakes and Shingle Bureau.

2. Handsplit and resawn wood shakes of naturally durable wood shall be No. 1 grade, and hip and ridge units shall be No. 1 grade. Shakes and hip and ridge units shall be manufactured in accordance with the grading rules of the Cedar Shake and Shingle Bureau.
3. Tapersawn shakes of naturally durable wood shall be No. 1 or 2 grades, and hip and ridge units shall be No. 1 or 2 grades. Shakes and hip and ridge units shall be manufactured in accordance with the grading rules of the Cedar Shake and Shingle Bureau.
4. Preservative treated tapersawn shakes of Southern Yellow Pine shall be of No. 1 or 2 grades manufactured in accordance with the grading rules of the Forest Products Laboratory of the Texas Forest Service. These shakes shall be preservative treated in accordance with AWPA Standard C2.

1509.8.2.3 Sheathing. Wood shingles and shakes shall be applied to roofs with solid or spaced sheathing boards. When spaced sheathing is used for all shingles, for 18-inch (457 mm) shakes, and for 24-inch (610 mm) shakes used as exposures less than 10 inches (254 mm), it shall be not less than 1x4, and the boards shall be spaced a distance on center equal to the weather exposure specified in Table 1509.8.4. For 24-inch (610 mm) shakes used at 10 inch (254 mm) exposure, the spaced sheathing shall be either 1x4 spaced 10 inches (254 mm) on center with an additional 1x4 placed between these boards, or 1x6 spaced 10 inches (254 mm) on center.

1509.8.3 Identification. Each bundle of shakes or shingles shall be identified by a label of an approved grading or inspection bureau or agency.

1509.8.4 Application Standards. Shingles and shakes of naturally durable wood shall be applied in accordance with recommendations of the Cedar Shake and Shingle Bureau. Preservative treated tapersawn shakes shall be applied in accordance with recommendations of the Forest Products Laboratory of the Texas Forest Service. All shingles and shakes shall be applied in accordance with weather and roof pitch requirements of Table 1509.8.4.

Table 1509.8.4
Weather Exposure and Roof Pitch[2]

			Exposure (in)	
Roofing Material	**Length (in)**	**Grade**	**3:12 pitch (minimum) to < 4:12**	**4:12 pitch (minimum) and steeper**
Shingle of naturally durable wood	16	No. 1	3 3/4	5
		No. 2	3 1/2	4
		No. 3	3	3 1/2
	18	No. 1	4 1/4	5 1/2
		No. 2	4	4 1/2
		No. 3	3 1/2	4
	24	No. 1	5 3/4	7 1/2
		No. 2	5 1/2	6 1/2
		No. 3	5	5 1/2
Shakes of naturally durable wood	18	No. 1	Not Permitted	7 1/2
	24	No. 1		10[1]
Preservative treated taper-sawn shakes of Southern Yellow Pine	18	No. 1	Not Permitted	7 1/2
	24	No. 1		10
	18	No. 2	Not Permitted	5 1/2
	24	No. 2		7 1/2
Taper-sawn shakes of naturally durable wood	18	No. 1	Not Permitted	7 1/2
	24	No. 1		10
	18	No. 2	Not Permitted	5 1/2
	24	No. 2		7 1/2

1 in = 25.4 mm

Note:

1. For 24-inch x 3/8-inch handsplit shakes, the maximum exposure is 7 1/2 inches for roof pitches of 4:12 and steeper only.

1509.8.5 Shingles.

1509.8.5.1 Shingles shall be laid with a side lap of not less than 1 1/2 inches (38 mm) between joints in courses, and no two joints in any three adjacent courses shall be in direct alignment. Spacing between shingles shall be 1/4 to 3/8 inch (6.4 to 9.5 mm). Each wood shingle shall be fastened to the sheathing with two corrosion-resistant fasteners (hot dipped zinc coated, aluminum or stainless steel) with a minimum penetration of 1/2 inch (12.7 mm) into the sheathing or completely through sheathing less than 1/2 inch (12.7 mm) in thickness. In all shingles the fasteners shall be flush with the surface of the shingle but shall not crush the wood.

1509.8.5.2 Weather exposure for wood shingles shall not exceed those set forth in Table 1509.8.4. Minimum roof slope shall be 3:12. Hip and ridge weather exposure shall not exceed those permitted for the field of the roof.

1509.8.6 Shakes.

1509.8.6.1 All shakes shall be laid with a side lap of not less than 1 1/2 inches (38 mm) between joints in adjacent courses. Spacing between shakes in the same course shall be approximately 3/8 to 5/8 inch (9.5 to 15.9 mm) for shakes and tapersawn shakes of naturally durable wood and shall be 1/4 to 3/8 inch (6.4 to 9.5 mm) for preservative treated tapersawn shakes. Each wood shake of any type shall be fastened to the sheathing with two corrosion-resistant fasteners (hot dipped zinc coated, copper, aluminum or stainless steel) with a minimum penetration of 1/2 inch (12.7 mm) into the sheathing or completely through sheathing less than 1/2 inch (12.7 mm) in thickness. For preservative treated tapersawn shakes 2 inches (51 mm) long, 16-gage (1.59 mm) galvanized staples with 7/16 to 1/2 inch (11.1 to 12.7 mm) wide crown may be used rather than nails. In all types of shakes the fasteners shall be flush with the surface of the shake but shall not crush the wood. The starter course at the eaves shall be doubled and the bottom or first layer may be either 15-inch or 18-inch (381 or 457 mm) wood shakes or wood shingles. 15-inch or 18-inch (381 or 457 mm) shakes may be used for the final course at the ridge.

1509.8.6.2 No. 1 shakes and tapersawn shakes of naturally durable wood shall be interlaid with 18-inch (457 mm) wide strips of minimum type 15 asphalt saturated felt. No. 2 tapersawn shakes of naturally durable wood, applied in accordance with Table 1509.8.4, shall be interlaid with 18-inch (457 mm) wide strips of minimum type 15 asphalt felt applied between alternate courses. No. 1 preservative treated tapersawn shakes shall be interlaid with 18-inch (457 mm) wide strips of minimum type 30 asphalt saturated felt. No. 2 preservative tapersawn shakes, applied in accordance with Table 1509.8.4, shall be interlaid with 18-inch (457 mm) wide strips of minimum type 30 asphalt saturated felt applied between alternate courses. Felt for all shakes shall be nonperforated and placed above the butt line of the course it covers at a distance equal to twice the weather exposure for the shake being used.

1509.8.7 Fire Retardant Shingles and Shakes.

1509.8.7.1 Fire retardant treated shakes and shingles of naturally durable wood used in assemblies that are listed and identified by an approved testing agency may be used as permitted in accordance with the listing of the assembly.

1509.8.7.2 Fire retardant treated shakes and shingles of naturally durable wood, when impregnated with chemicals by the full-cell vacuum-pressure process, shall be considered fire retardant (classified) roof coverings when tested in accordance with ASTM E 108, including the rain test ASTM D 2898. The fire resistance tests shall include the intermittent flame test, spread of flame test, burning brand test and flying brand test. In addition, at the conclusion of the rain test, test panels shall be subjected to the intermittent flame test, burning brand test and flying brand test.

1509.8.7.3 Each bundle of fire retardant treated shakes and shingles shall be identified with labels indicating the manufacturer, the classification of the material (Class B or C), and the quality control agency.

1509.9 Built-Up Roofs

1509.9.1 Specifications. Specifications of any manufacturer whose systems are bondable or guaranteed, whether or not such bond or guarantee is to be issued, shall be deemed to meet the requirements of this chapter, provided they do not conflict with the requirements of Chapter 16.

1509.9.2 Surface Preparation.

1509.9.2.1 Before starting the application of all roofing membranes, all roof decks shall be broom cleaned, and parapet walls, vertical walls, penthouses and similar structures above the roof level shall have been completed. All flat roof decks shall have been provided with a cant strip where the roof deck joins a vertical surface unless a metal flashing is used and/or is otherwise recommended by the manufacturer. Cant strips shall be nailable material and shall extend at least 3 1/2 inches (89 mm) up the vertical surfaces. Wood roof decks shall be solidly sheathed. Structural concrete decks shall be smooth, dry, and free from laitance. Lightweight insulating concrete roof decks shall be dry and at least 72 hours of precipitation-free weather is required prior to roof application. Subsequent to that time, if precipitation occurs, an additional 24 hours drying period is required.

1509.9.2.2 Gypsum roof decks shall be surface dry before starting application of roofing.

1509.9.2.3 Red rosin paper shall be used when the membrane is applied directly to a wood deck or cementitious fiber decks.

1509.9.3 Base Ply. Unless otherwise specified herein, a base ply shall be secured by mechanical fastening to any nailable deck. Where one or more layers of material are installed as the base ply, they shall be laid dry, not cemented and attached to the nailable deck with fasteners at 9 inches (229 mm) on center with 2-inch (51 mm) minimum side laps and stagger nailed at 18-inch (457 mm) centers along lines 12 inches (305 mm) from each edge. On nonnailable decks a minimum of 1/2-inch (12.7 mm) fiberboard insulation shall be solidly mopped to a primed concrete roof deck. Roofing plies shall then be solidly mopped in accordance with the manufacturer's specification for the installation of roofing over insulation.

1509.9.4 Additional Plies. Additional felts, ply sheets or cap sheets shall be adhered to the base ply or directly to roof insulation with solid mopping of a bituminous material applied in accordance with manufacturer's recommendations. Each additional ply sheet shall be solidly mopped to preceding ply sheets.

1509.9.5 Fasteners. Nails in nominal 1-inch lumber shall not be smaller than 12 gage (2.68 mm) wire nails with heads not less than 3/8-inch (10 mm) diameter driven through tin caps, and not less than 1 inch (25.4 mm) long. Caphead nails shall be in accordance with 1509.1.4.5. Roof decks of cement fiber, poured gypsum, lightweight insulating concrete, or similar nailable surfaces require fasteners specifically designed for use on the type of deck involved.

1509.9.6 Surface Treatment. Flood coatings, protective/reflective coatings, aggregates and other surface treatments shall be installed in accordance with manufacturer's requirements. Aggregate materials shall be embedded in a flood coat of hot bitumen (not mopped) and shall not be used on roof slopes greater than 3:12.

1509.9.7 Materials.

1509.9.7.1 Material for built-up roofs shall be in accordance with the requirements of the referenced standards listed in Table 1509.9.7A and Table 1509.9.7B and applied to roof slopes not exceeding the maximum indicated in Tables 1509.9.7C and 1509.9.7D.

1509.9.7.2 Manufacturers may recommend variation from the above requirements due to special geographic conditions. If such variation is the case, refer to the manufacturer's written specifications.

1509.9.7.3 Aggregate shall comply with ASTM D 1863 or local codes.

Table 1509.9.7A
Base Piles

Reinforcement Type	Standard Designation
Glass Mat	ASTM D 4601
Glass Mat, Venting Type	ASTM D 4897
Organic Base Sheet	ASTM D 2626

Table 1509.9.7B
Reinforcing Piles

Reinforcement Type	Standard Designation
Glass Mat, Asphalt	ASTM D 2178, Type IV or Type VI
Glass Mat, Coal Tar	ASTM D 4990
Organic Asphalt Saturated Felt	ASTM D 226, Type I
Organic Coal Tar Saturated Felt	ASTM D 227

Table 1509.9.7C
Maximum Roof Slope for Coal Tar Pitch

Type (ASTM D 450)	Interply	Surfacing
I & III	1/4:12 (20.8 mm/m)	1/4:12 (20.8 mm/m)

Table 1509.9.7D
Maximum Roof Slope for Asphalt

Type (ASTM D 312)	Interply	Surfacing
I	**Not Allowed**	**1/4:12**
II	**1/2:12**	**1/2:12**
III	**3:12**	**3:12**
IV	**4:12**	**4:12**

1509.10 Slate Or Mineral Surfaced Roll Roofing

1509.10.1 Material and Installation.

1509.10.1.1 Mineral surface roll roofing (organic) having a minimum weight of 74 lbs per 100 sq ft (3.6 kg/m^2) or mineral surfaced roll roofing (inorganic) having a minimum weight of 63 lbs per 100 sq ft (3.1 kg/m^2) or slate surfaced roofing shall have a minimum 6-inch (152 mm) end lap and 2-inch (51 mm) side lap mopped or cemented. Minimum slope 1:12. Fasteners securing underlayment felts shall be applied through tin caps.

1509.10.1.2 The edges of sheathing at eaves and gable ends in all cases shall be covered and protected with a noncorrosive metal.

1509.10.1.3 Mineral surfaced roof may be two layers of type 46 double coverage rolled roofing, each layer lapped 19 inches (483 mm) and fastened to wood deck with two rows of fasteners through tin caps spaced not more than 18 inches (457 mm) on center through unsurfaced portion of sheet and 6 inches (152 mm) on center at back of each sheet. Mop or cement unsurfaced portion of sheet. Minimum slope 1:12.

1509.11 Metal Roofs

1509.11.1 Materials.

1509.11.1.1 Copper shall weigh not less than 16 oz per sq ft (4.9 kg/m^2).

1509.11.1.2 Galvanized sheet metal shall be a minimum of 0.0142-inch (0.361 mm) zinc coated G-90.

1509.11.1.3 Lead: hard lead, 2 lb per sq ft (9.8 kg/m^2); soft lead, 3 lb per sq ft (14.6 kg/m^2).

1509.11.1.4 Terne (tin) and TCS (terne coated stainless); terne coating - 40 lb (18 kg) per double base box, field painted when applicable in accordance with manufacturer's specifications.

1509.11.1.5 Aluminum, 0.024-inch (0.610 mm) thick.

1509.11.2 Fasteners.

1509.11.2.1 Hard copper or copper alloy shall be used for copper roofs.

1509.11.2.2 Galvanized fasteners shall be used for galvanized roofs.

1509.11.2.3 Aluminum fasteners shall be used for aluminum roofs.

1509.11.2.4 Stainless steel fasteners are acceptable for all types of metal roofs.

1509.11.3 Metal Shingles.

1509.11.3.1 Galvanized shingles, minimum uncoated thickness of 0.0149 inch (0.378 mm).

1509.11.3.2 Aluminum shingles, minimum thickness, 0.024 inch (0.610 mm). Rosin paper shall be used under metal in addition to underlay.

1509.11.4 Flat Sheet Roofing. Seams and joints on flat sheet roofing shall be locked and soldered and made watertight.

1509.11.5 Corrugated Sheeting. Corrugated, Five-V crimp or other type of industrial roofing to be securely fastened with lead head or neoprene-washered fasteners.

1509.11.6 Sheeting To Steel Framing. Metal roofing fastened directly to steel framing shall be attached by manufacturers' approved fastenings and shall shed water away from structural members.

1509.11.7 Minimum Slope Nonsoldered Seams. Minimum slope for all lapped, nonsoldered seam metal roofs shall be 3:12.

EXCEPTION: The minimum slope for standing seam roof systems shall be 1/4:12.

1509.12 Synthetic Sheet Membrane Roofs

1509.12.1 General.

1509.12.1.1 For the purpose of this chapter, synthetic sheet membrane roofs (hereafter referred to as "membrane") include elastomeric and plastomeric preformed sheet materials and modified bituminous sheet materials, both reinforced and nonreinforced, which are typically, but not necessarily, installed in single layers.

1509.12.1.2 The structural roof system to which a ballasted membrane is to be applied shall be certified by a registered engineer or architect as being capable of sustaining the construction, membrane, ballast and ancillary material loads that will be encountered during and subsequent to membrane application. Preservative treated wood nailers shall be installed at the perimeter of the roof, around all roof vents, skylights and similar penetrations, and at all membrane terminations as required by the manufacturer, unless (a) the roof membrane is to be attached directly to the structural deck, (b) the roof membrane is to be attached through the substrate and into the structural deck, or (c) the substrate at these locations is capable of accepting mechanical fasteners and is fastened to the structural deck in a manner to obtain sufficient strength to resist the forces of wind uplift. The thickness of the nailer shall be such that the top of the nailer is flush with the surface to which the membrane is to be installed.

1509.12.2 Materials.

1509.12.2.1 There shall be no comingling of different types of materials except through proper adapters. In all cases, approved methods and sealers designed for the particular elasto/plastic materials shall be used.

1509.12.2.2 An elastomer, as defined by the Roofing Industry Educational Institute glossary, is a substance that can be stretched at room temperature to at least twice its original length, and after having been stretched and the stress removed, will return with force to approximately its original length in a short time.

1509.12.2.3 A plastic, as defined by ASTM D 883, is a material that contains as an essential ingredient one or more organic polymeric substances of large molecular weight, is solid in its finished state and at some stage in its manufacture or processing into finished articles, can be shaped by flow.

1509.12.2.4 Membrane: material shall be a minimum 0.040 inch (1.02 mm) thick.

1509.12.2.5 Flashing: Elasto/Plastic material, cured or uncured, shall be minimum 0.040 inch (1.02 mm) thick. Composite flashings shall be minimum 0.030 inch (0.762 mm) thick.

1509.12.3 Application. The membrane shall be applied by one or a combination of the following methods:

1509.12.3.1 Adhered Method.

1509.12.3.1.1 Substrate: The substrate to which the membrane is to be applied shall be clean, dry and free from debris or contaminants that will interfere with the adhesion or attachment of the membrane or that will puncture the membrane. Joints or gaps in the substrate greater than 1/4 inch (6.4 mm) shall be filled with material compatible with the substrate and membrane. Substrate materials shall be compatible with or shall be isolated from cleaning agents, solvents, adhesive or heat used to adhere the membrane or fabricate lap joints.

1509.12.3.1.2 Membrane: The membrane shall be free from defects. Lap joints shall be fabricated in accordance with manufacturer's requirements.

1509.12.3.1.3 Adhesives: Adhesives shall be applied in accordance with manufacturer's requirements, and within the weather limitations prescribed by the manufacturer.

1509.12.3.1.4 Mechanical Fastening: The membrane and the perimeter system shall be mechanically fastened at the perimeter of the roof, around all roof vent, skylight and similar penetrations, and at all membrane terminations. Mechanical fastening shall be conducted in accordance with manufacturer's requirements.

1509.12.3.1.5 Flashing: Flashing materials shall be compatible with the base membrane materials and substrates to which they are applied.

1509.12.3.1.6 Protective Coatings: Protective coatings shall be applied in accordance with manufacturer's requirements.

1509.12.3.2 Partially Adhered and Mechanically Fastened Methods.

1509.12.3.2.1 Substrate. The substrate to which the membrane is to be applied shall be clean, dry and free from debris or contaminants that will interfere with the adhesion or attachment of the membrane or that will puncture the membrane. Joints or gaps in the substrate greater than 1/4 in (6.4 mm) shall be filled with material compatible with the substrate and membrane. If insulation is to be used as the substrate, the insulation shall be adhered or mechanically attached to the structural deck. Substrate materials shall be compatible with or shall be isolated from cleaning agents, solvents, adhesives, or heat used to adhere the membrane or fabricate lap joints.

1509.12.3.2.2 Membrane. The membrane shall be free from defects. Lap joints shall be fabricated in accordance with manufacturer's requirements.

1509.12.3.2.3 Adhesives. Adhesives shall be applied in accordance with manufacturer's requirements, and within the weather limitations prescribed by the manufacturer.

1509.12.3.2.4 Mechanical Fastening. The membrane and the perimeter flashing system shall be mechanically fastened at the perimeter of the roof, around all roof vent, skylight and similar penetrations, at all membrane terminations, and as required within the field of the roof by the manufacturer.

1509.12.3.2.5 Flashing. Flashing materials shall be compatible with the base membrane materials and substrate to which they are applied.

1509.12.3.2.6 Protective Coatings. Protective coatings shall be applied in accordance with manufacturer's requirements.

1509.12.3.3 Loose Laid/Ballasted Method.

1509.12.3.3.1 Substrate. The substrate to which the membrane is to be applied shall be clean, dry and free from debris or contaminants that will puncture the membrane. Joints or gaps in the substrate greater than 1/4-in (6.4 mm) shall be filled with material compatible with the substrate and membrane. Substrate materials shall be compatible with or shall be isolated from cleaning agents, solvents, adhesives, or heat used to adhere the membrane or fabricate lap joints.

1509.12.3.3.2 Membrane. The membrane shall be free from defects. Lap joints shall be fabricated in accordance with manufacturer's requirements.

1509.12.3.3.3 Adhesives. Adhesives shall be applied in accordance with manufacturer's requirements and within the weather limitations prescribed by the manufacturer.

1509.12.3.3.4 Mechanical Fastening. The membrane and the perimeter flashing system shall be mechanically fastened at the perimeter of the roof, around all roof vent, skylight and similar penetrations, and at all membrane terminations. Mechanical fastening shall be conducted in accordance with manufacturer's requirements.

1509.12.3.3.5 Flashing. Flashing materials shall be compatible with the base membrane materials and substrates to which they are applied.

1509.12.3.3.6 Protective Coatings. Protective coatings shall be applied in accordance with manufacturer's requirements.

1509.12.3.3.7 Ballast. Ballast shall conform to and be applied in accordance with manufacturer's requirements. Systems requiring ballast shall not be used on roof slopes greater than 1:12.

1509.12.4 Precautions. The manufacturer's published installations and details shall be strictly adhered to and a copy of the instructions shall be available at all times on the job site during installation.

1509.13 Replacement/Recovering

1509.13.1 Installation.

1509.13.1.1 For the purposes of this section, the following definitions shall apply:

RECOVERING – the practice of preparing the old roof surface (as opposed to the removal of the existing roof) and installing a new roof system.

REPLACEMENT – the practice of removing the existing roofing membrane, repairing any damaged substrate, and installing a new roofing system.

REROOFI NG – the process of recovering or replacing a n existing roofing system.

1509.13.1.2 The structural roof components to which the roofing system is to be applied shall be capable of supporting the roof system, ancillary material, and equipment loads that will be encountered in any reroofing operation. Any structurally damaged roof components, e.g., roof deck, sheathing, rafters and joists shall be repaired in such a manner which maintains the structural integrity of the component and roofing system.

1509.13.1.3 Replacement rather than recovering shall be utilized in the following cases:

1. When the old roofing is water-soaked or deteriorated to the point that it is not suitable as a base for additional roofing.
2. When blisters exist in any roofing, unless blisters are cut or scraped open and nailed down before applying additional roofing.
3. When the existing roof surface is gravel or the like, unless the gravel shall be thoroughly removed or all loose gravel removed and an approved base material installed before applying additional roofing.
4. When existing roof is slate or the like.
5. When sheathing or supports are deteriorated to the point that the roof structural system is not substantial enough to support recovering.
6. When existing roof has two or more applications of any type roofing material. Conformance with this item shall make replacement mandatory.

   EXCEPTIONS:

   1. When the structural deck is concrete and the existing roof is firmly attached to the deck, then the roof shall be removed down to a minimum of three plies of moisture free felts.
   2. When otherwise approved by the building official.
7. Wood shingles or shakes shall not be placed over more than one application of wood or asphalt shingles. Wood shingles or shakes shall be permitted to be placed over existing shakes when installed in accordance with Cedar Shake and Shingle Bureau recommendations.
8. Wood shakes may be installed over not more than one existing wood shingle roof.

1509.13.1.4 All reroofing shall be applied in accordance with new roofing specifications.

EXCEPTION: Reroofing shall not be required to meet the slope requirements of 1509.1.2.3 for roofs that provide positive drainage.

1509.13.1.5 In any recovering operation, when chimneys, stucco, or brick walls would be damaged by removal of existing flashing or by cutting to install metal cap flashing, a minimum of two plies of felt consisting of one 4-inch (102 mm) and one 5-inch (127 mm) wide strips of felt set in plastic cement with the second felt extending 1 inch (25.4 mm) above the first, finished with a top coating of plastic cement, may be used in lieu of metal cap flashing. Felts shall extend over the base flashing a minimum of 2 inches (51 mm).

1509.14 Valleys and Wall Flashings

1509.14.1 General. Valleys and wall flashings shall meet the requirements of this section, except as otherwise specified in the listing.

1509.14.2 Rigid Shingle Roof Coverings.

1509.14.2.1 Flash and counterflash with sheet metal.

1509.14.2.2 Valley flashing shall be a minimum of 15 inches (381 mm) wide.

1509.14.2.3 Valley and flashing metal shall be a minimum uncoated thickness of 0.0179 inch (0.455 mm) zinc coated G90.

1509.14.2.4 Chimneys, stucco or brick walls that would be damaged by cutting to install metal cap flashing may have a minimum of two plies of felt for a cap flashing consisting of 4-inch (102 mm) wide strip of felt set in plastic cement and extending 1 inch (25.4 mm) above the first felt and a top coating of plastic cement. Felts to extend over the base flashing 2 inches (51 mm).

1509.14.3 Asphalt Shingle Roof Covering.

1509.14.3.1 Flashings. Base and cap flashings shall be installed in accordance with manufacturer's instructions. Base flashings shall be of either corrosion-resistant metal of minimum nominal 0.019 inch (0.483 mm) thickness or mineral surface roll roofing weighing a minimum of 77 lbs per 100 sq ft (3.76 kg/m^2). Cap flashings shall be corrosion resistant metal of minimum nominal 0.019 inch (0.483 mm) thickness.

1509.14.3.2 Valley lining s shall be installed in accordance with manufacturer's instructions before applying shingles. Valley linings may be of the following types:

1. For open valleys (valley lining exposed) lined with metal, the valley lining shall be at least 16 inches (406 mm) wide and of any of the corrosion-resistant metals in Table 1509.14.3.2.
2. For open valleys, valley lining may be of two plies of mineral surface roll roofing. The bottom layer shall be 18 inches (457 mm) and the top layer a minimum of 36 inches (914 mm) wide.
3. For closed valleys (valley covered with shingles), valley lining may be of one ply of smooth roll roofing at least 36 inches (914 mm) wide or types (l) and (2) above.

Table 1509.14.3.2
Valley Lining Material[1, 2]

Material	Minimum Thickness	Gage	Weight
Copper			16 oz
Aluminum	0.024 in		
Stainless Steel		28	
Galvanized Steel	0.0179 in	26 (zinc coated G90)	
Zinc Alloy	0.027 in		
Lead			2 1/2 pounds
Painted Terne			20 pounds

1 in = 25.4 mm
1 lb = 0.4536 kg

1509.14.4 Wood Shingles and Shakes.

1509.14.4.1 Wood shingles. Roof valley flashing shall be provided of not less than 0.017-inch (0.432 mm) corrosion-resistant metal and shall extend at least 8 inches (203 mm) from the center line each way. Sections of flashings shall have an end lap of not less than 4 inches (102 mm).

1509.14.4.2 Wood shakes. Roof valley flashing shall be provided of not less than 0.017-inch (0.432 mm) corrosion-resistant metal and shall extend at least 11 inches (279 mm) from the center line each way. Sections of flashing shall have an end lap of not less than 4 inches (102 mm).

1509.14.5 Built-Up Roofs.

1509.14.5.1 Base flash with a bituminous built-up flashing material on cant strips and cap flash with metal or other approved methods.

1509.14.5.2 Corrosion-resistant metal of a minimum nominal 0.019-inch (0.48 mm) thickness shall be used for cap or counterflashing.

1509.14.5.3 When a bituminous base flashing is used, a minimum of two plies of type 15 asphalt saturated felt or glass fiber ply sheets shall be installed with steep asphalt or plastic cement for a Class C roof, top nailed and top coated with steep asphalt or plastic cement.

1509.14.5.4 A bituminous base flashing for Class A or B roof shall be a minimum of three plies of type 15 asphalt saturated felt or glass fiber ply sheets. Each ply shall be set in a solid mopping of steep asphalt or in a continuous bed of plastic cement. The flashing assembly shall be coated with steep asphalt, plastic cement, or emulsified asphalt or the flashing shall comply with the recommendations of the roofing manufacturer for a base flashing.

1509.14.6 Gravel Stop and Drip Edge.

1509.14.6.1 On aggregate surfaced roofs, gravel stop shall extend up at least 5/8 inch (15.9 mm) above the roof flange, out on the roof a minimum of 3 inches (76 mm) fastened a maximum of 6 inches (152 mm) on center.

1509.14.6.2 On smooth surfaced built-up, modified bitumen, or nonballasted single-ply roofs, drip edge which extends out on the roof a minimum of 3 inches (76 mm) fastened a minimum of 6 inches (152 mm) on center shall be provided at the perimeter.

1509.14.6.3 All joints shall be sealed with plastic cement.

1509.14.6.4 Gravel stop shall be installed on top of all mopped felts in a layer of plastic cement and then stripped with two layers of felt, each embedded in a mopping of hot asphalt with the first strip of a minimum of 4 inches (102 mm) wide and the top strip a minimum of 6 inches (152 mm) wide.

1509.14.6.5 Metal flashing flanges to be set, nailed and stripped in accordance with gravel stop application specifications.

1509.14.6.6 An approved nailer is required for gravel stop and metal flashing flanges.

1509.14.6.7 Gravel stop shall comply with the minimum values listed in Table 1509.14.6.7.

Table 1509.14.6.7
Gravel Stops – Dimensions and Material[1,2]

Height of Gravel Stop (inches)	Galvanized Steel (gage)	Copper (oz.)	Aluminum (inches)	Zinc Alloy (inches)	Stainless Steel (gage)
4	26 (0.551 mm)	16	0.025	0.020	26 (0.475 mm)
5	24 (0.701 mm)	16	0.032	0.027	26 (0.475 mm)
6	22 (0.853 mm)	20	0.040	0.027	24 (0.635 mm)
7	22 (0.853 mm)	20	0.040		22 (0.792 mm)
8	20 (1.006 mm)	20	0.050		20 (0.953 mm)

1 lb = 0.4536 kg
in = 25.4 mm

1509.14.7 Eaves and Gables.

1509.14.7.1 Provide drip edge at eaves and gables of all shingle and tile roofs. Overlap to be a minimum of 2 inches (51 mm).

1509.14.7.2 Eaves drip shall extend 1/4 inch (6.4 mm) below sheathing and extend back on the roof a minimum of 2 inches (51 mm). This applies to both new and old roofs.

1509.14.7.3 Drip edge shall be mechanically fastened a maximum of 12 inches (305 mm) on center.

1509.14.8 Chimneys. Cricket or saddle coverings, if used, shall be sheet metal or of same material as roof covering.

1509.14.9 Parapet Walls. On parapet walls that require waterproofing within the fire limits, if a bituminous flashing is used, the top layer shall be one layer of type 15 fiberglass felt set in solid layer of plastic cement or hot steep asphalt.

1509.14.10 Openings in Roof.

1509.14.10.1 All plumbing and electrical pipes shall be flashed with an appropriate lead boot, copper or galvanized sheet metal flashing.

1509.14.10.2 In any reroofing application, all base flashings on protrusions extending through the plane of the roof shall be removed and replaced with corrosion-resistant metal flashings of minimum nominal 0.019-inch (0.48 mm) thickness.

1509.14.10.3 Metal flashing flanges shall be set, nailed, and stripped in accordance with gravel stop applications specifications.

1509.15 Liquid Applied Coatings

1509.15.1 General. The use of liquid applied coatings as waterproofing shall be made in accordance with the manufacturer's recommendations. The water barrier coating shall be a single or multiple component system consisting of the number of coats as recommended by the manufacturer, which will cure to form a continuous monolithic film bridging all gaps, seams, splits, joints, etc., totally preventing water from penetrating under the film and into the substrate. The dry mil thickness of the coating shall be in compliance with the weather barrier coating manufacturer's specification. In any event, the minimum dry thickness shall be 15 mils (0.38 mm).

1509.15.2 Preparation of Surface.

1509.15.2.1 The surface to which the coating is to be applied must be flat with no major fractures. Any fracture 1/16 inch (1.6 mm) or greater must be repaired before coating.

1509.15.2.2 Before starting the application, to insure adherence, the substrate must be clean, dry and free from dust, dirt, incompatible chemicals, grease, oil, wax, and laitance. A primer may be recommended by the manufacturer.

1509.15.2.3 All roofing substrate materials shall be solidly attached. All surface openings and flashing details are to be corrected prior to application of the liquid coating. If movement is anticipated in the deck, bond breakers or reinforcing embedded fabric should be considered at the roof joints according to manufacturer's instructions.

1509.15.3 Application. The applicator shall be familiar with the system and application equipment either through previous experience, training or assistance provided by the manufacturer's representative during application. The system should be applied uniformly at recommended thickness by the manufacturer. Weather conditions should be favorable and application should be performed between temperature limits of both the air and substrate as recommended by the manufacturer.

1509.15.4 Roof Slope. The minimum recommended roof slope is 1/4:12 (2%). Roofs which pond water are not acceptable.

1509.15.5 Precautions. The manufacturer's published installations and details shall be strictly adhered to and a copy of the instructions shall be available at all times on the job site during installation.

1509.16 Foamed in Place Roof Insulation

1509.16.1 General.

1509.16.1.1 Foamed in place roof insulation, when used in conjunction with a waterproof and protective surface coating, shall be applied in accordance with the manufacturer's recommendations. Quality of the foam surface shall be essentially smooth, free of voids, crevices and pinholes. Protective surfacing materials shall be applied no less than 2 hours nor more than 72 hours following the application of the foam.

1509.16.1.2 When liquid applied surfacing is used, requirements of 1509.15 apply. When elastomeric or plastomeric protection is used, requirements of 1509.12 apply.

CHAPTER 16

STRUCTURAL LOADS

1601 GENERAL

1601.1 Scope

Provisions of this chapter shall govern the structural design of buildings, structures and portions thereof. Structural systems shall have a defined load path transferring loads to the resisting elements.

1601.2 Structural Safety

1601.2.1 Every building and structure shall be of sufficient strength to support the loads and forces encountered, or combinations thereof, without exceeding in any of its structural elements the stresses prescribed elsewhere in this code.

1601.2.2 Buildings and structural systems shall possess general structural integrity to reduce the hazards associated with progressive collapse to levels consistent with good engineering practice. The structural system shall be able to sustain local damage or failure with the overall structure remaining stable. Compliance with the applicable provisions of ASCE 7 shall be considered as meeting the requirements of this section.

1601.2.3 Deleted

1601.2.4 Structural systems and components thereof shall be designed to have adequate stiffness and other properties to limit transverse deflections, lateral drift, vibration, or any other deformations that may adversely affect nonstructural elements or the serviceability of the structure.

1601.3 Restrictions on Loading

It shall be unlawful to place, or cause or permit to be placed, on any floor or roof of a building or other structure a load greater than is permitted by these requirements.

1601.4 Occupancy Permits for Changed Loading

Plans for other than residential buildings filed with the building official with applications for permits shall show on each drawing the live loads per square foot of area covered, for which the building is designed, and occupancy permits for buildings hereafter erected shall not be issued until the floor load signs, required by 105.3 have been installed.

1601.5 Items not Specifically Covered

Loads and forces for occupancies or uses not covered in this chapter shall be subject to the approval of the building official.

1602 DEFINITIONS

The following words and terms shall, for the purposes of this chapter and as stated elsewhere in this code, have the meanings shown here in. Refer to Chapter 2 for general definitions.

CRANE LOAD – the dead, live and impact load and forces resulting from the operation of permanent cranes.

1603 DEAD LOADS

1603.1 Weights of Materials and Construction

In estimating dead load for purposes of design, the actual weight of materials and constructions shall be used, provided that in the absence of definite information, values satisfactory to the building official may be assumed. For information on dead loads, see Appendix A.

1603.2 Provision for Partitions

The actual weight of all permanent partitions shall be included in the dead load. Where partitions are likely to be used, although not definitely located, or where they are likely to be shifted, 20 psf (958 Pa) shall be added to the dead load in the areas supporting them, except in the case of light partitioning.

1603.3 Weight of Fixed Service Equipment

In estimating dead loads for purpose of design, the weight of fixed service equipment, such as plumbing stacks and risers, electrical feeders, and heating, ventilating, and air conditioning systems, shall be included whenever such equipment is supported by structural elements.

1604 LIVE LOADS

1604.1 Uniform Floor Live Loads

The live loads assumed for purposes of design shall be the greatest loads that probably will be produced by the intended uses and occupancies, provided that the minimum live loads to be considered as uniformly distributed shall be as given in Table 1604.1.

1604.2 Reduction of Uniform Floor Live Load

Floor live loads in 1604.1 may be reduced in accordance with the following provisions. Such reductions shall apply to slab systems designed for flexure in more than one direction, beams, girders, columns, piers, walls and foundations.

1. A reduction shall not be permitted in Group A occupancies.
2. A reduction shall not be permitted when the live load exceeds 100 psf (4.8 kPa) except that the design live load for columns may be reduced 20%.
3. For live loads not exceeding 100 psf (4.8 kPa), the design live load for any structural member supporting 150 sq ft (14 m^2) or more may be reduced at the rate of 0.08% per sq ft of the area supported. Such reduction shall not exceed 40% for horizontal members, 60% for vertical members, nor R as determined by the following formula.

$$R = 23.1 (1 + D/L)$$

where: R = Reduction in percent
D = Dead load per square foot of area supported
L = Live load per square foot of area supported

1604.1 Uniform Floor Live Loads

Table 1604.1
Minimum Uniform Distributed Live Loads

Occupancy or Use	Live Load (psi)
Apartments (see Residential)	
Armories and drill rooms	150
Assembly halls and other places of assembly:	
Fixed seats	50
Movable seats	100
Balcony and decks (exterior) same as occupancy but not less than	60
On one and two family residences	40
Bowling alleys, poolrooms and similar recreational areas	75
Corridors:	
First floor	100
Other floors, same as occupancy served except as indicated	100
Dance halls and ballrooms	100
Dining rooms and restaurants	100
Dwellings (see Residential)	
Fire escapes	100
On multi- or single-family residential buildings only	40
Garages (passenger cars only)	50
For trucks and buses use AASHTO[1] lane loads	
Grandstands (see Reviewing Stands)	
Gymnasiums, main floors and balconies	100
Hospitals:	
Operating rooms, laboratories	60
Private rooms	40
Wards	40
Corridors, above first floor	80
Hotels (see Residential)	
Libraries:	
Reading rooms	60
Stack rooms (books and shelving at 65 pcf)	125
Corridors, above first floor	80
Manufacturing:	
Light	100
Heavy	150
Marquees	75
Office Buildings:	
Offices	50
Lobbies	100
Corridors, above first floor	80
File and computer rooms require heavier loads based upon anticipated occupancy	
Penal institutions:	
Cell blocks	40
Corridors	100

(continued)

Table 1604.1 *(continued)*
Minimum Uniform Distributed Live Loads

Occupancy or Use	Live Load (psi)
Residential:	
Multifamily houses:	
Private apartments	40
Public rooms	100
Corridors	80
Dwellings:	
Sleeping Rooms	30
Attics with storage	30
Attics without storage	10
All other rooms	40
Hotels:	
Guest Rooms	40
Public rooms	100
Corridors serving public rooms	100
Corridors	80
Review stands and bleachers[2]	100
Schools:	
Classrooms	40
Corridors	80
Sidewalks, vehicular driveways and yards, subject to trucking	200
Skating rinks	100
Stairs and exitways	100
Storage warehouse:	
Light	125
Heavy	250
Stores:	
Retail:	
First floor, rooms	75
Upper floors	75
Wholesale	100
Theaters:	
Aisles, corridors and lobbies	100
Orchestra floors	50
Balconies	50
Stage floors	150
Catwalks	40
Followspot, projection and control rooms	50
Yards and terraces, pedestrians	100

1 psf = 47.8803 Pa

Notes:
1. American Association of State Highway and Transportation Officials.
2. For detailed recommendations, see NFiPA 102.

1604.3 Concentrated Floor Live Loads

In the design of floors, probable concentrated loads shall be considered. Where such loads may occur, the supporting beams, girders and slabs shall be designed to carry either the concentrated loads or the live load described in 1604.1, whichever produces the greater stresses. Concentrated loads shall be equal to the machinery, vehicle, equipment, or apparatus anticipated but shall be not less than the loads specified in Table 1604.3.

Table 1604.3
Minimum Concentrated Loads[1]

Location	Load (lb)
Elevator machine room grating (on area of 4 sq in)	300
Finish light floor plate construction (on area of 1 sq in)	200
Garages	Note 2
Office floors	2,000
Scuttles, skylight ribs, and accessible ceilings	200
Stair treads (on area of 4 sq in at center of tread)	300
Root Structures	Note 3

1 lb = 4.4482 N 1 sq in = 645.16 mm^2 1 sq ft = 0.0929 m^2

Notes:

1. Load distributed uniformly over an area of 2 1/2 ft square unless noted otherwise.
2. Floors in garages or portions of buildings used for the storage of motor vehicles shall be designed for the uniformly distributed live loads of Table 1604.1 or the following concentrated loads: (1) for passenger cars accommodating not more than nine passengers, 2,000 lb acting on an area of 20 sq in; (2) mechanical parking structures without slab or deck, passenger cars only, 1,500 lb per wheel; (3) for trucks or buses, maximum wheel load on an area of 20 sq in.
3. Any panel point of the lower chord of roof trusses or any point of other primary structural members supporting roofs over garage, manufacturing, and storage floors shall be capable of carrying safely a suspended concentrated load of not less than 2000 pounds in addition to one half (1/2) the specified live load. For the purpose of this paragraph only, a primary member is a member carrying 200 square feet or more of roof load.

1604.4 Distribution of Live Loads

Where structural members are arranged so as to create continuity, the distribution of the live loads, such as on adjacent spans or alternate spans, which would cause maximum design conditions shall be used, except that roof live loads shall be distributed uniformly as provided in 1604.6.

EXCEPTION: The distribution of live loads on reinforced concrete structures shall be in accordance with ACI 318.

1604.5 Interior Wall Loads

Interior walls, permanent partitions, and temporary partitions shall be designed to resist all loads to which they are subjected but not less than 5 psf (240 Pa) applied perpendicular to the walls, except for decorative screen walls.

1604.6 Roof Live Loads

1604.6.1 The design roof live loads shall take into account the effects of occupancy and water but shall be not less than the minimum roof live loads as set forth in Table 1604.6.

Table 1604.6
Minimum Roof Live Load
(Pounds per square foot of horizontal projection)

	Tributary Loaded Area (sq ft) For Any Structural Member		
Roof Slope	**0 to 200**	**201 to 600**	**Over 600**
Flat or rise less than 4-in per ft Arch or dome with less than 1/8 of span	20	16	12
Rise 4-in per ft to less than 12-in per ft Arch or dome with rise 1/8 of span to less than 3/8 of span	16	14	12
Rise 12-in per ft and greater Arch or dome with rise 3/8 of span or greater	12	12	12
Awnings except cloth covered	5	5	5
Greenhouses, lath houses and agricultural buildings	10	10	10

1 in/ft = 83.33 mm/m 1 psf = 47.8803 Pa 1 sq ft = 0.0929 m^2

1604.6.2 Rain loads shall be designed for in accordance with the following:

1. Roof drainage systems shall be designed in accordance with Chapter 11 of the Standard Plumbing Code.
2. Roofs shall be designed to preclude instability from ponding loads.
3. Each portion of a roof shall be designed to sustain the load of all rainwater that could accumulate on it if the primary drainage system for that portion is blocked. In determining the load that could result should the primary drainage system be blocked, the load due to the depth of water (i.e. head) needed to cause the water to flow out of the secondary drainage system at the rate required by Chapter 11 of the Standard Plumbing Code shall be included. Ponding instability shall be considered in this situation. If the overflow drainage provisions contain drain lines, such lines shall be independent of any primary drain lines.
4. Roofs equipped with controlled drainage provisions shall be equipped with a secondary drainage system at a higher elevation which prevents ponding on the roof above the design water depth. Such roofs shall be designed to sustain all rainwater loads on them to the elevation of the secondary drainage system, plus the load due to the depth of water (i.e., head) needed to cause the water to flow out of the secondary drainage system. Ponding instability shall be considered in this situation.

1604.6.3 Roofs designed as future floors, for the parking of automobiles or for other occupancy loadings shall comply with the provisions of 1604.1 and 1604.3.

1604.6.4 Snow loads shall comply with the provisions of 1605.

1604.6.5 Wind loads shall comply with the provisions of 1606.

1604.7 Impact Loads

1604.7.1 For structures carrying live loads which induce unusual impact, the assumed live load shall be increased sufficiently to provide for same. If not otherwise specified, the increase shall be:

1. For supports of elevators 100%
2. For cab operated traveling crane support girders and their connections* 25%

3. For pendant operated traveling crane support girders and their connections* 10%
4. For supports of light machinery, shaft or motor driven, not less than 20%
5. For supports of reciprocating machinery or power driven units, not less than 50%
6. For hangers supporting floors and balconies 33%

*Live loads on crane support girders shall be taken as the maximum crane wheel loads.

1604.7.2 The lateral force on crane runways to provide for the effect of moving crane trolleys shall, if not otherwise specified, be 20% of the sum of the weights of the lifted load and of the crane trolley exclusive of other parts of the crane. The force shall be assumed to be applied at the top of the rails acting in either direction normal to the runway rails and shall be distributed with due regard for lateral stiffness of the structure supporting these rails. The longitudinal force shall, if not otherwise specified, be taken as 10% of the maximum wheel loads of the crane applied at the top of rail.

1604.8 Supports for Walkways

Where walkways are to be installed above ceilings, supports shall be designed to carry a load of 200 lb (890 N) occupying a space 2 1/2 sq ft (0.23 m^2), and placed as to produce maximum stresses in the affected members.

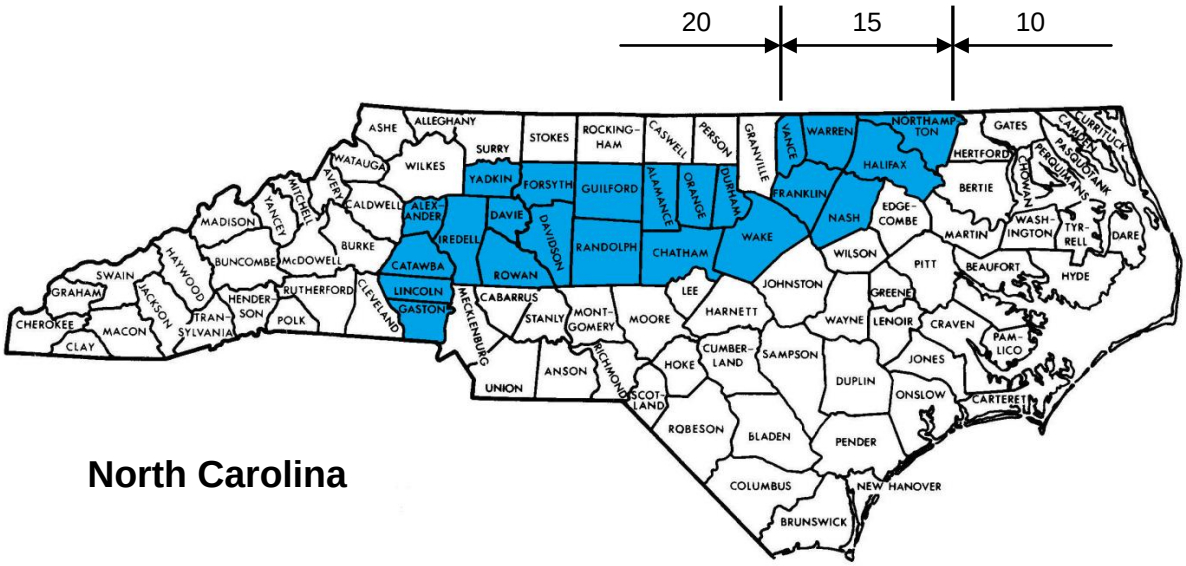
1604.9 Sidewalks

Sidewalks shall be designed to carry either a uniformly distributed load of 200 psf (9.6 kPa) or a concentrated load of 8,000 lb (35.6 N) on a space 2 1/2 ft square (0.58 m^2) and placed in any position, whichever will produce the greater stresses. This does not apply to sidewalks on grade.

1605 SNOW LOADS

Design roof snow loads shall be calculated in compliance with the provisions in Section 7, Snow Loads, of ASCE 7 and Figure 1605.

FIGURE 1605
GROUND SNOW LOADS, P_g (psf) FOR 50-YR MEAN RECURRENCE INTERVAL



NOTES:

1. In the mountain areas extreme local variations in snow loads preclude mapping at this scale.
2. The zoned value is not appropriate for certain geographic settings, such as high country, in these areas.

1606 WIND LOADS

1606.1 Applications

All buildings, structures and parts thereof shall be designed to withstand the appropriate wind loads prescribed herein. Decreases in wind loads shall not be made for the effect of shielding by other structures. Wind pressures shall be assumed to act normal to the surfaces considered.

1606.1.1 Determination of Wind Forces. Wind forces on every building or structure shall be determined by the provisions of ASCE 7, Figure 1606, and Table 1606. In the mountainous regions, where the elevations are 2700 feet above sea level or higher, Table 1606.1 shall be utilized to determine the design wind speed.

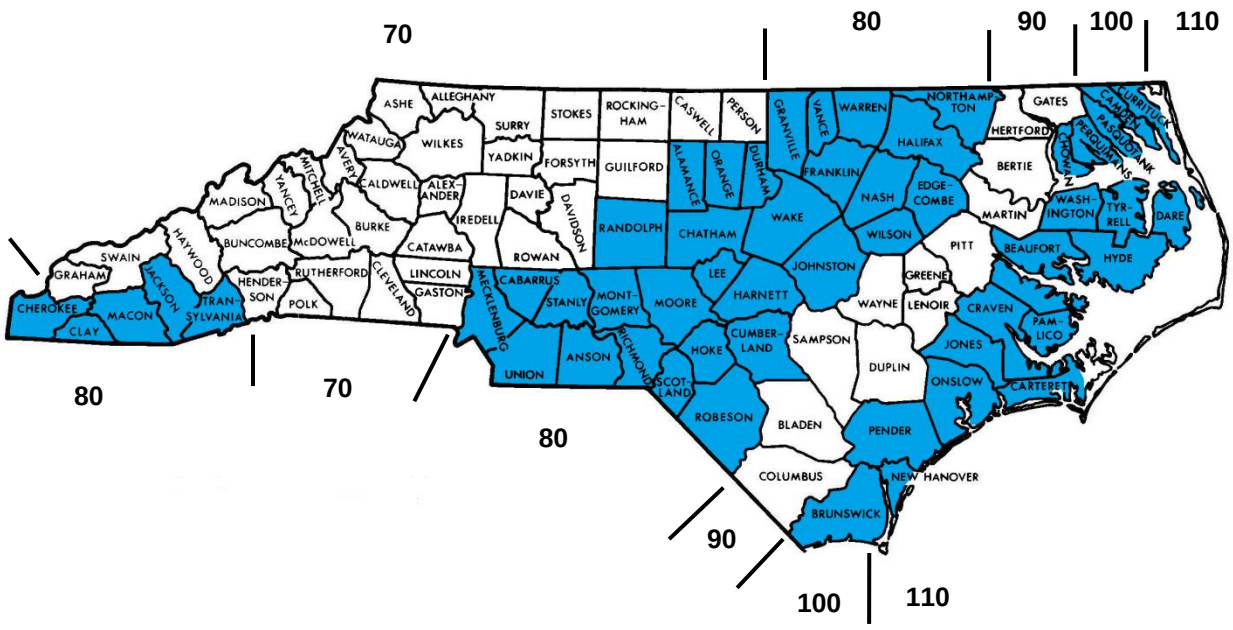
EXCEPTIONS:

1. Provisions of SBCCI SSTD 10-93 shall be permitted for applicable Group R2 and R3 buildings.
2. ANSI/NAAMM FP 1001 Specification for Design Loads of Metal Flagpoles.

1606.1.2 Minimum Wind Loads. No part (component, cladding or fastener) of a building or structure shall be designed for less than 10 psf (479 Pa).

1606.2 Stability. Anchorage shall be provided to resist excess overturning, uplift and sliding forces. The overturning moment due to wind load shall not exceed two-thirds of the dead load stabilizing moment unless the building or structure is anchored so as to resist the excess moment. The base shear due to wind load shall not exceed two-thirds of the total resisting force due to friction and adhesion unless the building or structure is anchored to resist the excess sliding force.

FIGURE 1606
BASIC WIND SPEED (mph)



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.

TABLE 1606
BASIC WIND SPEED, V

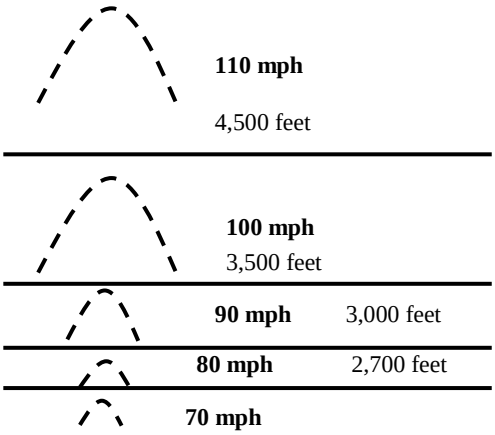
Counties not listed	70	Jones	100
Alamance	80	Lee	80
Anson	80	Lenoir	90
Beaufort	100	Macon	80
Bertie	90	Martin	90
Bladen	90	Mecklenburg	80
Brunswick	100	Montgomery	80
Cabarrus	80	Moore	80
Camden	100	Nash	80
Carteret	100	New Hanover	100
Chatham	80	Northampton	80
Cherokee	80	Onslow	100
Chowan	100	Orange	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
Edgecombe	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

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

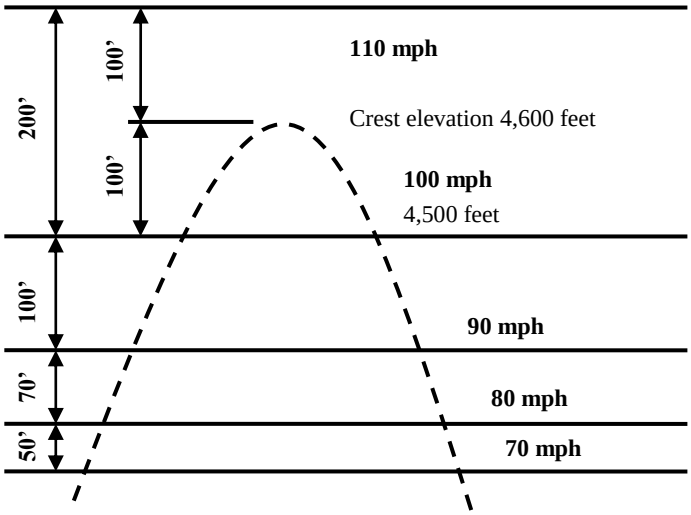
TABLE 1606.1
BASIC DESIGN WIND VELOCITIES FOR MOUNTAIN REGIONS

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 feet to 3,500 feet	90
3,500 to 4,500 feet	100
4,500 and above	110

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



Wind Velocity Diagram



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

1607 EARTHQUAKE LOADS

1607.1 General

1607.1.1 Scope. Every building and structure, and portion thereof, shall be designed and constructed to resist the effects of earthquake motions determined in accordance with 1607. Additions and change of occupancy to existing buildings and structures shall be designed and constructed to resist the effects of earthquake motions determined in accordance with 1607. Special structures, including but not limited to vehicular bridges, transmission towers, industrial towers and equipment, piers and wharves, and hydraulic structures shall be designed for earthquake loads using a properly substantiated analysis.

EXCEPTIONS:

1. Buildings of detached one and two family dwellings (Group R3) that are located in seismic map areas having an effective peak velocity-related acceleration value, A_v, according to 1607.1.5, less than 0.15 are exempt from the requirements of 1607.
2. Agricultural storage buildings which are intended only for incidental human occupancy are exempt from the requirements of 1607.
3. Buildings or structures located where the seismic coefficient representing the effective peak velocity-related acceleration, A_v, is equal to 0.05 need only comply with 1607.3.6.1.
4. Buildings of detached one and two-family dwellings (Group R3) with a building height not more than 35 feet (10.7 m) or two stories, which have seismic load-resisting systems which are entirely of wood frame construction in accordance with the requirements of Chapter 23, and are located in seismic map areas having an effective peak velocity-related acceleration, A_v, equal to or greater than 0.15, need only comply with 1607.3.6.1.
5. Buildings assigned to Seismic Performance Category B, according to 1607 1.5 and 1607.1.8, which have seismic load-resisting systems which are entirely of light frame wood construction in accordance with the provisions of Chapter 23, need only comply with 1607.3.6.1.

1607.1.2 Required Design Data. Where earthquake loads are applicable, the following design data shall be indicated on the design drawings:

1. The peak velocity related acceleration, A_v, according to 1607.1.5.
2. The peak acceleration, A_a, according to 1607.1.5.
3. The Seismic Hazard Exposure Group according to 1607.1.6.
4. The Seismic Performance Category according to 1607.1.8.
5. The soil profile type according to Table 1607.3.1.
6. The basic structural system and seismic resisting system according to Table 1607.3.3.
7. The response modification factor, R, and the deflection amplification factor, C_d, according to Table 1607.3.3.
8. The analysis procedure utilized in accordance with 1607.4 or 1607.5 as applicable.

1607.1.3 Additions to Existing Buildings. An addition which is structurally independent from an existing building shall be designed and constructed in accordance with the seismic requirements for new buildings. An addition which not structurally independent from an existing building shall be designed and constructed such that the entire building conforms to the seismic requirements for new buildings unless the following three provisions are complied with:

1. The addition complies with the seismic requirements for new buildings,
2. The addition shall not increase the seismic forces in any structural element of the existing building by more than 5% unless the increased forces on the element are still in compliance with these provisions.
3. The addition shall not decrease the seismic resistance of any structural element of the existing building below that required for new buildings.

1607.1.4 Change of Occupancy. When a change of occupancy results in an existing building being reclassified to a higher Seismic Hazard Exposure Group, the building shall conform to the seismic requirements for new buildings.

EXCEPTION: Upgrading the building for the seismic requirements of this section is not required for buildings located in seismic map areas having an effective peak velocity-related acceleration, A_v, value of less than 0.15 when the change of use results in a building being reclassified from Seismic Hazard Exposure Group I to Seismic Hazard Exposure Group II.

1607.1.5 Seismic Ground Acceleration Maps. The effective peak velocity-related acceleration, A_v, and the effective peak acceleration, A_a, shall be determined from Figures 1607.1.5A and 1607.1.5B, respectively.

1607.1.6 Seismic Hazard Exposure Groups. All buildings shall be assigned to one of the following Seismic Hazard Exposure Groups in Table 1607.1.6.

1607.1.6.1 Mixed Use. Where a building is occupied for two or more uses, not included in the same Seismic Hazard Exposure Group, the building shall be assigned the classification of the highest Seismic Hazard Exposure Group occupancy.

1607.1.7 Group III Building Operational Access. Where operational access to a Seismic Hazard Exposure Group III building is required through an adjacent building, the adjacent building shall conform to the requirements for Group III buildings. Where operational access is less than 10 feet (3048 mm) from the interior property line or another building on the same lot, protection from potential falling debris from adjacent property shall be provided by the owner of the Seismic Hazard Exposure Group III building.

1607.1.8 Seismic Performance Category. Buildings shall be assigned a Seismic Performance Category in accordance with Table 1607.1.8.

1607.1.9 Site Limitation for Seismic Performance Category E. A building assigned to Category E shall not be sited where there is the potential for an active fault to cause rupture of the ground surface under the building.

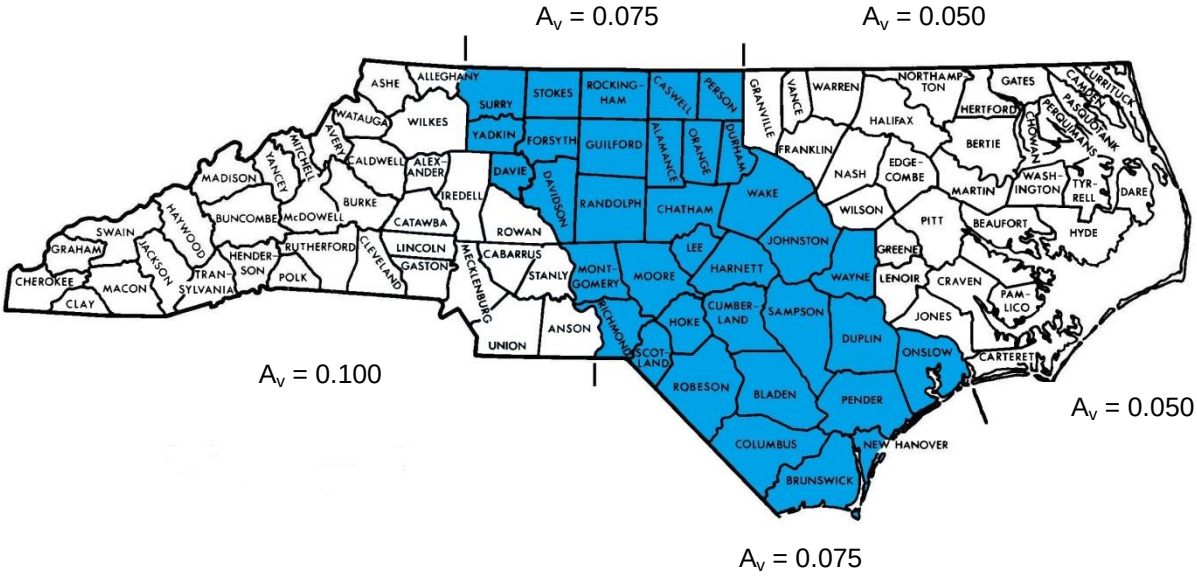


FIGURE 1607.1.5A
Map of Effective Peak Velocity-Related Acceleration Coefficient, A_v

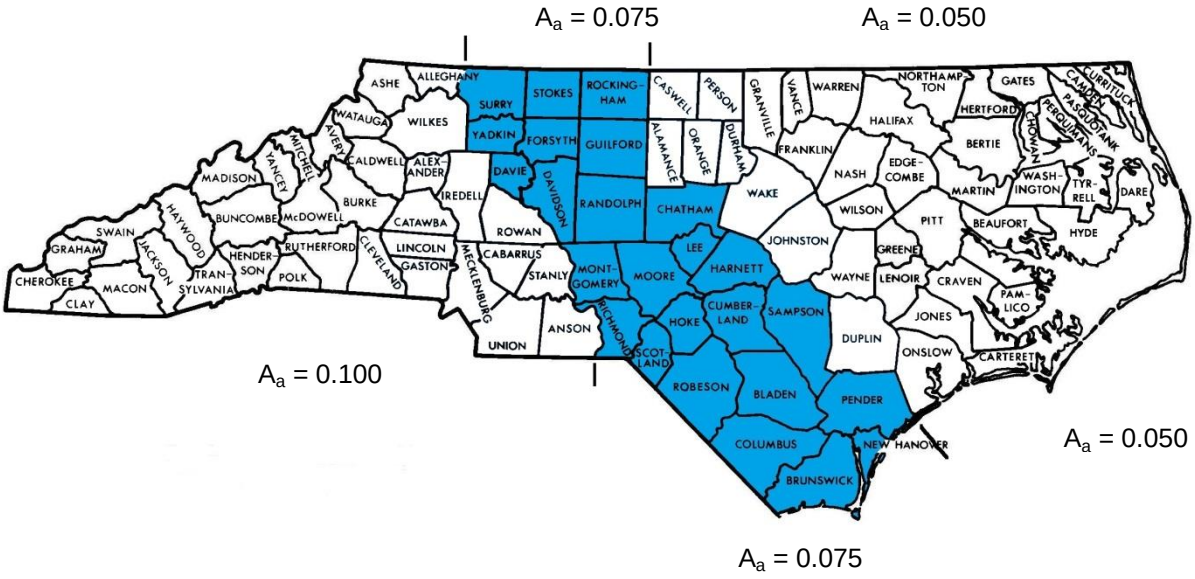


FIGURE 1607.1.5B
Map of Effective Peak Acceleration Coefficient, A_a

TABLE 1607.1.5

County	A_a	A_v	County	A_a	A_v
Counties not listed	0.100	0.100	Lee	0.075	0.075
Alamance	0.050	0.075	Lenoir	0.050	0.050
Beaufort	0.050	0.050	Martin	0.050	0.050
Bertie	0.050	0.050	Montgomery	0.075	0.075
Bladen	0.075	0.075	Moore	0.075	0.075
Brunswick	0.075	0.075	Nash	0.050	0.050
Camden	0.050	0.050	New Hanover	0.075	0.075
Carteret	0.050	0.050	Northampton	0.050	0.050
Chatham	0.075	0.075	Onslow	0.050	0.075
Chowan	0.050	0.050	Orange	0.050	0.075
Columbus	0.075	0.075	Pamlico	0.050	0.050
Craven	0.050	0.050	Pasquotank	0.050	0.050
Cumberland	0.075	0.075	Pender	0.075	0.075
Currituck	0.050	0.050	Perquimans	0.050	0.050
Davie	0.075	0.075	Person	0.050	0.075
Davidson	0.075	0.075	Pitt	0.050	0.050
Dare	0.050	0.050	Randolph	0.075	0.075
Duplin	0.050	0.050	Richmond	0.075	0.075
Durham	0.050	0.050	Robeson	0.075	0.075
Edgecombe	0.050	0.050	Rockingham	0.075	0.075
Forsythe	0.075	0.075	Sampson	0.075	0.075
Franklin	0.050	0.050	Scotland	0.075	0.075
Gates	0.050	0.050	Stokes	0.075	0.075
Granville	0.050	0.050	Surry	0.075	0.075
Greene	0.050	0.050	Tyrrell	0.050	0.050
Guilford	0.075	0.075	Vance	0.050	0.050
Halifax	0.050	0.050	Wake	0.050	0.075
Harnett	0.075	0.075	Warren	0.050	0.050
Hertford	0.050	0.050	Washington	0.050	0.050
Hoke	0.075	0.075	Wayne	0.050	0.075
Hyde	0.050	0.050	Wilson	0.050	0.050
Johnston	0.050	0.075	Yadkin	0.075	0.075
Jones	0.050	0.050			

Table 1607.1.6
Seismic Hazard Exposure Group

Group Type	Nature of Occupancy
Group I	All buildings except those listed below
Group II Seismic Hazard Exposure Group II buildings are those which have a substantial public hazard due to occupancy or use, including buildings containing any one or more of the indicated uses.	1. Group A in which more than 300 people congregate in one room. 2. Group E with an occupant load greater than 250. 3. Group B used for college or adult education with an occupant load greater than 500. 4. Group I – Unrestrained with an occupant load greater than 50, not having surgery or emergency treatment facilities. 5. Group I – Restrained. 6. Power generation stations and other public utility facilities not included in Group III Seismic Hazard Exposure Group. 7. Any other occupancy with an occupant load greater than 5,000.
Group III Seismic Hazard Exposure Group III buildings are those having essential facilities which are required for post-earthquake recovery, including buildings containing any one or more of the indicated uses.	1. Fire or rescue and police stations. 2. Group I – Unrestrained having surgery or emergency treatment facilities. 3. Earthquake emergency preparedness centers. 4. Post-earthquake recovery vehicle garages. 5. Power generation stations and other utilities required as emergency back-up facilities. 6. Primary communication facilities. 7. Highly toxic materials as defined by 308.2.1 as an H4 occupancy where the quantity of material exceeds the exempt amounts of Table 308.2D.

Table 1607.1.8
Seismic Performance Categories

Effective Peak Velocity-Related Acceleration, A_v	Seismic Hazard Exposure Group		
	I	II	III
$A_v = 0.05$	A	A	A
$0.05 < A_v < 0.10$	B	B	C
$0.10 \leq A_v < 0.15$	C	C	C
$0.15 \leq A_v < 0.20$	C	D	D
$0.20 \leq A_v$	D	D	E

1607.2 Definitions

For the purpose of this section, certain special terms are defined as follows.

ACCELERATION:

EFFECTIVE PEAK – coefficient A_a, according to 1607.1.5 for determining the prescribed seismic force.

EFFECTIVE PEAK VELOCITY-RELATED – coefficient A_v, for determining the prescribed seismic forces given in 1607.1.5.

BASE – the level at which the horizontal seismic ground motions are considered to be imparted to the building.

BASE SHEAR – total design lateral force or shear at the base of the building.

BEARING WALL SYSTEM – a structural system with bearing walls providing support for all, or major portions of, the vertical loads. Shear walls or braced frames provide seismic force resistance.

DESIGN EARTHQUAKE – the earthquake at the site under consideration that produces ground motions having a 90% probability of not being exceeded in 50 years.

DESIGINATED SEISM IC SYSTEMS – the Seismic Resisting System and those architectural, electrical, and mechanical systems and their components that require special performance characteristics.

DIAPHRAGM – a horizontal, or nearly horizontal, portion of the Seismic Resisting System, which is designed to transmit seismic force to the vertical elements of the Seismic Resisting System.

FRAME:

BRACED – an essentially vertical truss, or its equivalent, of the concentric or eccentric type that is provided in a bearing wall, building frame or dual system to resist seismic forces.

CONCENTRICALLY BRACED FRAME – a braced frame in which the members are subjected primarily to axial forces.

ECCENTRICALLY BRACED FRAME (EBF) – a diagonally braced steel frame in which at least one end of each brace frames into a beam a short distance from a beam-column joint or from another diagonal brace. These short beam segments are called link beams. The following FBF definitions apply:

DIAGONAL BRACE – a member of an EBF placed diagonally in the bay of the frame.

LATERAL SUPPORT MEMBERS – secondary members designed to prevent lateral or torsional buckling of beams in an EBF.

LINK BEAM – the horizontal beam in an EBF which has a length of the clear distance between the diagonal braces or between the diagonal brace and the column face.

LINK BEAM END WEB STIFFENERS – vertical web stiffeners placed on the sides of the web at the diagonal brace ends of the link beam.

LINK BEAM INTERMEDIATE WEB STIFFENER – vertical web stiffeners placed within the link beam.

LINK BEAM ROTATION ANGLE – the angle between the beam outside of the link beam and the link beam occurring at a total story drift of the deflection amplification factor, C_d, times the elastic drift at the prescribed design forces. The rotation angle is permitted to be computed assuming the EBF bay is deformed as a rigid, ideally plastic mechanism.

INTERMEDIATE MOMENT FRAME – a frame in which members and joints are capable of resisting forces by flexure as well as along the axis of the members. Intermediate moment frames of reinforced concrete shall conform to 1912.3.2.

ORDINARY MOMENT FRAME – a frame in which members and joints are capable of resisting forces by flexure as well as along the axis of the members.

SPECIAL MOMENT FRAME – a frame in which members and joints are capable of resisting forces by flexure as well as along the axis of the members. Special moment frames shall conform to the applicable requirements of 1912 or 2212.

SPACE FRAME – a structural system composed of interconnected members, other than bearing walls, that is capable of supporting vertical loads and, if so designed, resisting the seismic forces.

FRAME SYSTEM:

BUILDING – a structural system with an essentially complete space frame providing support for vertical loads. Seismic force resistance is provided by shear walls or braced frames.

DUAL – a structural system with an essentially complete space frame providing support for vertical loads. A moment resisting frame shall be provided that shall be capable of resisting at least 25% of the prescribed seismic forces. The total seismic force resistance is provided by the combination of the moment resisting frame together with shear walls or braced frames in proportion to their relative rigidities.

MOMENT RESISTING – a structural system with an essentially complete space frame providing support for vertical loads. Seismic force resistance is provided by special, intermediate, or ordinary moment frames capable of resisting the total prescribed forces.

HIGH TEMPERATURE ENERGY SOURCE – a fluid, gas, or vapor whose temperature exceeds 220°F (104°C).

INVERTED PENDULUM-TYPE STRUCTURES – structures which have a large portion of their mass concentrated near the top and thus have essentially one degree of freedom in horizontal translation. The structures are usually T-shaped with a single column supporting the beams or slab at the top.

LIGHT FRAMED WALL – a wall with wood or steel studs.

P-DELTA EFFECT – the secondary effect on shears and moments of frame members due to the action of the vertical loads induced by displacement of the building frame resulting from lateral forces.

RESILIENT STABLE MOUNTING SYSTEM – a system incorporating helical springs, air cushions, rubber-in-shear mounts, fiber-in-shear mounts, or other comparable approved systems. The force displacement ratios are equal in the horizontal and vertical directions.

RESTRAINING DEVICE – a device used to limit the vertical or horizontal movement of the mounting system due to earthquake motions.

ELASTIC – a fixed restraining device that incorporates an elastic element to reduce the seismic forces transmitted to the structure due to impact from the resilient mounting system.

FIXED – a nonyielding or rigid type of restraining device.

SEISMIC ACTIVATED – an interactive restraining device that is activated by earthquake motion.

SEISMIC RESISTING SYSTEM – that part of the structural system that has been considered in the design to provide the required resistance to the seismic forces prescribed herein.

SHEAR WALL – a wall, bearing or nonbearing, designed to resist seismic forces, from other than its own mass, acting in the plane of the wall.

STORY DRIFT RATIO – the story drift divided by the story height.

STORY SHEAR – the summation of design lateral forces at levels above the story under consideration.

1607.3 Structural Design Requirements

The seismic analysis and design procedures used in the design of buildings and their structural components shall be in accordance with the requirements of this section. The design seismic forces, and their distribution over the height of the building, shall be in accordance with the procedures in 1607.4 or 1607.5. The corresponding internal forces in the structural components of the building shall be determined by the use of a linearly elastic model. Structural concepts other than those in this section shall be permitted when evidence is submitted showing that equivalent ductility and energy dissipation are provided. Other procedures used to establish the seismic forces and the distribution of such forces shall be permitted if the corresponding internal forces and deformations in the structural components are determined using a model consistent with the approved procedure. Individual structural members shall be designed for the shears, axial forces, and moments determined in accordance with this section. Connections shall be designed to develop the strength of the connected members or the analysis forces, whichever is less. The design story drift of the building shall not exceed the allowable story drift requirements of 1607.3.7 when the building is subjected to the design seismic forces. All structural components of the building that transmit seismic force shall be connected, with adequate strength and stiffness, through a continuous path to the final point of resistance. The foundation shall be designed to accommodate the forces developed and the movements imparted to the building by the design ground motions. The foundation design shall consider the dynamic nature of the seismic forces and the design ground motions.

1607.3.1 Site Coefficient. The value of the site coefficient, S, shall be determined from Table 1607.3.1. In locations where the soil properties are not known in sufficient detail to determine the soil profile type or where the soil profile does not fit any of the four types indicated in Table 1607.3.1, a site coefficient, S, of 2.0 shall be used.

Table 1607.3.1
Site Coefficient

Soil Profile Type	Description	Site Coefficient S
S_1	A soil profile with either: Rock of any characteristic, either shale-like or crystalline in nature, which has a shear wave velocity greater than 2,500 feet per second or Stiff soil conditions where the soil depth is less than 200 feet and the soil types overlaying rock are stable deposits of sands, gravels or stiff clays.	1.0
S_2	A soil profile with deep cohesionless or stiff clay conditions, where the soil depth exceeds 200 feet and soil types overlaying rock are stable deposits of sands, gravels, or stiff clays.	1.2
S_3	A soil profile containing 20 to 40 ft in thickness of soft to medium-stiff clays with or without intervening layers of cohesionless soils.	1.5
S_4	A soil profile characterized by a shear wave velocity of less than 500 feet per second containing more than 40 ft of soft clay.	2.0

1607.3.2 Soil/Structure Interaction. The design base shear, story shears, overturning moments, and deflections determined by the requirements of 1607.4 or 1607.5 are permitted to be modified in accordance with approved procedures which account for the effects of soil/structure interaction.

1607.3.3 Structural framing systems. The basic structural framing systems to be used are indicated in Table 1607.3.3. Each type is subdivided by the types of vertical structural elements to be used to resist the design lateral forces. The structural system used shall be in accordance with the seismic performance category and height limitations indicated in Table 1607.3.3. The appropriate response modification factor, R , and the deflection amplification factor, C_d, indicated in Table 1607.3.3 shall be used in determining the base shear and the design story drift. Structural framing and seismic resisting systems which are not contained in Table 1607.3.3 shall be permitted if analysis and test data are submitted that establish the dynamic characteristics and demonstrate the lateral force resistance and energy absorption capacity to be equivalent to the structural systems listed in Table 1607.3.3 for equivalent response modification factor, R, values.

Table 1607.3.3[1]
Structural Systems

BASIC STRUCTURAL SYSTEM			Structural system limitations and building height (ft) limitations[2]			
			Seismic Performance Category			
Seismic resistance system	Response modification factor R	Deflection amplification factor C_d	A&B	C	D[4]	E[5]
BEARING WALL SYSTEM						
Light framed walls w/shear panels	6 1/2	4	NL	NL	160	100
Reinforced concrete shear walls	4 1/2	4	NL	NL	160	100
Reinforced masonry shear walls	3 1/2	3	NL	NL	160	100
Concentrically braced frames	4	3 1/2	NL	NL	160	100
Unreinforced masonry shear walls	1 1/4	1 1/4	NL	Note 3	NP	NP
Plain Concrete Shear Walls	1 1/2	1 1/2	NL	Note 3	NP	NP
BUILDING FRAME SYSTEM						
Eccentrically braced frames, moment resisting connections at columns away from link beam	8	4	NL	NL	160	100
Eccentrically braced frames, non-moment resisting connections at columns away from link beam	7	4	NL	NL	160	100
Light framed walls with shear panels	7	4 1/2	NL	NL	160	100
Concentrically braced frames	5		NL	NL	160	100
Reinforced concrete shear walls	5 1/2	5	NL	NL	160	100
Reinforced masonry shear walls	4 1/2	4	NL	NL	160	100
Unreinforced masonry shear walls	1 1/2	1 1/2	NL	Note 3	NP	NP
Plain Concrete Shear Walls	2	2	NL	Note 3	NP	NP
MOMENT RESISTING FRAME SYSTEM						
Special moment frames of steel	8	5 1/2	NL	NL	NL	NL
Special moment frames of reinforced concrete	8	5 1/2	NL	NL	NL	NL
Intermediate moment frames of reinforced concrete	5	4 1/2	NL	NL	NP	NP
Ordinary moment frames of steel	4 1/2	4	NL	NL	160	100
Ordinary moment frames of reinforced concrete	3	2 1/2	NL	NP	NP	NP
DUAL SYSTEM WITH A SPECIAL MOMENT FRAME CAPABLE OF RESISTING AT LEAST 25% OF THE PRESRIBED SEISMIC FORCES						
Eccentrically braced frames, moment resisting connections at columns away from link beam	8	4	NL	NL	NL	NL
Eccentrically braced frames, non-moment resisting connections at columns away from link beam	7	4	NL	NL	NL	NL
Concentrically braced frames	6	5	NL	NL	NL	NL
Reinforced concrete shear walls	8	6 1/2	NL	NL	NL	NL
Reinforced masonry shear walls	6 1/2	5 1/2	NL	NL	NL	NL
Wood sheathed shear walls	8	5	NL	NL	NL	NL

(continued)

Table 1607.3.3[1]*(continued)*
Structural Systems

BASIC STRUCTURAL SYSTEM			Structural system limitations and building height (ft) limitations[2]			
			Seismic Performance Category			
Seismic resistance system	Response modification factor R	Deflection amplification factor C_d	A&B	C	D[4]	E[5]
DUAL SYSTEM WITH AN INTERMIDIATE MOMENT FRAME OF REINFORCED CONCRETE OR AN ORDINARY MOMENT FRAME OF STEEL CAPABLE OF RESISTING AT LEAST 25% OF THE PRESCRIBED SEISMIC FORCES						
Concentrically braced frames	5	4 1/2	NL	NL	160	100
Reinforced concrete shear walls	6	5	NL	NL	160	100
Reinforced masonry shear walls	5	4 1/2	NL	NL	160	100
Wood sheathed shear walls	7	4 1/2	NL	NL	160	100
INVERTED PENDULUM STRUCTURES						
Special moment frames of structural steel	2 1/2	2 1/2	NL	NL	NL	NL
Special moment frames of reinforced concrete	2 1/2	2 1/2	NL	NL	NL	NL
Ordinary moment frames of structural steel	1 1/4	1 1/4	NL	NL	NP	NP

1 ft = 0.305 m

NL = not limited
NP = not permitted

Notes:

1. Response modification Factor R for use in 1607.4 and 1607.5. Deflection amplification factor C_d for use in 1607.4 and 1607.5.
2. The building height is not to exceed the general height limitation of Table 500 based on the type of construction.
3. The masonry shear walls shall have nominal reinforcement as required by Section A.3 of ACI 530/ASCE 5. See 2115.3.
4. See 1607.3.3.4.1 for description of building systems which are limited to buildings with a height of 240 ft or less.
5. See 1607.3.3.5 for description of building systems which are limited to buildings with a height of 160 ft or less.

1607.3.3.1 Dual System. For a dual system, the moment frame shall be capable of resisting at least 25% of the design seismic forces. The total seismic force resistance is to be provided by the combination of the moment frame and the seismic resisting elements in proportion to their rigidities.

1607.3.3.2 Combinations of Framing Systems. Different structural framing systems are permitted along the two orthogonal area of the building. Combinations of framing systems shall comply with the requirements of this section.

1607.3.3.2.1 Combination Framing Factor R. The response modification factor, R, in the direction under consideration at any story shall not exceed the lowest response modification factor R obtained from Table 1607.3.3 for the seismic resisting system in the same direction considered above the story.

EXCEPTION: Supported structural systems with a weight equal to or less than 10% of the weight of the building need not comply with this requirement.

1607.3.3.2.2 Combination Framing Detailing Requirements. The detailing requirements of 1607.3.6 required by the higher response modification factor R shall be used for structural components common to systems having different response modification factors.

1607.3.3.3 Seismic Performance Categories A, B, and C. The structural framing system for buildings assigned to Seismic Performance Categories A, B, and C shall comply with the building height and structural system limitations in Table 1607.3.3.

1607.3.3.4 Seismic Performance Category D. The structural framing system for buildings assigned to Seismic Performance Category D shall comply with 1607.3.3.3 and the additional provisions of this section.

1607.3.3.4.1 Limited Building Height. A building having a structural system of steel or cast-in-place concrete braced frames or shear walls is limited to a height of 240 ft (73.1 m) where there are braced frames or shear walls so arranged that braced frames or shear walls in one plane resist no more than the following proportion of the seismic design force in each direction, including torsional effects:

1. 60% when the braced frame or shear walls are arranged only on the perimeter,
2. 40% when some of the braced frames or shear walls are arranged on the perimeter,
3. 30% for other arrangements.

1607.3.3.4.2 Interaction Effects. Moment resisting frames that are enclosed or adjoined by more rigid elements not considered to be part of the seismic resisting system shall be designed so that the action or failure of the enclosing or adjoining elements will not impair the vertical load and seismic force resisting capability of the frame. The design shall provide for the effect of these rigid elements on the structural system at building deformations corresponding to the design story drift, Δ, as determined in 1607.4.5.

1607.3.3.4.3 Deformational Compatibility. Every structural component not included in the seismic force resisting system in the direction under consideration shall be designed to be adequate for the vertical load-carrying capacity and the induced moments resulting from the design story drift, Δ, as determined in accordance with 1607.4.5.

1607.3.3.4.4 Special Moment Frame. A special moment frame that is used but not required by Table 1607.3.3 is permitted to be discontinuous and supported by a more rigid system with a lower response modification factor, R, provided the requirements of 1607.3.6.2.4 are met. Where a special moment frame is required by Table 1607.3.3, the frame shall be continuous to the foundation.

1607.3.3.5 Seismic Performance Category E. The framing systems of buildings assigned to Category E shall conform to the requirements of 1607.3.3.4 for Category D and to the additional requirements and limitations of this section. The building height limitation in 1607.3.3.4.1 is reduced to 160ft (48.8 m) for buildings assigned to Seismic Performance Category E.

1607.3.4 Building Configuration. Buildings shall be classified as regular or irregular based on the plan and vertical configuration.

1607.3.4.1 Plan Irregularity. Buildings having one or more of the features listed in Table 1607.3.4.1 shall be designed as having plan irregularity and shall comply with the requirements in the referenced code sections of Table 1607.3.4.1.

Table 1607.3.4.1
Plan Structural Irregularities

Irregularity Type and Description	Reference Section	Seismic Performance Category Application
1. Torsional Irregularity – to be considered when diaphragms are rigid in relation to the vertical structural elements which resist the lateral seismic forces. Torsional irregularity shall be considered to exist when the maximum story drift, computed including accidental torsion, at one end of the structure transverse to an axis is more than 1.2 times the average of the story drifts at the two ends of the structure.	1607.3.6.4.2 1607.4.3.1	D and E C, D and E
2. Re-entrant Corners Plan configuration of a structure and its lateral force-resisting system contain re-entrant corners, where both projections of the structure beyond a re-entrant corner are greater than 15% of the plan dimension of the structure in the given direction.	1607.3.6.4.2	D and E
3. Diaphragm Discontinuity Diaphragms with abrupt discontinuities or variations in stiffness, including those having cutoff or open areas greater than 50% of the gross enclosed area diaphragm, or changes in effective diaphragm stiffness of more than 50% from one story to the next.	1607.3.6.4.2	D and E
4. Out-of-Plane Vertical Element Offsets Discontinuities in a lateral force resistance path, such as out-of-plane offsets of the vertical elements which resist the lateral seismic forces.	1607.3.6.4.2	D and E
5. Nonparallel Systems The vertical lateral force-resisting elements are not parallel to, or are not symmetric about, the major orthogonal axes of the lateral force-resisting system.	1607.3.6.3.1	C, D and E

1607.3.4.2 Vertical Irregularity. Buildings having one or more of the features listed in Table 1607.3.4.2 shall be designated as having vertical irregularity and shall comply with the requirements in the referenced code sections of Table 1607.3.4.2.

EXCEPTIONS:

1. Structural irregularities of Type 1 or 2 in Table 1607.3.4.2 do not apply where the building story drift ratio is less than 130% of the story drift ratio of the next story above. Torsional effects need not be considered in the calculation of story drifts. The story drift ratio relationship for the top 2 stories of the building are not required to be evaluated.
2. Irregularity Type 1 and 2 of Table 1607.3.4.2 are not required to be considered for one and two story buildings.

Table 1607.3.4.2
Vertical Structural Irregularities

Irregularity Type and Description	Reference Section	Seismic Performance Category Application
1. Stiffness Irregularity – Soft Story A soft story is one in which the lateral stiffness is less than 70% of that in the story above or less than 80% of the average stiffness of the three stories above.	1607.3.5.3	D and E
2. Weight (Mass) Irregularity Mass irregularity shall be considered to exist where the effective mass of any story is more than 150% of the effective mass of an adjacent story. A roof that is lighter than the floor below need not be considered.	1607.3.5.3	D and E
3. Vertical Geometric Irregularity Vertical geometric irregularity shall be considered to exist where the horizontal dimension of the lateral force-resisting system in any story is more than 130% of that in an adjacent story.	1607.3.5.3	D and E
4. In-Plane Discontinuity in Vertical Lateral Force-Resisting Elements An in-plane offset of the lateral force-resisting elements greater than the length of those elements.	1607.3.6.4.2	D and E
5. Discontinuity in Capacity – Weak Story A weak story is one in which the story lateral strength is less than 80% of that in the story above. The story strength is the total strength of all seismic resisting elements sharing the story shear for the direction under consideration.	1607.3.6.2.4	B, C, D and E

1607.3.5 Analysis Procedures. A structural analysis shall be made for all buildings in accordance with the requirements of this section. An alternative generally accepted procedure, including the use of an approved site-specific response spectrum, is permitted to be used, if approved by the building official. Where site-specific ground motions are used or required, they shall be developed with 90% probability of ground motion not being exceeded in 50 years. The limitations on the base shear in 1607.5 apply to dynamic modal analysis.

1607.3.5.1 Seismic performance category A. Regular or irregular buildings assigned to Category A are not required to be analyzed for seismic forces for the building as a whole. The requirements of 1607.3.6.1 apply.

1607.3.5.2 Seismic performance categories B and C. Regular or irregular buildings assigned to Category B or C shall be analyzed in accordance with the procedures in 1607.4.

1607.3.5.3 Seismic performance categories D and E. Buildings assigned to Categories D and E shall be analyzed in accordance with the referenced sections in Table 1607.3.5.3.

Table 1607.3.5.3
Analysis Procedures for Seismic Performance Categories D and E

Building Description	Referenced Section and Procedures
1. Buildings designated as regular which do not exceed 240 ft in height.	**1607.4**
2. Buildings that have only vertical irregularities of Type 1, 2 or 3 in Table 1607.3.4.2 and have a height exceeding 5 stories or 65 ft, and all buildings exceeding 240 ft in height.	**1607.5**
3. All other buildings designated as having plan or vertical irregularities in accordance with Table 1607.3.4.1 and Table 1607.3.4.2.	**1607.4 or 1607.5**
4. Buildings in Seismic Hazard Exposure Groups II and III in areas with A_a greater than 0.40 within 6.2 miles (10 km) of faults having the capability of generating magnitude 7 or greater earthquakes.	**A site-specific response spectrum shall be used but the design base shear shall not be less that that determined from 1607.4.**
5. Buildings in areas with A_v of 0.2 or greater with a building period of 0.7 seconds or greater, located on type S_4 soils.	**A site-specific response spectrum shall be used but the design base shear shall not be less that that determined from 1607.4. The modal seismic design coefficient (C_{sm}) shall not be limited in accordance with 1607.5.5.**

1 ft = 0.305 m

1607.3.6 Design, detailing requirements and structural component load effects. The design and detailing of structural components of the seismic resisting system shall comply with the requirements of this section. Foundation design shall conform to the applicable requirements of Chapter 18.

1607.3.6.1 Seismic performance category A. The design and detailing of buildings assigned to Seismic Performance Category A shall comply with the requirements of this section.

1607.3.6.1.1 Ties and continuity. Except for connections exempted by 1607.6, all parts of the building that transmit seismic force shall be interconnected to form a continuous path to the building's seismic resisting system. Any smaller portion of the building shall be tied to the remainder of the building with elements having a strength capable of transmitting the seismic force, F_p, determined in accordance with 1607.6, but not less than one-third of the effective peak velocity-related acceleration, A_v, times the weight of the smaller portion, W_c, or 5% of the portion's weight, whichever is greater. For a building which is exempt from a full seismic analysis by 1607.1 and is only required to comply with 1607.3.6.1, the building's main wind force resisting system according to 1606 shall be deemed to be the seismic resisting system.

A positive connection for resisting a horizontal force acting parallel to the member shall be provided for each beam, girder, or truss to its support. The connection shall have a minimum strength of 5% of the dead plus live load reaction.

1607.3.6.1.2 Concrete or masonry wall anchorage. Concrete and masonry walls shall be anchored to the roof and all floors that provide lateral support for the wall. The anchorage shall provide a direct connection between the walls and the roof or floor construction. The use of toe nailing or nails subject to withdrawal forces is not permitted. Wood ledgers shall not be subjected to cross grain bending or cross grain tension. The connections shall be capable of resisting a lateral seismic force, F_p, in accordance with either 1607.3.6.2.8 or 1607.6, for bearing and nonbearing walls respectively, but not less than 1,000 times the effective peak velocity-related acceleration, A_v, pounds per linear foot of wall. Walls shall be designed to resist bending between anchors where the anchor spacing exceeds 4ft (1219 mm).

1607.3.6.2 Seismic performance category B. Buildings assigned to Category B shall conform to the requirements of 1607.3.6.1 for Category A and the requirements of this section.

1607.3.6.2.1 Materials. The materials and the systems composed of those materials shall conform to the requirements of this code.

1607.3.6.2.2 Openings. Where openings occur in shear walls, diaphragms, or other plate type elements, the edges of the openings shall be designed to transfer the stresses into the structure. The edge chord shall extend into the body of the wall or diaphragm a distance sufficient to develop the stress of the chord member.

1607.3.6.2.3 Orthogonal effects. The design seismic forces shall be applied separately in each of two orthogonal directions.

1607.3.6.2.4 Discontinuities in vertical system. Buildings with discontinuity in lateral capacity, vertical irregularity Type 5 as defined in Table 1607.3.4.2, shall not be over 2 stories or 30 feet (9144 mm) in height where the "weak" story has a calculated strength of less than 65% of the story above.

EXCEPTI ON: Where the "weak" story is capable of resisting a total seismic force equal to 75% of the deflection amplification factor, C_d, times the design force prescribed in 1607.4.

1607.3.6.2.5 Nonredundant systems. The building design shall comply with 1607.1.2 for progressive collapse.

1607.3.6.2.6 Collector elements. Collector elements shall be provided that are capable of transferring the seismic forces originating in other portions of the building to the element providing the resistance to those forces.

1607.3.6.2.7 Diaphragms. The deflection in the plane of the diaphragm, as determined by engineering analysis, shall not exceed the permissible deflection of the attached elements. Permissible deflection shall be that deflection which will permit the attached element to maintain its structural integrity under the individual loading and continue to support the prescribed loads.

Floor and roof diaphragms shall be designed to resist the following seismic forces: A minimum force equal to 50% the effective peak velocity-related acceleration, A_v, times the weight of the diaphragm and other elements of the building attached thereto plus the portion of the seismic shear force at that level, V_x, required to be transferred to the components of the vertical seismic resisting system because of offsets or changes in stiffness of the vertical components above and below the diaphragm.

Diaphragms shall provide for both the shear and bending stresses resulting from these forces. Diaphragms shall have ties or struts to distribute the wall anchorage forces into the diaphragm. Diaphragm connections shall be positive, mechanical type connections.

1607.3.6.2.8 Bearing walls. Exterior and interior bearing walls and their anchorage shall be designed for a force of the effective peak velocity-related acceleration, A_v, times the weight of the wall, normal to the surface, with a minimum force of 10% of the weight of the wall. Interconnection of wall elements and connections to supporting framing systems shall have sufficient ductility, rotational capacity, or sufficient strength to resist shrinkage, thermal changes, and differential foundation settlement when combined with seismic forces.

1607.3.6.2.9 Inverted pendulum-type structures. Supporting columns or piers of inverted pendulum-type structures shall be designed for the bending moment calculated at the base determined using the procedures given in 1607.4 and shall vary uniformly to a moment at the top equal to one-half the calculated bending moment at the base.

1607.3.6.3 Seismic performance category C. Buildings assigned to Category C shall conform to the requirements of 1607.3.6.2 for Category B and the requirements of this section.

1607.3.6.3.1 Plan irregularity. Buildings that have plan structural irregularity Type 5 in Table 1607.3.4.1 shall be analyzed for the critical load effect due to direction of application of seismic forces. Alternatively, the building shall be analyzed in any two orthogonal directions. Structural elements and foundations shall be designed for 100% of the forces for one direction plus a simultaneous load of 30% of the forces for the perpendicular direction.

1607.3.6.4 Seismic performance categories D and E. Buildings assigned to Category D or E shall conform to the requirements of 1607.3.6.3 for Category C and to the requirements of this section.

1607.3.6.4.1 Orthogonal load effects. Buildings shall be designed for 100% of the seismic forces for one direction plus a simultaneous load of 30% of the seismic forces for the perpendicular direction. The load combination requiring the maximum structural component strength shall be used.

EXCEPTION: Diaphragms and components of the seismic resisting system utilized in only one of the two orthogonal directions are not required to be designed for the combined load effects.

1607.3.6.4.2 Plan or vertical irregularities. For buildings having a plan irregularity of Type 1**,** 2, 3, or 4 in Table 1607.3.4.1 or a vertical irregularity of Type 4 in Table 1607.3.4.2, the design forces determined from 1607.4 shall be increased 25% for connections of diaphragms to vertical elements and to collectors and for connections of collectors to the vertical elements.

1607.3.6.4.3 Vertical seismic loads. The vertical component of earthquake ground motion shall be considered in the design of horizontal cantilever and horizontal prestressed components. Horizontal prestressed components shall be designed for load combinations in accordance with 1609.2. Horizontal cantilever structural components are to be designed for a net upward force of 0.2 times the dead load in addition to the applicable load combinations of 1609.1.

1607.3.7 Deflection and drift limits. The design story drift, (Δ), as determined in 1607.4.5 or 1607.5.8, shall not exceed the allowable story drift (Δ_a) from Table 1607.3.7 for any story. For structures with significant torsional deflections, the maximum drift shall include torsional effects. The total deflection of a building due to seismic design forces shall not encroach on an interior property line. All portions of the building shall be designed and constructed to act as an integral unit in resisting seismic forces unless separated structurally by a distance sufficient to avoid contact which would damage the structural system of the building under total deflection, (δ_x), as determined by 1607.4.5.1.

Table 1607.3.7
Allowable Story Drift (Δ_a)[1]

Building	Seismic Hazard Exposure Group I	II	III
One story buildings without equipment attached to the structural resisting system and the interior walls, partitions, ceilings, and exterior wall systems which have been designed to accommodate the story drifts.	No limit	$0.025h_{sx}$	$0.025h_{sx}$
Buildings having 4 stories or less with interior walls, partitions, ceilings, and exterior wall systems which have been designed to accommodate the story drifts.	$0.025h_{sx}$	$0.025h_{sx}$	$0.025h_{sx}$
All other buildings.	$0.020h_{sx}$	$0.025h_{sx}$	$0.025h_{sx}$

Note:
1. h_{sx} is the story height below level x.

1607.4 Equipment Lateral Force Procedure

This section provides required standards for the equivalent lateral force procedure of seismic analysis of buildings. For purposes of analysis, the building is considered to be fixed at the base. See 1607.3.5 for limitations on the use of this procedure.

1607.4.1 Seismic Base Shear. The seismic bas shear, V, in a given direction, shall be determined in accordance with the following formula:

$$V = C_s W$$

Where:

Cs = The seismic design coefficient determined in accordance with 1607.4.1.1.

W = The total dead load and applicable portions of other loads listed below:

1. In Group S occupancies, a minimum of 25% of the floor live load shall be applicable.
   EXCEPTION: Floor live load in parking garages is not applicable.
2. Where an allowance for partition load is included in the floor load design, the actual partition weight or a minimum weight of 10 psf (479 Pa) of floor area, whichever is greater, shall be applicable.
3. Total operating weight of permanent equipment.
4. In areas where the ground snow load is equal to or greater than 30 psf (1436 Pa) of short duration and approved, snow load reductions of 80% are permitted. Where the ground snow load is less than 30 psf (1436 Pa), the snow load is not required to be included.

1607.4.1.1 Calculation of seismic coefficient, C_s. When the fundamental period of the building is computed, the seismic design coefficient, C_s, shall be determined in accordance with the following formulas:

$$C_s = \frac{1.2\ A_v S}{RT^{2/3}}$$

Where:

A_v = The coefficient representing effective peak velocity-related acceleration from 1607.1.5.

S = The coefficient for the soil profile characteristics of the site in Table 1607.3.1.

R = The response modification factor in Table 1607.3.3.

T = The fundamental period of the building determined in 1607.4.1.2.

A soil/structure interaction reduction is permitted when determined from a generally accepted procedure approved by the building official. Alternatively, the seismic design coefficient , C_s, need not be greater than the following equation:

$$C_s = \frac{2.5\ A_a}{R}$$

Where:

A_a = The seismic coefficient representing the Effective Peak Acceleration as determined in 1607.1.5.

R = The response modification factor in Table 1607.3.3.

1607.4.1.2 Period Determination. The fundamental period of the building, T, in the direction under consideration, shall be established using the structural properties and deformational characteristics of the resisting elements in a properly substantiated analysis. The fundamental period, T, shall not exceed the product of the coefficient for upper limit on calculated period, C_a, from Table 1607.4.1.2, and the approximate fundamental period, T_a. Alternatively, the fundamental period, T, shall be determined from the appropriate requirements of 1607.4.1.2.1.

Table 1607.4.1.2
Coefficient for Upper Limit on Calculated Period, C_a

A_v Coefficient Representing Effective Peak Velocity-Related Acceleration	C_a
0.4	1.2
0.3	1.3
0.2	1.4
0.15	1.5
0.1	1.7
0.05	1.7

1607.4.1.2.1 Approximate fundamental period, T_a. The approximate fundamental period T_a, in seconds, shall be determined from the following formula:

$$T_a = C_T h_n^{3/4}$$

Where:

h_n = The height (feet) from the base to the highest level of the building.

C_T = 0.035 for moment-resisting frame systems of steel which provide 100% of the required lateral force resistance, where the frame is not enclosed or adjoined by more rigid components.

C_T = 0.03 for moment-resisting frame systems of concrete which provide 100% of the required lateral force resistance, where the frame is not enclosed or adjoined by more rigid components.

C_T = 0.03 for building frame systems with an eccentrically braced steel frame or dual systems with an eccentrically braced frame.

C_T = 0.02 for seismic-resisting systems with shear walls, shear panels or concentrically braced frames and all other building systems.

Alternatively, the approximate fundamental period T_a, in seconds, shall be determined from the following formula for buildings in which the lateral force-resisting system consists of concrete or steel moment resisting frames which provide 100% of the required lateral force resistance and where such frames are not enclosed or adjoined by more rigid components tending to prevent the frames from deflecting when subjected to seismic forces. Such buildings shall not exceed 12 stories in height and shall have a story height of not less than 10 feet (3048 mm).

$$T_a = 0.1\ N$$

Where:

N = Number of stories.

1607.4.2 Vertical Distribution of Seismic Forces. The lateral force, F_x, induced at any level, shall be determined from the following formulas:

$$F_x = C_{vx} V$$

$$C_{vx} = \frac{w_x h_x^k}{\sum_{i=1}^{n} w_i h_i^k}$$

Where:

C_{vx} = Vertical distribution factor.

V = Total design lateral force or shear at the base of the building.

w_i and w_x = The portion of the total gravity load of the building, W, located or assigned to level i or x.

h_i and h_x = The height (feet) from the base to level i or x.

k = An exponent related to the building period as follows:

For buildings having a period of 0.5 seconds or less, k = 1.

For buildings having a period of 2.5 seconds or more, k = 2.

For buildings having a period between 0.5 and 2.5 seconds, k shall be 2 or shall be determined by linear interpolation between 1 and 2.

1607.4.3 Horizontal shear distribution. The seismic design story shear in any story, V_x, shall be determined from the following formula:

$$V_x = \sum_{i=x}^{n} F_i$$

Where:

F_i = The portion of the seismic base shear, V, induced at level i.

The seismic design story shear, V_x, shall be distributed to the various vertical elements of the seismic resisting system in the story under consideration based on the relative lateral stiffness of the vertical resisting elements and the diaphragm.

1607.4.3.1 Torsion. The design shall include the torsional moment, M_t, resulting from the location of the building masses plus the accidental torsional moments, M_{ta}, caused by assumed displacement of the mass each way from its actual location by a distance equal to 5% of the dimension of the building perpendicular to the direction of the applied forces. Buildings of Seismic Performance Category C, D, and E, where Type 1 torsional irregularity exists as defined in Table 1607.3.4.1, the effects shall be accounted for by increasing the accidental torsion at each level by a torsional amplification factor, A_x, determined from the following formula:

$$A_x = \left[\frac{\delta_{max}}{1.2\delta_{avg}} \right]^2$$

Where:

δ_{max} = The maximum displacement at level x.

δ_{avg} = The average of the displacements at the extreme points of the structure at level x.

The torsional amplification factor, A_x, is not required to exceed 3.0.

1607.4.4 Overturning. The building shall be designed to resist overturning effects caused by the seismic forces determined in 1607.4.2. At any story, the increment of overturning moment in the story under consideration shall be distributed to the various vertical resisting elements in the same proportion as the distribution of the horizontal shears to those elements.

The overturning moments at level x, M_x, shall be determined from the following formula:

$$M_x = \tau \sum_{i=x}^{n} F_i (hi - hx)$$

Where:

F_i = The portion of the seismic base shear, V, induced at level i.

h_i and h_x = The height, (feet), from the base to level I or x.

τ = 1.0 for the top 10 stories,

τ = 0.8 for the 20th story from the top and below, and

τ = A value between 1.0 and 0.8 determined by a straight line interpolation for stories between the 20th and the 10th stories below the top.

The foundations of buildings, except inverted pendulum structures, shall be designed for the foundation overturning design moment, M_f, at the foundation/soil interface determined using the equation for the overturning moment at level x, M_x above with an overturning moment reduction factor, τ, of 0.75 for all building heights.

1607.4.5 Drift determination and P-Delta effects. Story drifts and, where required, member forces and moments due to P-delta effects, shall be determined in accordance with this section.

1607.4.5.1 Story drift determination. The design story drift, Δ, shall be computed as the difference of the deflections at the top and bottom of the story under consideration. The deflection of level x at the center of the mass, Δ_x, shall be determined in accordance with following formula:

$$\delta_x = C_d \, \delta_{xe}$$

Where:

Cd = The deflection amplification factor in Table 1607.3.3.

δ_{xe} = The deflections determined by elastic analysis.

The elastic analysis of the seismic resisting system shall be made using the required seismic design forces of 1607.4.2.

For determining compliance with the story drift limitation of 1607.3.7, the deflections of level x at the center of mass, δ_x, shall be calculated as required in this section. For purposes of this drift analysis only, it is permissible to use the computed fundamental period, T, of the building without the upper bound limitation specified in 1607.4.1.2 when determining drift level seismic design forces.

Where applicable, the design story drift, Δ, shall be increased by the incremental factor relating to the P-delta effects as determined in 1607.4.5.2.

1607.4.5.2 P-Delta effects. P-delta effects on story shears and moments, the resulting member forces and moments, and the story drifts induced by these effects are not required to be considered when the stability coefficient, θ, as determined by the following formula, is equal to or less than 0.10:

$$\theta = \frac{P_x \Delta}{V_x h_{sx} C_d}$$

Where:

P_x = The total vertical design load at story level x. When calculating the vertical design load for the purpose of determining P-delta effects, individual load factors are not required to exceed 1.0.

Δ = The design story drift occurring simultaneously with the story shear (V_x).

V_x = The seismic shear force between levels x and x-1.

h_{sx} = The story height below level x.

C_d = The deflection amplification factor in Table 1607.3.3.

The stability coefficient (θ) shall not exceed θ_{max} determined as follows:

$$\theta_{max} = \frac{0.5}{\beta C_d} \leq 0.25$$

Where:

β = The ratio of shear demand to shear capacity for the story between levels x and x-1. The ratio is permitted to be considered as 1.0.

Where the stability coefficient (θ) is greater than 0.10 but less than or equal to θ_{max}, the incremental factor related to P-delta effects shall be determined by rational analysis. To obtain the story drift for including the P-delta effect, the design story drift determined in 1607.4.5.1 shall be multiplied by 1.0/1- θ.

1607.5 Modal Analysis Procedure

This section provides required standards for the modal analysis procedure of seismic analysis of buildings. See 1607.3.5 for limitations on the use of this procedure.

1607.5.1 General. The symbols used in this method of analysis have the same meaning as those for similar terms used in 1607.4, with the subscript "m" denoting quantities in the m^{th} mode.

1607.5.2 Modeling. The building shall be modeled as a system of masses lumped at the floor levels with each mass having one degree of freedom-lateral displacement in the direction under consideration.

1607.5.3 Modes. The analysis shall include, for each of two mutually perpendicular axes, at least the lowest three modes of vibration or all modes of vibration with periods greater than 0.4 second, whichever is greater. The number of modes shall equal the number of stories for buildings less than 3 stories in height.

1607.5.4 Periods. The required periods and mode shapes of the building in the direction under consideration shall be calculated by established methods of structural analysis for the fixed base condition using the masses and elastic stiffness of the seismic resisting system.

1607.5.5 Modal Base Shear. The portion of the base shear contributed by the m^{th} mode, V_m, shall be determined from the following formula:

$$V_m = C_{sm} W_m$$

Where:

C_{sm} = The modal seismic design coefficient determined below.

W_m = The effective modal gravity load determined by the following formula:

$$W_m = \frac{\left[\sum_{i=1}^{n} w_i \phi_{im}\right]^2}{\sum_{i=1}^{n} w_i \phi_{im}^2}$$

Where:

w_i = The portion of the total gravity load of the building at level i.

ϕ_{im} = The displacement amplitude at the i^{th} level of the building when vibrating in its m^{th} mode.

The modal seismic design coefficient, C_{sm}, shall be determined in accordance with the following formula:

$$C_{sm} = \frac{1.2\, A_v S}{R T_m^{2/3}}$$

Where:

A_v = Seismic coefficient representing the effective peak velocity-related acceleration as determined in 1607.1.5.

S = The coefficient for the soil profile characteristics of the site as determined in Table 1607.3.1.

R = The response modification factor determined from Table 1607.3.3.

T_m = The modal period of vibration, in seconds, of the m^{th} mode of the building.

The modal seismic design coefficient, C_{sm}, is not required to exceed 2.5 times the seismic coefficient representing the effective peak acceleration, A_a, divided by the response modification factor R.

EXCEPTIONS:

1. The limited value of the modal seismic design coefficient (C_{sm}) is not applicable to Category D and E buildings with a period of 0.7 seconds or greater located on type S_4 soils.
2. For building on soil profile characteristics S_3 or S_4, the modal seismic design coefficient, C_{sm}, for modes other than the fundamental mode that have periods less than 0.3 seconds is permitted to be determined by the following formula:

$$C_{sm} = \frac{A_a (1.0 + 5.0\, T_m)}{R}$$

3. For buildings where any modal period of vibration, T_m, exceeds 4.0 seconds, the modal seismic design coefficient, C_{sm}, for that mode is permitted to be determined by the following formula:

$$C_{sm} = \frac{3\,A_v S}{R\,T_m^{4/3}}$$

Where:

A_a = Seismic coefficient representing the effective peak acceleration as determined in 1607.1.5.

A_v = Seismic coefficient representing the effective peak velocity-related acceleration as determined in 1607.1.5.

R = The response modification factor determined from Table 1607.3.3.

T_m = The modal period of vibration, in seconds, of the m^{th} mode of the building.

S = The coefficient for the soil profile characteristics of the site as determined in Table 1607.3.1.

1607.5.6 Modal forces, deflections, and drifts. The modal force, F_{xm}, at each level shall be determined by the following formulas:

$$F_{xm} = C_{vxm}\,V_m$$

$$C_{vxm} = \frac{W_x \phi_{xm}}{\sum_{i=1}^{n} W_i\,\phi_{im}}$$

Where:

C_{vxm} = The vertical distribution factor in the m^{th} mode.

V_m = The total design lateral force or shear at the base in the m^{th} mode.

wi and wx = The portion of the total gravity load of the building, W, located or assigned to level i or x.

ϕ_{xm} = The displacement amplitude at the x^{th} level of the building when vibrating in the m^{th} mode.

ϕ_{im} = The displacement amplitude at the i^{th} level of the building when vibrating in its m^{th} mode.

The modal deflection at each level, dxm, shall be determined by the following formulas:

$$\delta_{xm} = C_d \delta_{xem}$$

$$\delta_{xem} = \left(\frac{g}{4\pi^2}\right)\left(\frac{T_m^2 F_{xm}}{w_x}\right)$$

Where:

C_d = The deflection amplification factor determined from Table 1607.3.3.

δ_{xem} = The deflection of level x in the m^{th} mode at the center of the mass at level x determined by an elastic analysis.

g = The acceleration due to gravity (feet per second)
T_m = The modal period of vibration, in seconds, of the m^{th} mode of the building.
F_{xm} = The portion of the seismic base shear in the m^{th} mode, induced at level x.
W_x = The portion of the total gravity load of the building, W, located or assigned to level x.

The modal drift in a story, Δ_m, shall be computed as the difference of the deflections, δ_{xm}, at the top and bottom of the story under consideration.

1607.5.7 Modal Story Shears and Moments. The story shears, story overturning moments, and the shear forces and overturning moments in walls and braced frames at each level, due to the seismic forces determined from the appropriate equation in 1607.5.6, shall be computed for each mode by linear static methods.

1607.5.8 Design Values. The design value for the modal base shear, V_t, each of the story shear, moment and drift quantities, and the deflection at each level shall be determined by combining their modal values, obtained from 1607.5.6 and 1607.5.7. The combination shall be determined by taking the square root of the sum of the squares of each of the modal values or by the complete quadratic combination technique.

The base shear, V, using the equivalent lateral force procedure in 1607.4 shall be calculated using a fundamental period of the building, in seconds, T of 1.2 times the coefficient for upper limit on the calculated period, C_a, times the approximate fundamental period of the building, T_a, Where the design value for the modal base shear, V_t, is less than the calculated base shear, V, using the equivalent lateral force procedure, the design story shears, moments, drifts and floor deflections shall be multiplied by the following modification factor:

$$\frac{V}{V_t}$$

Where:

V = The equivalent lateral force procedure base shear, calculated in accordance with this section and 1607.4.
V_t = The modal base shear, calculated in accordance with this section.

The modal base shear, V_t, is not required to exceed the base shear from the equivalent lateral force procedure in 1607.4.

1607.5.8.1 Category D and E buildings on soil profile type S_4: For Category D and E buildings in areas with an effective peak velocity-related acceleration (A_v) value of 0.2 and greater with a building period of 0.7 seconds or greater located on soil profile type S_4, the design base shear shall not be less than that determined using the equivalent lateral force procedure in 1607.4, in accordance with Table 1607.3.5.3.

1607.5.9 Horizontal Shear Distribution. The distribution of horizontal shear shall be in accordance with the requirements of 1607.4.3.

1607.5.10 Foundation Overturning. The foundation overturning moment at the foundation/soil interface shall not be reduced by more than 10%.

1607.5.11 P-Delta Effects. The P-delta effects shall be determined in accordance with 1607.4.5.2. The story drifts and story shears shall be determined in accordance with 1607.5.8.

1607.6 Architectural, Mechanical and Electrical Components and Systems

All components and systems in buildings shall be designed and constructed to resist seismic forces determined in accordance with this section.

EXCEPTIONS:

1. Architectural components in buildings assigned to Seismic Performance Category A are exempt from the requirements of this section.
2. Mechanical and electrical components and systems in buildings assigned to Seismic Performance Category A or B are exempt from the requirements of this section.
3. Architectural, mechanical and electrical components and systems in buildings assigned to Seismic Performance Category B or C, are in Seismic Hazard Exposure Group I buildings, and have a Performance Criteria Factor of 0.5, are exempt from the requirements of this section.
4. Elevator components and systems in buildings assigned to Seismic Performance Category A or B are exempt from the requirements of this section. Elevator components and systems in buildings assigned to Seismic Performance Category C, and are in Seismic Hazard Exposure Group I buildings, are exempt from the requirements of this section.

1607.6.1 Component force application. The component seismic force shall be applied at the center of gravity of the component nonconcurrently in any horizontal direction. Mechanical and electrical components and systems shall be designed for a nonsimultaneous vertical force of 33% of the horizontal force.

1607.6.2 Component force transfer. Components shall be attached such that the component forces are transferred to the structural system of the building. Component seismic attachments shall be positive connections without consideration of frictional resistance.

1607.6.3 Architectural component design. Architectural components and their attachments shall be designed for seismic forces, (Fp), determined in accordance with the following formula:

$$F_p = A_v\, C_c\, P\, W_c$$

Where:

A_v = The coefficient representing effective peak velocity-related acceleration from 1607.1.5.

C_c = The seismic coefficient for architectural components from Table 1607.6.3.

P = Performance criteria factor from Table 1607.6.3.

W_c = The weight of the architectural component.

Table 1607.6.3
Architectural Component Seismic Coefficient (C_c)
And Performance Criteria Factor (P)[1]

	Architectural Component	Component Seismic Coefficient (C_c)	Performance Criteria Factor (P) Seismic Hazard Exposure Group		
			I	II	III
1.	Exterior nonbearing walls[2]	0.9	1.5	1.5	1.5
2.	Interior nonbearing walls[2]				
	Stair and elevator enclosures	1.5	1.0	1.0	1.5
	Other vertical shaft enclosures	0.9	1.0	1.0	1.5
	Other nonbearing walls	0.9	1.0	1.0	1.5
3.	Cantilever elements:				
	Parapets, chimneys or stacks	3.0	1.5	1.5	1.5
4.	Wall attachments	3.0	1.5	1.5	1.5
5.	Veneer connections	3.0	0.5		
6.	Penthouses	0.6	Not required	1.0	1.0
7.	Membrane fire protection	0.9	1.0	1.0	1.5
8.	Ceilings				
	Fire-rated membrane	0.9	1.0	1.0	1.5
	Nonfire-rated membrane	0.6	0.5	1.0	1.0
9.	Storage racks more than 8 ft I height, contents included	1.5	1.0	1.0	1.5
10.	Access floors, supported equipment included	2.0	0.5	1.0	1.5
11.	Elevator & counterweight guardrails & supports	1.25	1.0	1.0	1.5

Notes:
1. See 1607.6 for general exceptions.
2. See 1607.3.6.2.8 for exterior and interior bearing wall requirements.

1607.6.3.1 Exterior wall panel connections. The connections of exterior wall panels to the building seismic resisting system shall be designed for the design story drift determined in accordance with 1607.4.5.1 or in accordance with 1607.5.6 and 1607.5.8.

1607.6.3.2 Architectural component deformation. Architectural components shall be designed for the design story drift of the structural seismic resisting system determined in accordance with 1607.4.5.1 or in accordance with 1607.5.6 and 1607.5.8. Architectural components shall be designed for vertical deflection due to joint rotation of cantilever structural members.

EXCEPTION: Architectural components having a performance criteria factor of 0.5 are to be designed for 50% of the design story drift.

1607.6.3.3 Ceilings. Provision shall be made for the lateral support and interaction of other architectural, mechanical and electrical systems or components incorporated into the ceiling which impose seismic forces into the ceiling system.

1607.6.4 Mechanical, electrical component and system design. Mechanical, electrical components and systems and their attachments shall be designed for seismic forces (F_p), determined in accordance with the following formula:

$$F_p = A_v C_c P a_c W_c$$

Where:

A_v = The coefficient representing effective peak velocity-related acceleration from 1607.1.5.

C_c = The seismic coefficient for mechanical, electrical components and systems from Table 1607.6.4A.

P = Performance criteria factor from Table 1607.6.4A.

a_c = The attachment amplification factor determined in accordance with Table 1607.6.4B.

W_c = The operating weight of the mechanical, electrical component or system.

Alternatively, the seismic forces, F_p, are to be determined by a properly substantiated dynamic analysis subject to approval by the building official.

EXCEPTION: Bracing of fire sprinkler systems shall be permitted to be in accordance with NFiPA 13 in buildings sited where the effective peak velocity-related acceleration, A_v, is less than 0.20.

1607.6.4.1 Component period. The fundamental period of the component and its attachments, (T_c), in seconds, shall be determined by the following formula:

$$T_c = 0.32 \sqrt{\frac{W_c}{K}}$$

Where:

W_c =Weight of the component (lbs)

For stable resilient mounting attachments:

K = Spring stiffness constant (lb/in)

For other resilient mounting attachments:

K = Slope of the load vs. deflection curve (lb/in) at the point of loading.

Alternatively, the fundamental period of the component, in seconds, (T_c), is to be determined by experimental test data or by a properly substantiated analysis.

1607.6.4.2 Component attachment. Systems, components and the means of their attachment shall be designed to accommodate relative seismic displacements between points of support. Displacements at points of support shall be determined in accordance with 1607.4.5 or 1607.5.8. Relative lateral displacements at points of support shall be determined considering the difference in elevation between the supports and considering full out-of-phase displacements across portions of the building that are capable of moving in a differential manner such as at seismic and expansion joints. Anchor bolts shall be designed for combined shear and tension. Restraining devices shall be provided to limit the horizontal and vertical motions, to prevent component resonance, and to prevent overturning.

1607.6.4.3 Component certification. When direct component attachment is used for components with performance criteria factors, (P), of 1.0 or greater, in buildings assigned an effective peak velocity-related acceleration, (A_v), equal to or greater than 0.15 per 1607.1, the manufacturer's certification of the component seismic acceleration operational capacity which meets the requirements of 1607.6.4 shall be submitted to the building official.

Table 1607.6.4A
Mechanical Electrical Component And System Seismic Coefficient (Cc) and Performance Criteria Factor (P)[1]

Mechanical, Electrical Component or System		Component or System Seismic Coefficient (C_c)	Performance Criteria Factor (P)		
			Seismic Hazard Exposure Group		
			I	II	III
1.	Fire protection equipment and systems	2.0	1.5	1.5	1.5
2.	Emergency or standby electrical systems	2.0	1.5	1.5	1.5
3.	Elevator drive, suspension system and controller anchorage	1.25	1.0	1.0	1.5
4.	General equipment				
	A. Boiler, furnace, incinerators, water heaters, and other equipment using combustible energy sources or high-temperature energy sources. B. Communication systems. C. Electrical bus ducts and primary cable systems[2]. D. Electrical motor control centers, motor control devices, switchgear, transformers and unit substations. E. Reciprocating or rotating equipment. F. Tanks, heat exchangers, and pressure vessels.	2.0	0.5	1.0	1.5
5.	Manufacturing and process machinery	0.67	0.5	1.0	1.5
6.	Pipe systems				
	Gas and high hazard piping	2.0	1.5	1.5	1.5
	Fire suppression piping	2.0	1.5	1.5	1.5
	Other pipe systems[3]	0.67	Not Required	1.0	1.5
7.	HVAC ducts[4]	0.67	Not Required	1.0	1.5
8.	Electrical panel boards	0.67	Not Required	1.0	1.5
9.	Lighting fixtures[5]	0.67	0.5	1.0	1.5

Notes:

1. See 1607.6 for general exceptions.
2. Electrical conduit seismic restraints are not required for any one of the following conditions:
   a. Conduit suspended by individual hangers 12 inches (305 mm) or less in length from the top of the conduit to the supporting structure.
   b. Conduit which has less than 2 1/2 inches inside diameter.
3. Seismic restraints are not required for any one of the following conditions for other pipe systems:
   a. Piping suspended by individual hangers 12 inches (305 mm} or less in length from the top of the pipe to the supporting structure.
   b. Piping in boiler and mechanical rooms which has less than 1 1/4 inch inside diameter.
   c. Piping in other areas which has less than 2 1/2 inches inside diameter.
4. Seismic restraints are not required for any one of the following conditions for HVAC ducts:
   a. Ducts suspended by hangers 12 inches (305 mm) or less in length from the top of the duct to the supporting structure.
   b. Ducts which have a cross-sectional area less than 6 sq ft (0.56 m^2).
5. Pendulum lighting fixtures shall be designed using a component seismic coefficient, (C_c), of 1.5. The vertical support shall be designed with a factor of safety of 4.0.

Table 1607.6.4B
Attachment Amplification Factor (a_c)

Component mounting system (a_c)	Attachment amplification factor
Fixed or direct connection	1.0
Resilient mounting system	
Seismic activated restraining device	1.0
Elastic restraining device where:	
$T_C/T < 0.6$ or $T_C/T > 1.4$[1]	1.0
$T_C/T > 0.6$ or $T_C/T <> 1.4$[1]	2.0

Note:
1. T is the fundamental period of the building in seconds determined by 1607.4.1.2 or 1607.5.4. T_C is the fundamental period in seconds of the component and its attachment determined by 1607.6.4.1.

1607.6.5 Elevator design requirements. The design and construction of elevators and elevator components in buildings assigned to seismic performance category D or E, according to 1607.1, shall comply with the requirements of ANSI/ASME A17.1, Appendix F.

1607.7 Provisions for seismic inspection and testing are contained in 1708.

1608 SPECIAL LOADS

1608.1Soil Pressures

1608.1.1 Basement Walls. In the design of basement walls and similar approximately vertical structures below grade, provisions shall be made for lateral pressure of adjacent soil. Due allowances shall be made for possible surcharge from fixed or moving loads.

1608.1.2 Basement Floors. In the design of basement floors and similar approximately horizontal constructions below grade, the upward pressure of water, if any, shall be taken as the full hydrostatic pressure applied over the entire area. The hydrostatic head shall be measured from the underside of the construction.

1608.2 Railings

1608.2.1 Handrail Design and Construction.

1608.2.1.1 Handrails shall be designed and constructed for a concentrated load of 200 lb (890 N) applied at any point and in any direction.

1608.2.1.2 Handrails located other than within dwelling units shall also be designed and constructed for a load of 50 plf (730 N/m) applied in any direction.

1608.2.1.3 Loading conditions in 1608.2.1.1 and 1608.2.1.2 shall not be applied simultaneously, but each shall be applied to produce maximum stress in each of the respective components or any of the supporting components.

1608.2.2 Guardrail System Design and Construction.

1608.2.2.1 Guardrail systems shall be designed and constructed for a concentrated load of 200 lb (890 N) applied at any point and in any direction at the top of the guardrail.

1608.2.2.2 Guardrail systems located other than within dwelling units shall be designed and constructed for a load of 50 plf (730 N/m) applied horizontally at the required guardrail height and a simultaneous load of 100 plf (1459 N/m) applied vertically downward at the top of the guardrail.

1608.2.2.3 The guardrail system shall also be designed and constructed to resist a 200 lb (890 N) concentrated horizontal load applied on a 1 ft square area (0.093 m^2) at any point in the system including intermediate rails or other elements serving this purpose.

1608.2.2.4 Loading conditions in 1608.2.2.1, 1608.2.2.2 and 1608.2.2.3 shall not be applied simultaneously, but each shall be applied to produce maximum stress in each of the respective components or any of the supporting components.

1608.2.3 Parking Guardrails. Impact guardrails and walls acting as impact guardrails in automobile parking garages shall be designed for a minimum horizontal ultimate load of 10,000 lb (44.5 kN) applied 18 inches (457 mm) above the floor at any point along the guardrail.

1608.3 Helistops/Heliports

In addition to other design requirements of this chapter, heliport and helistop landing or touchdown areas shall be designed for the maximum stress induced by the following:

1. Dead load plus actual gross weight of the helicopter plus snow load.
2. Dead load plus two single concentrated impact loads approximately 8 ft (2438 mm) apart anywhere on the touchdown pad (representing each of the helicopter's two main landing gear, whether skid type or wheeled type), with each concentrated load covering 1 sq ft (0.093 m^2) and having a magnitude of 0.75 times the gross weight of the helicopter. Both loads acting together total 1.5 times the gross weight of the helicopter.
3. The dead load plus a uniform live load of 60 psf (2873 Pa).

1609 LOAD COMBINATIONS

1609.1 Allowable Stress Design

Every building clement shall be provided with sufficient strength to resist the most critical effects resulting from the following combinations of loads:

1. Dead +Floor Live[1] + Roof Live (or Snow)[2].
2. Dead +Floor Live[1] + Wind (or Seismic).
3. Dead +Floor Live[1] + Wind + 1/2 Snow[2].
4. Dead +Floor Live[1] + 1/2 Wind + Snow[2].
5. Dead+ Floor Live[1] + Snow[3] +Seismic.

Notes:

1. Floor live load shall not be included where its inclusion results in lower stresses in the building element under investigation.
2. Crane loads need not be combined with roof live load nor with more than 3/4 of snow load or 1/2 wind load.
3. Snow loads over 30 psf (1.44 kPa) may be reduced no more than 80% upon approval of the building official. Snow loads 30 psi (1.44 kPa) or less need not be combined with seismic.
4. Loads for load cases involving wind or seismic may be multiplied by combination factor of 0.75. Where allowed by the referenced material design standard, load duration factors (based on lime duration of the load) may be used, in addition to the above referenced combination factors, to design members but not connections.

Load combinations in 1609.2 shall be used in lieu of load combinations 2 and 5 when allowable stresses are increased for seismic design in accordance with Chapters 21 and 22.

1609.2 Strength Design

Except for load combinations which include seismic, load factors for ultimate strength design of concrete and plastic design or LRFD of steel shall be as indicated in the appropriate design standards referenced in this code. For load combinations which include seismic loads, every building element shall be provided with sufficient strength to resist the most critical effects resulting from the following combinations of loads.

1. $(1.1 + 0.5A_v >$ Dead + Floor Live + (0.7) Snow[1] + Seismic.

2. $(0.9 - 0.5A_v >$ Dead + Seismic

3. $(0.9 - 0.5A_v)$ Dead + (2R/5) Seismic[2,3]

For columns supporting discontinuous lateral force-resisting elements, the axial compression in the columns shall be computed using the following load combination:

4. $(1.1 + 0.5A_v)$ Dead + Live + 0.7 Snow [1] ± (2R/5) Seismic[3]

The axial forces in such columns are not required to exceed the capacity of other elements of the structure to transfer such loads to the column.

Where:

A_v = The seismic coefficient representing effective peak velocity-related acceleration in accordance with 1607.1.5.

R = The response modification factor of the seismic-resisting system from Table 1607.3.3.

Notes:

1. The load factor may be reduced to zero where the ground snow load is less than 30 psi. The load factor may be reduced to 0.2 where the ground snow load is equal to or greater than 30 psf.
2. Applies to building structural systems which have unreinforced masonry, horizontal prestressed members assigned to Seismic Performance Category D or E (See 1607.3.6.4), or building structural systems with low ductility.
3. 2R/5 shall be greater than or equal to 1.0.

1610 DEFLECTIONS

Deflections of structural members shall not exceed that shown in Table 1610.1.

Table 1610.1
Deflection Limits1, 2, 3, 4, 5

Construction	LL	DL + LL
Roof member supporting plaster, or floor member	L/360	L/240
Roof members supporting nonplastered ceiling	L/240	L/180
Roof members not supporting ceiling	L/180	L/120
Exterior and interior walls and partitions with brittle finishes	L/240	---
Exterior and interior walls and partitions with flexible finishes	L/120	---
Farm buildings	---	L/180
Greenhouses	---	L/120
Masonry veneer on steel stud walls	L/600	---

LL = Live load
DL = Deal load
L = Length of member in same units as deflection

Notes:

1. Concrete structural members shall be governed by ACI 318.
2. For structural roofing and siding made of formed metal sheets, the total load deflection shall not exceed L/60. For secondary structural members to which formed metal roofing or siding is attached, the live load deflection shall not exceed L/150 for roofs and L/90 for walls. For roofs, this exception applies only when the metal sheets have no roof covering.
3. The above deflections do not ensure against ponding. Roofs not having sufficient slope or camber to assure adequate drainage shall be investigated for ponding.
4. Flexible, folding, and portable partitions under 6 ft in height are not governed by the provisions of this section.
5. See 2406 for glass supports.

1611 MANUFACTURED HOMES

Provisions for manufactured home tie downs are contained in the NC Regulations for Manufactured/Mobile Homes. These provisions are applicable only where included in the adopting ordinance.

CHAPTER 17

STRUCTURAL TESTS AND INSPECTIONS

1701 GENERAL

1701.1Scope

Provisions of this chapter shall govern structural tests and inspections of materials, assemblies, and construction to determine structural adequacy and protection.

1701.2 Tests

The building official may require a load test of any construction whenever there is a reason to question its safety for the intended use. Such tests are to be made at the expense of the owner or his agent. The testing shall be done by an approved testing laboratory, or under the supervision of a registered architect or engineer. Load tests are not required for construction that has been designed in accordance with applicable standards listed elsewhere in this code unless the construction has been damaged or there is reason to question the safety of the construction. Nothing in this chapter shall be deemed to modify load test procedures that are included in design standards referenced elsewhere in this code.

1702 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

1703 TEST REPORTS

Copies of the test procedure and the test report shall be submitted to the building official. The number of copies to be submitted shall be determined by the building official. As a minimum the test report shall identify the test procedure used, a detailed description of the construction tested, the various load capacities for which the construction was tested, and the type of failure observed.

1704 ALLOWABLE LOADS AND ALLOWABLE STRESSES

1704.1 Allowable Loads

1704.1.1 For a specific in-place construction the allowable load may be determined by testing, provided the testing is in conformance with this chapter.

1704.1.2 Load tests may be used to determine the allowable load for a construction or construction components that will be manufactured in quantities, provided a load is selected so that at least 95% of the construction or construction components will have load tests that are equal to or greater than the selected load. The selected load shall be modified by a factor of safety to establish the allowable load, or the load shall be used with load factors and strength reduction factors. Where standards exist, the established allowable load shall not exceed the allowable load determined by the standard.

1704.2 Allowable Stresses

1704.2.1 Load tests for a specific in-place construction are not intended to be used as a method for determining acceptable allowable working stresses of a material as an alternate to the established standard method of determining such stresses.

1704.2.2 Load tests may be used to determine the allowable stresses for a construction or construction components that will be manufactured in quantities, provided a stress is selected so that at least 95% of the construction or construction components will have a stress that is equal to or greater than the selected stress. The selected stress shall be modified by a factor of safety to establish the allowable stress, or the stress shall be used with load factors and strength reduction factors. Where standards exist, the established allowable stresses shall not exceed the allowable stresses determined by the standard.

1704.3 Inclusion Limit

1704.3.1 The determination of the load or stress at the 95% value shall be based on a confidence level of at least 75%.

1704.3.2 If the construction or construction components have a nationally recognized standard that establishes an inclusion limit different than the 95% value, the inclusion limit in the standard shall be used instead of the 95% value.

1705 LOAD AND DEFLECTION

1705.1Load

The live load, dead load, and wind load shall be at least equal to that required in Chapter 16. The construction shall sustain, without structural failure or excessive deflection, a superimposed load equal to two times the live load.

1705.2 Deflection

The maximum deflection of the construction shall be limited by Table 1610.1. The construction shall recover at least 75% of its maximum deflection within 24 hours after the load is removed.

1706 TEST PROCEDURE

1706.1Established Test Procedures

The construction shall be tested in accordance with one or more of the following test procedures:

ANSI Z97.1, Methods of Test for Safety Glazing Material Used for Buildings

ASTM D 1143, Testing Piles Under Static Axial Compressive Load

ASTM D 1761, Testing Mechanical Fasteners in Wood

ASTM D 3689, Testing Individual Piles Under Static Axial Tensile Load

ASTM E 72, Conducting Strength Tests of Panels for Building Construction

ASTM E 196, Gravity Load Testing of Floors and Flat Roofs

ASTM E 330, Test Methods for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure

ASTM E 447, Test Methods for Compressive Strength of Masonry Prisms

1706.2 Other Test Procedures

In the absence of an established test procedure governing any specific material or construction, the building official may recognize a test procedure that is established by a nationally recognized organization in the business of establishing test procedures or where no test procedure exists may accept authenticated reports from recognized sources which meet the requirements of this code.

1707 MATERIALS AND ASSEMBLY TESTS

1707.1 Concrete

The test procedure, test load, and acceptance criteria of ACI 318 shall be used for reinforced concrete structures.

1707.2 Glass

The test procedure, test load, and acceptance criteria for glass subjected to either impact loads or wind loads shall be in accordance with 2405.

1707.3 Wood

1707.3.1 Joist hangers, framing anchors, and similar devices shall be tested in accordance with ASTM D 1761 and be labeled and listed for their load-carrying capacity. The allowable direct load capacity shall be the lower value determined by 1707.3.1.1, 1707.3.1.2, 1707.3.1.3, 1707.3.1.4 or 1707.3.1.5. The allowable direct load capacity shall be for a normal duration of loading if limited by 1707.3.1.4 or 1707.3.1.5. The loads calculated in 1707.3.1.4 and 1707.3.1.5 may be increased for load duration, as allowed by the National Design Specification for Wood Construction, as long as they do not exceed the direct load from 1707.3.1, 1707.3.2 and 1707.3.3. Sections 1707.3.1, 1707.3.2 and 1707.3.3 are maximum direct loads and no load duration increase is allowed. The design values of metal fastening devices as determined by the provisions of Chapter 22 shall not be exceeded.

1707.3.1.1 When each individual ultimate direct load does not vary from the average ultimate load of three tests by more than 20%, the allowable direct load shall be the lowest ultimate direct load divided by three.

1707.3.1.2 When at least one of the ultimate direct loads varies from the average ultimate load by more than 20%, at least six tests shall be performed. The allowable direct load shall be the average of the ultimate direct loads divided by six.

1707.3.1.3 The allowable direct load shall be the direct load at which the vertical movement of the joist with respect to the header is 1/8 inch (3.2 mm) in any test.

1707.3.1.4 The allowable direct load shall be the allowable design for nails or other fasteners used to secure the device to wood members.

1707.3.1.5 The allowable direct load shall be the allowable design load for the wood members forming the connection.

1707.3.2 Allowable torsional moment capacity for joist hangers shall be the average torsional load at which the lateral movement of the top or bottom of the joist with respect to the original position of the joist is 1/8 inch (3.2 mm) based on a minimum of at least three tests.

1707.3.3 Wood structural panels shall conform to U.S. Product Standards PS 1 or PS 2. Wood structural panels of species or construction not covered in PS 1, when used structurally, shall meet the performance standards in U.S. Product Standard PS 2 for its type.

1707.4 Exterior Window and Door Assemblies

The design window pressure shall be calculated in accordance with Chapter 16. Each assembly shall be tested and listed for a time period equal to the quantity 3600/V, where the time period is in seconds and V is in miles per hour taken from Figure 1606. The time period shall include a 10 second period at a load equal to 1.5 times the design pressure.

1707.5 Concrete and Clay Roof Tiles

1707.5.1 Overturning Resistance. Concrete and clay roof tiles shall be tested to determine their resistance to overturning in accordance with the SBCCI SSTD 11-93.

1707.5.2 Wind Tunnel Testing. When roof tiles do not satisfy the limitations in Chapter 16 for rigid tile, a wind tunnel test may be used to determine the wind characteristic of the concrete or clay tile roof covering in accordance with the SBCCI SSTD 11-93.

1708 SEISMIC INSPECTIONS AND TESTING

1708.1General

Evidence of inspection and testing required in 1708 shall be furnished to the building official by the building owner in accordance with 105.3.

1708.2 Structural Steel Welding

1708.2.1 Welding of the structural seismic resisting system of buildings assigned to Seismic Performance Category C, hazard exposure group II or III by 1607.1.8 shall be inspected in accordance with this section. Each complete penetration groove weld in joints and splices shall be tested for the full length of the weld either by ultrasonic testing or by other approved methods, for special moment frames and eccentrically braced frames.

EXCEPTION: The nondestructive testing rate for welds made by an individual welder is permitted to be reduced to 25% of the welds, with the approval of the design professional responsible for the structural design, provided the weld inspection reject rate is 5% or less.

1708.2.2 Column splice welds, which are partial penetration groove welds, shall be tested by ultrasonic testing or other approved methods at a percentage rate established by the design professional responsible for the structural design. All partial penetration column splice welds designed for axial or flexural tension from seismic forces shall be tested.

1708.2.3 Base metal having a thickness more than 1.5 inches (38 mm) and subject to through-thickness weld shrinkage strains shall be ultrasonically tested for discontinuities behind and adjacent to the welds after joint welding. Any material discontinuities shall be evaluated based on a criteria established on the design drawings or the specifications by the design professional responsible for the structural design.

1708.3 High-Strength Bolts

Installation and tightening of high-strength bolts shall be periodically inspected in accordance with AISC specifications listed in 2203.

1708.4 Reinforced Concrete

In buildings assigned to Seismic Performance Category C, hazard exposure group II or III by 1607.1.8, the following inspections shall be provided for reinforced concrete construction:

1. Weldability of reinforcement that conforms to ASTM A 706 shall be determined in accordance with the requirement of 1903.5.2 for all reinforcement used in special moment frame, ordinary moment frames and boundary members of shear walls.
2. Location and installation details of reinforcing and prestressing steel in special moment frames, ordinary moment frame and shear walls.
3. During the welding of reinforcing in the structural seismic resisting system.
4. During placement of concrete in frames and shear walls.
5. During the stressing and grouting of bonded prestressing tendons in the structural seismic resisting system.

1708.5 Masonry Construction

In buildings assigned to Seismic Performance Category C, hazard exposure group II or III by 1607.1.8, inspection of welding of reinforcement, location and installation details of reinforcing in reinforced masonry shear walls, grouting, consolidation and reconsolidation shall be performed.

1708.6 Wood Construction

Inspection is required for nailing, bolting, structural gluing, or other fastening of the structural seismic resisting system of buildings assigned to Seismic Performance Category C, hazard exposure group II or III by 1607.1.8.

1708.7 Foundations

Inspection is required for pier and pile foundations of buildings assigned to Seismic Performance Category C, hazard exposure group II or Ill by 1607.1.8.

1708.8 Wall Panels and Veneers

Inspection is required for exterior and interior architectural wall panels and the anchoring of veneers for buildings assigned to Seismic Performance Category E by 1607.1.8.

1708.9 Mechanical and Electrical Components

Mechanical and electrical components shall be inspected, tested and certified as indicated in this section, when located in buildings assigned to Seismic Performance Category E by 1607.1.8.

1708.9.1 Inspection is required for the installation of the following components when the component has a performance criteria factor or 1.0 or 1.5 by 1607.1.8:

1. Equipment using combustible energy sources.
2. Electrical motors, transformers, switchgear unit substations, and motor control centers.
3. Reciprocating and rotating type machinery.
4. Piping distribution systems, 3 inches (76 mm) and larger.
5. Tanks, heat exchangers, and pressure vessels.

1708.9.2 The component manufacturer shall test or analyze the component and its mounting system or anchorage for the design forces in 1607.6.4 for those components having a performance criteria factor of 1.0 or 1.5 by 1607.6.4. The manufacturer shall submit a certificate of compliance for review and acceptance by the design professional responsible for the design and for approval by the building official. The basis of certification shall be by test on a shaking table, by three dimensional shock tests, by an analytical method using dynamic characteristics and forces from 1607.6.4 or by more rigorous analysis. The inspector shall inspect the component and verify that either its label or its anchorage or mounting conform to the certificate of compliance.

1708.9.3 Each manufacturer of equipment to be placed in a building assigned to Seismic Performance Category E by 1607.1.8 where the equipment has a performance criteria factor of 1.0 or 1.5 by 1607.6.4 shall maintain an approved quality control program. Evidence of the quality control program shall be permanently marked on each piece of equipment.

1709 INSPECTION OF SPRAYED MATERIALS FOR FIRE RESISTANCE

1709.1 Thickness and Density

1709.1.1 Sprayed fibrous and cementitious materials used for structural fire resistance shall provide the fire resistance ratings set forth in this code. The density and thickness shall be determined in accordance with 1709.1.2 and 1709.1.3.

1709.1.2 Thickness measurement and acceptance criteria:

1. 25% of the structural frame, columns and beams in each story shall be inspected for thickness determination in accordance with ASTM E 605.
2. 10% of beams (other than structural frame members) on each floor shall be selected at random and shall be measured for thickness as required by these methods.
3. Floor thickness measurements, where required, shall be taken on a random basis for each 10,000 sq ft (929 m^2) of area.
4. The average thickness as determined by this procedure shall not be less than that specified in inches (millimeters) subject to a tolerance of ± 1/8 inch (3.2 mm). The acceptance of measurements with a minus tolerance greater than 1/8 inch (3.2 mm) shall not be permitted. Measurements greater than 1/8 inch (3.2 mm) above the required shall not be used to determine the thickness average.

   EXCEPTION: When installed within tolerances allowed by publications listed in 701.4.2.
5. Where thicknesses are less than that required, the condition shall be corrected. The location of any uncorrected areas shall be reported to the building official.

1709.1.3 Density measurement and acceptance criteria:

1. There shall be density test specimens taken from a column, a beam and a deck for each 10,000 sq ft (929 m^2) of floor area or fraction thereof or from each floor if the floor area is smaller than 10,000 sq ft (929m^2) in accordance with ASTM E 605.
2. No density sample shall have a density less than 5% below the specified density. Where the density is less than the 5% tolerance allowed above, the work shall be corrected to the satisfaction of the building official.

CHAPTER 18

FOUNDATIONS AND RETAINING WALLS

1801 GENERAL

1801.1 The following sections outline minimum criteria that have, in the past, been found suitable for application to soils existing in North Carolina. These criteria are by necessity very general and are minimal for average soil conditions. It is strongly emphasized that North Carolina has variable sub-surface conditions from one Geological Province to another and that there is frequently considerable variation within a single Province. Therefore, building foundation designs, excavation bracing designs, and lateral earth pressure designs shall be based on the results of a subsurface investigation at the building site. The investigations made shall be planned and supervised by the designer who shall be responsible for the interpretation of the field and laboratory tests results.

1801.1.1 The term "designer" as used in this chapter shall be interpreted as meaning a Professional Engineer or Architect qualified in Geotechnical Analysis, or his authorized representative.

1801.1.2 The intent of the following sections is to provide conservative design parameters, for consideration by designers unfamiliar with the local soil conditions, to use in preliminary design when adequate test data cannot be obtained and to guide local code enforcement officials (CEO). Higher design soil stresses and structural material stresses may be allowed by the CEO when adequate test data, calculations, and/or other supporting information is submitted by the designer. The upper limit for design of foundation units shall be based on the maximum structural material stresses allowed by this code.

1801.2 Inspection

1801.2.1 General. Subsurface conditions not anticipated from the pre-design investigation but exposed during construction shall be brought immediately to the attention of the designer. The owner or his representative shall have the designer of record or equally qualified design professional inspect the construction of all retaining walls, shallow footings, piles, caissons, or other foundation support systems.

1801.2.2 Reports. The reports of all inspections and any field or laboratory test data shall be submitted to the CEO at his request.

1801.2.3 Retaining Walls. Inspection of retaining wall construction shall consist of observation and, in the case of walls exceeding 5’-0” in height, testing as required for: (1) The foundation support system as outlined in 1801.2.4, 1801.2.5, and 1801.2.6; (2) Measurement of the quality of construction materials for conformance with specifications; (3) Determination of similarity of actual soil conditions to those anticipated in the design; (4) Examination of backfill materials and any drainage systems for compliance with plans and specifications.

1801.2.4 Footing or Mats. Inspection and, if necessary, testing of footing or mat excavations shall be made to confirm the presence of foundation materials similar to those assumed in the design. The bearing materials shall be evaluated for both vertical and horizontal continuity and for the strength and compressibility parameters on which the design bearing pressure was based. Unanticipated conditions shall be evaluated by the designer to determine any necessary design modifications. Field change to the design drawings shall be documented and submitted to the CEO at his request.

1801.2.5 Piling. Based on the initial pile installation and any pile load test(s) results, criteria for minimum piling embedment and minimum driving resistance shall be established for production piles and the CEO shall be notified of the final driving criteria. The installation of all production piles shall be inspected by the designer and shall meet these criteria. All piles driven for load testing shall be driven under the direct observation of the designer. Complete driving records for each production pile shall be kept and identified by pile number and location. A plan showing clearly the designation of each individual pile by an identifying system shall be prepared and attached as part of the permanent record of the pile inspection. The tip and butt elevation, type of pile, and its conditions shall also be recorded. The type, size, and working condition of the driving hammer, the type of cushioning and the addition of new cushion material, as well as any unusual characteristics of the pile, driving procedure, or operating function of the hammer shall be recorded. A summary report on the pile installation shall be submitted to the CEO at his request.

1801.2.6 Drilled Piers.

1801.2.6.1. The owner or project manager shall have the designer of record inspect all caisson or drilled piers. The inspection shall include entering each excavation, except when using the wet method of installing drilled piers or caissons, and inspect the exposed bearing material for adequate bearing capacity, continuity, and cleanliness. General attention shall be given to the stability of the walls of belled piers for the possibility of sloughing when concrete is placed and liners removed. Each pier shall be identified by number and location and the pertinent data recorded; including any exceptions to the plans and specifications.

1801.2.6.2 The owner or project manager shall have the designer observe the placing of any steel, the influx of ground water from the time of last inspection to the time of pour, and the pulling of liners as the pour takes place. On any pier where sloughing of the sidewalls and/or influx of water causes serious doubts about the continuity of the concrete shaft, the full length of the shaft shall be cored to evaluate its condition. A summary report on the caisson or drilled pier installation shall be submitted to the CEO at his request.

1802 DEFINITIONS

The following words and terms shall, for the purposes of this chapter and as stated elsewhere in this code, have the meanings shown herein. Refer to Chapter 2 for general definitions.

HARD WEATHERED ROCK – Broken and partially weathered rock of sufficient hardness to refuse soil sampling tools; normally has Standard Penetration resistance (ASTM D 1586) in excess of 50 blows per inch.

SOFT WEATHERED ROCK – Broken and partially weathered rock with Standard Penetration resistance (ASTM D 1586) between 50 blows per six inches and 50 blows per inch.

HARD RISIDUAL SILT/DENSE SAND – Mechanically undisturbed rock that has been chemically weathered to such state or condition that it can be drilled with soil boring tools but yet retains the texture and structure of the parent material; normally has Standard Penetration resistance (ASTM D 1586) in excess of 50 blows per foot.

RESIDUAL SILT/SAND – Extensively weathered residual soil material retaining the general structural pattern of the parent rock. Breaks down to cohesionless, silt/sand sized particles with slight remolding; medium to low values of Standard Penetration resistance, frequently micaceous.

1803 EXCAVATION

1803.1 General

1803.1.1 Investigation. A subsurface investigation shall be conducted at the site. Soil properties used in the analysis shall be selected on the basis of a reasonable number of tests. When excavating for buildings or excavations accessory thereto, such excavations shall be made safe to prevent danger to life and property.

1803.1.2 Permanent Walls. Permanent excavations shall have retaining walls of such strength as to prevent movement or caving of the adjoining soil and any surcharged loads on that soil.

1803.1.3 Limits or Excavations. Excavation for any purpose shall not extend closer than 1 foot to a surface drawn at 45 degrees to the horizontal through the lower edge of any adjacent existing footing or foundation, unless such footing or foundation is first properly underpinned or otherwise protected against movement.

1803.2 Support Of Adjoining Structures

1803.2.1 Notice to Adjacent Owners. Notice to the owner of adjoining buildings or structures shall be served at least 30 days before an excavation is commenced, and it shall state the depth and location of the proposed excavation.

1803.2.2 Excavations 10 Feet Deep or Less. When an excavation extends not more than 10 feet below the established curb grade nearest the point of excavation under consideration, the owner of the adjoining building or structure, the footings or foundations of which are to be underpinned or protected under the requirements of this section, shall be notified in writing by the one causing the excavation to be made. The owner of the adjoining structure or building shall be afforded the necessary license to enter the premise where the excavation is to be made, and at his own expense, shall provide the necessary underpinning or protection.

1803.2.3 Excavations More Than 10 Feet Deep. When an excavation extends more than 10 feet below the established curb grade nearest the point of excavation under consideration, the one causing the excavation to be made, if given the necessary license to enter the adjoining premises, shall provide at his own expense the underpinning and protection required by that part of the excavation which extends to a depth greater than 10 feet below the established curb grade nearest the point of excavation under consideration, whether or not the existing footings or foundations extend to the depth of 10 feet or more below the curb grade; or he may shore and brace the sides of his excavation so as to prevent effectively any soil movement into his excavation. If the necessary license is not afforded the person causing the excavation to be made, it shall be the duty of the owner failing to afford such license to provide the required underpinning or protection, for which purpose he shall be afforded the necessary license to enter the premises where such excavation is to be made.

1803.2.4 Establishment of Curb Grade. If there is no established curb grade, the depth of excavation shall be referred to the level of the ground at the point under consideration. If any existing building or structure, the footings or foundations of which are required to be underpinned or protected, is so located that the curb grade level to which it is properly referred is at a higher level than the level to which the excavation is properly referred, then such part of the required underpinning or protection that is necessary due to the difference in these levels shall be made and maintained at the joint expense of the owner of the building or structure and the person causing the excavation to be made. For the purpose of determining such part of the underpinning, or protection that is necessary due to such difference in levels, the level to which a building more than five feet back of the street line is properly referred shall be considered to be the level of the natural ground surfaces adjoining the building or structure.

1803.2.5 Party Walls. A party wall which is in good condition and otherwise suitable for continued use, shall be underpinned or protected as required at the expense of the person causing the excavation to be made.

1803.2.6 Protection During Entry. Where the necessary license has been given to the person making an excavation to enter any adjoining structure for the purpose of underpinning or protecting it, the person receiving such license shall provide for such adjoining structure adequate protection against injury due to the elements resulting from such entry.

1803.2.7 Backfill. Only approved granular materials shall be used for back-fill under this section. It shall be compacted to have a strength sufficient to prevent lateral displacements of the soil of the adjoining property after the removal of the shores or braces. Engineered products may be used in lieu of granular materials when approved by the designer.

1803.2.8 Other Construction Activities. The party making an excavation shall take such action as necessary to prevent movement of or damage to adjacent structures. Adjoining property owners shall be protected against construction activities that include, but are not limited to ground water lowering, vibration, soil densification, surcharges from materials stockpiling and erosion or loss of ground.

1804 FOOTINGS, FOUNDATIONS AND FOUNDATION WALLS

1804.1 General

1804.1.1 Investigation. A subsurface investigation shall be conducted at the site. Soil properties used in the analysis shall be selected on the basis of a reasonable number of tests.

1804.1.2 Design. The areas of all footings and foundations shall be proportioned as specified in 1804.4 and 1804.6. Footings and foundations shall be constructed of masonry, reinforced concrete, or plain concrete.

1804.1.3 All such foundations shall be founded on stable natural soil or controlled compacted fill meeting the values shown in Table 1804.2.2, below the frost line and no less than 12 inches below finished grade.

1804.1.4 Temporary buildings and buildings not exceeding one story in height and 400 sq ft (37 m^2) in area shall be exempt from these requirements.

1804.1.5 Excavations for foundations shall be backfilled with soil which is free of organic material, construction debris, and large rocks.

1804.1.6 Where water impacts the ground from a roof valley, down pout, scupper, or other rain water collection or diversion device, provisions shall be made to prevent soil erosion and direct the water away from the foundation.

1804.1.7 Finish grade shall be sloped away from the foundation for drainage.

1804.1.8 The area under footings, foundations, and concrete slabs on grade shall have all vegetation, stumps, roots, and foreign materials removed prior to their construction. Fill material shall be free of vegetation and foreign material.

1804.2 Soils investigation

1804.2.1 Bearing Capacity From Engineering Analysis. Footings and foundations for structures not meeting the criteria for the use of Presumptive Bearing Values or where suspect soil conditions exist shall be designed for bearing capacity values from an engineering analysis supported by a reasonable number of tests. The types and numbers of tests shall be selected and evaluated by the designer in accordance with standard soil mechanics and foundation engineering practice. The bearing capacity values, as well as any special foundation requirements or conditions shall be shown on the plans by the designer.

1804.2.2 Presumptive bearing pressures may be used, not exceeding the values shown in Table 1804.2.2, provided that all of the following criteria are satisfied.

1. Presumptive bearing pressures are acceptable only for lightly loaded structures where column loads are less than 50 kips per column and wall loads do not exceed 3.0 kips per linear foot.
2. Finished grade, including cut or fill operations, do not differ from the natural grades by more than 5 feet.
3. Sufficient histories of favorable foundation performance are available from adjoining sites for similar loading conditions.

TABLE 1804.2.2
PRESUMPTIVE BEARING CAPACITIES OF VARIOUS SOILS AND ROCKS

Class	Material	Allowable Bearing Value in Tons Per Square Foot[1]
1	Massive igneous or metamorphic rocks all in sound condition (Minor cracks allowed)	100
2	Massive sedimentary rocks (when interbedded, strength shall be determined by weakest member)	20
3	Hard Weathered Rock[3]	30
4	Soft Weathered Rock	15
5	Hard Residual Silt / Dense Sand	5[2]
6	Residual Silt / Sand[3]	1 to 3[2]
7	Dense Sand	3[2]
8	Stiff Clay	2[2]
9	Loose Sand	1[2]
10	Soft Clay	1[2]
11	Compacted Controlled Fill	1.5[2]

Notes:

1. The allowable bearing value given in this section or when determined in accordance with the provisions of 1804.2.1 will assure that the soils will be stressed within limits that lie safely below their strength. However, such allowable bearing pressures for class 6 and class 8 through 11 do not assure that the settlements will be within tolerable limits for a given structure.
2. Alternatively the allowable bearing value may be calculated from soil properties determined by field or laboratory tests.
3. See 1802.

1804.2.3 Bearing Capacities of Soil and Rock. General Footings, combined footings, and mats shall be so designed that the allowable bearing capacities are not exceeded and excessive settlements do not occur. Where the settlement characteristics of the soil are not definitely known, or are in question, the CEO may require field and/or laboratory tests to determine the predicted overall settlement under the loading of the proposed structure. The type, number and location of tests shall be selected and the results evaluated by the designer. Where various portions of the same structure are supported by soils of differing settlement characteristics, special provision shall be made in the design to prevent damaging differential settlements. Either of two methods may be used to determine the appropriate design bearing pressures:

1804.2.3.1 The designer shall determine, based on the available historic data, that the expected settlements are within tolerable limits and that the foundations bear on stable soils. The presumptive values assigned and the required soil type shall be shown on the plans for field verifications.

1804.2.3.2 Where the bearing capacity is judged to be suspect by the CEO, field and/or laboratory tests or other adequate proof of the allowable bearing pressure for the particular location under the loading of the proposed structure may be required.

1804.2.4 Soil Bearing. For the load combinations, including seismic, as specified in 1609 the soil bearing strength shall be sufficient to resist loads, at acceptable strains, considering both the duration of loading and the properties of the soil.

1804.3 Expansive Soils

1804.3.1 General. Footings or foundations for buildings and structures founded on expansive soils shall be designed in accordance with this section. As an alternative to special design, the soil may be removed in accordance with 1804.3.4 or stabilized in accordance with 1804.3.5.

1804.3.2 Soil Tests. In areas likely to have expansive soil, the CEO may require soil tests to determine if such soils do exist. Soils meeting all four of the following provisions shall be considered expansive, except that tests to show compliance with items 1, 2 and 3 shall not be required if the test prescribed in item 4 is conducted:

1. Plasticity Index (PI) of 20 or greater, determined in accordance with ASTM D 4318.
2. More than 10% of the soil particles pass a #200 sieve (75 (m), determined in accordance with ASTM D 422.
3. More than 10% of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D 422.
4. Expansion Index greater than 20, determined in accordance with ASTM D4829 or ASTM D4526.

1804.3.3 Foundations.

1804.3.3.1 Footings or foundations placed on or within the active zone of expansive soils shall be designed to resist differential volume changes and to prevent structural damage to the supported structure. Deflection and racking of the supported structure shall be limited to that which will not interfere with the usability and serviceability of the structure.

1804.3.3.2 Foundations placed below where volume change occurs or below expansive soil shall comply with the following provisions:

1. Foundations extending into or penetrating expansive soils shall be designed to prevent uplift of the supported structure.
2. Foundations penetrating expansive soils shall be designed to resist forces exerted on the foundation due to soil volume changes, be isolated from the expansive soil or maintain a controlled moisture content.

1804.3.3.3 Slab-on-ground, mat or raft foundations on expansive soils shall be designed and constructed in accordance with WRI/CRSI Design of Slab-On-Ground Foundations or PTI Design and Construction of Post-Tensioned Slabs-On-Ground.

EXCEPTION: Slab-on-ground systems which have performed adequately in soil conditions similar to those encountered at the building site may be used if approved by the CEO.

1804.3.4 Removal of Expansive Soil. The expansive soil may be removed to a depth sufficient to assure a constant moisture content in the remaining soil. Expansive soil need not be removed to the depth of constant moisture, provided the confining pressure in the expansive soil created by the fill and supported structure exceeds the swell pressure.

1804.3.5 Stabilization. Stabilization of the active zone of expansive soils may be used when approved by the CEO Soils may be stabilized by approved techniques.

1804.4 Footing Size

1804.4.1 Footings shall be proportioned to sustain the applied loads and induced reactions without exceeding the allowable stresses specified in this code. In no case shall the unit load per square foot under any portion of the footing due to a combined dead, live, wind and/or any other loads exceed the allowable bearing capacities of the soil or rock upon which the footing rests, as determined by 1804.2. The total reduced live load occurring in the column immediately above the footing shall be the live load used in the above computation. Independent column footings shall not be less than 24 x 24 inches and independent wall footings shall not be less than 16 inches in width. Minimum width of edge of turned down slabs shall be 12 inches unless engineering analysis is provided.

1804.5 Foundation Design

1804.5.1 Materials. Concrete in foundations shall have a specified compressive strength (f'_c) of not less than 2500 (17238 kPa) pounds per square inch at age of 28 days. Concrete masonry units shall be Grade N complying with ASTM C 55, C 90, or C 145. Clay masonry units shall conform with ASTM C 62 Grade SW. Mortar shall be Type M or S.

1804.5.2 Concrete Design. The procedure used to design footings shall be in accordance with Chapter 19.

1804.5.3 Masonry Design. Procedure design of footings shall be in accordance with 2103.1 or 2103.2. The cores, if any, in concrete masonry unit footings shall be vertical and shall be filled solidly with Type M or S mortar. Masonry footings shall be laid on a leveling bed of sand or mortar.

1804.5.4 Pier foundation seismic ties. Pier foundations shall be interconnected by ties for buildings assigned to Seismic Performance Category C, D or E, by 1607.1.8. All ties shall be capable of resisting, in tension or compression, a force equal to 25% of the effective peak velocity-related acceleration (A_v) times the column dead plus live load. Individual tie beams are not required when it is demonstrated that equivalent restraint will be provided by structural members within slabs on grade or reinforced concrete slabs on grade or confinement by competent rock, hard cohesive soils, very dense granular soils, or other approved means.

1804.6 Foundation Wall

1804.6.1 General. Foundation walls shall be designed and constructed in accordance with accepted engineering practice. Provisions of 1804.6.2 may be used without additional engineering design.

1804.6.2 Earth Pressures On Walls And Other Permanent Or Temporary Retaining Structures. Every foundation wall or other wall serving as an earth retaining structure shall be designed to resist lateral earth pressure, in addition to any vertical loads acting thereon. The incident lateral earth pressure, any fluid pressures, and any additional horizontal pressure resulting from probable surcharge loads shall be considered in the wall design. In addition to the static pressures, consideration shall be given to the dynamic forces generated by compaction of backfill behind the wall. The designer shall consider the deflection conditions that may occur, both in service and during construction, as well as the properties of the backfill material to be used, in his choice of lateral earth pressures. In some areas of North Carolina swelling soils are present. Any proposed backfill borrow material shall be evaluated and soils with significant swelling potential as determined from tests such as ASTM D 4546 or ASTM D4829 shall not be used.

1804.6.3 Concrete and Masonry.

1804.6.3.1 Foundation walls shall be not less in thickness than the walls immediately above them. Where the height of unbalanced fill (height of finished grade above basement floor or inside grade) and the height between lateral supports does not exceed 8 ft (2438 mm), and where the equivalent fluid weight of unbalanced fill does not exceed 30 pcf (481 kg/m^3), the minimum thickness of foundation walls shall be that shown in Table 1804.6. Maximum depths of unbalanced fill permitted in Table 1804.6 may be increased with the approval of the building official when local soil conditions warrant such an increase. Foundation walls shall be designed in accordance with 2103 or 1901.1.2, where the height of unbalanced fill, the height between lateral supports, or the equivalent fluid weight of unbalanced fill exceeds that listed in this paragraph.

TABLE 1804.6
Thickness of Foundation Walls

Foundation Wall Construction	Normal Thickness, (inches)	Max. Depth of Unbalanced Fill, (feet)
Masonry of Hollow Units, Ungrouted	8	4
	10	5
	12	6
Masonry of Solid Units	8	5
	10	6
	12	7
Masonry of Hollow or Solid Units, Fully Grouted	8	7
	10	8
	12	9
Masonry of Hollow Units Reinforced vertically with #4 bars and grout at 24” o.c. Bars located not less than 4 1/2" from pressure side of wall	8	7
Plain Concrete	7.5	7
	10	8
	12	8

1 in = 25.4 mm
1 ft = 0.305 m

1804.6.3.2 Foundation walls 8 inches (203 mm) thick, except as provided for in 1804.6.3.3, and conforming to the provisions of 1804.6.1 may be used as foundations for dwellings with walls of brick veneer on frame walls or 10-inch (254 mm) cavity walls, provided that the dwelling is not more than two stories high and the total height of the wall, including the gable, is not more than 28 ft (8534 mm). Foundation walls 8 inches (203 mm) thick supporting brick veneer or cavity walls shall be corbeled with solid units to provide a bearing the full thickness of the wall above. The total projection shall not exceed 2 inches (51 mm) with individual corbels projecting not more than one-third the thickness of the unit nor one-half the height of the unit. The top corbel course shall not be higher than the bottom of floor joists and shall be a full header course.

1804.6.3.3 Foundation walls of cast-in-place concrete when supporting one story basementless structures may be 6 inches (152 mm) thick if the total height of the foundation wall and the wall supported is within the allowable height permitted by this code for 6-inch (152 mm) walls.

1804.6.3.4 Pier and wall foundations shall be permitted to be used to support Type VI construction in dwellings not more than two stories in height, provided the following requirements are met:

1. The wall shall be supported on a continuous concrete footing placed integrally with the exterior pier footings.
2. The minimum actual thickness of the wall shall be not less than 3 5/8 inches (92 mm) and integrally bonded into the piers.
3. Piers shall be constructed in accordance with 2103.
4. The maximum height of a 4-inch (102 mm) wall shall not exceed 4 ft (1219 mm).
5. Anchorage shall be provided in accordance with 1606.2.
6. The unbalanced fill for 4-inch (102 mm) walls shall not exceed 24 inches (610 mm) for solid masonry or 12 inches (305 mm) for hollow masonry.

1804.6.3.5 Curtain walls between piers and nonbearing perimeter wall shall be permitted for frame construction and masonry veneer frame construction in dwellings not more than two stories in height, subject to the following limitations:

1. Minimum thickness of the curtain wall shall be 4 inches nominal bonded into the piers and supported on a continuous concrete footing.
2. Masonry bearing piers shall comply with 2103. Pier spacing shall be governed by the beam or girder designed in accordance with 2307.2, maximum spacing of 8 ft (2438 mm) on center. Pier shall provide a true and even bearing surface.
3. Unbalanced fill placed against 4-inch (102 mm) curtain wall shall not exceed 24 inches (610 mm) for solid masonry or 16 inches (406 mm) for hollow masonry.
4. Maximum height of exterior, nonbearing curtain walls of pier and curtain wall construction shall not exceed those shown in Table 2107.1.

1804.6.4 Openings.

1804.6.4.1 Ventilation. Crawl spaces under buildings without basements shall be ventilated by approved mechanical means or by openings in foundation walls. Openings shall be arranged to provide cross ventilation and shall be covered with corrosion resistant wire mesh of not less than 1/4 inch (6.4 mm) nor more than 1/2 inch (12.7 mm) in any dimension. Openings in foundation walls shall be not less than the following:

1. Where wood floor systems are used, such openings shall have a net area of not less than 1 sq ft (0.093 m^2) for each 150 sq ft (14 m^2) of crawl space.
2. Where other than wood floor systems are used, such openings shall be not less than 1 1/2 sq ft (0.14 m^2) of net opening for each 15 linear feet (4572 mm) or major fraction thereof of exterior wall.

3. Where asphalt saturated felt weighing 55 lb (2.7 kg/m^2) per square, lapped at least 2 inches (51 mm) at joints, or 4 mil (0.102 mm) polyethylene lapped at least 4 inches (102 mm) at joints, or other approved vapor retarder is installed over the ground surface, the required net area of openings may be reduced to 10% of that required above. There shall be one ventilation opening within 3 ft (914 mm) of each corner, and these shall be of equal site totaling a minimum of 50% of required openings.
4. An operable vent louver shall be permitted only where an approved vapor retarder is installed over the ground surface.
5. Where combustion equipment is installed within a crawl space, air for combustion shall be provided in accordance with 705.1.1.4, 2810, and Chapter 7 of the Standard Mechanical Code.

1804.6.4.2 Access. Usable crawl spaces under buildings without basements shall be provided with a minimum of one access opening not less than 18x24 inches (457x610 mm). Access openings shall he readily accessible and provided with a door or device that may be easily removed or operated. For access to mechanical equipment installed in underfloor areas see Section 304.5 of the Standard Mechanical Code.

1804.6.5 Masonry with Type VI Construction. Foundation walls of hollow masonry supporting Type VI construction shall be capped with 4 inches (102 mm) of solid masonry or concrete or shall have cavities of the top course filled with concrete or grout unless a sill plate of 2-inch (51 mm) nominal thickness bears on both face shells.

1804.7 Wood Foundations

1804.7.1 Wood Foundations. Wood foundations are permitted for buildings of Type VI construction when the requirements of 1804.7.2 through 1804.7.4 are met.

1804.7.2 The foundation shall be designed, fabricated, and installed in accordance with the provisions of NFoPA Technical Report No. 7. with the following exceptions:

1. The minimum thickness of the stone layer under the footing shall be 12 inches.
2. For design purposes, the maximum allowable soil bearing pressure shall be 2000 pounds per square foot and the lateral loads from the soil shall be based on a minimum equivalent-fluid weight of 40 pounds per cubic foot for sandy oils and 50 pounds per cubic foot for clayey soils or as determined by a Professional Engineer who is experienced in soils engineering.
3. Adequate anchorage shall be provided to transfer all wind and soil pressures into supporting soil.
4. Foundation shall not be used for basements when the basement sump pit does not freely drain by gravity to grade or a storm sewer. Sump pumps are not permitted.

1804.7.3 Design shall be performed by a Professional Engineer whose seal shall be affixed to all foundation drawings.

1804.7.4 Materials, fabrication and installation shall be inspected and a certificate of compliance furnished by either a Professional Engineer or by an independent third party inspection agency approved by the North Carolina Building Code Council for this type of service.

1805 PILES

1805.1.1 Investigation. A subsurface investigation shall be conducted at the site to examine both the material in which the piles will be embedded and the underlying materials that will be significantly stressed by the pile foundation. The design pile lengths and capacities shall be selected on the basis of a reasonable number of soil and/or pile load test. See 3107 for additional requirements in coastal and flood plain areas.

1805.1.2. Subsurface Evaluation. Pile foundations for structures not meeting the criteria for the use of presumptive pile capacity values or when suspect soil conditions exist shall be designed for capacities determined by an engineering analysis based on a reasonable number of soil tests. The type and number of tests shall be elected and evaluated by the designer in accordance with standard soil mechanics and foundation engineering practice. The design pile capacities as well as any special foundation requirements or conditions shall be shown on the plans and attested by the designer. Design capacities determined in accordance with 1805.1.2 shall not exceed 60 tons for piles driven end bearing to materials of Class I nor 40 tons for other soil conditions. If higher design capacities are desired, they shall be determined by the provisions of 1806.

1805.2 Special Types of Foundations. Proprietary or special types of deep foundations not specifically covered in this code, such as piles with a minimum dimensions less than 8 inches or piles installed by methods other than driving, may be used if, in the judgment of the CEO, the proposed design is justified by test data and experience records submitted by the designer. In no case shall the design criteria exceed the limits specified in 1806.

1805.3 Protection of Pile Materials

Where boring records or site conditions indicate possible deleterious action on pile materials because of soil constituents, changing water levels or other factors, the pile materials shall be adequately protected by material, methods or processes approved by the CEO. Protective materials shall be applied to the piles so as not to be rendered ineffective by driving.

1805.4 Lateral Support

1805.4.1 General. Any soil other than fluid soil shall be deemed to afford sufficient lateral support to the pile to prevent buckling and to permit the design of the pile in accordance with accepted engineering practice and the applicable provisions of this code.

1805.4.2 Unbraced Piles. All piles standing unbraced in air, water, or soils not capable of providing lateral support, shall be designed as columns in accordance with the provisions of this code.

1805.5 Group Action. In no case shall the spacing of piles be such that the average stress in the supporting strata will exceed the safe bearing capacity of the supporting strata.

1805.6 Stability. A column or pier supported by piles, unless connected to permanent construction that provides adequate lateral support shall rest on not less than three piles. When the supporting capacity of a single row of piles is adequate for the wall of a structure, effective measure shall be taken to provide for eccentricity and lateral forces, or the piles shall be driven alternately in lines spaced at least one foot apart and located symmetrically under the center of gravity of the loads carried.

1805.7 Structural Integrity. Piles shall be installed in such a manner and sequence as to prevent distortion or damage to piles being installed or already in place to the extent that such distortion or damage affects the structural integrity of the piles.

1805.8 Spacing. The minimum center-to-center spacing of piles shall not be less than twice the average diameter of a round pile, or less than 1.75 times the diagonal dimension of a rectangular or rolled structural steel pipe. For piles driven to materials of Classes 1 through 4, Table 1804.2.2, the minimum spacing shall not be less than 2'-0". For piles driven into materials of Classes 5 through 11, the minimum spacing shall not be less than 2'-6".

1805.9 Splices. Splices shall be such that the resultant vertical and lateral loads at the splices are adequately transmitted. Splices shall be so constructed as to provide and maintain true alignment and position of the component parts of the pile during installation and subsequent thereto. Except for piles that can be visually inspected after driving, splices shall develop not less than 50 percent of the value of the pile in bending. Proper consideration shall be given to the design of splices at sections of piles which may be subject to tension or to bending.

1805.10 Pile Cap Design

1805.10.1 The design and details of pile caps shall be in accordance with Chapter 19 of this code and ACI 318.

1805.10.2 Pile Cap Seismic Connection.

1805.10.2.1 All concrete piles shall be connected to the pile cap for buildings assigned to Seismic Performance Category C, D or E, by 1607.1.8. The connection shall consist of embedment of the pile reinforcement in the pile cap for a distance equal to the development length as specified in ACI 318.

1805.10.2.2 Field placed dowels anchored in the plastic concrete piles are acceptable. The development length to be provided is the full development length for compression without reduction in length for excess area. Where seismic confinement reinforcement at the top of the pile is required, alternative measures for laterally confining concrete and maintaining toughness and ductile-like behavior at the top of the pile shall be permitted provided consideration is given to forcing the hinge to occur in the confined region.

1805.10.2.3 Where a minimum length for reinforcement or the extent of closely spaced confinement reinforcement is specified at the top of the pile, provisions shall be made so that those specified lengths or extents are maintained after pile cutoff.

1805.10.3 Pile Foundation Seismic Ties. Piles or pile caps shall be interconnected by ties for buildings assigned to Seismic Performance Category C, D or E, by 1607.1.8. All ties shall be capable of resisting, in tension or compression, a force equal to 25% of the effective peak velocity-related acceleration (A_v) times the column dead plus live load. Individual tie beams are not required when it is demonstrated that equivalent restraint will be provided by structural members within slabs on grade or reinforced concrete slabs on grade or confinement by competent rock, cohesive soils, very dense granular soils, or other approved means.

1805.11 Pre-excavation. Predrilling, Jetting, and Spudding. Piles may be placed in holes preformed by boring, jetting or spudding or combination of these methods when approved by the designer. Such preformed holes should not extend to a depth greater than 5 feet above the top of the design bearing strata except for pipes driven into drilled sockets in rock as approved by the designer. Piles shall be inserted into the preformed holes as soon as the hole is completed and driving shall commence immediately.

1805.12 Inspection. A qualified inspector representing the designer of record shall be present when pile foundations are being installed and during tests. The inspector shall make and submit to the CEO detailed records of the installation of each pile and the results of load tests. Records shall include the cutoff and tip elevation of each pile relative to a permanent reference.

1805.13 Identification. All pile materials shall be identified for conformity to the specified grade. This identification shall be maintained continuously from the point of manufacture to the point of installation or shall be tested by an approved agency to determine conformity to the specified grade. The approved agency shall furnish an affidavit of compliance to the CEO.

1805.14 Pile Location Plan. A plan showing the location and designation of all piles by an identifying system shall be filed with the designer of record prior to installation of such piles. All detailed records for individual piles shall bear an identification corresponding to that on the plan.

1805.15 Use of Existing Piles. Piles left in place where a structure has been demolished shall not be used for the support for new construction unless satisfactory evidence is submitted to the CEO indicating that the piles are sound and meet all the requirements of this code. Such piles shall be load tested or redriven to verify their capacity. The design load applied to such piles shall be the lowest allowable load as determined by test or redriving data.

1805.16 Pile Drivability. Pile cross sections shall be of sufficient size and strength to withstand driving stresses without damage to the pile and to provide sufficient stiffness to transmit the required driving forces.

1805.17 Heaved Piles. All piles that have heaved during the driving of adjacent piles shall be redriven as necessary to develop the required capacity and penetration or the capacity of the pile shall be verified by load test in accordance with 1806.1.2.

1805.18 Settlement Analysis. The settlement of individual piles or groups of piles shall be estimated based upon accepted methods of analyst. The predicted settlement shall not cause harmful distortion of or instability in the structure nor shall it lead to any stresses exceeding allowable values.

1805.19 Use of Vibratory Drivers. Vibratory drivers may he used to install piles only if pile load capacity is verified by load test in accordance with 1806.1.2. The installation of production piles shall be controlled according to power consumption and rate of penetration or other means acceptable to the CEO that assures pile capacities equal or exceeding that of test piles.

1805.20 Installation Sequence. Piles shall be installed in such sequence that the soil surrounding the piles is not compacted to the extent that other piles cannot be installed properly and that ground movements do not damage adjacent structures.

1806 ALLOWABLE PILE LOAD

1806.1 Determination of Allowable Loads. The allowable axial and lateral loads on piles shall be determined by formulas listed below, load test or recognized engineering analysis.

1806.1.1 Driving Resistance.

1806.1.1.1 Subject to the limitations prescribed in this section for the various types of piles, the allowable loads for piles driven into granular or non-cohesive soils up to a maximum of 40 tons per pile may be determined by a standard wave equation analysis or the value of R_d obtained from the following formula. If higher design capacities are desired, they shall be determined by the provisions of 1806.1.2. Pile hammers shall be operated at the full rated speed, pressure, and stroke as shown in the manufacturer's catalog. The minimum driving energy for piles intended to carry 10 tons shall be 7,500 foot pounds.

$$R_d = \frac{2E_n}{s + 0.1} \quad X \quad \frac{Wr + K\,W_p}{Wr + W_p}$$

in which

R_d = Computed design pile load capacity, pounds (Maximum 80,000 pounds)
s = Penetration of the pile in inches/blow averaged over the last 6 inches driven
E_n = Manufacturer's maximum rated energy, foot-pounds
W_r = Weight of hammer ram, pounds
W_p =Weight of pile (including driving appurtenances), pounds
K = Shall be taken as 0.2 for piles whose weight is 50 pounds per linear foot or less, as 0.4 for piles whose weight is in the range of 50 to 100 pounds per linear foot and as 0.6 for piles (or the mandrels of steel shell piles) whose weight is greater than 100 pounds per linear foot.

1806.1.1.2 When the allowable load is determined by formula, piles with an average diameter or side of 8 inches or less shall be driven with a power hammer whose rated energy is at least 7,500 pounds; piles with an average diameter or side greater than 8 inches and not more than 18 inches shall be driven with a power hammer whose rated energy is at least 15,000 foot pounds; piles with an average diameter or side of more than 18 inches shall be driven with a power hammer whose rated energy is at least 26,000 foot pounds.

1806.1.1.3 Drop hammer may be used when the pile capacity does not exceed 10 tons as calculated from the following formula:

$$P = \frac{2WH}{S + \frac{0.7\,(H)}{15}}$$ for gravity hammers:

where P = safe bearing power in pounds;
E = rating for foot pounds energy for the hammer, as determined by the Engineer;
W = weight, in pounds of striking parts of hammer;
H = height of fall in feet;
S = average penetration in inches per blow for the last 10 blows

The above formulas will be applicable only when:

1. The head of the pile is not broomed or crushed.
2. The penetration is reasonably quick and uniform.
3. There is no apparent bounce after the blow.
4. The hammer has a free fall.

Twice the height of the bounce will be deducted from "H" to determine its value in the formula.

For drop hammers, the hammer shall weigh not less than 3000 pounds and shall be equipped with leads, hoisting equipment, and free fall release mechanism. The fall of the hammer shall not exceed 10 feet.

1806.1.2 Pile Load Test

1806.1.2.1 The design load on piles may be determined or justified by the designer based on an analysis of the results of pile load tests performed in accordance with ASTM D 1143 for individual piles. For the determination of the maximum allowable pile load capacity, the test pile shall be loaded to failure or to at least two and one half times the proposed allowable load. Test loads shall be measured with a calibrated load cell and pile displacements shall be measured at three equally spaced points around the head of the pile. These data shall be evaluated by applying a safety factor of two to the load determined by the intersection of a tangent to the plotted curve drawn parallel to the elastic line (PL/AE) of the pile and a tangent to the plotted curve drawn at a slope of 0.05 inches/ton.

1806.1.2.2 Pile capacities determined under this paragraph shall in no case produce stresses in the pile in excess of the maximum allowable stresses given in 1807 through 1813.

1806.1.3 Presumptive Pile Capacity

1806.1.3.1 Presumptive pile capacities may be used, not exceeding the values shown in Tables 1804.2.2 and 1806.1.3, provided that all of the following criteria are satisfied:

1. Presumptive pile capacities are acceptable only for lightly loaded structures where column loads are less than 50 kips per column and wall loads do not exceed 3 kips per linear foot.
2. Finished grades, including cut or fill operations do not differ from the natural grades by more than 5 feet.
3. Sufficient histories of favorable foundation performance are available from adjoining sites for similar structural loading conditions.

1806.1.3.2 The designer shall determine, based on the available historic data, that the expected settlements are within tolerable limits and that the foundations bear on stable soils. The presumptive values assigned and the required soil type shall be shown on the plans for field verifications.

1806.1.3.3 Piles may be loaded to the values shown in Table 1806.1.3 provided that the exploratory borings show no soft or significantly compressible strata below the proposed pile tip elevation. See Table 1804.2.2 for presumptive capacity values for various classes of earth materials.

TABLE 1806.1.3
PRESUMPTIVE ALLOWABLE LOAD ON PILES

	Granular Materials	Cohesive Soils
Friction Piles	1/2 ton per ft. of embedment in supporting stratum.	1/3 of the average unconfined compressive strength of the stratum multiplied by the surface area of the pile embedded in the supporting stratum.
End Bearing Piles	Bearing pressures shall not exceed the values given in Table 1804.2.2	

1806.2 Piles in Subsiding Areas. Where piles are driven through subsiding fills or other subsiding strata and derive support from underlying firmer materials, the downward frictional forces which are imposed on piles by the subsiding upper strata shall be included in the design.

NOTE: For H piles the surface area shall be taken as the area of the enclosing rectangle times the embedded length.

1807 STRUCTURAL STEEL PILES

1807.1 Materials. Structural steel piles, steel pipe and fully welded steel piles fabricated from plates, shall conform to one of the following specifications: ASTM A 36, ASTM A 252, ASTM A 283, ASTM A 572, ASTM A 588, ASTM A 690.

1807.2 Allowable Stresses. The allowable design compressive stress shall not exceed 0.35 of the minimum specified yield strength of the steel, except the allowable design stress may be increased up to 50% of the minimum specified yield strength of the steel where substantiated by Chapter 22.

1807.3 Minimum Dimensions

1807.3.1 H-Piles. Sections of H-piles shall comply with the following:

1. The flange projections shall not exceed 14 times the minimum thickness of metal in either the flange or the web and the flange widths shall be not less than 80% of the depth of the section.
2. The nominal depth in the direction of the web shall be not less than 8 inches (203 mm).
3. Flanges and web shall have a minimum nominal thickness of 3/8 inch (9.5 mm).

1807.3.2 Steel Pipe Piles. Steel pipe piles driven open ended shall have a nominal outside diameter of not less than 8 inches (203 mm) and a minimum wall thickness of 0.25 inch (6.4 mm) for diameters less than 14 inches (356 mm) and a minimum wall thickness of 0.375 inch (9.5 mm) for diameters 14 inches (356 mm) and over. Pipe of less wall thickness may be driven open ended if a suitable cutting shoe is provided.

1807.4 Pile Cap Seismic Connection. All structural steel piles shall be connected to the pile cap for buildings assigned to Seismic Performance Category D or E by 1607.1.8. The connection between the pile cap and the structural steel plies shall he designed for a tensile force equal to 10% of the pile compression design load.

1808 CONCRETE-FILLED STEEL PIPE AND TUBE PILES

1808.1 Material

1808.1.1 Steel pipe and tube piles shall conform to one of the following specifications: ASTM A 252, ASTM A 283.

1808.1.2 Concrete shall conform to 1809.1.1. The maximum size coarse aggregate shall be 3/4 inch (19 mm).

1808.2 Allowable Stresses. The allowable design compressive stress in the concrete shall not exceed 0.33 f'_c. The allowable design compressive stress in the steel shall not exceed 0.35 of the minimum specified yield strength of the steel, except that the allowable design compressive stress may be increased up to 50% of the minimum specified yield strength of the steel where substantiated by Chapter 22.

1808.3 Minimum Dimensions. Piles shall have a nominal outside diameter of not less than 8 inches (203 mm) and a minimum wall thickness in accordance with 1807.3.2 except that for mandrel driven pipe piles the minimum wall thickness may be 0.10 inch (2.5 mm).

1808.4 Reinforcement.

1808.4.1 Reinforcement steel shall conform to 1809.1.2. Reinforcement shall not be placed within 1 inch (25.4 mm) of the steel casing.

1808.4.2 All concrete-filled steel pipe and tube piles shall have minimum reinforcement of 1% of the pile cross-sectional area for buildings assigned to Seismic Performance Category C. D or E, by 1607.1.8. The longitudinal reinforcement shall be provided in the top of the pile with a length equal to two times the required cap embedment anchorage into the pile cap.

1808.5 Placing Concrete. Placing concrete shall conform to 1809.1.3.

1809 CAST-IN-PLACE CONCRETE PILES

1809.1 General

1809.1.1 Material. All concrete shall have a 28 day specified compressive f'_c of not less than 3,000 psi (17 238 kPa). When concrete as strength placed through a funnel hopper at the top of the pile, the concrete mix shall be designed and proportioned so as to produce a cohesive workable mix having a slump of not less than 4 inches (102 mm) and not more than 6 inches (152 mm) unless a high range water reducing admixture as used. If concrete is to be pumped, the mix design including slump shall be adjusted to produce a pumpable concrete.

1809.1.2 Reinforcement. Except for steel dowels embedded 5 ft (1524 mm) or less in the pile and as provided in 1809.2, reinforcement when required shall be assembled and tied together and shall be placed in the pile as a unit before the reinforced portion of the pile is filled with concrete.

1809.1.3 Installation. Concrete shall be placed in such a manner as to insure the exclusion of any foreign matter and to secure a full-sized shaft. Concrete shall not be placed through water except when tremie methods are approved by the CEO. When depositing concrete from the top of the pile, the concrete shall not be chuted directly into the pile but shall be poured in a rapid and continuous operation through a funnel hopper centered at the top of the pile.

1809.1.4 Seismic Reinforcement. All cast-in-place concrete piles shall have minimum reinforcement of 0.25% of the pile cross-sectional area for buildings assigned to Seismic Performance Category C, and a minimum reinforcement of 0.50% for buildings assigned to Seismic Performance Category D or E by 1607.1.8. The reinforcing shall be placed in the top one third of the pile length or extend 10 ft (3048 mm) from the top of the pile, whichever is the longer length. For Seismic Performance Category C buildings, the pile reinforcing shall be a minimum of four longitudinal bars with closed ties, or equivalent spirals, having a minimum diameter of 1/4 inch (6.4 mm). The ties shall be provided at a maximum spacing of 16 times the longitudinal reinforcing bar diameter. The maximum tie spacing in the top 2 ft (610 mm) of the pile length shall be 4 inches (102 mm). Tie detailing shall be in accordance with 1903.5.2. For Seismic Performance Category D or E buildings, the pile reinforcing shall be a minimum of four longitudinal bars with closed ties, or equivalent spirals having a minimum of four longitudinal bars with closed tie, or equivalent spirals having a minimum diameter of 3/8 inch (9.5 mm), for piles with a diameter more than 20 inches (508 mm). The ties shall be provided at a maximum spacing of 8 times the longitudinal reinforcing bar diameter. The maximum tie spacing in the top 4 ft (1219 mm) of the pile length shall be 3 inches 76 mm).

EXCEPTION: Pile ties are not required where spiral welded metal casing is used, provided the casing has thickness of not less than 0.068 inch (1.7 mm), and is adequately protected from corrosion due to soil, changing water levels, or other subgrade material indicated by the site soil investigation.

1809.2 Augered Uncased Piles

1809.2.1 Allowable Stresses. The allowable design stress in the concrete of augered cast-in-place piles shall not exceed 0.25 f'_c.

1809.2.2 Dimensions. The pile length shall not exceed 30 times the average diameter. The minimum diameter shall be 12 inches (305 mm).

EXCEPTION: The length of piles shall be permitted to exceed 30 times the diameter, provided the design and installation method of the pile foundation is approved by a professional engineer knowledgeable in the field of soil mechanics and pile foundations.

1809.2.3 Installation.

1809.2.3.1 If concrete is placed by pumping through a hollow-stem auger, the auger shall be allowed to rotate slowly in positive direction during withdrawal and shall be withdrawn in a steady continuous motion. Concrete pumping pressures shall be measured and shall be maintained high enough at all times to offset hydrostatic and lateral earth pressures. Concrete volumes shall be measured to insure that the volume of concrete placed in each pile is equal to or greater than the theoretical volume of the hole created by the auger. If the installation process of any pile is interrupted or a loss of concrete pressure occurs, the pile shall be redrilled to original depth and reformed. Augered cast-in-place piles shall not be installed within 6 pile diameters center-to-center of a pile filled with concrete less than 24 hours old unless approved by the CEO. If the concrete level in any completed pile drops, the pile shall be rejected and replaced.

1809.2.3.2 A pile load test shall be performed if 400 psi shaft stress is exceeded. Pile load test shall be in accordance with 1806.1.2.

1809.2.3.3 For piles having a shaft stress exceeding 400 psi, the following quality control procedures shall be met:

1. Calibration of pile installation equipment is required to accurately measure grout volumes and pressure prior to test pile installation. This calibration shall be expressed in cubic feet per pump stroke
2. Document the amount of grout injected into the test pile by recording the number of pump strokes per linear foot or number of pump strokes per 5 linear foot section.
3. Subject the installation procedures to a static load test in accordance with ASTM D 1143.
4. If the load test is successful, insure that each production pile is installed using the same procedure that installed the successful test pile.
5. An engineer registered in the state the work is located shall certify to the CEO and Structural Engineer of Record that all pilings were installed in accordance with the approved design and tested installation procedure. The engineer shall be prepared to submit upon request a report showing the following minimum information:
    1. Pile Identification
    2. Pile Length
    3. Date
    4. Rate of Auger Withdrawal (grouting time)
    5. Grout volume in cubic feet per linear foot or cubic feet per 5 foot section.

1809.2.4 Reinforcement. For piles installed with a hollow stem auger, longitudinal steel reinforcement may be placed without lateral ties provided it is placed through ducts in the auger prior to filling the pile with concrete. All pile reinforcement shall have a concrete cover of not less than 2 1/2 inches (64 mm).

1809.3 Driven Uncased Piles

1809.3.1 Allowable Stress. The allowable design stress in the concrete shall not exceed 0.25 f'_c applied to a cross-sectional area not greater than the inside area of the drive casing or mandrel.

1809.3.2 Dimensions. The pile length shall not exceed 30 times the average diameter. The minimum diameter shall be 12 inches (305 mm).

1809.3.3 Installation. Piles shall not be driven within six pile diameters center-to center in granular soils or within one-half the pile length in cohesive soils of a pile filled with concrete less than 48 hours old unless approved by the CEO. If the concrete surface in any completed pile rises or drops, the pile shall be rejected and replaced. Piles shall not be installed in soils which could cause pile heave.

1809.3.4 Concrete Cover. All pile reinforcement shall have a concrete cover of not less than 2 1/2 inches (64 mm) measured from the inside face of the drive casing or mandrel.

1809.4 Enlarged Base Piles

1809.4.1 Materials. Concrete shall have a zero slump.

1809.4.2 Allowable Stress. The allowable design compressive stress in the concrete shall not exceed 0.33 f'_c.

1809.4.3 Installation. Enlarged bases formed by compacting concrete shall be driven into granular soils. All piles shall be constructed in the same manner as successful prototype test piles driven for the project. Pile shafts extending through soft materials, peat or other organic soil shall be encased in a permanent steel casing. If a cased shaft is used, it shall be adequately reinforced to resist column action or the annular space around the pile shaft shall be filled sufficiently to reestablish the lateral support of the soil. If pile heave occurs, the pile shall be rejected

1809.4.4 Bearing Capacity. Pile bearing capacity shall be verified by load tests in accordance with 1806.1.2.

1809.4.5 Concrete Cover. The minimum concrete cover shall be 2 1/2 inches (64 mm) for uncased shafts and 1 inch (25.4 mm) for cased shafts.

1809.5 Steel Cased Piles

1809.5.1 Materials. Pile shells or casings shall be of steel and shall be sufficiently strong to resist collapse and sufficiently watertight to exclude any foreign materials during the placing of concrete. Steel shells shall have a sealed tip with a diameter of not less than 8 inches (203 mm).

1809.5.2 Allowable Stresses. The allowable design compressive stress in the concrete shall not exceed 0.33 f'_c except that the allowable concrete stress may be increased to a maximum value of 0.40 f'_c for that portion of the pile meeting the following conditions:

1. The thickness of the steel shell is not less than 0.075 inch (1.9 mm) minimum.
2. The shell is seamless or is provided with seams of strength equal to the basic material and is of a configuration which will provide confinement to the cast-in-place concrete.
3. The ratio of steel yield strength, fy, to design f'_c shall be not less than six.
4. The nominal pile diameter is not greater than 16 inches (406 mm).

1809.5.3 Installation. Piles shall have steel shells mandrel-driven their full length in contact with the surrounding soil left permanently in place and filled with concrete. No pile shall be driven within 4 1/2 average pile diameters of a pile filled with concrete less than 24 hours old unless approved by the CEO. Concrete shall not be placed in steel shells within heave range of driving.

1809.5.4 Reinforcement. Reinforcement shall not be placed within 1 inch (25.4 mm) of the steel shell. Reinforcing shall be considered necessary only for unsupported pile length or when the pile is designed to resist uplift or unbalanced lateral loads.

1809.5.5 Seismic Reinforcement. All steel cased piles in buildings assigned to Seismic Performance Category C, D or E by 1607.1.8 shall have seismic reinforcement required by 1809.1.4.

1810 PRECAST CONCRETE PILES

1810.1 General

1810.1.1 Design And Manufacture. All plies shall be designed and manufactured in accordance with accepted practice and to resist all stresses induced by handling, driving and service loads. The minimum lateral dimension shall be 8 inches (203 mm). All corners of square piles shall be chamfered. Longitudinal steel shall be arranged in a symmetrical pattern and shall be laterally tied with steel ties or wire spiral spaced not more than 3 inches (76 mm) apart center-to-center for a distance of 2 ft (610 mm) from the ends of the pile and not more than 6 inches (152 mm) elsewhere except that at the ends of each pile the first five ties or spirals shall be spaced 1 inch (25.4 mm) center-to-center.

1810.1.2 Installation. All piles shall be handled and driven so as not to cause injury or overstressing which will affect their durability or strength.

1810.2 Reinforced Piles

1810.2.1 Design. The minimum amount of longitudinal reinforcement expressed as a percentage of the gross cross-sectional area of the pile shall be 1% for piles 40 ft (12 m) and shorter and 1 1/2% for piles longer than 40 ft (12 m) and shall consist of at least four bars.

1810.2.2 Material. All concrete shall have a 28 day specified strength f'_c of not less than 4,000 psi (28 MPa).

1810.2.3 Allowable Stress. The allowable compressive stress in the concrete shall not exceed $0.33\ f'_c$ applied to the gross cross-sectional area of the pile. The allowable compressive stress in the reinforcing steel shall not exceed $0.40\ f_y$ or a maximum of 30,000 psi (207 MPa). The allowable tensile stress in the reinforcing steel shall not exceed $0.50\ f_y$ or a maximum of 24,000 psi (165 MPa).

1810.2.4 Concrete Cover.

1810.2.4.1 Reinforcement for piles manufactured under plant control conditions shall have a concrete cover of not less than 1 1/4 inches (32 mm) for #5 bar, and smaller, and not less than 1 1/2 inches (38 mm) for #6 through #11 bars except that longitudinal bars spaced less than 1 1/2 inches (38 mm) clear distance apart shall be considered bundled bars for which the minimum concrete cover shall be equal to that for the equivalent diameter of the bundled bars.

1810.2.4.2 Reinforcement for piles not manufactured under plant control conditions shall have a concrete cover of not less than 2 inches (51 mm).

1810.2.4.3 Reinforcement for all piles exposed to sea water shall have a concrete cover of not less than 3 inches (76 mm).

1810.2.5 Installation. A precast concrete pile shall not be driven before the concrete has attained a compressive strength of at least $0.75\ f'_c$ except that in all cases the concrete strength shall be sufficient to withstand handling and driving forces.

1810.3 Prestressed Piles

1810.3.1 Design. The effective prestress in the pile shall be not less than 700 psi (4827 kPa).

1810.3.2 Material. Prestressing steel shall conform to ASTM A 416. All concrete shall have a 28 day specified compressive strength f'_c of not less than 5,000 psi (34 MPa).

1810.3.3 Allowable Stress. The maximum allowable design compressive stress f_c in concrete shall be determined as follows:

$$f_c = 0.33\ f'_c - 0.27 f_{pc}$$

where f_{pc} is the effective prestress stress on the gross section.

1810.3.4 Installation. A prestressed pile shall not be driven before the concrete has attained a compressive strength of at least 0.75 f'_c except that in all cases the concrete shall be of sufficient strength to withstand handling and driving forces.

1810.3.5 Concrete Cover. All prestressing steel and pile reinforcement shall have a concrete cover of not less than 1 1/4 inches (32 mm) for square piles of 12 inches (305 mm) or smaller size and 1 1/2 inches (38 mm) for larger piles except that for piles exposed to sea water, the minimum protective concrete cover shall be not less than 2 1/2 inches (64 mm).

1810.3.6 Pile Cap Seismic Connection. Prestressed pile connection to the pile cap shall be in accordance with the requirements of 1805.10.2 or by extension of the pile reinforcing strand into the pile cap. The embedment into the pile cap shall develop the strength of the reinforcing strand. Prestressed pile cap connections in buildings assigned to Seismic Performance Category D or E by 1607.1.8 shall not be by development of exposed strand.

1810.3.7 Spiral Seismic Reinforcing. The spiral reinforcement in prestressed piles for buildings assigned to Seismic Performance Category D or E. by 1607.1.8, shall not be less than 0.6% for the length of the fully embedded piling where subjected to vertical loads only or where the design bending moment does not exceed 20% of the unfactored ultimate moment capacity at balanced strain conditions computed in accordance with ACI 318.

1811 TIMBER PILES

1811.1 Materials. Timber piles shall conform to ASTM D 25.

1811.2 Preservative Treatment

1811.2.1 Timber piles used to support permanent structures shall be treated in accordance with this section.

1811.2.2 Preservative and minimum final retention shall be in accordance with AWPA Standard C 3.

1811.2.3 Preservative and minimum final retention for sawn timber piles shall be in accordance with AWPA Standard C 24.

1811.2.4 When timber piles are used in salt water, the treatment shall conform to AWPA C 18.

1811.2.5 Pile cutoffs shall be treated in accordance with AWPA M 4.

1811.3 Allowable Stresses. The allowable Stresses for treated round timber piles shall not exceed those set forth in Table 1811.3.

TABLE 1811.3
ALLOWABLE UNIT STRESSES FOR TREATED ROUND TIMBER PILES
NORMAL LOAD DURATION VALUES AT TIP OF PILE

Species	Compression Parallel to Grain psi[4]	Bending psi[4]	Shear Horiz. Psi[4]	Comp. Perp. To Grain[4]	Modulus of Elasticity
Pacific Coast Douglas Fir[1]	1,250	2,450	115	230	1,500,000
Southern Pine[1,2]	1,200	2,400	110	250	1,500,000
Red Oak[3]	1,200	2,450	135	350	1,250,000
Red Pine[5]	900	1,900	85	155	1,280,000

1 psi = 6.8948 kPa

NOTES:

1. The allowable unit stresses in compression parallel to grain for Pacific Coast Douglas Fir and Southern Pine may be increased 0.2% for each foot of length from the tip of the pile to the critical section. The increase shall not exceed 10% for any pile. The stress increase is cumulative with increase in section properties due to pile taper.
2. Southern Pine values apply to Longleaf, Slash, Loblolly, and Shortleaf Pines.
3. Red Oak values apply to Northern and Southern Red Oak.
4. The working stresses in the above table have been adjusted to compensate for strength reductions due to conditioning prior to treatment. Where piles are air dried or kiln dried prior to pressure treatment, or where untreated piles are to be used, the above working stresses shall be increased by multiplying the tabulated values by the fol1owing factors:

Pacific Coast Douglas Fir, Red Oak, Red Pine 1.11
Southern Pine 1.18

5. Red Pine values apply to Red Pine grown in the United States.

1811.4 End Bearing Piles. Any sudden decrease in driving resistance of an end bearing timber pile shall be investigated with regard to the possibility of damage and if the sudden decrease in driving resistance cannot be correlated to bearing data, the pile shall be removed for inspection or rejected.

1812 COMPOSITE PILES

1812.1 Design. Composite piles consisting of two or more approved pile types shall be designed to meet the conditions of installation.

1812.2 Limitation of Load. The maximum allowable load shall be limited by the capacity of the weakest section incorporated in the pile.

1812.3 Splices. Splices between concrete sections and steel or wood sections shall be designed to prevent separation of the sections both before and after the concrete portion has been set, and to insure the alignment and transmission of the total pile load. Splices shall be designed to resist uplift due to upheaval during driving of adjacent piles and shall develop the full compressive strength and not less than 50% of the strength in tension and bending of the weaker section.

1813 CAISSON PILES

1813.1 Construction. Caisson piles shall consist of a shaft section of concrete-filled pipe extending to bedrock with an uncased socket drilled into the bedrock and filled with concrete. The caisson pile shall have a full length structural steel core or a stub core installed in the rock socket and extending into the pipe portion a distance equal to the socket depth.

1813.2 Design. The depth of the rock socket shall be sufficient to develop the full loadbearing capacity of the caisson pile with a minimum factor of safety of two but the depth shall be not less than the outside diameter of the pipe. The design of the rock socket may be predicated on the sum of the allowable bearing pressure on the bottom of the socket plus bond along the sides of the socket. The minimum outside diameter of the caisson pile shall be 18 inches (457 mm) and the diameter of the rock socket shall be approximately equal to the inside diameter of the pipe.

1813.3 Material. Pipe and steel cores shall conform to the material requirements in 1807. Pipe shall have a minimum wall thickness of 3/8 inch (9.5 mm) and shall be fitted with a suitable steel driving shoe welded to the bottom of the pipe. All concrete shall have a 18 day specified compressive strength f'_c of not less than 4,000 psi (28 MPa). The concrete mix shall be designed and proportioned so as to produce a cohesive workable mix with a slump of from 4 to 6 inches (102 to 152 mm).

1813.4 Structural Core. The gross plan area of the structural steel core shall not exceed 25% of the gross caisson section. The minimum clearance between the structural core and the pipe shall be 2 inches (51 mm). If cores are to be spliced, the ends shall be milled or ground to provide full contact and shall be full depth welded.

1813.5 Allowable Stresses. The allowable design compressive stresses shall not exceed the following: concrete, 0.33 f'_c; steel pipe, 0.35 f_y; structural steel core, 0.50 f_y.

1813.6 Installation. The rock socket and pipe shall be thoroughly cleaned of all foreign materials before filling with concrete. Steel core shall be bedded to cement grout at the base of the rock socket. Concrete shall not be placed through water except when tremie methods are approved by the CEO.

1813.7 Seismic Reinforcement. All caisson piles in buildings assigned to Seismic Performance Category C, D or E by 1607.1.8 shall have seismic reinforcement required by 1809.1.4.

1814 DRILLED PIERS OR CAISSONS

1814.1 Investigation. A subsurface investigation as described in 1805.1.1 shall be conducted at the site to examine both the material through which the drilled pier or caisson will be drilled and the underlying materials that will be significantly stressed by the foundation unit. The design bearing evaluation and bearing and friction capacities shall be elected on the basis of a reasonable number of soil or rock tests.

1814.2 Minimum Size. If drilled piers or caissons are belled, such bells shall have at least a 4" thickness of concrete at the edge and the sides shall slope at an angle of not less than 45 degrees with the horizontal unless they have been designed as reinforced concrete cantilevers. In no case shall the shaft of a drilled pier or caisson be less than 2'-6" minimum horizontal dimension. Foundation elements with shaft diameters less than specified above shall be designed in accordance with 1809 Cast-In-Place Concrete Piles.

1814.3 Design. The shafts of drilled piers or caissons shall be designed as concrete columns with continuous lateral support. The unit compressive stress in the concrete shall not exceed 33% of its ultimate 28-day compressive strength. No steel reinforcement is required in concrete filled, drilled piers or caissons unless required by the load imposed thereon. Where steel reinforcement is used the shaft shall be designed in accordance with the requirements of Chapter 19 of this Code and ACI 318.

1814.3.1 Allowable Loads. The allowable load on individual units may be determined from an analysis of subsurface conditions as described in 1809.6.3.2 or by load test as described in 1814.3.2 or by the presumptive caisson capacity values given in 1814.17.

1814.3.2 Bearing Capacity From Engineering Analysis. The design lengths and end bearing pressures shall be selected on the basis of an analysis of subsurface conditions supported by a reasonable number of tests. These tests may be made in the laboratory on undisturbed soil samples or rock cores or in situ by a bore-hole or bottom of excavation tests. The testing and inspection program shall be specified by the designer to ensure that the bearing material is satisfactory to support the design bearing pressure. The bearing pressure so selected shall not produce stresses in the shaft in excess of those provided in 1814.3.

1814.3.3 Load Test. The design bearing pressure of drilled piers or caissons may be determined by the analysis of the results of load tests performed in accordance with the requirements of 1806.1.2 or other recognized methods of load testing.

1814.3.4 Presumptive Caisson Capacity. Presumptive capacities may be used, not exceeding the values shown in Tables 1804.2.2 and 1806.1.3 provided the following criteria are satisfied:

1. Presumptive caisson capacities are acceptable only for lightly loaded structures where column loads are less than 50 kips per column and wall loads do not exceed 3.0 kips per linear foot
2. Finished grades, including cut or fill operations do not differ from the natural grades by more than 5 feet.
3. Sufficient histories of favorable foundation performances are available from adjoining sites for similar structural loading conditions.

1814.4.1 Dry Method. Construction of drilled piers or caissons shall be by nondisplacement methods. Except as noted in 1814.4.2 the excavation shall be dewatered to permit hand cleaning of the bearing surface and inspection of the bearing material in place prior to placement of any concrete.

1814.4.2 Wet Method. With the approval of the CEO, the concrete for drilled piers or caissons may be placed below the surface of still water by means of a properly operated tremie tube or concrete pump. Concrete may be placed in a similar manner in a slurry filled excavation if no end bearing pressure is allowed. Concrete placed under this section of the code shall be handled in such a manner that fresh concrete entering the caisson does so at a point below the top of the mass of wet concrete in order that it shall be not mixed with the water or slurry filling the hole. As soon as an adequate seal has been effected, the water or slurry remaining on top of the concrete may be pumped out and the rest of the caisson concreted as in 1814.4.1.

1814.4.3 Liners. The excavation for drilled piers or caissons shall be protected against caving or sloughing by temporary steel liners that may be removed as the concrete is placed. The surface of the wet concrete shall remain at least 4’ above the bottom of the liner while the liners are being withdrawn. The design of the shaft shall be calculated from the interior dimensions of the smallest liner.

1815 WATERPROOFING AND DAMPPROOFING

1815.1 Where Required. Where a groundwater table investigation indicates that hydrostatic pressure conditions exist, walls and floors retaining earth and enclosing spaces below finished ground level shall be waterproofed in accordance with 1815.2. Where hydrostatic pressure conditions do not exist, dampproofing and perimeter drainage shall be provided in accordance with 1815.3.

EXCEPTION: See 1804.7 for dampproofing of wood foundations.

1815.2 Waterproofing

1815.2.1 Surfaces to be waterproofed shall be prepared in accordance with the waterproofing manufacturer's recommendations.

1815.2.2 Waterproofing shall be applied from the top of the footing to not less than 6 inches (152 mm) above finish grade.

1815.2.3 Waterproofing shall consist of one of the following systems:

1. 3-ply hot mopped felts.
2. Bentonite clay layer at a minimum 0.75 lb/sq ft (3.7 kg/m^2).
3. 50 mil (1 .3 mm) rubberized asphalt sheet or liquid.
4. 40 mil (1.0 mm) polymer modified asphalt.
5. 40 mil (1.0 mm) polyurethane rubber.
6. 20 mil (0.5 mm) single ply vulcanized rubber or thermoplastic sheet.
7. Other approved methods or materials capable of bridging nonstructural cracks.

1815.2.4 Wall and floor joints and penetrations shall be made watertight using approved methods and materials.

1815.2.5 Roof waterproofing shall consist of any material approved for waterproofing in 1815.2.3, with joints lapped and sealed in accordance with the waterproofing manufacturer's recommendations.

1815.3 Dampproofing

1815.3.1 Wall surfaces to be dampproofed shall have all holes and recesses, including those resulting from removal of form ties, sealed with a bituminous or other approved material.

1815.3.2 Dampproofing shall be applied to the exterior surface of walls from a point 12 inches (305 mm) below the top of the lowest slab to not less than 6 inches (152 mm) above finish grade.

1815.3.3 Dampproofing applied beneath the floor slab shall consist of 6 mil (0.15 mm) minimum polyethylene with joints lapped not less than 6 inches (152 mm) and taped, or other approved materials having a maximum perm rating of 0.5. Where installed below the finished walking surface dampproofing shall consist of mopped-on bitumen, 4 mil (0.10 mm) minimum polyethylene, or other approved materials having a maximum perm rating of 0.5 (2.873 E-11 kg/(Pa • s • m^3)), with joints lapped and sealed in accordance with the dampproofing manufacturers recommendations.

1815.3.4 Wall dampproofing shall consist of one of the following systems:

1. 3/8-inch (9.5 mm) portland cement parging with a 1/16-inch (1.6 mm) bituminous coating
2. 1/8-inch (3.2 mm) bituminous coating
3. 1/8-inch (3.2 mm) cementitious coating
4. 1/8-inch (3.2 mm) surface bonding mortar
5. 40 mil (1.02 mm) acrylic latex coating
6. 1/16-inch (1.6 mm) bituminous coating over concrete

7. 6 mil (0.152 mm) polyethylene over 1/16 inch (1.6 mm) bituminous coating applied to masonry.
8. Acrylic modified cement base coating at a total minimum thickness of 3 lb per sq yd (1.6 kg/m^2).
9. Any material approved for waterproofing in 1815.2.3.

1815.3.5 When dampproofing is required, perimeter drainage shall be provided in accordance with either 1815.3.5.1 or 1815.3.5.2. The foundation perimeter drain shall discharge by gravity or mechanical means into an approved drainage system.

EXCEPTION: Where a site is located in well-drained gravel or sand gravel mixture soils, perimeter drainage is not required.

1815.3.5.1 Method 1. A drain, consisting of gravel or crushed stone containing not more than 10% material that passes a No. 4 sieve, shall be placed around the perimeter of the foundation. The drain shall extend 12 inches (305 mm) minimum beyond the outside edge of the footing. The thickness shall be such that the bottom of the drain is not higher than the bottom of the base under the floor, and the top of the drain is not less than 12 inches (305 mm) above the top of the footing. The gravel or crushed stone drain shall be wrapped with an approved geotextile fabric.

1815.3.5.2 Method 2. A drain tile or perforated pipe shall be placed around the perimeter of a foundation. The invert of the pipe or tile shall be no higher than the floor elevation. The pipe or tile shall be placed on not less than 2 inches (51 mm) of gravel or crushed stone containing not more than 10% material that passes a No. 4 sieve and covered with not less than 6 inches (152 mm) of the same material. The gravel or crushed stone shall extend 12 inches (305 mm) minimum beyond the outside edge of the footing. The gravel or crushed stone drain shall be wrapped with an approved geotextile fabric.

1815.4 Backfilling. Backfill shall be placed in lifts and compacted in a manner which does not damage the waterproofing or dampproofing material, or the foundation wall.

CHAPTER 19

CONCRETE

1901 GENERAL

1901.1Scope

1901.1.1 Provisions of this chapter shall govern the materials, design and construction of concrete used in buildings.

1901.1.2 Structural members of reinforced concrete, including prestressed concrete, shall be designed and constructed in accordance with the provisions of this chapter and ACI 318.

1901.1.3 Structural members of plain concrete shall be designed and constructed in accordance with the provisions of this chapter and ACI 318.1. Concrete that is either unreinforced or contains less reinforcement than the minimum amount specified for reinforced concrete shall be classified as plain concrete.

1901.2 Special Provisions for Seismic Design.

Refer to 1912 for seismic design requirements for reinforced concrete. Refer to 1913 for seismic design requirements for plain concrete.

1902 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

1903 MATERIALS

1903.1 General

Materials used to produce concrete and admixtures for concrete shall comply with the requirements of this section and ACI 318.

1903.2 Cements

Cement shall conform to ASTM C 150 or to such other cements listed in ACI 318.

1903.3 Aggregates

1903.3.1 Concrete aggregates shall conform to ASTM C 33 or to ASTM C 330.

1903.3.2 Aggregates failing to meet the standards listed in 1903.3.1, but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used where authorized by the building official.

1903.3.3 Nominal maximum size of coarse aggregate shall be not larger than:

1. 1/5 the narrowest dimension between sides of forms, nor
2. 1/3 the depth of slabs, nor
3. 3/4 the minimum clear spacing between individual reinforcing bars or wires, bundles of bars, or prestressing tendons or ducts.

These limitations shall not apply if, in the judgment of the engineer, workability and methods of consolidation are such that concrete can be placed without honeycomb or voids.

1903.4 Water

1903.4.1 Water used in mixing concrete shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or reinforcement.

1903.4.2 Mixing water for prestressed concrete or for concrete that will contain aluminum embedments, including that portion of mixing water contributed in the form of free moisture on aggregates, shall not contain deleterious amounts of chloride ion. See 1904.4.

1903.4.3 Nonpotable water shall not be used in concrete unless specific requirements of ACI 318 allowing the use of nonpotable water are satisfied.

1903.5 Metal Reinforcement

1903.5.1 Reinforcement shall be deformed reinforcement, except that plain reinforcement shall be permitted for spirals or tendons. Reinforcement consisting of structural steel, steel pipe, or steel tubing shall be permitted as specified in ACI 318.

1903.5.2 Reinforcing bars to be welded shall be indicated on the drawings and welding procedure to be used shall be specified. ASTM reinforcing bar specifications, except for ASTM A 706, shall be supplemented to require a report of material properties necessary to conform to welding procedures specified in AWS D1.4.

1903.5.3 Reinforcement shall conform to the applicable ASTM standards Listed in ACI 318.

1903.6 Admixtures

1903.6.1 Admixtures to be used in concrete shall be subject to prior approval by the engineer.

1903.6.2 An admixture shall be shown capable of maintaining essentially the same composition and performance throughout the work as the product used in establishing concrete proportions in accordance with 1905.2.

1903.6.3 Calcium chloride or admixtures containing chloride from other than impurities from admixture ingredients shall not be used in prestressed concrete, in concrete containing embedded aluminum, or in concrete cast against stay-in-place galvanized metal forms. See 1904.3 and 1904.4.

1903.6.4 Air-entraining admixtures, water-reducing admixtures, retarding admixtures, accelerating admixtures, water-reducing and retarding admixtures, and water-reducing and accelerating admixtures shall conform to the applicable ASTM standards Listed in ACI 318.

1903.6.5 Fly ash or other pozzolans used as admixtures shall conform to ASTM C 618. The building official shall require certification of all fly ash materials used in concrete as conforming to the ASTM C 618 specification.

1903.6.6 Ground granulated blast furnace slag used as an admixture shall conform to ASTM C 989.

1903.7 Storage of Materials

1903.7.1 Cementitious materials and aggregate shall be stored in such manner as to prevent deterioration or intrusion of foreign matter.

1903.7.2 Any material that has deteriorated or has been contaminated shall not be used for concrete.

1903.8 Tests of Materials

1903.8.1 The building official shall have the right to order testing of any materials used in concrete construction to determine if materials are of quality specified.

1903.8.2 Tests of materials and of concrete shall be made in accordance with ASTM standards listed in ACI 318. Laboratories conducting tests on concrete and concrete aggregates for use in construction shall comply with ASTM C 1077 except Section 7.4.

1903.8.3 A complete record of tests of materials and of concrete shall be available for inspection during progress of work and for 2 years after completion of the project and shall be preserved by the inspecting engineer or architect for that purpose.

1904 DURABILITY REQUIREMENTS

1904.1 Water-Cementitious Materials Ratio

1904.1.1 Cementitious Materials. For purposes of this section, a cementitious material is one specified in 1903 which has cementing value when used in concrete either by itself, such as portland cement or blended hydraulic cements, or when used in combination with fly ash, other raw or calcined natural pozzolans, and/or ground granulated, blast furnace slag.

1904.1.2 Calculation of water-cementitious materials ratio. To determine compliance with the maximum water-cementitious materials ratio requirement of Tables 1904B and 1904D, the weight of cement shall include the weights of any of the following if contained in the concrete mixture: cement meeting ASTM C 150 or ASTM C 595, fly ash or pozzolan meeting ASTM C 618, and ground granulated, blast furnace slag meeting ASTM C 989.

1904.2 Freezing and Thawing Exposures

1904.2.1 Air-entraining. Normal weight and lightweight concrete exposed to freezing and thawing or deicer chemicals shall be air-entrained with air content indicated in Table 1904A. Tolerance on air content as delivered shall be ± 1.5%. For specified compressive strength f'_c greater than 5,000 psi (34.5 MPa), air content indicated in Table 1904A may be reduced 1%. When finely divided materials of fly ash or natural pozzolans are used as mineral admixtures (see 1903.6.5) in air-entrained portland cement concrete, the building official shall require air content tests to be made in accordance with ASTM C 231 to assure compliance with air content requirements of Table 1904A.

1904.2.2 Low Water-Permeability. Concrete that is intended to have low permeability to water or concrete that will be subject to freezing and thawing in a moist condition, or will be exposed to deicing salts, brackish water, sea water or spray from these sources shall conform to requirements of Table 1904B.

> EXCEPTION: Normal weight aggregate concrete used in buildings or their appurtenances of Group R occupancies three stories or less in height, and subject to weathering (i.e., freezing and thawing) as determined from Figure 1904 or deicer chemicals, shall comply with the requirements of Table 1904C.

In addition, concrete that will be exposed to deicing chemicals shall conform to the limitations of 1904.2.3.

1904.2.3 Limitations on use of certain cementitious materials. For concrete exposed to deicing chemicals, the maximum weight of fly ash, other pozzolan or ground granulated, blast furnace slag that is included in the calculation of water-cementitious materials ratio shall not exceed the percentages of the total weight of cementitious materials specified in 1904.2.3.1 through 1904.2.3.3.

1904.2.3.1 Concrete Containing Fly Ash or Pozzolan. The combined weight of fly ash and other pozzolan conforming to ASTM C 618 shall not exceed 25% of the total weight of cementitious materials. Fly ash or other pozzolan used to manufacture Type IP or IPM blended hydraulic cement conforming to ASTM C 595 shall be included with fly ash or other pozzolan added as an admixture.

1904.2.3.2 Concrete Containing Ground Granulated, Blast Furnace Slag. The weight of ground granulated, blast furnace slag conforming to ASTM C 989 shall not exceed 50% of the total weight of cementitious materials. Slag used to manufacture Type IS or ISM blended hydraulic cement conforming to ASTM C 595 shall be included with slag added as an admixture.

1904.2.3.3 Concrete Containing Fly Ash or Other Pozzolan and Slag. If fly ash or other pozzolan and slag are used in concrete, portland cement conforming to ASTM C 150 shall constitute not less than 50% of the total weight of cementitious materials. Fly ash or other pozzolan shall constitute no more than 25% of the total weight of cementitious materials. See 1904.2.3.1.

1904.3 Exposure to Sulfate-Containing Solutions

Concrete to be exposed to sulfate-containing solutions shall conform to requirements of Table 1904D or be made with a cement that provides sulfate resistance and used in concrete with maximum water-cementitious materials ratio or minimum specified compressive strength from Table 1904D. Calcium chloride as an admixture shall not be used in concrete to be exposed to severe or very severe sulfate containing solutions, as defined in Table 1904D.

1904.4 Water Soluble Chloride Ion Content

For corrosion protection, maximum water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials and admixtures shall not exceed the limits of Table 1904E. Tests performed to determine water soluble chloride ion content, shall conform to AASHTO T 260.

1904.5 Corrosion Protection for Reinforced Concrete

When reinforced concrete will be exposed to deicing salts, brackish water, sea water, or spray from these sources, requirements of Table 1904B for water-cementitious materials ratio or concrete strength and minimum concrete cover requirements of 1908.6 shall be satisfied. Refer to ACI 318 for unbonded prestressing tendons.

Table 1904A
Total Air Content for Frost Resistant Concrete

Maximum Nominal Aggregate Size (in)[1]	Air content (%)	
	Severe Exposure[3]	Moderate Exposure[3]
3/8	7 1/2	6
1/2	7	5 1/2
3/4	6	5
1	6	4 1/2
1 1/2	5 1/2	4 1/2
2[2]	5	4
3[2]	4 1/2	3 1/2

1 inch = 25.4 mm

Notes:

1. See ASTM C 33 for tolerances on oversize for various nominal maximum size designations.
2. These air contents apply to total mix, as for the preceding aggregate sizes. When testing these concretes, however, aggregate larger than 1 1/2 inches is removed by handpicking or sieving and air content is determined on the minus 1 1/2-inch. fraction of mix. (Tolerance on air content as delivered applies to this value). Air content of total mix is computed from value determined on the minus 1 1/2-inch fraction.
3. The severe and moderate exposures referenced in this table are not based upon the weathering regions shown In Figure 1904. For purposes of this table, Severe and Moderate exposures shall be defined as follows:

   Severe exposure occurs in a cold climate when concrete may be in almost continuous contact with moisture prior to freezing, or where deicing sel1s are used. Examples are pavements, bridge decks, sidewalks, parking garages and water tanks.

   Moderate exposure occurs in a cold climate when concrete will be only occasionally exposed to moisture prior to freezing, and where no deicing salts are used. Examples are certain exterior walls, beams, girders, and slabs not in direct contact with soil.

Table 1904B
Requirements for Special Exposure Conditions

Exposure Condition	Maximum Water-Cementitious Materials Ratio, by Weight, for Normal Weight Aggregate Concrete	Minimum f'_c for Normal Weight and Lightweight Aggregate Concrete (psi)
Concrete intended to have low permeability when exposed to water	0.50	4,000
Concrete exposed to freezing and thawing in a moist condition or to deicing chemicals	0.45	4,500
For corrosion protection for reinforced concrete exposed to chlorides from deicing chemicals salts, brackish water, sea water or spray from these sources	0.40	5,000

1 psi = 6.8948 kPa

Table 1904C
Minimum Specified Compressive Strength of Concrete (f 'c) Subject to Weathering and/or Deicer Chemicals[1]

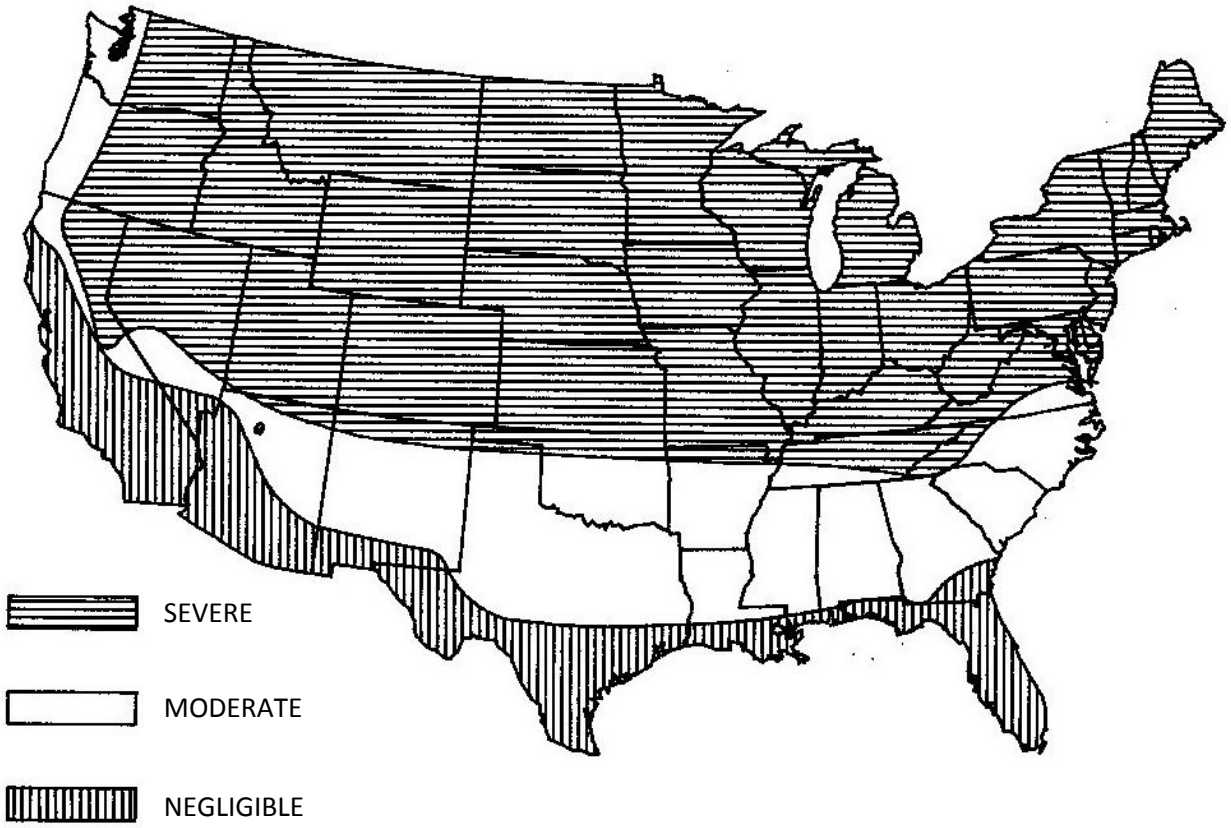
Type and or Location of Concrete Element	Minimum Specified Compressive Strength (f'_c)[1] (psi)		
	Weathering Probability[2]		
	Negligible	Moderate	Severe
Basement walls and foundations not exposed to the weather	2,500	2,500	2,500[3]
Basement slabs and interior slabs and interior slabs-on-grade, except garage floor slabs	2,500	2,500	2,500[3]
Basement walls, foundation walls, exterior walls, and other vertical concrete surfaces 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]	3,500[4]

1 psi = 6.8948 kPa

Notes:

1. At 28 days, psi.
2. See Figure 1904 for Weathering Probability.
3. Concrete in these locations which may be subject to freezing and thawing during construction shall be air-entrained concrete in accordance with Table 1904A.
4. Concrete shall be air-entrained in accordance with Table 1904A.

Figure 1904
Weathering Probability Map for Concrete[1,2]
(For Use with Table 1904C Only)



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. A Severe 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.

Table 1904D
Requirements for Concrete Exposed to Sulfate-Containing Soils or Water

Sulfate exposure	Water soluble Sulfate (SO_4) in soil (% by weight)	Sulfate (SO_4) in water (ppm)	Cement type	Maximum water-cementitious materials ratio, by weight for normal weight aggregate concrete[1]	Min. f'_c normal weight and lightweight aggregate concrete (psi)[1]
Negligible	0.00 – 0.10	0 – 105	---	---	---
Moderate[2]	0.10 – 0.20	150 – 1,500	II, IP (MS), IS (MS), P (MS), I (PM) (MS), I (SM) (MS)	0.50	4,000
Severe	0.20 – 2.00	1,500 – 10,000	V	0.45	4,500
Very severe	Over 2.00	Over 10,000	V plus pozzolan[3]	0.45	4,55

1 psi = 6.8948 kPa

Notes:

1. A lower water-cementitious material ratio or higher strength may be required for low permeability or for protection against items or freezing and thawing (Table 1904B).
2. Sea water.
3. Pozzolan that has been determined by test or service record to Improve sulfate resistance when used in concrete containing Type V cement

Table 1904E
Maximum Chloride ton Content for Corrosion Protection

Type of Member	Maximum Water Soluble Chloride Ion (Cl^-) in Concrete (% by Weight of Cement)
Prestressed concrete	0.06
Reinforced concrete exposed to chloride in service	0.15
Reinforced concrete that will be dry or protected from moisture in service	1.00
Other reinforced concrete construction	0.30

1905 CONCRETE QUALITY

1905.1 General

1905.1.1 Concrete shall be proportioned to provide an average compressive strength as prescribed in 1905.3.2 as well as satisfy the durability requirements in 1904. Concrete shall be produced to minimize frequency of strengths below f'_c as prescribed in 1905.6.2.3. The specified compressive strength f'_c for concrete designed and constructed in accordance with this chapter shall be not less than 2,500 psi (17.2 MPa).

1905.1.2 Requirements for f'_c shall be based on tests of cylinders made and tested as prescribed in 1905.6.2.

1905.1.3 Unless otherwise specified, f'_c shall be based on 28-day tests. If other than 28 days, test age of f'_c shall be as indicated in design drawings or specifications.

1905.2 Selection of Concrete Proportions

1905.2.1 Proportions of materials for concrete shall be established to provide:

1. Workability and consistency to permit concrete to be worked readily into forms and around reinforcement under conditions of placement to be employed, without segregation or excessive bleeding.
2. Resistance to special exposures as required by 1904.
3. Conformance with strength test requirements of 1905.6.

1905.2.2 Where different materials are to be used for different portions of proposed work, each combination shall be evaluated.

1905.2.3 Concrete proportions, including water-cementitious materials ratio, shall be established on the basis of field experience and/or trial mixtures with materials to be employed as required by 1905.3, except as permitted in 1905.4 or required by 1904.

1905.3 Proportioning on the Basis of Field Experience and/or Trial Mixtures

1905.3.1 Standard Deviation.

1905.3.1.1 Where a concrete production facility has test records, a standard deviation shall be established. Test records from which a standard deviation is calculated:

1. Shall represent materials, quality control procedures, and conditions similar to those expected and changes in materials and proportions within the test records shall not have been more restricted than those for proposed work.
2. Shall represent concrete produced to meet a specified strength or strengths f'_c within 1,000 psi (6900 kPa) of that specified for proposed work.
3. Shall consist of at least 30 consecutive tests or two groups of consecutive tests totaling at least 30 tests as defined in 1905.6.1.4, except as provided in 1905.3.1.2.

1905.3.1.2 Where a concrete production facility does not have test records meeting requirements of 1905.3.1.1, but does have a record based on 15 to 29 consecutive tests, a standard deviation may be established as the product of the calculated standard deviation and modification factor of Table 1905.3A. To be acceptable, test record must meet requirements 1 and 2 of 1905.3.1.1 and represent only a single record of consecutive tests that span a period of not less than 45 calendar days.

1905.3.2 Required Average Strength.

1905.3.2.1 Required average compressive strength f'_{cr} used as the basis for selection of concrete proportions shall be the larger of Eq. (1) or (2) using a standard deviation calculated in accordance with 1905.3.1.1 or 1905.3.1.2.

$$f'_{cr} = f'_c + 1.34s \qquad (1)$$

or

$$f'_{cr} = f'_c + 2.33s - 500 \qquad (2)$$

where s is the standard deviation, psi.

1905.3.2.2 When a concrete production facility does not have field strength test records for calculation of standard deviation meeting requirements of 1905.3.1.1 or 1905.3.1.2, required average strength f'_{cr} shall be determined from Table 1905.3B and documentation of average strength shall be in accordance with requirements of 1905.3.3.

Table 1905.3A
Modification Factor for Standard Deviation When Less Than 30 Tests are Available

Number of Tests[1]	Modification Factor[2] for Standard Deviation
less than 15	Use Table 1905.3B
15	1.16
20	1.08
25	1.03
30 or more	1.00

Notes:
1. Interpolate for Intermediate numbers of tests.
2. Modified standard deviation to be used to determine required average strength f'_{cr} from 1905.3.2.1.

Table 1905.3B
Required Average Compressive Strength When Data is not Available to Establish a Standard Deviation

Specified Compressive Strength, f'_c (psi)	Required Average Compressive Strength f'_{cr} (psi)
less than 3,000	f'_c + 1,000
3,000 to 5,000	f'_c + 1,200
over 5,000	f'_c + 1,400

1psi = 6.8948 kPa

1905.3.3 Documentation of Average Strength. Documentation that proposed concrete proportions will produce an average compressive strength equal to or greater than required average compressive strength (1905.3.2) shall consist of a field strength test record, several strength test records, or trial mixtures.

1905.3.3.1 When test records are used to demonstrate that proposed concrete proportions will produce the required average strength f'_{cr} (1905.3.2), such records shall represent materials and conditions similar to those expected. Changes in materials, conditions, and proportions within the test records shall not have been more restricted than those for proposed work. For the purpose of documenting average strength potential, test records consisting of less than 30, but not less than 10 consecutive tests shall be permitted provided test records encompass a period of time not less than 45 days. Required concrete proportions shall be permitted to be established by interpolation between the strengths and proportions of two or more test records each of which meets other requirements of 1905.3.

1905.3.3.2 When an acceptable record of field test results is not available, concrete proportions may be established based on trial mixtures meeting the following restrictions:

1. Combination of materials shall be those for proposed work.
2. Trial mixtures having proportions and consistencies required for proposed work shall be made using at least three different water-cementitious materials ratios or cementitious materials contents that will produce a range of strengths encompassing the required average strength f'_{cr}.
3. Trial mixtures shall be designed to produce a slump within ±0.75 inches (19 mm) of maximum permitted, and for air-entrained concrete, within ±0.5% of maximum allowable air content.

4. For each water-cementitious materials ratio or cementitious materials content, at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. Cylinders shall be tested at 28 days or at test age designated for determination of f'_c.
5. From results of cylinder tests a curve shall be plotted showing relationship between water-cementitious materials ratio or cementitious materials content and compressive strength at designated test age.
6. Maximum water-cementitious materials ratio or minimum cementitious materials content for concrete to be used in proposed work shall be that shown by the curve to produce the average strength required by 1905.3.2, unless a lower water-cementitious materials ratio or higher strength is required by 1904.

1905.4 Proportioning By Water-Cementitious Materials Ratio

1905.4.1 If data required by 1905.3 are not available, concrete proportions shall be based on water-cementitious materials ratio limits shown in Table 1905.4, if approved by the building official.

1905.4.2 Table 1905.4 shall be used only for concrete to be made with cements meeting strength requirements for Types I, IA, II, IIA, III, IIIA, or V of ASTM C 150, or Types IS, IS-A, IS(MS), IS-A(MS), I(SM), I(SM)-A, IP, IP-A, I(PM), I(PM)-A, IP(MS), IP-A(MS), or P of ASTM C 595 and shall not be applied to concrete containing lightweight aggregates or admixtures other than those for entraining air.

1905.4.3 Concrete proportioned by water-cementitious materials ratio limits prescribed in Table 1905.4 shall also conform to durability requirements of 1904and to compressive strength test criteria of 1905.6.

Table 1905.4
Maximum Permissible Water-Cementitious Materials Ratios for Concrete When Strength Data from Field Experience or Trial Mixtures are not Available

Specific Compressive Strength, f 'c (psi)	Absolute Water-Cementitious Materials Ratio by Weight	
	Nonair-Entrained Concrete	Air-Entrained Concrete
2,500	0.67	0.54
3,000	0.58	0.46
3,500	0.51	0.40
4,000	0.44	0.35
4,500	0.38	Note 2
5,000	Note 2	Note 2

1 psi = 6.8948 kPa

Notes:

1. 28-day strength. With most materials, water-cementitious materials ratios shown will provide average strengths greater than indicated in 1905.3.2 as being required.
2. For strengths above 4,500 psi (nonair-entrained concrete) and 4,000 psi (air-entrained concrete), concrete proportions shall be established by methods of 1905.3.

1905.5 Average Strength Reduction

As data becomes available during construction, amount by which value f'_{cr} must exceed specified value of f'_c may be reduced, provided:

1. 30 or more test results are available and average of test results exceeds that required by 1905.3.2.1 using a standard deviation calculated in accordance with 1905.3.1.1, or

2. 15 to 29 test results are available and average of test results exceeds that required by 1905.3.2.1 using a standard deviation calculated in accordance with 1905.3.1.2, and
3. Durability requirements of 1904are met.

1905.6 Evaluation And Acceptance Of Concrete

1905.6.1Frequency of Testing.

1905.6.1.1 Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 150 cu yd (115 m^3) of concrete nor less than once for each 5,000 sq ft (465 m^2) of surface area for slabs or walls.

1905.6.1.2 On a given project, if total volume of concrete is such that frequency of testing required by 1905.6.1.1 would provide less than five strength tests for a given class of concrete, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are used.

1905.6.1.3 When total quantity of a given class of concrete is less than 50 cu yd (38 m^3), strength tests are not required when evidence of satisfactory strength is submitted to and approved by the building official.

1905.6.1.4 A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at test age designated for determination of f'_c.

1905.6.2 Laboratory-Cured Specimens.

1905.6.2.1 Samples for strength tests shall be taken in accordance with ASTM C 172.

1905.6.2.2 Cylinders for strength tests shall be molded and laboratory-cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39.

1905.6.2.3 Strength level of an individual class of concrete shall be considered satisfactory if both of the following requirements are met:

1. Average of all sets of three consecutive strength tests equal or exceed f'_c.
2. No individual strength test (average of two cylinders) falls below f'_c by more than 500 psi (3450 kPa).

1905.6.2.4 If either of the requirements of 1905.6.2.3 is not met, steps shall be taken to increase the average of subsequent strength test results. Requirements of 1905.6.4 shall be observed if requirement of 1905.6.2.3(2) is not met.

1905.6.3 Field-Cured Specimens.

1905.6.3.1 The building official may require strength tests of cylinders cured under field conditions to check adequacy of curing and protection of concrete in the structure.

1905.6.3.2 Field-cured cylinders shall be cured under field conditions in accordance with ASTM C 31.

1905.6.3.3 Field-cured test cylinders shall be molded at the same time and from the same samples as laboratory-cured test cylinders.

1905.6.3.4 Procedures for protecting and curing concrete shall be improved when strength of field-cured cylinders at test age designated for determination of f'_c is less than 85% of that of companion laboratory-cured cylinders. The 85% may be waived if field-cured strength exceeds f'_c by more than 500 psi (3450 kPa).

1905.6.4 Investigation of Low-Strength Test Results.

1905.6.4.1 If any strength test (1905.6.1.4) of laboratory-cured cylinders falls below specified value of f'_c by more than 500 psi (3450 kPa) (1905.6.2.3(2)) or if tests of field-cured cylinders indicate deficiencies in protection and curing (1905.6.3.4) steps shall be taken to assure that load-carrying capacity of the structure is not jeopardized.

1905.6.4.2 If the likelihood of low-strength concrete is confirmed and computations indicate that load-carrying capacity may have been significantly reduced, tests of cores drilled from the area in question may be required in accordance with ASTM C 42. In such case, three cores shall be taken for each strength test more than 500 psi (3450 kPa) below specified value of f'_c.

1905.6.4.3 If concrete in the structure will be dry under service conditions, cores shall be air dried (temperature 60 to 80°F (15.6 to 26.7°C), relative humidity less than 60%) for 7 days before test and shall be tested dry. If concrete in the structure will be more than superficially wet under service conditions, cores shall be immersed in water for at least 40 hours and be tested wet.

1905.6.4.4 Concrete in an area represented by core tests shall be considered structurally adequate if the average of three cores is equal to at least 85% of f'_c and if no single core is less than 75% of f'_c. Additional testing of cores extracted from locations represented by erratic core strength results shall be permitted.

1905.6.4.5 If criteria of 1905.6.4.4 are not met, and if structural adequacy remains in doubt, the engineer or the building official may order load tests as outlined in Chapter 20 of ACI 318 for the questionable portion of the structure, or take other appropriate action.

1906 MIXING AND PLACING CONCRETE

1906.1 Preparation Of Equipment And Place Of Deposit

Preparation before concrete placement shall include the following:

1. All equipment for mixing and transporting concrete shall be clean.
2. All debris and ice shall be removed from spaces to be occupied by concrete.
3. Forms shall be properly coated.
4. Masonry filler units that will be in contact with concrete shall be well-drenched.
5. Reinforcement shall be thoroughly clean of ice or other deleterious coating.
6. Water shall be removed from place of deposit before concrete is placed unless a tremie is used or unless otherwise permitted by the building official.
7. All laitance and other unsound material shall be removed before additional concrete is placed against hardened concrete.

1906.2 Mixing

1906.2.1 All concrete shall be mixed until there is a uniform distribution of materials and shall be discharged completely before mixer is recharged.

1906.2.2 Ready-mixed concrete shall be mixed and delivered in accordance with requirements of ASTM C 94 or ASTM C 685.

1906.2.3 Job-mixed concrete shall be mixed in accordance with ACI 318.

1906.3 Conveying

1906.3.1 Concrete shall be conveyed from mixer to place of final deposit by methods that will prevent separation or loss of materials.

1906.3.2 Conveying equipment shall be capable of providing a supply of concrete at site of placement without separation of ingredients and without interruptions sufficient to permit loss of plasticity between successive increments.

1906.4 Depositing

1906.4.1 Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or flowing.

1906.4.2 Concreting shall be carried on at such a rate that concrete is at all times plastic and flows readily into spaces between reinforcement.

1906.4.3 Concrete that has partially hardened or been contaminated by foreign materials shall not be deposited in the structure.

1906.4.4 Retempered concrete or concrete that has been remixed after initial set shall not be used unless approved by the engineer.

1906.4.5 After concreting is started, it shall be carried on as a continuous operation until placing of a panel or section, as defined by its boundaries or predetermined joints, is completed except as permitted or prohibited by 1907.4.

1906.4.6 Top surfaces of vertically formed lifts shall be generally level.

1906.4.7 When construction joints are required, joints shall be made in accordance with 1907.4.

1906.4.8 All concrete shall be thoroughly consolidated by suitable means during placement and shall be thoroughly worked around reinforcement and embedded fixtures and into corners of forms.

1906.5 Curing

1906.5.1 Concrete (other than high-early-strength) shall be maintained above 50°F (10°C) and in a moist condition for at least the first 7 days after placement, except when cured in accordance with 1906.5.3.

1906.5.2 High-early-strength concrete shall be maintained above 50°F (10°C) and in a moist condition for at least the first 3 days, except when cured in accordance with 1906.5.3.

1906.5.3 Accelerated curing shall conform to the following:

1. Curing by high pressure steam, steam at atmospheric pressure, heat and moisture, or other accepted processes, shall be permitted to accelerate strength gain and reduce time of curing.
2. Accelerated curing shall provide a compressive strength of the concrete at the load stage considered at least equal to required design strength at that load stage.
3. Curing process shall be such as to produce concrete with a durability at least equivalent to the curing method of 1906.5.1 or 1906.5.2.
4. Supplementary strength tests in accordance with 1905.6.3 may be required to assure that curing is satisfactory.

1906.6 Cold Weather Requirements

1906.6.1 Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing weather.

1906.6.2 All concrete materials and all reinforcement, forms, fillers and ground with which concrete is to come in contact shall be free from frost.

1906.6.3 Frozen materials or materials containing ice shall not be used.

1906.7 Hot Weather Requirements

During hot weather, proper attention shall be given to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that may impair required strength or serviceability of the member or structure.

1907 FORMWORK, EMBEDDED PIPES, AND CONSTRUCTION JOINTS

1907.1 Design Of Formwork

1907.1.1 Forms shall result in a final structure that conforms to shapes, lines, and dimensions of the members as required by the design drawings and specifications.

1907.1.2 Forms shall be substantial and sufficiently tight to prevent leakage of mortar.

1907.1.3 Forms shall be properly braced or tied together to maintain position and shape.

1907.1.4 Forms and their supports shall be designed so as not to damage the previously placed structure.

1907.1.5 Design of formwork shall include consideration of the following factors:

1. Rate and method of placing concrete,
2. Construction loads, including vertical, horizontal, and impact loads, and
3. Special form requirements for construction of shells, folded plates, domes, architectural concrete, or similar types of elements.

1907.1.6 Forms for prestressed concrete members shall be designed and constructed to permit movement of the member without damage during application of prestressing force.

1907.2 Removal Of Forms And Shores

1907.2.1 No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to support safely its weight and loads placed thereon.

1907.2.2 Sufficient strength shall be demonstrated by structural analysis considering proposed loads, strength of forming and shoring system, and concrete strength data. Concrete strength data shall be based on tests of field-cured cylinders or, when approved by the building official, on other procedures to evaluate concrete strength. Structural analysis and concrete strength test data shall be furnished to the building official when so required.

1907.2.3 No construction loads exceeding the combination of superimposed dead load plus specified live load shall be supported on any unshored portion of the structure under construction, unless analysis indicates adequate strength to support such additional loads.

1907.2.4 Forms shall be removed in such manner as not to impair safety and serviceability of the structure. All concrete to be exposed by form removal shall have sufficient strength not to be damaged thereby.

1907.2.5 Form supports for prestressed concrete members shall not be removed until sufficient prestressing has been applied to enable prestressed members to carry their dead load and anticipated construction loads.

1907.3 Conduits and Pipes Embedded in Concrete

1907.3.1 Conduits, pipes and sleeves of any material not harmful to concrete and within limitations of 1907.3 shall be permitted to be embedded in concrete with approval of the engineer, provided they are not considered to replace structurally the displaced concrete, except as provided in 1907.3.6.

1907.3.2 Conduits and pipes of aluminum shall not be embedded in structural concrete unless effectively coated or covered to prevent aluminum/concrete reaction or electrolytic action between aluminum and steel.

1907.3.3 Conduits, pipes, and sleeves passing through a slab, wall, or beam shall not impair significantly the strength of the construction.

1907.3.4 Conduits and pipes, with their fittings, embedded within a column shall not displace more than 4% of the area of cross section on which strength is calculated or which is required for fire protection.

1907.3.5 Except when plans for conduits and pipes are approved by the engineer, conduits and pipes embedded within a slab, wall or beam (other than those merely passing through) shall satisfy the following:

1. They shall not be larger in outside dimension than one-third the overall thickness of slab, wall, or beam in which they are embedded.

2. They shall not be spaced closer than three diameters or widths on center.
3. They shall not impair significantly the strength of the construction.

1907.3.6 Conduits, pipes, and sleeves shall be permitted to be considered as replacing structurally in compression the displaced concrete provided:

1. They are not exposed to rusting or other deterioration.
2. They are of uncoated or galvanized iron or steel not thinner than standard Schedule 40 steel pipe.
3. They have a nominal inside diameter not over 2 inches (51 mm) and are spaced not less than three diameters on centers.

1907.3.7 In addition to other requirements of 1907.3, pipes that will contain liquid, gas, or vapor may be embedded in structural concrete under the following conditions:

1. Pipes and fittings shall be designed to resist effects of the material, pressure, and temperature to which they will be subjected.
2. No liquid, gas, or vapor, except water not exceeding 90°F (32°C) nor 50 psi (345 kPa) pressure, shall be placed in the pipes until the concrete has attained its design strength.
3. In solid slabs, piping, unless it is for radiant heating or snow melting, shall be placed between top and bottom reinforcement.
4. Concrete cover for pipes, conduit and fittings shall be not less than 1 1/2 inches (38 mm) for concrete exposed to earth or weather, nor 3/4 inch (19 mm) for concrete not exposed to weather or in contact with ground.
5. Reinforcement with an area of not less than 0.002 times area of concrete section shall be provided normal to piping.
6. Piping and conduit shall be so fabricated and installed that cutting, bending or displacement of reinforcement from its proper location will not be required.

1907.4 Construction Joints

1907.4.1 Surface of concrete construction joints shall be cleaned and laitance removed.

1907.4.2 Immediately before new concrete is placed, all construction joints shall be wetted and standing water removed.

1907.4.3 Construction joints shall be so made and located as not to impair the strength of the structure. Provision shall be made for transfer of shear and other forces through construction joints.

1907.4.4 Construction joints in floors shall be located within the middle third of spans of slabs, beams, and girders. Joints in girders shall be offset a minimum distance of two times the width of intersecting beams.

1907.4.5 Beams, girders, or slabs supported by columns or walls shall not be cast or erected until concrete in the vertical support members is no longer plastic.

1907.4.6 Beams, girders, haunches, drop panels and capitals shall be placed monolithically as part of a slab system, unless otherwise shown in design drawings or specifications.

1908 DETAILS OF REINFORCEMENT

1908.1 General

Details of reinforcement shall comply with the requirements of this section and ACI 318.

1908.2 Bending Reinforcement

1908.2.1 All reinforcement shall be bent cold, unless otherwise approved by the engineer.

1908.2.2 Reinforcement partially embedded in concrete shall not be field bent except as shown on the design drawings or approved by the engineer.

1908.3 Surface Conditions Of Reinforcement

1908.3.1 At time concrete is placed, metal reinforcement shall be free from mud, oil, or other nonmetallic coatings that decrease the bond. Epoxy coating of bars in accordance with the standards listed in ACI 318 is permitted.

1908.3.2 Metal reinforcement, except prestressing tendons, with rust, mill scale, or a combination of both shall be considered satisfactory, provided the minimum dimensions (including height of deformations) and weight of a hand-wire-brushed test specimen are not less than applicable specification requirements in the ASTM standards referenced in ACI 318.

1908.3.3 Prestressing tendons shall be clean and free of oil, dirt, scale, pitting and excessive rust. A light oxide is permissible.

1908.4 Placing Reinforcement

1908.4.1 Reinforcement, prestressing tendons, and ducts shall be accurately placed and adequately supported before concrete is placed, and shall be secured against displacement within tolerances permitted in 1908.4.2.

EXCEPTION: When approved by the engineer, embedded items (such as dowels or inserts) of precast concrete members that either protrude from concrete or remain exposed for inspection may be embedded while the concrete is in a plastic state provided:

1. Embedded items shall not be required to be hooked or tied to reinforcement within plastic concrete.
2. Embedded items shall be maintained in correct position while concrete remains plastic.
3. Embedded items shall be properly anchored to develop required factored loads.

1908.4.2 Unless otherwise specified by the engineer, reinforcement, prestressing tendons, and prestressing ducts shall be placed within the following tolerances:

1. Tolerance for depth "d," and minimum concrete cover in flexural members, walls and compression members shall be as follows:

Member Depth	Tolerance on Depth (d)	Tolerance on Minimum Concrete Cover
$d \leq 8$ in	$\pm$3/8 in	-3/8 in
$d > 8$ in	$\pm$1/2 in	-1/2 in

1 in = 25.4 mm

Except that tolerance for the clear distance to formed soffits shall be minus 1/4 inch (6 mm) and tolerance for cover shall not exceed minus one-third the minimum concrete cover required in the design drawings or specifications.

2. Tolerance for longitudinal location of bends and ends of reinforcement shall be ±2 inches (±51 mm) except at discontinuous ends of members where tolerance shall be ±1/2 inch (±12.7 mm).

1908.4.3 Welded wire fabric (with wire size not greater than W5 or D5) used in slabs not exceeding 10 ft (3048 mm) in span may be curved from a point near the top of slab over the support to a point near the bottom of slab at midspan, provided such reinforcement is either continuous over, or securely anchored at support.

1908.4.4 Welding of crossing bars shall not be permitted for assembly of reinforcement unless approved by the engineer.

1908.5 Spacing Limits For Reinforcement

The clear distance between reinforcing bars, bundled bars, prestressing tendons and ducts shall be in accordance with the limitations of ACI 318.

1908.6 Concrete Protection For Reinforcement

1908.6.1 Concrete cover shall be provided for reinforcement in cast-in-place concrete (non-prestressed) in accordance with Table 1908.6.

Table 1908.6
Cast-In-Place Concrete Reinforcement Protection

Exposure	Minimum Concrete Cover (inches)
Concrete cast against and permanently exposed to earth	3 (76 mm)
Concrete exposed to earth or weather:	
#6 through #18 bars	2 (51 mm)
#5 bar, W31 or D31 wire, and smaller	1 1/2 (38 mm)
Concrete not exposed to weather or in contact with ground:	
Slabs, walls, joists:	
#14 abd #18 bars	1 1/2 (38 mm)
#11 bar and smaller	3/4 (19 mm)
Beams, columns:	
Primary reinforcement, ties, stirrups, spirals	1 1/2 (38 mm)
Shells, folded plate members:	
#6 bar and larger	3/4 (19 mm)
#5 bar, W31 or D31 wire, and smaller	1/2 (12.7 mm)

1908.6.2 The minimum cover for reinforcement in precast concrete manufactured under plant control conditions, and for prestressed concrete shall be in accordance with ACI 318.

1908.6.3 In corrosive environments or other severe exposure conditions, amount of concrete protection shall be suitably increased, and denseness and nonporosity of protecting concrete shall be considered, or other protection shall be provided.

1908.6.4 Exposed reinforcement, inserts, and plates intended for bonding with future extensions shall be protected from corrosion.

1908.6.5 When this code requires a thickness of cover for fire protection greater than the minimum concrete cover specified in 1908.6 or ACI 318, such greater thicknesses shall be used.

1909 SLAB ON GROUND

1909.1 Minimum Thickness

The minimum thickness of concrete floor slabs supported directly on the ground shall be not less than 3 1/2 inches (89 mm) unless designed by an architect or engineer.

1909.2 Vapor Retarder

A vapor retarder consisting of 6 mil (0.152 mm) minimum polyethylene with joint lapped 6 inches (152 mm) and sealed, or other approved materials having a maximum perm rating of 0.5 (2.873 E-11 kg/(Pa • s • m^2)) shall be installed underneath the slab.

EXCEPTIONS: The vapor retarder may be omitted:

1. from detached structures accessory to one and two family dwellings such as garages, utility buildings, or other unheated facilities.
2. from buildings of other uses when migration of moisture through the slab from below will not be detrimental to the intended use of the building.
3. from driveways, walks, patios, and other flat work not likely to be enclosed and heated at a later date,
4. where approved by the building official , based upon local site conditions.

1910 GFRC EXTERIOR WALL PANELS

The minimum thickness of glass fiber reinforced concrete (GFRC) exterior wall panels shall be 3/8 inch (9.5 mm).

EXCEPTIONS:

1. Sandwich wall panels
2. Glass fiber reinforced concrete wall forms which are left in place.

1911 PARAPET WALLS

Provisions for parapet walls are contained in 1507.

1912 SEISMIC PROVISIONS

1912.1 General

The design and construction of reinforced concrete components that resist seismic forces shall conform to the requirements of this section and ACI 318, except as modified by 1912.1.1.

1912.1.1 Modifications to ACI 318. These sections of ACI 318 shall be modified as indicated in items 1 through 13.

1. Modify Section 8.1.2 to read: "Except where load combinations of Standard Building Code 1609 including seismic forces are used, design of nonprestressed reinforced concrete members using Appendix A, Alternate Design Method, is permitted."
2. Replace ACI 318 Section 9.2.3 with 1609 of this code.
3. Add the following definitions to Section 21.1 of AC1 318:

   "Confined region: That portion of a reinforced concrete component in which the concrete is confined by closely spaced special transverse reinforcement restraining the concrete in directions perpendicular to the applied rooms."

   "Joint: That portion of a column bounded by the highest and lowest surfaces of the other members framing into it."

   "Special transverse reinforcement: Reinforcement composed of spirals, closed stirrups, or hoops and supplementary crossties provided to restrain the concrete and qualify the portion of the component, where used, as a confined region."
4. Replace ACI 318 Sections 21.2.1.3 and 21.2.1.4 with the requirements of 1912.3 through 1912.6 of this code.
5. Modify Section 21.2.1.5 to read: "A reinforced concrete structural system not satisfying the requirements of this chapter, including those composed of precast elements, is allowed if it is demonstrated by experimental evidence and analysis that the proposed system will have strength and toughness equal to or exceeding that provided by a comparable monolithic reinforced concrete structure satisfying this chapter."

6. Add the following to the end Section 21.2.5.1: "Post-tensioning tendons are allowed in flexural members of frames provided the average prestress, (f_{pc}), calculated for an area equal to the member's shortest cross-sectional dimension multiplied by the perpendicular dimension, does not exceed 350 psi (2413 kPa)."
7. Add a new Section 21.3.2.5 to read : "For members in which prestressing tendons are used together with ASTM A 706 or ASTM A 615 (Grades 40 or 60) reinforcement to resist earthquake-induced forces, prestressing tendons shall not provide more than one quarter of the strength for both positive moments and negative moments at the joint face. Anchorages for tendons must be demonstrated to perform satisfactorily for seismic loadings. Anchorage assemblies shall withstand, without failure, a minimum of 50 cycles of loading ranging between 40 and 85% of the minimum specified anchored at the exterior face of the joint or beyond."
8. Modify Section 21.3.3.4 to read: "Where hoops are not required, stirrups with 135 degree (2.356 rad) or greater hooks with 6-bar diameter, but not less than 3-inch (76.2 mm), extensions shall be located throughout the length of the member and spaced not more than one-half the distance from the extreme compression fiber to the centroid of tension reinforcement, (d)."
9. Add a new Section 21.4.4.7 to read: "At any section where the nominal strength, (ϕP_n), of the column is less than the sum of the shear, (V_e), computed in accordance with Section 21.7 for all the beams framing into the column above the level under consideration, special transverse reinforcement shall be provided. For beams framing into opposite sides of the column, the moment components are allowed to be assumed to be of opposite sign. For determination of the nominal strength, (P_n), of the column, these moments are allowed to be assumed to result from the deformation of the frame in any one principal axis."
10. Add to the end of Section 21.5.1: "A cast-in-place topping on a present floor system is allowed to serve as a diaphragm provided the cast-in-place topping is proportioned and detailed to resist the design shear forces. Where untopped precast elements are used as diaphragms, the strength reduction factor, (ϕ), for connections between elements shall be 0.5 except that for connection elements that form a continuous tie across and through the untopped element, extending across the diaphragm, the strength reduction factor, (ϕ), shall be 0.7."
11. Renumber existing Sections 21.5.4 and 21.5.5 to Sections 21.5.5 and 21.5.6 respectively, and add a new Section 21.5.4 to read:

    "21.5.4 Coupling beam: A coupling beam (beam which interconnects two shear walls in their own plane) with clear-span-to-effective-depth ratio (1_n/d) of less than four and with factored shear force V_u exceeding $4\sqrt{f'c}\, b_w d$ shall be provided with shear reinforcement as specified in Sections 21.5.4.1 through 21.5.4.3."

    "21.5.4.1 Factored shear force V_u shall be resisted by two intersecting groups of symmetrical diagonally placed bars extending across the full length of the member and adequately anchored within the shear walls. Each group shall consist of a minimum of four bars providing an area A_{vd} not less than that calculated by the following formula:

$$A_{vd} = \frac{V_u}{2f_y \sin a}$$

    where a is the angle between the diagonal reinforcement and the longitudinal axis of the member."

"21.5.4.2 Contribution of the diagonal reinforcement to nominal flexural strength of the coupling beam shall be considered."

"21.5.4.3 Each group of diagonally placed bars shall be enclosed in special transverse reinforcement conforming to Section 21.4.4.1 through 21.4.4.3. For the purpose of computing A_g as per Equations 10-5 and 21-3, minimum cover as specified in Section 7.7 shall be assumed over each group of diagonally placed reinforcing bars."

12. Modify Section 21.7.1.3 to read: "The design shear force, V_u, shall be obtained from the lateral load analysis in accordance with the factored loads and combinations of loads specified in 1609."
13. Modify the title of Section 21.9 to read: "Requirements for Intermediate Moment Frames."

1912.2 Headed Bolts and Headed Stud Anchors in Concrete

Headed bolts and headed stud anchors shall be solidly cast in concrete. The factored loads on embedded headed bolts and headed stud anchors shall not exceed the design strengths determined by 1912.2.2.

1912.2.1 Load factor multipliers. In addition to the load factors in 1607, a multiplier of 2 shall be used if special inspection is not provided or of 1.3 if it is provided. Where anchors are embedded in the tension zone of a member, the load factors in 1609 shall have a multiplier of 3 if special inspection is not provided or of 2 if it is provided.

1912.2.2 Strength of anchors. The strength of headed bolts and headed stud anchors solidly cast in concrete shall be taken as the average of 10 tests for each concrete strength and anchor size or calculated in accordance with 1912.2.2.1 through 1912.2.2.3. The bearing area of headed anchors shall be at least one and one-half times the shank area for anchors of not over 60,000 psi (414 MPa) yield strength.

1912.2.2.1 Strength in tension. The design strength of anchors in tension shall be the minimum of P_s or ϕP_c where:

$$P_s = 0.9A_b f'_s$$

and for an anchor group where the distance between anchors is less than twice their embedment length

$$\phi P_c = \phi\lambda \sqrt{f'c}\,(2.8A_s + 4A_t)$$

or for a single anchor or anchor group where the distance between anchors is equal to or greater than twice their embedment length

$$\phi P_c = \phi\lambda \sqrt{f'c}\,(2.8A_s)$$

where

Ab = Area (sq in) of bolt or stud. Must be used with the corresponding steel properties to determine the weakest part of the assembly in tension. In shear, the insert leg need not be checked.

As = The sloping area (sq in) of an assumed failure surface. For a single anchor or anchor group where the distance between anchors is equal to or greater than twice their embedment length, the surface is assumed to be that of a truncated cone radiating at a 45° (0.785 rad) slope from the bearing edge of the anchor to the surface.

For an anchor group where the distance between anchors is less than twice their embedment length, the failure surface is assumed to be that of a truncated pyramid radiating at a 45° (0.785 rad) slope from the bearing edge of the anchor group to the surface.

In addition, for thin sections with anchor groups, the failure surface shall be assumed to follow the extension of this slope through to the far side rather than truncate as in A_t (i.e., $A_t = 0$) and the failure mode resulting in the lower value of ϕP_c shall control.

A_t = The area (sq in) of the flat bottom of the truncated pyramid of an assumed concrete failure surface. Where anchors in a group are closer than twice their embedment length, the failure surface pyramid is assumed to truncate at the anchor bearing edge rather than form separate cones.

f'_c = Specified compressive strength of concrete (psi), which shall not be taken greater than 6,000 psi (41 MPa) for design.

f'_s = Ultimate tensile strength (psi) of the bolt, stud, or insert leg wires, which shall not be taken greater than 60,000 psi (414 MPa). For A307 bolts or A108 studs, f'_s shall be permitted to be assumed to be 60,000 psi (414 MPa).

P_u = Tensile strength required due to factored loads (lb).

Vu = Shear strength required due to factored loads (lb).

λ = 1 for normal weight concrete, 0.75 for "all lightweight" concrete, and 0.85 for "sand-lightweight" concrete.

ϕ = Strength reduction factor shall be taken as 0.65, except ϕ is permitted to be taken as 0.85 where the anchor is attached to or hooked around reinforcing steel or otherwise terminated so as to effectively transfer forces to reinforcing steel that is designed to distribute forces and avert sudden local failure.

Where edge distance is less than embedment length , reduce ϕP_c proportionately. For multiple edge distances less than the embedment length, use multiple reductions.

1912.2.2.2 Strength in shear. The design strength of anchors in shear shall be the minimum of V_s or ϕV_c where:

$$V_s = 0.75 A_b f'_s$$

and where loaded toward an edge equal to or greater than 10 diameters away

$$\phi V_c = \phi 800 A_b \, {}_e\lambda \sqrt{f'_c}$$

or where loaded toward an edge less than 10 diameters away

$$\phi V_c = \phi 2\pi d_e^2 \, {}_e\lambda \sqrt{f'_c}$$

where d_e = distance from the anchor axis to the free edge.

For groups of anchors, the concrete design shear strength shall be taken as the smallest of:

1. The design strength of the weakest stud times the number of studs,
2. The design strength of the row of studs nearest the free edge in the direction of shear times the number of rows, or
3. The design strength of the row farthest from the free edge in the direction of shear.

For shear loading toward an edge less than 10 diameters away, or tension or shear not toward an edge less than 4 diameters away, reinforcing sufficient to carry the load shall be provided to prevent failure of the concrete in tension. In no case shall the edge distance be less than one-third the above.

1912.2.2.3 Combined tension and shear. Where tension and shear act simultaneously, both of the following shall be met:

$$\frac{1}{\phi}\left[\left(\frac{P_u}{P_c}\right)^2 + \left(\frac{V_u}{V_c}\right)^2\right] \leq 1$$

and

$$\left[\left(\frac{P_u}{P_s}\right)^2 + \left(\frac{V_u}{V_s}\right)^2\right] \leq 1$$

1912.2.3 Special provisions for anchor bolts in tops of columns. Anchor bolts at the tops of columns shall be enclosed with not less than two #4 ties located within 4 inches (102 mm) from the top of the column. Anchor bolts in the tops of columns shall be embedded not less than 9-bolt diameters.

1912.3 Moment Frames

Moment frames shall comply with 1912.3.1, 1912.3.2, or 1912.3.3.

1912.3.1 Ordinary moment frames. Ordinary moment frames shall comply with the requirements of ACI 318, exclusive of Chapter 21.

1912.3.2 Intermediate moment frames. Intermediate moment frames shall comply with the requirements of Section 21.9 of ACI 318, and with the requirements of 1912.3.1 for ordinary moment frames.

1912.3.3 Special moment frames. Special moment frames shall comply with the requirements of Sections 21.2 through 21.4, 21.6 and 21.7 of ACI 318 as modified in 1912.1.1, and with the requirements of 1912.3.1 for ordinary moment frames.

1912.4 Seismic Performance Categories A and B

Buildings assigned to category A or B per 1607.1 are allowed to be of any construction permitted in ACI 318 and this code. In addition, in category B buildings ordinary moment frames forming part of the seismic resisting system shall comply with 1912.4.1.

1912.4.1 Ordinary moment frames in category B. In category B buildings in flexural members of ordinary moment frames forming part of the seismic resisting system, at least two main flexural reinforcing bars shall be provided continuously top and bottom throughout the flexural members, and extending through or developed within exterior columns or boundary members.

1912.5 Seismic Performance Category C

Buildings assigned to category C shall conform to all the requirements for category B, and the requirements of 1912.5.1 and 1912.5.2.

1912.5.1 Moment frames. All moment frames that are part of this seismic resisting system shall be intermediate moment frames conforming to 1912.3.2, or special moment frames conforming to 1912.3.3.

1912.5.2 Discontinuous members. Columns supporting reactions from discontinuous stiff members such as walls shall be provided with special transverse reinforcement at the spacing, (s_o), as defined in Section 21.9.5.1 of ACI 318 over their full height beneath the level at which the discontinuity occurs. This special transverse reinforcement shall be extended above and below the column as required by Section 21.4.4.5 of ACI 318.

1912.6 Seismic Performance Categories D and E

Buildings assigned to category D or E shall conform to all of the requirements for category C, and the requirements of 1912.6.1 through 1912.6.3.

1912.6.1 Moment frames. All moment frames that are part of the seismic resisting system, regardless of height, shall be special moment frames conforming to 1912.3.3.

1912.6.2 Seismic resisting system. All materials and components in the seismic resisting system shall conform to Sections 21.2 through 21.7 in ACI 318, as modified by 1912.1.1.

1912.6.3 Frame members not proportioned to resist earthquake forces. All frame components which are not part of the seismic resisting system shall conform to 1607.3.3.4.3 and to Section 21.8.1.1 or 21.8.1.2, and 21.8.2 of ACI 318.

1913 SEISMIC REQUIREMENTS FOR PLAIN CONCRETE

1913.1 General

The design and construction of plain con c rete component s that resist seismic forces shall conform to the requirements of ACI 318.1, except as modified by this section.

1913.2 Seismic Performance Categories A and B

Structural members of plain concrete permitted by ACI 318.1 or by this code are permitted in buildings assigned to category A or B.

1913.3 Seismic Performance Category C

Structural members of plain concrete in buildings assigned to category C shall conform to all the requirements for categories A and B and the additional provisions and limitations of this section.

1913.3.1 Footings. Plain concrete footings supporting walls shall be provided with not less than two continuous longitudinal reinforcing bars. Bars shall not be smaller than #4, and have a total area of not less than 0.002 times the gross cross-sectional area of the footing. Continuity of reinforcing shall be provided at corners and intersections.

1913.3.2 Pedestals. Plain concrete pedestals shall not be used to resist lateral forces due to earthquakes.

1913.3.3 Walls. Basement and foundation walls shall be reinforced as specified in ACI 318.1. Other walls shall be reinforced vertically and horizontally as required by the following:

1. Vertical reinforcing consisting of at least one #4 bar shall be provided continuously from support to support at each corner, at each side of each opening and at ends of walls or panels.
2. Horizontal reinforcing consisting of at least one #4 bar shall be provided at the top and bottom of each wall opening, extending not less than 24 inches (610 mm) beyond the sides of the opening.
3. Horizontal reinforcing consisting of at least one #4 bar shall be provided continuously at structurally connected roofs and floors, the top of walls, at the bottom of the wall or in the top of the foundation when the foundation is doweled to the wall, and at a maximum vertical spacing of 10ft (3.05 m). Reinforcing at the top and bottom of wall openings shall be continuous to qualify as reinforcing required at a maximum vertical spacing of 10 ft (3.05 m).

1913.4 Seismic Performance Categories D and E

Structural members of plain concrete are not permitted in buildings assigned to category D or E.

EXCEPTIONS:

1. In buildings of Use Group R3 of wood frame construction, plain concrete footings without longitudinal reinforcement supporting walls, and plain concrete column footings are permitted.
2. In all other buildings, plain concrete footings supporting walls shall be permitted provided they are reinforced longitudinally as specified in 1913.3.1.
3. In buildings of Use Group R3, plain concrete foundation or basement walls having a thickness of not less than 7 1/2 inches (191 mm) and retaining 4ft (1219 mm) or less of unbalanced fill shall be permitted.

1914 REINFORCED GYPSUM CONCRETE

1914.1Standard Specifications

Reinforced poured gypsum concrete shall conform to the requirements of ASTM C 317. The design and application of reinforced gypsum concrete shall be in accordance with the requirements of ASTM C 956.

1914.2 Inspection

A competent inspector, satisfactory to the building official, shall be present on the work at all times when cast-in-place gypsum concrete is being mixed or deposited.

CHAPTER 20

LIGHT METAL ALLOYS

2001 GENERAL

2001.1 Scope

Provisions of this chapter shall govern the quality, design, fabrication and erection of light metal alloys used in building construction.

2002 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

2003 STRUCTURAL ALUMINUM

2003.1 General

The quality, design, fabrication and erection of aluminum used structurally in buildings or structures shall conform to good engineering practice, the provisions of this chapter and other applicable requirements of this code.

2003.2 Structural Aluminum Construction

The design, fabrication and assembly of structural aluminum for buildings or structures shall conform to Specifications for Aluminum Structures, Aluminum Construction Manual, Section 1, of the Aluminum Association. The use of aluminum alloys not listed in the Manual shall be permitted provided their standard of performance is not less than those required in the Manual and the performance is substantiated to the satisfaction of the building official.

CHAPTER 21

MASONRY

2101 GENERAL

2101.1 Scope

2101.1.1 The provisions of this chapter shall govern the materials, design construction and quality of masonry.

2101.1.2 Masonry shall comply with 2103.1 Engineered Masonry Design or 2103.2 Empirical Masonry Design.

2101.2 Construction Documents

Drawings and details shall show all the items required to be shown on the drawings by the code including the following:

1. Specified size, grade, type and location of reinforcement, anchors and wall ties.
2. Reinforcing bars to be welded and welding procedure.
3. Size and location of all structural elements.
4. Provision for dimensional changes resulting from elastic deformation, creep, shrinkage, temperature and moisture.

2101.3 Support

2101.3.1 Lintels. Masonry directly above chases or recesses wider than 12 inches (305 mm) shall be supported on lintels. The design for lintels shall be in accordance with 2103.1. Minimum end bearing shall be 4 inches (102 mm).

2101.3.2 Support on Wood. No masonry shall be supported on wood girders or other form of wood construction.

EXCEPTIONS:

1. Prefabricated partitions weighing not more than 30 psf (146 kg/m^2) may be supported on combustible construction provided the supporting construction has been designed to carry such loads. Partitions shall be properly strapped or reinforced and provided with proper nailing devices for attachment.
2. Glass block units may be installed in accordance with 2112, provided the supporting construction has been designed to carry such loads. Panels shall be properly anchored and reinforced.
3. Masonry veneers having an installed weight of 40 psf (195 kg/m^2) or less may be used as an interior wall finish when installed in conformance with the provisions of 1403.2. When the masonry veneer is supported by wood floor construction, the floor shall be designed to limit deflection to 1/600 of the span of the supporting members.

2102 DEFINITIONS

The following words and terms shall, for the purposes of this chapter and as stated elsewhere in this code, have the meanings shown herein. Refer to Chapter 2 for general definitions.

ANCHOR – metal rod, wire or strap that secures masonry to its structural support.

AREA, GROSS CROSS-SECTIONAL – the areas delineated by the out-to-out dimensions of masonry in the plane under consideration.

BED JOINT – the horizontal layer of mortar on which a masonry unit is laid.

CAST STONE – a building stone manufactured from portland cement concrete precast and used as a trim, veneer or facing on or in buildings or structures.

COLLAR JOINT – vertical longitudinal joint between wythes of masonry or between masonry and backup construction which is permitted to be filled with mortar or grout

CONNECTOR – a mechanical device for securing two or more pieces, parts, or members together; including anchors, wall ties, and fasteners.

DIAPHRAGM – a roof or floor system designed to transmit lateral forces to shear walls or other vertical resisting elements.

DIMENSIONS, NOMINAL – equal to the actual dimension plus the width of the mortar joint Dimensions and thicknesses specified in this chapter are nominal dimensions.

EFFECTIVE HEIGHT – clear height of a braced member between lateral supports and used for calculating the slenderness ratio of a member. Effective height for unbraced members shall be calculated.

HEAD JOINT – vertical mortar joint placed between masonry units within the wythe at the time the masonry units are laid.

HEADER (BONDER) – a masonry unit that connects two or more adjacent wythes of masonry.

MASONRY – that form of construction composed of stone, brick, concrete, gypsum, hollow clay tile, concrete block or tile, glass block or other similar building units or materials or a combination of these materials laid up unit by unit and set in mortar.

MASONRY, FILLED CELL – that form of solid masonry in which the aligned, unobstructed vertical cells of hollow units are filled with grout.

MASONRY, GROUTED – that form of solid masonry in which the interior vertical spaces are filled with grout, except that cores of solid masonry units and end spaces of stretcher units need not be grouted.

MASONRY, HOLLOW – construction built with masonry units whose net cross-sectional area in every plane parallel to the bearing surface is less than 75% of its gross cross-sectional area measured in the same plane.

MASONRY, SOLID – construction built with masonry units whose net cross-sectional area of cored brick in any plane parallel to the surface containing the cores shall be at least 75% 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.

RUNNING BOND – the placement of masonry units such that head joints in successive courses are horizontally offset at least one quarter of the unit length.

STACK BOND – the placement of masonry units in a bond pattern such that head joints in successive courses are vertically aligned. For the purpose of this code, requirements for stack bond shall apply to all masonry laid in other than running bond.

STONE MASONRY – masonry composed of field, quarried, or cast stone units bonded by mortar.

STONE MASONRY, ASHLAR – stone masonry composed of rectangular units having sawed, dressed, or squared bed surfaces and bonded by mortar.

STONE MASONRY, RUBBLE – stone masonry composed of irregular shaped units bonded by mortar.

TIE, WALL – metal connector which connects wythes of masonry walls together.

WALL, CAYITY – a wall built of masonry units or of plain concrete, or a combination of these materials, so arranged as to provide a continuous air space within the wall, and in which the inner and outer wythes of the wall are tied together with metal ties.

WALL, COMPOSITE MASONRY – a multiple-wythe wall in which at least one of the wythes is dissimilar to the other wythe or wythes with respect to type or grade of masonry unit or mortar and so bonded as to exert a common action under load.

WALL, HOLLOW MASONRY – a wall built of masonry units so arranged as to provide an air space within the wall, and in which the inner and outer wythes of the wall are bonded together with masonry units.

WALL, MASONRY VENEER – a wall having a facing of masonry units securely attached to the backing for the purpose of providing ornamentation, protection, or insulation, but not so bonded to exert common action under load.

WYTHE – each continuous, vertical section of a wall, one masonry unit in thickness.

2103 DESIGN

2103.1 Engineered Masonry Design

Engineered masonry shall conform to the requirements of Chapter 1 through 8 of ACI 530/ASCE 5/TMS 402 or BIA Building Code Requirements for Engineered Brick Masonry.

2103.2 Empirical Masonry Design

2103.2.1 Empirically designed masonry shall conform to this chapter.

EXCEPTION: Masonry veneer designed and constructed in accordance with 1403.2 and 1403.3.

2103.2.2 Empirical masonry design is permitted provided the building conforms to the following criteria:

1. The building is located in Seismic Performance Category A according to 1607.1; and
2. If greater than 35 feet (10.7 m) in height, the building does not rely on masonry walls for lateral load resistance.

2103.2.3 Buildings which do not comply with one or more of the above shall be designed in accordance with the engineered design provisions of 2103.1. Members which are not part of the lateral force resisting system of the building are permitted to be designed m accordance with the empirical design provisions of 2103.2.

2103.3 Seismic Requirements

2103.3.1 General. Masonry shall comply with 2103.3 2 and 2103.3.3 based on the Seismic Performance Category assigned in accordance with 1607.1.8.

2103.3.2 Seismic Performance Category A. Masonry in buildings assigned to Seismic Performance Category A shall comply with the requirements of either 2103.1 or 2103.2.

2103.3.3 Seismic Performance Category B, C, D or E. Masonry in buildings assigned to Seismic Performance Category B, C, D or E shall comply with the requirements of 2115.

2104 MATERIALS

2104.1 Concrete Masonry Units

Concrete masonry units shall conform to one of the following standards; ASTM C 55, ASTM C 73, ASTM C 90, and ASTM C 744.

2104.2 Clay or Shale Masonry Units

Clay or shale masonry units shall conform to the following standards for the intended uses specified therein: ASTM C 34, ASTM C 56, ASTM C 62, ASTM C 126, ASTM C 212, ASTM C 216, ASTM C 530, ASTM C 652 and ASTM C 1088.

EXCEPTION: Structural clay tile for nonstructural use in fireproofing of structural members and in wall furring shall not be required to meet the compressive strength specifications. The fire resistance rating shall be determined in accordance with 701.2 and comply with the requirements of Table 600.

2104.3 Stone Masonry Units

Stone masonry units shall conform to one of the following standards: ASTM C 503, ASTM C 568, ASTM C 615, ASTM C 616, and ASTM C 629.

2104.4 Ceramic Tile

Ceramic tile shall be as defined in ANSI A137.1 and shall conform to the requirements of ANSI A137.1.

2104.5 Glass Block

Glass block shall be partially evacuated, hollow masonry units made of clear, colorless glass (with or without a highly reflective oxide surface coating), having a thickness of not less than 3 1/8 inches (79 mm) or shall be solid glass block units, having a thickness of not less than 3 inches (76 mm).

2104.6 Secondhand Units

Secondhand masonry units shall not be reused unless the units conform to the requirements for new units. The units shall be of whole sound material and be free from cracks and other defects that would interfere with proper laying or use. All old mortar shall be cleaned from the units before reuse.

2104.7 Mortar and Grout

2104.7.1 Mortar for use in masonry construction shall comply with ASTM C 270 for Mortar for Unit Masonry.

2104.7.1.1 Mortar shall conform to the proportion specifications of Table 2104.7A or the property specifications of Table 2104.7B.

2104.7.2 Grout for use in masonry construction shall comply with ASTM C 476 for Grout for Reinforced and Non-Reinforced Masonry.

2104.7.2.1 Grout shall conform to the proportion specifications of Table 2104.7C.

Table 2104.7A
Mortar Proportons[1,2]

Mortar	Type	Proportions by Volume (Cementitious Materials)					Aggregate Ratio (Measured in Damp, Loose Conditions)
		Portland Cement or Blended Cement	Masonry Cement			Hydrated Lime or Lime Putty	
			M	S	N		
Cement-lime	M	1	---	---	---	1/4	Not less than 2 1.4 and not more than 3 times the sum of separate volumes of lime, if used, and cement
	S	1	---	---	---	over 1/4 to 1/2	
	N	1	---	---	---	over 1/2 to 1 1/4	
	O	1	---	---	---	over 1 1/4 to 2 1/2	
Masonry Cement	M	1	---	---	1	---	
	M	---	1	---	---	---	
	S	1/2	---	---	1	---	
	S	---	---	1	---	---	
	N	---	---	---	1	---	
	O	---	---	---	1	---	

1 lb = 0.4536 kg

1 cu ft = 0.02832 **m3**

Notes:

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

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

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

Table 2104.7B
Mortar Properties[4]

Mortar	Type	Average Compressive[1] Strength at 28 Days, Min. (psi)	Water Retention Min. (%)	Air Content, Max. (%)
Cement-lime	M	2,500	75	12
	S	1,800	75	12
	N	750	75	14[2]
	O	350	75	14[2]
Masonry cement	M	2,500	75	Note 3
	S	1,800	75	Note 3
	N	750	75	Note 3
	O	350	75	Note 3

1 psi = 6.895 kPa

Notes:

1. Average of three 2-inch cubes of laboratory prepared mortar, in accordance with ASTM C 270.
2. When structural reinforcement is incorporated in cement-lime mortars, the maximum air content shall not exceed 12%.
3. When structural reinforcement is incorporated in masonry cement mortar, the maximum air content shall not exceed 18%.
4. The aggregate ratios (measured in damp, loose conditions) shall be not less than 2 1/4 and not more than 3 1/2 times the sum of the separate volumes of cementitious materials.

Table 2104.7C
Grout Proportions by Volume for Masonry Construction

Type	Portland Cement or Blended Cement Slag Cement	Hydrated Lime or Lime Putty	Aggregate Measured in a Damp, Loose Condition	
			Fine	Coarse
Fine	1	0 to 1/10	2 1/4 to 3 times the sum of the volumes of the cementitious materials	---
Coarse	1	0 to 1/10	2 1/4 to 3 times the sum of the volumes of the cementitious materials	1 to 2 times the sum of the volumes of the cementitious materials

2104.8 Surface-bonding Mortar

Surface-bonding mortar shall comply with ASTM C 887. Surface bonding of concrete masonry units shall comply with ASTM C 946.

2104.9 Metal Reinforcement and Accessories

2104.9.1 Deformed Reinforcing Bars. Deformed reinforcing bars shall conform to the following standards: ASTM A 615, ASTM A 616, ASTM A 617, and ASTM A 706.

2104.9.2 Joint Reinforcement.

2104.9.2.1 Joint reinforcing wire shall conform to the following standards: ASTM A 82 and ASTM A 167, Type 304.

2104.9.2.2 Longitudinal wires shall be deformed. One set of two deformations shall occur around the perimeter of the wire at a maximum spacing of 0.7 times the diameter of the wire but not less than eight sets per inch (25.4 mm) of length. The overall length of each deformation within the set shall be such that the summation of gaps between the ends of the deformations shall not exceed 33 percent of the perimeter of the wire. The indentation depth of the deformations shall be 0.006 inch ± 0.003 inch (0.15 ± 0.076 mm).

2104.9.3 Deformed Reinforcing Wire. Deformed reinforcing wire shall conform to ASTM A 496.

2104.9.4 Wire Fabric. Wire fabric shall conform to ASTM A 185 or ASTM A 497.

2104.9.5 Anchors, Ties and Accessories. Anchors, ties and accessories shall conform to ASTM A 36, ASTM A 82, ASTM A 167, Type 304, ASTM A 185, or ASTM A 366.

2104.9.6 Corrosion Protection. Joint reinforcement anchors, wall ties and accessories, except those of stainless steel (ASTM A 167, Type 304), shall be protected from corrosion by galvanizing as follows. Metal accessories for use in exterior wall construction shall be hot dipped galvanized after fabrication with a minimum coating of 1.50 ounces per sq ft (0.458 kg/m^2) in accordance with ASTM A 153. Metal accessories for use in interior wall construction shall be mill galvanized with a minimum coating of 0.1 ounce per sq ft (0.031 kg/m^2) in accordance with ASTM A 641 or ASTM A 525, Class G-60.

2104.9.7 Tests. Where unidentified reinforcement is approved for use, not less than three tension and three bending tests shall be made on representative specimens of the reinforcement from each shipment and grade of reinforcing steel proposed for use in the work.

2104.10 Mortars For Ceramic Wall and Floor Tile

Portland cement mortars for installing ceramic wall and floor tile shall comply with ANSI A108.1 and be of the compositions indicated in Table 2104.10.

Table 2104.10
Ceramic Tile Mortar Compositions

Location	Coat	Composition
Walls	Scratchcoat	1 cement; 1/5 hydrated lime; 4 dry or 5 damp sand
	Setting bed and leveling coat	1 cement; 1/2 hydrated lime; 5 damp sand to 1 cement; 1 hydrated lime; 7 damp sand
Flooring	Setting bed	1 cement; 1/10 hydrated lime; 5 dry or 6 damp sand; or 1 cement; 5 dry or 6 damp sand
Ceilings	Scratchcoat and sand bed	1 cement; 1/2 hydrated lime; 2 1/2 dry sand or 3 damp sand

2104.10.1 Dry-set Portland Cement Mortars. Premixed prepared portland cement mortars, which require only the addition of water and which are used in the installation of ceramic tile, shall comply with ANSI A118.1. The shear bond strength for tile set in such mortar shall be as required in accordance with that standard. Tile set in dry-set portland cement mortar shall be installed in accordance with ANSI A108.5.

2104.10.2 Electrically Conductive Dry-set Mortars. Premixed prepared portland cement mortars, which require only the addition of water and which comply with ANSI A118.2, shall be used in the installation of electrically conductive ceramic tile. Tile set in electrically conductive dry-set mortar shall be installed in accordance with ANSI A108.7.

2104.10.3 Latex-modified Portland Cement Mortars. Latex-modified portland cement thin-set mortars, in which latex is added to dry-set mortar as a replacement for all or part of the gaging water, which are used for the installation of ceramic tile shall comply with ANSI A118.4. Tile set in latex-modified portland cement shall be installed in accordance with ANSI A108.5.

2104.10.4 Epoxy Mortar. Ceramic tile set and grouted with chemical resistant epoxy shall comply with ANSI A118.3. Tile set and grouted with epoxy shall be installed in accordance with ANSI A108.6.

2104.10.5 Furan Mortar and Grout. Chemical-resistant furan mortar and grout which are used to install ceramic tile shall comply with ANSI A118.5. Tile set and grouted with furan shall be installed in accordance with ANSI A108.8.

2104.10.6 Modified Epoxy-emulsion Mortar and Grout. Modified epoxy-emulsion mortar and grout which are used to install ceramic tile shall comply with ANSI A118.8. Tile set and grouted with modified epoxy- emulsion mortar and grout shall be installed in accordance with ANSI A108.9.

2104.10.7 Organic Adhesives. Water resistant organic adhesives used for the installation of ceramic tile shall comply with ANSI A136.1. The shear bond strength after water immersion shall not be less than 40 psi (0.028 kg/mm^2) for Type I adhesives, and not less than 20 psi (0.014 kg/mm^2) for Type II adhesive, when tested in accordance with ANSI A136.1. Tile set in organic adhesives shall be installed in accordance with ANSI A108.4.

2104.10.8 Portland Cement Grouts. Portland cement grouts used for the installation of ceramic tile shall comply with ANSI A118.6. Portland cement grouts for tilework shall be installed in accordance with ANSI A108.10.

2104.11 Grout

Grout shall conform to ASTM C 476.

2105 LATERAL STABILITY

2105.1 Shear Walls

Where the structure depends upon masonry walls for lateral stability, shear walls shall be provided parallel to the direction of the lateral forces resisted.

2105.1.1 Shear Wall Thickness. Minimum nominal thickness of masonry shear walls shall be 8 inches (203 mm).

EXCEPTION: Shear walls of one story buildings are permitted to be a minimum nominal thickness of 6 inches (152 mm).

2105.1.2 Cumulative Length of Shear Walls. In each direction in which shear walls are required for lateral stability, the minimum cumulative length of shear walls provided shall be 0.4 times the long dimension of the building. Cumulative length of shear walls shall not include openings.

2105.1.3 Maximum Diaphragm Ratio. Masonry shear walls shall be provided so that the span to width or depth ratio of floor or roof diaphragms does not exceed that indicated in Table 2105.1.

Table 2105.1
Maximum Span to Width (Depth) Ratio of Floor and Roof Diaphragms

Floor or Roof Diaphragms Construction	Maximum Span to Width (Depth) Ratio of Diaphragm
Cast-in-place concrete	5:1
Precast concrete	4:1
Metal deck with concrete fill	3:1
Metal deck no fill	2:1
Wood diaphragm	2:1

2105.2 Roofs

The roof construction shall be designed so as not to impart out of plane lateral thrust to the walls under roof gravity load.

2105.3 Surface-bonded Walls

Dry-stacked, surface-bonded concrete masonry walls shall comply with the requirements of this code for masonry wall construction, except where otherwise noted in this section.

2105.3.1 Strength. Dry-stacked, surface-bonded concrete masonry walls shall be of adequate strength and proportions to support all superimposed loads without exceeding the allowable stresses listed in Table 2105.3.1. Allowable stresses not specified in Table 2105.3.1 shall comply with the requirements of ACI 530/ASCE 5/TMS 402.

Table 2105.3.1
Allowable Stress Gross Cross-Sectional Area for Dry-Stacked, Surface-Bonded Concrete Masonry Walls

Description		Maximum Allowable Stress, psi (MPa)
Compression: standard block		45 (0.31)
Shear		10 (0.069)
Flexural tension:	vertical span	18 (0.12)
	horizontal span	30 (0.21)

2105.4 Construction

Construction of dry-stacked, surface-bonded masonry walls, including stacking and leveling of units, mixing and application of mortar, curing and protection, shall comply with ASTM C 946.

2106 COMPRESSIVE STRESS REQUIREMENTS

2106.1Vertical Dead Plus Live Loads

Compressive stresses in masonry due to vertical dead plus live loads, excluding wind or seismic loads, shall be determined in accordance with 2106.2.1. Dead and live loads shall be in accordance with Chapter 16, with live load reductions as permitted in 1604.2.

2106.2 Maximum Values

The compressive stresses in masonry shall not exceed the values given in Table 2106.2. Stress shall be calculated based on actual rather than nominal dimensions.

2106.2.1 Calculated Compressive Stresses. Calculated compressive stresses for single wythe walls and for multiwythe composite masonry walls shall be determined by dividing the design load by the gross cross-sectional area of the member. The area of openings, chases, or recesses in walls shall not be included in the gross cross-sectional area of the wall.

2106.2.2 Multiwythe Walls. The allowable stress shall be as given in Table 2106.2 for the weakest combination of the units and mortar used in each wythe.

Table 2106.2
Allowable Compressive Stresses for Empirical Design of Masonry

Construction Compressive Strength of Unit, Gross Area, psi (MPa)	Allowable Compressive Stresses Gross Cross-Sectional Area, psi (MPa)[1]	
	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 (55) or greater	350 (2.4)	300 (2.1)
4,500 (31)	225 (1.6)	200 (1.4)
2,500 (17)	160 (1.1)	140 (0.97)
1,500 (10)	115 (0.79)	100 (0.69)
Grouted masonry, of clay or shale, sand-lime or concrete:		
4,500 (31) or greater	225 (1.55)	200 (1.4)
2,500 (17)	160 (1.10)	140 (0.97)
1,500 (10)	115 (0.792)	100 (0.69)
Solid masonry of solid concrete masonry units:		
3,000 (21) or greater	225 (1.55)	200 (1.4)
2,000 (14)	160 (1.10)	140 (0.97)
1,200 (8.3)	115 (0.792)	100 (0.69)
Masonry or hollow load bearing units:		
2,000 (14) or greater	140 (0.97)	120 (0.83)
1,500 (10)	115 (0.79)	100 (0.69)
1,000 (6.9)	75 (0.52)	70 (0.48)
700 (4.8)	60 (0.41)	55 (0.38)
Hollow walls (noncomposite masonry bonded2):		
Solid units		
2,500 (17) or greater	160 (1.10)	140 (0.97)
1,500 (10)	115 (0.792)	100 (0.69)
Hollow units	75 (0.52)	70 (0.48)
Stone ashlar masonry:		
Granite	720 (5.0)	640 (4.4)
Limestone or marble	450 (3.1)	400 (2.8)
Sandstone or cast stone	360 (2.5)	320 (2.2)
Rubble stone masonry:		
Coarse, rough, or random	120 (0.83)	100 (0.69)

Notes:

1. Linear interpolation for determining allowable stresses for masonry units having compressive strengths which are intermediate between those given in the table is permitted.
2. 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 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 noncomposite walls unless collar joints are filled with mortar or grout.

2107 LATERAL SUPPORT

2107.1 General

Exterior masonry walls shall be laterally supported in either the horizontal or the vertical direction at intervals not exceeding those given in Tables 2107.1a and b. Interior masonry walls shall be laterally supported in either the horizontal or vertical direction such that the H/t ratio does not exceed 36.

Table 2107.1a
H/t Lateral Support Ratios for Unreinforced Exterior Masonry Walls[1,2,4,5]

	Other than Enclosed Building Design Wind Speed, mph[3]				
Wall Construction	**70**	**80**	**90**	**100**	**110**
Solid Mas. Units	19	17	14	13	11
Hollow concrete Mas. Units or Mas. Bonded Hollow Walls	14	12	10	9	8
Cavity walls, Identical wythes	The H/t ratio shall be 0.70 of the H/t ratio for single wythe walls. The t value shall the sum of the nominal thickness of the individual wythes.				
Cavity walls with wythes of different types or size masonry	The wall shall be designed based on ACI-530 or the H/t ratio may be 0.70 of the H/t ratio of a single wythe hollow wall. The t value shall be the sum of the nominal thickness of the individual wythes.				

Notes:

1. H = clear height or length between lateral supports.
   t = nominal wall thickness.
2. All masonry units shall be laid in Type M, S or N mortar. Where Type N mortar is used and the wall spans in the vertical direction, the ratios shall be reduced by 10%.
3. Design based on partially enclosed building.
4. These values are based on using masonry cement mortar. If nonairentrained portland cement/lime mortar is used the values in the table may be increased by 1.2.
5. Larger H/t ratio's may be used if the design is done in accordance with ACI-530.

Table 2107.1b
H/t Lateral Support Ratios for Unreinforced Exterior Masonry Walls[1,2,4,5]

	Enclosed Building Design Wind Speed, mph[3]				
Wall Construction	**70**	**80**	**90**	**100**	**110**
Solid Mas. Units	23	20	16	15	13
Hollow concrete Mas. Units or Mas. Bonded Hollow Walls	16	14	11	10	9
Cavity walls, Identical wythes	The H/t ratio shall be 0.70 of the H/t ratio for single wythe walls. The t value shall the sum of the nominal thickness of the individual wythes.				
Cavity walls with wythes of different types or size masonry	The wall shall be designed based on ACI-530 or the H/t ratio may be 0.70 of the H/t ratio of a single wythe hollow wall. The t value shall be the sum of the nominal thickness of the individual wythes.				

Notes:

1. H = clear height or length between lateral supports.
   t = nominal wall thickness.
2. All masonry units shall be laid in Type M, S or N mortar. Where Type N mortar is used and the wall spans in the vertical direction, the ratios shall be reduced by 10%.
3. Enclosed buildings are buildings in which the openings in any wall do not exceed the sum of the percentages of openings in the remaining walls and roof surfaces by 5%. Buildings in which the 5% limit is exceeded by one wall may still be considered enclosed if the percentage of openings in no other wall exceeds 20%.
4. These values are based on using masonry cement mortar. If nonairentrained portland cement/lime mortar is used the values in the table may be increased by 1.2.
5. Larger H/t ratio's may be used if the design is done in accordance with ACI-530.

2107.1.1 Thickness. 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 thicknesses 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 2108.2.

2107.2 Lateral Support

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.

2108 THICKNESS OF MASOI\RY

2108.1 Thickness of Walls

The nominal th1ck.nes of masonry walls shall conform to the requirements of 2108.

2108.1.1 Minimum Thickness. The minimum thickness of masonry bearing walls more than one story high shall be 8 inches (203 mm). Bearing walls of one story buildings shall not be less than 6 inches (152 mm) thick.

2108.1.2 Rubble Stone Walls. The minimum thickness of rough or random or coursed rubble stone walls shall be 16 inches (406 mm).

2108.1.3 Change in Thickness. Where a wall of masonry of hollow units or a masonry bonded hollow wall is decreased in thickness, a course or courses of solid masonry shall be interposed 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.

2108.2 Parapet Walls

2108.2.1 Unreinforced parapet walls shall be at least 8 inches (203 mm) thick, and their height shall not exceed three times their thickness.

2108.2.2 Additional provisions for parapet walls are contained in 1507.

2108.3 Foundation Walls

For the minimum thicknesses of masonry foundation walls, see 1804.6.

2109 BOND

2109.1 General

The facing and backing of multiple wythe masonry walls shall be bonded in accordance with 2109.2, 2109.3 or 2109.4.

2109.2 Bonding with Masonry Headers

2109.2.1 Solid Units. Where the facing and backing (adjacent wythes) of solid masonry construction are bonded by means of masonry headers, no less than 4 percent of the wall surface of each face shall be composed of headers extending not less than 3 inches (76 mm) into the backing. The distance between adjacent full-length headers shall not exceed 24 inches (610 mm) either vertically or horizontally. In wall in which a single header does not extend through the wall, headers from the opposite sides shall overlap at least 3 inches (76 mm), or headers from opposite sides shall be covered with another header course overlapping the header below at least 3 inches (76 mm).

2109.2.2 Hollow Units. Where two or more hollow units are used to make up the thickness of a wall, the stretcher courses shall be bonded at vertical intervals not exceeding 34 inches (864 mm) by lapping at least 3 inches (76 mm) over the unit below, or by lapping at vertical intervals not exceeding 17 inches (432 mm) with units which are at least 50 percent greater in thickness than the units below.

2109.2.3 Masonry Bonded Hollow Walls. In masonry bonded hollow walls, the facing and backing shall be bonded so that not less than 4% of the wall surface of each face is composed of masonry bonding units extending not less than 3 inches (76 mm) into the backing. The distance between adjacent bonders shall not exceed 24 inches (610 mm) either vertically or horizontally.

2109.3 Bonding with Wall Ties or Joint Reinforcement

2109.3.1 Bonding with Wall Ties. Except as required by 2109.3.1.1, where the facing and backing (adjacent wythes) of masonry walls are bonded with 3/16 inch (4.8 mm) 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 sq ft (0.42 m^2) of wall area. Ties in alternate courses shall be staggered. The maximum vertical distance shall not exceed 24 inches (610 mm), and the maximum horizontal distance shall not exceed 36 inches (914 mm). Rods or ties bent to rectangular shape shall be used with hollow masonry units laid with the cells vertical. In other walls, the ends of ties shall be bent to 90° (1.57 rad) angles to provide hooks no less than 2 inches (51 mm) long. Additional bonding ties shall be provided at all openings, spaced not more than 3 feet (914 mm) apart around the perimeter and within 12 inches (305 mm) of the opening.

2109.3.1.1 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 1.77 sq ft (0.164 m^2) of wall area. Neither the vertical nor horizontal spacing of the adjustable wall ties shall exceed 16 inches (406 mm). The maximum vertical offset of bed joints from one wythe to the other shall be 1 1/4 inches (32 mm). The maximum clearance between connecting parts of the ties shall be 1/16 inch (1.6 mm). When pintle legs are used, ties shall have at least two 3/16 inch (4.8 mm) diameter legs.

2109.3.2 Bonding with Prefabricated Joint Reinforcement. Where the facing and backing (adjacent wythes) of masonry are bonded with prefabricated joint reinforcement, there shall be at least one cross wire serving as a tie for each 2 2/3 sq ft (0.25 m^2) of wall area. The vertical spacing of the joint reinforcement shall not exceed 16 inches (406 mm). Cross wires on prefabricated joint reinforcement shall be not less than W1.7 (11 mm^2). The longitudinal wires shall be embedded in the mortar.

2109.4 Bonding with Natural or Cast Stone

2109.4.1 Ashlar Masonry. In ashlar masonry, bonder units, uniformly distributed, shall be provided to the extent of not less than 10 percent of the wall area. Such bonder units shall extend not less than 4 inches (102 mm) into the backing wall.

2109.4.2 Rubble Stone Masonry. Rubble stone masonry 24 inches (610 mm) or less in thickness shall have bonder units with a maximum spacing of 3 feet (914 mm) vertically and 3 feet (914 mm) horizontally and, if the masonry is of greater thickness than 24 inches (610 mm), shall have one bonder unit for each 6 sq ft (0.56 m^2) of wall surface on both sides.

2109.5 Masonry Bonding Pattern

2109.5.1 Masonry Laid in Running Bond. In each wythe of masonry laid in running bond, head joints an successive courses shall be offset by not less than one quarter the unit length, or the masonry walls shall be reinforced longitudinally as required in 2109.5.2.

2109.5.2 Masonry Laid in Stack Bond. Where unit masonry is laid with less head joint offset than in 2109 5.1, the minimum area of horizontal reinforcement placed in mortar bed joints or in bond beams spaced not more than 48 inches (1219 mm) apart, shall be 0.0007 times the vertical cross-sectional area of the wall.

2110 ANCHORAGE

2110.1 General

Masonry elements shall be anchored in accordance with 2110.

2110.2 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 2110.2.1 through 2110.2.5:

2110.2.1 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 (76 mm) on the unit below.

2110.2.2 Steel Connectors. Walls shall be anchored by steel connectors having a minimum cross section of 1/4 inch (6.4 mm) by 1 1/2 inches (38 mm) with ends bent up at least 2 inches (51 mm), or with cross pins to form anchorage. Such anchors shall be at least 24 inches (610 mm) long and the maximum spacing shall be 4 feet (1219 mm).

2110.2.3 Joint Reinforcement. Walls shall be anchored by Joint reinforcement spaced at a maximum distance of 8 inches (203 mm). Longitudinal reinforcement shall be at least W1.7 (11 mm^2) and shall extend at least 30 inches (762 mm) in each direction at the intersection.

2110.2.4 Interior Nonbearing Walls. Interior nonbearing walls shall be anchored at their intersection at vertical intervals of not more than 16 inches (406 mm) with joint reinforcement or 1/4 inch (6.4 mm) galvanized mesh hardware cloth.

2110.2.5 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.

2110.3 Floor and Roof Anchorage

Floor and roof diaphragms providing lateral support to masonry in 70, 80, and 90 mph wind zones shall comply with 1607.3.6.1.2 and shall be connected to the masonry in accordance with 2110.3.1 through 2110.3.3. Floor and roof diaphragms providing lateral support to masonry in wind zones greater than 90 mph shall be designed as required by 2103.1.

2110.3.1 Wood Floor Joists. Wood floor joists bearing on masonry walls shall be anchored to the wall at intervals not to exceed 6 feet (1829 mm) by metal strap anchors. Joists parallel to the wall shall be anchored with metal traps spaced not more than 6 feet (1829 mm) on centers extending over or under and secured to at least 3 joists. Blocking shall be provided between joists at each strap anchor.

2110.3.2 Steel Floor Joists. Steel floor joists shall be anchored to masonry walls with 3/8 inch (9.5 mm) round bars, or their equivalent, spaced not more than 6 feet (1829 mm) on center. Where joists are parallel to the wall, anchors shall be located at joist cross bridging.

2110.3.3 Roof Structures. Roof structures shall be anchored to masonry walls with 1/2 inch (12.7 mm) bolts 6 feet (1829 mm) on center or their equivalent. Bolts shall extend and be embedded at least 15 inches (381 mm) into the masonry, or be hooked or welded to not less than 0.2 square inches (129 mm^2) of bond beam reinforcement placed not less than 6 inches (152 mm) from the top of the wall.

2110.4 Walls Adjoining Structural Framing

Where walls are dependent upon the structural frame for lateral support, they shall be anchored to the structural members with metal anchors or otherwise keyed to the structural members. Metal anchors shall consist of 1/2 inch (12.7 mm) bolts spaced at 4 feet (1219 mm) on center embedded 4 inches (102 mm) into the masonry, or their equivalent area.

2111 MASONRY CONSTRUCTION

2111.1 Masonry Construction

Masonry construction shall comply with the requirements of 2111.1.1 through 2111.5.

2111.1.1 Tolerances. Masonry shall be constructed within the tolerances specified in ACI 530.1/ASCE 6/TMS 602.

2111.1.2 Placing Mortar and Units.

2111.1.2.1 Head and bed joints. Unless otherwise required or indicated on the project drawings, head and bed joints shall be 3/8 inch (9.5 mm) thick, except that the thickness of the bed joint of the starting course placed over foundations shall not be less than 1/4 inch (6.4 mm) and not more than 3/4 inch (19 mm).

2111.1.2.2 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, column 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.

2111.1.2.3 Solid units. Unless otherwise required or indicated on the project drawings, place solid units in fully mortared bed and head joints, and:

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

2111.1.2.4 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.

2111.1.3 Weepholes. Weepholes shall be provided in masonry veneer and in the outside wythe of masonry walls at a maximum spacing of 4 ft (1219 mm) on center by omitting mortar in the head joints. Weepholes shall be located in the first course above the foundation wall or slab, and other points of support, including structural floors, shelf angles, and lintels.

2111.1.4 Installation of Wall Ties. 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 (12.7 mm). Wire wall ties shall be embedded at least 1 1 /2 inches (38 mm) into the mortar bed of solid masonry units or solid grouted hollow units. Wall ties shall not be bent after being embedded in grout or mortar.

2111.1.5 Chases. Chases shall be constructed as masonry units are laid.

2111.1.6 Bracing of masonry. Bracing that will assure stability of masonry during construction shall be provided and installed.

2111.1.7 Construction loads. Construction loads shall not exceed the superimposed loads the masonry with supplemental supports is capable of supporting safely.

2111.1.8 Masonry protection. The top of unfinished masonry work shall be covered to protect it from the weather.

2111.2 Corbelled Masonry

Solid masonry units shall be used for corbelling. The maximum corbelled 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.

2111.2.1 Molded Cornices. Unless structural support and anchorage are provided to resist the overturning moment, the center of gravity of all projecting masonry or molded cornices shall lie within the middle one-third of the supporting wall. Terra cotta and metal cornices shall be provided with a structural frame of approved noncombustible material anchored in an approved manner.

2111.3 Cold Weather Construction

The following cold weather procedures shall be implemented when either the ambient temperature falls below 40°F (4°C) or the temperature of masonry units is below 40°F (4°C):

2111.3.1 Temperature of masonry units shall not be less than 20°F (-7°C) when laid in the masonry. Remove visible ice on masonry units before the unit is laid in the mortar.

2111.3.2 Heat mortar sand or mixing water to produce mortar temperatures between 40°F (4°C) and 120°F (49°C} at the time of mixing. Maintain mortar above freezing until used in masonry.

2111.3.3 Use heat sources where ambient temperatures are between 25°F (-4°C) and 20°F (-7°C), on both sides of the masonry under construction and install wind breaks when wind velocity is in excess of 15 mph (6.7 m/s).

2111.3.4 Where ambient temperatures are below 20°F (-7°C), provide an enclosure for the masonry under construction and use heat sources to maintain temperatures above 32°F (0°C) within the enclosure.

2111.3.5 Where mean daily temperatures are between 40°F (4°C) and 32°F (0°C), protect completed masonry from rain or snow by covering with a weather resistive membrane for 24 hours after construction.

2111.3.6 Where mean daily temperatures are between 32°F (0°C) and 25°F (-4°C), completely cover completed masonry with a weather resistive membrane for 24 hours after construction.

2111.3.7 Where mean daily temperatures are between 25°F (-4°C) and 20°F (-7°C), completely cover completed masonry with insulating blankets or equal protection for 24 hours after construction.

2111.3.8 Where mean daily temperatures are below 20°F (-7°C), maintain masonry temperature above 32°F (0°C) for 24 hours after construction by enclosure with supplementary heat, by electric heating blankets, by infrared heat lamps, or by other approved methods.

2111.4 Hot Weather Construction

The following hot weather procedures shall be implemented when either the ambient temperature equals or exceeds 100°F (38°C), or the ambient temperature equals or exceeds 90°F (32°C) with a wind velocity greater than 8 mph (3.58 m/s):

2111.4.1 Mortar beds shall not be spaced more than 4 feet (1219 mm) ahead of masonry.

2111.4.2 Masonry units shall be laid within 1 minute after mortar placement.

2111.5 Wetting of Brick

Brick (clay or shale) at the time of laying shall require wetting if the unit's initial rate of water absorption exceeds 30 grams per 30 square inches (30 g/194 cm^2) per minute or 0.035 ounces per square inch (0.0015 g/mm^2), as determined by ASTM C 67.

2112 GLASS BLOCK WALLS

2112.1 General

2112.1.1 Masonry of glass blocks used in nonbearing exterior or interior walls and in window openings, either isolated or in continuous bands, shall have a minimum thickness of 3 inches (76 mm) at the mortar joint and all the mortar-bearing surfaces of the glass block shall be treated for mortar bonding. Sizes of structural members supporting glass block panels shall be determined by structural analysis to avoid excessive or harmful deflection. Maximum deflection of such members shall not exceed 1/600 of the span of the supporting members.

2112.1.2 Solid or hollow approved glass blocks shall not be used in fire-rated partitions, or for loadbearing construction. Such blocks shall be erected with mortar and reinforcement in metal-channel-type frames, structural frames, masonry or concrete recesses or embedded panel anchors as provided for both exterior and interior walls or other approved joint materials. Wood strip framing shall not be used in fire-rated partitions.

EXCEPTIONS:

1. Glass block assemblies having a fire resistance rating of not less than 3/4 hour shall be permitted as opening protectives in fire-rated partitions which have a required fire resistance rating of 1 hour or less and do not enclose exit stairways or exit passageways.
2. Glass block assemblies as permitted in 414.5, Paragraph 2.

2112.2 Size of Panels

2112.2.1 The maximum dimensions of all hollow glass block wall panels in both exterior and interior walls, where used singly or in multiples to form continuous bands of glass blocks between structural supports, shall be 25 feet (7620 mm) in length and 20 feet (6096 mm) in height between structural supports and expansion joints; and the area of each individual panel shall not be more than 144 sq ft (13.4 m^2) for exterior panels and 250 sq ft (23.2 m^2) for interior panels. Intermediate structural supports shall be provided to support the dead load of the wall and all other superimposed loads. Where individual panels are more than the maximum area permitted for those panels, a supplementary structural stiffener shall be proved to anchor the panels to the structural supports.

2112.2.2 The maximum area of all solid glass-block wall panels in both exterior and interior walls shall not be more than 100 sq ft (9.3 m^2).

2112.3 Joint Materials

Glass block shall be laid up in Type S or N mortar. Both vertical and horizontal mortar joints shall be at least 1/4 inch (6.4 mm) and not more than 1/2 inch (12.7 mm) thick and shall be completely filled. The sills of glass block panels shall be coated with approved water-based asphaltic emulsion, or other elastic waterproofing material, prior to laying the first mortar course. All individually framed glass-block panels shall be proved with 3/8-inch (9.5 mm) expansion joints at the sides and top. Expansion joints shall be entirely free of mortar and shall be caulked to a depth of not less than 1/2 inch (12.7 mm) with nonhardening caulking compound on both faces, or other approved expansion joints shall be provided.

2112.4 Reinforcement

Glass-block panels shall have joint reinforcement in every other mortar bed joint extending the entire length of the panel, but not across expansion joints. Joint reinforcement is permitted to be spliced by lapping longitudinal wires at least 6 inches (152 mm). Joint reinforcement shall be placed in the bed joint immediately below and above any opening in the panel. Joint reinforcement shall be hot dipped galvanized after fabrication.

2112.5 Wind and Earthquake Loads

Exterior wall panels shall be held in place in the wall opening to resist both the internal and external pressures due to wind and earthquake loads as specified in 1606 and 1607 with metal-channel-type frames, structural frames, masonry or concrete recesses or embedded panel anchors at the sides and top. Where recess type framing is used, glass block shall be recessed within the framing not less than 1 inch (25.4 mm).

2113 MASONRY CHIMNEYS

2113.1 General

Masonry chimneys shall be built in accordance with 2113 and 2804.

2113.2 Support

2113.2.1 Masonry chimneys shall be supported on properly designed foundations of masonry or reinforced concrete. Noncombustible material having a fire resistance rating of not less than 3 hours may be used to support masonry chimneys where such supports are independent of the floor construction and the load is transferred to the ground.

2113.2.2 Masonry chimneys shall not be corbeled from a wall or foundation more than 6 inches (152 mm), nor shall a chimney be corbeled from a wall or foundation which is less than 12 inches (305 mm) thick unless it projects equally on each side of the wall provided that in the second story of two story dwellings corbeling of chimneys on the exterior of the enclosing walls may equal the wall thickness. Individual corbels or the maximum projection of one unit shall not exceed one-half the height of the unit nor one-third its bed depth. Corbeled smoke chambers shall be parged with fireclay mortar or refractory mortar.

2113.3 Construction

2113.3.1 A chimney or chimney flue shall not change in size or shape within 6 inches (152 mm) above or below where the chimney passes through floor components, ceiling components or roof components.

2113.3.2 Masonry chimneys shall be constructed of solid masonry units or reinforced concrete with the walls not less than 4 inches (102 mm) thick or rubble stone masonry not less than 12 inches (305 mm) thick.

2113.3.3 Masonry chimneys shall be lined with approved fireclay liners not less than 5/8 inch (5.9 mm) thick, or with other approved liner of material that will resist corrosion, softening or cracking from flue gases at temperatures up to 1800°F (982.2°C). Fireclay tile liners shall be installed ahead of the construction of the chimney as it is carried up, carefully bedded one on the other in fireclay mortar or refractory air setting mortar with close fitting joints left smooth on the inside.

2113.3.4 Liners shall be separated from the chimney wall by a minimum of 1/2 inch (12.7 mm) and a maximum of 1 inch (25.4 mm) of air space. The air space shall not be filled and only enough mortar shall be used to make a good joint to hold the liners in position.

2113.3.5 Flue liners shall start from a point not less than 8 inches (203 mm) below the intake. They shall extend as vertical as possible, with a maximum slope no greater than 30 degrees (0.524 rad) from vertical. The liner shall extend at least 4 inches (102 mm) above the crown of the chimney, but not more than 6 inches (152 mm).

2113.3.6 Where two adjoining flues in the same chimney are separated only by flue liners, the joints of the adjacent flue liners shall be staggered at least 7 inches (178 mm).

2113.3.7 Where more than two flues are located in the same chimney, masonry wythes (partitions) at least 4 inches (102 mm) wide and bonded into the masonry walls of the chimney shall be built at such points between adjacent flue linings that there are not more than two flues in a group of adjoining flues without such wythe separation.

2113.3.8 When existing masonry chimneys are lined with a listed system, such as, stainless steel, poured system or different type titles, the system shall be installed in accordance with the listing.

2113.3.9 All damper assemblies in chimney structures shall be capable of opening and closing manually.

2113.4 Fireblocking

All spaces between chimneys and floors and ceilings through which chimneys may pass shall be fireblocked with noncombustible material. The fireblocking of spaces between chimneys and wood joists, beams, or headers shall be to a depth of 1 inch (25.4 mm) only, placed on strips of metal or metal lath laid across the spaces between combustible material and the chimney.

2113.5 Separation from Combustibles

2113.5.1 Headers, beams, joists and studs shall be not less than 2 inches (51 mm) from the outside face of a chimney or from masonry enclosing a flue. Ends of wood girders may be supported on a corbeled shelf of a masonry chimney provided there is not less than 8 inches (203 mm) of solid masonry between the ends and the flue liner.

2113.5.2 Combustible lathing, furring or plaster grounds shall not be placed against a chimney at any point more than 1 1/2 inches (38 mm) from the corner of the chimney, but this shall not prevent plastering directly on the masonry or on metal lath and metal furring, nor shall it prevent placing chimneys entirely on the exterior of a building against the sheathing.

2113.6 Cleanouts

Cleanout openings provided in chimneys shall be equipped with ferrous metal doors and frames arranged to remain tightly closed when not in use. Adequate clearance between cleanout doors and combustible material shall be provided.

2113.7 Smoke Test

Masonry chimneys shall be proven tight by a smoke test after erection and before being put into use.

2114 MASONRY FIREPLACES AND BARBECUES

2114.1 General

The provisions of this section shall govern the construction of masonry fireplaces and barbecues.

2114.2 Definitions

For the purpose of this section, certain special terms are defined as follows:

THROAT – the throat of a fireplace is a tapered passageway that begins above the top of the firebox walls and terminates at the damper.

2114.3 Masonry Fireplaces

2114.3.1 Fireplaces shall be constructed of solid masonry or of reinforced concrete with back and sides of the thickness specified in this paragraph, except as provided in 2806.1. Where a lining of firebrick at least 2 inches (51 mm) thick or other approved lining is provided, the total thickness of back and sides, including the lining, shall be not less than 8 inches (203 mm) of solid masonry or reinforced concrete. Where no such lining is provided, the thickness of back and sides shall be not less than 12 inches (305 mm) of solid masonry or reinforced concrete.

2114.3.2 The firebox of a masonry fireplace shall have a minimum depth of 20 inches (508 mm). The throat shall be at least 8 inches (203 mm) above the fireplace opening. The throat opening shall have a minimum width equal to the firebox opening width and shall be at least 4 inches (102 mm) in depth. The cross-sectional area of the passageway above the firebox, including the throat, damper and smoke chamber, shall be not less than the cross-sectional area of the flue.

EXCEPTION: Rumford fireplaces shall be permitted provided the depth of the fireplace is a minimum of 12 inches (305 mm) and a minimum of 1/3 of the width of the fireplace opening. The throat shall be a minimum of 12 inches (305 mm) above the lintel and shall be a minimum of 1/20 of the cross-sectional area of the fireplace opening.

2114.3.3 The cross-sectional area of the chimney flue shall be determined in accordance with Figure 2114.3.3. The height of the chimney shall be measured from the firebox floor to the top of the last chimney flue tile. Individual flue tiles shall not have a cross-sectional area less than 50 sq in (0.032 m^2) for round flues or 64 sq in (0.041 m^2) for square or rectangular flues.

2114.3.4 Steel fireplace units incorporating a firebox liner of not less than 1/4-inch (6.4 mm) thick steel and an air chamber may be installed with masonry to provide a total thickness at the back and sides of not less than 8 inches (203 mm), not less than 4 inches (102 mm) of which shall be solid masonry.

2114.3.5 Warm air ducts employed with steel fireplace units of the circulating air type shall be constructed of metal or masonry.

2114.3.6 Fireplace hearth extensions shall be of approved noncombustible material for all fireplaces. Where the fireplace opening is less than 6 sq ft (0.56 m^2), the hearth extension shall extend at least 16 inches (406 mm) in front of the facing material and at least 8 inches (203 mm) beyond each side of the fireplace opening. Where the fireplace opening is 6 sq ft (0.56 m^2) or larger, the hearth extension shall extend at least 20 inches (508 mm) in front of the facing material and at least 12 inches (305 mm) beyond each side of the fireplace opening. Where a fireplace is elevated above or overhangs a floor, the hearth extension shall also extend over the area under the fireplace.

2114.3.7 Fireplaces constructed of masonry or reinforced concrete shall have hearth extensions of brick, concrete, stone, tile, or other approved noncombustible material properly supported and with no combustible material against the underside thereof. Wooden forms or centers used during the construction of a hearth and hearth extension shall be removed when the construction is completed.

EXCEPTION: A header of combustible material may be used to support the hearth extension provided that it is located more than 12 inches (305 mm) from the face of the fireplace.

2114.3.8 All combustible wood beams, joists, and studs shall be maintained a minimum of 2 inches (51 mm) from the outside face of chimney or fireplace masonry. Headers supporting trimmer arches at fireplaces shall be not less than 20 inches (508 mm) from the face of the chimney breast. Trimmers shall be not less than 6 inches (152 mm) from the inside face of the nearest flue lining.

2114.3.9 Woodwork shall not be placed within 4 inches (102 mm) of the back of a fireplace, but this shall not prevent plastering directly on the masonry or on metal lath and metal furring.

2114.3.10 All combustible mantles and similar trim shall be kept at least 6 inches (152 mm) from the fireplace opening. Parts of the mantle assembly located along the sides of the fireplace opening, which project more than 1 1/2 inches (38 mm) from the face of the fireplace, shall have additional clearance equal to the projection. Parts of the mantle assembly located above and projecting more than 1 1/2 inches (38 mm) from the fireplace opening shall not be placed less than 12 inches (305 mm) from the top of the fireplace opening.

2114.4 Masonry Built Barbecues

Masonry built barbecues shall meet the applicable requirements of 2114.3.

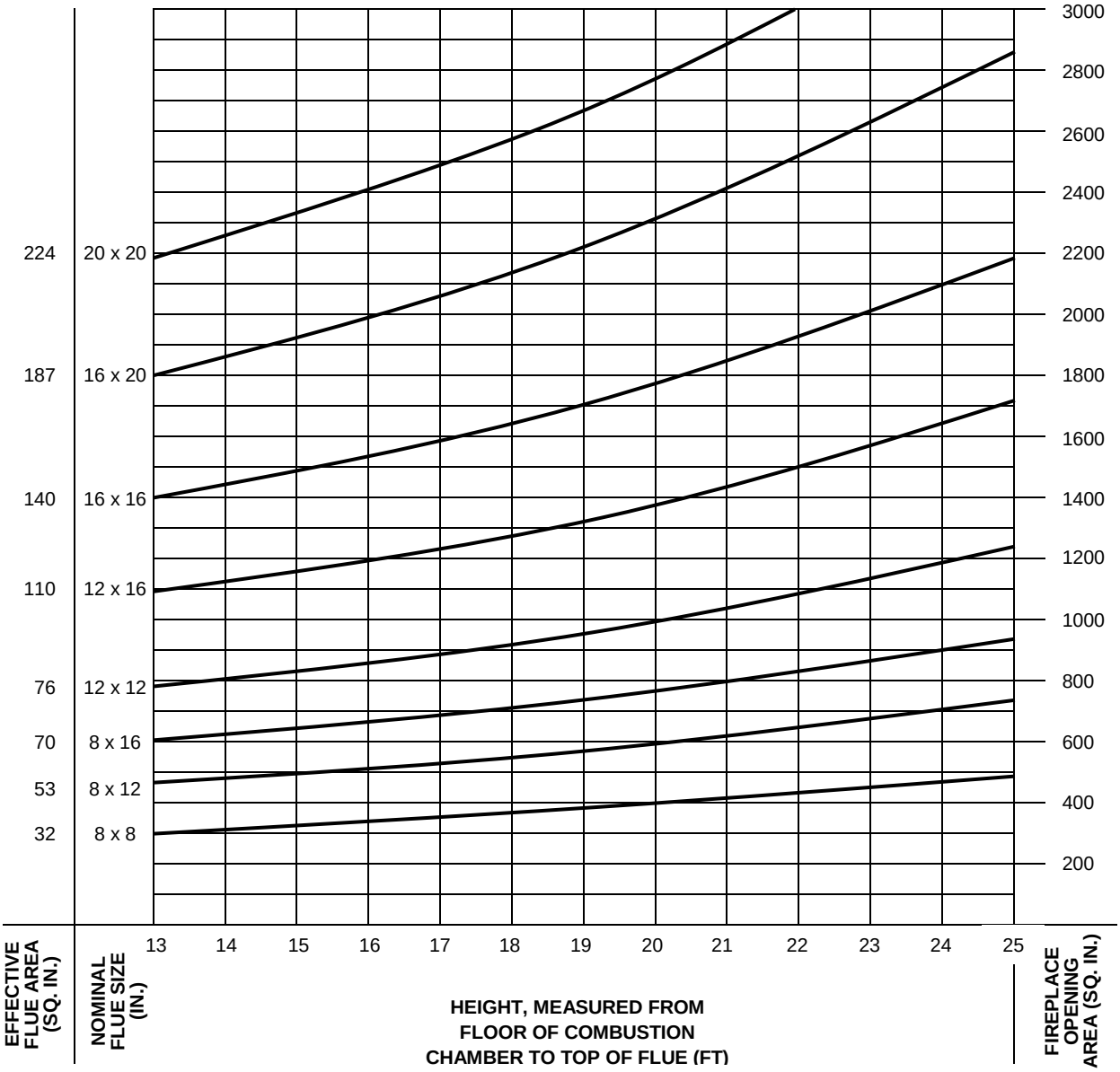


Figure 2114.3.3
Flue Sizes for Masonry Chimneys[1]

Note:
1. When using Figure 2114.3.3, select the smaller flue size when the opening and height selected for the fireplace and chimney, respectively, intersect between standard flue sizes.

1 in = 25.4 mm
1 in^2 = 645.16 mm^2
1 ft = 0.305 m

2115 SEISMIC REQUIREMENTS

2115.1Scope

Masonry in buildings assigned to Seismic Performance Category B, C, D or E, in accordance with 1607.1.8, shall comply with the requirements of 2115. Masonry in buildings assigned to Seismic Performance Category A, in accordance with 1607.1.8, shall comply with the requirements of 2115.4.1.

2115.2 General

Masonry shall conform to the requirements of ACI 530/ASCE 5/TMS 402 including Appendix A and ACI 530.1/ASCE 6/TMS 602, as modified in accordance with 2115.3.

2115.3 Modifications to ACI 530/ASCE 5/TMS 402, Appendix A

The sections of Appendix A of ACI 530/ASCE 5/TMS 402 shall be modified as indicated in the following items 1 through 6:

1. Revise title of Section A.2 to read: "Special Provisions of Seismic Performance Category B."
2. Revise title of Section A.3 to read: "Special Provisions for Seismic Performance Category C."
3. Revise title of Section A.4 to read: "Special Provisions for Seismic Performance Categories D and E."
4. Modify Section A.4.1 to read: "All masonry structures assigned to Seismic Performance Category D or E shall be designed and constructed in accordance with the requirements for structures assigned to Seismic Performance Category C and with the following additional requirements."
5. Modify Section A4.2 to read: "The provisions of Chapters 6 and 9 of ACI 530/ASCE 5/TMS 402 do not apply to structures assigned to Seismic Performance Category D or E."
6. Modify Section A.4.10.1 to read: "The term hook or standard hook used herein for tie anchorage for structures assigned to Seismic Performance Category D or E shall mean a standard 135-degree (2.36 rad) or 180-degree (3.14 rad) hook."

2115.4 Strength of Members and Connections

2115.4.1 For load combinations including seismic forces, the strength of members and connections shall be determined using the following capacity reduction factors(ϕ) and 2.5 times the allowable working stress determined from ACI 530/ASCE 5/TMS 402:

1. When considering axial or flexural compression and bearing stress in the masonry $\phi = 0.8$
2. For reinforcement stresses except when considering shear $\phi = 0.8$
3. When considering shear carried by shear reinforcement and bolts $\phi = 0.6$
4. When permitted to consider masonry tension parallel to the bed joints (i.e., horizontally in normal construction) $\phi = 0.6$
5. When considering shear carried by masonry $\phi = 0.6$
6. When permitted to consider masonry tension perpendicular to the bed joint (i.e., vertically in normal construction) $\phi = 0.4$

2115.4.2 Splice lengths shall be in accordance with ACI 530/ASCE 5/TMS 402, Section 8.5.7, without modification of allowable stress in reinforcement.

2115.5 Response Modification Factors

The response modification factors (R) of Table 1607.3.3 for reinforced masonry shall apply, provided masonry is designed in accordance with Chapter 7, and Appendix A of ACI 530/ASCE 5/TMS 402. The response modification factors (R) of Table 1607. 3.3 for unreinforced masonry shall apply for all other masonry.

2115.6 Seismic Performance Category B

Buildings assigned to Seismic Performance Category B shall conform to all of the requirements for Seismic Performance Category A, and the lateral load-resisting system shall be designed in accordance with ACI 530/ASCE 5/TMS 402, Chapter 6 or 7.

2115.7 Seismic Performance Category C

Buildings assigned to Seismic Performance Category C shall conform to the requirements of Seismic Performance Category B and to the additional requirements of this section.

2115.7.1 Multiple-wythe walls not acting compositely. At least one wythe of a cavity wall shall be designed and reinforced in accordance with ACI 530/ASCE 5/TMS 402. The other wythe shall be tied to its backup and reinforced with a minimum of one W1.7 (11.1 mm^2), (No. 9 gage) at a maximum spacing of 16 inches (406 mm) on center. The wall wythes shall be tied in accordance with ACI 530/ASCE 5/TMS 402, Section 5.8.2.2.

2115.7.2 Perforated screen walls. Masonry screen walls with perforations that preclude the use of reinforced cores, laterally supported but not otherwise connected on all edges by a structural frame of concrete, masonry or steel, shall conform to 2115.7.2.1 and 2115.7.2.2.

2115.7.2.1 All screen walls shall be reinforced in accordance with this section. Joint reinforcement shall be considered effective in resisting stresses. The units of a panel shall be so arranged that either the horizontal or the vertical joint containing reinforcing is continuous without offset. This continuous joint shall be reinforced with joint reinforcement having a minimum steel area of 0.03 sq in (19.4 mm^2). Joint reinforcement shall be embedded in mortar or grout.

2115.7.2.2 In calculating the resisting capacity of the system, compression and tension in the spaced wires are permitted to be utilized. Joint reinforcement shall not be spliced and shall be the widest that the mortar joint will accommodate allowing 1/2 inch (12.7 mm) of mortar cover.

2115.7.3 Material requirements. Structural clay loadbearing wall tile (ASTM C 34) and structural clay nonbearing wall tile (ASTM C 56) shall not be used for any structural masonry.

2115.8 Seismic Performance Category D

Buildings assigned to Seismic Performance Category D shall conform to all of the requirements of Seismic Performance Category C and to the additional requirements of 2115.8.1 and 2115.8.2.

2115.8.1 Construction requirements for masonry laid in other than running bond. The maximum spacing of horizontal reinforcement shall not exceed 24 inches (610 mm) vertically.

2115.8.2 Shear wall requirements. Shear walls shall comply with 2115.8.2.1 and 2115.8.2.2.

2115.8.2.1 The maximum spacing of reinforcement in each direction shall be one-third the length and height of the element or 48 inches (1219 mm) maximum, whichever is less. The area of reinforcement perpendicular to the shear reinforcement shall be at least equal to one-third the area of the required shear reinforcement. The portion of the reinforcement required to resist shear shall be uniformly distributed.

2115.8.2.2 When reinforcement is required in accordance with ACI 530/ASCE 5/TMS 402 Section 7.5.2, the computed reinforcement shall be placed horizontally.

2115.9 Seismic Performance Category E

Buildings assigned to Seismic Performance Category E shall conform to the requirements of Seismic Performance Category D and to the additional requirements and limitations of 2115.9.1 through 2115.9.1.2.

2115.9.1 Construction requirements. Construction procedures or admixtures shall be used to minimize cracking of grout and to maximize bond. The thickness of the grout between masonry units and reinforcing shall be a minimum of 1/2 inch (12.7 mm) for structural masonry.

2115.9.1.1 Reinforced Hollow Unit Masonry. Structural reinforced hollow-unit masonry shall conform to the following requirements:

2115.9.1.1.1 Vertical reinforcement shall be securely held in position at tops, bottoms, splices and at intervals not exceeding 112 bar diameters.

2115.9.1.1.2 Horizontal wall reinforcement shall be securely tied to the vertical reinforcement or held in place during grouting by equivalent means.

2115.9.1.1.3 Other reinforced hollow unit construction used structurally, but not part of the seismic resisting system, shall be grouted solid and all head joints shall be made solid by the use of open-end units.

2115.9.1.2 Stack Bond Construction. All stack bond construction shall conform to the following requirements:

2115.9.1.2.1 The minimum ratio of horizontal reinforcement shall be 0.0015 for nonstructural masonry and 0.0025 for structural masonry. The maximum spacing of horizontal reinforcement shall not exceed 24 inches (610 mm) for nonstructural masonry or 16 inches (406 mm) vertically for structural masonry.

2115.9.1.2.2 Reinforced hollow unit construction that is part of the seismic resisting system shall be grouted solid, shall use double open-end (H block) units such that all head joints are made solid, and shall use bond beam units to facilitate the flow of grout.

2115.9.1.2.3 Other reinforced hollow unit construction used structurally, but not part of the seismic resisting system, shall be grouted solid and all head joints shall be made solid by the use of open-end units.

2116 ADOBE CONSTRUCTION

DELETED

CHAPTER 22

STEEL

2201 GENERAL

2201.1Scope

The provisions of this chapter shall govern the quality, design, fabrication and erection of steel and iron used structurally in buildings or structures.

2202 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

2203 STRUCTURAL STEEL CONSTRUCTION

2203.1 General

The design, fabrication and erection of structural steel for buildings shall conform to the requirements of either the AISC Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design or the AISC Load and Resistance Factor Design Specification for Structural Steel Buildings, except as modified by 2212.

2203.2 Structural Steel Seismic Requirements

The design of structural steel members and connections to resist seismic forces shall be in accordance with 2203 and the AISC Design Specification for Structural Steel Buildings - Seismic Provisions.

2204 COLD-FORMED STEEL CONSTRUCTION

2204.1 Regular Cold-Formed Steel

The design of structural members cold-formed from carbon or low alloy steel shall conform to the AISI Specification for the Design of Cold-Formed Steel Structural Members or the AISI Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members. All individual structural members and assembled panels of cold-formed steel construction, except where fabricated of approved corrosion-resistant steel or of steel having corrosion-resistant metallic or other approved coating, shall be protected against corrosion with an acceptable shop coat of paint, enamel, or other approved protection.

2204.2 Cold-Formed Stainless Steel

The design, fabrication and erection of cold-formed stainless steel construction shall conform to ASCE 8.

2204.3 Cold-Formed Carbon or Low Alloy Steel Seismic Requirements.

The AISI Specification for the Design of Cold-Formed Steel Structural Members, hereafter referred to as AISI-CFSD ASD, and AISI Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members, hereafter referred to as AISI-CFSD-LRFD, shall be modified as indicated in this section. The reference to sections and paragraph numbers are to those of the particular specification modified.

1. AISI-CFSD-ASD: The nominal strength of members and connections shall be as specified in the AISI-CFSD-ASD except that the nominal strength for shear and web crippling shall be determined by multiplying the allowable stress by 1.7. Design strengths shall be determined by multiplying the nominal strengths by the following resistance factors (ϕ):

Shear strength for $h/t > (Ek_v / F_y)^{1/2}$	$\phi = 0.9$
Shear strength for $h/t \leq Ek_v / F_y)^{1/2}$	$\phi = 1.0$
Web crippling for members with single unreinforced webs	$\phi = 0.75$
Web crippling of "I" sections	$\phi = 0.8$
All other cases where Ω is the factor of safety.	$\phi = 0.55/\Omega$

2. AISI-CFSD-LRFD: Modify section A5.1.4 in the AISI-CFSD-LRFD Specification by substituting a load factor of 1.0, in place of 1.5, for nominal earthquake load.

2204.4 Steel Deck Diaphragms

2204.4.1 Steel deck diaphragms shall be made from materials conforming to the requirements of the AISI-CFSD-ASD Specification, the AISI-CFSD- LRFD Specification, or ASCE 8.

2204.4.2 Nominal strengths shall be determined in accordance with approved test procedures prepared by a design professional. Design strengths shall be determined by multiplying the nominal strength by a resistance factor (ϕ) of 0.60. The steel deck installation for the building, including fasteners, shall comply with the test assembly arrangement.

2205 OPEN WEB STEEL JOIST CONSTRUCTION

2205.1 The design, fabrication and erection of open web steel joist construction shall comply with the following SJI specifications:

1. Standard Specifications for Open Web Steel Joists, K-Series.
2. Standard Specifications for Longspan Steel Joists, LH-Series, and Deep Longspan Steel Joists, DLH-Series.
3. Standard Specifications for Joist Girders.

2205.2 Steel Joist Seismic Requirements

The design of steel joists and joist girders to resist seismic forces shall be in accordance with 2205.1, as modified by this section. Nominal stresses shall be determined by multiplying the unit (allowable) stresses determined in accordance with 2205.1 by 1.7. Design stresses shall be determined by multiplying the nominal stresses by the following resistance factors (ϕ):

Members, connections, and base plates that develop the strength of the members of structural system	$\phi = 0.90$
Connections that do not develop the strength of the member or structural system, including connections to base plates, and anchor bolts	$\phi = 0.67$

2206 STRUCTURALSTEELCABLES

2206.1 General

The design, deflection, connections, protective coatings, fabrication, erection and inspection of building construction using steel cables shall conform to the AISI Criteria for Structural Application of Steel Cables for Buildings.

2206.2 Steel Cable Seismic Requirements.

The AISI Criteria for Structural Applications of Steel Cables for Buildings shall be modified as indicated in this section. The reference to sections are those of the AISI Criteria for Structural Applications of Steel Cables for Buildings listed in Appendix A.

1. Load combination "d" of Section 5 shall be modified by substituting $1.5T_4$ instead of $2.0T_4$, where T_4 is the net tension in the cable due to dead load, prestress, live load and seismic load.
2. A load factor of 1 .1 shall be applied to the prestress forces to be added to the load combination in Section 3 of the steel cable specification.
3. The effective design breaking strength in Section 6 shall be multiplied by the following Resistance Factors (ϕ):

   Members, connections, and base plates that develop the strength of the members or structural systems $\phi = 0.90$

   Connections that do not develop the strength of the member or structural system, including connections to base plates, and anchor bolts $\phi = 0.67$

2207 WELDING

Details of design, workmanship and technique for welding, inspection of welding, and qualification of welding operators shall conform to the requirements of the specifications listed in 2203, 2204, 2205, and 2206.

2208 HIGH STRENGTH BOLTS

The design and assembly of structural joints and connections using high strength steel bolts shall conform to the following specifications as approved by the Research Council on Structural Connections of the Engineering Foundation (RCSC).

1. Specification for Structural Joints Using ASTM A 325 or A 490 Bolts.
2. Load and Resistance Factor Design Specification for Structural Joints Using A 325 or A 490 Bolts.

2209 MATERIAL STANDARDS

Steel for structural applications in buildings shall conform to ASTM A 6.

2210 PARAPET WALLS

Provisions for parapet walls are contained in 1507.

2211 COMPOSITE SLABS

The design and construction of composite steel deck/concrete slabs for buildings shall conform to the ASCE Specification for the Design and Construction of Composite Slabs.

2212 SEISMIC REQUIREMENTS FOR STEEL STRUCI'URES

2212.1General

Steel structural elements that resist seismic forces shall be designed in accordance with the applicable provisions of 2203, 2204, 2205, 2206, and 2207. Steel structures shall also be designed in accordance with the requirements of 2212.2, 2212.3, and 2212.4 for specific Seismic Performance Categories.

2212.2 Seismic Performance Categories A and B

Buildings assigned to Seismic Performance Categories A and B in accordance with 1607.1.8 shall be of any type of construction permitted by 2203, 2204, 2205, 2206, and 2207.

2212.3 Seismic Performance Category C

Buildings assigned to Seismic Performance Category C in accordance with 1607.1.8 shall be designed in accordance with 2203.1 and the additional requirements of this section.

2212.3.1 Braced Frames. Braced frames that are part of the seismic force resisting system shall be designed in accordance with the requirements of this section. For Seismic Hazard Exposure Group III buildings where the effective peak velocity-related acceleration coefficient, A_v, is greater than or equal to 0.10, braced frames shall be designed in accordance with 2212.1. In all other cases, brace connections shall be designed to develop the tensile yield capacity of the brace or to provide tensile deformation equivalent to the deflection amplification factor (C_d), as specified in Table 1607.3.3, multiplied by the brace deformation caused by the seismic design forces.

2212.4 Seismic Performance Categories D and E

Buildings assigned to Seismic Performance Categories D and E in accordance with 1607.1.8 shall be designed in accordance with 2203.1 and the additional requirements of this section.

2212.4.1 Light Framed Walls. Cold-formed steel stud wall designed in accordance with 2204 shall also comply with the requirements of this section.

2212.4.1.1 Boundary Members. All boundary members, chord s, and collectors shall be designed to transmit the induced axial forces.

2212.4.1.2 Connections. Connections for diagonal bracing members, top chord splices, boundary members, and collectors shall be designed to develop the tensile strength of the member, or in those cases where (2R/5) is equal to or greater than 1 .0, (2R/5) multiplied by the design seismic force. The pull-out resistance of screws shall not be used to resist seismic forces.

2212.4.1.3 Braced Bay Members. Vertical and diagonal members in braced bays shall be anchored such that the bottom track is not required to resist uplift forces by bending of the track web. Both flanges of studs shall be braced to prevent lateral torsional buckling.

CHAPTER 23

WOOD

2301 GENERAL

2301.1 Scope

2301.1.1 The provisions of this chapter shall govern the material, design, quality, and construction of wood used in buildings or structures.

2301.1.2 The detailed structural requirements contained in this chapter are based on sound engineering principles such as those in the standards listed in this chapter and are intended for light frame construction in general use for structures having light loads (e.g., live loads of 40 psf (1.92 kPa) or less, locations in noncoastal areas) and closely spaced framing. Where additional structural requirements should be applied because of the nature of the structure, the standards m 2301.2.5 shall be accepted as good engineering practice.

2301.1.3 For heavily loaded or engineered timber construction, structural design based on the recommendations of the standards listed in 2301.2.5 shall be accepted as conformance with good engineering practices.

2301.1.4 Other sections of this chapter which are applicable shall apply to heavily loaded or engineered timber construction as well as light frame construction.

2301.2 Design

2301.2.1 The quality and design of wood members and their fastenings used for load supporting purposes shall conform to good engineering practice.

2301.2.2 All members shall be framed, anchored, tied and braced so as to develop the strength and rigidity necessary for the purposes for which they are used.

2301.2.3 Preparation, fabrication and installation of wood members and the glues, connectors, and mechanical devices for the fastening thereof shall conform to good engineering practices.

2301.2.4 For engineered wood structural panel diaphragm design, provisions of 2310 shall apply. For engineered particleboard structural diaphragm design, provisions of 2311 shall apply.

2301.2.5 The following standards hall be accepted as conforming to good engineering practice:

National Forest Products Association:

National Design Specification for Wood Construction

Wood Construction Data No. 5, Heavy Timber Construction Details

American Institute of Timber Construction:

AITC 104: Typical Construction Details

AITC 110: Standard Appearance Grades for Structural Glued Laminated Timber

AITC 112: Standard for Tongue-and-Groove Heavy Timber Roof Decking

AITC 113: Standard for Dimensions of Structural Glued Laminated Timber

AITC 117: Structural Glued Laminated Timber of Softwood Species

AITC I 19: Standard Specifications for Hardwood Glued Laminated Timber

American Plywood Association:

APA Design/Construction Guide - Residential & Commercial Cantilevered In-Line Joist System

Plywood Design Specifications

Plywood Design Specification Supplement 1 - Design & Fabrication of Plywood Curved Panels

Plywood Design Specification Supplement 2 - Design & Fabrication of Plywood-Lumber Beams

Plywood Design Specification Supplement 3 - Design & Fabrication of Plywood Stressed-Skin Panels

Plywood Design Specification Supplement 4 - Design & Fabrication of Plywood Sandwich Panels

Plywood Design Specification Supplement 5 - Design & Fabrication of All-Plywood Beams

Truss Plate Institute, Inc.:

Design Specifications for Metal Plate Connected Wood Trusses

American Wood Preservers Institute:

Pole Building Design

National Particleboard Association:

Particleboard: The Ideal Floor Underlayment

2301.3 Determination of Required Sizes

2301.3.1 Wood structural members shall be of sufficient size to carry the dead and required live load without exceeding the allowable working stresses as contained in the standards listed in 2301.2.5.

2301.3.2 Where applicable as determined by end use, allowable working stresses may be determined by machine stress rating us approved by the American Lumber Standard Committee as established by USDOC PS 20-70.

2301.3.3 Where minimum size of lumber members are shown herein, they shall be construed as meaning nominal sizes. Minimum dressed sizes corresponding to nominal sizes shall conform with the provisions of USDOC PS 20-70.

2301.3.4 For convenience, nominal sizes may be shown on the plans. If rough sizes or finished sizes greater or smaller than USDOC PS 20-70 dressed sizes are to be used, computations shall be predicated on such actual sizes, provided they are specified on the plans or in a statement appended thereto.

2301.4 Quality of Materials

2301.4.1 Lumber used for load-supporting purposes, including end-jointed or edge-glued lumber, shall be identified by the grade mark of a lumber grading or inspection agency which is accredited through a program which complies with USDOC PC 20-70 or the equivalent. Grading practices and identification shall comply with rules published by an agency approved in accordance with procedures of USDOC PS 20-70 or equivalent procedures. In lieu of a grade mark on the material, a certificate of inspection as to species and grade issued by a lumber grading or inspection agency meeting the requirements of this section may be accepted for precut, remanufactured, or rough-sawn lumber, and for sizes larger than 3 inches nominal thickness.

2301.4.2 Structural glued laminated timber shall be manufactured and identified a required in ANSI/AITC A190.1.

2301.4.3 Wood structural panels when used structurally (including among others those used for siding, roof and wall sheathing, subflooring, diaphragms and built-up members) shall conform to the requirements for its type in U.S. Product Standards PS 1 or PS 2. Wood structural panels shall include plywood, oriented strandboard (OSB) and composite panels. Each panel or member shall be identified for grade and glue type by the trademarks of an approved testing and grading agency. Wood structural panel components shall be designed and fabricated in accordance with the applicable standards listed in 2301.2.5 and identified by the trademarks of an approved testing and inspection agency indicating conformance with the applicable standard. In addition, wood structural panels when permanently exposed in outdoor applications shall be of exterior type, except that wood structural panel roof sheathing exposed to the outdoors on the underside may be interior type bonded with exterior glue.

2301.4.4 Fiberboard for its various uses shall conform to ANSI/AHA A194.1. Fiberboard sheathing when used structurally shall be so identified by an approved agency as conforming to ANSI/AHA A194.1.

2301.4.5 Particleboard shall conform to ANSI A208.1. Particleboard shall be identified by the grade mark or certificate of inspection issued by an approved agency.

2301.4.5.1 Particleboard floor underlayment shall conform to Type 1-M-1 or Sanded Type 2-M-W of ANSI A208.1. Type 1-M-1 underlayment shall be not less than 1/4 inch (6.4 mm) thick and shall be installed in accordance with the installation instructions of the National Particleboard Association. Sanded Type 2-M-W underlayment shall be not less than 1/4 inch (6.4 mm) thick and shall be installed in accordance with the installation instructions of the Structural Board Association and the manufacturer.

2301.4.5.2 Particleboard subfloor or combination subfloor/underlayment shall conform to one of the grades in Table 2307.6C.

2301.4.6 All lumber, sawn timber, plywood, piles and poles supporting permanent structures required by 2304 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 product as described in the AWPA standards listed in Chapter 35. Quality control inspection agencies for pressure treated wood shall be certified as to competency and performance by an approved organization.

2301.4.7 Hardwood and decorative plywood shall be manufactured and identified as required in ANSI/HPMA HP.

2301.4.8 Wood flooring of the various types shall be manufactured and identified as required in the appropriate standard as listed:

Laminated Hardwood Flooring – ANSI/HPMA LHF

Flooring Grading Rules:

Oak, Pecan, Beech, Birch, Hard Maple (Acer Saccharum) – NOFMA

Mosaic-Parquet Hardwood Slat Flooring ANSI/APA 1

Hard Maple, Beech and Birch – MFMA

2301.4.9 Hardboard siding used structurally shall be identified by an approved agency as conforming to ANSI/AHA A135.6. Hardboard underlayment shall meet the strength requirements of 7/32-inch (5.6 mm) or 1/4- inch (6.4 mm) service class hardboard planed or sanded on one side to a uniform thickness of not less than 0.200 inch (5.1 mm). Prefinished hardboard paneling shall meet the requirements of ANSI/AHA A 135.5. Other basic hardboard product shall meet the requirements of ANSI/AHA A135.4. Hardboard products shall be installed in accordance with manufacturer's recommendations.

2301.4.10 Metal plate connected parallel chord wood trusses shall be manufactured as required in the Truss Plate Institute Design Specification for Metal Plate Connected Parallel Chord Wood Trusses.

2301.4.11 Prefabricated wood I-joist design and structural capacities shall conform to ASTM D 5055.

2301.5 Minimum Lumber Grades

The minimum grade of lumber used for light frame construction shall be:

1. For joists and rafters: Those obtained in NFoPA Design Values for Joists and Rafters.
2. For loadbearing studs: No. 3 Grade, Standard Grade or Stud Grade. Utility Grade may be Used to support floor and ceiling loads only.
3. For nonloadbearing studs: Utility Grade.

2301.6 End-Jointed Lumber

End-jointed lumber may be used interchangeably with solid sawn lumber of the same grade and species. Such uses shall include, but are not limited to, light framing, studs, joists, planks and decking.

2301.7 Moisture Content

All lumber and wood structural panel members, including pressure treated 2-inch (51 mm) thick and less shall contain not more than 19% moisture at the time of permanent incorporation in a building or structure.

2301.8 Fire Retardant Treated Wood

2301.8.1 The allowable unit stresses for fire retardant treated wood, 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 treated wood will be subjected, the type of treatment and the redrying process.

2301.8.2 All fire retardant treated wood shall bear an identification mark showing the flamespread index thereof issued by an approved agency which audits the quality assurance program of the treating facility each month that the facility is in production. Fire retardant treated wood shall bear the quality mark of an approved inspection agency which maintains continued supervision and inspection over the method of drying. The drying shall be done according to AWPA C20 for lumber and AWPA C27 for plywood.

2301.8.3 Where fire retardant treated wood is exposed to weather, it shall be further identified to indicate that there is no increase in the listed flame-spread index as defined above when subjected to ASTM D 2898.

2301.8.4 Where experience has demonstrated a specific need for use of material of low hygroscopicity, fire retardant treated wood to be subjected to high humidity conditions shall be identified as Type A in accordance with AWPA C20 or AWPA C27 to indicate the treated wood has a moisture content of not over 28% when tested in accordance with ASTM D 3201 procedures at 92% relative humidity.

2301.8.5 Fire retardant treated wood shall be dried to a moisture content of 19% or less for lumber and 15% or less for wood structural panels before use. The identification mark shall show the method of drying after treatment.

2302 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

2303 CONSTRUCTION PRACTICES

2303.1 Preparation of Building Site and Removal of Debris

2303.1.1 All building sites shall be graded so as to provide drainage under all portions of the building not occupied by basements.

2303.1.2 The foundation and the area encompassed therein shall have all vegetation, stumps, roots and foreign material removed and the fill material shall be free of vegetation and foreign material. The fill shall be compacted to assure adequate support of the foundation.

2303.1.3 After all work is completed, loose wood and debris shall be completely removed from all spaces under the building. All wood forms and supports shall be completely removed. Wood shall not be stored in contact with the ground under any building.

2303.2 Foundations

2303.2.1 Foundations shall be designed and constructed in accordance with the provisions of 1606.4 and 1804. Where spot piers are used, spacing shall not exceed 8 ft (2438 mm) o.c. unless engineering analysis indicates a greater spacing is acceptable.

2303.2.2 A one story building, except a dwelling, which does not exceed 400 sq ft (37 m^2) in area may be constructed without masonry or reinforced concrete foundation, provided such building is placed on a sill of approved wood of natural decay resistance or pressure treated wood and provided the structure is properly anchored to resist overturning and sliding as required in 1601.2. Mud sills shall be not less than a 2x6 or 3x4.

2303.3 Moisture Protection

Surfaces exposed to the weather shall have an approved barrier to protect the structural frame and the interior wall covering. The barrier shall be at least Type 15 felt or kraft waterproof building paper. Building paper and felt shall be free from holes and breaks other than those created by fasteners and construction systems due to attaching of the barrier, and shall be applied over studs or sheathing of all exterior walls. Such felt or paper shall be applied horizontally with the upper layer lapped over the lower layer not less than 2 inches (51 mm). Where vertical joints occur, felt or paper shall be lapped not less than 6 inches (152 mm).

EXCEPTIONS: The approved barrier is not required in any of the following circumstances:

1. When exterior covering is of approved weatherproof panels.
2. In back-plastered construction.
3. When there is no human occupancy.
4. Over water-repellent panel sheathing including wood structural panels complying with Tables 2308.1B and 2308.1D, fiberboard not less than 7/16 inch (11.1 mm) thick, particleboard complying with ANSI A208.1 grades in Table 2308.1C, and gypsum not less than 1/2 inch (12.7 mm) thick.
5. Under approved paperbacked metal or wire fabric lath.
6. Behind lath and portland cement plaster applied to the underside of roof and eave projections.

2304 PROTECTION AGAINST DECAY AND TERMITES

2304.1Protection

2304.1.1 Where protection of wood members is required by this section, protection shall be provided by using naturally durable or pressure treated wood.

2304.1.1.1 The expression "naturally durable wood" refers to the heartwood of the following species with the exception that an occasional piece with corner sapwood may be included if 90% or more of the width of each side on which it occurs is heartwood:

1. Decay resistant Redwood, Cedars, Black Locust.
2. Termite resistance – Redwood, Eastern Red Cedar.

2304.1.1.2 The expression "pressure treated wood" refers to wood meeting the retention, penetration and other requirements applicable to the species, product, treatment and conditions of use in the approved standards of the American Wood Preservers Association (AWPA) listed in Table 2304.

Table 2304
Preservative Retention Requirements

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

Notes:

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.

2304.1.1.3 Wood subject to damage from both decay and termites shall be a naturally durable species resistant to termites or pressure treated.

2304.1.2 In territories where hazard of termite damage is known to be very heavy the building official may require floor framing of naturally durable wood, pressure treated wood, soil treatment or other approved methods of termite protection. Where the floor is constructed of a concrete slab on ground, the building official shall require soil treatment under the slab.

2304.1.3 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 to prevent moisture or water accumulation on the surface or at joints between members. Depending on local experience, such members may Include horizontal members such as girders, joists, and decking and vertical members such as posts, poles and column.

2304.1.4 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 product as described in the standards listed in Table 2304. 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 piling shall be marked legibly with indelible ink, branding or noncorrosive metal tags.
2. All dressed dimensional lumber shall be legibly marked with indelible ink, branding or noncorrosive tags. If tags are used, after construction is completed, the contractor shall insure that 20% to 30% of the lumber used has an identification tag in an accessible location. This may require reattaching tags on the end or bottom of a portion of the lumber used.
3. Treating plants during normal working hours shall permit members of the North Carolina State Building Code Council or their staff access to its plant to monitor the performance of the third party agency by inspecting the operating of the facility and examining all records of the certification program.

2304.1.5 The standards of the North Carolina Pest Control Committee of the North Carolina Department of Agriculture shall be deemed as approved in respect to preconstruction soil treatment for protection against termites.

2304.1.6 When in contact with the ground, foam plastic shall be installed in accordance with 2603.8.

2304.2 Wood in Ground Contact or Exposed to the Weather

2304.2.1 Wood in contact with ground or below ground level which supports permanent structures shall be approved pressure treated wood suitable for ground contact use.

EXCEPTIONS:

1. Naturally durable wood used in contact with the ground for support of structures other than buildings and walking surfaces.
2. Untreated wood used for supports where entirely below ground water level or continuously submerged in fresh water.

2304.2.2 All posts, poles, and columns supporting permanent structures and embedded in concrete which is in contact with ground shall be approved pressure treated wood suitable for ground contact use.

EXCEPTION: Naturally durable wood used for posts, poles, and columns embedded in concrete for structures other than building and walking surfaces or in structures where wood is above ground level and not exposed to weather.

2304.2.3 Posts or columns supporting permanent structures which are closer than 8 inches (203 mm) to exposed ground in enclosed crawl spaces or unexcavated areas located within the periphery of the building shall be approved naturally durable or pressure treated wood.

2304.2.4 Wood posts or columns exposed to the weather or in basement or cellars. and which support permanent structures shall be supported by concrete piers or metal pedestals projecting at least 1 inch (25.4 mm) above concrete or masonry floors or decks and 6 inches (152 mm) above exposed earth and separated therefrom by an approved impervious barrier except when approved naturally durable or pressure treated wood is used.

2304.2.5 Clearance between wood siding and earth on the exterior of a building shall be not less than 6 inches (152 mm) except where siding, sheathing and wall framing are of approved pressure treated wood or approved naturally durable wood.

2304.2.6 Those portions of glued laminated timber which form the structural supports of a building or other structure and are exposed to weather and not properly protected by a roof, eave or similar covering shall be pressure treated with preservative or be manufactured from naturally durable wood.

2304.3 Crawl Space Construction

2304.3.1 Crawl spaces under buildings without basements shall be ventilated in accordance with 1804.6.3.1.

2304.3.2 All wood framing and sheathing less than 8 inches (203 mm) from exposed earth in exterior walls that rest on treated wood, concrete or masonry foundations shall be approved naturally durable or pressure treated wood.

2304.3.3 When the bottoms of wood structural floor elements, including joists, girders and subfloor, are less than 8 inches (203 mm) above the horizontal projection of the outside ground level and extend toward the outside ground beyond the plane represented by the interior face of the foundation wall studs, such elements shall be approved naturally durable or pressure treated wood.

2304.3.4 When wood joists or the bottom of wood structural floors without joists are closer than 18 inches (457 mm) or wood girders are closer than 12 inches (305 mm) to exposed ground located within the periphery of the building over crawl space or unexcavated areas, they shall be of approved naturally durable wood or pressure treated wood.

2304.4 Slabs

2304.4.1 Sleepers, sills and sole plates on a concrete or masonry slab which is in direct contact with earth shall be approved naturally durable or pressure treated wood.

2304.4.2 Wood structural members supporting moisture permeable floors or roofs which are exposed to the weather, such as concrete or masonry slabs, shall be of approved naturally durable wood or pressure treated wood unless separated from such floors or roofs by an approved impervious moisture barrier.

2304.5 Walls

2304.5.1 Ends of wood girders entering exterior masonry or concrete walls shall be provided with 1/2-inch (12.7 mm) air space on tops, sides, and ends unless approved naturally durable or pressure treated wood is used.

2304.5.2 Wood furring strips or other wood framing members attached directly to the interior of exterior masonry or concrete walls below grade shall be approved naturally durable or pressure treated wood.

2304.5.3 Wood used in retaining or crib walls shall be approved pressure treated wood.

EXCEPTIONS:

1. It may be of untreated wood when the wall is not more than 2 ft (610 mm) high and is separated from the property line or a permanent building by a minimum distance equal to the height of the wall.
2. It may be of approved naturally durable wood when the wall is not more than 2ft (610 mm) high and is located on the property line.
3. It may be of approved naturally durable wood when the wall is not more than 4 ft (1219 mm) high and is separated from the property line or a permanent building by a minimum distance equal to the height of the wall.

2305 FIRE PROTECTION

2305.1 Fireblocking

2305.1.1 Fireblocking shall be provided to cut off all vertical and horizontal concealed draft openings. Fireblocking shall be as indicated in this section and as provided in 705.3.

2305.1.2 Fireblocking, when of wood, shall effectively fill all spaces for the entire width or depth of the framing or structural member.

2305.1.3 Fireblocking, when of other materials as provided in 705.3, shall be securely and tightly fitted into place. In the case of spaces between chimneys and wood framing, such spaces shall be solidly filled with mortar or loose noncombustible matter on noncombustible supports.

2305.1.4 Fireblocking shall be installed in wood frame construction in the following locations:

1. In concealed spaces of stud walls and partitions including furred spaces at ceiling and floor levels.
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 levels with approved materials in accordance with 705.4.6, except in the case of approved metal chimney installations as set forth in 2804.4.
5. At all interconnections between concealed vertical stud wall or partition spaces and concealed spaces created by an assembly of floor joists, fireblocking shall be provided for the full depth of the joists at the ends and over the supports.

2305.1.5 Except as provided in 2305.1.4(4), fireblocking 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 (18.3 mm) wood structural panel with joints backed by 23/32-inch (18.3 mm) wood structural panel or one thickness of nominal 3/4-inch 2-M-W particleboard with joints backed by 3/4-inch particleboard or other approved materials.

2305.2 Draftstopping

2305.2.1 Draftstopping shall be provided in wood frame construction in the locations listed in 2305.2.2 through 2305.2.4.

2305.2.2 F1oor/Ceiling Assemblies:

1. Single family dwellings. In floor/ceiling assemblies separating useable spaces into two or more approximate areas with no area greater than 500 sq ft (46.5 m^2) Draftstopping shall be provided parallel to the main framing members.
2. Multifamily (two or more) dwellings, motels hotel. In the floor/ceiling assemblies above and in line with the tenant separation, when tenant separation walls do not extend to the floor sheathing above.

3. Other Buildings. In floor/ceiling assemblies so that horizontal areas do not exceed 1,000 sq ft (92.9 m^2).

2305.2.3 Attics:

1. Single family dwellings. None required.
2. Multifamily (two or more) dwellings, motel, hotel. In the attic, mansard, overhang, or other concealed roof space above and in line with the tenant separation when tenant separation walls do not extend to the roof sheathing above.

   EXCEPTIONS:

   1. Where corridor walls provide a tenant separation, draftstopping shall only be required above one of the corridor walls.
   2. Where flat roofs with solid joist construction are used, draftstopping over tenant separation walls is not required.
   3. Where approved sprinklers are provided (NFiPA 13), draftstopping shall be required for areas over 9,000 sq ft (836 m^2).
   4. In multifamily dwellings, where approved sprinklers are provided (NFiPA 13R), draftstopping shall be at least 1/2-inch gypsum wall board with joints butted to each other, not required to be taped or mudded, on each side of partitions or trusses at a maximum of 3,000 sq ft (279m^2) of attic space.
   5. In multifamily dwellings, one layer of 1/2-inch gypsum wall board on each side of partitions or trusses on every two adjoining units may be provided in lieu of every tenant unit.
3. Other buildings. In attic spaces so that horizontal areas do not exceed 3,000 sq ft (279m^2).

   EXCEPTIONS:

   1. Where flat roofs with solid joist construction are used, draftstopping over tenant separation walls is not required.
   2. Where approved sprinklers are provided, the area may be tripled.

2305.2.4 Continuous exterior cornices of wood, or of wood frames, shall be draftstopped at intervals not exceeding 20ft (6096 mm).

EXCEPTION: Draftstopping of cornices is not required in single family dwellings.

2305.2.5 Ventilation of concealed roof spaces shall be maintained in accordance with 2309.7.

2305.2.6 Draftstopping materials shall be not less than 1/2-inch (12.7 mm) gypsum board, 15/32-inch (11.9 mm) wood structural panel, 1/2-inch (12.7 mm) particleboard or other approved materials adequately supported.

2305.2.7 The integrity of all draftstops shall be maintained.

2305.3 Fire Resistance Ratings

2305.3.1 When fire resistance ratings are specified by this code, they shall be provided in conformance with the requirements of 701.2.

2305.3.2 Where fire resistance ratings are involved, wood spacers, backup cleats or other devices shall not be used unless specifically approved for such use.

2305.4 Fire Cuts

Where joists, beams, or girders enter and terminate in a masonry wall, they shall be provided with a fire cut of 3 inches (76 mm) or provided with wall plate boxes of self-releasing type or approved hangers. If located in a required fire resistant wall, the joists, beams, or girders shall be separated from the opposite side of the wall by at least 4 inches (102 mm) of solid masonry.

2306 FASTENINGS

2306.1 Nailing and Stapling Requirements

The number and size of nails or staples connecting wood members shall not be less than those specified in Table 2306.1. Where nails of a type other than those shown in the table are used, the number and spacing shall be in accordance with the manufacturer's instructions.

2306.2 Other Fastenings

Where framing anchors, clips, staples, glues, or other methods of fastening are used, they shall be labeled, listed and installed in accordance with their listing.

2306.3 In Treated Wood

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

EXCEPTION: Fastenings in contact with pressure treated wood products that are not exposed to rainfall or ground moisture.

Table 2306.1
Fastening Schedule

Connection	Fastener	Number or Spacing
Joist to band joist, face nail	16d common	3
Joist to sill or girder, toe nail	8d common	3
Bridging to joist, toe nail each end	8d common	2
Ledger strip	16d common	3 at each joist
1x6 or less subflooring to each joist, face nail	8d common	2
Over 1x6 subfloor to each joist, face nail	8d common	3
2-inch subfloor to joist or girder, blind and face nail	16d common	2
Sole plate to joist or blocking, face nail	16d common	16" o.c.
Top or sole plate to stud, end nail	16d common	2
Stud to sole plate, toe nail	8d common	4
Doubled studs, face nail	10d common	24" o.c.
Doubled top plates, face nail	10d common	16" o.c.
Top plates, lap and intersections face nail	---	2-16d or 3-10d common
Continuous header, two pieces	16d common	16" o.c. along each edge
Ceiling joists to plate, toe nail	8d common	3
Continuous header to stud, toe nail	8d common	3
Ceiling joists, laps over partitions, face nail	---	3-16d or 4-10d common
Ceiling joists to parallel rafters, face nail	---	3-16d or 4-10d common
Rafter to plate, toe nail	8d common	3
1-inch brace to each stud and plate, face nail	8d common	2
1x8 or less sheathing to each bearing, face nail	8d common	2
Over 1x8 sheathing to each bearing, face nail	8d common	3
Built-up corner studs	16d common	24" o.c.
Built-up girders and beams, of three members	20d common	32" o.c. at top and bottom and staggered 2 ends and at each splice.
2-inch planks	16d common	2 each bearing
Studs to sole plate, end nail	16d common	2 each end
Wood Structural Panel and Particleboard Subflooring[7]		
15/32", 1/2"	6d common, annular or spiral thread	6" o.c. edges and 12" o.c. intermediate
19/32"-3/4"	8d common or 6d common, annular or spiral thread	6" o.c. edges and 12" o.c. intermediate
1", 1 1/8"	10d common or 8d annular or spiral thread	6" o.c. edges and 6" o.c. intermediate
15/32", 1/2"	16 ga galvanized wire staples, 3/8" minimum crown 1 5/8" length	4" o.c. edges and 7" o.c. intermediate
19/32", 5/8"	16 ga galvanized wire staples, 3/8" minimum crown 1 5/8" length	2 1/2" o.c. edges and 4" o.c. intermediate
Wood Structural Panel and Particleboard Roof & Wall Sheathing		
1/2" or less	6d common	6" o.c. edges and 12" o.c. intermediate
19/32" or greater	6d common	6" o.c. edges and 12" o.c. intermediate
5/16" – 1/2"	16 ga galvanized wire staples, 3/8" min. crown. Length of 1" plus wood structural panel or particleboard thickness	4" o.c. edges and 8" o.c. intermediate
19/32" – 3/4"	16 ga galvanized wire staples, 3/8" min. crown. Length of 1" plus wood structural panel or particleboard thickness	2" o.c. edges and 5" o.c. intermediate

(continued)

Table 2306.1
Fastening Schedule *(continued)*

Connection	Fastener	Number or Spacing
Fiberboard Sheathing[1]		
1/2"	1 1/2" galvanized roofing nail 6d common wall	3" o.c. edges and 6" at other bearings
25/32"	1 3/4" galvanized roofing nail 8d common wall	3" o.c. edges and 6" o.c. at other bearings
Gypsum Sheathing		
1/2"	11 ga 1 1/2" galvanized 7/16" head	4" o.c. edges and 8" o.c. at other bearings
5/8"	11 ga 1 3/4" galvanized 7/16" head	3" o.c. edges and 6" o.c. at other bearings
Gypsum Wallboard		
1/2"	1 3/8" drywall nail[2]	7" o.c. on ceilings 8" o.c. on walls
5/8"	1 1/2" drywall nail[2]	7" o.c. on ceilings 8" o.c. on walls
Particleboard Siding		
5/16" – 1/2" [3]	6d[4]	
5/8" [5]	8d[4]	
3/4" [6]	8d[4]	
Hardboard Lap Siding		
Direct to Studs	8d [8] corrosion-resistant with minimum shank diameter of 0.099 inch and minimum head diameter of 0.240 inch	16 inch o.c. at top and bottom edges
Over Sheathing	10d [6] corrosion-resistant with minimum shank diameter of 0.099 inch and minimum head diameter of 0.240 inch	16 inch o.c. at top and bottom edges
Hardboard Panel Siding		
Direct to Studs	6d [6] corrosion-resistant with minimum shank diameter of 0.092 inch and minimum head diameter of 0.225 inch	6 inch o.c. at edges and 12 inch o.c. at intermediate supports
Over Sheathing	8d [6] corrosion-resistant with minimum shank diameter of 0.092 inch and minimum head diameter of 0.225 inch	6 inch o.c. at edges and 12 inch o.c. at intermediate supports

1 in = 25.4 mm

Notes:

1. Fiberboard sheathing may be stapled using 16 ga galvanized staples 1 1/8" long for 1/2" sheathing and 1 1/2" long for 25/32" sheathing. Staples to have minimum crown of 7/16" and spaced 3" o.c. at edges and 6" o.c. at other bearings.
2. Drywall nails shall conform to ASTM C 514.
3. Siding applied to 5/8" net wood sheathing, 15/32" wood structural panel or 1/2" particleboard sheathing.
4. Corrosion-resistant nails spaced 6" on center at edge and 8" on center at intermediate supports. Nails shall have a minimum edge distance of 3/8".
5. Siding applied to studs spaced 16" on center maximum.
6. Siding applied directly to studs spaced 24" on center maximum.
7. Use annular or spiral thread nails for combination subfloor/underlayment.
8. Nail must be of sufficient length to accommodate thickness of siding and sheathing, if used, and allow minimum stud penetration of 1 1/2 inches.

2307 FLOOR FRAMING

2307.1 Sill on Foundation

Sills on continuous foundation walls shall be not less than 2 inches nominal thick and shall be anchored thereto by 1/2-inch (12.7 mm) bolts spaced not more than 4 ft (1219 mm) apart and which are embedded at least 6 inches (152 mm) in concrete or 8 inches (203 mm) in masonry units. Except where wood of natural decay resistance or pressure treated wood is used, an approved moisture barrier shall be provided between the sill and the foundation. Piers supporting girders shall provide a true and even bearing surface.

EXCEPTION: All buildings or structures located in seismic map areas having a peak velocity-related acceleration, A_v, equal to or less than 0.05 by 1607.1 and buildings of Group R3 located in seismic map areas having a peak velocity-related acceleration, A_v, less than 0.15 and agricultural storage buildings which are intended only for incidental human occupancy are permitted to have maximum intermediate bolt spacings of 6ft (1828 mm).

2307.2 Beams and Girders

Beams and girders shall be designed in accordance with 2301.1 or 2301.2.5. Where two or more pieces of 2-inch lumber are nailed together to provide girders, the wide faces shall be vertical and the end joints shall occur over supports, provided that for a girder continuous over three or more supports the end joints may be staggered in adjacent pieces at one-fourth the distance from intermediate supports. Where a girder is spliced over the support an adequate tie shall be provided. The ends of beams or girders supported on masonry or concrete shall have not less than 3 inches (76 mm) of bearing.

2307.3 Floor Joists

2307.3.1 Maximum spans for floor joists shall be in accordance with the NFoPA Span Tables for Joists and Rafters or may be designed in accordance with 2301.2 or 2301.3.1.

2307.3.2 Spans for field-glued wood structural panel-lumber floor systems using approved adhesives shall be as set forth in APA Design/Construction Guide Residential & Commercial. Approved adhesives shall be those meeting the requirements of APA AFG-01.

2307.3.3 Except where supported on a 1x4 ribbon strip and nailed to the adjoining stud, the ends of each joist shall have not less than 1 1/2 inches (38 mm) bearing on wood or metal nor less than 3 inches (76 mm) bearing on masonry.

2307.3.4 Except in one and two family and multifamily dwellings, floor joists with a depth to thickness ratio exceeding six or a design live load in excess of 40 psf (1.92 kPa) shall be supported laterally by bridging or blocking installed at intervals not exceeding 8 ft (2438 mm).

2307.3.5 Joists shall be supported laterally at the ends by solid blocks or diagonal struts except where the ends of joists are nailed to a beam (wood or steel with an attached nailer), header, band joists or to an adjoining stud.

2307.3.6 Notches on the ends of joists shall not exceed one-fourth the depth. Holes bored for pipes or cable shall not be within 2 inches (51 mm) of the top or bottom of the joist and the diameter of any such hole shall not exceed one-third the depth of the joist. Notches for pipes in the top or bottom of joists shall not exceed one-sixth the depth and shall not be located in the middle one-third of the span.

2307.3.7 Joists framing from opposite sides of a beam, girder or partition shall be lapped at least 3 inches (76 mm) and fastened, or the opposing joists shall be tied together in an approved manner.

2307.3.8 Joists framing into the side of a wood girder shall be supported by framing anchors, on not less than 2x2 ledger strips or by other approved methods.

2307.4 Framing Around Openings

Trimmer and header joists shall be doubled when the span of the header exceeds 4 ft (1219 mm). The ends of header joists more than 6 ft (1829 mm) long shall be supported by framing anchors, joist hangers, or other approved methods unless bearing on a beam, partition or wall. Tail joists over 12 ft (3658 mm) long shall be supported at header by framing anchors or on not less than 2x2 ledger strips.

2307.5 Joists Supporting Partitions

Bearing partitions parallel to joists shall be supported on beams, girders, walls, or other bearing partitions. Bearing partitions perpendicular to joists shall not be offset from supporting girders, wall or partitions more than the joist depth, unless such joists are of sufficient size to carry the additional load.

2307.6 Subfloors

2307.6.1 Except as provided in 2307.6.2, all floor joists shall be covered with subflooring of lumber as shown in Table 2307.6A or wood structural panels applied in accordance with Table 2307.6B and fastened in accordance with Table 2306.1, or particleboard applied in accordance with Table 2307.6C and fastened in accordance with Table 2306.1.

Table 2307.6A
Minimum Net Thickness of Lumber Subflooring (in)

Joist Spacing (in)[1]	Perpendicular to Joists	Diagonally to Joists
24	11/16	3/4
16	5/8	5/8
12	5/8	5/8

1 in = 25.4 mm

Note:

1. Joints in subflooring shall occur over supports unless end-matched lumber is used, in which case each piece shall bear on at least two joists.

2307.6.2 Subflooring may be omitted when joist spacing does not exceed 16 inches (407 mm) and nominal 1-inch tongue-and-grooved wood strip flooring is applied perpendicular to the joists.

2307.6.3 When resilient flooring is applied directly to wood structural panel subfloor, the subfloor shall be applied in accordance with Table 2307.6D and fastened in accordance with Table 2306.1.

Table 2307.6B
Allowable Spans and Loads for Wood Structural Panel Sheathing and Single Floor Grades Continuous Over Two or More Spans With Long Dimension Perpendicular to Supports[1,6]

Sheathing Grade		Roof				Floor
Span Rating	Panel Thickness (in)	Maximum Span (in)		Load (psf)		
Roof/Floor Span		With Edge Support[2]	Without Edge Support	Total Load	Live Load	Maximum Span (in)
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[3]	40	30	0
24/16	7/16, 1/2	24	24	50	40	16[5]
32/16	15/32, 1/2, 5/8	32	28	40	30	16[4,5]
40/20	19/32, 5/8, 3/4, 7/8	40	32	40	30	20
48/24	23/32, 3/4, 7/8	48	36	45	35	24
54/32	7/8, 1	54	40	45	35	32
60/48	7/8, 1, 1-1/8	60	48	45	35	48
Single Floor Grade		**Roof**				**Floor**
		Maximum Span (in)		Load (psf)		
Span Rating	Panel Thickness (in)	With Edge Support[2]	Without Edge Support	Total Load	Live Load	Maximum Span (in)
16 o.c.	19/32, 5/8	24	24	50	40	16[5]
20 o.c.	19/32, 5/8, 3/4	32	32	40	30	20[4,5]
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 in = 25.4 mm

1 psf = 47.8803 Pa

Notes:

1. The allowable loads were determined using a dead load of 10 psf. If the dead load exceeds 10 psf then the live load shall be reduced accordingly.
2. Tongue-and-groove edges, panel edge clips (one midway between each support, except two equally spaced between supports 48 inches on center), lumber blocking, or other. Only lumber blocking shall satisfy blocked diaphragm requirements.
3. For 1/2-inch panels maximum span shall be twenty-four inches.
4. Maximum framing space shall be 24 inches on center for floors where 1-12/ inches of cellular or lightweight concrete is applied over the panels.
5. Maximum frame spacing shall be 24 inches on center where 3/4-inch wood strip flooring is installed at right angles to joists.
6. Shall apply only to panels 24 inches or wider.

Table 2307.6C
Allowable Spans for Particleboard Subfloor and Combined Subfloor/Underlayment[1]

Grade	Thickness	Maximum Spacing of Supports (in)[2,3]	
		Subfloor (in)	Combined Subfloor/ Underlayment
2-M-W	1/2	16	---
	5/8	20	16
	3/4	24	24
2-M-3	3/4	20	20

1 in = 25.4 mm

Notes:

1. All panels continuous over two or more spans. Tongue-and-groove panels are installed with the long dimension perpendicular to supports.
2. Uniform deflection limitation: 1/360th of the span under 100 psf (4.79 kPa) minimum load.
3. Edges shall have tongue-and-groove joints or shall be supported with blocking unless 1/4 inch minimum thickness underlayment or 1 1/2-inch approved cellular or lightweight concrete installed, or finish floor is 3/4-inch wood strips.

Table 2307.6D
Allowable Spans for Wood Structural Panel Combination Subfloor/Underlayment (Single Floor)[1]

(Panels Continuous over Two or More Spans and Long Panel Dimension Perpendicular to Supports)

Identification	Maximum Spacing of Joints (in)				
Species Groups[2]	**16**	**20**	**24**	**32**	**48**
1	1/2"	5/8”	3/4"	---	---
2, 3	5/8”	3/4"	7/8”	---	---
4	3/4"	7/8”	1”	---	---
Single Floor Span Ratings[3]	16 o.c.	20 o.c.	24 o.c.	32 o.c.	48 o.c.

1 in = 25.4 mm

Notes:

1. Spans shall be limited to values shown because of possible effect of concentrated loads. Allowable uniform load based deflection of 1/360 of span shall be 100 psf, except panels with a Span Rating of 48 o.c. shall be limited to 65 psf total load at maximum span. Wood structural panel edges shall have approved tongue-and-groove joints or shall be supported with blocking, unless 1/4 inch minimum thickness underlayment is installed, 1 1/2-inch approved cellular or lightweight concrete installed, or finish floor is 3/4-inch wood strip. If wood strips are perpendicular to supports, thicknesses shown for 16-inch and 20-inch spans shall have a maximum span of 24-inches.
2. Applicable to all grades of sanded exterior-type plywood.
3. Applicable to underlayment grade and C-C (plugged) plywood, and Single Floor grade panels.

2307.7 Plank-And-Beam Framing

2307.7.1 Beams supporting plank floors shall not exceed the limitations set forth in 2307.2.

2307.7.2 The allowable span for 2-inch planks shall be determined in accordance with 2301.2 or 2301.3.1.

2307.8 Floor Framing To Masonry Walls

Wood floor construction which rests on masonry walls shall be anchored thereto in accordance with 2110.3.

2307.9 Stair Framing

2307.9.1 Stair framing shall be supported adequately on floor framing or on walls or partitions.

2307.9.2 Except in public stairs where the number and size of stringers shall be determined by engineering analysis, two rough stringers shall be provided for each set of stairs, cut to receive finish treads and risers of uniform width and height.

2307.9.3 Unless stringers are supported on walls or partitions, the minimum effective depth at each notch shall be not less than 3 1/2 inches (88.9 mm).

2308 VERTICAL FRAMING

2308.1 Exterior Wall Framing

2308.1.1 Studs in one and two story buildings shall be not less than 2x4 with the wide face perpendicular to wall. In three story buildings, studs in the first story shall be not less than 3x4 or 2x6. Studs shall be spaced in accordance with Table 2308.1A.

Table 2308.1A
Maximum Stud Spacing

Stud Size	Lateral Unsupported Stud Height (ft)	Supporting roof and ceiling only (in)	Supporting 1 floor, roof and ceiling (in)	Supporting 2 floors, roof and ceiling (in)
2x4	10	24	16	---
3x4	10	24	24	16
2x5	10	24	24	---
2x6	10	24	24	16

1 in = 25.4 mm
1 ft = 0.305 m

Table 2308.1B
Allowable Spans for Wood Structural Panel Wall Sheathing[1,2]

Panel Span Rating	Panel thickness (in) and Construction	Maximum Stud Spacing (in) with Exterior covering nailed to:	
		Stud	Sheathing
12/0, 16/0, 20/0 or Wall-16 oc	5/16	16	16[3]
24/0, 24/16, 32/16 or Wall-24 oc	3/8, 7/16, 15/32, 1/2	24	24[4]

1 in = 25.4 mm

Notes:

1. When wood structural panel sheathing is used, diagonal wall bracing shall not be required.
2. Blocking of horizontal joints shall not be required.
3. Plywood sheathing 3/8-inch thick or less shall be applied with long dimension across studs.
4. 3-ply plywood panels shall be applied with long dimension across studs.

Table 2308.1C
Allowable Spans for Particleboard Wall Sheathing Not Exposed to the Weather, Long Dimensions of the Panel Parallel or Perpendicular to Studs

Grade	Thickness (in)	Stud Spacing (in)	
		Siding Nailed to Studs	Sheathing Under Coverings Specified in 1403.6.3 and 1403.7 Parallel or Perpendicular to Studs
2-M-W	5/16	16	---
	3/8	24	16
	7/16	24	24
2-M-1 and 2-M-2	3/8	16	---
	1/2	16	16

1 in = 25.4 mm

Table 2308.1D
Plywood Exterior Wall Coverings[1]

Wall Covering	Plywood[2] Thickness (in)	Nail Size	Nail Type	Panel Edges (in)	Nail Spacing on Supports Intermediate (in)
Panel Siding[4]	3/8, 1/2	6d	Noncorrosive, box or casing nails	6	12 on each stud
	5/8 & thicker	8d		6	12 on each stud
Lap Siding (over nailable sheathing)	1/2 thick or less	6d	Noncorrosive, box or casing nails	8[5]	One nail per stud on widths 12 or less, 8 inches on center for widths greater than 12
	Thicker than 1/2	8d			
303 Specialty Siding	11/32, 15/32	6d	Noncorrosive, box or casing nails	6[3]	12 on each stud
	19/32 & thicker	8d		6[3]	12 on each stud
Texture 1-11[4]	19/32	8d	Noncorrosive, box or casing nails	6	12 on each stud

1 in = 25.4 mm

Notes:

1. Panel thickness shall be not less than 3/8-inch nominal except for “303 Specialty Siding” panels which are grooved, striated, brushed, or have other surface texture. Average thickness of “303 Specialty Siding” panels after texturing shall not be less than 5/16-inch. Nailing of plywood shall be as indicated.
2. Minimum edge distance of 3/8-inch.
3. Special Requirement: Nails on ship-lap edges 3/8-inch from exposed edge and slant driven towards it; do not set.
4. In direct-to-stud applications 41 and 5-ply panels of 15/32-inch nominal thickness or more may be used over studs 24” o.c. if texturing does not penetrate through the face veneer. Other panels shall be used with face grain vertical on studs spaced 16-inch o.c. or with face grain horizontal on studs spaced 24-inch o.c. Five ply panels having a nominal thickness of 19/32-inch or more, grooves no wider than 1 1/2-inch and space no closer than12-inch o.c. may also be applied direct to studs spaced 24-inch o.c.
5. Along bottom edge.

2308.1.2 Utility grade studs shall not be spaced more than 16 inches (406 mm) on center, support more than a roof and ceiling and exceed 8ft (2438 mm) in height for exterior load bearing walls.

2308.1.3 Heights listed in 2308.1.1 are distances between points of horizontal lateral support placed perpendicular to the plane of the wall. Heights may be increased where justified by analysis.

2308.1.4 Where floor trusses, floor joists or roof trusses are spaced more than 16 inches (406 mm) on center and the bearing studs are spaced 24 inches (610 mm) on center, such joists or trusses shall bear within 5 inches (127 mm) of the studs beneath.

EXCEPTIONS:

1. The top plates are two 2x6 or two 3x4 members.
2. A third top plate is installed.
3. Solid blocking equal in size to the studs is installed to reinforce the double top plate.

2308.1.5 Studs shall be capped with double top plates installed to provide overlapping at corners and at intersections with bearing partitions. End joints in double top plates shall be offset at least 24 inches (610 mm). In lieu of double top plates, a continuous header may be used.

EXCEPTION: Buildings or structures located in seismic map areas having a peak velocity-related acceleration, (A_v), less than 0.05, according to 1607.1, buildings of Group R3 located in seismic map areas having an A_v less than 0.15 and agricultural storage buildings which are intended only for incidental human occupancy are permitted to have a single 2x6 top plate installed in 2x6 bearing and exterior walls provided the plate is adequately tied at joints, corners and intersecting walls by at least the equivalent of 3x6x0.036-inch (76x 152x0.91 mm) thick galvanized steel 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 (25.4 mm). Top plates may be omitted over lintels which are adequately tied to adjacent wall section as previously described or with 1x4x12-inch (305 mm) wood members splice nailed to each wall section by three 8d nails or equivalent.

2308.1.6 Studs shall have full bearing on a plate or sill of not less than 2 inch nominal thickness and having a width at least equal to the width of the studs.

2308.2 Bracing Of Exterior Stud Walls

2308.2.1 Corner Bracing. Not less than three studs shall be installed at every corner of an exterior wall, except that a third stud may be omitted through the use of continuous wood spacer or backup cleat of 3/8-inch (9.5 mm) thick wood structural panel or 2-M-W particleboard, 1-inch thick lumber or other approved devices which will serve as an adequate backing for the attachment of facing materials.

EXCEPTION: Where fire resistance or shear loads apply, wood spacers, backup cleats or other devices shall not be used unless specifically approved.

2308.2.2 Wall Bracing. Where structural analysis is not required, according to 1607.1 and 2301.1.2, all exterior walls shall be in accordance with Table 2308.2.2A. Structural sheathing shall be installed in accordance with the provisions of Table 2308.2.2B when acting as wall bracing. To be considered effective as bracing, the sheathing shall be at least 48 inches (1219 mm) in width covering three 16-inch (406 mm) stud spaces or two 24-inch (610 mm) stud spaces and be fastened to the wall studs according to Table 2306.1. All vertical joints of panel sheathing shall occur over studs and all horizontal joints shall occur over blocking at least equal in size to the studs. All framing in connection with sheathing used for bracing shall be not less than 2-inch nominal thickness.

Table 2308.2.2A
Wall Bracing

Building Seismic Classification	Bracing Story Location	Type of Bracing	Bracing Location
Minimum bracing for all wood frame construction where the peak velocity-related acceleration, A_V, is equal to or less than 0.05, according to 1607	Each story	1x4 let-in diagonal bracing or in accordance with Table 2308.2.2B	Located at each corner and at every 25 ft (7620 mm) of each exterior wall.
Buildings assigned to Seismic Performance Category B and Detached one and two family dwellings (Group R3) 35 ft or less in height, assigned to Category C by 1607.1	First story	In accordance with Table 2308.2.2B	25% of the length of each exterior wall.
	All other stories	In accordance with Table 2308.2.2B	Located at each corner and at every 25 ft (7620 mm) of each exterior wall.
Detached one and two family dwellings (Group R3) 35ft or less in height, assigned to Seismic Performance Category D by 1607.1	All stories below the top story	Wood board sheathing or wood structural panels	40% of the length of each exterior wall.
	Top story	In accordance with Table 2308.2.2B	Located at each corner and at every 25 ft (7620 mm) of each exterior wall.

1 ft = 0.305 m

Table 2308.2.2B
Minimum Thickness if Wall Sheathing

Sheathing Type	Minimum thickness (inches)	Maximum stud spacing (inches)
Wood boards	5/8	24
Fiberboard	7/16	26
Wood Structural Panel	According to Table 2308.1B	
2-M-1 or 2-M-W Particleboard	According to Table 2308.1C	
Gypsum sheathing	1/2	16
Gypsum wallboard	1/2	24
Reinforced cement mortar	1	24

1 in = 25.4 mm

2308.2.3 Fiberboard Sheathing

2308.2.3.1 Wood stud walls sheathed with fiberboard sheathing are permitted to resist horizontal loads provided they comply with Table 2308.2.3. Fiberboard shear walls shall not be used to resist horizontal loads from concrete or masonry walls.

2308.2.3.2 Framing. 4x8 ft (1219x2438 mm) fiberboard sheathing shall be applied vertically to wood studs not less than 2-inch nominal thick spaced 16 inches (406 mm) on center.

2308.2.3.3 Nailing. Nailing shall be in accordance with Table 2308.2.3. Nails shall be spaced not less than 3/8 inch (0.375 mm) from edges and ends of sheathing.

Table 2308.2.3
Allowable Working Stress Shears for Wind or Seismic Forces on Vertical Shear Walls of Fiberboard Sheathing Board[1]

Size/Application	Fastener Type	Shear for 3-inch nail spacing around perimeter and 6-inch at intermediate studs (lb/ft of wall)
1/2 inch x 4 ft x 8 ft	No. 11 ga. galv. roofing nail, 1 1/2" long, 7/16" head	125[2]
25/32 inch x 4 ft x 8 ft	No. 11 ga. galv. roofing nail, 1 3/4" long, 7/16" head	175

1 in = 25.4 mm
1 ft = 0.305 m
1 plf = 14.5939 N/m

Notes:

1. In Category C buildings, the allowable values shall be reduced 50%.
2. The shear value may be 175 lb/ft for fiberboard classified as nail-based sheathing.

2308.3 Openings In Exterior Walls

2308.3.1 Headers shall be provided over each opening in exterior bearing walls. The spans in Tables 2308.3A through 2308.3J may be used for one and two family residences. Headers for other buildings shall be designed in accordance with 2301.2 or 2301.3.1. Headers may be of two pieces of nominal 2-inch framing lumber set on edge and nailed together or may be of solid lumber of equivalent size.

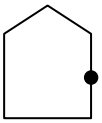
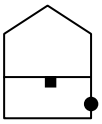
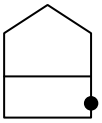
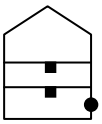
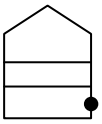
2308.3.2 A wall stud shall be at each side of the opening with the ends of the header supported as follows:

1. For openings 3 ft (914 mm) or less wide each end of the header shall rest on a single header stud or may be supported by framing anchors attached to the wall stud.
2. For openings more than 3ft (914 mm) but not more than 6ft (1829 mm) wide each end of the header shall rest on a single header stud.
3. For openings more than 6ft (1829 mm) wide each end of the header shall rest on two header studs.

Table 2308.3A
Header Design Chart[1]

(Douglas Fir-Larch, Southern Pine No. 2, Roof Load = 20LL + 10DL, Floor Load = 40LL + 10DL)

F_b = 1200 E = 1,600,000 F_v = 90

Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Nonstructural Sheath.			1/2" Insul. Bd. Sheath.[2]			15/32" Plywood Sheath.[3]			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	4-7	4-6	4-3	4-11	4-8	4-6	5-7	5-4	5-1	
	2-2x6	6-8	6-4	5-11	6-11	6-7	6-4	7-7	7-3	7-0	
	2-2x8	8-3	8-0	7-7	8-6	8-2	7-11	8-11	8-7	8-4	
	2-2x10	9-10	9-6	9-3	10-0	9-8	9-4	10-4	10-0	9-9	
	2-2x12	11-4	10-11	10-7	11-5	11-1	10-9	11-10	11-5	11-1	
Roof + One Story (Bearing)	2-2x4	5-2	4-11	4-9	5-4	5-1	4-10	5-8	5-5	5-2	
	2-2x6	6-9	6-5	6-0	6-11	6-7	6-3	7-4	7-0	6-8	
	2-2x8	8-0	7-5	7-0	8-1	7-8	7-3	8-5	8-2	7-9	
	2-2x10	9-3	8-9	8-3	9-4	9-0	8-5	9-7	9-3	8-11	
	2-2x12	10-5	10-1	9-7	10-6	10-2	9-9	10-10	10-5	10-1	
Roof + One Story (No Bearing)	2-2x4	4-8	4-5	4-3	4-9	4-6	4-3	5-1	4-10	4-8	
	2-2x6	5-10	5-5	5-1	6-0	5-7	5-3	6-7	6-2	5-9	
	2-2x8	6-9	6-3	5-11	7-0	6-6	6-1	7-6	7-0	6-7	
	2-2x10	8-0	7-5	6-11	8-2	7-7	7-1	8-8	8-1	7-7	
	2-2x12	9-3	8-7	8-1	9-5	8-9	8-3	9-11	9-3	8-8	
Roof + Two Stories (Bearing)	2-2x4	4-8	4-5	4-3	4-9	4-6	4-3	5-1	4-10	4-8	
	2-2x6	5-10	5-5	5-1	6-0	5-7	5-3	6-7	6-2	5-9	
	2-2x8	6-9	6-3	5-11	7-0	6-6	6-1	7-6	7-0	6-7	
	2-2x10	8-0	7-5	6-11	8-2	7-7	7-1	8-8	8-1	7-7	
	2-2x12	9-3	8-7	8-1	9-5	8-9	8-3	9-11	9-3	8-8	
Roof + Two Stories (No Bearing)	2-2x4	3-11	3-8	3-5	4-1	3-9	3-7	4-5	4-2	4-0	
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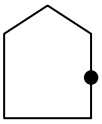
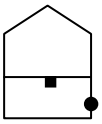
	2-2x8	5-5	5-0	4-8	5-7	5-2	4-10	6-0	5-7	5-3	
	2-2x10	6-4	5-11	5-6	6-6	6-0	5-8	6-11	6-5	6-0	
	2-2x12	7-5	6-10	6-5	7-6	7-0	6-6	7-11	7-4	6-11	

See notes following Table 2308.3J. 1 in = 25.4 mm 1 ft = 0.305 m 1 psi = 6.8948 kPa

Table 2308.3B
Header Design Chart[1]

(Douglas Fir-Larch, Southern Pine No. 2, Roof Load = 30LL + 10DL, Floor Load = 40LL + 10DL)

F_b = 1200 E = 1,600,000 F_v = 90

Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Nonstructural Sheath.			1/2" Insul. Bd. Sheath.[2]			15/32" Plywood Sheath.[3]			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	4-2	3-11	3-8	4-5	4-3	4-1	5-1	4-10	4-8	
	2-2x6	5-10	5-6	5-2	6-3	5-10	5-6	6-11	6-7	6-4	
	2-2x8	7-6	7-0	6-7	7-10	7-3	6-10	8-4	8-0	7-7	
	2-2x10	9-2	8-8	8-2	9-3	8-11	8-5	9-8	9-4	9-1	
	2-2x12	10-6	10-2	9-10	10-8	10-4	10-0	11-0	10-8	10-4	
Roof + One Story (Bearing)	2-2x4	4-11	4-8	4-6	5-0	4-9	4-7	5-4	5-1	4-11	
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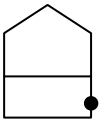
	2-2x8	7-4	6-10	6-5	7-7	7-0	6-7	8-1	7-7	7-1	
	2-2x10	8-7	8-1	7-6	8-10	8-2	7-8	9-2	8-8	8-2	
	2-2x12	10-0	9-4	8-9	10-1	9-6	8-11	10-4	9-11	9-5	
Roof + One Story (No Bearing)	2-2x4	4-5	4-3	4-0	4-9	4-4	4-2	4-10	4-8	4-5	
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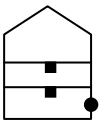
	2-2x8	6-4	5-11	5-6	6-6	6-1	5-8	7-0	6-6	6-2	
	2-2x10	7-6	6-11	6-6	7-7	7-1	6-8	8-1	7-6	7-0	
	2-2x12	8-8	8-1	7-7	8-10	8-2	7-8	9-3	8-8	8-1	
Roof + Two Stories (Bearing)	2-2x4	4-5	4-3	4-0	4-9	4-4	4-2	4-10	4-8	4-5	
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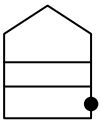
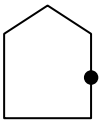
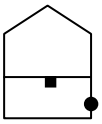
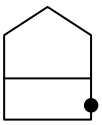
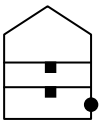
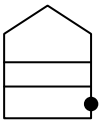
	2-2x8	6-4	5-11	5-6	6-6	6-1	5-8	7-0	6-6	6-2	
	2-2x10	7-6	6-11	6-6	7-7	7-1	6-8	8-1	7-6	7-1	
	2-2x12	8-8	8-1	7-7	8-10	8-2	7-8	9-3	8-8	8-1	
Roof + Two Stories (No Bearing)	2-2x4	3-9	3-6	3-3	3-11	3-8	3-5	4-3	4-0	3-9	
	2-2x6	4-5	4-1	3-10	4-7	4-3	4-0	5-1	4-8	4-5	
	2-2x8	5-2	4-10	4-6	5-4	4-11	4-8	5-9	5-4	5-0	
	2-2x10	6-1	5-8	5-4	6-3	5-9	5-5	6-7	6-2	5-9	
	2-2x12	7-1	6-7	6-2	7-2	6-8	6-3	7-7	7-1	6-7	

See notes following Table 2308.3J. 1 in = 25.4 mm 1 ft = 0.305 m 1 psi = 6.8948 kPa

Table 2308.3C
Header Design Chart[1]

(Hem Fir No. 2, Roof Load = 20LL + 10DL, Floor Load = 40LL + 10DL)

F_b = 1000 E = 1,400,000 F_v = 75

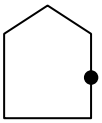
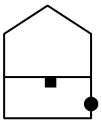
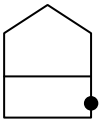
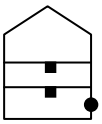
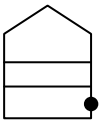
Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Nonstructural Sheath.			1/2" Insul. Bd. Sheath.[2]			15/32" Plywood Sheath.[3]			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	4-5	4-2	3-11	4-8	4-5	4-3	5-4	5-1	4-11	
	2-2x6	6-2	5-9	5-5	6-7	6-1	5-9	7-4	7-1	6-8	
	2-2x8	7-10	7-4	6-11	8-3	7-8	7-3	8-7	8-4	8-0	
	2-2x10	9-6	9-2	8-8	9-8	9-4	8-10	10-0	9-8	9-5	
	2-2x12	10-11	10-7	10-3	11-1	10-8	10-5	11-5	11-1	10-9	
Roof + One Story (Bearing)	2-2x4	4-12	4-9	4-6	5-1	4-10	4-8	5-5	5-2	5-0	
	2-2x6	6-3	5-10	5-5	6-6	6-1	5-8	7-0	6-8	6-3	
	2-2x8	7-4	6-10	6-4	7-6	7-0	6-7	8-1	7-7	7-1	
	2-2x10	8-7	8-0	7-6	8-10	8-2	7-8	9-4	8-8	8-2	
	2-2x12	10-0	9-4	8-9	10-2	9-6	8-11	10-5	10-0	9-4	
Roof + One Story (No Bearing)	2-2x4	4-5	4-2	3-11	4-7	4-4	4-1	4-10	4-8	4-5	
	2-2x6	5-4	4-11	4-7	5-6	5-1	4-9	6-1	5-7	5-3	
	2-2x8	6-2	5-9	5-5	6-4	5-11	5-6	6-10	6-5	6-0	
	2-2x10	7-3	6-9	6-4	7-5	6-11	6-6	7-11	7-4	6-11	
	2-2x12	8-5	7-10	7-4	8-7	8-0	7-6	9-1	8-5	7-11	
Roof + Two Stories (Bearing)	2-2x4	4-5	4-2	3-11	4-7	4-4	4-1	4-10	4-8	4-5	
	2-2x6	5-4	4-11	4-7	5-6	5-1	4-9	6-1	5-7	5-3	
	2-2x8	6-2	5-9	5-5	6-4	5-11	5-6	6-10	6-5	6-0	
	2-2x10	7-3	6-9	6-4	7-5	6-11	6-6	7-11	7-4	6-11	
	2-2x12	8-5	7-10	7-4	8-7	8-0	7-6	9-1	8-5	7-11	
Roof + Two Stories (No Bearing)	2-2x4	3-7	3-4	3-1	3-9	3-6	3-3	4-2	3-10	3-7	
	2-2x6	4-3	3-11	3-8	4-5	4-1	3-10	4-10	4-6	4-2	
	2-2x8	4-11	4-7	4-3	5-1	4-9	4-5	5-6	5-1	4-9	
	2-2x10	5-10	5-5	5-1	5-11	5-6	5-2	6-4	5-10	5-6	
	2-2x12	6-9	6-3	5-10	6-10	6-4	6-0	7-3	6-8	6-3	

See notes following Table 2308.3J. 1 in = 25.4 mm 1 ft = 0.305 m 1 psi = 6.8948 kPa

Table 2308.3D
Header Design Chart[1]

(Hem Fir No. 2, Roof Load = 30LL + 10DL, Floor Load = 40LL + 10DL)

F_b = 1000 E = 1,400,000 F_v = 75

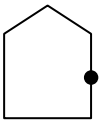
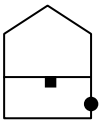
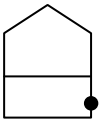
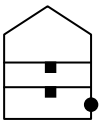
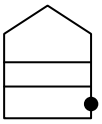
Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Nonstructural Sheath.			1/2" Insul. Bd. Sheath.[2]			15/32" Plywood Sheath.[3]			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	3-10	3-7	3-5	4-2	3-11	3-8	4-10	4-7	4-5	
	2-2x6	5-4	5-0	4-9	5-8	5-4	5-0	6-7	6-2	5-9	
	2-2x8	6-10	6-4	6-0	7-1	6-8	6-3	7-10	7-4	6-11	
	2-2x10	8-6	7-11	7-6	8-9	8-2	7-8	9-4	8-9	8-3	
	2-2x12	10-2	9-6	8-11	10-4	9-9	9-2	10-8	10-3	9-9	
Roof + One Story (Bearing)	2-2x4	4-8	4-5	4-3	4-9	4-7	4-5	5-2	4-11	4-8	
	2-2x6	5-9	5-3	5-0	5-11	5-6	5-2	6-6	6-1	5-8	
	2-2x8	6-8	6-3	5-10	6-11	6-5	6-0	7-5	6-11	6-6	
	2-2x10	7-10	7-4	6-11	8-0	7-6	7-0	8-6	7-11	7-6	
	2-2x12	9-2	8-6	8-0	9-4	8-8	8-2	9-9	9-1	8-7	
Roof + One Story (No Bearing)	2-2x4	4-2	3-11	3-8	4-4	4-1	3-10	4-8	4-5	4-3	
	2-2x6	5-0	4-7	4-4	5-2	4-9	4-6	5-8	5-3	4-11	
	2-2x8	5-9	5-5	5-1	6-0	5-7	5-2	6-5	6-0	5-7	
	2-2x10	6-10	6-4	5-11	6-11	6-6	6-1	7-5	6-10	6-5	
	2-2x12	7-11	7-4	6-11	8-1	7-6	7-0	8-6	7-11	7-5	
Roof + Two Stories (Bearing)	2-2x4	4-2	3-11	3-8	4-4	4-1	3-10	4-8	4-5	4-3	
	2-2x6	5-0	4-7	4-4	5-2	4-9	4-6	5-8	5-3	4-11	
	2-2x8	5-9	5-5	5-1	6-0	5-7	5-2	6-5	6-0	5-7	
	2-2x10	6-10	6-4	5-11	6-11	6-6	6-1	7-5	6-10	6-5	
	2-2x12	7-11	7-4	6-11	8-1	7-6	7-0	8-6	7-11	7-5	
Roof + Two Stories (No Bearing)	2-2x4	3-5	3-2	3-0	3-7	3-4	3-1	3-11	3-8	3-5	
	2-2x6	4-1	3-9	3-6	4-2	3-11	3-8	4-7	4-3	4-0	
	2-2x8	4-9	4-5	4-1	4-10	4-6	4-3	5-3	4-10	4-7	
	2-2x10	5-7	5-2	4-10	5-8	5-3	4-11	6-0	5-7	5-3	
	2-2x12	6-5	6-0	5-7	6-7	6-1	5-9	6-11	6-5	6-0	

See notes following Table 2308.3J. 1 in = 25.4 mm 1 ft = 0.305 m 1 psi = 6.8948 kPa

Table 2308.3E
Header Design Chart[1]

(Spruce-Pine-Fir No. 2, Roof Load = 20LL + 10DL, Floor Load = 40LL + 10DL)

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

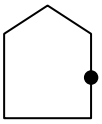
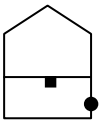
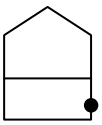
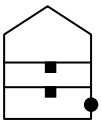
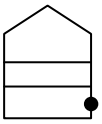
Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Nonstructural Sheath.			1/2" Insul. Bd. Sheath.[2]			15/32" Plywood Sheath.[3]			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	4-2	3-11	3-8	4-5	4-3	4-0	5-2	5-0	4-9	
	2-2x6	5-10	5-5	5-1	6-2	5-9	5-5	7-1	6-7	6-3	
	2-2x8	7-4	6-10	6-6	7-8	7-2	6-9	8-6	7-11	7-6	
	2-2x10	9-2	8-7	8-1	9-5	8-9	8-3	9-10	9-6	8-11	
	2-2x12	10-9	10-3	9-8	10-10	10-6	9-11	11-3	10-10	10-6	
Roof + One Story (Bearing)	2-2x4	4-10	4-7	4-4	5-0	4-9	4-6	5-4	5-1	4-10	
	2-2x6	5-10	5-6	5-2	6-1	5-8	5-4	6-8	6-3	5-10	
	2-2x8	6-10	6-4	6-0	7-1	6-7	6-2	7-7	7-1	6-8	
	2-2x10	8-1	7-6	7-1	8-3	7-8	7-2	8-9	8-2	7-8	
	2-2x12	9-4	8-8	8-2	9-6	8-10	8-4	10-0	9-4	8-9	
Roof + One Story (No Bearing)	2-2x4	4-3	3-11	3-8	4-5	4-1	3-10	4-9	4-6	4-3	
	2-2x6	5-0	4-7	4-4	5-2	4-9	4-5	5-8	5-3	4-11	
	2-2x8	5-9	5-4	5-0	6-0	5-6	5-2	6-5	6-0	5-7	
	2-2x10	6-10	6-4	5-11	6-11	6-5	6-1	7-5	6-10	6-5	
	2-2x12	7-11	7-4	6-11	8-1	7-6	7-0	8-6	7-11	7-5	
Roof + Two Stories (Bearing)	2-2x4	4-3	3-11	3-8	4-5	4-1	3-10	4-9	4-6	4-3	
	2-2x6	5-0	4-7	4-4	5-2	4-9	4-5	5-8	5-3	4-11	
	2-2x8	5-9	5-4	5-0	6-0	5-6	5-2	6-5	6-0	5-7	
	2-2x10	6-10	6-4	5-11	6-11	6-5	6-1	7-5	6-10	6-5	
	2-2x12	7-11	7-4	6-11	8-1	7-6	7-0	8-6	7-11	7-5	
Roof + Two Stories (No Bearing)	2-2x4	3-4	3-1	2-11	3-6	3-3	3-0	3-10	3-7	3-4	
	2-2x6	4-0	3-8	3-5	4-1	3-10	3-7	4-6	4-2	3-11	
	2-2x8	4-7	4-3	4-0	4-9	4-5	4-2	5-1	4-9	4-5	
	2-2x10	5-5	5-1	4-9	5-7	5-2	4-10	5-11	5-6	5-2	
	2-2x12	6-4	5-10	5-6	6-5	6-0	5-7	6-9	6-3	5-11	

See notes following Table 2308.3J. 1 in = 25.4 mm 1 ft = 0.305 m 1 psi = 6.8948 kPa

Table 2308.3F
Header Design Chart[1]

(Spruce-Pine-Fir No. 2, Roof Load = 30LL + 10DL, Floor Load = 40LL + 10DL)

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

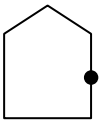
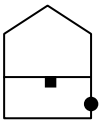
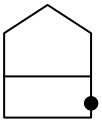
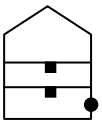
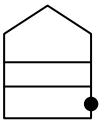
Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Nonstructural Sheath.			1/2" Insul. Bd. Sheath.[2]			15/32" Plywood Sheath.[3]			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	3-7	3-4	3-2	3-11	3-8	3-5	4-10	4-6	4-3	
	2-2x6	5-0	4-8	4-5	5-4	5-0	4-8	6-2	5-9	5-5	
	2-2x8	6-5	5-11	5-7	6-8	6-3	5-11	7-4	6-11	6-6	
	2-2x10	8-0	7-5	7-0	8-2	7-7	7-2	8-10	8-3	7-9	
	2-2x12	9-6	8-11	8-5	9-9	9-1	8-7	10-5	9-8	9-2	
Roof + One Story (Bearing)	2-2x4	4-7	4-3	4-0	4-8	4-5	4-2	5-0	4-9	4-7	
	2-2x6	5-4	5-0	4-8	5-6	5-2	4-10	6-1	5-8	5-4	
	2-2x8	6-3	5-10	5-6	6-5	6-0	5-8	6-11	6-5	6-1	
	2-2x10	7-4	6-10	6-5	7-6	7-0	6-7	8-0	7-5	7-0	
	2-2x12	8-6	7-11	7-6	8-8	8-1	7-7	9-2	8-6	8-0	
Roof + One Story (No Bearing)	2-2x4	3-11	3-8	3-5	4-1	3-10	3-7	4-6	4-3	3-11	
	2-2x6	4-8	4-4	4-1	4-10	4-6	4-2	5-3	4-11	4-7	
	2-2x8	5-5	5-0	4-9	5-7	5-2	4-10	6-0	5-7	5-3	
	2-2x10	6-5	5-11	5-7	6-6	6-1	5-8	6-11	6-5	6-0	
	2-2x12	7-5	6-10	6-5	7-6	7-0	6-7	7-11	7-4	6-11	
Roof + Two Stories (Bearing)	2-2x4	3-11	3-8	3-5	4-1	3-10	3-7	4-6	4-3	3-11	
	2-2x6	4-8	4-4	4-1	4-10	4-6	4-2	5-3	4-11	4-7	
	2-2x8	5-5	5-0	4-9	5-7	5-2	4-10	6-0	5-7	5-3	
	2-2x10	6-5	5-11	5-7	6-6	6-1	5-8	6-11	6-5	6-0	
	2-2x12	7-5	6-10	6-5	7-6	7-0	6-7	7-11	7-4	6-11	
Roof + Two Stories (No Bearing)	2-2x4	3-3	3-0	2-10	3-4	3-1	2-11	3-8	3-5	3-3	
	2-2x6	3-10	3-6	3-4	3-11	3-8	3-5	4-4	4-0	3-9	
	2-2x8	4-5	4-1	3-10	4-6	4-3	4-0	4-11	4-6	4-3	
	2-2x10	5-2	4-10	4-6	5-4	4-11	4-7	5-8	5-3	4-11	
	2-2x12	6-0	5-7	5-3	6-2	5-9	5-4	6-6	6-0	5-8	

See notes following Table 2308.3J. 1 in = 25.4 mm 1 ft = 0.305 m 1 psi = 6.8948 kPa

Table 2308.3G
Header Design Chart[1]

(Douglas Fir-Larch, Southern Pine No. 2, Roof Load = 40LL + 10DL, Floor Load = 40LL + 10DL)

F_b = 1200 E = 1,600,000 F_v = 90

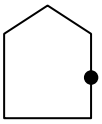
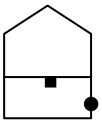
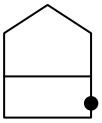
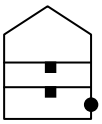
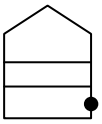
Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Nonstructural Sheath.			1/2" Insul. Bd. Sheath.[2]			15/32" Plywood Sheath.[3]			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	3-9	3-6	3-4	4-1	3-10	3-7	4-8	4-6	4-4	
	2-2x6	5-3	4-11	4-7	5-7	5-3	4-11	6-5	6-0	5-8	
	2-2x8	6-8	6-3	5-10	6-11	6-6	6-1	7-9	7-2	6-9	
	2-2x10	8-4	7-9	7-4	8-7	8-0	7-6	9-2	8-8	8-1	
	2-2x12	10-0	9-4	8-9	10-1	9-7	9-0	10-5	10-1	9-7	
Roof + One Story (Bearing)	2-2x4	4-8	4-5	4-3	4-9	4-6	4-4	5-1	4-10	4-8	
	2-2x6	5-10	5-5	5-1	6-0	5-7	5-3	6-7	6-2	5-10	
	2-2x8	6-9	6-4	5-11	7-0	6-6	6-1	7-6	7-0	6-7	
	2-2x10	8-0	7-5	7-0	8-2	7-7	7-2	8-8	8-1	7-7	
	2-2x12	9-3	8-7	8-1	9-5	8-9	8-3	9-11	9-3	8-8	
Roof + One Story (No Bearing)	2-2x4	4-3	4-0	3-9	4-4	4-2	3-11	4-8	4-5	4-3	
	2-2x6	5-2	4-9	4-6	5-4	4-11	4-8	5-10	5-5	5-1	
	2-2x8	6-0	5-7	5-3	6-2	5-9	5-4	6-8	6-2	5-9	
	2-2x10	7-0	6-6	6-2	7-2	6-8	6-3	7-8	7-1	6-8	
	2-2x12	8-2	7-7	7-1	8-4	7-9	7-3	8-9	8-2	7-8	
Roof + Two Stories (Bearing)	2-2x4	4-3	4-0	3-9	4-4	4-2	3-11	4-8	4-5	4-3	
	2-2x6	5-2	4-9	4-6	5-4	4-11	4-8	5-10	5-5	5-1	
	2-2x8	6-0	5-7	5-3	6-2	5-9	5-4	6-8	6-2	5-9	
	2-2x10	7-0	6-6	6-2	7-2	6-8	6-3	7-8	7-1	6-8	
	2-2x12	8-2	7-7	7-1	8-4	7-9	7-3	8-9	8-2	7-8	
Roof + Two Stories (No Bearing)	2-2x4	3-7	3-4	3-2	3-9	3-6	3-3	4-2	3-10	3-7	
	2-2x6	4-3	4-0	3-9	4-5	4-1	3-10	4-10	4-6	4-3	
	2-2x8	5-0	4-7	4-4	5-1	4-9	4-5	5-6	5-1	4-10	
	2-2x10	5-10	5-5	5-1	6-0	5-7	5-2	6-4	5-11	5-6	
	2-2x12	6-9	6-4	5-11	6-11	6-5	6-0	7-4	6-9	6-4	

See notes following Table 2308.3J. 1 in = 25.4 mm 1 ft = 0.305 m 1 psi = 6.8948 kPa

Table 2308.3H
Maximum Allowable Header Span (ft-in)[1]

(Hem Fir No. 2, Roof Load = 40LL + 10DL, Floor Load = 40LL + 10DL)

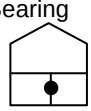
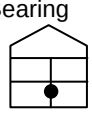
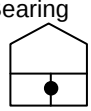
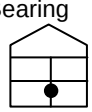
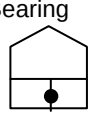
F_b = 1000 E = 1,400,000 F_v = 75

Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Nonstructural Sheath.			1/2" Insul. Bd. Sheath.[2]			15/32" Plywood Sheath.[3]			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	3-5	3-3	3-0	3-9	3-6	3-4	4-6	4-3	4-0	
	2-2x6	4-10	4-6	4-3	5-1	4-9	4-6	5-11	5-6	5-2	
	2-2x8	6-1	5-8	5-4	6-4	5-11	5-7	7-0	6-7	6-2	
	2-2x10	7-7	7-1	6-8	7-10	7-4	6-10	8-5	7-11	7-5	
	2-2x12	9-1	8-6	8-0	9-4	8-9	8-2	9-11	9-3	8-9	
Roof + One Story (Bearing)	2-2x4	4-5	4-2	3-11	4-7	4-4	4-1	4-10	4-8	4-5	
	2-2x6	5-4	4-11	4-8	5-6	5-1	4-10	6-1	5-8	5-3	
	2-2x8	6-2	5-9	5-5	6-4	5-11	5-7	6-10	6-5	6-0	
	2-2x10	7-3	6-9	6-4	7-5	6-11	6-6	7-11	7-4	6-11	
	2-2x12	8-5	7-10	7-5	8-7	8-0	7-6	9-1	8-5	7-11	
Roof + One Story (No Bearing)	2-2x4	4-0	3-8	3-5	4-1	3-10	3-7	4-6	4-3	4-0	
	2-2x6	4-8	4-4	4-1	4-10	4-6	4-3	5-4	4-11	4-8	
	2-2x8	5-5	5-1	4-9	5-7	5-3	4-11	6-1	5-8	5-3	
	2-2x10	6-5	6-0	5-7	6-7	6-1	5-9	7-0	6-6	6-1	
	2-2x12	7-5	6-11	6-6	7-7	7-1	6-7	8-0	7-5	7-0	
Roof + Two Stories (Bearing)	2-2x4	4-0	3-8	3-5	4-1	3-10	3-7	4-6	4-3	4-0	
	2-2x6	4-0	4-4	4-1	4-10	4-6	4-3	5-4	4-11	4-8	
	2-2x8	5-5	5-1	4-9	5-7	5-3	4-11	6-1	5-8	5-3	
	2-2x10	6-5	6-0	5-7	6-7	6-1	5-9	7-0	6-6	6-1	
	2-2x12	7-5	6-11	6-6	7-7	7-1	6-7	8-0	7-5	7-0	
Roof + Two Stories (No Bearing)	2-2x4	3-4	3-1	2-10	3-5	3-2	3-0	3-10	3-6	3-4	
	2-2x6	3-11	3-7	3-5	4-0	3-9	3-6	4-5	4-1	3-10	
	2-2x8	4-6	4-3	3-11	4-8	4-4	4-1	5-0	4-8	4-5	
	2-2x10	5-4	4-11	4-8	5-6	5-1	4-9	5-10	5-5	5-1	
	2-2x12	6-2	5-9	5-5	6-4	5-10	5-6	6-8	6-2	5-10	

See notes following Table 2308.3J.

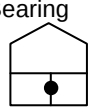
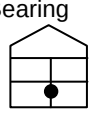
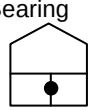
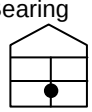
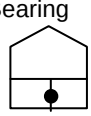
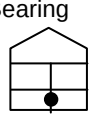
1 in = 25.4 mm 1 ft = 0.305 m 1 psi = 6.8948 kPa

Table 2308.3I
Maximum Allowable Header Span (ft-in)[1]
Design Procedure: Single Top Plate Construction: Interior Bearing Walls

Species, Grade Properties	Header Supporting	Header Size:	Nonstructural Sheath. House Depth (ft) 24	28	32	1/2" Insul. Bd. Sheath.[2] House Depth (ft) 24	28	32	15/32" Plywood Sheath.[3] House Depth (ft) 24	28	32
Douglas Fir Larch Southern Pine No. 2 E = 1,600,000 F_b = 1200 F_v = 90	One Story Bearing 	2-2x4	3-5	3-2	3-0	3-10	3-7	3-4	4-7	4-4	4-2
		2-2x6	5-1	4-8	4-5	5-5	5-0	4-8	6-4	5-10	5-6
		2-2x8	6-7	6-1	5-8	6-10	6-4	5-11	7-8	7-1	6-7
		2-2x10	8-3	7-8	7-2	8-6	7-11	7-4	9-1	8-6	8-0
		2-2x12	10-0	9-3	8-8	10-1	9-6	8-10	10-5	10-0	9-5
	Two Story Bearing 	2-2x4	2-7	2-4	2-3	2-10	2-8	2-6	3-7	3-4	3-1
		2-2x6	3-9	3-6	3-3	4-0	3-9	3-6	4-8	4-4	4-1
		2-2x8	4-10	4-6	4-2	5-1	4-8	4-5	5-8	5-3	4-11
		2-2x10	6-1	5-8	5-4	6-4	5-10	5-6	6-10	6-4	5-11
		2-2x12	7-5	6-10	6-5	7-7	7-0	6-7	8-1	7-6	7-0
Hem Fir No. 2 E = 1,400,000 F_b = 1000 F_v = 75	One Story Bearing 	2-2x4	3-2	2-11	2-9	3-6	3-3	3-0	4-4	4-1	3-10
		2-2x6	4-8	4-3	4-0	4-11	4-7	4-3	5-9	5-4	5-0
		2-2x8	6-0	5-6	5-2	6-3	5-9	5-5	7-0	6-5	6-0
		2-2x10	7-6	7-0	6-6	7-9	7-2	6-9	8-5	7-9	7-3
		2-2x12	9-1	8-5	7-11	9-4	8-8	8-1	10-0	9-3	8-7
	Two Story Bearing 	2-2x4	2-4	2-2	2-0	2-7	2-5	2-3	3-3	2-11	2-8
		2-2x6	3-5	3-2	3-0	3-8	3-5	3-2	4-3	4-0	3-9
		2-2x8	4-5	4-1	3-10	4-8	4-3	4-0	5-2	4-9	4-6
		2-2x10	5-7	5-2	4-10	5-9	5-4	5-0	6-3	5-9	5-5
		2-2x12	6-9	6-3	5-10	6-11	6-5	6-0	7-5	6-10	6-5
Spruce-Pine-Fir No. 2 E = 1,300,000 F_b = 875 F_v = 70	One Story Bearing 	2-2x4	2-11	2-9	2-7	3-3	3-0	2-10	4-1	3-10	3-7
		2-2x6	4-4	4-0	3-9	4-8	4-3	4-0	5-5	5-0	4-8
		2-2x8	5-7	5-2	4-10	5-10	5-5	5-1	6-6	6-0	5-8
		2-2x10	7-1	6-6	6-1	7-3	6-9	6-3	7-10	7-3	6-10
		2-2x12	8-6	7-11	7-5	8-9	8-1	7-7	9-4	8-7	8-1
	Two Story Bearing 	2-2x4	2-2	2-0	1-11	2-5	2-3	2-1	3-1	2-10	2-6
		2-2x6	3-3	3-0	2-9	3-5	3-2	3-0	4-0	3-9	3-6
		2-2x8	4-2	3-10	3-7	4-4	4-0	3-9	4-10	4-6	4-2
		2-2x10	5-3	4-10	4-6	5-5	5-0	4-8	5-10	5-5	5-1
		2-2x12	6-4	5-10	5-6	6-5	6-0	5-7	6-11	6-5	6-0

See notes following Table 2308.3J. 1 in = 25.4 mm 1 ft = 0.305 m 1 psi = 6.8948 kPa

Table 2308.3J
Maximum Allowable Header Span (ft-in)[1]
Design Procedure: Double Top Plate Construction: Interior Bearing Walls

Species, Grade Properties	Header Supporting	Header Size:	Nonstructural Sheath. House Depth (ft) 24	28	32	1/2" Insul. Bd. Sheath.[2] House Depth (ft) 24	28	32	15/32" Plywood Sheath.[3] House Depth (ft) 24	28	32
Douglas Fir Larch Southern Pine No. 2 E = 1,600,000 F_b = 1200 F_v = 90	One Story Bearing 	2-2x4	3-10	3-6	3-4	4-2	3-10	3-7	4-9	4-6	4-4
		2-2x6	5-4	4-11	4-7	5-8	5-3	4-11	6-6	6-1	5-8
		2-2x8	6-9	6-3	5-10	7-0	6-6	6-1	7-10	7-3	6-9
		2-2x10	8-5	7-9	7-3	8-8	8-0	7-6	9-2	8-8	8-1
		2-2x12	10-0	9-4	8-9	10-2	9-7	9-0	10-6	10-1	9-7
	Two Story Bearing 	2-2x4	2-10	2-7	2-5	3-1	2-10	2-8	3-9	3-6	3-3
		2-2x6	3-11	3-8	3-5	4-2	3-11	3-8	4-10	4-6	4-2
		2-2x8	5-0	4-8	4-4	5-2	4-10	4-6	5-9	5-4	5-0
		2-2x10	6-3	5-9	5-5	6-5	5-11	5-7	6-11	6-5	6-0
		2-2x12	7-6	6-11	6-6	7-8	7-1	6-8	8-2	7-7	7-1
Hem Fir No. 2 E = 1,400,000 F_b = 1000 F_v = 75	One Story Bearing 	2-2x4	3-6	3-3	3-0	3-10	3-6	3-4	4-6	4-3	4-0
		2-2x6	4-10	4-6	4-2	5-2	4-9	4-6	6-0	5-6	5-2
		2-2x8	6-2	5-8	5-4	6-5	5-11	5-7	7-1	6-7	6-2
		2-2x10	7-8	7-1	6-8	7-11	7-4	6-10	8-6	7-11	7-5
		2-2x12	9-3	8-7	8-0	9-5	8-9	8-2	10-1	9-4	8-9
	Two Story Bearing 	2-2x4	2-7	2-5	2-3	2-10	2-7	2-5	3-5	3-2	3-0
		2-2x6	3-7	3-4	3-1	3-10	3-6	3-4	4-5	4-1	3-10
		2-2x8	4-7	4-3	3-11	4-9	4-5	4-1	5-3	4-11	4-7
		2-2x10	5-8	5-3	4-11	5-10	5-5	5-1	6-4	5-10	5-6
		2-2x12	6-10	6-4	5-11	7-0	6-6	6-1	7-6	6-11	6-6
Spruce-Pine-Fir No. 2 E = 1,300,000 F_b = 875 F_v = 70	One Story Bearing 	2-2x4	3-3	3-0	2-10	3-7	3-4	3-1	4-4	4-0	3-9
		2-2x6	4-7	4-2	3-11	4-10	4-6	4-2	5-7	5-2	4-10
		2-2x8	5-9	5-4	5-0	6-0	5-7	5-2	6-8	6-2	5-9
		2-2x10	7-2	6-8	6-3	7-5	6-10	6-5	8-0	7-5	6-11
		2-2x12	8-8	8-0	7-6	8-10	8-2	7-8	9-5	8-9	8-2
	Two Story Bearing 	2-2x4	2-5	2-3	2-1	2-8	2-5	2-3	3-3	3-0	2-9
		2-2x6	3-4	3-1	2-11	3-7	3-4	3-1	4-2	3-10	3-7
		2-2x8	4-3	3-11	3-8	4-5	4-1	3-10	4-11	4-7	4-3
		2-2x10	5-4	4-11	4-7	5-6	5-1	4-9	5-11	5-6	5-2
		2-2x12	6-5	5-11	5-7	6-7	6-1	5-8	7-0	6-6	6-1

See notes following Table 2308.3J. 1 in = 25.4 mm 1 ft = 0.305 m 1 psi = 6.8948 kPa

Notes To Tables 2308.3A Through 2308.3J

1. Linear interpolation for house widths not in table is permitted. For example, assume 26 ft (7924 mm) wide house with 15/32 inch (11.9 mm) plywood sheathing – roof load – 2x6 header: allowable header span = 7 ft – 5 in (2261 mm).
   Header spans identified as having "no bearing" construction apply to both interior and exterior loadbearing 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.
2. Sheathing or combined sheathing/siding having a minimum density of 18 pcf (288.3 kg/m^3).
3. Minimum 15/32 inch (11.9 mm) plywood sheathing or combined sheathing/siding applied between the bottom of the header, the top of the top plate and between the center lines of the broken vertical studs at the ends of the header, top plates, cripples and studs – 6 inches (152 mm) o.c. at the edges and 12 inches (305 mm) o.c. at intermediate framing.

 Supporting beam or bearing wall below floor.

 Location of header.

2308.4 Post and Beam Framing

2308.4.1 Where post and beam framing is used in lieu of stud and joist construction, the posts shall be located to support the beams above and shall be designed in accordance with 2301.2 or 2301.3.1.

2308.4.2 Intermediate framing shall be attached to the posts and braced in the manner specified in 2306.2.

2308.5 Interior Bearing Partitions

2308.5.1 The provisions of 2308.1.1, 2308.1.2, 2308.1.3 and 2308.1.4 shall apply to interior bearing partitions supporting more than a ceiling under an attic with no storage.

2308.5.2 Studs supporting a ceiling under an attic with no storage shall be installed with the wide face perpendicular to the partition and spaced not more than 24 inches (610 mm) o.c.

2308.5.3 Headers shall be provided over each opening in interior bearing partitions as required in 2308.3.

2308.5.4 Studs shall be capped with double top plates installed to provide overlapping at comers and at intersections with exterior walls. End joints in double top plates shall be offset at least 24 inches (610 mm). For platform frame construction, studs shall rest on a single bottom plate.

EXCEPTION: A single top plate may be installed in accordance with 2308.1.5.

2308.6 Interior Nonbearing Partitions

2308.6.1 Framing for nonbearing partitions shall be of adequate size and spacing to support the finish applied thereto in accordance with the manufacturer's recommendations. In nonbearing walls and partitions, studs may be spaced not more than 28 inch (711 mm) o.c. and may be set with the long dimension parallel to the wall.

2308.6.2 Openings in the nonbearing partitions may be framed with single studs and headers.

2308.7 Cutting, Notching and Bored Holes

2308.7.1 In exterior walls and bearing partitions, any wood stud may be cut or notched to a depth not exceeding 25% of its width. Cutting or notching of studs to a depth not greater than 40% of the width of the stud is permitted in nonbearing partitions supporting no loads other than the weight of the partition.

2308.7.2 A hole not greater in diameter than 40% of the stud width may be bored in any wood stud. Bored holes not greater than 60% of the width of the stud are permitted in nonbearing partitions or in any wall where each bored stud is doubled, provided not more than two successive double studs are bored.

2308.7.3 In no case shall the edge of the bored hole be nearer than 5/8 inch (15.8 mm) to the edge of the stud. Bored holes shall not be located at the same section of stud as a cut or notch.

2309 ROOF AND CEILING FRAMING

2309.1 Ceiling Joist and Rafter Framing

2309.1.1 Maximum spans for ceiling joists and rafters shall be in accordance with the NFoPA Span Tables for Joists and Rafters, or may be designed in accordance with 2301.2 or 2301.3.1.

2309.1.2 Where rafters meet to form a ridge, they shall be placed directly opposite each other and nailed to a ridge board not less than 1 inch (25.4 mm) thick, and not less in depth than the cut end of rafters.

2309.1.3 Ceilings joists and rafters shall be nailed to each other where possible and the assembly shall be nailed to the top wall plate in an adequate manner to secure the roof framing to the walls.

2309.1.4 Ceiling joists shall be continuous or securely joined where they meet over interior partitions to provide a continuous tie across the building.

2309.1.5 Where ceiling joists are not parallel to rafters, subflooring or metal straps attached to the ends of the rafters shall be installed in a manner to provide a continuous tie across the building. Where ceiling joists are not provided at the top of the rafter support walls, the ridge formed by these rafters shall also be supported by a beam conforming to 2307.2.

2309.1.6 Valley and hip rafters shall be 2 inches (51 mm) deeper than the jack rafters.

2309.1.7 Collar beams of lx6 boards shall be installed in the upper third of the roof height to every third pair of rafters.

2309.1.8 Notches on the ends of joists shall not exceed one-fourth the depth. Holes bored for pipes or cable shall not be within 2 inches (51 mm) of the top or bottom of the joist and the diameter of any such hole shall not exceed one-third the depth of the joist. Notches for pipes in the top or bottom of joists shall not exceed one-sixth the depth and shall not be located in the middle one-third of the span.

2309.1.9 Where ends of rafters are not nailed to ridge boards, band joists, or similar framing members the ends of the rafters shall be supported laterally by solid blocking or diagonal bracing.

2309.2 Trussed Rafters

2309.2.1 Trussed rafters shall be designed in accordance with accepted engineering practice. Members may be joined by nails, glue, bolts, timber connectors or other approved framing devices.

2309.2.2 The design and manufacture of metal plate connected wood roof and floor trusses shall comply with TPI-85 and addendum, and TPI PCT-80.

2309.2.3 The bracing of metal plate connected wood trusses shall comply to their appropriate engineered design. In the absence of specific bracing requirements, trusses shall be braced in accordance with the Truss Plate Institute's "Handling, Installing and Bracing Metal Plate Connected Wood Trusses, HIB-91."

2309.2.4 Truss members and components shall not be cut, notched, drilled, spliced or otherwise altered in any way without written concurrence and approval of the design engineer. No additional loading of any member (e.g., HVAC equipment, water heater) shall be permitted without such additional load being incorporated in the engineering design.

2309.3 Roof Sheathing

2309.3.1 All rafters and roof joists shall be covered with one of the following sheathing materials:

1. Lumber, solid sheathing of wood boards 5/8 inch (15.9 mm) (net) minimum thick, or spaced sheathing of wood boards 3/4 inch (19.1 mm) (net) minimum thick.
2. Wood structural panels applied in accordance with the provisions of Table 2307.6B, Table 2309.3A and nailed in accordance with Table 2306.1.
3. Fiberboard insulating roof deck not less than 1 inch nominal thickness.
4. Particleboard applied in accordance with the provisions of Table 2309.3B and nailed in accordance with Table 2306.1.

2309.3.2 Joints in lumber sheathing shall occur over supports unless end-matched lumber or approved clips are used in which case each piece shall bear on at least two rafters or joists.

Table 2309.3A
Allowable Loads (psf) for Wood Structural Panel Roof Sheathing Over Two or More Spans and Long Dimension Parallel to Supports
(Wood Structural Panels are 5-ply, 5-layer unless otherwise noted)[1]

Panel Grade	Thickness (in)	Span Rating	Maximum Span (in)	Load at Maximum Span (psf)	
				Live	Total
Structural I Sheathing	7/16	24/0, 24/16	24	20	30
	15/32	32/16	24	35[2]	45[2]
	1/2	32/16	24	40[2]	50[2]
	19/32, 5/8	40/20	24	70	80
	23/32, 3/4	48/24	24	90	100
Sheathing	7/16	24/0, 24/16	16	40	50
	15/32	32/16	24	20	25
	1/2	24/0, 32/16	24	25	30
	19/32	40/20	24	40[2]	50[2]
	5/8	32/16, 40/20	24	45[2]	55[2]
	23/32, 3/4	40/20, 48/24	24	60[2]	65[2]

1 in = 25.4 mm

1 psf = 4.882 kg/m^2

Notes:

1. Uniform load deflection limitations: 1/180 of span under live load plus dead load, 1/240 under live load only. Edges shall be blocked with lumber or other approved type of edge supports.
2. For composite and 4-ply plywood panels, load shall be reduced by 15 psf.

TABLE 2309.3B
Allowable Loads for Particleboard Roof Sheathing[1,2]

Grade	Thickness (in)	Maximum On-Center Spacing of Supports (in)	Live Load (psf)	Total Load (psf)
2-M-W	3/8[3]	16	45	65
	7/16	24	30	40
	1/2	16	110	150
	1/2	24	40	55

1 in = 25.4 mm

1 psf = 4.882 kg/m^2

Notes:

1. Panels are continuous over two or more spans.
2. Uniform load deflection limitation: 1/180th of the span under live load plus dead load and 1/240th of the span under live load only.
3. Edges shall be tongue-and-groove or supported with blocking or edge clips.

2309.4 Plank-and-Beam Roofs

Beams shall be supported on posts, piers or other beams and shall conform to 2307.2. Roof planks shall conform to 2307.7.

2309.5 Anchorage of Roof Framing to Masonry Walls

Wood roof construction which rests on masonry walls shall be anchored thereto in a manner equivalent to that specified in 2110.3.

2309.6 Access to Attic Space

Attic spaces shall be provided with an interior access opening not less than 22x36 inches (559x914 mm). Access opening shall be accessible and provided with a lid or device that may be easily removed or operated. When mechanical equipment is to be installed in the attic, it shall be installed in accordance with Section 304.4 of the Standard Mechanical Code. Access is not required when the clear height of the attic space, measured at the roof peak, is less than 24 inches (610 mm).

2309.7 Ventilation of Attic Space

2309.7.1 For gabled and hipped roofs, ventilation shall be provided to furnish cross ventilation of each separate attic space with weather protected vents. All vents shall be screened to protect the interior from intrusion of birds. The ratio of total net free ventilating area to the area of the ceiling shall be not less than 1/150. That ratio may be reduced to 1/300 provided:

1. A vapor retarder having a permeance not exceeding one perm is installed on the warm side of the ceiling, or
2. At least 50% of the required ventilating area is provided by ventilators located in the upper portion of the space to be ventilated (at least 3ft (914 mm) above eave or cornice vents) with the balance of the required ventilation provided by eave or cornice vents.

2309.7.2 For flat roofs, blocking and bridging shall be arranged so as not to interfere with the movement of air. Such roofs shall be ventilated along the overhanging eaves, with the net area of opening being not less than 1/250 of the area of the ceiling below.

2309.7.3 All openings into the attic space of any habitable building shall be covered with screening, hardware cloth or equivalent to prevent the entry of birds, squirrels, rodents, etc. The openings therein shall not exceed 1/4 inch (6.4 mm).

2310 WOOD STRUCTURAL PANEL DIAPHRAGMS

2310.1General

2310.1.1 Wood structural panel diaphragms may be used to resist horizontal forces in horizontal and vertical distributing or resisting elements, provided the deflection in the plane of the diaphragm, as determined by calculations, tests, or analogies drawn therefrom, does not exceed the permissible deflection of attached distributing or resisting elements.

2310.1.2 Permissible deflection shall be that deflection up to which the diaphragm and any attached distributing or resisting element will maintain its structural integrity under assumed load conditions, i.e., continue to support assumed loads without danger to occupants of the structure.

2310.1.3 Connections and anchorages capable of resisting the design forces shall be provided between the diaphragms and the resisting elements. Openings in diaphragms which materially affect their strength shall be fully detailed on the plans, and shall have their edges adequately reinforced to transfer all shearing stresses.

2310.1.4 Size and shape of diaphragms shall be limited as set forth in Table 2310.1. In buildings of wood construction where rotation is provided for, transverse shear resisting elements normal to the longitudinal element shall be provided at spacings not exceeding two times the width for wood structural panel diaphragms. In masonry or concrete buildings, wood structural panel diaphragms shall not be considered as transmitting lateral forces by rotation.

Table 2310.1
Maximum Diaphragm Dimension Ratios

Type	Horizontal Diaphragms Maximum Span-Width Ratios	Vertical Diaphragms Maximum Height-Width Ratios
Wood structural panel, nailed all edges	4:1	3 1/2:1
Wood structural panel, blocking omitted at intermediate joints	4:1	2:1

2310.2 Design

2310.2.1 Horizontal and vertical diaphragms sheathed with wood structural panel may be used to resist horizontal forces not exceeding those set forth in Table 2310.2A and 2310.2B, or may be calculated by principles of mechanics without limitations by using values for nail strength and wood structural panel shear strength given elsewhere in this code. Wood structural panel thickness for horizontal diaphragms shall be not less than set forth in Tables 2307.6B and 2309.3A for corresponding joist spacing and loads, except that 1/4 inch (6.4 mm) may be used where perpendicular loads permit.

2310.2.2 All boundary members shall be proportioned and spliced where necessary to transmit direct stresses. Framing members shall be at least 2-inch nominal in width. In general, panel edges shall bear on the framing members and butt along their center lines. Nails shall be placed not less than 3/8 inch (9.5 mm) from the panel edge, not more than 12 inches (305 mm) apart along intermediate supports, and 6 inches (152 mm) along panel edge-bearings, and shall be firmly driven into the framing members. No unblocked panel less than 12 inches (305 mm) wide shall be used.

Table 2310.2A
Allowable Shear (plf) for Horizontal Wood Structural Panel Diaphragms with Framing of Douglas Fir-Larch or Southern Pine for Wind or Seismic Loading[1]

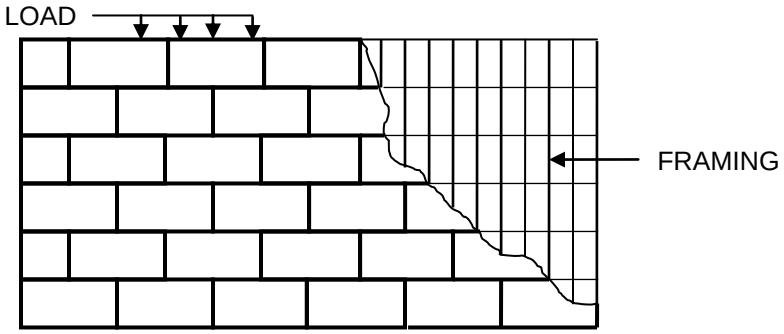
Wood Structural Panel Grade	Staple or Common Nail Size	Minimum Nominal Penetration in Framing (in)	Minimum Nominal Panel Thickness (in)	Minimum Nominal Width of Framing Member (in)	Lines of Fasteners	Blocked Diaphragms							Unblocked Diaphragms	
						Nail Spacing (in) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 3 & 4) and at all panel edges (Cases 5 & 6)							Nails spaced 6" max. at support edges	
						6	4		2 1/2		2		Case 1 (No Unblocked Edges or Cont. Joints Parallel to Load)	All other cases (2, 3, 4, 5 & 6)
						Nail Spacing (in) at other panel edges (Cases 1, 2, 3 & 4)								
						6	6	4	4	3	3	2		
Structural 1 Sheathing Exp 1 or Ext	6d	1 1/4	1/4 or 5/16	2	1	185	250		375		420		165	125
				3	1	210	280		420		475		185	140
	8d	1 1/2	3/8	2	1	270	360		530		600		240	180
				3	1	300	400		600		675		265	200
	10d	1 5/8	15/32	2	1	320	425		640		730		285	215
				3	1	360	480		720		820		320	240
	10d	1 5/8	23/32	3	2		650	870	940	1,230				
				4	2		755	980	1,080	1,410				
				4	3		940	1,305	1,375	1,810				
	14 ga Staples	2	23/32	3	2		600	600	840	900	1,040	1,200		
				4	3		840	900	1,140	1,350	1,440	1,800		
C-C Exterior, and other grades covered in PS-1	6d	1 1/4	5/16	2	1	170	225		335		380		150	110
				3	1	190	250		380		430		170	125
			3/8	2	1	185	250		375		420		165	125
				3	1	210	280		420		475		185	140
	8d	1 1/2	3/8	2	1	240	320		480		545		215	160
				3	1	270	360		540		610		240	180
			7/16	2	1	255	340		505		575		230	170
				3	1	285	380		570		645		255	190
			15/32	2	1	270	360		530		600		240	180
				3	1	300	400		600		675		265	200
Sheathing Single Floor and other grades covered in PS-1	10d	1 5/8	15/32	2	1	290	385		575		655		255	190
				3	1	325	430		650		735		290	215
			19/32	2	1	320	425		640		730		285	215
				3	1	360	480		720		820		320	240
			23/32	3	2	645	870		935	1,225				
				4	2	750	980		1,075	1,395				
				4	3	935	1,305		1,390	1,510				
	14 ga Staples	2	23/32	3	2		600	600	820	900	1,020	1,200		
				4	3		820	900	1,120	1,350	1,400	1,510		

1 in = 25.4 mm
1 plf = 14.5939 N/m

Notes:

1. These values are for short-term loads due to wind or earthquake and must be reduced 25% for normal loading.

CASE 1



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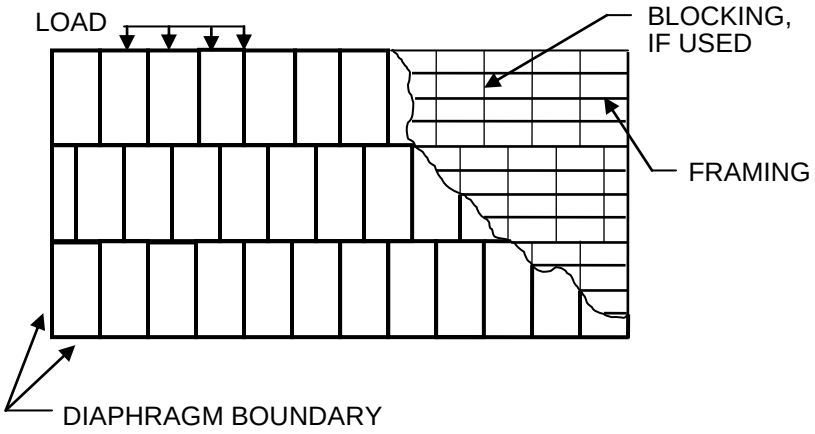

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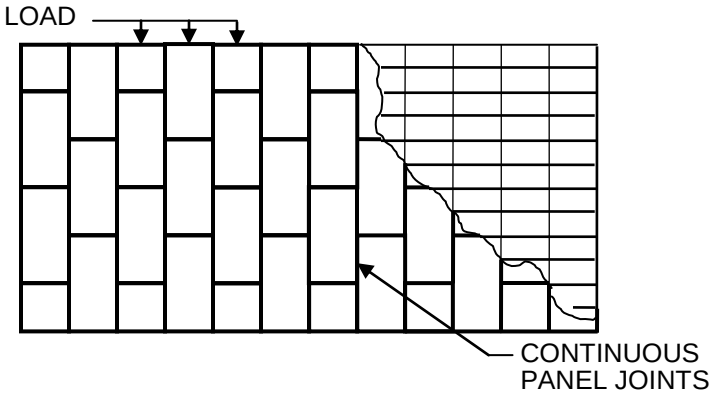

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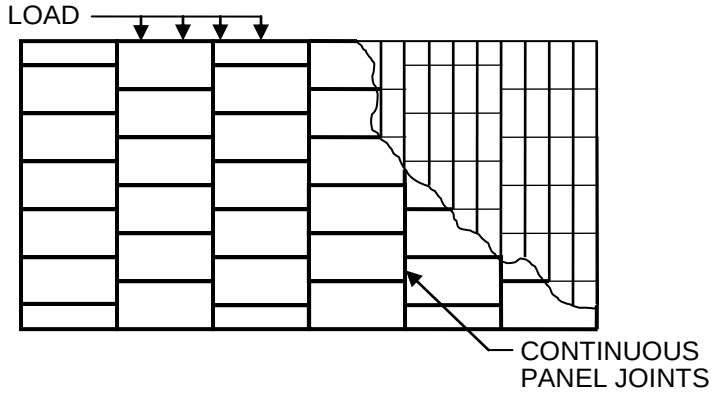

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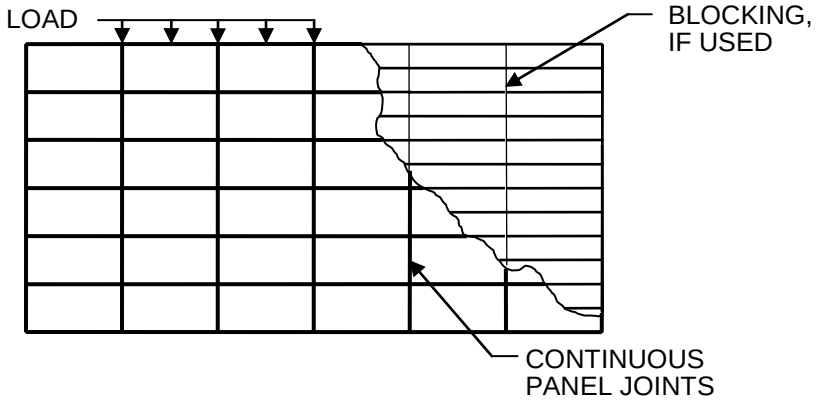

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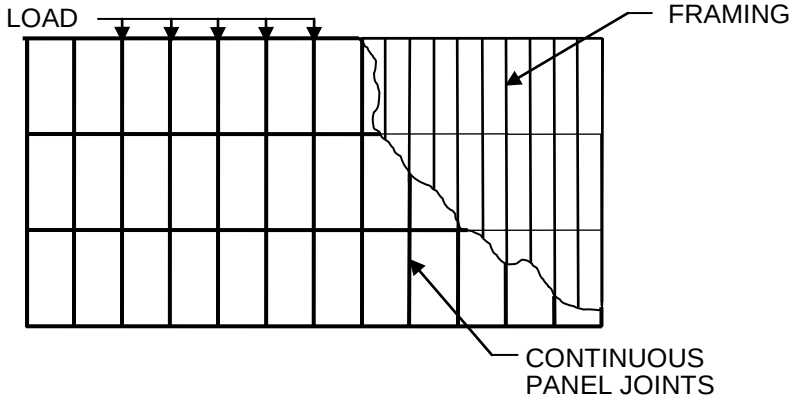


Table 2310.2B
Allowable Shear (plf) for Wood Structural Panel Shear Walls with Framing of Douglas Fir-Larch or Southern Pine for Wind or Seismic Loading

Panel Grade	Minimum Nominal Panel Thickness (inch)	Minimum Nail Penetration in Framing (inches)	Panel Direct To Framing					Panel Applied Over 1/2-in or 5/8-in Gypsum Sheathing				
			Nail Size (Common or Galvanized Box)	Nail Spacing at Panel Edges (in)				Nail Size (Common or Galvanized Box)	Nail Spacing at Panel Edges (in)			
				6	4	3	2		6	4	3	2
Structural I	5/16	1-1/4	6d	200	300	390	510	8d	200	300	390	510
	3/8 7/16 15/32	1-1/2	8d	230 255 280	360 395 430	460 505 550	610 670 730	10d	280	430	550	730
	15/32	1-5/8	10d	340	510	665	870	---	---	---	---	---
Sheathing, Plywood Siding	5/16 3/8	1-1/4	6d	180 200	270 300	350 390	450 510	8d	180 200	270 300	350 390	450 510
	3/8 7/16 15/32	1-1/2	8d	220 240 260	320 350 380	410 450 490	530 585 640	10d	260	380	490	640
	15/32 19/32	1-5/8	10d	310 340	460 510	600 665	770 870	---	---	---	---	---
			Nail Size (Galvanized Casing)					Nail Size (Galvanized Casing)				
Plywood Siding	5/16 3/8	1-1/4 1-1/2	6d 8d	140 160	210 240	275 310	360 410	8d 10d	140 160	210 240	275 310	360 410

1 in = 25.4 mm
1 plf = 14.5939 N/m

2310.3 Wood Structural Panel Floor and Roof

2310.3.1 Nail size and spacing at diaphragm boundaries and at the edges of each sheet of wood structural panel shall be provided as shown in Table 2310.2A and by the provisions of 2310.3.2 through 2310.3.5. Nails of the same size shall be placed along all intermediate framing members at 12 inches (305 mm) on center.

2310.3.2 Shear capacities for fasteners in framing members of other wood species shall be calculated by multiplying the shear capacities for STRUCTURAL I Panels by 0.82 for Group III species and 0.65 for Group IV species, as contained in the NFoPA NDS.

2310.3.3 The orientation of the structural framing and wood structural panels shall comply with Case 1, 2, 3, 4, 5, or 6 of Table 2310.2A. For blocked diaphragms, the maximum shear for Cases 3, 4, 5, and 6 shall not exceed 1,200 pounds per linear foot (17.5 kN/m).

2310.3.4 Where either 2-inch (51 mm) or 2 l/2-inch (64 mm) fastener spacings are used with 2-inch wide framing members in accordance with Table 2310.2A, the framing member adjoining panel edges shall be 3 inch (28.6 mm) nominal width and nails at panel edges shall be staggered in two lines.

2310.3.5 Unblocked 1 1/8-inch (28.6 mm) panels with tongue-and-groove edges are permitted to use the blocked diaphragm shear capacities for 19/32-inch (15.1 mm) minimum nominal panel thickness values where 1-inch by 3/8-inch crown by No. 16 ga staples are driven through the tongue-and-groove edges 3/8 inch (9.5 mm) from the panel edges so as to penetrate the tongue. Staples shall be spaced at one half the boundary nail spacing for Cases 1 and 2 and at one third the boundary nail spacing for Cases 3, 4, 5 and 6.

2310.4 Wood Structural Panel Shear Wall Construction

2310.4.1 Nail size and spacing at the edge of each panel shall be provided as shown in Table 2310.2B and by the provisions of 2312. For 3/8-inch (9.5 mm) and 7/16-inch (0.438 mm) panels, installed on studs spaced 24 inches (610 mm) on center, nails shall be spaced at 6 inches (152 mm) on center along intermediate framing members. For all other thicknesses and spacing of studs, intermediate framing members shall have nails of the same size spaced at 12 inches (305 mm) on center. All panel edges shall be backed with 2-inch (51 mm) or wider framing members.

2310.4.2 In Category E buildings, the allowable shear capacity for wood structural panel shear walls, used to resist horizontal forces in buildings with masonry or reinforced concrete walls, shall be one-half of the allowable loads in Table 2310.2B.

2310.4.3 Shear capacities for fasteners in framing members of other wood species, shall be calculated by multiplying the shear capacities for Structural I panels by 0.82 for Group III species and 0.65 for Group IV species as contained in the NFoPA NDS. For galvanized casing nails, shear values shall be taken directly from Table 2310.2B. These values shall be multiplied by 0.82 for lumber Group III or 0.65 for lumber Group IV.

2310.4.4 Framing shall be 3-inch nominal or wider and the nails shall be staggered where nails are spaced 2 inches (51 mm) on center or where 10d nails, having a penetration into framing of more than 1 5/8 inches (41 mm), are used with a 3-inch (76 mm) nail spacing.

2310.4.5 Nail spacings given in Table 2310.2B are for common or galvanized box nails except that galvanized casing nails shall be permitted with plywood panel siding in grades included in PS 1.

2310.4.6 An increase in shear values shall be permitted for 3/8-inch (9.5 mm) and 7/16-inch (11.1 mm) panels with 8d nails to those shown for 15/32-inch (11.9 mm) sheathing with the same nailing, provided the studs are spaced a maximum of 16 inches (406 mm) o.c. or the panels are applied with long dimension across studs.

2311 PARTICLEBOARD DIAPHRAGM

2311.1 General

2311.1.1 Particleboard diaphragms may be used to resist horizontal forces in horizontal and vertical distributing or resisting elements, provided the deflection in the plane of the diaphragm, as determined by calculations, tests or analogies drawn therefrom, does not exceed the permissible deflection of attached distributing or resisting elements.

2311.1.2 Permissible deflection shall be that deflection up to which the diaphragm and any attached distributing or resisting element will maintain its structural integrity under assumed load conditions, i.e., continue to support assumed loads without danger to occupants of the structure.

2311.1.3 Connections and anchorages capable of resisting the design forces shall be provided between the diaphragms and the resisting elements. Openings in diaphragms which materially affect their strength shall be fully detailed on the plans, and shall have their edges adequately reinforced to transfer all shearing stresses.

2311.1.4 Size and shape of diaphragms shall be limited as set forth in Table 2311.1. In buildings of wood construction where rotation is provided for, transverse shear resisting elements normal to the longitudinal element shall be provided at spacings not exceeding two times the width for particleboard diaphragms. In masonry or concrete buildings, particleboard diaphragms shall not be considered as transmitting lateral forces by rotation.

Table 2311.1
Maximum Diaphragm Dimension Ratios

Type	Horizontal Diaphragms Maximum Span-Width Ratios	Vertical Diaphragms Maximum Height-Width Ratios
Particleboard, nailed all edges	4:1	3 1/2:1
Particleboard, blocking omitted at intermediate joints	4:1	2:1

2311.2 Design

2311.2.1 Horizontal and vertical diaphragms sheathed with particleboard may be used to resist horizontal forces not exceeding those set forth in Table 2311.2A for horizontal diaphragms and Table 2311.2B for vertical diaphragms.

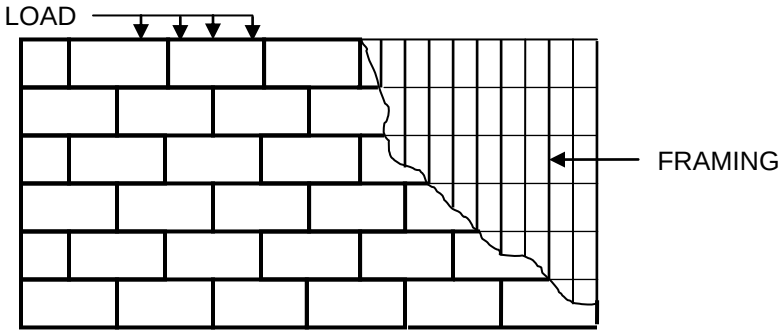
Table 2311.2A
Allowable Shear (plf) for Horizontal Particleboard Diaphragms with Framing of Douglas Fir-Larch or Southern Pine[1]

Panel Grade	Common Nail Size	Nail Penetration in Framing (in)	Minimum Nominal Panel Thickness (in)	Minimum Nominal Width of Framing Member (in)	Blocked Diaphragms: Nail Spacing (in.) at Diaphragm Boundaries (All Cases), at Continuous Panel Edges Parallel to Load (Cases 3 & 4) and at All Panel Edges (Cases 5 & 6)				Blocked Diaphragms: Nail Spacing (in.) at other panel edges (Cases 1, 2, 3 & 4)				Unblocked Diaphragms: Nails Spaced 6" Max. at Support Edges	
					6	4	2 1/2	2	6	6	4	3	Case 1 (No Unblocked Edges of Continuous Joints Parallel to Load)	All Other Cases (Cases 2, 3, 4, 5 & 6)
2-M-W	6d	1 1/4	5/16	2	170	225	335	380	150	110				
				3	190	250	380	430	170	125				
			3/8	2	185	250	375	420	165	125				
				3	210	280	420	475	185	140				
	8d	1 1/2	3/8	2	240	320	480	545	215	160				
				3	270	360	540	610	240	180				
			7/16	2	255	340	505	575	230	170				
				3	285	380	570	645	255	190				
			1/2	2	270	360	530	600	240	180				
				3	300	400	600	675	265	200				
	10d	1 3/8	1/2	2	290	385	575	655	255	190				
				3	325	430	650	735	290	215				
			5/8	2	320	425	640	730	285	215				
				3	360	480	720	820	320	240				
2-M-3	10d	1 5/8	3/4	2	320	425	640	730	285	215				
				3	360	480	720	820	320	240				

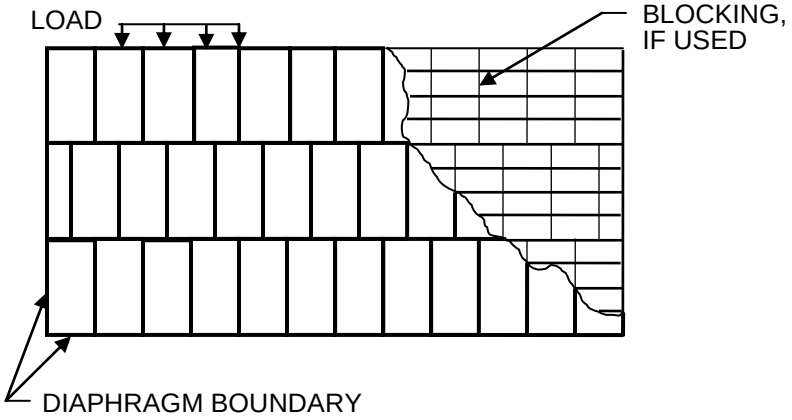
1 in = 25.4 mm
1 plf = 14.5939 N/m

Notes:
1. These values are for short-term loads due to wind or earthquake and must be reduced 25% for normal loading.

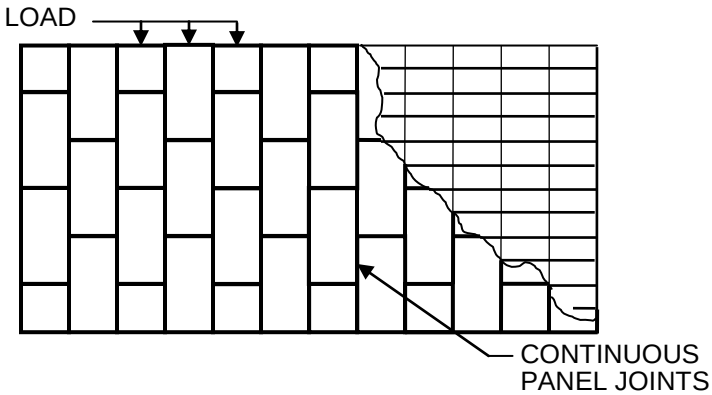
CASE 1



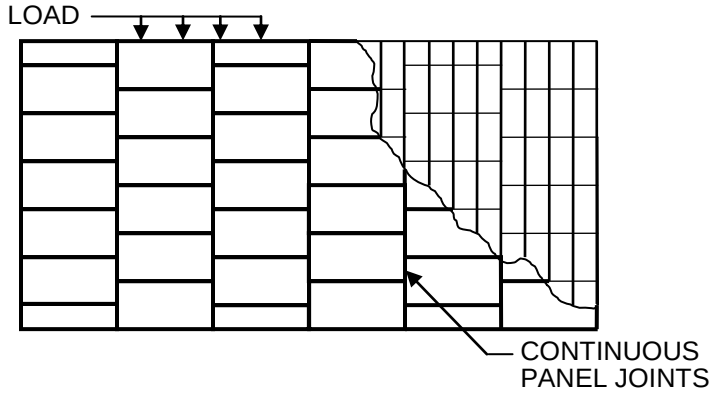
CASE 2



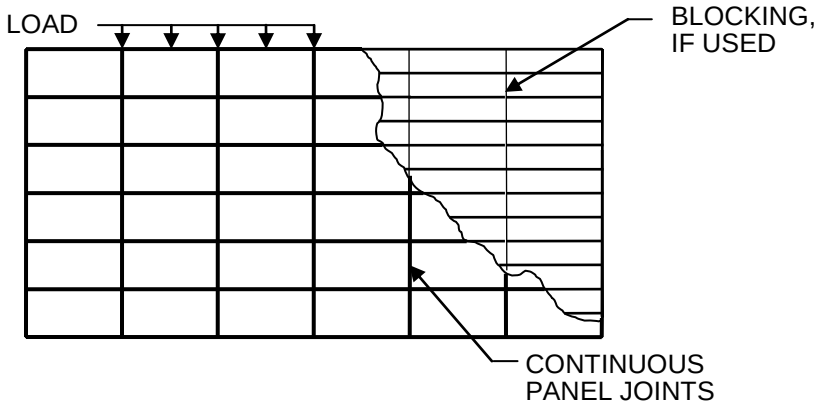
CASE 3



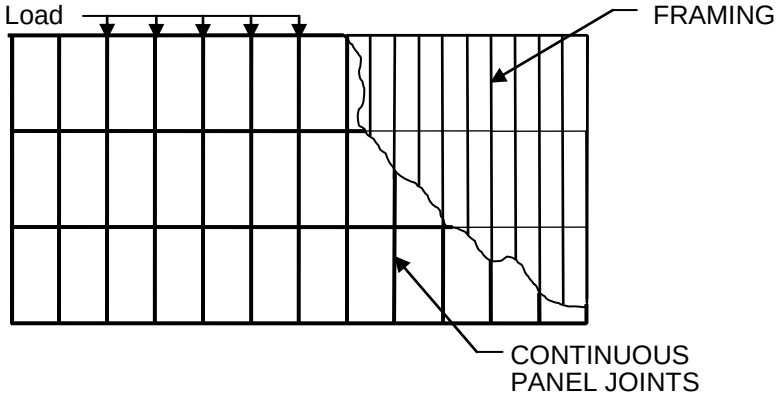
CASE 4



CASE 5



CASE 6



2311.2.2 Particleboard for horizontal diaphragms shall be as set forth in Table 2309.3B for roofs and Table 2307.6C for floors.

2311.2.3 Particleboard for shear walls shall be as set forth in Table 2308.1C.

2311.2.4 Grades of particleboard and maximum spans for subfloor/underlayment shall be as set forth in Table 2307.6C.

2311.2.5 All boundary members shall be proportioned and spliced where necessary to transmit direct stresses. Framing members shall be at least 2-inch nominal in the dimension to which the particleboard is attached. In general, panel edges shall bear on the framing members and butt along their center lines. Nails shall be placed not less than 3/8 inch (9.5 mm) from the panel edge, shall be spaced not more than 6 inches (152 mm) on center along panel edge bearings, 12 inches (305 mm) apart along intermediate supports, and shall be firmly driven into the framing members. No unblocked panels less than 12 inches (305 mm) wide shall be used.

Table 2311.2B
Allowable Shear for Wind or Seismic Forces (plf) for Particleboard Shear Walls with Framing of Douglas Fir-Larch or Southern Pine[1]

Panel Grade	Minimum Nominal Panel Thickness (in)	Minimum Nail Penetration in Framing (in)	Nail Size (Common or Galvanized Box)	Panels Applied Direct To Framing: Nail Spacing at Panel Edges (in) 6	4	3	2	Nail Size (Common or Galvanized Box)	Panels Applied Over 1/2-in or 5/8-in Gypsum Sheathing: Nail Spacing at Panel Edges (in) 6	4	3	2
2-M-W And 2-M-F	5/16	1-1/4	6d	180	270	350	450	8d	180	270	350	450
	3/8			200	300	390	510		200	300	390	510
	3/8	1-1/2	8d	220	320	410	530	10d	260	380	490	640
	7/16			240	350	450	585	---	---	---	---	---
	1/2			260	380	490	640	---	---	---	---	---
	1/2	1 5/8	10d	310	460	600	770	---	---	---	---	---
	5/8			340	510	665	870	---	---	---	---	---

1 in = 25.4 mm
1 plf = 14.5939 N/m
Notes:
1. These values are for short-term loads due to wind or earthquake and must be reduced 25% for normal loading.

2311.3 Particleboard Floor and Roof Diaphragm Construction

2311.3.1 The nail size and spacing at diaphragm boundaries and the edges of each sheet of particleboard shall be as shown in Table 2311.2A and shall be designed in accordance with the provisions of this section. Nails of the same size shall be placed along all intermediate framing members at 12 inches (305 mm) on center.

2311.3.2 Shear capacities for fasteners in framing members of other wood species, shall be calculated by multiplying the shear capacities by 0.82 for Group III species and 0.65 for Group IV species, contained in the NFoPA NDS.

2311.3.3 The orientation of the structural framing and particleboard panels shall comply with Case 1, 2, 3, 4, 5, or 6 in Table 2311.2A.

2311.3.4 When either 2-inch or 2 1/2-inch fastener spacings are used with 2-inch wide framing members in accordance with Table 2311.2A, the framing member adjoining panel edges shall be 3-inch nominal width and nails at panel edges shall be staggered in two lines.

2311.3.5 Framing at adjoining panel edges shall be 3-inch nominal or wider and nails shall be staggered where 10d nails having penetration into framing of more than 1 5/8 inches (41 mm) are spaced 3 inches (76 mm) or less on center.

2311.4 Particleboard Shear Wall Construction.

2311.4.1 Nailing. The required nail size and spacing in Table 2311.2B apply to panel edges only. All panel edges shall be backed with 2-inch nominal or wider framing. Sheets are permitted to be installed either horizontally or vertically. For 3/8-inch (9.5 mm) particleboard sheets installed with the long dimension parallel to studs spaced 24 inches (610 mm) on center, nails shall be spaced at 6 inches (152 mm) on center along intermediate framing members. For all other conditions, nails of the same size shall be spaced at 12 inches (305 mm) on center along intermediate framing members.

2311.4.2 Other Wood Species. Shear capacities for fasteners in framing members of other wood species, shall be calculated by multiplying the shear capacities by 0.82 for Group III species and 0.65 for Group IV species as contained in the NFoPA NDS.

2311.4.3 Framing. Framing shall be 3-inch nominal or wider and the nails shall be staggered where nails are spaced 2 inches (51 mm) on center or where 10d nails, having a penetration into framing of more than 1 5/8 inches (41 mm), are used with a 3-inch (76 mm) nail spacing.

2311.4.4 Shear Capacity Increase. The shear capacities for 3/8-inch (9.5 mm) and 7/16-inch (11.1 mm) particleboard applied directly to framing with 8d nails are permitted to be increased to the 1/2-inch (12.7 mm) particleboard shear capacities of Table 2311.2B when the framing studs are spaced a maximum of 16 inches (406 mm) on center or the particleboard is applied with the long dimension perpendicular to the studs.

2311.4.5 Offset Joints. Where particleboard is applied to both faces of a wall and the nail spacing is less than 6 inches (152 mm) on center on either side, panel joints shall be offset to be placed on different framing members, or framing shall be 3-inch nominal or thicker and nails on each side shall be staggered.

2312 SEISMIC PROVISIONS

2312.1 General

All buildings for which a seismic analysis is required, according to 1607.1, and which are constructed partially or wholly of wood or wood based materials shall be designed in accordance with the provisions of this section and Chapter 23.

2312.2 Definitions

The following words and terms shall apply to the provisions of this section and have the following meanings:

BLOCKED DIAPHRAGM – a diaphragm in which all sheathing edges not occurring on a framing member are supported on and connected to blocking.

DIAPHRAGM – a horizontal or nearly horizontal system designed to transmit lateral forces to the vertical elements of the seismic resisting system.

WOOD SHEAR PANEL – a wood floor, roof, or wall component sheathed to act as a shear wall or diaphragm.

2312.3 Strength of Members and Connections

The allowable load capacities of this section are to be used with allowable stress design load combinations.

2312.4 Engineered Timber Construction

When seismic analysis is required, according to 1607.1, the proportioning and design of wood systems, members and connections shall be in accordance with this section, the NFoPA NDS and APA Plywood Design Specification.

2312.4.1 Column framing requirements. All wood columns shall be provided with full end bearing. Columns shall be provided with adequate support to maintain stability. Where post and beam or girder construction is used, positive connections shall be provided to resist uplift and lateral displacement.

2312.4.2 Wood Shear Panels. Wood shear panels shall comply with 2312.4.2.1 through 2312.4.2.5. Diaphragm construction shall comply with 2312.4.3. Shear wall construction shall comply with 2312.4.4. The construction of wood shear panels shall comply with 2312.4.5 for diagonally sheathed lumber shear panels, 2312.4.6 for wood structural panel sheathed shear panels, 2312.4.7 for particleboard sheathed shear panels, or 2312.4.8 for other shear panel sheathing.

2312.4.2.1 All framing members used in shear panel construction shall be at least 2 inches in nominal thickness. Boundary members, chords, and collector members shall be designed to transfer the axial forces. Boundary members shall be connected at all corners.

2312.4.2.2 Openings in shear panels shall be designed and detailed to transfer all shear loads.

2312.4.2.3 Positive connections and anchorages, capable of resisting the design forces, shall be provided between the shear panel and the attached components.

2312.4. 2.4 In Category E buildings, wood structural panels used for shear panels that are a part of the seismic resisting system shall be applied directly to the framing members.

EXCEPTION: Wood structural panels nailed over solid lumber decking or laminated decks.

2312.4.2.5 The diaphragms in buildings having torsional irregularity, where the lateral stiffness ratio of the structural members are greater than 4 to 1, or in buildings with one line of resistance in either orthogonal direction, shall be sheathed with diagonal boards or wood structural panels. The length of the diaphragm normal to the soft side shall not exceed 25 ft (7.6 m) nor shall the diaphragm length to width ratio exceed 1 for one story buildings or 0.67 for buildings over one story in height.

EXCEPTION: Where calculations demonstrate that the diaphragm deflections can be tolerated, the length limit of 25 ft (7.6 m) does not apply and the length-to-width ratio of 1.5 is permitted for diaphragms sheathed with single diagonal boards and a ratio of 2 where sheathed with double diagonal boards or wood structural panels.

2312.4.3 Diaphragms. Wood diaphragms shall not be used to resist torsional forces induced by concrete or masonry construction in buildings of Category D or E which are more than two stories in height.

2312.4.3.1 Diaphragm sheathing shall not be used for providing ties and splices required by 1607.3.6.1.1 and 1607.3.6.1.2.

EXCEPTION: Diaphragm sheathing in buildings of Categories A and B, Category C buildings of Seismic Hazard Performance Groups I and II and Category C buildings of Seismic Hazard Performance Group III with an effective peak velocity-related acceleration, (A_v) of less than 0.10.

2312.4.3.2 Unblocked diaphragms shall not be used as part of the seismic resisting system in buildings of Category E.

2312.4.4 Shear wall construction shall comply with the requirements of this section.

2312.4.4.1 The design shear capacity is permitted to be doubled when identical materials are applied to both sides of the wall. Where the shear capacities of the materials are not equal, the allowable shear shall be considered to be equal to either the shear for the side with the higher capacity or twice the shear for the side with the lower capacity.

2312.4.4.2 Shear walls shall be sheathed with wood structural panels in Category B, C, D and E buildings.

EXCEPTIONS:

1. In Category B and C buildings, particleboard, gypsum sheathing, gypsum wallboard, fiberboard and wire lath and cement plaster shear walls are permitted.
2. In Category D buildings, particleboard, gypsum sheathing, gypsum wallboard and wire lath and cement plaster shear walls in one story buildings and the top story of buildings two stories or more in height are permitted.

2312.4.5 Diagonally Sheathed Lumber Shear Panels. Diagonally sheathed lumber shear panels shall be nailed in accordance with Table 2312.4.5.

Table 2312.4.5
Diagonally Sheathed Shear Panel Nailing Schedule

Sheathing Nominal Dimension	Nailing to Intermediate and End Bearing Studs		Nailing at the Shear Panel Boundaries	
	Type, Size and Number of Nails per Board			
	Common nails	Box nails	Common nails	Box nails
1 x 6	two 8d	three 8d	three 8d	five 8d
1 x 8	three 8d	four 8d	four 8d	six 8d
2 x 6	two 16d	three 16d	three 16d	five 16d
2 x 8	three 16d	four 16d	four 16d	six 16d

2312.4.5.1 Single diagonally sheathed lumber shear panels shall be constructed of minimum 1-inch thick nominal sheathing boards laid at an angle of approximately 45° (0.785 rad) to the supports. The shear capacity for single diagonally sheathed lumber shear panels of southern pine or douglas fir-larch shall not exceed 200 pounds per linear foot (2.92 kN/m) of width. The shear capacities shall be adjusted by reduction factors of 0.82 for Group III framing species and 0.65 for Group IV framing species, as contained in the NFoPA NDS.

2312.4.5.1.1 End joints in adjacent boards shall be separated by at least one stud or joist space and there shall be at least two boards between joints on the same support.

2312.4.5.1.2 Wood shear panels made up of 2-inch nominal diagonal lumber sheathing fastened with 16d nails shall be designed with the same shear capacities as shear panels using 1-inch boards fastened with 8d nails, provided there are no splices in adjacent boards on the same support and the supports are not less than 4 inch nominal depth or 3 inch nominal thickness.

2312.4.5.2 Double diagonally sheathed lumber shear panels shall be constructed of two layers of diagonal sheathing boards laid at 90° (1.57 rad) to each other on the same face of the supporting members. Each chord shall be considered as a beam loaded with uniform load per foot equal to 50% of the unit shear due to diaphragm action. The load shall be assumed as acting normal to the chord in the plane of the diaphragm in either direction. The span of the chord or portion thereof shall be the distance between framing members of the diaphragm such as the joists, studs, and blocking that serve to transfer the assumed load to the sheathing. The shear capacity of double diagonally sheathed diaphragms of southern pine or douglas fir-larch shall not exceed 600 pounds per linear foot (8.76 kN/m) of width. The shear capacity shall be adjusted by reduction factors of 0.82 for Group III framing species and 0.65 for group IV framing species, as contained in the NFoPA NDS.

2312.4.6 Wood Structural Panel Shear Panels. The design and shear capacity of wood structural panel shear panels shall be in accordance with Table 2310.2A for diaphragms and Table 2310.2B for shear walls, or shall be calculated by using nail strengths in the NFoPA NDS and plywood design properties as given in the APA Plywood Design Specifications. Shear panels shall be constructed of wood structural panels, manufactured with exterior glue, not less than 4x8 ft (1.22x2.44 m), except at boundaries and changes in framing. Wood structural panels shall be designed to resist shear only, and chords, collector members, and boundary members shall be designed to transfer the axial forces. Boundary members shall be connected at all corners. Wood structural panels less than 12 inches (305 mm) wide shall be blocked.

2312.4.7 Particleboard Shear Panels. The design shear capacity of particleboard panels shall be in accordance with 2311.3 for diaphragms and 2311.4 for shear walls. Shear panels shall be constructed with particleboard sheets not less than 4x8 ft (1.22x2.44 m), except at boundaries and changes in framing. Particleboard panels shall be designed to resist shear only, and chords, collector members, and boundary members shall be connected at all corners. Particleboard panels less than 12 inches (305 mm) wide shall be blocked.

2312.4.8 Shear Panels Sheathed with Other Materials. Wood stud wall sheathed with lath and plaster, gypsum sheathing board, gypsum wallboard constructed in accordance with 2506, or fiberboard sheathing constructed in accordance with 2308.2.2 shall be permitted to resist earthquake forces in wood framed buildings. Nails shall be spaced at least 3/8 inch (9.5 mm) from the edges and ends of boards and panels. The maximum height-to-width ratio shall be 1.5. The shear capacities used in design shall not be cumulative with the shear capacities of other materials applied to the same wall.

CHAPTER 24

GLASS AND GLAZING

2401 GENERAL

2401.1 Scope

Provisions of this chapter shall govern the types, use, support, structural adequacy and safety provisions for glass in buildings and structures.

2402 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

2403 LABELING

2403.1 Labels

Each light shall bear the manufacturer's label designating the type and thickness of glass. When approved by the building official, labels may be omitted from other than tempered glazing materials, providing an affidavit is furnished by the glazing contractor certifying that each light is glazed in accordance with approved plans and specifications.

2403.2 Identification

Each unit of tempered glass shall be permanently identified by the manufacturer. The identification shall be etched or ceramic fired on the glass and be visible when the unit is glazed. Tempered spandrel glass is exempt from permanent labeling. This type of glass shall be identified with a removable paper label by the manufacturer.

2404 LOUVERED WINDOWS OR JALOUSIES

Regular float, wired or patterned glass in jalousies and louvered windows shall be no thinner than nominal 3/16 inch (5 mm) and no longer than 48 inches (1219 mm). 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.

2405 IMPACT, WIND, AND OTHER LOADS

2405.1 General

Individual glazed areas including glass mirrors in hazardous locations such as those indicated in 2405.2 shall pass the test requirements of CPSC 16-CFR, Part 1201 or by comparative test shall be proven to produce at least equivalent performances.

EXCEPTIONS:

1. Polished wire glass installed in fire doors, fire windows and view panels in fire resistant walls and hazardous locations in 2405.2.1(3) and 2405.2.1(4) shall comply with ANSI Z97.1.
2. Approved plastic materials used as glazing in hazardous locations shall comply with ANSI Z97.1.

2405.2 Hazardous Locations

2405.2.1 The following shall be considered specific hazardous locations for the purpose of glazing:

1. Glazing in swinging doors and fixed and sliding panels of sliding (patio) door assemblies.
2. Glazing in doors and enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs, and showers. Glazing in any portion of a building wall enclosing these compartments where the bottom edge of the glazing is less than 60 inches (1524 mm) above the drain inlet.
3. Glazing in an individual fixed or operable panel adjacent a door where the nearest vertical edge is within 24-inch (610 mm) radius of the door in a closed position and whose bottom edge is less than 60 inches (1524 mm) above the floor or walking surface.
4. Glazing in an individual fixed or operable panel, other than those locations described in items 2 and 3 above, that meets all of the following conditions:
    1. Exposed area of an individual pane greater than 9 sq ft (0.84 m^2).
    2. Bottom edge less than 18 inches (457 mm) above the floor.
    3. Top edge greater than 36 inches (914 mm) above the floor.
    4. One or more walking surfaces within 36 inches (914 mm) horizontally of the pane of the glazing.
5. All glazing in railings regardless of area or height above walking surface including structural baluster panels and nonstructural in-fill panels.
6. Glazing in walls and fences enclosing indoor and outdoor swimming pools where the bottom edge of the glazing is 1) less than 60 inches (1525 mm) above the walking surface on the pool side, and 2) within 36 inches (914 mm) horizontally of the walking surface on the pool side. This shall apply to single glazing and all panes in multiple glazing.

2405.2.2 The following products, materials and uses are exempt from the above hazardous locations:

1. Openings in doors through which a 3-inch (76 mm) sphere is unable to pass.
2. Assemblies of leaded glass panels, faceted glass or items of carved glass when used for decorative purposes in locations described in 2405.2.1(1), 2405.2.1(2), 2405.2.1(3), 2405.2.1(4). The exemption for 2405.2.1(2) applies to building walls enclosing the compartments only.
3. Glazing materials used as curved glass panels in revolving doors.
4. Commercial refrigerated cabinet glazed doors.
5. Glass block panels where the minimum uniform face thickness of the block is 0.25 inch (6.4 mm).
6. Glazing in 2405.2.1(3) when there is an intervening wall or other permanent barrier between the door and the glazing.
7. Glazing in 2405.2.1(4) when a protective bar is installed on the accessible sides of the glazing 36 inches + 2 inches (914 + 51 mm) above the floor. The bar shall be capable of withstanding a horizontal load of 50 plf (730 N/m) without contacting the glass and be a minimum of 1 ½ inches (38 mm) in height.
8. Outboard panes in insulating glass units and other multiple glazed panels in 2405.2.1(4) when the bottom edge of the glass is 25 ft (7620 mm) or more above grade, a roof, walking surface, or other horizontal or sloped (within 45^O (0.78 rad) of horizontal) surface adjacent to the glass exterior.
9. Louvered windows, and jalousie doors and jalousie windows, complying with the requirements of 2404.

10. Mirrors mounted on a solid wall or hung on a flush door or a panel door without a cutout for the glass.

2405.3 Wind, Snow, and Dead Loads

2405.3.1 Vertical glass. All glass within 15^{O} (0.26 rad) of vertical in windows, curtain and window walls, doors and other exterior applications shall be chosen to resist the combination of wind loads in 1606 for components and cladding. Maximum allowable sizes shall be based on Figure 2405.3. The equivalent load for use in the graph shall be determined by dividing the design wind load by the applicable factor from Table 2405.3A. Figure 2405.3 is for rectangular glass firmly supported on all four edges.

2405.3.2 Sloped glass. All glass sloped more than 15^{O} (0.26 rad) from vertical in skylights, sunspaces, sloped roofs, and other exterior applications shall be chosen to resist the combination of wind loads in 1606 for components and cladding, the snow loads in 1605 and the glass dead load. Maximum allowable sizes shall be based on Figure 2405.3. This graph is for rectangular glass firmly supported on all four edges.

The combined load shall be calculated as follows. The largest of the three shall be used:

1. [negative wind load] – [F x dead load]

2. [positive wind load] + [F x)dead load + 1/2 snow load)]

3. [F x (snow load + dead load)] + [1/2 positive wind load]

where: F = 2.0 when any pane or ply is regular glass
F = 1.5 when any pane or ply is heat-strengthened glass and the remainders are fully tempered glass
F = 1.2 when all panes and plies are fully tempered glass

The glass dead load is equal to the cosine of the slope from horizontal x the total glass thickness in inches by 13.

The equivalent load for use in Figure 2405.3 shall be determined by dividing the combined load by the applicable factor from Table 2405.3B. Figure 2405.3 is for rectangular glass firmly supported on all four edges.

2405.3.3 When approved, alternate means for selecting glass shall be permitted in place of Table 2405.3A and 2405.3B and Figure 2405.3.

Table 2405.3A
Factors for Vertical Glass [1,2,3,4,5]
(Use with Figure 2405.3)

Glass Type	Factor
Single Glass	
Regular (annealed)	1.0
Heat-strengthened	2.0
Fully tempered	4.0
Wired	0.50
Patterned	1.0
Sandblasted	0.50
Laminated – regular plies	0.75
Laminated – heat strengthened plies	1.5
Laminated – fully tempered plies	3.0
Insulating Glass	
Regular (annealed)	1.8
Heat-strengthened	3.6
Fully tempered	7.2
Laminated – regular piles	1.4
Laminated – heat strengthened plies	2.7
Laminated – fully tempered plies	5.4

Notes:

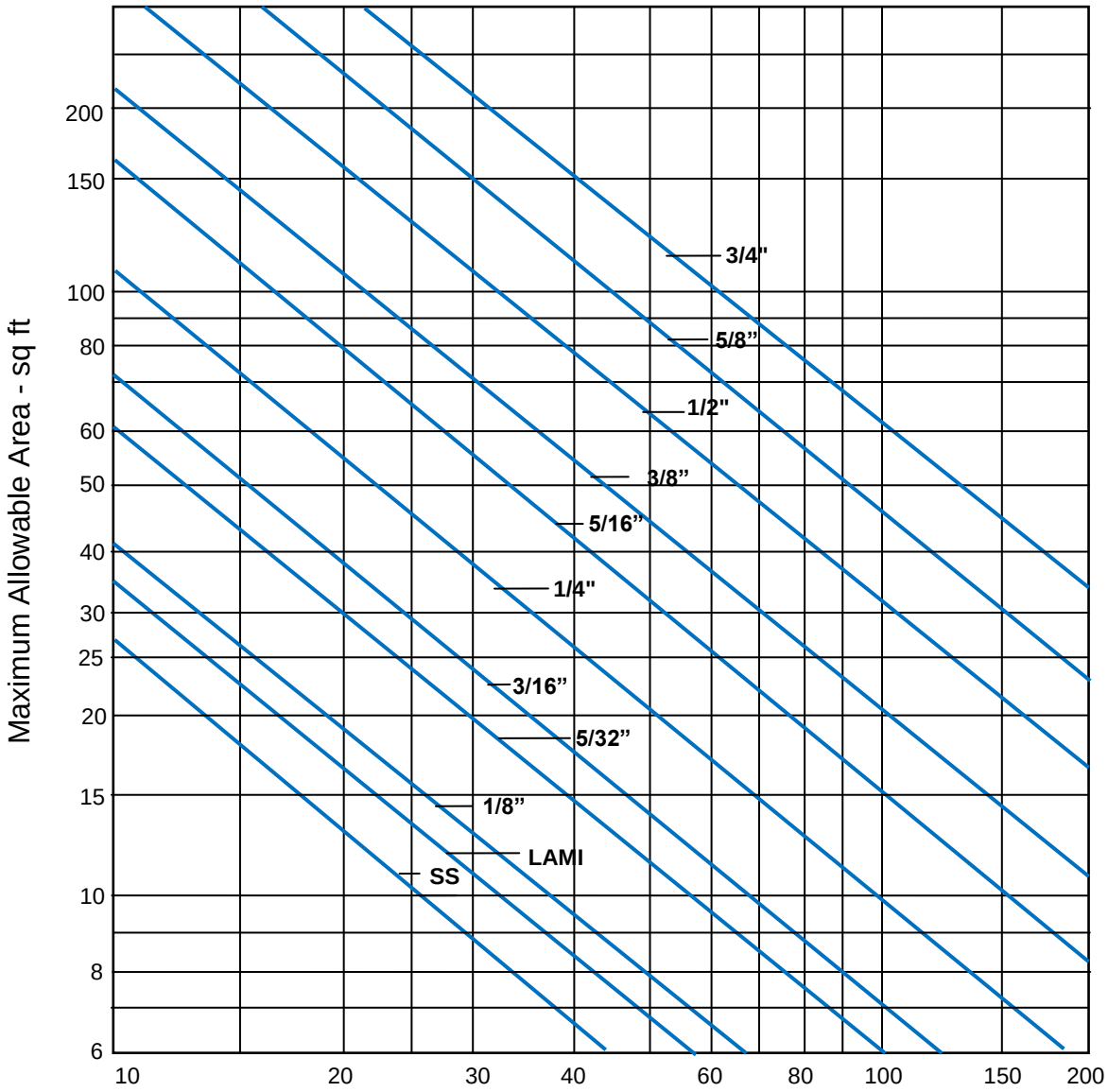
1. For laminated glass, use line in Figure 2405.3 for total glass thickness (after adjusting the loads by Table 2405.3A or 2405.3B).
2. For laminated glasses, the values are based on two plies of the same thickness and type.
3. For insulating glasses, values are based on two panes if identical thickness and type. Use thickness for one pane. For example, the maximum allowable area for an insulated glass unit consisting of two plies of fully tempered 1/4 inch (6.4 mm) glass would be determined using the line for 1/4 inch (6.4 mm) glass.
4. Values for patterned glass are based on the thinnest part of the pattern. Interpolation between lines in the graph may be necessary.
5. Value for sandblasted glass is minimum and depends on severity and depth of the sandblast.

Table 2405.3B
Factors for Sloped Glass [1,2,3,4,5]
(Use with Figure 2405.3)

Glass Type	Factor
Single Glass	
Heat-strengthened	1.7
Fully tempered	3.6
Wired	0.36
Laminated – regular plies	0.54
Laminated – heat strengthened plies	1.3
Laminated – fully tempered plies	2.7
Regular (annealed)	0.72
Insulating Glass	
Heat-strengthened	3.1
Fully tempered	6.6
Laminated – regular piles	1.0
Laminated – heat strengthened plies	2.3
Laminated – fully tempered plies	4.9
Regular (annealed)	1.3

Notes:

1. For laminated glass, use line in Figure 2405.3 for total glass thickness (after adjusting the loads by Table 2405.3A or 2405.3B).
2. For laminated glasses, the values are based on two plies of the same thickness and type.
3. For insulating glasses, values are based on two panes if identical thickness and type. Use thickness for one pane. For example, the maximum allowable area for an insulated glass unit consisting of two plies of fully tempered 1/4 inch (6.4 mm) glass would be determined using the line for 1/4 inch (6.4 mm) glass.
4. Values for patterned glass are based on the thinnest part of the pattern. Interpolation between lines in the graph may be necessary.
5. Value for sandblasted glass is minimum and depends on severity and depth of the sandblast.



Combined Wind Load Determined from 2405.3.1 and Tables 2405.3A or 2405.3B in psf

1 sq ft = 0.0929 m^2

1 in = 24.4 mm

1 psf = 47.8803 Pa

Figure 2405.3
Maximum Allowable Area for Vertical and Sloped Glass Based in Width-to-Length Ratios of 1:1 to 1:5

2405.4 Glazing Replacement

The installation or replacement of glass shall be as required for new installations.

2405.5 Railings

2405.5.1 Glass used as structural baluster panels shall be one of the following types:

1. Single, fully tempered glass
2. Laminated, fully tempered glass
3. Laminated, heat-strengthened glass

2505.5.1.1 The panels and their support system shall be designed to withstand the loads specified in 1608.2.1 and 1608.2.2. A safety factor of 4 shall be used. The glass shall meet provisions of 2405.5.4.

2405.5.1.2 Each handrail or guardrail section shall be supported by a minimum of three glass balusters or be otherwise supported so that it remains in place should one baluster panel fail.

2405.5.1.3 Glass balusters shall not be installed without a handrail or guardrail attached.

2405.5.2 Glass in in-filled panels shall be an approved safety glazing material meeting the provisions of 2405.5.4. For all glass types, the minimum nominal thickness shall be 1/4 inch (6.4 mm).

2405.5.3 Glazing materials shall not be installed in railings in parking garages except for pedestrian areas not exposed to impact from vehicles.

2405.5.4 Fully tempered glass and laminated glass shall comply with Federal Law (CPSC) 16 CFR 1201, Category II. Wired glass shall comply with ANSI Z97.1.

2406 GLASS SUPPORTS

2406.1 Deflection

Glass supports such as sash members, glazing stops or glazing clips shall be considered firm when deflection of the support at design load does not exceed 1/175 of the span.

2406.2 Special Cases

Where other than firm support on all sides is provided, (three sides, two sides, cantilever, or highly flexible, for example), detailed shop drawings, specifications and rational analysis and/or test data assuring safe performance for the specific installation shall be prepared by engineers experienced in this work and shall be submitted for and receive, if warranted, formal approval by the building official.

2406.3 Structural Glazing Systems

2406.3.1 Glazing systems in which one or more edges of the glass are supported against outward wind loads, and other loads that may be applied, solely by silicone sealant/adhesive bond to a structural member shall comply with 2406.3. The structural silicone shall be applied to the inboard glass surface or the edge of the glass or both.

Note: Any individual pane of glass with two opposite edges (normally top and bottom) or three edges installed into channels or otherwise mechanically supported, and the other edges free with no structural support, is not considered structural silicone glazing.

2406.3.2 The classes and types of structural silicone glazing systems shall be as follows:

Class 1: Individual panes supported by framing on all edges: The framing shall be metal, wood, or other material capable of supporting the applied loads. The glass shall be single glass (including laminated glass) or insulating glass.

Type A: Individual panes that have two opposite edges or three edges mechanically supported during installation and the remaining edges supported with a silicone sealant/adhesive.

Type B: Individual panes that have all edges, three edges or two adjacent edges mechanically supported with a silicone sealant/adhesive.

Class 2: Glazing systems consisting of glass panels supported at the vertical or sloped edges by glass stiffeners with a silicone sealant/adhesive bond: The assemblies shall be two or more panes in height with no support of the horizontal butting edges of the glass. The glass shall be single, fully tempered or laminated, fully tempered glass designed using a safety factor of 5.0.

2406.3.3 The framing members for each individual glass pane shall be designed so the deflection perpendicular to the glass pane shall not exceed 1/175 of the glass edge length or 3/4 inch (19.1 mm), whichever is less, when subject to the larger of the positive or negative loads when loads are combined as specified in 1609.1.

2406.3.4 Vertical glass shall comply with the limits of Table 2405.3A and Figure 2405.3. Sloped glass shall comply with the limits of Table 2405.3B and Figure 2405.3 and the requirements of 2407.

2406.3.5 The silicone sealant/adhesive shall comply with the following:

1. The silicone joints shall be designed to limit the tensile stress of shear stress or the vector sum of the two to 20 psi (138 kPa) for the design loads, provided the minimum tensile strength is 50 psi (345 kPa) or more when tested according to ASTM C 1135. Test shall be run at 190^{O}F (87.8^{O}C) with a rate of pull or 0.5 inch per minute (0.21 mm/s). The distance between substrates (width of the silicone specimen) shall be 0.375 inch (9.5 mm).
2. Where the silicone supplier provides certification showing his material has a minimum tensile strength greater than 60 psi (414 kPa) for the intended application, the maximum working stress shall be taken as this value divided by at least 3.0. The silicone shall be tested as described in the preceding paragraph.
3. The silicone shall meet the requirements for Type S or M, Grade NS, and Glass 25 as listed in ASTM C 920.
4. One-part silicone shall meet the requirements of Federal Specification TT-S-001543A.

2406.3.6 The manufacturer of the insulating glass shall certify the insulating glass is designed for structural glazing and complies with the following:

1. The insulating glass unit shall meet all requirements for Class CBA in ASTM E 774. Tests shall be run according to ASTM E 773.
2. The secondary sealant shall be structural silicone. In the design of the sealant depth, load sharing between the glass panes shall be permitted.

2406.3.7 Class 1, Type B systems shall not be glazed with structural silicone on site in place except as allowed in 2406.3.11. These systems shall have the glass installed onto the framing with the framing in a horizontal or sloped position and not moved until the silicone has cured.

2406.3.8 Class 1, Type A systems shall be permitted to have the glass installed onto the framing with the framing in its final vertical or sloped position.

2406.3.9 Class 2 systems shall be erected on site only. Class 2 systems shall be designed, and the drawings and specifications stamped, by a registered professional engineer.

2406.3.10 The installer shall provide evidence from the silicone manufacturer that the silicone sealant/adhesive will adhere to each substrate material to which it must bond. Evidence shall also be provided that the silicone sealant/adhesive is compatible with other materials it will contact when tested according to ASTM C 1087.

2406.3.11 Glass that has broken or requires replacement for other reasons shall be permitted to be replaced on site for all classes and types of glazing systems. Replacement procedures shall comply with recommendations from the silicone manufacturer.

2407 SLOPED GLAZING

2407.1 Scope

Sloped glazing includes any installation of glass or other transparent, translucent, or opaque glazing materials installed at a slope of 15^{O} (0.26 rad) or more from vertical plane. Glazing materials in skylights, roofs and sloped walls are included within this definition.

2407.2 Allowable Glazing Materials

2407.2.1 Sloped glazing shall be any of the following materials, subject to the limitations specified in 2407.3 and the exceptions specified in 2407.4.

1. For monolithic glazing systems, the glazing material of the single lite or layer shall be laminated glass with a minimum 30 mil (0.76 mm) polyvinyl butyral (or equivalent) interlayer, wired glass, approved plastic materials meeting the requirements of Chapter 26, heat-strengthened glass, or fully tempered glass.
2. For multiple layer glazing systems, each lite or layer shall consist of any of the glazing materials specified in (1) above.

2407.3 Limitations

Heat-strengthened glass and fully tempered glass when used in monolithic glazing systems shall have screens installed below the glazing material, subject to exceptions in 2407.4, to protect building occupants from falling glass should breakage occur. The screens shall be capable of supporting the weight of the glass and shall be substantially supported below and installed within 4 inches (102 mm) of the glass. They shall be constructed of a noncombustible material not thinner than 0.0808 inch (25.4x25.4 mm). In a corrosive atmosphere, structurally equivalent noncorrosive screening materials shall be used. Heat-strengthened glass, fully tempered glass, and wired glass when used in multiple layer glazing systems as the bottom glass layer over the walking surface shall be equipped with screening meeting the requirements specified for monolithic glazing systems.

2407.4 Exceptions

In monolithic and multiple layer sloped glazing systems, the following exceptions apply:

1. Fully tempered glass may be installed without required protective screens when glazing between intervening floors at a slope of 30^{O} (0.52 rad) or less from the vertical plane if the highest point of the glass is 10 ft (3048 mm) or less above the walking surface.
2. Any glazing material, including annealed glass, may be installed without required screens if the walking surface or any other accessible are below the glazing material is permanently protected from the risk of falling glass.
3. Any glazing material, including annealed glass, may be installed without screens in the sloped glazing systems of greenhouses used exclusively for growing plants, not used as a habitable space, and not accessible to the public, provided the height of the greenhouse at the ridge does not exceed 20 ft (6096 mm) above grade.
4. Screens shall not be required in Group R3 occupancy when fully tempered glass is used as single glazing or the bottom pane in an insulated-glass unit and the following conditions are met:
    1. Glass area 16 sq ft ($1.5m^2$) or less.
    2. Highest point of glass 12 ft (3658 mm) or less above a walking surface or other accessible area.
    3. Glass thickness 3/16 inch (4.8 mm) or less.

2407.5 Sloped Glazing Framing

In other than Types III, V, and VI construction, all sloped glazing and skylight frames shall be constructed of noncombustible materials. In foundries or buildings where acid fumes deleterious to metal are incidental to the use of the building, approved pressure treated woods or other approved noncorrosive materials shall be permitted for sash and frames. All sloped glazing and skylights shall be designed for the tributary roof loads in 1604.6. All skylights set at an angle of less than 45^{O} (0.79 rad) from the horizontal plane shall be mounted at least 4 inches (102 mm) above the plane of the roof on a curb construction as required for the frame. Sloped glazing may be installed in the plane of the roof where the roof pitch is greater than 45^{O} (0.79 rad) from horizontal.

EXCEPTION: Curbs for skylights may be omitted on roofs with a minimum slope of 3:12 in one and two family dwellings.

CHAPTER 25

GYPSUM BOARD AND PLASTER

2501 GENERAL

2501.1 Scope

2501.1.1 Provisions of this chapter shall govern the materials, design, construction and quality of gypsum and plaster.

2501.1.2 Lathing, plastering and gypsum construction shall be done in the manner and with the materials specified in this chapter, and when required for fire protection shall also comply with the provisions of Chapter 7.

2501.2 Inspection

2501.2.1 No plaster shall be applied until the lathing has been inspected and approved by the building official.

2501.2.2 The building official may require that test holes be made in the wall for the purpose of determining the thickness and proportioning of the plaster, provided the permit holder has been notified 24 hours in advance of the time of making such tests.

2502 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

2503 MATERIALS

Materials used in construction involving gypsum board and plaster shall conform to Table 2503.

Table 2503
Materials

Materials	Designation
Sand – Shall be washed and when used with portland cement for scratch coat plastering the amount of sand retained on a No. 16 sieve shall not be less than 10% nor more than 40%,	ASTM C 35
Perlite	ASTM C 35
Vermiculite	ASTM C 35
Gypsum Plasters	ASTM C 28
Gypsum Veneer Plaster	ASTM C 587
Gypsum Veneer Base	ASTM C 588
Water Resistant Gypsum Backing Board	ASTM C 630
Bonding Compounds for Interior Plastering	ASTM C 631
Lime-Special Finishing Hydrated Lime Type “S”	ASTM C 206
Quicklime for structural purposes (Lime putty shall be made from quicklime or hydrated lime and shall be prepared in an approved manner.)	ASTM C 5
Keene’s Cement	ASTM C 61
Portland Cement	
Type I, II, or III Type I-A, II-A, or III-A Exception: Approved types of plasticizing agents may be added to portland cement Type I or II in the manufacturing process, but not in excess of 12% of the total volume. Plastic or waterproofed cements so manufactured shall meet the requirements for portland cement as specified in ASTM C 150 except in respect to the limitation on insoluble residue, air-entrainment and additions subsequent to calcination.	ASTM C 150
Masonry Cement Type II	ASTM C 91
Portland Blast Furnace Slag Cement	ASTM C 595 Type IS-A
Gypsum Lath	ASTM C 37
Metal Lath	ASTM C 847
Exterior Soffit Board	ASTM C 931
Gypsum Wallboard	ASTM C 36
Gypsum Backing Board	ASTM C 442
Predecorated Gypsum Board	ASTM C 960
Joint Reinforcing Tape	ASTM C 474,
and Adhesive Materials	ASTM C 475
Exterior Soffit Board	ASTM C 931
Steel Studs (for use with gypsum boards)	ASTM C 645
Steel Studs, Loadbearing (for use with gypsum boards)	ASTM C 955
Screws (for use with Framing covered with gypsum boards; types G, S and W)	ASTM C 1002
Screws (for Loadbearing Steel Framing)	ASTM C 954

2504 APPLICATION

2504.1 Interior Lathing and Plastering

2504.1.1 Installation of interior gypsum lathing and furring shall comply with ASTM C 841.

2504.1.2 Interior gypsum plastering shall comply with ASTM C 842.

2504.1.3 Portland cement plaster shall comply with ASTM C 926.

2504.2 Exterior Lathing and Plastering

2504.2.1 Exterior use of portland cement plaster shall comply with the application requirements of ASTM C 926.

2504.2.2 Installation of exterior lathing and framing shall comply with ASTMC 1063.

2504.3 Pneumatically Placed Portland Cement Plaster

2504.3.1 Pneumatically placed portland cement plaster shall be a mixture of portland cement and aggregate conveyed by air through a pipe or flexible tube, and deposited by air pressure in its final position.

2504.3.2 Rebound material may be screened and reused as aggregate in an amount not greater than 25% of the total sand in any batch.

2504.3.3 Pneumatically placed portland cement plaster shall consist of a mixture of one part cement to not more than five parts of aggregate. Plasticity agents may be used as specified elsewhere in this chapter. Except when applied to concrete or masonry, such plaster shall be applied in not less than two coats to a minimum total thickness of 7/8 inch (22.2 mm)

2504.4 Application of Gypsum Wallboard

2504.4.1 Interior and exterior applications and finishing of gypsum board, other than gypsum veneer base and plaster, shall be done in accordance with 701.4, 2506 or GA 216.

2504.4.2 Gypsum veneer base and veneer plaster shall be applied and finished in compliance with 701.4, 2506, or ASTM C 843 and ASTM C 844.

2504.4.3 Joint treatment of gypsum wallboard shall not be applied until the wallboard application has been approved by the building official.

2504.5 Application of Steel Studs

2504.5.1 Nonloadbearing steel framing shall be installed in compliance with the provisions of ASTM C 754.

2504.5.2 Loadbearing (transverse and axial) steel studs and related accessories shall be installed in compliance with the provisions of ASTM C 1007.

2505 ALLOWABLE PARTITION HEIGHTS

Composite nonbearing partitions of gypsum wallboard and steel studs shall be limited in height in accordance with Table 2505.

Table 2505
Allowable Nonbearing Partition Heights Based on Wallboard and No. 25 Gage Studs Acting as a Composite Section[1,2]

Stud Spacing (in)	Facing Each Side	Stud Depth (in)					
		1 5/8	2 1/2	3 1/4	3 5/8	4	6
16	1/2"-one ply	11'0"	14'8"	17'10"	19'5"	20'8"	18'10"
24	1/2"-one ply	10'0"	13'5"	16'0"	17'3"	18'5"	17'8"
24	1/2"-two ply	12'4"	15'10"	18'3"	19'5"	20'8"	19'0"

Notes:
1. The tabulated stud heights are based on 0.0179" uncoated thickness (25 ga) steel studs manufactured in compliance with ASTM C 754 for installation of screw-type steel framing members to receive gypsum boards.
2. Gypsum board product must be 1/2" minimum thick and may be applied vertically or horizontally.

2506 VERTICAL GYPSUM BOARD DIAPHRAGMS

2506.1General

2506.1.1 Gypsum wallboard, gypsum sheathing and gypsum veneer base may be used on wood studs for vertical diaphragms if applied in accordance with 2506. Shear resisting values shall not exceed those set forth in Table 2506. When such construction is designed to resist seismic forces, panel size and arrangement provisions of 2312.4.8 shall be met in addition to this section.

2506.1.2 All studs, top and bottom plates and blocking shall be nailed in accordance with Table 2506.

2506.1.3 The shear values tabulated shall not be cumulative with the shear value of other materials applied to the same wall. Cumulative allowable shear values for wall sheathed with more than one type of material shall be supported by engineering calculations or tests. The shear values may be doubled when identical materials applied as specified in 2506.3 are applied to both side of the wall.

2506.2 Wall Framing

2506.2.1 Framing for vertical diaphragms shall comply with 2308.2 for bearing walls. Studs shall be spaced no farther apart than 16 inches (406 mm) center-to-center. Marginal studs and plates shall be anchored to resist all design forces.

2506.2.2 The maximum allowable height-to-length ratio for the construction shall be 1 1/2:1.

2506.3 Application

2506.3.1 End joints of adjacent courses of gyp um board sheets shall not occur over the same stud.

2506.3.2 Where required in Table 2506, blocking having the same cross-sectional dimensions as the studs shall be provided at all joints that are perpendicular to the studs.

2506.3.3 The size and spacing of nails shall be as set forth in Table 2506. Nails shall be spaced not less than 3/8 inch (9.5 mm) from edges and ends of gypsum boards or sides of studs, blocking and top and bottom plates.

2506.3.4 Gypsum sheathing 4 ft (1219 mm) wide may be applied parallel or perpendicular to studs. Pieces 2 ft (610 mm) wide shall be as set forth in Table 2506.

2506.3.5 Gypsum wallboard or veneer base may be applied parallel or perpendicular to studs. Maximum allowable shear values shall be as set forth in Table 2506.

2506.4 Masonry and Concrete Construction

Gypsum board shall not be used in vertical diaphragms to resist forces imposed by masonry or concrete construction.

Table 2506
Shear Capacity for Shear Walls of Lath and Plaster, Gypsum Sheathing Board, and Gypsum Wallboard Wood-Framed Assemblies[1,4]

Material Type		Material Thickness	Wall Construction	Nail Spacing[2]	Shear[1] Values (lb/ft of wall)	Fastener Size[3]
Woven or welded wire lath and portland cement plaster		7/8”	Unblocked	6”	180	No. 11 ga 1 1/2" long, 7/16” head, or No. 16 ga staples having 7/8” long legs
Gypsum lath, plain of perforated		3/8” lath and 1/2" plaster	Unblocked	5”	100	No. 13 ga 1 1/8” long, 19/64” head, plasterboard blued nail
Gypsum sheathing board	2x8 ft	1/2”	Unblocked	4”	75	No 11 ga 1 3/4” long, 7/16” head, diamond point, galvanized
	4x8 ft		Blocked	4”	175	
	4x8 ft		Unblocked	7”	100	
	4x8 ft	5/8”	Blocked	Edges 4” Intermediate 7”	200	
Gypsum Wallboard		1/2"	Unblocked	7”	100	5d cooler nails
			Unblocked	4”	125	
			Blocked	7”	125	
			Blocked	4”	150	
		5/8”	Blocked	4”	175	6d cooler nails
			Blocked Two Ply	Base ply 9” Face ply 7”	250	Base ply 6d cooler nails Face ply 8d cooler nails

1 in = 24.4 mm

1 plf = 14.5939 N/m

Notes:

1. These vertical diaphragms shall not be used to resist loads imposed by masonry or concrete walls. Values are for short-term loading due to wind or earthquake and must be reduced 25% for normal loading.
2. Applies to nailing at all studs, top and bottom plates, and blocking.
3. Drywall screws may be substituted for the 5d, 6d (cooler) nails listed above: 1-1/4" type S or W, #6 for 5d or 6d (cooler) nails.
4. Framing spacing shall be 16 inches maximum.

CHAPTER 26

PLASTIC

2601 GENERAL

Provisions of this chapter shall govern the materials, design, application, construction and installation of foam plastic insulation and light-transmitting plastics.

2602 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

2603 FOAM PLASTIC INSULATION

2603.1 General

2603.1.1 The provision of this section shall govern the requirements and uses of foam plastic insulation in all buildings and structures regardless of type of construction.

2603.1.2 All packages and containers of foam plastic and foam plastic ingredients shall bear the label of an approved agency showing either the flamespread rating and smoke developed rating of the product at the thickness tested or the use for which the product has been listed.

2603.2 Surface Burning Characteristics

Except where otherwise provided in this section, all foam plastics or foam plastic cores in manufactured assemblies used in building construction shall have a flamespread rating of not more than 75 and shall have a smoke developed rating of not more than 450 when tested in the maximum thickness intended for use in accordance with ASTM E 84.

EXCEPTIONS:

1. Cold Storage Construction. Foam plastic, when tested in a thickness of 4 inches (102 mm) may be used in a thickness up to 10 inches (254 mm) when the building is equipped with an approved automatic fire suppression system. The approved automatic suppression system shall be provided in both the room and that part of the building in which the room is located. When exterior walls of a cold storage building are required to be constructed of noncombustible materials and the building is more than one story in height, the exterior wall shall also comply with the provisions of 2603.4.
2. Roofing. Foam plastic roof insulation which complies with Factory Mutual 4450 or UL 1256 need not meet the requirements of 2603.2. For all roof applications, the smoke developed rating shall not be limited.

2603.3 Thermal Barrier Requirements

Foam plastic, except where otherwise provided, shall be separated from the interior of a building by an approved thermal barrier of 1/2-inch (12.7 mm) gypsum wallboard or equivalent thermal barrier material which will limit the average temperature rise of the unexposed surface to no more than 250°F (121°C) after 15 minutes of fire exposure complying with the ASTM E 119 standard time-temperature curve. The thermal barrier shall be installed in such a manner that it will remain in place for the duration of the particular test used, either the procedures outlined in UL 1715 or FM 4880 or UL 1040, and meet the acceptance criteria thereof.

EXCEPTIONS: The thermal barrier is not required under any of the following conditions:

1. Masonry or Concrete Construction. When the foam plastic is protected by a minimum of 1-inch (25.4 mm) thickness of masonry or concrete.

2. Walk-in Coolers. Foam plastics having a maximum flamespread of 75 may be used up to 4 inches (102 mm) thick in walk-in coolers or freezer units with an aggregate area not exceeding 400 sq ft (37 m^2) in floor area without an automatic fire suppression system when the foam plastic is covered by a metal facing not less than 0.032-inch (0.81 mm) thick aluminum or corrosion-resistant steel having a minimum base metal thickness of 0.016 inch (0.41 mm). When protected by a thermal barrier, the foam plastic may be used in a thickness up to 10 inches (254 mm).
3. Roofing. In a roof covering assembly when the foam is separated from the interior of the building by wood structural panels sheathing not less than 15/32-inch (12 mm) thick 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 Factory Mutual 4450 or UL 1256 need not meet the requirements of 2603.2. For all roof applications, the smoke developed rating shall not be limited.
4. Attics and Crawl Spaces. Within an attic or crawl space where entry is made only for service of utilities, foam plastic shall be protected against ignition by 1 1/2-inch (38 mm) thick mineral fiber insulation, 1/4-inch (6.4 mm) thick wood structural panels, 1/4-inch (6.4 mm) particleboard, 1/4-inch (6.4 mm) hardboard, 3/8-inch (9.5 mm) gypsum wallboard, corrosion-resistant steel having a base metal thickness of 0.016 inch (0.41 mm), 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 type of construction.
5. Doors Not Required to be Rated for Fire Resistance. Where doors are permitted without a fire resistance rating, foam plastic having a flame spread of 75 or less may be used as a core material when the door facing is metal having a minimum thickness of 0.032 inch (0.81 mm), aluminum or sheet steel having a minimum thickness of 0.016 inch (0.41 mm).
6. Doors of One and Two Family Dwellings. In one and two family dwellings, foam filled exterior entrance doors not requiring a fire resistance rating may be faced with wood.
7. Siding Backer Board. Foam plastic of not more than 2,000 Btu/sq ft (22.7 MJ/m^2) as determined by NFiPA 259 may be used a siding backer board with a maximum thickness of 1/2 inch (12.7 mm), provided it is separated from the interior of the building by not less than 2 inches (51 mm) of mineral fiber insulation or equivalent or when applied as insulation with re-siding over existing wall construction.
8. One Story Buildings. For one story buildings of fire resistant or noncombustible construction, foam plastic insulation having a flamespread of 25 or less may be used without thermal barriers in or on exterior walls in a thickness not more than 4 inches (102 mm) when the foam plastic is covered by a thickness of not less than 0.032 inch (0.81 mm), aluminum or corrosion-resistant steel having a base metal thickness of 0.0160 inch (0.41 mm) and the insulated area is protected with automatic sprinklers.

2603.4 Exterior Walls of Multistory Buildings

Exterior walls of multistory buildings of Types I, II, III, IV, or V construction shall comply with 2603.4. Other exterior walls shall comply with 2603.1, 2603.2, and 2603.3.

2603.4.1 Where walls face a street or permanent open space of 30 ft (9144 mm) or more, foam plastic insulation may be used in a nonfire-rated exterior wall assembly. Where a separation of less than 30 ft (9144 mm) exists, foam plastic may be used within exterior walls, provided the wall assembly affords the required fire resistance.

2603.4.2 Any foam plastic insulation shall be separated from the building interior by a thermal barrier meeting the provisions of 2603.3 unless a specific approval is obtained on the basis of 2603.7.

2603.4.3 The potential heat of foam plastic in any portion of the wall or panel shall not exceed 6,000 Btu/sq ft (68.1 MJ/m^2) of projected area as described by tests conducted in accordance with NFiPA 259.

2603.4.4 Foam plastic insulation, exterior coatings and facings tested separately shall each have a flame spread rating of 25 or less and a smoke developed rating of 450 or less as determined in accordance with ASTM E 84.

EXCEPTION: When approved by the building official, prefabricated or factory-manufactured panels having minimum 0.020 inch (0.51 mm) aluminum facings and a total thickness of 1/4 inch (6.4 mm) or less may be tested as an assembly when the foam plastic core is not exposed in the course of construction.

2603.4.5 Results of diversified or full-scale fire tests reflecting an end use configuration shall be submitted to the building official to demonstrate that the assembly in its final form does not propagate flame over the surface or through the core when exposed on the exterior face to a fire source.

2603.4.6 The edge or face of each piece of foam plastic insulation shall bear the label of an approved agency. The label shall contain the manufacturer's or distributor's identification, model number, serial number of definitive information describing the product or materials performance characteristics and approved agency's identification.

2603.4.7 Exterior walls complying with 2603.4 on buildings required to be of Type I, II, III, IV, or V construction shall be resistant to ignition as required by 2603.5.

EXCEPTION: Assemblies protected on the outside with one of the following:

1. A thermal barrier complying with 2603.3
2. A minimum 1 inch (25.4 mm) thickness of concrete or masonry
3. Glass fiber reinforced concrete panels complying with 1910.
4. Metal faced panels having minimum 0.019 inch (0.48 mm) thick aluminum or 0.016 inch (0.41 mm) thick corrosion-resistant steel outer facings.

2603.5 Test Procedure

The testing procedure shall comply with 2603.5.1 and 2603.5.2.

2603.5.1 Test Specimen. The test specimen shall conform to 2603.5.1.1 and 2603.5.1.2.

2603.5.1.1 The test specimen shall be constructed to reflect the end use configuration. Where a material is intended to be installed in more than one thickness, tests of the minimum and maximum thickness intended to be used shall be performed.

2603.5.1.2 Test specimens shall consist of a minimum 4x8 ft (1219x2438 mm) assembly which shall be mounted in a vertical position.

2603.5.2 Test Exposure and Apparatus. The test exposure and apparatus shall conform to 2603.5.2.1 through 2603.5.2.4.

2603.5.2.1 Apparatus. A 3x3 ft (914x914 mm) propane-fired radiant panel shall be provided and shall operate at a constant temperature of 1,600°F ± 50°F (871°C ± 10°C).

2603.5.2.2 Configuration. The radiant panel and the test specimen shall be configured in a parallel plate orientation such that the axis perpendicular to, and running through, the center of the radiant panel face and the test specimen are concurrent

2603.5.2.3 Heat Flux. The temperature of the radiant panel shall be controlled and the orientation of the radiant panel and the test specimen shall be fixed to produce an average heat flux of 12.5 ± 5% kW/m^2 over the center square foot of the test assembly. Average heat flux shall be determined as the average of four calorimeter readings located at the comers of the center sq ft of the test assembly.

2603.5.2.4 Exposure. The 4x8 ft (1219x2438 mm) test specimen shall be exposed to a "square wave" exposure for a period of 20 minutes. A spark igniter shall be installed and located at a point 18 inches (457 mm) vertically above the center point of the test specimen. The igniter shall be operated throughout the 20 minute test period. If the spark igniter is operated in an intermittent mode, the "off' portion of the cycle shall be no longer than 2 seconds and the "on" portion of each cycle shall be at least 5 seconds duration.

2603.5.3 Conditions of Acceptance. Materials shall qualify for use under the provisions of 2603.5.3.1.

2603.5.3.1 Allowable Use. An assembly shall be acceptable for use if, during the exposure described in 2603.5.2, continuous flaming ignition does not occur for a time period greater than 5 seconds. Continuous flaming ignition shall be judged to occur when continuous flaming is visually observed by the laboratory personnel for greater than 5 seconds.

2603.6 Veneer

The limitations contained within 2604 dealing with veneer materials do not apply to this section.

2603.7 Special Approval

2603.7.1 Foam plastic, having a flamespread rating of not more than 75 and a smoke developed rating of not more than 450, not meeting the requirements of 2603.1 through 2603.4, may be specifically approved on the basis of tests such as, but not limited to, a tunnel test in accordance with ASTM E 84, FM 4880, UL 1040, UL 1715, ASTM E 152, or fire tests related to actual end use configuration. The specific approval may be based on end use, quantity, location and similar consideration where such tests would not be applicable or practical.

2603.7.2 Foam plastics which are used as interior finish shall also meet the flamespread requirements for interior finish.

2603.8 Special Requirements for Foam Plastic in Buildings of Type III, Type IV, Type V, or Type VI Construction.

2603.8.1 General. This section shall apply to both treated and untreated foam plastic.

2603.8.2 Foundation walls. All foam plastic shall be a minimum of 8" above grade.

EXCEPTION: Foam plastic less than 8" above or in contact with grade shall be installed in accordance with 2603.8.5.

2603.8.3 Chemical treatment. When foam plastic is in contact with the ground, the soil area shall be chemically treated in accordance with the North Carolina Department of Agriculture rules and regulations.

2603.8.4 Slab on grade. Foam plastic shall be installed along the vertical edge and underneath the slab as specified in 1301.2.5. Foam plastic shall not be positioned so as to receive vertical building loads.

2603.8.5 Foam plastic in contact with ground

2603.8.5.1 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.

2603.8.5.2 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.

2603.8.5.3 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 manufacturer's installation instructions.

2603.8.5.4 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 1815.

EXCEPTIONS: Dampproofing or waterproofing methods designed for application after placement.

2604 LIGHT-TRANSMITTING PLASTICS

2604.1 General

2604.1.1 Scope

2604.1.1.1 The provision of this chapter shall govern the quality and methods of application of plastics for use as light-transmitting materials in buildings and structures. When used as interior finish, plastic materials shall meet the requirements of 803.3. Light-transmitting plastic materials which meet the performance requirements for walls and roofs may be used in accordance with the other applicable chapters of this code.

2604.1.1.2 Plastic materials may be of any class as defined by this section. Before any plastic material is approved for use, the manufacturer shall file with the department technical data which relates to the proposed use of the material. The data shall include the pertinent physical, mechanical, and thermal properties such as weather resistance, expansion coefficient and combustibility characteristics. The department shall determine the adequacy of the data. Where the department determines that the material is satisfactory for the intended use, approval of the material hall be given subject to the limitations specified in this chapter.

2604.1.1.3 All plastic materials approved for use under this code shall be identified by the trade formula number or name or other acceptable identification. Each unit or package shall bear the approval number or other identification mark of the approving authority.

2604.1.2 Design And Installation

2604.1.2.1 All plastic materials and their assemblies shall be of adequate strength and durability to withstand the loads and forces specified in Chapter 16 for their approved use.

2604.1.2.2 Fastenings shall be adequate to withstand design loads as prescribed elsewhere in this code. Adequate allowance shall be made in the fastenings and supports for differential expansion and contraction of the connected materials.

2604.2 Definitions

The following words and terms shall, for the purpose of this chapter and as stated elsewhere in this code, have the meanings shown herein. Refer to Chapter 2 for general definitions.

LIGHT DIFFUSING SYSTEM – a suspended construction consisting in whole or in part of lenses, panels, grids or baffles suspended below independently mounted electrical lighting sources.

PLASTIC, ROOF PANELS – plastic materials which are fastened to structural members or to structural panels or sheathing and which are used as light transmitting media in the plane of the roof.

PLASTIC, WALL PANELS – plastic materials which are fastened to structural members or to structural panels or sheathing and which are used as light-transmitting media in exterior walls.

THERMOPLASTIC MATERIAL – a plastic material which is capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature.

THERMOSETTING MATERIAL – a plastic material which is capable of being changed into a substantially nonreformable product when cured

2604.3 Glazing of Unprotected Openings

2604.3.1 Doors, sash, and openings which are not required to have opening protectives shall be permitted to be glazed or equipped with approved plastic materials subject to the following requirements:

1. The area of such glazing shall not exceed 25% of the wall face of the story in which it is installed, or the percentage of unprotected openings permitted in Table 600, whichever is smaller.
2. The area of a pane of glazing installed above the first story shall not exceed 16 sq ft (1.50 m^2) and the vertical dimension of a pane shall not exceed 4ft (1219 mm). There shall be a minimum 3ft (914 mm) vertical spandrel wall between stories.
3. Approved plastic glazing shall not be installed more than 75 ft (22.9 m) above grade level.

EXCEPTION: When complete automatic sprinkler protection is provided in the building, the permissible area of glazing in 2604.3.1 (1) may be increased to a maximum of 50% of the wall face of the story in which it is installed, but not exceeding the percentage of unprotected openings permitted in Table 600, and shall be exempt from the provisions of 2604.3.1 (2) and 2604.3.1 (3).

2604.3.2 Approved plastic materials shall be permitted in areas up to 50% of the wall area of each story, but not exceeding the percentage of unprotected openings permitted in Table 600, in structures less than 75 ft (22.9 m) high, provided each floor above the first floor is equipped with continuous architectural projections constituting an effective fire canopy extending at least 3 ft (914 mm) from the surface of the wall in which the glazing is installed. The size and the dimensions of the individual units shall not be limited in such installations except as required to meet structural loading requirements.

2604.3.3 Combinations of plastic glazing and plastic wall panels shall be subject to the area, height, percentage limitations and separation requirements applicable to the class of plastics as prescribed for plastic wall panel installations in 2604.4.

2604.4 Exterior Plastic Wall Panels.

2604.4.1 Except in Group I, A-1 and H occupancies, approved plastic materials shall be permitted to be used as wall panels in exterior walls not required to have a fire resistance rating, subject to the following requirements:

The maximum area of a single wall panel and minimum vertical and horizontal separation requirements for exterior wall panels shall be as provided in Table 2604.4. The maximum percentage of wall area of any story in plastic wall panels shall not exceed that indicated in Table 2604.4, or the percentage of unprotected openings permitted in Table 600, whichever is smaller.

EXCEPTION: When complete automatic sprinkler protection is provided in the building, the maximum percent area of plastic panels in the exterior wall and the maximum square feet of single area given in Table 2604.4 shall be permitted to be increased 100%, but in no case shall the area of plastic wall panels exceed 50% of the wall area, or the area of unprotected openings permitted in Table 600. These uses shall be exempt from height limitations.

2604.4.2 In structures which are provided, on any floor above the first, with continuous architectural projections constituting an effective fire canopy extending at least 36 inches (9l4 mm) from the surface of the wall in which plastic wall panels are installed, there need be no vertical separation at that floor except that provided by the vertical thickness of the projection.

Table 2604.4
Area Limitations and Separation Requirements for Plastic Wall Panels[1]

Fire Separation	Class of Plastic	Max. % area of Ext. Walls in Plastic Panels	Max. sq ft Single Area	Minimum Separation of Panels (ft)	
				Vertical	Horizontal
Less than 6 ft	---	NP	NP	---	---
6 ft or more but less than 11 ft	CC 1	10	50	8	4
	CC 2	NP	NP	---	---
11 ft or more but less than 30 ft	CC 1	25	90	6	4
	CC 2	15	70	8	4
Over 30 ft	CC 1	30	300	3[2]	---
	CC 2	25	100	6[2]	3

1 ft = 0.305 m
1 sq ft = 0.0929 m^2

Notes:
1. See 2604.3.3 for combination of glazing and wall panel areas permitted.
2. See 2604.3.1 (2).

2604.5 Roof Panels

2604.5.1General. Approved plastic roof panels may be installed, except in Group I and Group H occupancies, as follows:

1. In roofs of buildings protected by approved complete automatic fire suppression systems, or
2. Where the roof is not required to have a fire resistance rating, or
3. Where the roof panels meet the requirements for roof coverings.

2604.5.2 Limitations.

2604.5.2.1 Individual roof panels or units shall be separated from each other by a distance of not less than 4 ft (1219 mm) measured in a horizontal plane.

EXCEPTION: A fire separation between roof panels is not required in a building provided with an automatic fire suppression system.

2604.5.2.2 Where exterior wall openings are required to be fire resistance rated, a roof panel or unit shall not be installed within 6 ft (1829 mm) of such exterior wall.

2604.5.2.3 Roof panels or units shall be limited in area and the aggregate area of panels shall be limited by a percentage of the floor area of the room or space sheltered in accordance with Table 2604.5.

EXCEPTION: The tabular area limits may be increased 100% in buildings provided with an automatic fire suppression system.

Table 2604.5
Area Limitations for Plastic Roof Panels and Skylights

Class of Plastic	Maximum Area Individual Unit Panel (sq ft)	Maximum Aggregate Area (% of floor area)
CC 1	300	33
CC 2	100	25

1 sq ft = 0.0929 m^2

2604.5.3 Exceptions.

2604.5.3.1 Low hazard uses such as swimming pool shelters, greenhouses, etc., are exempt from the area limitations of 2604.5.2 provided they do not exceed 5,000 sq ft (465m^2) in area and are not closer than 11 ft (3353 mm) to the property line of adjacent buildings.

2604.5.3.2 Roof coverings over terraces and patios of one and two family dwellings shall be permitted with approved plastics.

2604.6 Skylights

2604.6.1 General.

2604.6.1.1 Skylight assemblies may be glazed with approved plastic materials in accordance with the provisions of 2604.6.

EXCEPTION: These provisions need not be applied if the building on which the skylights are located is not more than one story in height, the building has an exterior separation from other buildings of at least 30 ft (9144 mm) and the room or space sheltered by the roof is not classified in a group of high hazard or institutional uses or as a means of egress, or the plastic material meets the fire resistance requirements of the roof.

2604.6.1.2 The approval of thermoplastic light-transmitting materials without a curb shall include the following considerations:

1. Expansion and contraction.
2. Durability.
3. Condensation removal.
4. Effects of sealants and roofing cements.

2604.6.2 Mounting. The glazing shall be mounted at least 4 inches (102 mm) above the plane of the roof on a curb constructed consistent with the requirements for the type of construction classification. Edge of plastic skylights and domes shall be protected by metal or noncombustible material, or skylights shall be tested to show equivalent fire protection is provided.

EXCEPTIONS:

1. Curb requirements for skylights may be omitted when used on roofs with a minimum slope of 3:12 in one and two family dwellings or on buildings with an unclassified roof covering.
2. The metal or noncombustible edge material is not required where unclassified roof coverings are permitted.

2604.6.3 Slope. Flat or corrugated plastic skylights shall slope at least 4:12. Dome-shaped skylights shall rise above the mounting flange a minimum distance equal to 10% of the maximum span of the dome but not less than 3 inches (76 mm).

EXCEPTION: Skylights which pass the Class B burning brand test specified in ASTM E 108.

2604.6.4 Maximum Area of Skylight Unit. Each skylight unit shall have a maximum area of 100 sq ft (9.3 m^2) within the curb.

EXCEPTION: The area of skylight units shall not be limited in buildings equipped with an automatic fire suppression system, or if the skylight is serving as an approved fire venting system.

2604.6.5 Aggregate Area. The aggregate area of skylights shall not exceed 33 1/3% when CC 1 materials are used, and 25% when CC 2 materials are used, of the floor area of the room or space sheltered by the roof in which they are installed.

EXCEPTION: The aggregate area of skylights may be increased 100% provided the building is equipped with an automatic fire suppression system, or if the skylight is serving as an approved fire venting system.

2604.6.6 Separation. Skylights shall be separated from each other by a distance of not less than 4ft (1219 mm) measured in a horizontal plane.

EXCEPTIONS:

1. The separation shall not be required provided the building is equipped with an automatic fire suppression system, or if the skylight is serving as an approved fire venting system.
2. In one and two family dwellings or on buildings with an unclassified roof covering, skylights shall be separated from each other by a distance of not less than 16 inches (407 mm) measured in a horizontal plane.

2604.6.7 Location. Where exterior wall openings are required to be fire resistance rated, a skylight shall not be installed within 6 ft (1829 mm) of such exterior wall.

2604.7 Light-Diffusers In Ceilings

2604.7.1 Light-Diffusing Systems.

2604.7.1.1 Plastic light-diffusing systems shall not be installed in Group I, Group A-1 and Group H occupancies unless protected with automatic sprinkler systems. Plastic diffusers shall be supported directly or indirectly from ceiling or roof construction by use of noncombustible hangers.

2604.7.1.2 Approved plastic material s shall comply with 803.3, unless the plastic panels meet all of the following requirements:

1. Fall from their mounting at an ambient temperature of at least 200°F (93°C) below the ignition temperature of the plastic material as measured by ASTM D 1929.
2. Remain in place at an ambient room temperature of 175°F (79°C) for a period of not less than 15 minutes.
3. The maximum length of any single plastic panel shall not exceed 10 ft (3048 mm) and the maximum area of any single light diffuser shall not exceed 30 sq ft (2.8 m^2).

2604.7.1.3 A plastic light-diffusing system shall not be installed in areas required to be equipped with automatic sprinklers unless appropriate tests by a recognized laboratory have shown that such system does not prevent effective operation of the sprinklers or unless sprinklers are located both above and below the light diffusing system to give effective sprinkler protection.

2604.7.2 Electrical Lighting Fixtures. Plastic light-transmitting panels and light-diffuser panels installed in approved electrical lighting fixtures shall comply with 803 unless the plastic panels meet the requirements of 2604.7.1.2.

2604.7.3 Area Limitations. Unless the occupancy is protected by an approved automatic sprinkler system, the area of approved plastic materials when used in required fire exits or corridors shall not exceed 30% of the aggregate area of the ceiling in which they are installed.

2604.8 Partitions

Refer to control of partitions in the applicable section of this code.

2604.9 Exterior Veneer

Exterior plastic veneer shall be approved plastic material and except for rigid vinyl siding shall meet the following requirements:

1. Plastic veneer shall not be attached to any exterior wall to a height greater than 35 ft (10.6 m) above grade.
2. Sections of plastic veneer shall not exceed 200 sq ft (19 m^2) in area.
3. Sections of plastic veneer shall be separated by a minimum of 4 ft (1219 mm) vertically.

2604.10 Awnings And Similar Shelters

Approved plastic may be used on awnings and similar structures in conformance with general provisions of other sections of this code.

2604.11 Greenhouses

Approved plastic may be used in lieu of plain glass in greenhouses.

2604.12 Signs And Outdoor Displays

The use of plastics in signs, outdoor displays, and similar structures shall be governed by provisions of 3108.

2604.13 Bathroom Accessories

Approved plastics shall be permitted as glazing for shower stalls, shower doors, bathtub enclosures, and similar accessory units provided they meet the human impact requirements of the applicable code.

2604.14 Railing In-Fill Panels

Plastic complying with ANSI Z97.1 may be used for in-fill panels in railing systems. The minimum nominal thickness shall be 1/4 inch.

2604.15 Interior Signs

2604.15.1 General. Approved plastic shall be permitted on interior walls and ceilings as specified in 2604.15.2 and 2604.15.3. Applications using approved plastic interior signs in covered mall buildings shall comply with 413.13.

2604.15.2 Area. The signs shall not exceed 20% of the wall and ceiling area on which it is located.

2604.15.3 Encasement. All edges and backs of internally illuminated signs shall be fully encased in metal or other noncombustible material.

CHAPTER 27

ELECTRIC SYSTEMS

2701 GENERAL

2701.1 Scope

Provisions of this chapter shall govern the electrical systems employed in buildings and structures covered by this code.

2701.2 Electrical systems shall comply with the provisions of NFiPA 70. Where provisions conflict, this code shall govern.

2702 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

CHAPTER 28

MECHANICAL SYSTEMS

2801 GENERAL

2801.1Scope

Provisions of this chapter and the Standard Mechanical Code and Standard Gas Code shall govern heating, air conditioning, refrigeration, mechanical ventilation and plenums, and the design and construction of factory-built chimneys, fireplaces and barbecues.

2802 DEFINITIONS

The following words and terms shall, for the purposes of this chapter and as stated elsewhere in this code, have the meanings shown herein. Refer to Chapter 2 for general definitions.

CHIMNEY CONNECTOR – the pipe which connects a fuel-burning appliance to a chimney.

2803 HEATING, AIR CONDITIONING, REFRIGERATION AND VENTILATION

All heating, air conditioning, refrigeration and ventilation equipment shall conform to the requirements set forth in the Standard Mechanical Code.

2804 CHIMNEYS

2804.1 General

2804.1.1 Chimneys shall be required for all heating or heat-producing appliances except electrical heating and appliances listed for use with venting systems. Every chimney shall be constructed and every venting system shall be installed in accordance with the applicable requirements of this chapter.

2804.1.2 Every chimney, vent or venting system shall be capable of producing a draft at the appliance not less than that required for the safe operation of the appliance connected thereto. A power exhauster may be used except with incinerators to increase low draft. When an exhauster is used, provision shall be made to shut off the fuel supply to the appliance in the event of failure to the exhauster.

2804.1.3 Nothing in this code shall prohibit the joining of two or more connectors into a combined connector provided that all pipes are of sufficient size to serve all of the appliances thus connected, and provided that all pipes are constructed to comply with the severest requirements for any of those connected.

2804.1.4 The connector of a fuel-burning appliance shall not be connected into the chimney flue of an incinerator which has the rubbish chute identical with the chimney flue.

2804.2 Chimney Construction

2804.2.1 A chimney shall not carry any load other than its own dead weight.

2804.2.2 Chimney crickets of metal or other roofing materials shall be laid or installed on solid roof decking consistent with the construction of the roof.

2804.2.3 All chimneys which are or become unsafe or dangerous shall be made safe or taken down.

2804.2.4 Chimneys shall extend at least 3 ft (914 mm) above the highest point where they pass through the roof of the building and at least 2 ft (610 mm) higher than any portion of the roof or building located within 10 ft (3048 mm) horizontally of such chimney.

2804.2.5 An appliance equipped with a forced or induced draft system which may result in positive pressure in the venting system shall be connected to a pressure-tight venting system.

2804.3 Raising Adjoining Chimneys

2804.3.1 Whenever a building is hereafter erected, enlarged or raised, the owner of such building shall, at his own expense, carry up, either independently or on his own building, all chimneys, smoke stacks, and smoke flues of any adjoining buildings which are within 10ft (3048 mm) of any portion of the wall extending above such chimney or flue.

2804.3.2 The construction of such chimney shall conform to all requirements of this code. Such a chimney shall be carried up simultaneously with the walls.

2804.3.3 It shall be the duty of the owner of the building to be erected, enlarged or raised, to notify in writing, at least 10 days before such work is to begin, the owner of the chimney affected, of his intention to carry up such chimney.

2804.4 Factory-Built Chimneys

2804.4.1 Factory-built chimneys shall be listed and shall be installed in accordance with the conditions of the listing, and the manufacturer's instructions. Nothing contained in this code shall be construed as prohibiting the use of insulated suspended factory-built chimneys provided such assemblies have been tested and approved by a recognized laboratory for the use intended and are installed in accordance with their approval.

2804.4.2 Factory-built chimneys may be installed with zero clearance from wood structural members, such as framing, roof rafters, floor and ceiling joists and other component structural members, when it has been determined by test reports of recognized and approved testing laboratories that the unit does not transmit heat to the supporting combustible members of more than 90°F (32°C) above room temperature. Supports for such chimneys attached to ceiling or floor joists shall be permitted provided the joists are of adequate size to support additional load.

2804.4.3 All chimney installations shall conform with the height requirements of this code.

2804.4.4 Factory-built chimneys for use with closed combustion wood-burning appliances shall comply with the Type HT requirements of UL 103.

2804.4.5 Chimneys for use with factory-built fireplaces shall meet the requirements of UL 127.

2805 MASONRY CHIMNEYS AND BARBECUES

Provisions for masonry chimneys and barbecues are contained in 2113 and 2114.

2806 FIREPLACES-FACTORY-BUILT

2806.1 Factory-Built Fireplaces

2806.1.1 Factory-built fireplaces shall be listed and shall be installed in accordance with the conditions of the listing.

2806.1.2 Factory-built fireplaces shall be tested in accordance with and meet the requirements of UL 127.

2806.1.3 Hearth extensions of approved factory-built fireplaces and fireplace stoves shall be installed in accordance with the listing. Masonry hearth extensions if used with factory-built fireplaces shall be installed as required in 2114.3.7. The hearth extension shall be readily distinguished from the surrounding area.

2806.1.4 Factory-built fireplaces shall be installed in accordance with 2114.3.10.

2806.2 Factory-Built Fireplace Stoves and Solid Fuel Room Heaters

2806.2.1 Factory-built fireplace stoves and solid fuel type room heaters shall be listed and shall be installed in accordance with the conditions of the listing. The factory-built fireplace stoves shall be tested in accordance with and meet the requirements of UL 737. The solid fuel type room heaters shall be tested in accordance with and meet the requirements of UL 1482.

2806.2.2 Factory-built fireplace stoves shall also be installed in accordance with 2806.1.2 and 2114.3.10.

2807 FALSE FIREPLACES

False fireplaces may be used in connection with listed gas or electric heaters, provided such fireplaces are constructed of noncombustible materials.

2808 BARBECUES-FACTORY-BUILT

Factory-built barbecues shall be of an approved type and shall be installed in accordance with the manufacturer's instructions.

2809 GAS APPLIANCES

Gas appliances shall be installed and vented in accordance with the requirements of the Standard Gas Code.

2810 FRESH AIR INTAKES

Fresh air intakes shall be screened with a corrosion-resistant material not larger than 1/2-inch (12.7 mm) mesh. Fresh air intakes shall not be taken from a location closer than 10 ft (3048 mm) from any chimney or vent outlet, or sanitary sewer vent outlet, unless such vent is not less than 24 inches (610 mm) above the fresh air vent. See 705.1.1.4 for fire protection.

2811 PLENUM FLOOR SYSTEMS

Plenum floor systems shall comply with the requirements of section 609.2 of the Standard Mechanical Code.

CHAPTER 29

PLUMBING SYSTEMS

2901 GENERAL

2901.1 Scope

Provisions of this chapter shall govern the installation of plumbing fixtures and systems in buildings and structures.

2901.2 Plumbing Installations

All plumbing fixtures and plumbing installations shall conform to the Standard Plumbing Code. See 1204.

2902 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

CHAPTER 30

ELEVATORS AND CONVEYING SYSTEMS

3001- GENERAL

3001.1 Scope

The provisions of this chapter shall govern the design, construction, installation, and maintenance of elevators and conveying systems.

3001.1.2 Elevators, dumbwaiters, escalators and moving walks shall be constructed, installed, and maintained to provide proper safety in accordance with the requirements of this code. Construction, installation and maintenance shall conform with ANSI/ASME A17.1 and Addenda A17.1a, except as otherwise provided for in this code.

3001.1.3 Passenger elevators shall comply with CABO/ANSI A117.1.

3002 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

3003 ELEVATORS

3003.1 Elevator Enclosures

3003.1.1 All openings in elevator or dumbwaiter shafts shall be protected as required by ANSI/ASME A17.1 and Addenda A17.la and they shall not in any case be less than the requirements of 705.2 of this code.

3003.1.2 When there are three or fewer elevator cars in a building, they may be located within the same hoistway enclosure. When there are four elevator cars, they shall be divided in such a manner that at least two separate hoistways enclosures are provided. When there are more than four elevators, not more than four elevator cars shall be located within a single hoistway enclosure. Hoistway enclosures shall be protected in accordance with Table 700.

3003.1.3 Where an elevator is installed in a blind hoistway or on the outside of a building, there shall be installed in the blind portion of the hoistway or blank face of the building, an emergency door at every third floor but not more than 36 ft (11 m) apart at least 30 inches (762 mm) wide and 78 inches (1981 mm) high conforming to the requirements of 705.1.5.

3003.1.4 Elevators shall not be in a common enclosing shaft with a stairway, and the path of travel from one flight of stairs to the next shall not pass directly in front of elevator doors.

3003.1.5 Elevator lobbies shall have access to at least one exit. Such exit access shall not require the use of a key, tool, special knowledge or effort.

EXCEPTION: Lobby doors providing access to an exit may be maintained closed and locked in buildings protected throughout by an approved supervised automatic smoke detection system or fast response automatic sprinkler system. The doors shall unlock without unlatching upon actuation of a smoke detector or sprinkler, a manual pull box, or the elevator's emergency recall. The doors shall be similarly unlocked upon loss of primary power.

3003.1.6 Doors other than the hoistway door and the elevator car door shall be prohibited at the point of access to an elevator car.

EXCEPTION: Doors which are readily openable from the car side without a key, tool, special knowledge, or effort.

3003.1.7 Construction at top and bottom of hoistway.

3003.1.7.1 Where a hoistway extends into the top floor of a building, fire resistant or machinery space enclosures, where required, shall be carried to the underside of the roof if the roof is of fire resistant construction, and at least 3 ft (914 mm) above the top surface of the roof if the roof is of nonfire resistant construction.

3003.1.7.2 Where a hoistway does not extend into the top floor of a building, the top of the hoistway shall be enclosed with fire resistant construction having a fire resistance rating at least equal to that required for the hoistway enclosure.

3003.1.7.3 Pits extending to the ground shall have noncombustible floors and shall be so designed as to prevent entry of ground water into the pit. The pit floor of any hoistway not extending to the ground shall be of fire resistant construction having a fire resistance rating at least equal to that required for the hoistway enclosure.

EXCEPTION: Partitions between fire resistant hoistways and machine rooms having fire resistant enclosures and which are located at a side of or beneath that hoistway, may be of unperforated noncombustible material at least equal to 0.055-inch (1.4 mm) thick sheet steel in strength and stiffness with openings therein essential for ropes, drums, sheaves and other elevator equipment.

3003.1.8 A metal or concrete floor shall be provided at the top of the hoistway.

EXCEPTIONS: Floors are not required below:

1. Secondary and deflecting sheaves of traction-type machines located over the hoistway.
2. Overhead sheaves, governors and other equipment where the elevator machine is located below or at the side of the hoistway, provided that:
    1. Mean of access for inspection and servicing of governors is provided from outside the hoistway, conforming to the requirements of Rule 101.3c, ANSI/ASME A17.1.
    2. Sheaves and other equipment (except governors) may be inspected and serviced from the top of the car, or means of access from outside the hoistway may be provided conforming to the requirements of Rule 101.3c, ANSI/ASME A17.1.

3003.1.9 Floors may be of concrete or may be of metal construction with or without perforations. Metal floors shall conform to the following:

1. If of bar-type grating, the openings between bars shall reject a 3/4-inch (19 mm) diameter ball.
2. If of perforated sheet metal or of fabricated openwork construction, the openings shall reject a 1-inch (25.4 mm) diameter ball.

3003.1.10 There is no limit on the number of cars which may be in a bank or group but there may not be more than four cars within a common hoist way.

3003.2 Emergency Exit

Every elevator shall have an emergency exit as required by ANSI/ASME A17.1 and Addenda A17.1a.

3003.3 Signs

A permanent sign shall be installed immediately above each hall push button station on each floor reading: IN FIRE EMERGENCY, DO NOT USE ELEVATOR. USE EXIT STAIRS. This sign shall be letters not less than 1/2 inch (12.7 mm) high.

3003.4 Stretcher Requirements

3003.4.1 In all structures four or more stories in height, at least one elevator serving all floors shall have a minimum inside car platform 51 x80 inches (1295x2032 mm) with a minimum clear opening width of 42 inches (1067 mm), unless otherwise designed to provide equivalent utility, to allow the entrance and exit of an ambulance stretcher (minimum size 22x78 inches) (559x 1981 mm) in its horizontal position. This elevator shall be identified. The elevator entrance may be of the side opening entrance type in order to accommodate a stretcher in its horizontal position to accomplish design flexibility.

EXCEPTION: In buildings where one elevator does not serve all floors, two or more elevators may be used. Each elevator shall be identified as to which floors are served.

3003.4.2 Passenger elevators serving areas of buildings required to be accessible to the physically disabled shall comply with CABO/ANSI A117.1.

3003.5 Standby Power

In all buildings or structures where standby power is required or furnished to operate an elevator, the operation shall be as follows:

1. Where only one elevator is installed, the elevator shall transfer to standby power within 60 seconds after failure of normal power.
2. Where two or more elevators are controlled by a common operating system, all elevators may transfer to standby power within 60 seconds after failure of normal power; or if the standby power source is of insufficient capacity to operate all elevators at the same time, all elevators shall transfer to standby power in sequence, return to the designated landing and discharge their load. After all elevators have been returned to the designated landing, at least one elevator shall remain operable from the standby power source.

3003.6 Vents

3003.6.1 Hoistways of elevators serving more than three floors shall be provided with means of venting smoke and hot gases to the outer air in case of fire.

EXCEPTION: Hoistways not extending into the top floor of the building, in buildings other than hotels, apartment houses, hospitals and similar buildings with overnight sleeping quarters, where the hoistways are equipped with approved automatic sprinklers connected to the building water supply system or to an approved automatic sprinkler system. See NFiPA 13. Such systems shall be responsive to an accumulation of smoke as well as heat at the top of the hoistway.

3003.6.2 Vents shall be located below the floor or floors at the top of the hoistway, and shall open either directly to the outer air or through noncombustible ducts to the outer air. Noncombustible ducts shall be permitted to pass through the elevator machine room provided proper clearances are maintained for the elevator equipment. Vents which require the use of noncombustible ducts located directly outside the hoistway or machine room area shall be provided with the same fire protection rating as required for the hoistway.

3003.6.3 The area of the vents shall be not less than 3 1/2% of the area of the hoistway nor less than 3 sq ft (0.28 m^2) for each elevator car, whichever is greater.

EXCEPTIONS: Where mechanical ventilation providing equivalent venting of the hoistway is provided, the required vent area may be reduced subject to the following:

1. The building if not a hotel, apartment house, hospital or similar building with overnight sleeping quarters.
2. The hoistway or machine room is so located that it has no outside exposure.
3. The hoist way does not extend to the top of the building.
4. The hoistway or machine room exhausted fan is automatically reactivated by thermostatic means.

3003.6.4 Holes in the machine room floor for the passage of ropes, cables or other elevator equipment shall be limited to a 1 1/2 inch (38 mm) clearance on all sides.

3003.7 Access to Machine Rooms and Machinery Spaces

3003.7.1 General. A permanent, safe and convenient means of access to elevator machine rooms and overhead machinery spaces shall be provided for authorized persons. The means of access shall not be through restrooms, dressing rooms or tenant spaces.

3003.7.2 Access Across Roofs. Where passage over roofs is necessary to reach the mean of access to machine rooms or machinery spaces, the following requirements shall be conformed to:

1. Stairway shall extend through and to the roof. Roof hatches are not permitted.
2. A stairway with a swing door and platform at the top level, conforming to 1007 shall be provided from the top floor of the building to the roof level. Interior landing 36" X 44" required at roof level. Door shall swing onto the roof. Maximum 8" curb permitted.
3. Where the passage is over a sloping roof having a slope exceeding 15° from the horizontal, an unobstructed, permanent and substantial walkway not less than 24 inches (610 mm) wide, equipped on at least one side with a standard guardrail not less than 42 inches (1067 mm) high, shall be provided from the building exit door at the roof level to the means of access to the machine room or machinery spaces. Guardrails shall conform to the requirements of 1015.

3003.8 Change In Use

Any change in use of an elevator, freight to passenger, passenger to freight, or from one freight class to another, shall not be made without the approval of the building official. Said approval shall be granted only after it is demonstrated that the installation conforms to the requirements of Part XII of ANSI/ASME A17.1.

3004 MANLIFTS

Manlifts shall be installed in accordance with ANSI A90.1 .

CHAPTER 31

SPECIAL CONSTRUCTION

3101 GENERAL

3101.1 Scope

Provisions of this chapter shall govern special building construction including tents, membrane structures, canopies, signs and buildings located in a floodplain.

3102 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

3103 TENTS FOR PUBLIC ASSEMBLY

3103.1 Certification of Flame Resistance

Before a temporary permit is granted, the owner or agent shall file with the building official a certificate executed by an acceptable testing laboratory, certifying that the tent, decorative materials and tarpaulins meet the requirements for flame resistance prescribed for both the small scale and the large scale tests in NFiPA 701, and that such flame resistance is effective for the period specified by the permit.

3103.2 Clearing

Ground within and adjacent to tents shall be cleared of all grass, underbrush or similar fire hazards.

3104 COVERED AND ENCLOSED WALKWAYS AND TUNNELS

3104.1Scope

This section shall apply to connections between buildings such as walkways or tunnels, located at, above, or below grade level, that are used as a means of travel by persons.

3104.2 Definitions

For the purpose of this section, certain special terms are defined as follows:

WALKWAY, COVERED – a roofed, unobstructed walkway, where the least horizontal dimension is less than 30 ft (9144 mm), connecting buildings and used as a means of travel by persons and where less than 50% of the perimeter is enclosed.

WALKWAY, ENCLOSED – a roofed, unobstructed walkway, where the least horizontal dimension is less than 30 ft (9144 mm), connecting buildings and used as a means of travel by persons and where 50% or more of the perimeter is enclosed.

WALKWAY, TUNNELED – an unobstructed underground walkway connecting buildings and used as a means of travel by persons.

3104.3 Construction

3104.3.1 A covered walkway shall be of any type of construction permitted by this code, provided the walls and openings at the point of connection to the buildings shall be protected so as to reasonably prevent the spread of fire from one building into the other.

3104.3.2 An enclosed walkway shall be of a type of construction permitted for the buildings connected. Separation between the enclosed walkway and the building to which it is connected, except when used as an exit outlet, shall be of not less than 1-hour fire resistant construction, and openings therein shall be protected in accordance with Table 700.

EXCEPTION: An enclosed walkway connecting buildings required to have a fire resistance rating may be of unprotected noncombustible construction when meeting the following requirements.

1. When separated from adjoining buildings by a minimum of 2-hour fire resistant walls and 1 1/2 hour fire doors.
2. Openings in the building wall which are within 10 ft (3048 mm) horizontally or vertically of the walkway shall be protected by approved, 3/4-hour fire resistant automatic opening protectives.
3. The maximum height above grade shall be limited to three stories or 40ft (12m), or five stories or 55ft (17m) when sprinklered.

3104.3.3 A tunneled walkway shall be of a type of construction suitable for underground location. Separation between the tunneled walkway and the building to which it is connected shall be not less than 2-hour fire resistant construction and openings therein shall be protected in accordance with Table 700.

3104.4 Ventilation

Smoke and heat venting shall be provided for enclosed walkways and tunneled walkways. Such venting systems shall be in accordance with NFiPA 204M or other accepted engineering practice.

3105 MEMBRANE STRUCTURES

3105.1 Scope

The provisions of this section shall apply to permanent air supported, air inflated, and tensioned membrane structures, collectively known as membrane structures used as complete buildings and as roofs or other portions of buildings of other types of construction. Membrane structures shall also comply with the applicable provisions of NFiPA 102, not otherwise covered in this code. Temporary membrane structures erected for a period of less than 180 days shall comply with the applicable provisions of Chapter 39 of the Standard Fire Prevention Code.

EXCEPTION: Water storage facilities, water clarifiers, water treatment plants, sewer plants, aqua-culture pond covers, residential and agricultural greenhouses, and similar facilities not used for human occupancy need meet only the requirements of 3105.4.1 and 3105.7.1.

3105.2 Definitions

For the purpose of this section, certain special terms are defined as follows:

AIR INFLATED STRUCTURE – a building or portion thereof whose shape is maintained by air pressurization of unoccupied cells or tubes. A system of cables, bands, webbing, ropes or similar tensile elements may be used to restrain the membrane and transfer the tensile forces to supports.

AIR SUPPORTED STRUCTURE – a building or portion thereof whose shape is attained by air pressure and where the pressurized space may be occupied. A system of cables, bands, webbing ropes or other similar tensile elements may be used to restrain the membrane and transfer the tensile forces to supports.

TENSIONED MEMBRANE STRUCTURE – a nonpressurized membrane structure wherein the membrane is prestressed and the structural support system includes cables and/or rigid elements to maintain the structural form.

3105.3 Materials

3105.3.1 General. All material used in the construction of membrane structures shall conform to the requirements of this section or to applicable provisions of this code.

3105.3.2 Membrane. All membranes shall be classified as either Class I or II.

3105.3.2.1 A Class I membrane shall comply with the requirements of 3105.4.1, 3105.4.2, 3105.4.3 and 3105.4.4.

3105.3.2.2 A Class II membrane shall comply with the requirements of 3105.4.1, 3105.4.3 and 3105.4.4.

3105.3.3 Interior Liners. All interior liners installed for decorative, acoustical, thermal insulation or other purposes shall comply with the requirements of 3105.4.1.

3105.4 Membrane Testing

All membranes shall be tested for flammability per the provisions of 3105.4.

3105.4.1 Flame Resistance.

3105.4.1.1 Membranes shall perform as specified in Table 3105.4 when tested in accordance with the provisions of the large and small scale tests of NFiPA 701. Membranes shall be tested both as produced and after accelerated weathering per Section 4-6 of NFiPA 701.

3105.4.1.2 The test report shall contain the actual performance of the fabric for each criteria.

3105.4.1.3 The test shall be conducted with the following additional provisions:

1. Place a horizontal layer of dry, absorbent surgical cotton 12 inches (305 mm) below the bottom edge of the specimen. The cotton layer shall be approximately 20 inches (508 mm) square with a freestanding thickness of 0.25 inch (6.4 mm).
2. No test specimen shall drip molten or flaming particles that ignite the cotton.

Table 3105.4
Acceptance Criteria for NFiPA 701 Test

Maximum After Flame	2.0 seconds
Maximum Melt/Drip Flame Time	0.0 seconds
Maximum Length of Char or Destroyed Material:	
Maximum Average of 10 Specimens	3 1/2 inches
Maximum for Any Specimen	4 1/2 inches

3105.4.2 Combustibility. Membranes shall have a base fabric of material meeting the test requirements set forth in ASTM E 136. The coated fabric shall have a potential heat of not more than 3,000 Btu/sq ft (34.1 mJ/m^2) as determined by tests conducted in accordance with NFiPA 259.

3105.4.3 Exterior Exposure. All membranes shall be classified as to their resistance to exterior fire exposure when tested in accordance with ASTM E 108. The minimum classification for membranes shall be Class C. The tests shall be conducted at a slope of 5:12. The test decks and conditions of classification of ASTM E 108 shall be modified in accordance with 3105.4.4 and 3105.4.5.

3105.4.4 Test Decks.

3105.4.4.1 Membranes shall not be tested over a deck. Membranes shall be stretched over a frame to provide a test panel of the size specified for the test deck for the specific test being conducted.

3105.4.4.2 Membranes limited to use for air supported structure may be attached to the top of an airtight chamber to provide a test panel of the size specified for the test being conducted. The chamber shall be pressurized to a level representative of the in-use conditions. The side and end panels of the chamber shall be of a material to enable viewing of the underside of the fabric test specimen.

3105.4.4.3 Membranes limited to use for air inflated structures may be attached to a frame to provide a test panel of the size specified for the test being conducted and inflated to a pressure representative of the in-use pressure.

3105.4.5 Conditions of Classifications. A membrane material must meet the following conditions when subjected to the particular class of fire tests:

1. At no time during or after the intermittent flame, spread of flame, or burning brand tests shall any portion of the membrane material be blown off or fall through the test specimen in the form of flaming or glowing brands that continue to glow after reaching the floor, nor shall portions of the membrane fall away in the form of particles that continue to glow after reaching the floor.
2. At no time during the Class A, B, or C intermittent flame tests or the Class A or B burning brand tests shall there be sustained flaming of the underside of the membrane. If flaming does occur, conduct another series of tests, during which no sustained flaming shall occur.
3. In the Class C burning brand tests, there may be sustained flaming on the underside of the membrane of not more than 20% of the brands applied.
4. During the spread of flame tests, the flaming shall not spread beyond 6 ft (1829 mm) for Class A, 8 ft (2438 mm) for Class B, nor 13 ft (3962 mm) (the top of the membrane) for Class C. There shall be no significant lateral spread of flame from the path directly exposed to the test flame.

3105.4.6 Flame Spread. All membranes, including interior liners, exposed to the interior of the building shall have a flame spread index of 25 or less and a smoke developed index of 450 or less when tested in accordance with ASTM E 84. Membranes shall be mounted for testing on poultry netting as described in Appendix Section X1.8 of ASTM E 84. Membranes shall not be bonded to a substrate.

3105.5 Design

3105.5.1 General. Membrane structures which provide the complete enclosure for the occupied space shall be considered as complete buildings and subject to the requirements of this section.

3105.5.2 Membrane structures shall have a horizontal separation greater than 30 ft (9144 mm).

EXCEPTION: Horizontal separations of 30ft (9144 mm) or less shall be permitted when an exterior wall is provided in accordance with Table 600 and the wall has a minimum fire resistance rating of l hour. The exterior wall shall extend from ground level to the height where the slope of the tangent to the membrane structure exceeds 30° (0.52 rad) from the vertical, but in no case less than 8 ft (2438 mm) above the first floor level.

3105.5.3 Heights and Areas.

3105.5.3.1 Membrane structures shall be limited to one story in height but shall not be limited in number of feet of height.

3105.5.3.2 For determining allowable area, the construction type for a membrane structure shall be based on the support system. Air supported membrane structures shall not exceed the allowable areas listed in Table 500 for Type IV unprotected construction.

3105.5.3.3 Area increases permitted by 503.3 shall be permitted.

3105.5.4 Occupancy Separation. A membrane structure building which is occupied by more than one use group shall comply with 303 and 704.1.

3105.6 Mixed Construction

3105.6.1 General. Membrane structures shall be permitted to be utilized as specified in this section as a portion of buildings of other types of construction. Height and area limits shall be as specified for the type of construction and occupancy of the building.

3105.6.2 Class I Membrane. A Class I membrane shall be permitted for use as the roof or as a skylight of any building or atrium of a building of any type of construction provided it is at least 20 feet (6096 mm) above any floor, balcony or gallery and has a horizontal separation greater than 15 ft (4572 nun) from the edge of the membrane.

3105.6.3 Class II Membrane. A Class II membrane shall be permitted to be used as the roof or as a skylight on buildings of Types III, IV–Unprotected, V, and VI construction provided it is at least 20ft (6096 mm) above any floor, balcony or gallery and has a horizontal separation greater than 15ft (4572 mm) from the edge of the membrane.

3105.7 Structural

3105.7.1 General. The design, materials and construction of the building shall be based upon plans and specifications by a licensed architect or engineer licensed by the state to practice as such.

3105.7.2 Loads. The structure shall be designed and constructed to sustain all dead loads, loads due to tensioning or inflation and live loads including wind, snow, and seismic loads.

3106 CANOPIES ON EXTERIOR WALLS

3106.1 Over Public Property

Canopies extending over public property shall comply with the requirements of Chapter 32.

3106.2 Other Permanent Canopies

Other permanent canopies may extend over adjacent open spaces and be of any material permitted by this code provided:

1. When located less than 30ft (9144 mm) from an interior lot line or other structure, the canopy and its supports shall be of noncombustible material, fire retardant treated wood, wood of Type III sizes, or of 1-hour fire resistant construction.

   EXCEPTION: Any textile covering for the canopy shall be flame resistant as determined in accordance with both the small scale and large scale tests in NFiPA 701.
2. The canopy shall have at least one long side open.
3. The maximum horizontal width of the canopy shall not exceed 15 ft (4572 mm).
4. The fire resistance of exterior walls shall not be reduced.

3107 FLOODPLAIN

For construction located within the regulatory floodplain, refer to the SBCCI Standard for Floodplain Management.

3108 SIGNS

3108.1 General

3108.1.1 Outdoor Advertising Displays. Outdoor advertising display means any letter, figure, character, mark, plane, point, marquee sign, design, poster, pictorial, picture, stroke, stripe, line, trademark, reading matter, or illuminated service, which shall be so constructed, placed, attached, painted, erected, fastened, or manufactured in any manner whatsoever, so that the same shall be used for the attraction of the public to any place, subject, person, firm, corporation, public performance, article, machine, or merchandise, whatsoever, which is displayed in any manner whatsoever outdoors. Every outdoor display shall be classified and conform to the requirements of that classification as set forth in this chapter.

3108.1.2 Classifications. For the purpose of this chapter and the regulations and provisions thereof, outdoor advertising displays shall be classified as a ground, marquee, projection, roof, shingle, spectacular or wall sign as defined in 3108.2.

3108.1.3 Permits Required.

3108.1.3. 1 An outdoor advertising display sign shall not hereafter be erected, constructed, altered or maintained except as provided in this code, until after permit for the same has been issued by the building official as required in 104 and the applicable fee paid.

3108.1.3.2 A permit fee shall not be required for a shingle sign over a show window or door of a store or business establishment, announcing without display or elaboration only the name of the proprietor and nature of the business; nor shall a permit be required for a ground sign, providing such sign is not over 15 sq ft (1.4 m^2) in area.

3108.1.4 Identification of Signs. Every outdoor advertising display sign hereafter erected, constructed or maintained, for which a permit is required shall be plainly marked with the name of the person, firm or corporation erecting and maintaining such sign and shall have affixed on the front thereof the permit number issued for said sign by the building official.

3108.1.5 Sign Inspection. Every ground sign, roof sign, wall sign, and projection sign, may be inspected by the building official or his authorized representative at intervals as required by the building official.

3108.1.6 Unsafe Signs. Should any sign become insecure or in danger of falling or otherwise unsafe in the opinion of the building official, the owner thereof, or the person or firm maintaining the same, shall upon written notice from the building official, forthwith in the case of immediate danger and in any case within 10 days, remove such sign or secure the same in a manner to be approved by the building official, in conformity with the provisions of this code. If such order is not complied within 10 days, the building official shall remove such sign at the expense of the owner or lessee thereof.

3108.1.7 Maintenance. All signs for which a permit is required, together with all their supports, braces, guys and anchors shall be kept in repair and unless of galvanized or noncorroding metal shall be thoroughly painted at least once every 2 years. The building official may order the removal of any sign that is not maintained in accordance with the provisions of this section. Such removal shall be at the expense of the owner or lessee.

3108.1.8 Unlawful Signs. In case any sign shall be installed, erected, or constructed in violation of any of the terms of this code, the building official shall notify, by registered mail or written notice served personally, the owner or lessee thereof to alter such sign so as to comply with this code or the zoning regulations and to secure the necessary permit therefor, or to remove the sign. If such order is not complied with within 10 days, the building official shall remove such sign at the expense of the owner or lessee thereof.

3108.1.9 Location Restrictions. An outdoor advertising display sign shall not be erected, constructed or maintained so as to obstruct any fire escape or any window or door or opening used as a means of egress or so as to prevent free passage from one part of a roof to any other part thereof. A sign shall not be attached in any form, shape or manner to a fire escape, nor be placed in such manner as to interfere with any opening required for legal ventilation.

3108.1.10 Signs Projecting Over Public Property. Signs projecting from a building or extending over public property shall maintain a clear height of 9 ft (2743 mm) above the sidewalk and all such signs shall extend not more than within 18 inches (457 mm) of the curbline.

3108.2 Definitions

For the purpose of this section, certain special terms are defined as follows:

DISPLAY SIGN – a structure that is arranged, intended, designed or used as an advertisement, announcement or direction, and includes a sign, sign screen, billboard, and advertising devices of every kind.

GROUND SIGN – an outdoor advertising display sign supported by uprights or braces in or upon the ground, or mounted on a vehicle, trailer, or mobile structure principally used for the purpose of advertising.

MARQUEE SIGN – a projecting sign attached to or hung from a canopy or covered structure projecting from and supported by a building, when such canopy or covered structure extends beyond the building, building line or property line.

PROJECTION SIGN – an outdoor advertising display sign affixed to any building wall or structural and extending beyond the building wall, structure, building line or property line more than 12 inches (305 mm).

ROOF SIGN – an outdoor advertising display sign erected, constructed, or maintained above the roof of any building.

SHINGLE SIGN – a projection or wall sign not over 6 sq ft (0.56 m^2) in area, constructed of metal or other noncombustible material attached securely to a building and not projecting more than 24 inches (610 mm) over public property.

SPECTACULAR SIGN – an outdoor advertising display sign, advertising copy usually animated, constructed of metal, wired for lights or luminous tubing, or both, with copy action controlled by the flashed circuit breakers or matographs and attached on an open face steel structure built especially for the purpose. Spectacular signs may be built upon the ground, attached to a wall, or above the roof, or projecting from a wall, provided that such signs meet the requirements of the provisions of this code governing ground, roof, wall, projection or marquee sign, depending upon where such signs are built, as set forth below. Spectacular signs shall be illuminated with electricity only.

WALL SIGN – an outdoor advertising display sign affixed to the wall of any building, projecting not more than 12 inches (305 mm) from the building.

3108.3 Structural Requirements

3108.3.1 Design Required. Before a permit shall be granted, the erector of every outdoor advertising sign, with the exception of shingle signs and light cloth temporary signs, shall submit to the building official a design and stress diagram or plan, containing the necessary information to enable the building official to determine that such sign complies with all the regulations of this code.

3108.3.2 Wind Pressure. In the design and erection of all outdoor advertising display signs, the effect of wind shall be carefully considered. All signs shall be constructed to withstand the wind pressure as specified in 1606.

3108.3.3 Working Stresses. In all outdoor advertising display signs, the allowable working stresses shall conform with the requirements of 1606.

EXCEPTIONS:

1. The allowable working stresses for steel and wood shall be in accordance with the provisions of Chapter 22 and Chapter 23.
2. The working strength of chains, cables, guys, or steel rods shall not exceed one-fifth of the ultimate strength of such chains, cables, guys, or steel.

3108.4 Construction

3108.4.1 Ground Signs.

3108.4.1.1 Lighting reflectors may project beyond the face of the sign.

3108.4.1.2 The bottom coping of every ground sign shall be not less than 3 ft (914 mm) above the ground or street level, which space may be filled with platform decorative trim or light wooden construction.

3108.4.1.3 Every ground sign shall provide rigid construction to withstand wind action from any direction.

3108.4.1.4 Any person or persons, partnership, firm, or corporation occupying any vacant lot or premises by means of a ground sign shall be subject to the same duties and responsibilities as the owner of the lot or premises, with respect to keeping the same clean, sanitary, inoffensive, free and clear of all obnoxious substances and unsightly conditions on the ground in the vicinity of such ground sign on said premises for which they may be responsible.

3108.4.1.5 Wherever anchors or supports consist of wood embedded in the soil, the wood shall be pressure treated with an approved preservative.

3108.4.2 Roof Signs.

3108.4.2.1 All roof signs shall be so constructed as to leave a clear space of not less than 6 ft (1829 mm) between the roof level and the lowest part of the sign and shall have at least 5 ft (1524 mm) clearance between the vertical supports thereof. No portion of any roof sign structure shall project beyond an exterior wall.

EXCEPTION: Signs on flat roofs with every part of the roof accessible.

3108.4.2.2 Every roof sign shall be constructed entirely of steel construction, including the upright supports and braces, except that only the ornamental molding and battens behind the steel facing and the decorative lattice work may be of wood construction.

3108.4.2.3 The bearing plates of all roof signs shall distribute the load directly to or upon masonry walls, steel roof girders, columns or beams. The building shall be designed to avoid overstress of these members.

3108.4.2.4 A roof sign having a tight or solid surface shall not be at any point over 24 ft (7315 mm) above the roof level.

3108.4.2.5 Open roof signs in which the uniform open area is not less than 40% of total gross area may be erected to a height of 75 ft (22.9 m) on buildings of Type I or Type II construction and on other type buildings to a height of 40 ft (12.2 m). All such signs shall be thoroughly secured to the building upon which they are installed, erected or constructed by iron, metal anchors, bolts, supports, chains, stranded cables, steel rods or braces and they shall be maintained in good condition as set forth in 3108.1.7.

3108.4.3 Wall Signs.

3108.4.3.1 Wall signs attached to exterior walls of solid masonry, concrete or stone, shall be safely and securely attached by means of metal anchors, bolts or expansion screws of not less than 3/8-inch (9.5 mm) diameter and shall be embedded at least 5 inches (127 mm). Wood blocks shall not be used for anchorage, except in the case of wall signs attached to buildings with walls of wood. A wall sign shall not be supported by anchorages secured to an unbraced parapet wall.

3108.4.3.2 Temporary cloth signs with wood frames may be kept in place for a period not exceeding 30 days.

3108.4.4 Projecting Signs.

3108.4.4.1 All projecting signs shall be constructed entirely of metal or other noncombustible material and securely attached to a building or structure by metal supports such as bolts, anchors, supports, chains, guys, or steel rods. Staples or nails shall not be used to secure any projecting sign to any building or structure.

3108.4.4.2 The dead load of projecting signs not parallel to the building or structure and the load due to wind pressure shall be supported with chains, guys or steel rods having net cross-sectional dimension of not less than 3/8-inch (9.5 mm) diameter. Such supports shall be erected or maintained at an angle of at least 45° (0.78 rad) with the horizontal to resist the dead load and at an angle of 45° (0.78 rad) or more with the face of the sign to resist the specified wind pressure. If such projecting sign exceeds 30 sq ft (2.8 m^2) in one facial area, there shall be provided at least two such supports on each side not more than 8 ft (2438 mm) apart to resist the wind pressure.

3108.4.4.3 All supports shall be secured to a bolt or expansion screw that will develop the strength of the supporting chains, guys or steel rods, with a minimum 5/8-inch (15.9 mm) bolt or lag screw, by an expansion shield. Turn buckles shall be placed in all chains, guys, or steel rods supporting projecting signs.

3108.4.4.4 Chains, cables, guys, or steel rods used to support the live or dead load of projecting signs may be fastened to solid masonry walls with expansion bolts or by machine screws in iron supports, but such supports shall not be attached to an unbraced parapet wall. Where the supports must be fastened to walls made of wood, the supporting anchor bolts must go through the wall and be plated or fastened on the inside in a secure manner.

3108.4.4.5 A projecting sign shall not be erected on the wall of any building so as to project above the roof or cornice wall or above the roof level where there is no cornice wall; except that a sign erected at a right angle to the building, the horizontal width of which sign is perpendicular to such a wall and does not exceed 18 inches (457 mm), may be erected to a height not exceeding 2ft (610 mm) above the roof or cornice wall or above the roof level where there is no cornice wall. A sign attached to a corner of a building and parallel to the vertical line of such corner shall be deemed to be erected at a right angle to the building wall.

3108.4.5 Marquee Signs. Marquee signs shall be constructed entirely of metal or noncombustible material and may be attached to, or hung from a marquee. Such signs when hung from a marquee shall be at least 8 ft (2438 mm) at its lowest level above the sidewalk or ground level, and further, such signs shall not extend outside the line of such marquee. Marquee signs may be attached to the sides and front of a marquee, and such signs may extend the entire length and width of said marquee, provided such signs do not extend more than 6ft (1829 mm) above, nor 1 ft (305 mm) below such marquee, but under no circumstances, shall the sign or signs have a vertical dimension greater than 8 ft (2438 mm).

3108.5 Use Of Plastic Materials

3108.5.1 Notwithstanding any other provisions of this code, plastic materials which burn at a rate no faster than 2 1/2 inches per minute (1.06 mm/s) when tested in accordance with ASTM D 635 shall be deemed approved plastics and may be used as the display surface material and for the letters, decorations and facings on signs and outdoor display structures.

3108.5.2 Individual plastic facings of electric signs shall not exceed 200 sq ft (18.6m^2) in area.

3108.5.3 If the area of a display surface exceeds 200 sq ft (18.6 m^2), the area occupied or covered by approved plastics shall be limited to 200 sq ft (18.6 m^2) plus 50% of the difference between 200 sq ft (18.6 m 2) and 2,000 sq ft (186 m^2). The area of plastic on a display surface shall not in any case exceed 1,100 sq ft (102m^2).

3108.5.4 Letters and decorations mounted upon an approved plastic facing or display surface may be made of approved plastics.

CHAPTER 32

CONSTRUCTION IN THE PUBLIC RIGHT OF WAY

3201 GENERAL

3201.1 Scope

The provisions of this chapter shall govern the use of public property or any portion thereof, except signs which shall conform to the requirement of Chapter 31 and allowable use of public property during construction in 3303.

3202 DEFINITIONS

This chapter contains no unique definitions. For general definitions, see Chapter 2.

3203 DOORS AND WINDOW

Doors shall not open or project upon public property. Exit doors, as specified in Chapter 10, which are required to open in the direction of exit travel, shall be set back from the property line by means of vestibule or similar enclosures. Windows which swing over public property shall have a clearance of not less than 8 ft (2438 mm) above the sidewalk or ground level.

3204 MARQUEES, CANOPIES OR FIXED AWNING

3204.1 Support

Fixed Awnings, marquees or canopies shall be entirely supported from the building.

3204.2 Fire Resistance

All combustible materials except coverings used in the construction of such canopies, awnings or marquees shall be protected with not less than 1-hour fire resistance as specified in Chapter 7. Textile coverings shall be flame resistant as determined in accordance with both the small scale and large scale tests in NFiPA 701. Other combustible coverings shall have a flamespread rating not greater than 25 when tested in accordance with ASTM E 84 in the form and manner intended for use. All glazing in marquees, canopies, or fixed awnings shall be of wired glass.

3204.3 Clearance

Every fixed awning, canopy or marquee shall be at least 9 ft (2438 mm) in the clear, between the lowest point or projection and a sidewalk immediately below. See 3108.4.5. The fixed awning, canopy or marquee shall not extend or occupy more than two-thirds the width of the sidewalk measured from the building, except that such fixed awning, canopy or marquee may occupy the entire width of the sidewalk, provided it is 14 ft (4267 mm) in the clear above the sidewalk. The overall height of any marquee or canopy, including signs, shall not exceed 8 ft (2438 mm) measured from the roof of such marquee.

EXCEPTION: Any valance attached to an awning or canopy shall not project above the roof of the awning or canopy at attachment and in no case shall any portion of a valance be less than 7ft (2134 mm) in height above a public way.

3204.4 The Load

Marquees or canopies designed for a roof live load of not less than 5 psf (240 Pa) shall be permitted the full width of the building (front) and full depth of the building (corner location.)

3204.5 Movable Awnings

Metal or canvas awnings may extend over public property for a distance of not more than 5 ft (1524 mm), provided such awnings or any part thereof maintain a clear height of 8 ft (2438 mm) above the sidewalk. All such movable awnings shall be supported on metal frames attached to the building.

3204.6 Prohibited Locations

3204.6.1 Every awning, marquee or canopy shall be so located as not to interfere with the operation of any exterior standpipe, stairway or exit from the building.

3204.6.2 Awnings, marquees or canopies shall not be used as a landing for any fire escape or exterior stair.

3204.7 Construction Requirements

Marquees, canopies and awnings shall be so constructed and anchored to the building so as to support all live and dead loads specified in Chapter 16.

3205 ROOF DRAINAGE REQUIRED

The roof of every fixed awning, marquee or canopy shall be sloped to downspouts at the building, which shall conduct all drainage under the sidewalk to the curb.

3206 OTHER PROJECTIONS

3206.1 General

3106.1.1 Every projection of any character projecting over or upon public property shall have such projection regulated as determined by the clearance of the lowest point of the projection above the grade immediately below as follows:

1. Clearance 8 ft (2438 mm) or less above grade – no projection is permitted.
2. Clearance more than 8 ft (2438 mm) above grade – 1inch (25.4 mm) projection is permitted for each additional inch of clearance, provided that no such projection shall exceed a distance of 4 ft (1219 mm).

   EXCEPTION: Cornices, belt courses, sills, pilasters, water tables or any decorative features – 6-inch (152 mm) projections shall be permitted below the 8 ft (2438 mm) clearance.

3206.1.2 See 1404 for fire protection requirements.

3206.2 Sidewalk Or Street Obstructions

Public property shall be maintained clear of any and all obstructions, including among others, posts, columns, display of wares or merchandise and sidewalk signs.

3207 SPACE UNDER PUBLIC PROPERTY

3207.1 Space Under Sidewalk

Where space under the sidewalk is used for any purpose, a special permit shall be required.

3207.2 Sidewalk Lights

When glass is set in the sidewalk to provide light for spaces underneath, the glass shall be supported by metal or reinforced concrete frames and such glass shall be not less than 1/2 inch (12.7 mm) thick. Where such glass is over 12 sq in (7742 mm^2), it shall have wire mesh embedded in the glass. All portions of sidewalk lights shall be of not less strength than required for the loads specified in 1604.3.

CHAPTER 33

SITE WORK, DEMOLITION AND CONSTRUCTION

3301 GENERAL

3301.1 Scope

3301.1.1 Provisions of this chapter shall govern safety during construction and the moving and demolition of buildings.

3301.2 The temporary use of streets or public property for the storage or handling of materials or of equipment required for construction or demolition, and the protection provided to the public shall comply with the provisions of the applicable governing authority and this chapter.

3302 DEFINITIONS

The following words and terms shall, for the purposes of this chapter and as stated elsewhere in this code, have the meanings shown herein. Refer to Chapter 2 for general definitions.

FIRE DEPARTMENT CONNECTIONS – a hose connection at grade or street level for use by the fire department only for the purposes of supplying water to standpipes or sprinkler systems.

3303 ALLOWABLE USE OF PUBLIC PROPERTY DURING CONSTRUCTION

3303.1 General

The amount of space and conditions under which use of public property is permitted for construction or demolition purposes shall be as set forth in 3303.2.

3303.2 Limitations

Street or sidewalk space shall be permitted to be used if approved by the applicable governing authority and provided the following provisions are met:

1. A walkway shall be constructed in the outer portion of the permissible occupied street space, conforming to the requirements of 3305.
2. Building materials, fences, sheds or any obstruction of any kind shall not be placed so as to obstruct free approach to any fire hydrant, lamppost, manhole, fire alarm box, or catch basin, or so as to interfere with the passage of water in the gutter. Protection against damage shall be provided to such utility fixtures during the progress of the work, but sight of them shall not be obstructed.
3. A 10 ft (3048 mm) clear roadway shall be maintained through any alley located along the building site.
4. Proper precaution shall be made during construction to prevent concrete, mortar washings, or any other material from entering a sewer.
5. The person or persons to whom a permit is issued for such purposes as stated herein, shall post with the applicable governing authority a bond of such type and amount as may be deemed advisable by the applicable governing authority as protection from any and all liability.

EXCEPTION: The provisions in 3303.2 may be modified if approved by the applicable governing authority, provided alternate provisions are made to protect the public.

3304 WHERE COVERED WALKWAYS ARE REQUIRED

3304.1 Erection or Demolition

During the erection or demolition of any building exceeding one story in height that is located at a distance less than 10 ft (3048 mm) or less than one-quarter of the height of the building from any street or alley property line, or when required by the building official, a roof covering for the entire length of the project shall be provided over the temporary or permanent sidewalk, from the time the construction or demolition extends above the second floor level until materials are no longer being used or handled on the front above such walk.

3304.2 Exterior Alterations or Repair

Buildings having their exteriors altered or repaired in an extensive manner involving any hazard shall be provided with a covered walk as required for new structures during erection.

EXCEPTION: Where, in the opinion of the building official, a covered walk is not necessary, a permit may be issued to block off part of the sidewalk and have a temporary walk constructed as provided in 3305.

3305 CONSTRUCTION OF WALKWAYS, FENCES, AND PROTECTIVE COVERINGS

3305.1General

Before any construction work is commenced, the owner or his agent shall construct a temporary walkway in conformity with this section.

3305.2 Visual Obstruction

All fences, barriers, or temporary structures of any kind located on public highways shall be so constructed as not to obstruct vision at the intersection of streets.

3305.3 Width

Walkways shall be not less than 4 ft (1219 mm) wide in the clear except that in congested districts the building official may require a walkway as wide as, in his opinion, is necessary. Walks shall be built in a safe and substantial manner and be maintained in that condition at all times.

3305.4 Handrail

A smooth handrail of substantial construction, not less than 3 ft (914 mm) high, shall be provided on the traffic or street side of the walkway, and also on the building side when considered necessary by the building official.

3305.5 Separation

Where the distance from building to street or alley property line is less than half the height of the building, a fence of substantial solid construction at least 8 ft (2438 mm) high shall be provided on the building side of the walkway.

3305.6 Roof

Roof coverings over walkways, as required by 3304, shall be considered of not less than one layer of 2-inch nominal dimension wood plank spanning not over 3 ft (914 mm) between supports, or equivalent decking. The framework supporting the walkway covering shall be well-braced and designed to support at least 150 psf (7.2 kPa), but the top deck shall be designed to carry not less than 250 psf (12 kPa). The roof covering shall be of width sufficient to cover the entire walkway or sidewalk, and shall be made watertight. Suitable provision shall be made for adequate lighting of the walk under the covering, at all times. A minimum clearance of 8 ft 6 in (2591 mm) shall be maintained above walkways.

3306 WALKWAYS OVER EXCAVATED AREAS

When the area occupied by the sidewalk or temporary walkways is to be excavated, such walk shall be made of boards not less than 2 inches nominal dimension designed to support a load of not less than 150 psf (7.2 kPa), provided with suitable ramps at each end. Such walkways shall be provided with a fence and handrails on each side.

3307 STORAGE OF MATERIALS OVER WALKWAYS

Whenever a roof of a walkway is used for the storing of materials, it shall be designed for the load to which it is to be subjected and a railing and footboard shall be installed so as to prevent the materials from spilling into the street. The posts or other supporting members on the street side shall be protected so as to insure against failure due to impact from street traffic.

3308 WALKWAYS TO BE KEPT IN REPAIR

The street side of any barricade or fence, handrails and sidewalks shall be kept reasonably smooth and in good repair while construction work is in progress, or while such barricades, fences, or walkways are placed on or over public property.

3309 CLEANING OF SIDEWALKS AND STREETS

The owner or his agent, upon the completion of the building, shall immediately remove all walkways, debris and all other obstructions and leave such public property in as good a condition as it was before such work was commenced.

3310 RED LIGHTS REQUIRED

Every walkway shall be kept well-lighted continuously between sunset and sunrise and the outer edge of the occupied space of the street or sidewalk shall have placed thereon red lights which shall burn continuously between sunset and sunrise.

3311 SAFETY REQUIREMENTS DURING CONSTRUCTION

3311.1Equipment

All equipment such as temporary stairs, ladders, ramps, scaffolds, hoists, runways, barricades, chutes, elevators, etc., as required for the execution of any construction work shall be substantially constructed and erected to insure the safety of the workmen using them or passing under, on or near them. Where a large amount of scaffolding is used, the building official may require the use of noncombustible material or fire retardant treated wood. The flameproofing of tarpaulins may also be required by the building official where, in his opinion, the fire hazard warrants such precaution.

3311.2 Sanitary

Adequate sanitary facilities for the convenience of all workmen shall be provided. These facilities shall be kept in a clean and sanitary condition throughout the duration of the work. Temporary toilets shall be enclosed, screened, and weatherproofed and shall be connected to a sewer. Upon removal of the temporary facilities the sewer connections shall be removed and the sewer capped. In lieu of connecting to a sewer, the temporary facility may be a portable, enclosed, chemically treated, tank-tight unit.

3311.3 Standpipe System

3311.3.1 During the construction of a building, standpipe systems shall be provided in accordance with this section and Chapter 9.

3311.3.1.1 Required standpipes shall be installed when the work progresses more than 50 ft (15.2 m) above the lowest level of fire department vehicle access and shall be extended as construction progresses to within one floor of the highest point of construction having secured decking or flooring. Standpipe systems shall be provided with fire department connection at accessible locations adjacent to usable stairs.

3311.3.1.2 When approved by the building official and/or fire official, standpipes with water supply valves shut shall be permitted. Readily accessible fire department connections shall be available at all times.

3311.4 Exits

Required exits shall be maintained at all times during remodeling or alterations and additions to any building.

3312 PROTECTION OF ROOFS AND SKYLIGHTS OF ADJOINING BUILDINGS

When a building or structure is to be carried above the roof of an adjoining building, protection for the skylights and roof of such adjoining building shall be provided, at his own expense, by the person constructing or causing the construction of such building or structure; provided that if the owner, lessee or tenant of the adjoining building should refuse permission to have the roofs and skylights protected, the responsibility and expense for the necessary protection shall transfer to the person refusing such permission.

3313 MOVING OF BUILDINGS

3313.1 General

A building or part of any building shall not be moved through or across any sidewalk, street, alley or highway within the governmental limits without first obtaining a permit from the building official.

3313.2 Written Application

Any person desiring to move a building shall first file with the building official a written application setting forth the following information:

1. Type and kind of building to be moved.
2. The original cost of such building.
3. The extreme dimensions of the length, height and width of the building.
4. Its present location and proposed new location by lot, block, subdivision and street numbers.
5. The approximate time such building will be upon the streets, and contemplated route that will be taken from present to new location.

3313.3 Permit Refusal

If in the opinion of the building official, the moving of any building will cause serious injury to persons or property or serious injury to the streets or other public improvements, or the building to be moved has deteriorated more than 50% of its original value by fire or other element, or the moving of the building will violate any of the requirements of this code or of the zoning regulations, the permit shall not be issued and the building shall not be moved over the streets. Any building being moved for which permit was granted shall not be allowed to remain in or on the streets for more than 48 hours.

3313.4 Bond Required

The building official, as a condition precedent to the issuance of such permit, shall require a bond to be executed by person desiring such removal permit, with corporate surety to his satisfaction. Such bond shall be made payable to applicable governing body and for such amount as he prescribes. It shall indemnify the applicable governing body against any damage caused by the moving of such building to streets, curbs, sidewalks, shade trees, highways and any other property which may be affected by the moving of a building. Such surety bond shall also be conditioned upon and liable for strict compliance with the terms of said permit, as to route to be taken and limit of time in which to effect such removal and to repair or compensate for the repair and to pay said applicable governing body as liquidated damages an amount not exceeding $50.00 to be prescribed by the building official for each and every day's delay in completing such removal or in repairing any damages to property or public improvement or in clearing all public streets, alleys or highways of all debris occasioned thereby.

3313.5 Notice of Permit

Upon the issuance of said moving permit, the building official shall cause notice to be given to the superintendent of fire alarm, chief of fire department, telephone or light companies, or others whose property may be affected by such removal. The building department shall set forth in all notices the route that will be taken, time started, and approximate time of completion.

3313.6 Public Safety Requirements

3313.6.1 Every building which occupies any portion of public property after sundown shall have sufficient lights continuously burning between sunset and sunrise for the protection of the public.

3313.6.2 There shall be a minimum of five red lights placed on each street side of the building. Such red lights shall be attached to the building in such a fashion as to indicate extreme width, height, and size.

3313.6.3 In addition to the red lights on the building, flares shall be placed at regular intervals for a distance of 200 ft (61 m) up the street on each side of the building.

3313.6.4 When more than 50% of the street, measured between curbs, is occupied at night by the building, or when in the opinion of the building official, flagmen are necessary to divert or caution traffic, the owner or person moving such building shall employ at their expense, two flagmen, one at each street intersection beyond the building. Such flagmen shall remain at these intersections diverting or cautioning traffic from sunset to sunrise. Red lights shall be employed in flagging traffic at night.

3313.7 Improvements By Owner

The owner of any house, building, or structure proposed to be moved shall make all necessary improvements required in order for said house, building or structure to comply with the requirements of this code within 90 days from the date of the issuance of the moving permit. Extensions of such time as deemed reasonable may be granted by the building official upon a showing of delay caused by matters beyond the control of the owner or house mover. The application for the moving permit shall be accompanied by an application for a building permit, accompanied by complete plans and specifications showing the changes or conditions of said house, building, or structure as the same is proposed to be when moving, and all contemplated improvements, signed by the owner or the owner's agent.

3314 DEMOLITION OF BUILDINGS

Additional provisions for building demolition are contained in Appendix D. Those provisions are applicable only where specifically included in the adopting ordinance.

CHAPTER 34

SAFETY TO LIFE REQUIREMENTS FOR EXISTING BUILDINGS

3401 SCOPE

The provisions of this chapter shall apply to all existing buildings except one and two family dwellings. The local CEO shall enforce the provisions of this chapter as part of the periodic inspections required under General Statutes 153A-364 or l60A-424.

3402 DETERMINING AND POSTING OF FLOOR LOADS

In every existing building used for business, industrial, mercantile or storage occupancy, in which heavy loads or concentrations occur or machinery is introduced, the owner or occupant shall cause the weight that each floor will safely sustain to be estimated by a design professional and filed with the building official, and when accepted by him posted as required for new buildings by Chapter 16.

3403 INTERIOR FINISH

The interior finish of every existing building shall comply with 803 in the areas and spaces where that section requires the interior finish to have flame spread rating of not over 75; and when, in the opinion of the building official, the flame spread rating of interior finish in existing areas and spaces used for assembly or educational occupancies is of such magnitude as to present a hazard to life safety, he may order such interior finish to comply with 803.

3404 ROOF COVERING REPAIRS

3404.1 No roof covering on an existing roof shall be renewed or repaired to a greater than 1/10 of the roof surface, except in conformity with the requirements of 1509.

3404.2 The placing of new roof covering conforming to 1509 over existing combustible roof covering shall not be prohibited; provided the existing roof covering is removed for a distance of 4 inches along all edges of the roof and replaced by strips of weatherproof material over which the new roof coverings shall extend.

3405 CHIMEYS AND VENTS

3405.1 All existing masonry chimneys which upon inspection by the building official are found to be without flue liner and with open mortar joints which will permit smoke or flame to be discharged into the building or which are cracked as to be dangerous shall be made safe by means of a standard flue liner or with a corrosion resistant metal pipe one inch less in diameter than the interior of the chimney with the entire annular space between the metal pipe and the walls of the chimney filled with cement mortar and otherwise repaired if necessary or they shall be removed.

3405.2 Existing chimneys and vents of metal which are corroded or improperly supported shall be replaced, unless suitable repairs are made.

3406 HEAT PRODUCING APPLIANCES

In case the installation of an existing heat producing appliance, heating, ventilation, air conditioning, blower or exhaust system does not conform to the code requirements for new installations, the CEO may order such changes in the installation as may be necessary to remove existing fire hazards.

3407 MEANS OF EGRESS

3407.1 General

Every existing building shall be provided with exit facilities adequate for the safety of the occupants. Such exit facilities shall be as approved by the CEO, but shall not provide less safety to the occupants than that obtained by compliance with the provisions of this section. This section shall not apply to dwellings or farm buildings.

3407.2 Number and Location of Exitways

3407.2.1 Every story for 100 or more occupants as determined by 1003 shall have at least 2 separate exitways (as defined in 1004.2). A single exitway may be permitted under conditions outlined in 3407.2.2.

3407.2.2 When the stairway and other floor openings have enclosures with a fire resistance rating of not less than one hour and all openings therein are protected as required in 3407 a single exitway may be used for stories having less than 100 occupants in:

1. A building not over 4 stories in height of Type I or Type II construction except educational and institutional occupancies.
2. A building of other than Type I or Type II construction not over 2 stories and not having educational or institutional occupancies.
3. Any sprinklered building not over 4 stories in height, other than educational and institutional occupancies.

Exception to 3407.2.2:

Owners of buildings whose occupancy classification is not changed and which do not meet the minimum number of exitways required by this section, which do not meet the egress requirements required by General Statutes and Building Code regulations which were in effect at the time of their construction, or for which documentation cannot be provided to verify that alternate methods of compliance have previously been approved shall submit to the COE having jurisdiction a plan to bring the building into compliance by January 1, 1997. Work required to meet the provisions of the plan shall be completed by January 1, 1999.

1. Install second means of egress, or
2. Provide an evaluation and design by a design professional registered in North Carolina who is qualified in fire protection engineering. The evaluation and design shall meet the following:
   A. Provide a design of fire protection systems and/or devices which provide the safety features which are equivalent or better than those provided by an additional exitway, and
   B. At the completion of work, the design professional shall certify in writing that based on his inspection all work performed complies with the requirements of their alternate design and
   C. When the building is required by Volume IA to be submitted to the Department of Insurance for approval, the design professional shall submit the evaluation and design for approval prior to work commencing and shall provide a copy of completed work certification.
3. A building of business occupancy only, built prior to the adoption of the 1953 edition of the Building Code, may have a single exit remain if the building complies with the Building Code on or before December 11, 2006. A building of business occupancy only, built prior to the adoption of the 1953 edition of the Building Code, may have a single exit remain after December 31, 2006, when complying with the following:

A. A building of any type of construction not exceeding four stories when:
   1. The building has a supervised sprinkler system with quick response sprinklers.
   2. The single exit stair enclosure shall have a one hour fire rating with all openings protected.
   3. The single exit stair shaft shall be equipped with a smoke pressurization system activated by the sprinkler system water flow in compliance with Section 412.2.1.1 and 412.2.1.2.
   4. Travel distance does not exceed 175 feet or

B. A building of noncombustible construction over four stories, but not greater than 75 feet when:
   1. The building has a supervised sprinkler system with quick response sprinklers.
   2. The single exit stair enclosure shall have a two hour fire rating with all openings protected.
   3. The single exit stair shaft shall be equipped with a smoke pressurization system activated by the sprinkler system water flow in compliance with Section 412.2.1.1 and 412.2.1.2.
   4. Travel distance does not exceed 150 feet.
   5. A supervised smoke detection system complying with NFiPA 72 including a detector head in every exit corridor, mechanical, electrical, telephone, elevator equipment, janitor's closet and similar rooms and storage rooms or

C. A building of noncombustible construction over 75 feet when:
   1. The building has a supervised sprinkler system with quick response heads.
   2. The single exit stair enclosure shall have a two hour fire rating with all openings protected.
   3. The single exit stair shaft shall be equipped with a smoke pressurization system activated by the sprinkler system water flow in compliance with Section 412.2.1.1 and 412.2.1.2.
   4. Travel distance does not exceed 125 feet.
   5. A supervised smoke detection system complying with NFPA 72 including a detector head in every exit corridor, mechanical, electrical, telephone, elevator equipment, janitor's closet or similar rooms and storage rooms.
   6. The primary elevator shaft is pressurized and the elevator is equipped with automatic recall and firemen’s service feature.
   7. Provide engine driven automatic emergency generator, sized and wired to operate all life safety system including exit and emergency lighting, fire and smoke alarm system, fire pumps, pressurization fans and one elevator.

3407.2.3 Exit doorways shall be so located that the maximum distance from any point in a floor area, room or space to an exit doorway, measured along the line of travel, does not exceed:

100 feet for high hazard occupancies;

125 feet for educational, industrial, institutional, mercantile, residential, and storage occupancies;

150 feet for assembly and business occupancies, except that:

1. Where a floor area is subdivided into smaller areas such as rooms in hotels, multifamily houses and office buildings, the distance to an exit doorway shall be measured from the corridor entrance of such room,.

2. Where the building is protected by an approved automatic sprinkler system; or where the building is either Type I, Type II or Type IV construction occupied exclusively by stocks of noncombustible material, not packed or crated in combustible material; the distances to an exit doorway may be increased 50 percent.

3407.2.4 In multi-family houses having two or more dwelling units above the first story, every dwelling unit shall have access to at least two exitways except as provided in Chapter 10 for one exitway.

3407.2.5 Every room used as a place of assembly shall have at least two doorways which open onto an exitway, except that for such rooms located on the first or grade floor a single such doorway may be used for an occupancy not in excess of 200 occupants provided the doorway has a clear width of not less than 44 inches.

3407.2.6 Every place of assembly having a capacity greater than 200 occupants shall have exitways conforming as to number and width with 1004.2 and 1003.3. In applying 1003.3 a stairway 40 inches wide may be accepted as two units.

3407.2.7 Institutional occupancies shall be provided with at least two exitways in accordance with 309.

3407.3 Minimum Requirements for Existing Exit Stairways

3407.3.1 The stairways in one of the required exitways from and story or stories occupied by a total of 6 or more persons shall have treads not less than 7 inches in width and risers not higher than 9 1/2 inches nor more than 1.2 times the width of tread. Winder treads shall have a width of not less than 6 inches measured one foot from the narrow end. This section shall not be construed as modifying the pitch and tread requirements for any new stairway construction.

3407.3.2 All exit stairs shall be guarded at the sides by well secured balustrades or other acceptable guards where ever such are needed for the safety of users and shall have a handrail on at least one side.

3407.4 Fire Escapes

Exterior fire escapes on existing building used for educational, institutional or assembly occupancies shall conform to the requirements for exterior stairways in 1006 2. Exterior fire escapes on other buildings shall conform to the following minimum requirements:

1. They shall be constructed of non-combustible materials.
2. They shall be constructed with stairs not less than 22 inches wide between rails, having risers not higher than 9 inches and having treads not narrower than 7 inches. Ladders may be used for the upper landing of a fire escape to the roof
3. Unless the stair leading to the ground at the foot of the fire escape is permanently fixed, it shall be constructed with counter-balancing devices that permit it to be easily and quickly released and placed in rigid position for use.
4. They shall be of sufficient strength to sustain a live load of 100 pounds per square foot or concentrated loads of 300 pounds, so located as to produce maximum stress conditions.
5. They shall be so placed that they can be readily and safely reached by the occupants of the building.
6. They shall be so located that safe egress shall be provided at the foot either directly or through an enclosed exitway to a street or to an open space that communicates with a street.
7. They shall be spacious enough that the movements of those using the fire escapes will not be retarded.
8. All balconies and stairs shall be provided with substantial guard railings at least 4 feet high, without any openings greater than 8 inches in width, except that for buildings not over 5 stories high, triple guard rails equally spaced, with top rail not less than 42 inches high may be used. Height for stairs is to be measured at center of tread.

9. Except on buildings not exceeding 3 stories in height and on buildings of wood frame construction, all doors opening on or within 10 feet of the fire escape shall be approved self-closing fire doors, and any windows opening on or within 10 feet of the fire escape shall be approved fire windows; provided that where the occupancy inside these windows or doors is such as to present a light fire hazard or is sprinklered, or the overall exit arrangements are such that this protection is of minor importance, the building official may waive this requirement.

Note: Metal Ladder Fire Escapes extending from second floor windows or doors which are already installed on existing buildings are not required to be replaced with stairway type fire escapes, provided such ladders are in good repair and do not serve more than 15 people.

3407.5 Vertical Openings Which Shall Be Protected

All vertical openings including interior stairways, escalators and elevators, shall be enclosed or their floor openings otherwise protected, in accordance with Section 3407.6 and 3407.7 except:

1. Vertical openings which are not required to be enclosed in new construction. See 1006.
2. Vertical openings, including stairways and elevators in buildings of other than educational or institutional occupancies not over 2 stories in height.
3. Vertical openings, including stairways and elevators in buildings of other than educational or institutional occupancy, not over 4 stories in height, where the stories above the second are used for storage only.
4. The installation of approved automatic sprinkler systems in historic buildings shall permit the acceptance of unenclosed stairways to be recognized as exits, provided the building is not more than 2 stories in height.

3407.6 Required Protection For Vertical Openings

3407.6.1 Except as provided in 3407.6.2 and 3407.6.3, required enclosure for vertical openings shall have a fire resistance rating of not less than one hour. In buildings of Type I or Type II construction such enclosures shall consist of noncombustible materials.

3407.6.2 In any building of Type I or Type II construction, or of other types of construction not over 4 stones high, and in any sprinklered building, required enclosures may be constructed of 3/4-inch gypsum plaster on metal lath on each side of studs, or equivalent, or of wired glass in metal framework.

3407.6.3 In any building not over 4 stories high and in any sprinklered building, existing enclosures or pans thereof constructed of plaster on wood lath or equivalent, and in good repair, may be continued in use provided they are effectively firestopped at the basement ceiling.

3407.6.4 An enclosure required by this section may include both elevators and stairs but two or more separate stairways shall not be in a single enclosure.

3407.6.5 In lieu of a full enclosure, stairways, including escalators not required as exitways, may be protected with an enclosure at the head or at the foot of each stairway from one floor to another. The construction of such enclosures shall be in accord with the requirements of 3407.6.1, 3407.6.2, and 3407.6.3.

3407.6.6 In lieu of an enclosure, floor openings for elevators in industrial occupancies may be protected by substantial guards or gates with approved trap doors at each floor opening. Such trap doors shall be constructed to form a substantial floor surface when closed, and arranged to open and close by action of the elevator in ascending or descending. The guards or gates and trap doors shall be kept closed when the shaftway is not in use.

3407.6.7 The installation of approved automatic sprinkler systems in historic building shall permit the acceptance of existing walls and partitions that do not comply with the provisions of 3407.6.2 or 3407.6.3, provided the walls and partitions prevent the passage of smoke and automatic sprinklers are installed in the enclosed stairways and ramps, as well as the occupied areas and spaces.

3407.7 Door and Window Openings in Required Enclosures For Vertical Openings

3407.7.1 All openings in required enclosures for vertical openings, except window openings to the exterior of the building, shall be protected with doors in accordance with the following paragraphs. Movable transoms in such enclosures are prohibited.

3407.7.2 Doors in such enclosures shall be metal doors or metal covered doors or approved solid wooden doors except that existing doors in acceptable existing enclosures or parts thereof in any building not over 4 stories high and in any sprinklered building, may be any substantial wood doors having any wood panels less than 1/2-inch thick covered on the side opposite the stair side with sheet steel of not less than 28 gauge, securely attached with bolts or screws. Any glass in doors or fixed transoms shall be wired glass.

3407.7.3 Doors in such enclosures, except doors opening into apartments, shall be automatic or self-closing.

3407.7.4 The Installation of approved automatic sprinkler systems in historic buildings shall permit the acceptance of doors that do not comply with the provisions of 3407.7.1 or 3407.7.2, provided the doors are of substantial construction and automatic sprinklers are installed in the enclosed stairways and ramps, as well as the occupied areas or spaces.

3407.8 Path of Exit Travel From Stairway to Street

3407.8.1 All interior stairways required to be enclosed shall lead directly or through an enclosed passageway to a street or to an open space that communicates with a street.

3407.8.2 The enclosure of such passageway shall conform to the requirements applying to the stair enclosure. The enclosure shall separate from the exitway all basement occupancies, and all unsprinklered business and mercantile occupancies except those of a size and character which do not constitute a serious life hazard from fire, such as newsstands, cigar stands, lunch counters and small offices.

3407.8.3 The installation of approved automatic sprinkler systems in historic buildings shall permit the acceptance of unenclosed stairways which are not components of means of egress, provided the building is not more than 4 stories in height.

3407.9 Exit Doors

3407.9.1 Doorways opening onto an exit stairway, street or to a court or open space communicating with a street, and serving as a required exitway for 50 or more occupants shall have the doors, including the doors of vestibules, so hung as to swing open in the direction of exit travel.

3407.9.2 All doors serving in a required exitway or leading to a required exitway from rooms occupied by 50 or more occupants and all doors serving in a required exitway or leading to a required exitway from places of assembly shall be hung to swing open in the direction of exit travel. Panic hardware shall be installed in accordance with 1019.7.2.

3407.9.3 Revolving doors shall be used in exitways only under the conditions specified in 1012.3.

3407.10 Exit Signs, Lighting, and Maintenance

Exitways shall be equipped with signs and be lighted and maintained in accordance with 1016.

3408 SPECIAL SAFETY TO LIFE REQUIREMENTS APPLICABLE TO EXISTING HIGH RISE BUILDINGS

Section 1008 is incorporated in the General Statutes as G.S. 143 138(i) and G.S. 143-138(j). The Building Code Council does not have any authority to amend the General Statutes and any amendments must be made by the Legislature. (See Appendix of Volume I-A Administration and Enforcement Requirements).

3409 HISTORIC BUILDINGS

For Historic Buildings, see North Carolina State Building Code, Volume IX-Existing Buildings.

CHAPTER 35

REFERENCE STANDARDS

3501 SCOPE

This chapter contains the designations, names and edition of standards referenced in this code listed alpha-numerically and the section numbers where they are referenced.

3502 REFERENCED STANDARDS

Standard Designation	Section
AA Specification for Aluminum Structures, Aluminum Construction Manual, 1976	2003.2
AAMA 1402-86, Standard Specifications for Aluminum Siding, Soffit and Fascia	1403.4.1
AAMA 1602.1, Voluntary Procedure for Determining the Annual Energy Balance of Skylights, 1977	E103.1.2 (Deleted)
AASHTO T 260-84, Method of Sampling and Testing for Total Chloride Ion in Concrete and Concrete Raw Materials	1904.4
ACI 318-89, (Revised 1992), Building Code Requirements for Reinforced Concrete	1604.4, Table 1610.1, 1707.1, 1805.10.2.1, 1810.3.7, 1901.1.2, 1903.1, 1903.2, 1903.4.3, 1903.5.1, 1903.5.3, 1903.6.4, 1903.8.2, 1904.5, 1905.6.4.5, 1906.2.3, 1908.1, 1908.3.1, 1908.3.2, 1908.5, 1908.6.2, 1908.6.5, 1912.1, 1912.1.1, 1912.3.1, 1912.3.2, 1912.3.3, 1912.4, 1912.5.2, 1912.6.2, 1912.6.3

ACI 318.1-89, (Revised 1992), Building Code Requirements for Structural Plain Concrete	1901.1.3, 1913.1, 1913.2, 1913.3.3
ACI 530/ASCE 5/TMS 402-92, Building Code Requirements for Masonry Structures	T.1607.3.3, 2103.1, 2103.2.1, 2105.3.1, 2115.2, 2115.3, 2115.4.2, 2115.5, 2115.6, 2115.7.1, 2115.8.2.2
ACI 530.1/ASCE 6/TMS 602-92, Specifications for Masonry Structures	T.1607.3.3, 2111.1.1, 2115.2
AISC Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design, 1989	1708.3, 2203.1, 2203.2
AISC Load and Resistance Factor Design Specification for Structural Steel Buildings, 1993	1708.3, 2203.1
AISI Criteria for Structural Application of Steel Cables for Buildings, 1973	2206.1, 2206.2
AISI Design for Cold-Formed Steel Structural Members, 1986 with 1989 Addendum	2204.1, 2204.3, 2204.4.1
AISI Load and Resistance Factor Design Specification for Cold-formed Steel Structural Members, 1990	2204.1, 2204.3, 2204.4.1
AITC 104-84, Typical Construction Details	2301.2.5
AITC 110-84, Standard Appearance Grades for Structural Glued Laminated Timber	2301.2.5
AITC 112-81, Tongue-and-Groove Heavy Timber Roof Decking	2301.2.5
AITC 113-83, Dimensions of Structural Glued Laminated Timber	2301.2.5
AITC 117-87, Structural Glued Laminated Timber of Softwood Species - Design	2301.2.5
AITC 117-88, Structural Glued Laminated Timber of Softwood Species with Addendum No. 1 - Manufacturing	2301.2.5
AITC 119-85, Hardwood Glued Laminated Timber	2301.2.5
AITC Technical Note No.7, Calculation of Fire Resistance of Glued Laminated Timbers, Sept. 1984, updated 10/9/85	709.6.3.4
ANSI A 13.l-81, Scheme for the Identification of Piping Systems	408.7.3
ANSI A42.2-71	G105.6 (Deleted)
ANSI A42.3.71	G105.6 (Deleted)
ANSI A90.1-69, Safety Standard for Manlifts	3004

ANSI A108.1-85, Glazed Wall Tile, Ceramic Mosaic Tile, Quarry Tile and Paver Tile Installed with Portland Cement Mortar	2104.10
ANSI A 108.4-85, Ceramic Tile Installed with Organic Adhesives or Water-Cleanable Tile Setting Epoxy Adhesive	2104.10.7
ANSI A108.5-85, Ceramic Tile Installed with Dry-Set Portland Cement Mortar or Latex Portland Cement Mortar	2104.10.1, 2104.10.3
ANSI A 108.6-85, Ceramic Tile Installed with Chemical-Resistant, Water-Cleanable Tile-Setting-and-Grouting Epoxy	2104.10.4
ANSI A 108.7-85, Electrically Conductive Ceramic Tile Installed with Conductive Dry-Set Portland Cement Mortar	2104.10.2
ANSI A 108.8-85, Ceramic Tile Installed with Chemical-Resistant Furan Mortar and Grout	2104.10.5
ANSI A 108.9-85, Ceramic Tile Installed with Modified Epoxy Emulsion Mortar/Grout	2104.10.6
ANSI A 108.10-85, Installation of Grout in Tile work	2104.10.8
ANSI A 118, Dry-Set Portland Cement Mortar	2104.10.1
ANSI A 118.2-85, Conductive Dry-Set Portland Cement Mortar	2104.10.2
ANSI A 118.3-85, Chemical-Resistant, Water-Cleanable Tile-Setting and Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive	2104.10.4
ANSI A 118.4-85, Latex-Portland Cement Mortar	2104.10.3
ANSI A 118.5-85, Chemical-Resistant Furan Mortar and Grout	2104.10.5
ANSI A 118.6-85, Ceramic Tile Grouts	2104.10.8
ANSI A 118.8-85, Modified Epoxy Emulsion Mortar/Grout	2104.10.6
ANSI A 136.1-85, Organic Adhesives for Installation of Ceramic Tile	2104.10.7
ANSI A 137.1 -80, Ceramic Tile	2104.4
ANSI A208.1-89, Mat-Formed Wood Particleboard	1403.6.7, 2301.4.5, 2303.3, 2301.4.5.1
ANSI B31.3-84, Chemical Plant and Petroleum Refinery Piping Including Addendum B31.3b-1986	408.7.1
ANSI Z34.1-82, Certification-Third-Party Certification Program	H106.1 (Deleted)
ANSI Z97.1-84, Glazing Material Used for Building, Performance Specifications and Methods of Test	1706.1, 2405.1, 2405.5.4, 2604.14
ANSI/AHA A l35.4-82, Basic Hardboard	1403.6.6, 2301.4.9
ANSI/AHA A 135.5-82, Prefinished Hardboard Paneling	1403.6.6, 2301.4.9

ANSI/AHA A 135.6-R4. Hardboard Siding	1403.6.6, 2301.4.9
ANSI/AHA A 194.1-85, Cellulosic Fiberboard	2301.4.4
ANSI/AITC A 190.1-83. Standard for Structural Glued Laminated Timber	2301.4.2
ANSI/APA 1-84, Floors and Flooring-Mosaic-Parquet Hardwood Slat Flooring	2301.4.8
ANSI/ASME A 17.1-87, with Addenda A 17.1a-88, Standard Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks	1607.6.5, 3001.1.2, 3003.1.1, 3003.1.8, 3003.2, 3003.8, 3403.1.3 (Deleted)
ANSI/BHMA A 156.10-85, Power Operated Pedestrian Doors	1012.2.3
ANSI/HPMA HP-83, Hardwood and Decorative Plywood	2301.4.7
ANSI/HPMA LHF-82, Laminated Hardwood Flooring	2301.4.8
ANSI/NAAMM FP 1001-90 Guide Specifications for Design Loads of Metal Flagpoles	1606.1.1
ANSI/RMA/SPRI RP-4 (1988) Wind Design Guide For Ballasted Single-Ply Roofing Systems	1509.3.3
APA AFG-01-84, Adhesives for Field-Gluing Plywood to Wood Framing	2307.3.2
APA Cantilevered In-Line Joist System	2301.2.5
APA Design/Construction Guide-Residential & Commercial, 1986	2301.2.5, 2307.3.2
APA Plywood Design Specification. 1986	2301.2.5, 2312.4, 2312.4.6
APA Plywood Design Specification Supplement 1 - Design and Fabrication of Plywood Curved Panels	2301.2.5
APA Plywood Design Specification Supplement 2- Design and Fabrication of Plywood-Lumber Beams	2301.2.5
APA Plywood Design Specification Supplement 3- Design and Fabrication of Plywood Stressed-Skin Panels	2301.2.5
APA Plywood Design Specification Supplement 4- Design and Fabrication of Plywood Sandwich Panels	2301.2.5
APA Plywood Design Specification Supplement 5 - Design and Fabrication of All Plywood Beams	2301.2.5
ASCE 7-88, Minimum Design Loads for Buildings and Other Structures	411.10.4, 1601.2.2, 1605, 1606.1.1

ASCE 8-90, Specification for the Design of Cold-formed Stainless Steel Structural Members	2204.2, 2204.4.1
ASCE Specification for the Design and Construction of Composite Slabs, 1984	2211
ASHRAE 62-89, Ventilation for Acceptable Indoor Air Quality	1203.5
ASHRAE/IES 90A-80, Energy Conservation in New Building Design	E102.1 (Deleted)
ASHRAE/IES 90B-75, Energy Conservation in New Building Design	E102.1 (Deleted)
ASHRAE/IES 90.1-89, Energy Efficient Design of New Buildings Except New Low-Rise Residential Buildings	E102.1 (Deleted)
ASTM A 6-88c, General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use	2209
ASTM A 36-88b, Structural Steel	1807.1, 2104.9.5
ASTM A 82-88, Steel Wire, Plain, For Concrete Reinforcement	2104.9.2.1, 2104.9.5
ASTM A 90-81, Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles	1509.7.1.5.5
ASTM A 153-82(1987), Zinc Coating (Hot-Dip) on Iron and Steel Hardware	2104.9.6
ASTM A 167-92b, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip	2104.9.2.1, 2104.9.5, 2104.9.6
ASTM A 185-90a, Specification for Steel Welded Wire, Plain, for Concrete Reinforcement	2104.9.4, 2104.9.5
ASTM A 252-88, Welded and Seamless Steel Pipe Piles	1807.1, 1808.1.1
ASTM A 283-87, Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars	1807.1, 1808.1.1
ASTM A 307-92a, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile	1912.2.2.1
ASTM A 325-92a, Specification for Structural Bolts, Steel, Heat-Treated, 120/105 Ksi Minimum Tensile Strength	2208
ASTM A 366-85, Steel, Carbon, Cold-Rolled Sheet, Commercial Quality	2104.9.5
ASTM A 370-88, Mechanical Testing of Steel Products	H105.5.2.2 (Deleted)
ASTM A 416-90a, Steel Strand, Uncoated Seven-Wire for Prestressed Concrete	1810.3.2
ASTM A490-92a, Specification for Heat-Treated, Steel Structural Bolts, 150 ksi (1035 MPa) Tensile Strength	2208
ASTM A 496-90a, Specification for Steel Wire, Deformed, for Concrete Reinforcement	2104.9.3
ASTM A 497-90b, Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement	2104.9.4

ASTM A 525-87, General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process	1509.7.1.5.5, 2104.9.6
ASTM A 572-88b, High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality	1807.1
ASTM A 588-88, High-Strength Low-Alloy Structural Steel with 50 ksi Minimum Yield Point to 4 Inches Thick	1807.1
ASTM A 615-92a, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement	1912.1.1, 2104.9.1
ASTM A 616-92, Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement	2104.9.1
ASTM A 617-92, Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement	2104.9.1
ASTM A 641-82, Zinc-Coated (Galvanized) Carbon Steel Wire	2104.9.6
ASTM A 690-88, High-Strength Low-Alloy Steel H-Piles and Sheet Piling for Use in Marine Environments	1807.1
ASTM A 706-90, Low-Alloy Steel Deformed Bars for Concrete Reinforcement	1708.4, 1903.5.2, 1912.1.1, 2104.9.1
ASTM B 370-88, Copper Sheet and Strip for Building Construction	1509.7.1.5.5
ASTM C 5-92, Quicklime for Structural Purposes	T.2503
ASTM C 28-86, Gypsum Plasters	T.2503
ASTM C 29-87, Test for Unit Weight and Voids in Aggregate	703.8, 703.9
ASTM C 31-90, Making and Curing Concrete Test Specimens in the Field	1905.6.2.2, 1905.6.3.2
ASTM C 33-90, Concrete Aggregates	1903.3.1, T.1904A
ASTM C 34-91, Structural Clay Load-Bearing Wall Tile	703, T.709.4.1A, T.709.4.1B, 2104.2, 2115.7.3
ASTM C 35-89, Inorganic Aggregates for Use in Gypsum Plaster	703.8, 703.9
ASTM C 36-85 (1988), Gypsum Wallboard	202, 703.5.3, F.709.5.1B, F.709.5.1C, T.2503
ASTM C 37-89a, Gypsum Lath	703.5.1, T.2503
ASTM C 39-86c[1], Test for Compressive Strength of Cylindrical Concrete Specimens	1905.6.2.2

ASTM C 42-87, Obtaining and Testing Drilled Cores and Sawed Beams of Concrete	1905.6.4.2
ASTM C 55-85, Concrete Building Brick	703.2, T.709.3.1, 2104.1
ASTM C 56-91, Structural Clay Non-Load Bearing Tile	703.3, T.709.4.1B, 2104.2, 2115.7.3
ASTM C 61-87, Gypsum Keene's Cement	T.2503
ASTM C 62-92c, Building Brick (Solid Masonry Units Made from Clay or Shale)	703.2, T.709.4.1A, 2104.2
ASTM C 67-94, Sampling and Testing Brick and Structural Clay Tile	2111.5, G103.1.1 (Deleted)
ASTM C 73-85. Calcium Silicate Face Brick (Sand-Lime Brick)	703.2, T.709.3.1, 2104.1
ASTM C 79-87, Gypsum Sheathing Board	202, 703.5.4
ASTM C 90-90, Hollow Load-Bearing Concrete Masonry Units	703.7, T.709.3.1, 2104.1
ASTM C 91-91, Masonry Cement	1509.7.1.5.7, T.2503
ASTM C 94-90, Ready-Mixed Concrete	1906.2.2
ASTM C 126-91, Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units	703.2, T.709.4.1A, 2104.2
ASTM C 129-85, Non Load-Bearing Concrete Masonry Units	703.7
ASTM C 140-90, Sampling and Testing Concrete Masonry Units	T.709.3.1
ASTM C 144-91, Aggregate for Masonry Mortar	1509.7.1.5.7
ASTM C 150-89, Portland Cement	1509.7.1.5.7, 1903.2, 1904.1.2, 1904.2.3.3, 1905.4.2, T.2503
ASTM C 172-90, Sampling Freshly Mixed Concrete	1905.6.2.1
ASTM C 192-90a, Making and Curing Concrete Test Specimens in the Laboratory	1905.3.3.2
ASTM C 206-84, Finishing Hydrated Lime	T.2503
ASTM C 212-91, Structural Clay Facing Tile	703.3, T.709.4.1B, 2104.2

ASTM C 216-94a, Facing Brick (Solid Masonry Units Made from Clay or Shale)	703.2, T.709.4.1A, 2104.2
ASTM C 230-83, Flow Table for Use in Tests of Hydraulic Cements	1509.7.1.5.9
ASTM C 231-89a, Test for Air Content of Freshly Mixed Concrete by the Pressure Method	1904.2.1
ASTM C 270-92, Mortar for Unit Masonry	2104.7.1, T.2104.7B
ASTM C 317-87, Gypsum Concrete	1914.1
ASTM C 330-89, Lightweight Aggregates for Structural Concrete	1903.3.1
ASTM C 442-84a (l988), Gypsum Backing Board	T.2503
ASTM C 474-88, Testing Joint Treatment Materials for Gypsum Wallboard Construction	T.2503
ASTM C 475-89, Joint Treatment Materials for Gypsum Wallboard Construction	T.2503
ASTM C 476-83, Grout for Reinforced and Non-reinforced Masonry	2104.7.2, 2104.11
ASTM C 503-89, Specification for Marble Dimension Stone (Exterior)	2104.3
ASTM C 514-84, Nails for the Application of Gypsum Wall Board	T.2306.1
ASTM C 530-91, Structural Clay Non Load Bearing Screen Tile	T.709.4.1B, 2104.2
ASTM C 557-73(1985), Adhesives for Fastening Gypsum Wallboard to Wood Framing	1509.7.1.5.6
ASTM C 568-89, Specification for Limestone Dimension Stone	2104.3
ASTM C 587-83, Gypsum Veneer Piaster	703.5.6, T.2503
ASTM C 588-84a, (1988) Gypsum Base for Veneer Plasters	703.5.5, T.2503
ASTM C 595-89c[1], Blended Hydraulic Cement	1904.1.2, 1904.2.3.1, 1904.2.3.2, 1905.4.2, T.2503
ASTM C 615-92, Specification for Granite Dimension Stone	2104.3
ASTM C 616-89, Specification for Quartz-Based Dimension Stone	2104.3
ASTM C 618-89a, Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete	1903.6.5, 1904.1.2, 1904.2.3.1
ASTM C 629-89, Specification for Slate Dimension Stone	2104.3
ASTM C 630-85, Water-Resistant Gypsum Backing Board	703.5.8, T.2503
ASTM C 631-88, Bonding Compounds for Interior Plastering	T.2503
ASTM C 635-87, Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings	804.2.2
ASTM C 636-86, Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels	804.2.2
ASTM C 645-88, Non Load (Axial) Bearing Steel Studs, Runners (Track) and Rigid Furring Channels for Screw Application of Gypsum Wallboard	T.2503

ASTM C 652-94, Hollow Brick (Hollow Masonry Units Made from Clay or Shale)	703.2, T.709.4.1A, T.709.4.1D, T.709.4.2, 2104.2
ASTM C 685-90c[1], Concrete Made by Volumetric Batching and Continuous Mixing	1906.2.2
ASTM C 727-90a, Practice for Use and Installation of Reflective Insulation in Building Constructions	E105 (Deleted)
ASTM C 739-91, Cellulosic Fiber (Wood-Based) Loose-Fill Thermal Insulation	708.8
ASTM C 744-73 (1985), Prefaced Concrete and Calcium Silicate Masonry Units	2104.1
ASTM C 754-88, Installation of Steel Framing Members to Receive Screw-Attached Gypsum Wallboard, Backing Board, or Water-Resistant Backing Board	2504.5.1, T.2505
ASTM C 841-87, Installation of Interior Lathing and Furring	2504.1.1
ASTM C 842-85, Application of Interior Gypsum Plaster	2504.1.2
ASTM C 843-88, Application of Gypsum Veneer Plaster	2504.4.2
ASTM C 844-85, Application of Gypsum Base to Receive Gypsum Veneer Plaster	2504.4.2
ASTM C 847-88, Metal Lath	T.2503
ASTM C 887-79a, Specification for Packaged, Dry Combined Materials for Surface Bonding Mortar	2104.8
ASTM C 920-86, Elastomeric Joint Sealants	2406.3.5
ASTM C 926-86, Application of Portland Cement Based Plaster	2504.1.3, 2504.2.1
ASTM C 931-85, (1988) Exterior Gypsum Soffit Board	703.5.7, T.2503
ASTM C 933-80, (1985), Welded Wire Lath	703.6.4
ASTM C 946-91, Practice for Construction of Dry-Stacked, Surface-Bonded Walls	2104.8, 2105.4
ASTM C 954-86a, Steel Drill Screws for the Application of Gypsum Board to Steel Studs from 0.33 inch to 0.112 inch in thickness	T.2503
ASTM C 955-88, Load Bearing (Transverse and Axial) Steel Studs, Runners (Track), and Bracing or Bridging, for Screw Application of Gypsum Board and Metal Plaster Bases	T.2503
ASTM C 956-81 (1986), Installation of Cast-in-Place Reinforced Gypsum Concrete	1914.1
ASTM C 960-87 (1988) Predecorated Gypsum Board	T.2503
ASTM C 989-89, Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars	1903.6.6, 1904.1.2, 1904.2.3.2
ASTM C 1002-88, Steel Drill Screws for the Application of Gypsum Board	T.2503
ASTM C 1007-83, Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories	2504.5.2
ASTM C 1015-84(1990), Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation	E104 (Deleted)
ASTM C 1032-86, Woven Wire Plaster Base	703.6.5

ASTM C 1063-86, Installation of Lathing and Furring for Portland Cement-Based Plaster	2504.2.2
ASTM C 1077-87, Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluations	1903.8.2
ASTM C 1087-87, Test Method for Compatibility Determination of Liquid-Applied Sealants with Accessories Used in Structural Glazing Techniques	2406.3.10
ASTM C 1088-91a, Thin Brick Veneer Units Made from Clay or Shale	2104.2
ASTM C 1135-90, Test Method for Determining the Tensile Adhesion of Structural Sealants	2406.3.5
ASTM D 25-88a, Round Timber Piles	1811.1
ASTM D 173-86, Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing	1509.7.1.5.3
ASTM D 226-89, Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing	T.1509.9.7B
ASTM D 227-89, Coal-Tar-Saturated Organic Felt Used in Roofing and Waterproofing	T.1509.9.7B
ASTM D 312-84, Asphalt Used in Roofing	1509.7.1.5.6, T.1509.9.7D
ASTM D 422-63 (1972) Particle-Size Analysis of Soils	1804.3.2
ASTM D 450-78(1984), Coal-Tar Pitch Used in Roofing, Dampproofing and Waterproofing	T.1509.9.7C
ASTM D 635-88, Test for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position	202, 3108.5.1
ASTM D 883-86b, Definitions of Terms Relating to Plastics	1509.12.2.3
ASTM D 1056-91, Specifications for Flexible Cellular Materials-Sponge or Expanded Rubber	1509.7.1.5.10
ASTM D 1143-81 (1987), Testing Piles Under Static Axial Compressive Load	1706.1
ASTM D 1586-84, Penetration Test & Split-Barrel Sampling of Soils	H105.5.2.2(3) (Deleted), T.H105.5 (Deleted)
ASTM D 1668-86, Glass Fabrics (Woven and Treated) for Roofing and Waterproofing	1509.7.1.5.3
ASTM D 1761-77, (1988) Testing Mechanical Fasteners In Wood	1706.1, 1707.3.1
ASTM D 1863-86, Mineral Aggregate Used on Built-Up Roofs	1509.9.7.3
ASTM D 1929-77(1985), Ignition Properties of Plastics	202, 2604.7.1.2
ASTM D 2178-89, Asphalt Glass Felt Used in Roofing and Waterproofing	T.1509.9.7B
ASTM D 2487-85, Classification of Soils for Engineering Purposes	H105.5.2.2(3) (Deleted)
ASTM D 2626-86, Asphalt Saturated and Coated Organic Felt Base Sheet Used in Roofing	T.1509.9.7A
ASTM D 2822-75(1982), Asphalt Roof Cement	1509.7.1.5.6
ASTM D 2843-88, Test for Density of Smoke from the Burning or Decomposition of Plastics	202
ASTM D 2898-81(1986), Test for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing	1509.2.1, 1509.8.7.2, 2301.8.3
ASTM D 3019-85, Lap Cement Used with Asphalt Roll Roofing	1509.7.1.5.6

ASTM D 3201-86, Hygroscopic Properties of Fire-Retardant Wood and Wood-Base Products	2301.8.4
ASTM D 3498-76(1987), Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems	1509.7.1.5.6
ASTM D 3679-88, Rigid Poly (Vinyl Chloride) (PVC) Siding	1403.9.1
ASTM D 3689-83, Individual Piles Under Static Axial Tensile Load	1706.1
ASTM D 4318-84, Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils	1804.3.2
ASTM D 4601-86, Asphalt-Coated Glass Fiber Base Sheet Used in Roofing	T.1509.9.7A
ASTM D 4897-89, Asphalt-Coated Glass Fiber Venting Base Sheet Used in Roofing	T.1509.9.7A
ASTM D 4990-89, Coal Tar Glass Felt Used in Roofing and Waterproofing	T.1509.9.7B
ASTM D 5055-90, Establishing and Monitoring Structural Capacities of Prefabricated Wood I-Joists	2301.4.11
ASTM E 72-80, Conducting Strength Tests of Panels for Building Construction	1706.1
ASTM E 84-91a, Test for Surface Burning Characteristics of Building Materials	202, 404.2.2(2), 412.7, 708.1, 708.4, 803.2, 803.4, 803.5.1, 803.5.2, 2603.2, 2603.4.4, 2603.7.1, 3105.4.6, 3204.2
ASTM E 108-91 a, Method for Fire Tests of Roof Coverings	1509.2.1, 1509.8.7.2, 2604.6.3, 3105.4.3
ASTM E 119-88, Test Methods for Fire Tests of Building Construction and Materials	601.3.1, 601.4.1, 701.2.1, 705.4.5, 2603.3
ASTM E 136-92, Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.	202, 3105.4.2
ASTM E 152-81a, Fire Tests of Door Assemblies	415.4.2, 705.1.3.2, 705.1.3.2.2, 2603.7.1
ASTM E 163-84, Fire Tests of Window Assemblies	703.10, 705.1.3.2
ASTM E 196-80(1985), Gravity Load Testing of Floors and Flat Roofs	1706.1
ASTM E 330-84, Test for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference	1706.1
ASTM E 447-84, Compressive Strength of Masonry Prisms	1706.1
ASTM E 605-77(1982), Tests for Thickness and Density of Sprayed Fire-Resistive Material Applied to Structural Members	1709.1.2, 1709.1.3

ASTM E 773-88, Test Method for Sealed Insulating Glass Units	2406.3.6
ASTM E 774-88, Sealed Insulating Glass Units	2406.3.6
ASTM E 814-88, Standard Method of Fire Tests of Through-Penetration Fire Stops	705.4.7 (Deleted)
AWPA C1-90, All Timber Products-Preservative Treatment by Pressure Processes	1804.7, 2301.4.6
AWPA C2-90, Lumber, Timbers and Ties-Preservative Treatment by Pressure Processes	T.1509.8.2, 1509.8.2.2, 1804.7, 2301.4.6
AWPA C3-90, Piles-Preservative Treatment by Pressure Processes	1804.7, 1811.2.2, 2301.4.6
AWPA C4-90, Poles-Preservative Treatment by Pressure Processes	1804.7, 2301.4.6
AWPA C9-90, Plywood-Preservative Treatment by Pressure Processes	1804.7, 2301.4.6
AWPA C18-90, Standard for Pressure Treated Material in Marine Construction	1804.7, 1811.2.4, 2301.4.6
AWPA C22-90, Lumber and Plywood for Permanent Wood Foundations-Preservative Treatment by Pressure Processes	1804.7, 2301.4.6, 2301.8.2, 2301.8.4
AWPA C23-84, Round Poles and Posts Used In Building Construction - Preservative Treatment by Pressure Processes	1804.7, 2301.4.6
AWPA C24-86, Sawn Timber Piles Used for Residential Commercial Building	1804.7, 1811.2.3, 2301.4.6
AWPA C27-88, Plywood - Fire-retardant Treatment by Pressure Process	1804.7, 2301.4.6, 2301.8.2, 2301.8.4
AWPA C28-90, Standard for Preservative Treatment of Structural Glued Laminated Members and Laminations before Gluing of Southern Pine, Pacific Coast Douglas Fir, Hemfir and Western Hemlock by Pressure Processes	1804.7, 2301.4.6
AWPA M4-90, Standard For the Care of Preservative-Treated Wood Products	1804.7, 1811.2.5, 2301.4.6
AWPA P1/P13-89, Coal Tar Creosote for Land and Fresh Water Use	1804.7, 2301.4.6
AWPA P2-90, Creosote and Creosote Solutions	1804.7, 2301.4.6

AWPA P3-67, Creosote-Petroleum Oil Solution	1804.7, 2301.4.6
AWPA P5-90, Waterborne Preservatives	1804.7, 2301.4.6
AWPA P8-90, Oil-Borne Preservatives	1804.7, 2301.4.6
AWPA P9-89, Solvents and Formulations for Organic Preservative Systems	1804.7, 2301.4.6
AWPI Pole Building Design	2301.2.5
AWS D1.4-79, Structural Welding Code-Reinforcing Steel	1903.5.2
BIA Building Code Requirements for Engineered Brick Masonry, 1969	2103.1
CABO Model Energy Code, 1993 Edition	E101.2 (Deleted)
CABO One and Two Family Dwelling Code 1989 (1990 Amendments)	App. C
CABO Recommended Requirements to Code Officials for Solar Heating, Cooling and Hot Water Systems, June 1980	E102.3 (Deleted)
CABO/ANSI A117.1-92, Accessible and Usable Buildings, and Facilities	1016.2.2, 3001.1.3, 3003.4.2
CAN 4-S102.2-M83, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials and Assemblies	708.4
CPSC 16 CFR Part 1201, Architectural Glazing Materials, Federal Register	2405.1, 2405.5.4
CPSC 16 CFR Part 1209-87, Cellulose Insulation - Interim Safety Standard	708.8
CPSC 16 CFR Part 1404-87, Cellulose Insulation	708.8
CPSC 16 CFR 1500.41, Method of Testing Primary Irritant Substances	407.1.2
CPSC 16 CFR 1500.42, Test for Eye Irritants	407.1.2
CSSB Design and Application Manual for New Roof Construction, 1989	1509.8.4, 1509.13.1.3
CSSB Design and Application Manual for Exterior and Interior Walls, 1989	1403.6.3
CSSB Grading Rules for Wood Shakes and Shingles, 1992	T.1509.8.2, 1509.8.2.2
DOT CFR 49 Part 173	407.1.2

Federal Manufactured Home Construction and Safety Standards	H102 (Deleted), H104.1 (Deleted), H105.3.1 (Deleted), H105.3.4 (Deleted), H105.5.2.2 (Deleted)
FM Specification Tested Products Guide, 1986	701.4.2
FM 4450-77 Class I Insulated Steel Deck Roofs	2603.2(2), 2603.3
FM 4880-72 Building Comer Fire Test	2603.3, 2603.7.1
FS QQ-S-781-F, Strapping, Steel and Seals, 1977	H105.4.5 (Deleted)
FS TT-S-001543A Interim Federal Specification Sealing Compound: Silicone Rubber Base (for Caulking, Sealing, and Glazing in Buildings and other Structures)	2406.3.5
GA 216-89, Recommended Specifications for the Application and Finishing of Gypsum Board	2504.4.1
GA-600 Fire Resistance Design Manual, 12th Edition	701.4.2
MFMA Hard Maple Flooring Standard Specification (Hard Maple, Beech and Birch), 1969	2301.4.8
NBS BMS 71, Fire Tests of Wood and Metal-Framed Partitions, National Bureau of Standards	709.7
NBS Fire Tests of Building Columns, joint report of Underwriters Laboratories Inc., Associated Factory Mutual Insurance Companies and National Bureau of Standards, 1920	709.7
NBS TRBM-44, Fire-Resistance and Sound-Insulation Ratings for Walls, Partitions and Floors, National Bureau of Standards, 1946	709.7
NCMA-TEK 95-87 Design Details for Concrete Masonry Firewalls	704.5.1.3
NFiPA 10-94, Portable Fire Extinguishers	409.2.13.5

NFiPA 13-94, Installation of Sprinkler Systems	403.2.8, 407.1.3.1, 407.1.3.4, 409.2.13.1, 409.2.13.2, 409.2.17.4, 412.10.1, 413.8, 415.3, 705.2.2, 903.2, 903.7.4, 904.3.6, 904.8.3, 905.1.3, 1405.2, 1607.6.4, 3003.6.1
NFiPA 13D-94, Sprinkler Systems, One-and Two Family Dwellings	415.1(1)
NFiPA 13R-94, Installation of Sprinkler Systems	T.500, 903.7.6
NFiPA 14-96, Installation of Standpipe and Hose Systems	413.9.2, 904.1.1, 904.8.2
NFiPA 30-96, Flammable and Combustible Liquids Code	408.6.1
NFiPA 30B-94, Code for the Manufacture and Storage of Aerosol Products	308.2.1
NFiPA 40-94. Storage and Handling of Cellulose Nitrate Motion Picture Film	403.2.10, 403.3.1
NFiPA 43B-93, Storage of Organic Peroxide Formulation	407.9.2
NFiPA 70-96, National Electrical Code	101.4.3 (Deleted), 102.2.2 (Deleted), 407.2.9.1, 407.2.9.4, 408.3.10, 408.6.7, 408.7.2, 409.2.17.1, 409.2.18.1, 411.1.2, 415.9.1, 2701.2
NFiPA 71-89, Installation, Maintenance, and Use of Central Station Signaling Systems	409.1.7, 409.2.11, 903.8.1

NFiPA 72-93, National Fire Alarm Code	403.5.5.3, 409.1.7, 409.2.10.1, 409.2.11, 409.2.12, 409.2.14.6, 412.3.1, 415.6, 415.5.2, 415.7.3, 903.8.1, 905.1.1, 905.1.5, 905.2.4, 1005.6.3
NFiPA 74 89, Household Fire Warning Equipment	905.2.1
NFiPA 75 95, Protection of Electronic Computer/Data Processing Equipment	417
NFiPA 77-93, Static Electricity	407.2.9.3
NFiPA 80-95, Fire Doors and Windows	705.1.3.1, 705.1.3.3, 1012.4
NFiPA 82-94, Incinerator, Waste and Linen Handling Systems and Equipment	409.2.17.4
NFiPA 99-96, Health Care Facilities	1024.1.5
NFiPA 102-95, Grand Stands, Folding and Telescopic Seating, Tent and Membrane Structures	T.1604.1, 3105.1
NFiPA 204M-91, Guide for Smoke and Heat Venting	1004.1.4.2, 1004.1.4.3, 3104.4
NFiPA 231-95, General Storage	903.2
NFiPA 231C-95, Rack Storage of Materials	903.2
NFiPA 253-95, Test for Critical Radiant Flux of Floor Covering Systems	803.7.2, 803.7.3, 803.7.4
NFiPA 259-93, Test Method for Potential Heat of Building Materials	2603.3, 2603.4.3, 3105.4.2
NFiPA 409-95, Standard on Aircraft Hangars	411.7.7
NFiPA 701-96, Fire Test for Flame-Resistant Textiles and Films	3103.1, 3105.4.1.1, 3106.2, 3204.2, F102.2.8
NFiPA 704-90, Identification of the fire Hazards of Materials	407.2.5.1, 407.2.10, 407.5.8, 408.2, 408.7.1
NFoPA Design Values for Joists and Rafters, 1991	2301.5

NFoPA National Design Specification for Wood Construction, 1991 and Design Values for Wood Construction, July 1991, a Supplement to the National Design Specification	709.6.3.3, 1707.3.1, 2301.2.5, 2310.3.2, 2310.4.3, 2311.3.2, 2311.4.2, 2312.4, 2312.4.5.1, 2312.4.5.2, 2312.4.6
NFoPA Span Table for Joists and Rafters, 1977	2307.3.1, 2309.1.1
NFoPA Technical Report No.7, The Permanent Wood Foundation System, 1/87	1804.7.2, 2306.3
NFoPA Wood Construction Data No.5, Heavy Timber Construction Details, 1990	2301.2.5
NIOSH Publication No. 81-123	407.5.3
NOFMA 1981 "Flooring Grading Rules" (Oak, Pecan, Beech, Birch, Hard Maple), 1981	2301.4.8
NPA Particleboard: The Ideal Floor Underlayment	2301.2.5, 2301.4.5.1
OSHA 29 CFR 1910.1000, Air Contaminants	407.1.2
PCA Simplified Thermal Design of Building Envelopes for Use with ASHRAE Standard 90A-80 (1981)	E102.2 (Deleted)
PCI Design for Fire Resistance of Precast Prestressed Concrete, 1977	709.2.3.1, 709.2.3.3
PS l-83, Construction and Industrial Plywood	1707.3.3, 2301.4.3, T.2310.2A, 2310.4.5
PS 2-92, Wood-Based Structural-Use Panels	1707.3.3, 2301.4.3
PTI Design and Construction of Post-tensioned Slabs-on Ground, 1985	1804.3.3.3
RCSC Load and Resistance Factor Design Specification for Structural Joints Using A325 and A490 Bolts, 1988	2208
RCSC Structural Joints Using ASTM A325 or A490 Bolts, 1985	2208
SBCCI SSTD 10-93, Standard for Hurricane Resistant Residential Construction	1606.1.1
SBCCI SSTD 11-97, Standard for Determining the Wind Resistance of Concrete or Clay Roof Tiles	1707.5.1, 1707.5.2

SBCCI Standard Building Code, Appendix A, 1994Edition	1603.1
SBCCI Standard Building Code, Appendix D, 1994Edition	3314
SBCCI Standard Building Code, Appendix E, 1994Edition	1301.2
SBCCI Standard Building Code, Appendix F, 1994Edition	505, T.600
SBCCI Standard Building Code, Appendix G, 1994Edition	2116
SBCCI Standard Building Code, Appendix H, 1994Edition	1611
SBCCI Standard for Expansive Soil Tests, 1986	1804.3.2
SBCCI Standard for Flood Plain Management, 1989	3107
SBCCI Standard Fire Prevention Code, 1994 Edition	201.3, 308.2.1, T.308.2A, T.308.2B, T.308.2C, 403.2.10, 404.2.5, 404.3.1, 407.1.1.1, 407.1.3.1, 407.2.1, 407.2.3.5, 407.2.8, 407.3, 407.4, 407.5.1, 407.6, 407.7.1, 407.7.2, 407.8.1, 407.9.1, T.407.9.2, 407.9.4, 407.10.2, 407.10.4, 407.11.1, 407.11.4, 407.12.1, 407.13, 407.14.1, 407.14.4, 407.15.1, 407.16.1, 408.3.8, 411.1.1, 503.4.1, 903.5, 903.7.3, T.1004.1.4, 1405.1, 3105.1

SBCCI Standard Gas Code, 1994 Edition	101.4.3 (Deleted), 101.4.4 (Deleted), 102.2.2 (Deleted), 201.3, 2801.1, 2809
SBCC'I Standard Housing Code, 1992 Edition	H102 (Deleted), H107.2 (Deleted)
SBCCI Standard Mechanical Code, 1994 Edition	101.4.5 (Deleted), 102.2.2 (Deleted), 201.3, 202, 407.2.4.2, 407.14.2, 407.17.4, 408.3.6.1, 409.2.8.3, 413.10.2, 414.6.1, 704.1.3.3.1, 704.1.3.3.4,
SBCCI Standard Mechanical Code, 1994 Edition (continued)	704.2.3.2, 705.1.2.4, 705.1.2.6, 705.2.1.4.1, 707.1, 707.2, 708.6, 1804.6.3.1, 1804.6.3.2, 2309.6, 2801.1, 2803, 2811
SBCCI Standard Plumbing Code, 1994 Edition	102.2.2 (Deleted), 201.3, 1204.1, 1507.4.2, 1507.4.3, 1508, 1604.6.2, 2901.2
SBCCI Standard Unsafe Building Abatement Code, 1985 Edition	103.5 (Deleted)
SBCCI Standard Test Method for Evaluating Room Fire Growth Contribution of Textile Wallcovering, 1988	803.5.2
SBCCI PST & ESI Evaluation Report Listing Compiled July 1993	202, 701.4.2, H105.5.3 (Deleted)
SJI Joist Girders. 1992	2205.1

SJI Longspan Steel Joists, LH-Series, and Deep Longspan Steel Joists, DLH-Series, 1992	2205.1
SJI Open Web Steel Joist, K-Series, 1992	2205.1
TFS-90 Grading Rules for Preservative Treated Southern Yellow Pine Tapersawn Shakes	T.1509.8.2, 1509.8.2.2, 1509.8.4
TPI Design Specification for Metal Plate Connected Wood Trusses, ANSI/TPI 1-1995	2301.2.5, 2309.2.2
TPI Design Specification for Metal Plate Connected Parallel Chord Wood Trusses PCT-80	2301.4.10, 2309.2.2
TPI Handling, Installing and Bracing Metal Plate Connected Wood Trusses, HIB-91	2309.2.3
UL 9-89, Fire Tests of Window Assemblies	703.10
UL 103-89, Factory Built Chimneys	2804.4.4
UL 127-89, Factory-built Fireplaces	2804.4.5, 2806.1.2
UL 217-89, Single and Multiple Station Smoke Detectors	409.1.1.1
UL 268-89, Smoke Detectors for Fire Protective Signaling Systems	409.1.1.1
UL 555-90, Fire Dampers	705.1.2.2, 705.2.1.4.2
UL 737-88, Fireplace Stoves	2806.2.1
UL 1040-80, Insulated Wall Construction	2603.3, 2603.7.1
UL 1256-85, Fire Test of Roof Deck Construction	2603.2(2), 2603.3
UL 1482-88, Room Heaters, Solid-Fuel Type	2806.2.1
UL 1715-89, Fire Test of Interior Finish Material	2603.3, 2603.7.1
UL 1975-90, Fire Test for Foamed Plastics Used for Decorative Purposes	403.2.10
UL Fire Resistance Directory, 1993	701.4.2
USDOC PS 20-70 (1986), American Softwood Lumber Standard	2301.3.2, 2301.3.3, 2301.3.4, 2301.4.1
Webster's 9th New Collegiate Dictionary	201.3
WRI/CRSI Design of Slab-On-Ground Foundations, August 1981	1804.3.3.3

3503 ORGANIZATIONS

The following is a list by name and address of those agencies, associations, institutes and others that are referred to in this Code by name, initials or symbols.

AA	Aluminum Association 900 19th Street, N.W. Washington, DC, 20006
AAMA	American Architectural Manufacturers Association 1540 East Dundee Road, Suite 310 Palatine, IL 60067
AASHTO	American Association of State Highway & Transportation Officials 444 North Capital Street Northwest Station 249 Washington, DC 20001
ACI	American Concrete Institute P.O. Box 19150 Detroit, MI 48219-0150
AHA	American Hardboard Association 1210 W. Northwest Highway Palatine, IL 60067-1897
AISC	American Institute of Steel Construction, Inc. One East Wacker Drive, Suite 3100 Chicago, IL 60601-2001
AISI	American Iron and Steel Institute 1101 17th Street, NW, Suite 1300 Washington. DC 20036-4700
AITC	American Institute of Timber Construction 11818 S.E. Mill Plain Blvd., Suite 415 Vancouver, WA 98684-5092
ANSI	American National Standards Institute 11 West 42nd Street, 13th Floor New York. NY 10036

APA	American Plywood Association P.O. Box 11700 Tacoma, WA 98411-0700
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers 1791 Tullie Circle, N.E. Atlanta, GA 30329
ASCE	American Society of Civil Engineers United Engineering Center 345 East 47th Street New York, NY 10017-2398
ASME	American Society of Mechanical Engineers United Engineering Center 345 East 47th Street New York, NY 10017
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103-1187
AWPA	American Wood Preservers Association P.O. Box 849 Stevensville, MD 21666
AWPI	American Wood Preservers Institute Tyson's International Building 1945 Gallows Road, Suite 550 Vienna, VA 22182
AWS	American Welding Society, Inc. 550 N.W. Lejeune Road Miami, FL 33135
BHMA	Builders Hardware Manufacturers Association 355 Lexington Avenue, 17th Floor New York, NY 10017
BIA	Brick Institute of America 11490 Commerce Park Drive, Suite 300 Reston, VA 22091-1506

CABO	Council of American Building Officials 5203 Leesburg Pike, Suite 708 Falls Church, VA 22041
CAN	National Standards of Canada designation (The number or name following the CAN designation represents the agency under whose auspice the standard is issued. CAN1 designates CGA, CAN2 designates CGSB, CAN3 designates CSA, and CAN4 designates ULC. 350 Sparks Street, Ottawa, Ontario K1R 7S8
CPSC	U.S. Consumer Product Safety Commission 5401 Westbard Ave., Room 420 Washington, DC 20207
CSSB	Cedar Shake and Shingle Bureau 515 116th Avenue, N.E., Suite 275 Bellevue, WA 98004-5294
DOT	U.S. Department of Transportation Research and Special Program Administration 400 7th Street S.W. Washington, DC 20590
FM	Factory Mutual Research Corp. 1151 Boston-Providence Turnpike Norwood, MA 02062-9102
FS	Federal Specifications General Services Administration, Specification Activity Office, Bldg. 197 Washington Navy Yard 2nd & M Streets S.E. Washington, DC 20407
GA	Gypsum Association 810 First St., N.E., No. 510 Washington, DC 20002

HPMA	Hardwood Plywood Manufacturer's Association P.O. Box 2789 Reston, VA 22090-2789
MFMA	Maple Flooring Manufacturers Association 60 Revere Drive, Suite 500 Northbrook, IL 60062
NAAMM	National Association of Architectural Metal Manufacturers 600 South Federal Street Chicago, IL 60605
NBS	National Bureau of Standards U.S. Dept. of Commerce Superintendent of Documents Government Printing Office Washington, DC 20401
NCMA	National Concrete Masonry Association 2302 Horse Pen Road Herndon, VA 22071-3406
NFiPA	National Fire Protection Association One Batterymarch Park Quincy, MA 02269-9101
NIOSH	National Institute for Occupational Safety and Health 5600 Fishers Lane Rockville, MD 20857
NOFMA	National Oak Flooring Manufacturers Association Falls Building, Suite 660 22 North Front Street Memphis, TN 38173-0009
NPA	National Particleboard Association 18928 Premiere Court Gaithersburg, MD 20879-1569
OSHA	Occupational Safety and Health Administration Francis Perkins Dept. of Labor Building 200 Constitution Ave., N.W. Washington, DC 20210

PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 60077-1083
PCI	Prestressed Concrete Institute 175 West Jackson Boulevard, Suite 1859 Chicago, IL 60604-9773
PS	Product Standards National Institute of Standards & Technology U.S. Department of Commerce Standards Management Program A625 Administration Gaithersburg, MD 20899
PTI	Post-Tensioning Institute 1717 West Nonhero Avenue, Suite 218 Phoenix, AZ 85021
RCSC	Research Council on Structural Connections c/o Stanley D. Lindsey & Assoc., Ltd. 2244 Metro Center Blvd, Suite 208 Nashville, TN 37228-1320
SBCCI PST & ESI	SBCCI Public Safety Testing and Evaluation Services, Inc. 900 Montclair Road, Suite A Birmingham, AL 35213-1206
SJI	Steel Joist Institute 1205 48th Ave. North, Suite A Myrtle Beach, SC 29577
TFS	Texas Forest Service Forest Products Laboratory P.O. Box 310 Lufkin, TX 75902-0310
TPI	Truss Plate Institute 583 D'Onofrio Drive, Suite 200 Madison, WI 53719

UL	Underwriters Laboratories, Inc. 333 Pfingsten Road Northbrook, IL 60062-2096
USDOC	U.S. Department of Commerce National Technical Information Service 5285 Port Royal Road Springfield, VA 22161
WEBSTER'S	Merriam-Webster Inc. Language Research Service P.O. Box 281 Springfield, MA 01102
WRI	Wire Reinforcement Institute, Inc. 203 Loudon Street, S.W. 2nd Floor, Suite 203C Leesburh, VA 22075

CHAPTER 36

PIERS, BULKHEADS AND WATERWAY STRUCTURES

3601 GENERAL

The intent of this Chapter is to provide minimum standards for the design, construction and maintenance of piers, bulkheads and waterway structures that are not covered by other existing codes or design standards. This Chapter exempts farm structures not on public waters, marine terminal or port facilities for berthing, mooring, docking and servicing ships, barges or tug boats which handle cargo of all types including bulks, liquids, fuels and passengers.

The design of piers, bulkheads and waterway structures is essential for the protection of life and property without causing adverse effects to the shoreline. These structures by their very nature result in some modification of physical environment and therefore require minimum design standards. The guidelines in this Chapter address minimum standards for foundations, design forces, structural integrity, material selection and utilization, and construction techniques.

3602 PERMITS AND APPROVALS

The construction of any pier, bulkhead or waterway structure in public waters or the placement of dredged materials in waters or wetlands, generally requires the owner to obtain permits prior to construction. A permit from the United States Army Corps of Engineers is generally required for all marine construction. In addition to the permit issued by the Corps of Engineers, additional permits may be required from municipal, county, or state governments and/or local marine commissions. In cases of structures to be built on lakes operated by an electric utility for the generation of power, a permit from the operating utility may also be required.

3603 MINIMUM DESIGN LOADS

3603.1 General

Every structure shall be of sufficient strength to support the imposed dead, live, wind and impact loads without exceeding the allowable stresses prescribed for the various materials elsewhere in this code. Adequate consideration shall be made for forces imposed by earth, water, docking and mooring.

3603.2 Dead Loads

The weight of the component parts of a structure shall be used in the design when it will influence the strength of the structural elements.

3603.3 Live Loads

Design live loads shall be the greatest load that will probably be imposed on the structure including superimposed loads on retained material which exert horizontal loads on the structure. Where vehicles are allowed, use actual weight of vehicles and wheel loads as specified in the latest Edition of "Standard Specifications for Highway Bridges" of the American Association of State Highway and Transportation Officials. The Design load shall be posted at the dock or pier approach where vehicles are allowed. Minimum live loads are:

1. FIXED PIERS, DOCKS, CATWALKS – 40 lbs. per sq. ft. or 300 lbs. concentrated load on any area 2ft. square.

2. FLOATING PIERS, DOCKS, FINGERS – 20 lbs. per sq. ft. or 300 lbs. concentrated load on any area 2 ft square. Under dead load, floating piers shall have a minimum of 15 inches freeboard. The pier shall have not more than six degrees tilt from the horizontal under uniform live loading on one-half of the pier width or under concentrated load of 600 lbs. applied on any side.
3. BULKHEADS, SEAWALLS, REVETMENTS

   Design loads shall be the greatest combinations of loads exerted on the structure. Consideration shall be given to horizontal loads exerted by superimposed loads on the retained earth and by inclined surface slopes.
4. PUBLIC FISHING PIERS
   1. Mean low water line to land – 100 psf.
   2. Mean low water line to end of pier – 50 psf.

3603.4 Wind Loads

As prescribed in Chapter 16.

3603.5 Impact Loads

As prescribed in Chapter 16 but not less than the 1.25 times the kinetic energy exerted by a striking vessel or vehicle.

3603.6 Water Loads

Hydrostatic horizontal pressures along with the equivalent fluid pressure of soil and any surcharge thereon shall be considered. Provide sufficient anchorage against uplift between all components and between the structure and its support of not less than 1.5 times the uplift force. Wave forces shall be determined from wave record where available. Where no wave records are available the design wave shall be determined from probable wind speed, direction, fetch and water depth which will yield a critical wave. Forces shall then be calculated using current coastal engineering practice.

3603.7 Earth Loads

Lateral earth pressures shall be determined by considering the specific soil properties and applying earth pressure theories generally accepted for oil mechanics in engineering practice. Except for simple and inexpensive structures this normally requires the services of specialists in soil mechanics and/or foundation design. Adequate consideration shall be given for the effect or probable varying levels of ground water, tide and flood water. Pressures exerted by the earth shall be checked for dry, saturated and submerged conditions as applicable.

3603.8 Erosion

The effects of reasonably predictable erosion and wave induced scour shall be given ample consideration.

3604 ENGINEERED DESIGNS

3604.1 Docks, Piers and Catwalks used by the public or are intended for use by vehicles shall be designed by a Professional Engineer or Architect.

3604.2 Bulkheads and Other Type Retaining Walls used by the public having an exposed face above the ground or above mean low water of 5 feet or greater shall be designed by a Professional Engineer or Architect.

3604.3 Ocean Front Retaining Walls, Bulkheads and other-type retaining walls used by the public on the coastline of the Ocean or adjacent inlets shall be designed by a Professional Engineer or Architect.

3605 MATERIALS

3605.1 General

The quality of materials and fastenings used for load supporting purposes shall conform to good engineering practices. In areas subject to attack from wood borers such as termites, teredoes, or limnoria, the wood used shall be approved wood having natural resistance or shall be pressure treated with a preservative recommended by the American Wood Preservers Association for the specific application. Piling shall comply with applicable provisions of Chapter 18. Wood components shall comply with applicable provisions of Chapter 23. Concrete components shall comply with applicable provisions of Chapter 19. Steel components shall comply with applicable provisions of Chapter 22. In areas of severe corrosion such as salty or brackish waters, all metal components shall be protected by coating, cathodic protection or be oversized accordingly to allow for the specific exposure. Aluminum bulkhead sheets or aluminum bulkhead or dock components shall be of proper alloy to resist corrosive elements in the adjacent water and soil. Galvanized bulkhead components and dock components shall be coated by the "Hot Dip" process to sufficient cover to provide corrosion protection equal to the degree of exposure of corrosive elements. Masonry used in bulkheads and dock work shall comply with Chapter 21.

3606 CONSTRUCTION OF PIERS, DOCKS, CATWALKS AND FLOATING DOCKS

3606.1 Fixed Piers

Fixed piers for coastal areas shall be supported by piling with tip penetrations of not less than 8 ft dependent on the total applied load. Les penetration is approved only if other means of resisting flotation uplift is provided. Pier support by shallow piling, legs or columns with point bearing on rock shall have provisions for horizontal forces and overturn as well as flotation uplift. Connection between piling or legs to cap beams, stringers, beams and deck shall have sufficient capacity to safely support all applied load and provide transfer of load to adjoining members. Maximum spans for pier joists shall be in accordance with the Span Table for Joists and Rafters, as published by the National Forest Products Association or may be designed in accordance with accepted engineering practice.

3606.2 Metal Barrels Flotation Units

The use of metal barrels not specifically designed for use as flotation devices is prohibited.

3606.3 Decomposable Flotation Units

Floating docks or piers using exposed polystyrene billets (or other foam material) shall be designed for 125% of tabulated loads here to allow for deterioration from environmental effects.

3606.4 Electrical Service

All electrical service to marine structures shall be in accordance with the North Carolina State Building Code, Volume IV – Electrical.

3606.5 Fuel Docks

Fuel docks and other marine facilities handling flammable liquids shall comply with the National Fire Code, NFiPA 30. All fuel installations shall be designed to prevent fuel spillage from entering the water. The fuel docks or floats shall be a separate structure from berths and shall be isolated to the extent that fire or explosion would have minimal opportunity to spread to or from the fuel dock to the berths. Storage tanks for public facilities shall be located a minimum distance of 50ft from the dispenser with a shut-off valve at the tank.

3606.6 Handrails

For walkways, access piers, steps or ranges, personnel handrails or other safety provisions shall be provided along the edges where the vertical drop to the mean low water level or mud line exceeds 6 ft. Edges which have a primary function other than walks or access ways, such as docking frontage and swimming access shall not require railing. Railing shall be designed in accordance with Chapter 16 for balcony railing.

3606.7 Maintenance of Public Structures

The Building Official shall have the authority to condemn and close to the public any structure which is considered unsafe, and it shall not be used by the public until the deficiencies are corrected. Before the structure is reopened to the public, a certification by a Professional Engineer or Architect shall be required. Each owner shall be responsible for the proper and satisfactory maintenance of any public structure covered by this section. All such structures shall be subject to inspection at any time by the Building Official.

3607 CONSTRUCTION: BULKHEADS, SEAWALLS AND REVETMENTS

3607.1 Bulkheads

3607.1.1 Bulkheads shall be constructed in a manner to be effective against erosion and provide for adequate bank stabilization. The bulkhead system may consist of either of the following combinations thereof: braced sheet pile walls with tie backs, king piles and horizontal panels, gravity walls, cantilever and counterfort retaining walls. Bulkhead walls shall be constructed to prevent passage of fine material through joints or cracks from the fill side to the stream side.

3607.1.2 Local site conditions and performance of bulkheads in service should govern in selection of a system. The potential for erosion and scour at the mud line shall also be investigated, and appropriate compensating features shall be reflected in the construction. Bulkheads shall be terminated by either tying into adjoining structures or by extending the bulkhead line a minimum of 10 ft in a landward direction at an angle of not less than 45° to the shoreline in order to protect against end erosion or flanking by wave action. No structure shall be terminated without regard for end anchorage and stabilization. Sheet pile bulkheads with an exposed vertical height of 4 ft or greater shall be stabilized at the top by providing adequate anchorage, such as, the use of batter piles or tie backs. Anchor blocks for tie backs shall be located landward of the soil wedge formed by the wall and a line projected on an angle measured from the horizontal and passing upward from the berm surface on the outward face. The angle shall be the internal friction angle of the material being retained. The tie back anchor shall be located no closer than twice the height of the exposed vertical surface of the wall. Sheet pile embedment shall be determined by analysis and design, but shall not be less than the length of the pile exposed above ground. Cantilever and gravity wall bulkheads shall be founded on a firm foundation with special construction given to undermining and progressive instability.

3607.1.3 Where public walkways, steps or ramps run adjacent to bulkheads, personnel handrails or other safety provisions shall be provided along the top of the wall where the vertical drop to the mean low water line or mud line exceeds 6 feet. Handrails shall be designed in accordance with Chapter 16 for Balcony Railings.

3607.1.4 Wood members used for permanent features shall be not less than 2 inches in nominal thickness. All steel bolts, rods and other hardware shall be hot dipped galvanized or protected with an equivalent system. Bolts, rods and other metal materials shall be no smaller than 1/2 inch in diameter or thickness. Threaded fasteners shall not be tightened directly against wood surfaces but used only in conjunction with standard ogee or flat washer.

3607.1.5 Concrete, steel and cement asbestos bulkheads shall be constructed in such a manner to assure adequate performance. Connections shall be designed to resist the full applied load. Adequate attention shall be given to material protection against corrosion and concrete cover for reinforcing steel. Concrete shall have a 28 day minimum compressive strength of 3,000 psi and shall be "air-entrained" type concrete.

3607.2 Seawalls

Seawalls may be constructed of concrete or stone rubble mound or other suitable materials. They shall be founded on a firm foundation and may require the use of piling or other suitable support. The face shall be shaped and supported to withstand the full force of the design wave. A provision shall be provided to prevent undermining and progressive instability by installing a sheet pile wall along the toe and/or by placing adequate stone rip rap protection.

3607.3 Revetments

3607.3.1 Rigid revetments shall be founded on a firm foundation to prevent against undermining and progressive instability. Provisions should be made to provide for adequate toe protection by extending the face a minimum of 2 ft below the mud line plus a depth to compensate for known or anticipated scour. Additional protection may be needed in active areas and may consist of sheet piling along the toe and/or stone rip rap. An adequate pattern of weep holes shall be provided in the face to relieve hydrostatic pressure behind the wall. Joints shall be sealed to prevent loss of fines from the protected slope.

3607.3.2 Flexible revetments may be utilized where foundations will produce minor consolidation and settlement. Adequate provisions shall be made to prevent migration of fine materials through the wall. The face shall not be steeper than 1.0 horizontal to 1.0 vertical. Flatter slopes may be needed for stability depending on the construction materials and site conditions. The face may consist of stone rip rap or individual interlocking concrete units or poured concrete. Toe protection provisions shall be provided as discussed for the rigid type. Flexible revetments must be porous enough to allow for water passage and thereby relieve hydrostatic pressure behind the face.

3608 CONSTRUCTION OF GROINS AND JETTIES

3608.1 Groins

3608.1.1 Groins are designed and constructed for the purpose of building or maintaining a protection beach by trapping littoral drift (beach materials) or to retard the recession of an eroding shoreline. The planning and design of a groin/groin system shall be based on wave height, period and direction, characteristics of beach material and beach slope.

3608.1.2 Location. Groins shall extend landward a sufficient distance to prevent flanking.

3608.1.3 Types. Groins shall be either (1) very low, impermeable and nonadjustable or (2) impermeable and adjustable.

3608.1.4 General Specifications. Adjustable groins shall be maintained at elevations in accord with actual beach needs and development of desirable changes of the beach profile, and so as to avoid damage to adjacent beaches. In no case shall the top of such groins be set higher than 2 ft above the beach profile. Impermeable, nonadjustable groins shall not extend seaward beyond the mean low water line, and their top elevation shall not be higher than 6 inches above the beach profile. Considerations of the degree of beach protection to be provided by proposed groins and the acceptability of such installation, will be based primarily on the following factors: direction and volume of littoral drift; wave force and direction; wind force and direction; land usage; type of bulkhead; type of groin; and spacing and lengths of groins. A complete coastal engineering study may be required before approval is given to the number, type, and length of groins. The design should account for the wave and current forces focused on the beach. The groin/groin system should not adversely modify the littoral drift, to the extent to cause severe erosion on the lee side of the structure.

3608.2 Groins and Jetties

There is no universal type of groin/groin system or jetty because of the wide variations in conditions at each location. It is incumbent on the owner of a groin or jetty type structure to recognize the legal implications of the coastal structure and to plan, design, construct and maintain the structure accordingly. It is thus prudent to seek the advice of a Professional Engineer or Architect with coastal engineering experience.

3609 DEFINITIONS

BASIN, BOAT – A naturally or artificially enclosed or nearly enclosed harbor area for docking and securing small craft.

BULKHEAD – A vertical wall structure designed to retain shoreline material and prevent erosion due to wave activity.

BULKHEAD LINE – The line formed along the shore by the most seaward elements of the bulkhead.

CATWALK – A narrow footway platform extending alongside a structure.

DATUM, PLANE – The horizontal plane to which soundings, ground elevations water surface elevations are referenced.

DOCK – A pier, wharf, or platform for the unloading of materials or living beings.

FETCH – The area in which waves are generated having a rather constant direction of speed.

GANGWAY – A narrow footway bridge extending from the shore usually to a floating structure.

GROIN – A shore protection structure built (usually perpendicular to the shoreline) to trap littoral drift or retard erosion of the shore.

GROIN SYSTEM – A series of groins that function to protect a section of shoreline.

JETTY – A structure designed to protect and/or stabilize a navigation entrance.

KING PILE – The primary structural member that supports horizontal panels to form a vertical wall sometimes used in bulkhead or groin construction.

LITTORAL DRIFT – The sedimentary material transported along the shore by wave and currents.

LONGSHORE TRANSPORT – The movement of littoral drift (material) running parallel to the shoreline.

PIER – An elevated deck structure, usually pile supported, extending out into the water from the shore.

PIERHEAD LINE – The limiting line to which any pier or dock structure can extend into the water.

PILE – A cylindrical timber, concrete or metal member embedded into the ground to support or brace a structure.

PILE, SHEET – A pile with a generally slender flat cross section to be embedded into the ground or seabed and meshed or interlocked with like members to form a diaphragm, wall or bulkhead.

REVETMENT – A flexible structure usually constructed of stone or concrete and placed on a bank slope to protect it against erosion by wave and current action.

SEAWALL – A massive structure built along and parallel to a shoreline for the purpose of protecting and stabilizing the shore against erosion resulting from heavy wave activity.

WAVE, DESIGN – A wave that is potentially most damaging to an economically feasible structure, or wave for which a structure is designed.

CHAPTER 37

COASTAL & FLOOD PLAINS CONSTRUCTION STANDARDS

3701 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 within the 110 MPH wind zone. Mountain wind velocities are not applicable to this section.

3702 DEFINTIONS

"MSL": Mean sea level as defined by National Geodetic Vertical Datum.

"Base Flood 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. It shall be based on a flood having a one percent chance of being equaled 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 approval by 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: (1) Historical or predicted future trends of long term erosion, (2) erosion expected to occur during a coastal storm reaching the base flood elevation, or (3) shoreline fluctuations due to tidal inlets.

"Flood Plains": 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 the Building Code Council.

"Lowest Floor" means 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 buoyancy or,
2. Construction shall 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).

3703 PILING STANDARDS

3703.1 All buildings in areas identified as coastal high hazard areas or ocean hazard areas shall be constructed on a piling foundation. Within the 110 mile per hour wind zone or portions of the regulatory flood plain which were outside the ocean hazard and coastal high hazard areas, pile foundations, if used, shall comply with the requirements of this section.

3703.2 The foundation shall be designed (as required by Chapter 16 and Chapter 18) to withstand vertical and horizontal loads in combination with the loss of soil support due to erosion and shoreline change likely to occur.

1. All pilings shall have a minimum tip penetration of not less than 8 ft below the natural or finished grade of the lot, whichever is lower, and as required by Chapter 18.

2. All pilings within ocean hazard areas shall have a tip penetration of at least 5 ft below MSL or 16 ft below average original grade whichever is least. Structures within the Ocean Hazard Area 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 are exempt from this additional tip penetration requirement.

3704 ELEVATION STANDARDS

3704.1 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.

3705 ANCHORING AND BRACING STANDARDS

3705.1 All construction shall be anchored and braced to resist uplift, floatation, collapse, or lateral movement of the structure.

3705.2 The Building Official may require plans scaled by a Professional Engineer or Architect certifying to the building complying with 3703.2(1).

3706 CONSTRUCTION, MATERIALS, AND METHODS STANDARDS

3706.1 All construction and equipment located below the Base Flood Elevation shall be resistant to flood damage.

3706.2 Other than in Coastal High Hazard and Ocean Hazard Areas, all habitable spaces and areas containing equipment located below the Base Flood Elevation shall meet the following:

1. Floodproofing shall comply with classification standard FP1 and FP2 contained in the US Army Corps of Engineers "Flood-Proofing Regulations" dated June 1972 or other approved methods.
2. A Professional Engineer or Architect shall certify that the floodproofing has been designed to withstand the flood pressure, velocities, impact, and uplift forces.

3706.3 All construction shall be adequately anchored and connected to prevent floatation, collapse, lateral movement or overturning during design storm conditions. Special attention should be given to connection between major structural subsystems such as piling to floor beam, beam to floor joist, joist to exterior side wall diaphragms and side wall to roof joist. The Building Official may require that plans signed by a Professional Engineer or Architect submitted on the connection, anchoring and support system documenting its ability to withstand combined storm wind and wave forces.

3706.4 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 A 153. 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 A 123 or ASTM A 153. Metal connectors of approved equivalent corrosion resistant material may be accepted. See Table 3706.4.

3707 STABILITY STANDARDS

Calculations to determine overturning forces and moments on the foundation shall be made as set forth in Chapter 16 including appropriate consideration for increased moments and reduced piling penetration due to erosions.

3708 RECORDS AND CERTIFICATIONS

The building permit shall include the minimum elevation above MSL for the first habitable floor. The required elevation (MSL) shall be provided by the builder or contractor upon issuance of the permit. This certification of elevation shall be provided by the contractor or builder at the time of inspection of the flooring prior to further vertical construction. The Building Official shall require that the actual elevation required by 3704 be certified by a Registered Land Surveyor or Professional Engineer.

3709 FIRE AND SAFETY STANDARDS FOR TYPES V AND VI CONSTRUCTION

(RESIDENTIAL OCCUPANCY)

3709.1 Section 3709 applies to all residential occupancy in areas identified as coastal high hazard areas or ocean hazard areas, or areas in 110 MPH wind zone. (See Chapter 16).

3709.2 All roof coverings shall be Class A or Class B covering, or Class C Asphalt covering.

TABLE 3706.4
CORROSION RESISTANCE

(Applies Only to Structures Located in Coastal High Hazard Areas and Ocean Hazard Areas)

Exposure Level	OPEN (exterior, porches, underhouse)	VENTED/ENCLOSED (attic, floor trusses, enclosed crawl spaces and stud cavity)	CONDITIONED (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, joist hangers, steel joists and beams	Stainless steel or Hot Dipped galvanized after fabrication	Hot Dip galvanized after 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

APPENDIX A
WEIGHTS OF BUILDING MATERIALS

A101 GENERAL

In estimating dead loads for purposes of design, the actual weights of materials and constructions shall be used, provided that in the absence of definite information, values satisfactory to the Building Official may be assumed.

A102 DEAD LOADS

Dead loads of typed building materials and constructions are listed in Table A1 and Table A2.

Table A1
Dead Load in Pounds Per Square Foot

Component	Load	Component	Load
CEILING		Insulation, roof boards (per inch):	
Acoustical fiber tile	1	Cellular glass	0.7
Gypsum board (per 1/8-in)	0.55	Fibrous glass	1.1
Mechanical duct allowance	4	Fiberboard	1.5
Plaster on tile or concrete	5	Perlite	0.8
Plaster on wood lath	8	Polystyrene foam	0.2
Suspended steel channel system	2	Urethane foam with skin	0.5
Suspended metal lath and cement plaster	15	Plywood (per 1/8-in)	0.4
Suspended metal lath and gypsum plaster	10	Rigid insulation, 1/2-inch	0.75
Wood furring suspension system	2.5	Skylight, metal frame, 3/8-in wire glass	8
		Slate, 3/16-in	7
COVERINGS, ROOF AND WALL		Slate, 1/4-in	10
Asbestos-cement shingles	4	Waterproofing membranes:	
Asphalt shingles	2	Bituminous, gravel covered	5.5
Cement tile	16	Liquid applied	1.0
Clay tile (for mortar add 10 lb.):		Bituminous, smooth surface	1.5
Book tile, 2-in	12	Single-ply, sheet (Fully adhered,	0.7
Book tile, 3-in	20	mechanically attached)	
Ludowici	10	Singly-ply, sheet (Ballasted)	11.0
Roman	12	Wood sheathing (per inch)	3
Spanish	19	Wood shingles	3
Composition:			
Three-ply ready roofing	1	FLOOR FILL	
Four-ply felt and gravel	5.5	Cinder concrete, per inch	9
Five-ply felt and gravel	6	Lightweight concrete, per inch	8
Copper or tin	1	Sand, per inch	8
Corrugated asbestos-cement roofing	4	Stone concrete, per inch	12
Deck, metal, 20 gage	2.5		
Deck, metal, 18 gage	3	FLOORS AND FLOOR FINISHES	
Decking, 2-in wood (Douglas Fir)	5	Asphalt block (2-in), 1/2-in mortar	30
Decking, 3-in wood (Douglas Fir)	8	Cement finish (1-in) on stone-concrete fill	32
Fiberboard, 1/2-in	0.75	Ceramic or quarry tile (3/4-in) on 1/2-in mortar bed	16
Gypsum sheathing, 1/2-in	2	Ceramic or quarry tile (3/4-in) on 1-in mortar bed	23

1 in = 25.4 mm
1 psf = 47.8803 Pa

(continued)

Table A1
Dead Load in Pounds Per Square Foot *(continued)*

Component	Load
Concrete fill finish (per inch)	12
Hardwood flooring, 7/8-in	4
Linoleum or asphalt tile, 1/4-in	1
Marble and mortar on stone-concrete fill	33
Slate (per inch)	15
Solid flat tile on 1-in mortar base	23
Subflooring, 3/4-in	3
Terrazzo (1 1/2-in) directly on slab	19
Terrazzo (1-in) on stone-concrete fill	32
Terrazzo (1-inch), 2-in stone-concrete	32
Wood block (3-in) on mastic, no fill	10
Wood block (3-in) on 1/2-in mortar base	16
FLOORS, WOOD JOIST (NO PLASTER)-DOUBLE WOOD FLOOR	

Joist Sizes	12-in Spacing	16-in Spacing	24-in Spacing
2x6	6	5	5
2x8	6	6	5
2x10	7	6	6
2x12	8	7	6

Component	Load
FRAME PARTITIONS	
Movable steel partitions	4
Wood or steel studs, 1/2-in gypsum board each side	8
Wood studs, 2x4, unplastered	4
Wood studs, 2x4, plastered one side	12
Wood studs, 2x4, plastered two sides	20
FRAME WALLS	
Exterior stud walls:	
2x4 @ 16 in, 5/8-in gypsum, insulated, 3/8-in siding	11
2x6 @ 16 in, 5/8-in gypsum, insulated, 3/8-in siding	12
Exterior stud walls with brick veneer	48
Windows, glass, frame and sash	8
MASONRY PARTITIONS	
Clay tile:	
4 inch	18
6 inch	24
8 inch	34
Concrete block, heavy aggregate	
4 inch	30
6 inch	42
8 inch	55
12 inch	85
Concrete block, light aggregate	
4 inch	20
6 inch	28
8 inch	38
12 inch	55
MASONRY WALLS	
Clay brick, medium absorption:	
4 inch	39
8 inch	79
12 1/2 inch	115
17 inch	155
22 inch	194
Concrete brick, heavy aggregate:	
4 inch	46
8 inch	89
12 1/2 inch	130
17 inch	174
22 inch	216
Concrete brick, light aggregate:	
4 inch	33
8 inch	68
12 1/2 inch	98
17 inch	130
22 inch	160
Concrete block, heavy aggregate:	
8 inch	55
12 inch	85
Concrete block, light aggregate:	
8 inch	35
12 inch	55
Structural clay tile, load bearing:	
8 inch	42
12 inch	58
Brick, load-bearing structural clay tile backing:	
4 inch + 4 inch	60
4 inch + 8 inch	75
8 inch + 4 inch	102
Furring tile (2 in) on one side of masonry wall: Add to above figures	12

1 in = 25.4 mm
1 psf = 47.8803 Pa

(continued)

Table A1
Dead Load in Pounds Per Square Foot *(continued)*

Component	Load
Glass Block hollow units (1/4 inch mortar)	
3 7/8-inch	
3 1/8-inch	

1 in = 25.4 mm
1 psf = 47.8803 Pa

Table A2
Dead Load in Pounds Per Cubic Foot

Component	Load	Component	Load
Bituminous Products:		Sand and gravel, dry packed	110
Asphaltum	81	Sand and gravel, wet	120
Graphite	135	Earth (submerged):	
Paraffin	56	Clay	80
Petroleum, crude	55	Soil	70
Petroleum, refined	50	River mud	90
Petroleum, benzine	46	Sand or gravel	60
Petroleum, gasoline	42	Sand or gravel, and clay	65
Pitch	69	Gravel, dry	104
Tar	75	Gypsum, loose	70
Brass	526	Gypsum wallboard	50
Bronze	552	Ice	57.2
Cast-stone masonry (cement, stone, sand)	144	Iron	
Cement, portland, loose	90	Cast	450
Ceramic tile	150	Wrought	480
Charcoal	12	Lead	710
Cinder fill	57	Lime	
Cinders, dry, in bulk	45	Hydrated, loose	32
Coal		Hydrated, compacted	45
Anthracite, piled	52	Masonry, ashlar:	
Bituminous, piled	47	Granite	165
Lignite, piled	47	Limestone, crystalline	165
Peat, dry, piled	23	Limestone, oolitic	135
Concrete plain:		Marble	173
Cinder	108	Sandstone	144
Expanded-slag aggregate	100	Masonry, brick:	
Haydite (burned-clay aggregate)	90	Hard (low absorption)	130
Slag	132	Medium (medium absorption)	115
Stone (including gravel)	144	Soft (high absorption)	100
Vermiculite and perlite aggregate, nonloadbearing	25-50	Masonry, rubble mortar:	
		Granite	153
Other light aggregate, load-bearing	70-105	Limestone, crystalline	147
Concrete, reinforced:		Limestone, oolitic	138
Cinder	111	Marble	156
Slag	138	Sandstone	137
Stone (including gravel)	150	Mortar, hardened:	
Copper	556	Cement	130
Cork, compressed	14.4	Lime	110
Earth (not submerged):		Particleboard	45
Clay, dry	63	Plywood	36
Clay, damp	110	Riprap (not submerged)	
Clay and gravel, dry	100	Limestone	83
Silt, moist, loose	78	Sandstone	90
Silt, moist, packed	96	Sand	
Silt, flowing	108	Clean and dry	90
Sand and gravel, dry, loose	100	River, dry	106

1 in = 25.4 mm
1 psf = 47.8803 Pa

(continued)

Table A2
Dead Load in Pounds Per Cubic Foot *(continued)*

Component	Load	Component	Load
Slag		Tin	459
Bank	70	Water	
Bank screenings	108	Fresh	62.4
Machine	96	Sea	64
Sand	52	Wood, seasoned:	
Slate	172	Ashe, commercial white	41
Steel	489	Cypress, southern	34
Stone, quarried, piled:		Fir, Douglas, coast region	34
Basalt, granite, gneiss	96	Hem fir	28
Limestone, marble, quartz	95	Oak, commercial and reds and whites	47
Sandstone	82	Pine, southern yellow	37
Shale	92	Redwood	28
Greenstone, hornblende	107	Spruce, red, white, and sitka	29
Terra cotta, architectural:		Western hemlock	32
Voids filled	120	Zinc, rolled, sheet	449
Voids unfilled	72		

1 in = 25.4 mm
1 psf = 47.8803 Pa

APPENDIX B

RESERVED FOR FUTURE USE

APPENDIX C
ONE AND TWO FAMILY DWELLINGS

All one and two family dwellings and their accessory structures shall be permitted to be designed and constructed in accordance with the North Carolina State Building Code, Volume VII – Residential.

APPENDIX D
STANDARDS FOR DEMOLITION

D101 PURPOSE AND SCOPE

The standards set forth in this appendix shall apply to the demolition of buildings or structures for which a permit is required under 104 of this code.

D102 DEFINITION

DEMOLITION – the act of razing, dismantling or removal of a building or structure, or portion thereof to the ground level.

D103 TIME LIMIT

Notwithstanding the provision of 104.6 the building official may impose a time limit as an additional condition of a permit for completion of demolition work once such work shall have commenced, provided that for cause one or more extensions of time, for periods not exceeding thirty days each, may be allowed in writing by the building official.

D104 STANDARDS

D104.1 Demolition work having commenced shall be pursued diligently and without unreasonable interruption with due regard to safety. It is the intent of this section to limit the existence of an unsafe condition or nuisance on the premises during the period of demolition operations.

D104.2 Any surface holes or irregularities, wells, septic tanks, basements, cellars, sidewalk vaults, or coal chutes remaining after demolition of any building or structure shall be filled with material as approved by the building official, and shall be graded in such manner that will provide effective surface drainage.

D104.3 All debris and accumulation of material resulting from demolition of any building or structure shall be removed from the premises.

D104.4 All building sewers shall be effectively plugged with concrete at the property line, or as may be required by the building official.

D104.5 Except where there is adequate space, or approval has been granted by the building official, the demolition of a multistory building by other than explosive means shall proceed with the complete removal of one story at a time. In the demolition of any building other than by explosive means, story after story shall be removed and shall be properly wet to alleviate any dust.

D104.6 No wall, chimney or other construction shall be allowed to fall in mass on an upper floor. Bulky material, such as beams and columns, shall be lowered and not allowed to fall. When any building over one story in height is demolished, precautions for protecting the public shall be taken as prescribed in Chapter 33.

D105 INSPECTIONS

In lieu of the inspections required by 105.6, the building official shall make the following inspections upon notification from the permit holder or his agent:

1. Initial Inspection: To be made after all utility connections have been disconnected and secured in such manner that no unsafe or unsanitary conditions shall exist during or remain after demolition operations.
2. Final Inspections: To be made after all demolition work is completed.

APPENDIX E
ENERGY CONSERVATION

See the North Carolina State Building Code, Volume X – Energy.

APPENDIX F
FIRE DISTRICT

F101 GENERAL

F101.1 Scope

F101.1.1 The fire district shall include such territory or portion as outlined in an ordinance or law entitled "An Ordinance (Resolution) Creating and Establishing a Fire District." Whenever, in such ordinance creating and establishing a fire district, reference is made to the fire district, it shall be construed to mean the fire district designated and referred to in this appendix.

F101.1.2 The fire district complying with the provisions of F101.1.1 shall be shown on a map which shall be available to the public.

F101.2 Establishment of Area

F101.2.1 For the purpose of this code, the fire district shall include that territory or area as described in F101.2.1.1 through F101.2.1.3.

F101.2.1.1 Two or more adjoining blocks, exclusive of intervening streets, where at least 50% of the ground area is built upon and more than 50% of the built-on area is devoted to hotels and motels of Group R occupancy; all Group B occupancies; theaters, nightclubs, restaurants of Group A occupancy; garages, express and freight depots, warehouses and storage buildings used for the storage of finished products (not located with and forming a part of a manufactured or industrial plant) or Group S occupancy. Where the average height of a building is two and one-half stories or more, a block should be considered if the ground area built upon is at least 40%.

F101.2.1.2 Where four contiguous blocks or more comprise a fire district, there shall be a buffer zone of 200 ft (6096 mm) around the perimeter of such district. Streets, rights-of-way, and other open spaces not subject to building construction may be included in the 200 ft (6096 mm) buffer zone.

F101.2.1.3 Where blocks adjacent to the fire district have developed to the extent that at least 25% of the ground area is built upon and 40% or more of the built-on area is devoted to the uses specified in F101.2.1.1, they may be considered for inclusion in the fire district, and may form all or a portion of the 200ft (6096 mm) buffer zone required in F101.2.1.2.

F102 BUILDING RESTRICTIONS

F102.1 Types Of Construction Permitted

Within the Fire District every building hereafter erected shall be either Type I, II, III, IV or V, except as permitted in F104.

F102.2 Other Specific Requirements

F102.2.1 Exterior walls of buildings located in the fire district shall comply with the requirements in Table 600, except as required in F102.2.6.

F102.2.2 Every Group H occupancy shall be prohibited from location within the fire district.

F102.2.3 Every building shall be fire protected throughout as specified for the various types of construction in Chapter 6.

F102.2.4 Roof covering in the fire district shall conform to the requirements of Class A or B roof coverings as defined in 1509.2.

F102.2.5 In buildings two stories or more in height unless of Type III construction, sprinklered throughout, an automobile parking structure or surrounded on all sides by a permanently open space of not less than 30 ft (9144 mm), all walls, floors, roofs, and their supporting structural members shall provide not less than 1-hour fire resistance. Temporary partitions are set forth in 704.2.3.1.

F102.2.6 Exterior walls of Type IV buildings shall have a fire resistance of 2 hours or more when such walls are located within 30ft (9144 mm) of a common property line or an assumed property line. Exterior walls located more than 30 ft (9144 mm) from a common property line or an assumed property line shall comply with Table 600.

EXCEPTION: In the case of one story buildings which are 2,000 sq ft (186 m^2) or less in area, exterior walls located more than 15 ft (4572 mm) from a common property line or an assumed property line need only comply with Table 600.

F102.2.7 Architectural trim on buildings located in the fire district shall be constructed of approved noncombustible materials or fire retardant treated wood.

F102.2.8 Permanent Canopies may extend over adjacent open spaces provided:

1. The canopy and its supports shall be of noncombustible material, fire retardant treated wood, wood of Type III sizes, or of 1-hour resistant construction.

   EXCEPTION: Any textile covering for the canopy shall be flame resistant as determined in accordance with both the small scale and large scale tests in NFiPA 701.
2. The canopy shall have at least one long side open.
3. The maximum horizontal width of the canopy shall not exceed 15 ft (4572 mm).
4. The fire resistance of exterior walls shall not be reduced.

F102.2.9 Structures, except aerial supports 12ft (3658 mm) high, or less, flag poles, water tanks and cooling towers, placed above the roof of any building within the fire district shall be of noncombustible material and shall be supported by construction of noncombustible material.

F102.1.10 The use of plastics complying with 3108.5 for signs is permitted provided the structure of the sign in which the plastic is mounted or installed is noncombustible.

F102.2.11 Exterior plastic veneer is not permitted in the fire district.

F103 CHANGES TO BUILDINGS

F103.1 Existing Buildings Within The Fire District

An existing building shall not hereafter be increased in height or area unless it is of a type of construction permitted for new buildings within the fire district or is altered to comply with the requirement for such type of construction. Nor shall any existing building be hereafter extended on any side, nor square footage or floors added within the existing building unless such modifications are of a type of construction permitted for new buildings within the fire district.

F103.2 Other Alterations

Nothing in F103.1 shall prohibit other alterations within the fire district provided there is no change of occupancy that is otherwise prohibited and provided the fire hazard is not increased by such alteration.

Fl03.3 Moving Buildings

Buildings shall not hereafter be moved into the fire district or to another lot in the fire district unless the building is of a type of construction permitted in the fire district. See 3313.

F104 BUILDINGS LOCATED PARTIALLY IN THE FIRE DISTRICT

Any building located partially in the fire district shall be of a type of construction required for the fire district, unless the major portion of such building lies outside of the fire district and no part is more than 10 ft (3048 mm) inside the boundaries of the fire district.

F105 EXCEPTIONS TO RESTRICTIONS IN FIRE DISTRICT

The preceding provisions of this chapter shall not apply in the following instances:

1. Temporary buildings used in connection with duly authorized construction.
2. A private garage used exclusively as such, not more than one story in height, nor more than 650 sq ft (60 m^2) in area, located on the same lot with a dwelling.
3. Fences not over 8 ft (2438 mm) high.
4. Coal tipples, material bins, trestles conforming to 411.9.
5. Water tanks and cooling towers conforming to 1504 and 1505.
6. Greenhouses less than 15 ft (4572 mm) high.
7. Porches on dwellings not over one story in height, and not over 10 ft (3048 mm) wide from the face of the building, provided such porch does not come within 5 ft (1524 mm) of any property line.
8. Display signs as provided in 3108.
9. Sheds open on a long side not over 15ft (4572 mm) high and 500 sq ft (46 m^2) in area.
10. One and two family dwellings when of a type of construction not permitted in the fire district may be extended 25% of the floor area existing at the time of inclusion in the fire district by any type of construction permitted by this code.
11. Wood decks less than 600 sq ft (56m^2) when constructed of 2-inch nominal wood, pressure treated for exterior use.
12. Wood veneers on exterior walls conforming to 1403.6.8.

APPENDIX G
EXTERIOR WOOD DECK CONSTRUCTION

G101 Decks for residential occupancies, other than townhouses, having an area of 100 sq ft and less shall meet the requirements of this section. Deck for residential occupancies, other than townhouses, exceeding 100 sq ft in area and decks for other types of occupancies shall be structurally designed by a Professional Engineer or Architect.

G102 Support posts shall be attached to a footing or embedded in the ground to a depth of 20% of the post length or a minimum of 2 ft. The footing width shall be a minimum of four times the maximum cross sectional dimension or the post with a minimum thickness of 6 inches for precast concrete or 8 inches for cast-in-place concrete.

G103 Lumber in contact with the ground, concrete or masonry shall be pressure treated in accordance with AWPA Standard C-15. All remaining deck lumber shall be pressure treated in accordance with AWPA Standard C-2 or a standard giving equal protection. The Building Official may also approve a natural decay resistant wood per 2304.

G104 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 structure 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.

G105 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	12' Max Joist Span	16' Max Joist Span
5/8" galv. Bolts with Washers[1]	1 @ 42" o.c.	1 @ 20" o.c.	1 @ 20" o.c.
or	or	or	or
3/4" Hot Dipped Galv. Bolts with Washers[1]	1 @ 48" o.c.	1 @ 24" o.c.	1 @ 24" o.c.
and	and	and	and
12d Common Hot Dipped Galv. Nails[2]	2 @ 8" o.c.	3 @ 8" o.c.	3 @ 6" o.c.

Notes:
1. Minimum edge distance for bolts in 3 inches.
2. Nails must penetrate the supporting structure band a minimum of 1 1/2".

B. Brick Veneer Structures:

Fasteners	8' Max Joist Span	12' Max Joist Span	16' Max Joist Span
5/8" Hot Dipped Galv. Bolts[1]	1 @ 2'-0" o.c.	1 @ 2'-0" o.c.	1 @ 1'-4" o.c.
3/4" Hot Dipped Galv. Bolts	1 @ 3'-4" o.c.	1 @ 2'-0" o.c.	1 @ 1'-4" o.c.

Notes:
1. Minimum edge distance for bolts in 3 inches.

G106 Decks shall be designed for a live load of 40 psf with a load duration factor of 1.0. For girder sizes and spans, refer to 2307. However, girders shall be a minimum of 2 - 2x10's, if the 2x10's are bolted to the side of the post and not fully bearing on the post. Girders shall bear directly on the posts, or the posts may be notched a minimum of 1 inch on both sides of the post with the girder components bearing on the notches and bolted to the post with 2-3/4 inch hot dipped galvanized bolts. Floor joists shall be sized in accordance with "Wood Structural Design Data" or the "National Design Specification" as published by NFoPA.

G107 Floor decking shall be No. 2 grade treated Southern Pine or equivalent. The minimum floor decking thickness shall be as follows:

Joist Spacing	Decking
12" o.c.	1" S4S (Nominal)
16" o.c. or 16" o.c.	1" T&G (Nominal) or 1 1/4" S4S (Nominal)
24" o.c.	2" S4S (Nominal)

G108 Maximum Height of Deck Support Posts[1]

Post Size	Max Tributary Area	Max. Post Height [2,3]
4 x 4	25 SF	8' 0"
4 x 6	25 SF	8' 0"
6 x 6	25 SF	14' 0"
8 x 8	25 SF	20' 0"

Notes:
1. This table is based on No. 2 treated Southern Pine posts.
2. From top of footing to bottom of girder.
3. Decks with post heights over 20 ft shall be designed and sealed by a Professional Engineer or Architect.

G109 Decks shall be braced to provide lateral stability by one of the following methods:

1. When the deck floor height is less than 4 ft and the deck is attached to the structure in accordance with G105, lateral bracing is not required. When the band and floor joists of the structure are parallel, full depth blocking or 1 x 4 diagonal bridging shall be provided at 2 ft o.c. for a minimum of one joist space on the structure.

2. 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 inch hot dipped galvanized bolt at each end of each bracing member.
3. 4 x 4 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. Attach each brace to the post and the girder with a minimum of one 5/8 inch hot dipped galvanized bolt at each end of the brace. Minimum post size for this type of construction is 6 x 6.
4. Posts may be embedded in 2500 psi concrete for stability with the following limitations.

Nom. Post Size	Max Tributary Area	Max Post Height	Embedment Depth	Total Post Length	Concrete Diameter
4 x 4	25SF	4'-0"	2'-6"	6'-6"	1'-0"
6 x 6	25SF	6'-0"	3'-6"	9'-6"	1'-8"
6 x 6	25SF	8'-0"	3'-6"	11'-6"	1'-8"
8 x 8	25SF	10'-0"	4'-6"	14'-6"	2'-0"
8 x 8	25SF	10'-0"	6'-6"	16'-6"	w/o concrete
8 x 8	25SF	12'-0"	4'-0"	16'-0"	2'-0"
8 x 8	25SF	12'-0"	6'-0"	18'-0"	w/o concrete

5. For embedment of piles in coastal regions see Chapter 37.

G110 Variations in deck design may be approved by the Local Building Official when designed and sealed by a professional engineer or architect.

APPENDIX H

EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS)

(Effective Date – March 12, 1996)

These recommendations apply only to EIFS design as a barrier system which does not provide for drainage of water to the exterior and which is applied to Type VI Construction.

H-1 General. Exterior Insulation and Finish Systems (EIFS) are non-load bearing barrier wall exterior cladding systems generally consisting of an insulation board, an adhesive and/or mechanical attachment of the insulation board to the substrate, glass fiber reinforcing mesh, a base coat on the face of the insulation board that functions as a weather barrier and a textured protective finish coat.

H-2 Standards. The EIFS shall meet or exceed the following standards. Tests to certify compliance with these standards must be performed by a nationally recognized independent testing agency or evaluation service. Tests may be performed by the EIFS manufacturer if the test specimens and procedures are certified by a nationally recognized testing agency. Testing agencies shall provide unannounced follow-up inspections at least every six months to insure that system components continue to meet performance standards. Any changes in components or composition of components from the original compliance report will require a re-evaluation.

Test	Method	Acceptance Criteria
A. Durability		
1. System Performance		
a. Abrasion Resistance	ASTM D 968	No cracking, checking or loss of film integrity at 528 quarts (500 liters) if sand.
b. Accelerated Weathering	ASTM G 23 or G 53	No deleterious effects* after 2000-hours when viewed under 5x magnification.
c. Freeze/Thaw Resistance	Modified ASTM C 67	50 cycles. No deleterious effects.*
d. Mildew Resistance	ASTM D 3273 or Mil. Std. 810B, Method 108	No growth supported during 42-day exposure period.
e. Salt Spray Resistance	ASTM B 117	No deleterious effects* at 300 hours exposure.
f. Water Penetration	ASTM E 331	No water penetration.
g. Water Resistance	ASTM D 2247	No deleterious effects* at 14-day exposure.

* No deleterious effects: no cracking, checking, crazing, erosion, rusting, blistering, peeling or delamination.

Test	Method	Acceptance Criteria
B. Fire Performance		
1. System Performance		
a. Fire Endurance	ASTM E 119	No effect on fire resistance rating of wall assembly.
b. Full-Scale Diversified	ASTM E 108 (Modified)	No significant Fire Test contribution to vertical or horizontal flame spread.
c. Radiant Heat Exposure	1996 N. C. State Building Code, Section 2603	No ignition at 20 minutes.
2. Component Performance		
a. Surface Burning	ASTM E 84	Adhesive, insulation board, reinforced base coat and finish coat shall each separately have a flame spread of 25 or less, and smoke developed of 450 or less.
C. Structural Performance		
1. System Performance		
a. Impact Resistance	ASTM E 695	No cracking or denting with 30-lb. (14 kg) impact mass at 6 feet.
b. Wind Load	ASTM E 330	Withstand negative and positive wind loads required by applicable building code.
D. Components		
1. Water Resistant Glass Mat Gypsum Sheathing	ASTM C-1177	
2. Gypsum Sheathing	ASTM C-79	Mechanically applied systems only.
3. Insulation Board	ASTM C-578	0.95 #/cf minimum density and maximum absorption of 2.5% by volume.
4. Portland Cement	ASTM C-150	
5. Sealants	ASTM C-920	Type M or S Grade NS.
6. Sealants	ASTM C-719	Movement capability.
7. Sealants	ASTM C-1193	Installation guide.

The ASTM E-119 and E-108 tests are only required in construction required to have a fire resistance rating. Each EIFS system shall have a current compliance report issued by one of the model code organizations.

H-3 Design Limitations. The maximum allowable deflection of structural wall components must be specified and is limited to a maximum L/240 of span except where more restrictive requirements prevail such as a type PM system which requires L/360. The design wind load required by the code shall not exceed the wall systems allowable wind load as stated in the manufacturer's compliance report. Structural tests are required to determine allowable positive and negative wind pressures that may be imposed on the EIFS.

Expansion joints are required in the system where they exist in the substrate, where the system adjoins dissimilar construction, and at floor lines in multilevel wood frame construction. Supplementary control joints are required in wall areas. Wall areas defined by the placement of control joints shall not exceed 150-sq. ft. (13.9m^2) when a type PM system is used.

H-4 Installation Requirements

H-4.1 Substrate (Sheathing). Exterior type plywood, water-resistant glass mat gypsum sheathing, complying with ASTM C 1171, or equivalent material listed in the manufacturer's compliance report is acceptable for adhesively applied applications. Gypsum sheathing meeting the requirements of ASTM C 79 and OSB type sheathing shall be used only with mechanically applied systems with asphalt-saturated felt cover. Substrates (sheathing) such as concrete, masonry, or other non-moisture sensitive substrates are also acceptable for adhesively applied systems.

The substrate shall be free of planar irregularities greater than 1/4 inch in 8 feet and shall be sound and free of foreign substances. The substrate surface shall be determined by the applicator to be sound, free of release agents, or other residue and in all other ways suitable for the application of the EIFS. A moisture meter shall be used to determine if the surface is dry (19% moisture or less). Any areas of moisture damage shall be replaced. The substrate surface shall be free of paint, coatings, sealers, algae, chalkiness, dirt, dust, oil, fungus, grease, mildew or other foreign substances.

H-4.2 Insulation Board. Insulation board shall be polystyrene board meeting ASTM C-578 and the manufacturer's current published specifications. The board shall have a minimum density of 0.95 pounds per cubic foot and a maximum absorption of 2.5 percent by volume when tested in accordance with the provisions of ASTM C-272. The thickness of the board shall be in accordance with the EIFS compliance report but not less than 1" in thickness for adhesively applied systems and 1 1/2" in thickness for mechanically applied systems. The maximum size of the insulation board allowable shall be in accordance with the EIFS compliance report. Insulation boards shall be delivered in labeled plastic bags or other protective cover with the physical properties of the board identified on the package. Each board shall be clearly marked with the brand name. All boards shall be wire cut with edges square. Boards shall be stored flat in a dry area and shall be protected from direct sunlight during storage and after installation. The insulation board shall not be used in contact with chimneys or other surfaces which could heat the board to a temperature greater than 150° F.

Prior to applying the insulation boards to the substrate, a strip of reinforcing mesh shall be applied to the substrate. This mesh will eventually wrap around the end of the insulation a minimum of 2 1/2" on the face of the board. This procedure, known as “backwrapping” must be used wherever the insulation starts or stops such as the base of the system, when meeting window and door frames and at seams. If backwrapping is not possible, the board shall be prewrapped at the end terminations.

When an adhesive is used to adhere the insulation board to the substrate, the adhesive shall be applied with a notched trowel approved by the EIFS manufacturer resulting in a minimum of 50% contact area between the adhesive and substrate. Apply notched trowel pattern in vertical direction. Ribbon and dab adhesive applications consisting of a 2" wide band of adhesive 3/8" in thickness applied to the perimeter of the insulation board and 4" round dabs spaced at 8" on center resulting in a minimum of 33 percent contact area is allowed only when adhering to a non-moisture sensitive substrate or when permitted by the EIFS compliance report. Installations may be a combination of mechanical fasteners and adhesive. Mechanical fasteners shall be of corrosion resistant materials and shall have the necessary pull out tensile and shear strength when installed to resist the design loads imposed on the system.

Mechanically fastened systems that are installed in areas with wind speed ratings in excess of 90 mph require applying the fastener through the initial layer of reinforced base coat, adding a 4" x 4" piece of reinforcing mesh over the fastener head, and applying an additional layer of base coat over the surface. In general, one fastener per 1.25 square feet is required for areas with basic wind speeds in excess of 90 mph or equivalent fastening system detailed in EIFS manufacturer's compliance report.

When applying the insulation boards, always start from a level base line. Excess adhesive shall be removed from the edge of the board. Boards shall be installed by sliding them into place and butted tightly together. Any gaps greater than 1/16" shall be filled with insulation and not adhesive. Pressure shall be applied to the entire surface of the board. The board should be checked occasionally to insure proper contact with the substrate. Proper contact is when a piece of board is removed and a similar amount of adhesive is adhered to both the substrate and the board. When using mechanical fasteners, the fastening pattern shall be according to the manufacturer's written instructions, but in no case shall the spacing be less than one fastener per 2 square feet. Mechanical fasteners must be specifically described by the EIFS manufacturer to include type, shank diameter, length, head diameter and corrosion resistant treatment.

Expansion joints, weep screeds, corner reinforcement, trim, etc. must be specifically described by the EIFS manufacturer including any corrosion- resistance treatment.

The insulation boards shall be installed in a running board pattern, with staggered vertical joints and interlocking insulation boards on the inside and outside corners. Board joints shall be offset from sheathing joints and corners of openings. Insulation boards applied with adhesive shall be allowed to remain undisturbed for 24 hours prior to proceeding with the installation of the base coat. Cool or damp conditions may extend the drying time.

H-4.3 Base Coat and Reinforcing Mesh. Prior to applying the base coat, the insulation board must be rasped so that the entire surface is level and uniform. After preparation, the wall must be protected from sun and water damage. Rerasp if ultraviolet damage occurs between the initial insulation board preparation and the applications of the base coat.

The base coat shall be a cementitious mixture of the manufacturer's base or ground coat mixed with portlant cement, complying with ASTM C 150 in the proportions listed in the compliance report, or a non-cementitious base coat with or without fibers also listed in the manufacturer's compliance report or accepted by the manufacturer as an equal to the more common cementitious base coat.

The base coat shall be compatible with the insulation board and reinforcing mesh. The reinforcing mesh shall be alkali resistant and have a minimum tensile strength of 200 lbs. per linear inch in either direction and retain at least 40 percent of its original strength when tested for 90 days in a mixture of 25 percent cement and 75 percent water (by weight). The manufacturer's description shall include the type, weight, thread count, strength, weave and treatments for compatibility with coatings. The base coat shall be of a thickness required by the EIFS compliance report and shall be mixed in accordance with the manufacturer's written instructions.

After applying the base coat to the insulation board, immediately embed the mesh in the base coat by troweling from the center to the edges of the mesh to avoid wrinkles. Trowel off any excess base coat from the surface. The mesh shall be embedded so that no mesh color or pattern is visible. When embedding the mesh into the base coat, work vertically or horizontally in 40 inch strips. Overlap the edges of the mesh a minimum of 2 1/2" or butt the edges together in accordance with the manufacturer's instruction. After the mesh is embedded, an additional coat shall be applied to achieve the uniform thickness specified by the manufacturer.

In high impact areas a layer of high impact mesh of 14 oz/yd^2 minimum shall be applied first with joints butted and no mesh color visible. After this layer has dried, a standard mesh described above shall be applied. Additional protection at doors and windows shall be provided by applying butterflies or small strips of mesh diagonally at the sills and headers prior to application of field mesh. All inside and outside corners shall have two layer of mesh applied.

H-4.4 Finish Coat. The base coat must be allowed to dry a minimum of 24 hours prior to the application of the finish coat. Surface irregularities in the base coat such as trowel marks, board lines, etc. shall be corrected. A primer recommended and installed in accordance with the manufacturer's instructions shall be applied except in cases of fine textured (sand blast) sprayed applied applications. The finish coat shall be mixed and applied to a thickness in accordance with the manufacturer's written instructions. The application must be performed by sufficient workers to finish entire sections of a wall area at one time uninterrupted. The finish coat shall be applied using only stainless steel or plastic trowels. Applicators shall work in pairs with the first applying the finish and the second floating the finish to the desired texture. Finish coat shall not be applied in direct sunlight. Follow or precede the sun around a building.

H-4.5 Windows, Doors, Flashing, Closures, etc. Windows and doors shall be tested and labeled to indicate compliance with the requirements of the following specifications;

Aluminum, Polyvinyl Chloride	AAMA (ANSI) 101
Wood	ANSI/NWWDA I.S.-2

Windows and doors shall be self-flashing, including corners, unless otherwise specified and detailed by the EIFS manufacturers. The EIFS manufacturers installation instructions shall include illustrated details of the flashing and/or sealing around heads, sills and jambs of windows and doors of a type which may be used with the system and at the top of exposed walls.

Approved corrosion-resistive flashing shall be provided at the top and sides of all exterior window and door openings in such a manner to be leakproof. Pan flashing shall be installed at all exterior window sills and door thresholds such that the flashing diverts water to the outside face of the EIFS. Similar flashings shall be installed at EIFS intersections with parapets, fascia's, gutters, soffits, wood trim, porches, decks, stairs, guardrails, handrails, and plumbing and electrical penetrations.

Windows shall meet minimum water penetration requirements for grade of window indicated on the certification label when tested in accordance with the required test method.

A. ASTM E 547-86, Water Leakage, penetration of water into the plane of the innermost face of the test specimen under specified conditions of air pressure difference across the specimen. In tests of windows and doors, it also occurs whenever water penetrates through the frame of the test specimen during the specified test period. Windows shall be tested with brick molding or other trim in place. Leakage behind any trim will be considered failure when considering installation with EIFS. If not tested with the trim, the EIFS manufacturer shall specify the specific window(s) by manufacturer and model number and include a flashing detail.

B. NWWDA I.S.2-93 requires water penetration tests in accordance with ASTM E 547-86. NWWDA I.S.2-93 further states that "Water penetration levels are expressed in pounds per square foot (psf) of static test pressure at which there is no water leakage through the window into the wall cavity or the room when tested according to ASTM E 547. Failure also occurs whenever water penetrates through the frame of the test specimen during the specified test period.

C. Water test pressure requirements are typically 2.86 psf minimum or 10% of the structural test pressure.

Chimneys shall be provided with crickets when the chimney does not intersect the ridgeline. The EIFS system shall be terminated a minimum of 3" above the metal step flashing. The intersection of the cricket and the chimney shall be flashed and counterflashed in the same manner as normal roof-chimney intersections.

The EIFS manufacturer's compliance report and/or supplement to the compliance report, shall include illustrated details of the following:

1. Closures and flashing at terminations, such as eaves, sills and other exterior wall coverings.

2. Typical conditions within the field of the wall covering, showing substrates, control joints, etc.
3. Parapet at top and termination on backside.
4. Flashing and/or sealing at all wall penetrations.
5. Other details deemed necessary to prohibit water intrusion into the wall cavity including details for sealing between the exterior trim and window frame.

H-4.6 Sealants (Caulk). Since EIFS are barrier wall systems, sealants and caulks play a vital role in maintaining an effective barrier against air and water infiltration into the wall. If water is allowed to enter behind the EIFS, it can do damage to the substrate and framing. Whenever the EIFS or the insulation board meets another material such as door, frame, window frame, roof, pipe, wires, meter boxes, faucets, etc. the area shall be protected from moisture intrusion with a product or method specified by the manufacturer

A properly Installed sealant provides a leak proof joint between two materials. A three point bond is not allowed. When a sealant bonds to a third surface, such as the substrate at the joint between a window frame and the insulation board, the sealant will fail. To prevent third surface bonding, a backup material shall be pushed into the joint. Backup material shall be approved by the sealant manufacturer and shall be either a closed cell polyethylene rod, extruded polyolefin foam made of a non-absorbing outer skin or a bond-breaker tape.

Sealants shall comply with ASTM C 920, type M or S, Grade NS and the particular sealant manufacturer must be acceptable to the EIFS manufacturer. The movement capability shall be 50 percent + when tested under the provisions of ASTM C 719. Sealants shall be Installed in accordance with ASTM C 1193 Standard Guide for Use of Joint Sealants.

All joints shall be made so that the sealant material may be removed and replaced. The minimum sealant joint width shall be 1/2 inch or 4 times the anticipated movement, whichever is greater. Minimum expansion of sealant joint width shall be 3/4" or 4 times the anticipated movement, whichever is greater. The minimum joint depth and width shall be in accordance with the sealant manufacturer's recommendations and the provisions of ASTM C-1193. At all areas requiring sealant joints, the insulation board shall be held back to allow for the reinforced base coat and any required coatings to form a sealant joint of the required dimension. Fillet Joints shall not be used unless required by a particular window trim being used. In case of fillet joints, a bond breaker tape or triangular backer material shall be used to prevent three-sided bonding. All insulation board edges shall be back wrapped or protected in accordance with the EIFS manufacturer. This includes all penetrations such as holes for piping and wiring. Sealant shall not come into direct contact with the insulation board or reinforcing mesh. Joints to be sealed shall be clean, dry and free of dust or other foreign materials and primed. The sealant must be applied to the base coat and not to the finish coat. Sealants may be applied to prepared, primed base coat when the moisture level reaches 70 percent of the original moisture level or a minimum of 72 hours or as specified by the sealant manufacturer whichever is longer. Open joints shall be protected from water intrusion by installing a backer-rod or temporary covering. Tops of walls must be immediately covered with the final trim or temporarily protected to prevent water intrusion.

Apply sealant with a gun having a proper size nozzle using sufficient pressure to fill all voids and joints solid to the backup material. The surface of the sealant shall be a full smooth head, free of ridges, wrinkles, sags, air pockets and embedded impurities. After all joints have been completely filled, they shall be neatly tooled to force sealant into complete contact with joint surfaces, to eliminate air pockets or voids and provide a smooth neat appearance. Protect adjacent surfaces from excess sealant material. Use masking tape where required to prevent contact of sealant with EIFS surfaces.

The sealant contractor shall be knowledgeable in the proper installation of sealants on buildings that utilize EIFS type cladding. The sealant contractor shall have demonstrated the ability to install the sealant on projects of similar size and complexity and shall provide a list of completed projects. The sealant contractor shall provide the proper equipment, manpower and supervision to install the sealant properly. An installation card shall be completed by the sealant contractor at the completion of each project and shall be provided to the certified contractor. The card states that the sealant installation complies with the EIFS Evaluation Report, the Sealant Manufacturer's Installation Methods and Procedures and ASTM C-1193, Standard Guide for Use of Sealants.

H-4.7 Special Installation Requirements. The ambient temperature shall be 40° F or greater and rising at the time of application, but not greater than 100° F and shall remain in this range for a minimum of 24 hours. Other temperatures may exist when covered by the compliance report. No additives or materials of any kind, such as binder, antifreeze agents, accelerators, fillers, etc. except specified amounts of clean water, shall be allowed unless specifically approved in writing by the manufacturer. EIFS materials shall be delivered at the job site in their original sealed containers bearing the manufacturer's name and identification of the product. All materials shall be purchased from a single source or a source approved by the EIFS manufacturer. Use of materials and systems without compliance reports or mixing of one manufacturer's product with one or more other manufacturer's system is prohibited. All products in pails shall be stored away from direct sunlight, shall be protected from freezing and temperatures in excess of 90° F. Products in bags shall be stored off the ground under a cover.

H-5 Applicator. The installation of EIFS shall be performed only by an applicator who has been trained by the EIFS material manufacturer or who has been trained and certified by an organization accepted by the manufacturer and carries a current certificate of qualification by the manufacturer and identification card issued by the manufacturer. The card shall be renewed every four (4) years. During application at least one certified applicator with proper identification card shall be on the job site at all times. Through the issuance of a certificate and identification card, the manufacturer is certifying that the applicator either through product seminars or by field training is familiar and confident with the materials they will install, is familiar with the conditions of the compliance report, and the manufacturer's installation instructions, and with the provisions of this code. The contractor when securing a permit shall provide a copy of the manufacturer's installation instructions and compliance report to the inspector. When requested by the building inspector or owner, the applicator shall provide a list of projects he has completed. The contractor shall provide to the building official at the end of each project an EIFS installation card along with the sealant installation card completed by the sealant contractor.

H-6 Warranty. The manufacturer shall warrant their EIFS including any caulks and sealants for twenty (20) years against faulty performance. The warranty shall include correction of delamination, chipping, denting, peeling, blistering, flaking, bulging, unsightly discoloration, or other serious deterioration of the system such as the intrusion of water through the wall or failure of the systems surface materials. Should any of these defects occur, the manufacturer shall make a prorata allowance for replacement or pay the owner the amount of the allowance. The manufacturer shall not be liable for damages or defects resulting from misuse, natural catastrophes or other causes beyond the control of the manufacturer.

The contractor shall provide a statement or EIFS and Sealant Certification Form to the owner that the product has been installed in compliance with this code, manufacturer's installation instructions and the compliance report .

H-7 Maintenance. The manufacturer shall provide maintenance recommendations necessary for compliance with the warranty. Recommendations for periodic inspections necessary to maintain the durability and integrity of the EIFS shall also be provided.

EIFS CERTIFICATION

Date Completed _____

Project Location _____

_____

_____

_____

EIFS Manufacturer's Name _____

Compliance Report
Materials _____
Substrate Type _____
Adhesive and/or Fasteners _____
Reinforcing Fabric _____
Base Coat _____
Finish _____

This is to certify that the EIFS materials noted above were installed on this project in accordance with the EIFS Manufacturer's Installation Requirements, Compliance Report and North Carolina State Building Code.

Name and Address of Contractor _____

Signature of Responsible Officer _____
Typed Name of Officer _____
Title _____
Telephone Number _____

Must be submitted with Sealant Certification to building official.

Sealant Certification

Date Completed _____

Project Location _____

Materials
Primer(s) _____
Bond Breakers _____
Sealant Materials _____

This is to certify that the sealant materials noted above were installed on this project in accordance with ASTM C-920, ASTM C-1193, the sealant manufacturer's installation instructions, the EIFS manufacturer's installation methods and procedures and the manufacturer's evaluation report.

Name or Sealant Contractor
Address _____

_____

_____

Signature of Responsible Officer _____
Typed Name of Officer _____
Title _____
Telephone Number _____
Must be submitted to EIFS contractor.

INDEX

METRIC CONVERSIONS

	MULTIPLY	BY	TO GET
Length	inches	25.4	mm
	ft	0.3048	m
Area	sq in	645.16	mm^2
	sq ft	0.0929	m^2
Volume	cu in	0.01639	L
	cu ft	28.3169	L
	cu ft	0.02832	m^3
	gal	3.785	L
	gal	0.003785	m^3
Mass	lb	0.4536	kg
Mass/unit length	plf (lp/ft)	1.4882	kg/m
Mass/unit area	psf (lb/sq ft)	4.882	kg/m^2
Mass density	pcf (lb/cu ft)	16.02	kg/m^3
Force	lb	4.4482	N
Force/unit length	plf (lb/ft)	14.5939	N/m
Pressure, stress, modulus of elasticity	psi	6.895	kPa
	psi (lb/sq ft)	47.88	Pa
Second moment of area	in^4	416,231	mm^4
Section modulus	in^3	16,387.064	mm^3
Temperature	^{O}F-32	5/9	^{O}C
	^{O}F + 459.67	5/9	K
Energy, work, quantity of heat	kWh	3.6	MJ
	Btu	1055	J
	ft • lb (force)	1.3558	J
Power	ton (refrig)	3.517	kW
	Btu/s	1.0543	kW
	hp (electric)	745.7	W
	Btu/h	0.2931	W

(continued)

METRIC CONVERSIONS *(Continued)*

	MULTIPLY	BY	TO GET
Thermal conductance (U value)	Btu/f2 • h • ^{O}F	5.6783	W/m^2 • K
Thermal resistance (R value)	ft^2 • h • ^{O}F/Btu	0.1761	m^2 • K/W
Flow	gpm	0.0631	L/s
	cfm	0.4719	L/s
Illuminance	footcandle (lm/sq ft)	10.76	lx (lux)
Velocity (speed)	mph	0.447	m/s
Plane angle	^{O}(angle)	0.01745	rad