North Carolina
State Building Code

Volume I – General Construction
(1988 Standard Building Code with North Carolina Amendments)

1991 Edition

North Carolina Building Code Council

and

North Carolina Department of Insurance

Post Office Box 26387

Raleigh, North Carolina 27611

North Carolina
State Building Code

1995 Revisions
TO THE
1991 EDITION

Volume I – General Construction
(Revisions Adopted Through September 13, 1994
Effective January 1, 1995)

(Reprinted by permission of the International Code Council)

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

REVISION MARKS NOTATIONS

(For purposes of reproduction the notations have been modified from the format used in the original printing)

Underlining within the body of the code indicates a technical change to the 1991 North Carolina State Building Code with Revisions through 1995.

NORTH CAROLINA STATE BUILDING CODE PUBLICATIONS

Available from: North Carolina Department of Insurance
Code Book Section
Visit the North Carolina Department of Insurance web site for contact information

Volume I – GENERAL CONSTRUCTION CODE

Volume IA – ADMINISTRATION & ENFORCEMENT REQUIREMENTS

Volume IC – ACCESSIBILITY CODE

Volume II – PLUMBING CODE

Volume III – MECHANICAL CODE

Volume IV – ELECTRICAL CODE

Volume V – FIRE PREVENTION CODE

Volume VI – GAS CODE

Volume VII – RESIDENITAL CODE

Volume VIII – MODULAR CONSTRUCTION REQUIREMENTS

Volume IX – EXISTING BUILDINGS

NORTH CAROLINA STATE BUILDING CODE COUNCIL
September 13, 1994

Chairman:
SAM T. SNOWDON, JR., AIA – 99
(Architect)
P.O. Box 1764
Laurinburg, NC 28353
(910) 276-3038

Vice Chairman:
JOHN R. ANDREW, P.E. – 97
(Structural Engineer)
Andrew & Kuske Consulting Engineers
202 North Fifth Avenue
Wilmington, NC 28401
(910) 343-9653

Members:
MARK B. TROLLINGER – 99
(Home Builder)
200 Worth Street
Asheboro, NC 27203
(910) 625-6033

EARL DRIGGERS – 95
(Electrical Contractor)
Driggers Electric & Control Co.
P.O. Box 36873
Charlotte, NC 28236
(704) 333-2152

ELLIS P. THOMAS, P.E. – 95
(Electrical Engineer)
P.O. Box 69
Newland, NC 28657
(704) 733-5597

J. HARMON BYRD, P.E. – 99
(State Agency)
Division of State Construction
NC Dept. of Administration
300 N. Salisbury St.
Raleigh, NC 27611
(919) 733-7962

STEPHEN B. PEAY – 99
(Public Representative)
P.O. Box 25511
Raleigh, NC 27611-5511
(919) 233-0711

JAMES G. ANDREWS, JR. – 95
(Plumbing and Heating Contractor)
J.G. Andrews, Inc.
P.O. Box 2937
Winston-Salem, NC 27102
(910) 723-7556

BARRY W. GARDNER – 97
(General Contractor)
Shelco, Inc.
P.O. Box 25747
Winston-Salem, NC 27114-5747

EDWARD L. WOODS, P.E. – 97
(Building Inspector)
Director of Building Stds Dept.
Mecklenburg County
P.O. Box 31097
Charlotte, NC 28231
(704) 336-3827

CLIFTON N. BISHOP, P.E. - 97
(Mechanical Engineer)
Craftmen Fabrics Indust., Inc.
P.O. Box 1329
Concord, NC 28026
(704) 786-1157

JIM SMITH, II – 97
(Fire Services)
Fire Chief
P.O. Box 2509
Asheboro, NC 27204
(910) 629-9457

LARRY C. HAYES – 99
(County Representative)
Route 4, Box 165
Mocksville, NC 27028
(704) 284-4471

ROBERT C. PIERCE – 95
(Gas Industry)
Piedmont Natural Gas Company
P.O. Box 33068
Charlotte, NC 28223
(704) 364-3126

JACK F. NEEL, P.E. – 99
(Municipal Representative)
1007 Colonial Drive
Albemarle, NC 28001
(704) 983-2974

NORTH CAROLINA DEPARTMENT OF INSURANCE

By Statute the Commissioner of Insurance has general supervision of the administration and enforcement of the North Carolina State Building Code and the Engineering Division serves as the staff for the Building Code Council. Officials of the Insurance Department are:

JIM LONG
Commissioner

JOHN R. WIGGINS, PE
Chief Code Council Engineer
Code Council Section

LEE HAUSER, P.E.
Deputy Commissioner
And Secretary to Council

JESSE F. ALLRED, P.E.
Chief Code Consultant
Code Consultant Section

COMMITTEES OF THE COUNCIL
September 13, 1994

GENERAL CONSTRUCTION
Ed Woods, P.E. – Chairman
Mark Trollinger
Barry Gardner
Larry Hayes
Stephen Peay
Jim Smith

RESIDENTIAL
Mark Trollinger – Chairman
Harmon Byrd, P.E.
Barry Gardner
Jack Neel

ELECTRICAL
Earl Driggers – Chairman
Cliff Bishop, P.E.
Ellis Thomas, P.E.

FIRE PREVENTION
Jim Smith – Chairman
Stephen Peay
Bob Pierce
Larry Hayes
Jack Neel

STRUCTURAL
John R. Andrews, P.E. – Chairman
Harmon Byrd, P.E.
Ed Woods, P.E.

MECHANICAL
Cliff Bishop, P.E. – Chairman
James Andrews
Bob Pierce
Jim Smith
Ellis Thomas, P.E.

ADMINISTRATION
Sam Snowdon, AIA – Chairman
John R. Andrews, P.E.
Cliff Bishop, P.E.
Mark Trollinger
Earl Driggers
Jim Smith
Ed Woods, P.E.

THE STANDARD CODES

Standard Amusement Device Code
Standard Building Code
Standard Excavation and Grading 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 the Installation of Roof Coverings
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

EDUCATION PUBLICATIONS

Building Inspection Manual
Building Official Management Manual
Electrical Inspector Manual
Fire Prevention Inspection Manual
Gas Inspector Manual
Guide to Automatic Sprinklers
Hurricane Resistant Construction
Legal Aspects of Code Administration
Mechanical Inspector Manual
One and Two Family Dwelling Inspector Manual
Plumbing Drainage Principles
Plumbing Inspector Manual
Plumbing Venting Principles
Rehabilitation and Preservation Inspector Manual
Structural Plan Review

SAMPLE ORDINANCE TO ADOPT STANDARD CODES

ORDINANCE NO. _____

AN ORDINANCE TO ADOPT VARIOUS STANDARD CODES RELATING TO INSPECTION ACTIVITIES OF THE (City, County, State) AND ENFORCEMENT OF BUILDING PROVISIONS AS PROVIDED IN SAID CODES.

Section 1: WHEREAS, it is the desire of, (Name of Adopting Authority) to adopt, in all respects, the various Standard Codes relating to amusement devices, building, fire prevention, gas, grading, housing, mechanical, plumbing and swimming pools and

WHEREAS, the adoption of these Codes is done to facilitate proper inspection activities by (City, County, State) relating to construction and to maintenance of buildings within the corporate limits of said town and relating to public safety, health and general welfare;

NOW, THEREFORE, BE IT ORDAINED BY (City, County, State) that the following Codes are hereby adopted by reference as though they were copied herein fully:

Standard Amusement Device Code – 1985 Edition
Standard Building Code – 1988 Edition
Standard Excavation and Grading Code – 1975 Edition
Standard Existing Buildings Code – 1988 Edition
Standard Fire Prevention Code – 1988 Edition
Standard Gas Code – 1988 Edition
Standard Housing Code – 1988 Edition
Standard Mechanical Code – 1988 Edition
Standard Plumbing Code – 1988 Edition
Standard Swimming Pool Code – 1985 Edition
Standard Unsafe Building Abatement Code – 1985 Edition

Section 2: BE IT FURTHER ORDAINED BY (Name of Adopting Authority) that any matters in said Codes which are contrary to existing Ordinances of the City, shall prevail and that Ordinance No. _____, entitled (fill in here the complete title of the present building ordinance or ordinances in effect at the present time) are hereby repealed and, to that extent any existing Ordinances to the contrary are hereby repealed in that respect only.

Section 3: BE IT FURTHER ORDAINED that within said Codes when reference is made to the duties of certain officials named therein that designated official of (City, County, State) who has duties corresponding to those of the named official in said Code shall be deemed to be the responsible official insofar as enforcing the provisions of said Code are concerned.

Section 4: BE IT FURTHER ORDAINED that this Ordinance shall take effect and be in force from and after its passage, the public welfare requiring it.

PASSED AND APPROVED BY (Name of Adopting Authority) on the day of _____.

ATTEST: _____
CLERK: BY:

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 if the building. (Chapter 4)

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 400)
   (b) Check allowable height and area increases permitted. (Chapter 4)

4. Check detailed Occupancy requirements.

5. Check detailed Construction requirements.
   (a) Special restrictions if in Fire District (Chapter 3)
   (b) Fire Protection of Structural Members (Chapter 6 and Table 600)
   (c) Fire Protection Requirements (Chapter 7 and Table 700)
   (d) Means of Egress Requirements (Chapter 11)

6. Review design as related to standards. (Chapter 12-20)

7. Check other requirements as necessary.
   (a) Use if public property (Chapter 22)
   (b) Elevators (Chapter 24)
   (c) Sprinklers, Standpipes and Alarm Systems (Chapter 9)
   (d) Use of Combustible Materials-Interior (704)
   (e) Roof coverings (302, 706)
   (f) Light, ventilation and sanitation (2001, 2002)
   (g) Energy (Chapter 32)
   (h) 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 review of buildings.

TABLE OF CONTENTS

CHAPTER 1 ADMINISTRATION

CHAPTER 2 DEFINITIONS

CHAPTER 3 FIRE DISTRICT

CHAPTER 4 CLASSIFICATION OF BUILDING BY OCCUPANCY

TABLE OF CONTENTS

CHAPTER 5 SPECIAL OCCUPANCY REQUIREMENTS

CHAPTER 6 CLASSIFICATION OF BUILDING BY CONSTRUCTION

CHAPTER 7 FIRE PROTECTION REQUIREMENTS

TABLE OF CONTENTS

CHAPTER 7 FIRE PROTECTION REQUIREMENTS (CONT.)

CHAPTER 8 APPURTENANCE REQUIREMENTS

CHAPTER 9 SPRINKLERS, STANDPIPES AND ALARM SYSTEMS

CHAPTER 10 FIRE RESISTANCE STANDARDS FOR MATERIALS AND CONSTRUCTION

TABLE OF CONTENTS

CHAPTER 11 MEANS OF EGRESS

CHAPTER 12 MINIMUM DESIGN LOADS

TABLE OF CONTENTS

CHAPTER 13 FOUNDATIONS

CHAPTER 14 MASONRY CONSTRUCTION

CHAPTER 15 STEEL CONSTRUCTION

TABLE OF CONTENTS

CHAPTER 16 CONCRETE CONSTRUCTION

CHAPTER 17 WOOD CONSTRUCTION

CHAPTER 18 LATHING, PLASTERING AND GYPSUM CONSTRUCTION

TABLE OF CONTENTS

CHAPTER 19 SAFETY TO LIFE REQUIREMENTS FOR EXISTING BUILDINGS

CHAPTER 20 LIGHT, VENTILATION AND SANITATION

CHAPTER 21 SAFEGUARDS DURING CONSTRUCTION

CHAPTER 22 USE OF PUBLIC PROPERTY

CHAPTER 23 SIGNS AND OUTDOOR DISPLAYS

CHAPTER 24 ELEVATORS, DUMBWAITERS, ESCALATORS, MOVING SIDEWALKS

TABLE OF CONTENTS

CHAPTER 25 STRUCTURAL TESTS

CHAPTER 26 LIGHT-TRANSMITTING PLASTICS

CHAPTER 27 GLASS

CHAPTER 28 ALUMINUM CONSTRUCTION

CHAPTER 29 ACOUSTICAL CEILING SYSTEMS

TABLE OF CONTENTS

CHAPTER 30 LISTING OF REFERENCE STANDARDS

CHAPTER 31 CALCULATED FIRE RESISTANCE

CHAPTER 32 EFFICIENT ENERGY UTILIZATION IN NEW BUILDINGS

CHAPTER 33 PIERS, BULKHEADS, AND WATERWAY STRUCTURES

TABLE OF CONTENTS

CHAPTER 34 COASTAL & FLOOD PLAINS CONSTRUCTION STANDARDS

APPENDIX

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 Tense, Gender and Number

For the purpose of this Code, certain abbreviations, terms, phrases, words, and their derivatives, shall be construed as set forth in this chapter. 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.

201.2 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 or less wide which has been dedicated or deeded for public use.

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

ALTERNATING TREAD STAIRWAY - a stairway having a series of steps between 50° and 70° from horizontal, usual1y 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.

AMUSEMENT BUILDING, SPECIAL - any building or portion thereof, temporary, permanent or mobile contains a device or system which conveys 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.

AMUSEMENT DEVICE - a mechanically operated device which is used to convey persons in any direction as a form of amusement.

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.

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 - a dwelling unit as defined in this Code.

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 maximum horizontally projected area of the building at or above grade, exclusive of areas open and unobstructed to the sky.

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 404.

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

ATTIC SPACE VENTILATION - any means if removing hot or stale air from an attic space such as ridge vents, powered or gravity turbines, gable vents, etc., in conjunction with eave or soffit vents.

ATTIC STORY - any story situated wholly or partly in the roof, so designated, arranged or built as to be used for business, storage or habitation.

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 405.2.

BALCONY, ASSEMBLY ROOM - that portion of the seating space of an assembly room, the lowest part of which is raised 4 ft 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 in which an area of 3 sq ft or less is assigned per person.

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.

SHED - a structure in which its exterior walls have uniformly distributed openings on two or more sides totaling not less than 75% of its perimeter. Interior wall lines and column lines shall be at least 20% open and uniformly distributed.

OPEN SHED - any structure that has no enclosing walls

BUILDING, EXISTING - any structure erected prior to the adoption of this Code, or one for which a legal building permit has been issued.

BUILDING, TEMPORARY CONSTRUCTION - any building or portion of a building used as a temporary field office for the coordination of a nearby construction project by the general contractor and/or subcontractors. No portion of a temporary construction building may be used as an accessory occupancy (such as a sales office) into which the general public would be allowed access. Temporary construction buildings shall be built under the standards of the *North Carolina Stale Building Code, Volume VIII-Modular*.

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 405.

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.

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 29 CFR 1910.1000.

CHIMNEY CONNECTOR - the pipe which connects a fuel burning appliance to a chimney.

CITY - see definition for Applicable Governing Body.

COMBUSTIBLE FIBERS - any readily ignitable and free burning fiber, 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.

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

COMMON PROPERTY LINE - a line dividing one lot from another when said lots are not of one ownership.

COMPLIANCE REPORT - a report indicating compliance with the provisions of the Standard Building Code as analyzed by the Committee on Research and Compliance of the Southern Building Code Congress International.

CONDOMINIUM DWELLING UNIT - a dwelling unit as defined in this Code.

CONSTRUCTION TYPES -

Type I - See Section 602	Type IV - See Section 605
Type II - See Section 603	Type V - See Section 606
Type III - See Section 604	Type VI - See Section 607

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 may be stored, dispensed, used or handled.

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.

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

COURT - an open, uncovered and unoccupied space on the same lot as a building where such space is enclosed wholly or partly by buildings, walls or other enclosing devices (see Section 2003).

INNER - any court enclosed wholly by buildings, walls or other enclosing devices.

OUTER - a court extending to and opening upon a street, public alley or other approved open space that is not less than 15 feet wide, or upon a required yard.

WIDTH - as applied to an inner court, means the least horizontal dimension. As applied to an outer court, means the shortest horizontal dimension measured in a direction substantially parallel with the principal open end of such court.

COVERED MALL BUILDING - a single building three stories or Jess 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.

CRANE LOAD - the dead, live and impact loads and forces resulting from the operation of permanent cranes.

CURB LEVEL - referring to a building, means the elevation at that point of the street grade that is opposite the center of the wall nearest to and facing the street line.

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.

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.

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.

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.

DOOR, BALANCED - a door equipped with double-pivoted hardware so designed as to cause a semicounterbalanced swing action when opening.

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.

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 are 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 111 - 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.

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. 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 406.

EMERGENCY RESPONSE RECOVERY KIT - a chlorine emergency kit is 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.

ENGINEER - a duly registered and licensed engineer.

EXCESS FLOW CONTROL - a failsafe 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.

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

EXIT DISCHARGE, FLOOR OF - the floor most accessible to the exterior grade. A building may have more than one floor of exit discharge.

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).

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 DEPARTMENT CONNECTIONS - a hose connection at grade or street level for use by the fire department only for the purpose of supplying water to standpipes or sprinkler systems.

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

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

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

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

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 1001.1.

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 beyond the center line of the burners shall at any time during the test.

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.

FLAMESPREAD - the propagation of flame over a surface.

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

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 2l2°F (l00°C), or which burns so vigorously or persistently when ignited so as to create a serious hazard.

FLY - the space over the stage of a theater where scenery and equipment can be hung out of view. Also called loft and rigging loft.

FLY GALLERY - a narrow raised platform at the side of a legitimate stage from which the lines for flying scenery are manipulated.

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.

FRONT OF LOT - the front boundary line of a lot bordering on the street, and in the case of a corner lot, may be either frontage.

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.

GRADE - with reference to lumber, means 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 wherein an area of more than 3 sq ft is provided for each person.

GRIDIRON - the arrangement of beams over a legitimate stage supporting the machinery for flying scenery and hanging battens from which lighting is hung.

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.

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.

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, 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.

HAZARD CONTENTS, HJGH - Contents which are liable to burn with extreme rapidity or from which poisonous fumes or explosion are to be feared in case of fire.

HAZARDOUS MATERIALS - those chemicals or substances which are physical hazards or health hazards as defined and classified in 408 whether the materials are in usable or waste condition.

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.

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.

HEATING - see Chapter 8 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 does not include basements, except as specifically provided for in 402.2.4.

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.

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 (LDSO) 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 (LDSO) 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 (LCSO) 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^{O}C).

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.

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.

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.

INDUSTRIAL OCCUPANCY - defined in 407.

INNER COURT - an open unoccupied space bounded by the walls of the building, but located within the exterior walls of the building.

INSTITUTIONAL OCCUPANCY - defined in 409.

INTERIOR LOT LINE - synonymous with Common Property Line.

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.

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.

LODGING HOUSE - any building or portion thereof containing not more than five guest rooms which are used by not more than five guests where rent is paid in money, goods, labor or otherwise. A lodging house shall comply with all the requirements for dwellings.

LOT - a parcel of land considered as a unit.

MALL - a roofed or covered common pedestrian area within a covered mall building which serves as access for two or more tenants.

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 in every plane parallel to the bearing surface is 75% or more of its gross cross-sectional area measured in the same plane.

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:

(1) 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, escalators, horizontal exits, courts and yards. See Exit and Exit Access.

MEZZANINE - one or more intermediate levels between the floor and ceiling of a story. See 402.2.3.

MOTEL - see Hotel.

MULTIPLE DWELLING - see Apartment House.

NAILS - Nails shall be defined as in ASTM F-547.

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 l/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 1105.1.

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.

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.

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

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.

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.

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).

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.

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

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.

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.

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.

PINRAIL - a beam at one side of a legitimate stage through which wooden or metal pins are driven and to which lines from the flies are fastened.

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 mm) or less when tested in nominal .060 inch (I .5 mm) thickness by ASTM D 635.

CC 2 - Plastic materials which have a burning rate of 2 1/2 inches per minute or less when tested in nominal .060 inch (1.5 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.

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.

PLATFORM - that raised area within a building used for the presentation of music, plays or other entertainment, the head table for special guests, the raised area for lectures and speakers, boxing and wrestling rings, theater-in-the-round, and similar purpose wherein there are no overhead hanging curtains, drops, scenery or stage effects other than lighting.

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.

PLYWOOD - in this code, the word plywood, structural-use panel or wood structural panel may be used interchangeably.

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

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.

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 when lots are not of one ownership.

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

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).

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.

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 AIRCRAFT HANGAR - an accessory building less than 2000 sq ft (186 m2) 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.

RESIDENTIAL OCCUPANCY - defined in 411.

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 grandstands.

ROOF STRUCTURE - an enclosed structure on or above the roof of any part of a building.

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 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.

SCUPPER - an opening in a wall or parapet that allows water to drain from a roof.

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.

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.

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.

SERVICE STATION - defined in 405.2.

ENSITIZER - 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.

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

SHALL - as used in this Code, is mandatory.

SMOKE DETECTOR - an approved listed detector sensing either visible or invisible particles of combustion.

SMOKE BARRIER - a smoke barrier is a continuous membrane, either vertical or horizontal, such as a wall, floor or ceiling assembly that is designed and constructed to restrict the movement of smoke. A smoke barrier may or may not have a fire resistance rating. Such barriers may have protected openings.

SMOKE COMPARTMENT - a smoke compartment is a space within a building enclosed by smoke barriers on all sides, including the top and bottom.

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

SMOKE-PROTECTED ASSEMBLY SEATING - seating served by a means of egress that is not subject to smoke accumulation within or under a structure.

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.

STAGE - a partially enclosed area within a building used for the purpose of entertainment and classified as either:

1. STAGE, LEGITIMATE (working stage) - a stage wherein curtains, drops, leg drops, scenery, lighting devices or other stage effects are retractable horizontally or suspended overhead.
2. STAGE, REGULAR - a stage wherein curtains, fixed leg drops, valances, scenery and other stage effects are hung and are not retractable. A valance, a light trough, the main (house) curtain and a single backdrop may be retractable without the stage being considered a legitimate stage.
3. STAGE, THRUST - a platform extending beyond the proscenium arch and into the audience.

STAGE, DAIS - a small and low platform or rostrum that may be placed on a stage. May be permanent, temporary, or portable.

STAGE, PLATFORM - a raised section of floor within the assembly hall or auditorium area, and setting on the floor thereof, not enclosed above the platform floor level, and usually a relatively small area compared to the auditorium seating area. A platform may be of permanent, temporary, or portable construction and may have "flat" movable scenery and draw curtains.

STAGE, PODIUM - a small dais of size sufficient to accommodate one or two persons, such as a band or orchestra conductor or a soloist. A podium may be located on a stage, platform, rostrum, or dais, or the floor of the audience section of a place of assembly. A podium is almost always a portable construction.

STAGE, ROSTRUM - a stage usually used for single or small group or persons such as lectures with no scenery or curtains. May be permanent, temporary, or portable.

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.

STANDARD FIRE TEST - the fire test formulated under the procedures of ASTM E 119.

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) outlets 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.

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.

TANK - a vessel containing more than 60 gallons (0.23 m^3).

TANK, PORTABLE - any packaging over 60 U.S. gallons capacity and designed primarily lobe 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 lbs (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 lbs (454 kg) water capacity.

TEMPORARY SEATING - seating facilities which are intended for use at a location for not more than 90 days. Applies to reviewing stands, grandstands and bleachers.

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 or 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 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.

THERMOSETTING MATERIAL - a plastic material which is capable of being changed into a substantially nonreformable product when cured.

THERMOPLASTIC MATERIAL - a plastic material which is capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature.

THROUGH-PENETRATION PROTECTION SYSTEM - a system installed to resist, 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.

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

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 1000 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 2000 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.

TRAVEL DISTANCE - the distance from the most remote point in a building or structure to the nearest exit measured along the natural path of travel. Where any part of an exit stair is within 10 ft horizontal distance of an unprotected opening, the distance to the exit shall include the length of travel to the ground level.

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 non-compatible materials.

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.

WALKWAY, COVERED - a roofed, unobstructed walkway, where the least horizontal dimension is less than 30ft (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 30ft (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.

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

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

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

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, 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, 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.

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.

WORKING STAGE - see Stage, Legitimate.

WRITING - includes printing and typewriting.

WRITIEN 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

FIRE DISTRICT

301 GENERAL PROVISIONS

301.1 Establishment

For the purpose of this Code a Fire District may be established. The Fire District shall be in accordance with the provisions of 301.2.

301.2 Scope

301.2.1 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 construed to mean the Fire District designated and referred to in this be chapter. See Appendix G for recommended method of establishing said Fire District.

301.2.2 The Fire District complying with the provisions of 301.2.1 shall be shown on a map which shall be available to the public.

302 BUILDING RESTRICTIONS

302.1 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 304.

302.2 Other Specific Requirements

302.2.1 Exterior walls of buildings located in the Fire District shall comply with the requirements in Table 600, except as required in 302.2.6.

302.2.2 Every Group H occupancy shall be prohibited from location within the Fire District.

302.2.3 Every building shall be fire protected throughout as specified for the various types of construction in Chapter 6.

302.2.4 Roof covering in the Fire District shall conform to the requirements of Class A or B roof coverings as defined in 706.

302.2.5 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, all walls, floors, roofs, and their supporting structural members shall provide not less than 1-hour fire resistance. Temporary partitions are set forth in 702.4.

302.2.6 Exterior walls of Type IV buildings shall have a fire resistance of 2 hours or more when such walls are located within 30 ft of a common property line or an assumed property line. Exterior walls located more than 30ft 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 2000 sq ft or Jess in area, exterior walls located more than 15 ft from a common property line or an assumed property line need only comply with Table 600.

303 CHANGES TO BUILDINGS

303.1 Existing Buildings Within The Fire District

An existing building shall not be hereafter increased in height unless it is of a type of construction permitted for new buildings within the Fire District or is altered to comply with the requirements for such type of construction. Nor shall any existing building be hereafter extended on any side unless such extensions are of a type of construction permitted for new buildings within the Fire District.

303.2 Other Alterations

Nothing in 303.1 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.

303.3 Moving Buildings

Buildings shall not hereafter be moved into the Fire District or to another lot in the Fire District unless it is of a type of construction permitted in the Fire District. See 2204.

303.4 Type VI Buildings Within Fire District

No Type VI building or structure shall be erected, repaired, moved into the Fire District, or addition thereto except upon the permit of the local inspection department approved by the city council, and approved by the commissioner of insurance or his designee.

304 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 inside the boundaries of the Fire District.

305 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 in area, located on the same lot with a dwelling.
3. Fences not over 8 ft high.
4. Coal tipples, material bins, trestles conforming to 412.3.
5. Water tanks and cooling towers conforming to 713 and 714.
6. Greenhouses less than 15ft high.
7. Porches on dwellings not over one story in height, and not over 10 ft wide from the face of the building, provided such porch does not come within 5 ft of any property line.
8. Display signs as provided in Chapter 23.
9. Sheds open on a long side not over 15ft high and 500 sq ft 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.

CHAPTER 4

CLASSIFICATION OF BUILDING BY OCCUPANCY

401 GENERAL

401.1 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 404)
Group B	-Business (see 405)
Group E	-Educational (see 406)
Group F	-Factory Industrial (see 407)
Group H	-Hazardous (see 408)
Group I	-Institutional (see 409)
Group M	-Mercantile (see 410)
Group R	-Residential (see 411)
Group S	-Storage (see 412)

401.2 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.

402 HEIGHT AND AREA

402.1 Application

402.1.1 For the purpose of this Code, "height" and "area," as applied to a building, has the meaning designated in Chapter 2.

402.1.2 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 400 except as modified in 402.2 and 402.3 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.

402.1.3 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 402.1.2.

402.1.4 An existing building shall not be increased in height unless the entire building is altered to meet the requirements of this Code for a new building of such increased height and building areas.

402.2 Height Modifications

402.2.1 Rooftop Structures. Church spires, chimneys, tanks and supports, aerial supports, parapet walls not over 4ft (12 cm) 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 712,713,714,715 and 716.

402.2.2 Parking Under Group R. Where a one story automobile parking structure, 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 shall provide the occupancy separation required in 403.1.3.

402.2.3 Mezzanines. A mezzanine shall not be counted as a story when it meets the following requirements:

402.2.3.1 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.

402.2.3.2 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.

402.2.3.3 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 (107 cm) 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.

402.2.3.4 Two means of egress shall be provided from any mezzanine with an occupant load in excess of the following, or when the travel distance to an exit or to a point where there is a choice of more than one means of egress exceeds the following:

Use	Occupant Load	Travel Distance No Greater Than:
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*
Storage	30	100 feet

* Maximum area with one exit or exit access door shall be 200 sq ft.

402.2.3.5 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.

402.2.3.6 Egress stairways from mezzanines shall conform with the requirements of 1112. 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 space 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 72E which sounds an alarm in the mezzanine.
2. The travel distance from the most remote point on the floor of the mezzanine to the building exit or to a protected egress corridor, exit court, horizontal passageway, enclosed stairway, or exterior exitway balcony, inclusive of travel on the stairway, does not exceed 75 ft where a single means of egress is permitted, or the limits of Table 1103 where multiple means of egress are required.
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.

402.2.4 Basements. A basement of a building shall not count as a story 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 7ft (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.

402.2.5 Group A and E Basements. Group A and Group E basements used as classrooms or assembly rooms shall be counted as a story.

402.3 General Area Modifications

402.3.1 The exceptions and requirements of 402.3 and 402.4 shall modify unsprinklered areas permitted by Table 400 and the specific use provisions of this chapter.

402.3.2 Where streets or public spaces, or horizontal separation from property lines of total width of not less than 30ft (9.1 cm), or 30ft (9.1 cm) between buildings on commonly owned property, extend along the building perimeter, except for hazardous occupancies, the areas permitted by Table 400 may be increased as follows:

$$I = 4/3[100 (F/P - 0.25)]$$

Where
- I = Percent increase of unsprinklered areas in Table 400
- F = Building perimeter which fronts on streets, public spaces or horizontal separation not less than 30ft (9.1 cm) wide
- P = Total perimeter of building

402.3.3 For both an unsprinklered building and a sprinklered building, the percent increase is multiplied by the unsprinklered area permitted in Table 400 for the type of construction of the building, and the resulting area increase is added to either the sprinklered or unsprinklered areas in Table 400. When there are no unsprinklered areas permitted for the building in Table 400 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.

402.4 Occupancy Area Modifications

402.4.1 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 90 I, 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.

3. Existing buildings, which complied with the unlimited areas modifications of previous code editions at the time of construction, may be enlarged provided that all exterior walls of the addition maintains the required permanent open space of not less than 60 feet.

402.4.2 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 901, is surrounded on all sides by a permanent open space of not less than 60 ft (18 m), and is provided with 1-hour fire resistant smokestop partitions dividing the building into areas not to exceed 30,000 sq ft (2787 m2) in floor area.

402.4.3 One story Group A buildings without legitimate stage of Type III, IV or V 1-hour construction which are surrounded on all sides by a permanent open space of not less than 60 ft (18 m), are provided with an approved automatic sprinkler system, and the assembly floor is located at, or within 21 inches (53 cm) 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.

402.4.4 Where there are no balconies or galleries in Group A - Large Assemblies without working stage or in Group A - Small Assembly, with or without working stage, and the assembly floor is located at or within 21inches (53 cm) of street or grade level and all exits meet the street or grade level by ramps having a slope not exceeding 1:12 the maximum allowable areas of Type III, IV and V construction may be increased 50% over the unsprinklered areas specified in Table 400. This increase may be added to the area increase permitted by 402.3.2.

402.4.5 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 30ft (9.1 m) of permanent open space.

402.4.6 When used as a place of worship, the allowable areas for Group A - Small Assembly without working stage may be increased 33 1/3% over the unsprinklered areas specified in Table 400. This increase may be added to the area increase permitted by 402.3.2.

402.4.7 The area of a one story Group B Type III, IV or V building may be increased 100% over the unsprinklered areas specified in Table 400 if the building is surrounded on all sides by a permanent open space of not less than 60 ft (18 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 402.3.2.

402.4.8 Group H area modifications:

1. For sprinkler requirements- see 408.2.5.
2. Dry cleaning establishments using flammable solvents - see 408.4.
3. Tire Recapping- see 408.6.
4. Storage of Combustible Fibers - see 408.8.
5. Storage of Hay - see 408.9.

402.4.9 Group M area modifications:

1. Malls - see 507.
2. Sprinkler requirements - see 901.7.1.

402.4.10 Group S area modifications:

1. Aircraft Hangers - see 412.2.2.
2. Automobile parking structures - see 412.6.
3. Commercial garages sprinkler requirements - see 901.6.

402.4.11 The permanent open space of 60ft required in 402.4.1, 402.4.2, 402.4.3 and 402.4.7 shall be permitted to be reduced to not less than 40 ft 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.

402.4.12 The area of a one story shed may be increased 100% over the unsprinklered area specified in Table 400. This increase may be added to the area increase permitted by 402.3.2.

403 MIXED OCCUPANCY SEPARATION

403.1 General

403.1.1 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
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.

403.1.2 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.

403.1.3 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 403.1.

TABLE 403.1
OCCUPANCY SEPARATION REQUIREMENTS

Large Assembly	2 hour
Small Assembly	2 hour
Business	1 hour
Educational	2 hour
Factory-Industrial	2 hour
Hazardous	See 408
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 hour
Automobile Repair Garages	2 hour

403.2 Accessory Occupancies

403.2.1 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 412.1.3 need not be considered mixed occupancies. Height and area will be governed by the principal intended use.

403.2.2 The following occupancies need not be separated from the uses to which they are accessory:

1. Assembly rooms having a floor area of not over 750 sq ft ($70m^2$).
2. 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.
3. 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.

403.3 Special Occupancy Separations

403.3.1 A separation between a private garage and any occupancy shall be the minimum fire resistance specified in Table 403.1 for the occupancy, except in the case of a one or two family dwelling where, fire resistance separation shall not be required.

403.3.2 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.

403.3.3 A 2-hour fire resistance separation shall be required between:

1. Day school classrooms and Group A - Large Assembly occupancy, auditorium, cafeteria, and gymnasium, which is used exclusively as an accessory use to the education occupancy.
2. Sunday school classrooms and a church auditorium or sanctuary of Group A - Large Assembly occupancy.

403.3.4 A separation between an automobile parking structure 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 403.1 shall be 2 hours.

403.4 Tenant Separation

403.4.1 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 Group B and Group S buildings, non-fire rated partitions may be used to separate tenants provided no area between partitions rated at 1-hour or more exceeds 3000 sq ft.

403.4.2 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.

403.5 Separation Between Townhouses

Each townhouse shall be considered a separate building and shall be separated from adjoining townhouses by the use of separate exterior wa1ls meeting the requirements of Table 600 for zero clearance from property lines as required for the type of construction, or by a party wall, or when not more than three stories in height, may be separated by a single wall meeting the following requirements:

1. Such wall shall provide not Jess than a 2-hour fire resistance rating. Plumbing, piping, ducts, electrical or other building services shall not be installed within or through the 2-hour wall, unless such materials and methods of penetration have been tested in accordance with 1001.1.

2. Such wall shall be continuous from the foundation to the underside of the roof sheathing. The roof sheathing shall be of noncombustible material, or fire retardant treated wood, or one layer of 5/8-inch Type X gypsum wallboard attached to the underside of the roof decking, for not Jess than a 4-ft width on each side of such wall.
3. Each dwelling unit sharing such wall shall be designed and constructed to maintain its structural integrity independent of the unit on the opposite side of the wall.
   EXCEPTION: Said wall may be penetrated by roof and floor structural members provided that the fire resistance rating and the structural integrity of the wall is maintained.

404 ASSEMBLY OCCUPANCY – GROUP A

404.1 Scope

404.1.1 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.

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

Amusement Park Buildings
Auditoriums
Churches
Dance Halls
Gymnasiums
Restaurants that
accommodate 100 or more people, or
provide dancing or entertainment
Motion Picture Theaters
Museums
Passenger Depots
Public Assembly Halls
Recreational Halls
Stadiums and Grandstands
Tents for Assembly
Theaters for Stage Production

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

404.2 Subclassifications

404.2.1 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. Large Assembly shall include theaters and places of assembly having a capacity of 1000 or more persons. Also, Large Assembly shall include theaters and places of assembly having a working stage (see definition of Stage, Legitimate) and having a capacity of 700 or more persons.
2. Small Assembly shall include theaters and places of public assembly with or without a legitimate stage having a capacity of 100 or more persons but having a capacity less than designated for Large Assembly.

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

404.3 Occupant Capacity

404.3.1 The capacity of occupant content for Group A occupancies shall be as set forth in Chapter 11.

404.3.2 A sign setting forth the allowable capacity of every Group A occupancy, in number of occupants other than employees, shall be displayed in a prominent place. Such signs shall read as follows:

> Occupancy by more than _____ persons is dangerous and unlawful
>
> _____ Building Official

404.3.3 A permit as required by the Standard Fire Prevention Code shall not be issued unless all seats, stands and· structures conform to the requirements of Chapter 12. The width of all seats shall be marked allowing a space for each person of not less than 18 inches.

404.4 Special Construction Requirements

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

404.4.2 Buildings of Group A - Large Assembly without a working stage shall conform to the limitations of use prescribed in Table 400.

404.4.3 Buildings of Group A - Small Assembly shall conform to the limitations of use prescribed in Table 400.

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

404.4.5 All walls and partitions for enclosing stairs, passageways or corridors (except foyers or waiting spaces) which are used for exits, or enclosing rooms used for exit purposes in Group A occupancies, shall be of not less than 2-hour fire resistant construction. Refer to Table 700 for other requirements.

404.4.6 A kitchen in a Group A occupancy does not constitute a mixed occupancy. A fire resistant separation is not required.

404.5 Interior Finish

404.5.1 For regulations governing flame spread of ceiling and wall finish materials, see 704.

404.5.2 Imitation leather or other material, consisting of, or coated with a pyroxylin or similarly hazardous base, shall not be used in Group A occupancies.

404.5.3 For churches or places of worship nothing in this section shall prevent the use of wood for ornamental purposes, trusses, paneling, or chancel furnishing.

404.6 Sprinklers And Standpipes For Large Assembly With Working Stages

404.6.1 Every theater classified as Group A - Large Assembly with working stage shall have an approved system of automatic sprinklers and standpipes conforming with Chapter 9.

404.6,2 Sprinklers may be omitted in auditoriums, foyers and lobbies and over generators and other electrical equipment or switch boards.

404.7 Supplementary Lighting System

There shall be installed in every Group A - Large Assembly a supplementary lighting system in addition to the regular system by local electric power. Such supplementary or emergency lighting shall be automatically actuated in case of power failure.

404.8 Stages And Platforms

404.8.1 Materials used in the construction of platforms and stages shall conform to the applicable material requirements as set forth in the Code. The design of platforms and stages shall comply with the requirements of Chapter 12.

404.8.2 Temporary platforms may be constructed of any materials. The space between the floor and the platform above shall not be used for any purpose other than electrical wiring to platform equipment.

404.8.3 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.

404.9 Stages

404.9.1 Construction. Regular stages and thrust stages shall be constructed of materials as required for the type of construction of the building in which located. In all cases the finish floor may be of wood.

404.9.1.1 Legitimate stages shall be constructed of materials as required for a Type I building except that the portion of the legitimate stage extending back from and 6 ft beyond the full width of the proscenium opening on each side may be constructed of steel or heavy timber covered with a wood floor of not less than 2 inch nominal thickness. Except for the finished floor, combustible construction shall not extend through the proscenium opening.

404.9.1.2 Openings through stage floors (traps) shall be equipped with tightfitting trap doors of wood having a nominal thickness of not less than 2 inches with approved safety locks.

404.9.2 Accessory Rooms. Dressing rooms, workshops and store rooms accessible to stages shall be separated from each other and from the stage by not less than 1-hour fire resistant construction and openings within such separations shall be protected as required for corridors (20-minute fire door assemblies).

EXCEPTION: A separation is not required for stages having a floor area not exceeding 500 sq ft.

404.9.3 Vents. Stages exceeding 500 sq ft in floor area shall be provided with one or more vents constructed of noncombustible material. Vents shall he located near the center and above the highest part of any stage. They shall be raised above the stage roof and shall have a total vent area equal to at least *5%* of the floor area of the stage.

404.9.3.1 The vents shall open by spring action or force of gravity sufficient to overcome the effects of neglect, rust, dirt, frost, snow, or expansion by heat or warping of the framework. Glass, if used in vents, must be protected against falling onto the stage. A wire screen, if used under the glass, must be so placed that if clogged, it cannot reduce the required venting area or interfere with the operating mechanism or obstruct the distribution of water from an automatic sprinkler. Vents shall be arranged to open automatically by the use of fusible links. The fusible links and operating cable shall hold each door closed against the minimum 30 lb counter force which may be exerted by springs or counterweights. This minimum counter force shall be exerted on each door through its entire arc of travel and for a minimum of 155^{O}. A manual control shall also be provided.

404.9.3.2 Springs, when employed to actuate vent doors, shall be capable of maintaining full required tension. Springs shall not be stressed more than 50% of their rated capacity and shall not be located directly in the air stream nor exposed to the outside. A fusible link shall be placed in the cable control system on the underside of the vent at or above the roof line or as approved by the Building Official and shall be so located as not to be affected by the operation of an automatic sprinkler system. Remote, manual or electrical controls shall provide for both opening and closing of the vent doors for periodic testing and shall be located at a point on the stage designated by the Building Official. When remote control vents are electrical, power failure shall not affect its instant operation in the event of fire. Hand winches may be employed to facilitate operation of manually controlled vents. Curb for vents shall be as required for skylights.

404.9.4 Proscenium Walls. Legitimate stages shall be completely separated from the seating area by a proscenium wall of not less than 2-hour fire resistive noncombustible construction. The proscenium wall shall extend at least 4ft above the roof of the auditorium.

404.9.4.1 Proscenium walls may have, in addition to the main proscenium opening, one opening at the orchestra pit level and not more than two openings into the auditorium at the legitimate stage floor level. Each such opening shall not be more than 25 sq ft in area.

404.9.4.2 All openings in the proscenium wall of a legitimate stage shall be protected by a fire assembly having a 1 1 /2-hour fire resistant rating. The main proscenium opening used for viewing performances shall be provided with an automatic closing fire resistant curtain as provided in the SBCCI Standard for Proscenium Curtains.

404.9.5 Gridirons, Fly Galleries and Pinrails. Gridirons, fly galleries and pinrails shall be constructed of noncombustible materials.

404.9.6 Special Exiting. Each side of a legitimate stage shall be provided with at least one well-marked means of egress providing not less than 32 inches clear width. Such means of egress shall open directly to the street, exit court or exit passageway leading to a street.

404.9.6.1 Fly galleries shall be provided with a stair not less than 30 inches wide. Each tier of dressing rooms shall be provided with two means of egress meeting the requirements of the Chapter 11.

404.9.6.2 Stairways required by 404.9.6 need not be enclosed.

404.10 Flame Retardant Requirements

Combustible scenery of cloth, film, vegetation (dry), and similar effects shall meet the requirements of the Standard Fire Prevention Code.

404.11 Motion Picture Projection Rooms

404.11.1 The provisions of 404.11 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.

404.11.2 Every motion picture machine projecting film as mentioned in 404.11.1 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.

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

404.11.4 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.

404.11.5 The room shall have a floor area of not less than 80 sq ft for a single machine, and at least 40 sq ft for each additional machine. Each motion picture projector, floodlight, spotlight or similar piece of equipment shall have a clear working space not less than 30 x 30 inches on each side and at the rear thereof, but only one such space shall be required between two adjacent projectors.

404.11.6 The projection room and the rooms appurtenant thereto shall have a ceiling height of not less than 7 ft 6 in.

404.11.7 The projection room shall be provided with not less than one exit having a minimum opening of not less than 30 inches wide and 80 inches high.

404.11.8 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.

404.11.9 Projection booth ventilation shall be not less than the following:

404.11.9.1 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.

404.11.9.2 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.

404.11.10 A maximum of four containers for flammable liquids not greater than 16 oz capacity and of a noncombustible type may be permitted in each projection room.

404.12 Foyers And Lobbies

404.12.1 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.

404.12.2 The width of foyer at any point shall not be less than the combined width of aisles, stairways, and passageways tributary thereto. The foyer shall be at the same level as the back of the auditorium, and exits leading therefrom shall not have a steeper gradient than 1:12.

404.12.3 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 high.

404.13 Boxes, Balconies And Galleries

Refer to 1122.9, 1122.10, 1122.11.

404.14 Tents For Public Assembly

404.14.1 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 fire resistance prescribed in NFiPA 701, and that such fire resistance is effective for the period specified by the permit.

404.14.2 Tent exits, aisles, seating, etc., shall conform with the requirements for places of assembly. All exits shall be kept free and clear of obstructions while the occupied by the public.

404.14.3 Ground within and adjacent to tents shall be cleared of all grass, underbrush or similar fire hazards.

404.15 Amusement Park Buildings

404.15.1 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.

404.15.2 Amusement park buildings over one story in height, or 1200 sq ft in floor area, shall have exterior walls, floors and their supports of not less than 1-hour fire resistant construction.

404.15.3 Where amusement park buildings are located within 30ft of adjacent property lines, buildings or other structures, the exterior walls shall be constructed of noncombustible materials, or shall be protected to provide not less than 1-hour fire resistance.

404.15.4 Structures of open skeleton frame type shall not be limited in height or area, except that grandstands shall comply with the requirements of 503.

404.15.5 Amusement structures shall provide adequate safety for all loads to which they may be subjected and shall be equipped with approved safety devices and safeguards.

405 BUSINESS OCCUPANCY – GROUP B

405.1 Scope

405.1.1 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.

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

Animal hospitals, kennels, pounds
Automobile and other motor vehicle Showroom
Automobile or other vehicle service stations
Banks
Barber shops
Beauty shops
Bowling alleys
Car wash
Civic administration
Clinic - outpatient
Dry cleaning; pick-up and delivery stations and self-service
Educational occupancies above the 12th grade
Electronic data processing
Florist and nurseries showrooms
General post offices
Greenhouses
Laboratories; testing and research (nonhazardous)
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

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

EXCEPTION: Provisions of 404.4, 404.8, 404.11, 404.14, 1105.2, 1122, and 1123 shall apply to buildings used for assembly purposes regardless of occupant load.

405.1.4 See 506 for high rise provisions.

405.1.5 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.

405.2 Automotive Service Station

405.2.1 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 underground 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 the vehicle washing, lubrication and minor replacement, adjustment and repair service are rendered. An automobile service station building shall not have a basement, but may have open pits if such pits are continually ventilated may be of any construction type. Aboveground gasoline storage tanks are permitted when the provisions of Appendix Tare met.

405.2.2 Canopies and their supports over pumps shall be of noncombustible materials, wood of Type III sizes, or of construction providing l-hour fire resistance.

405.2.3 All equipment likely to cause an explosion, or capable of igniting gasoline vapor from heat, sparks, or open flames, shall be located at least 4 ft above the floor, or be completely and tightly enclosed by noncombustible construction, or construction of not less than 1-hour fire resistance. Any openings to such enclosures shall be from the outside with the sill raised at least 1 ft above the adjoining outside level, and shall be located at least 5 ft from any property line or adjacent building.

405.2.4 Pumps or other dispensing devices shall be located a minimum of 10 ft 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 of any building opening.

405.2.5 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.

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

405.2.7 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 deenergized upon replacement of the hose nozzle in its boot.

405.2.8 A clearly labeled manually operated pump master switch shall be provided in an approved location, within 75 ft of, but not nearer than 15 ft to, any dispenser. Where such master switch is not visible from all dispensers, the location thereof shall be indicated by approved signs. Signs identifying the pump master switch shall be labeled EMERGENCY PUMP SHUTOFFS.

405.2.9 Pressure systems shall incorporate with each turbine an indicator light illuminated when the turbine is running. Said light shall be visible from the pump island, and suitably identified as to the system served.

405.3 Bowling Alleys

405.3.1 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.

405.3.2 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.

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

405.3.4 Door openings shall be provided with noncombustible sills raised 6 inches above floor level and protected with approved fire doors.

405.3.5 Shelving, containers, and all furnishings shall be of noncombustible material. Machinery shall be effectively grounded. See 408.2.6.

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

406 EDUCATIONAL OCCUPANCY – GROUP E

406.1 Scope

406.1.1 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.

406.1.2 Child care facilities which accommodate children who stay more than 4 hours per day shall meet the requirements of 513.

406.1.3 Parts of buildings used for the congregation 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.

406.1.4 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 1105 for the occupancy classification used.

406.2 Special Protective Requirements

406.2.1 The following references to other protective requirements, as set forth in this Code, shall apply to all areas classified as Group E occupancies.

1. Where permanent motion picture projectors using cellulose nitrate film are installed, booths shall be provided, as set forth in 404.11.
2. Rooms used for day care nurseries, kindergarten or first grade pupils shall not be located above or below the floor of exit discharge. Rooms used for second grade pupils shall not be located more than one story above the floor of exit discharge.
3. Every heating appliance which produces an unprotected open flame shall be prohibited.
4. In public schools, 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.

406.3 Windows for Rescue and Ventilation

Every room or space used for classrooms or other educational purposes or normally subject to student occupancy shall have at least one outside window used for emergency rescue or ventilation. Such window shall be openable from the inside without the use of tools and shall provide a clear opening with a minimum dimension of 24 inches and 5.7 sq ft in area. Maximum sill height shall be 32 in. for grades K-6 and 44 in. for grades 7-12.

EXCEPTIONS:

1. Openable windows are not required in buildings with a complete approved sprinkler system.

2. Windows are not required where a room or space has a door leading directly to the outside of the building.
3. This section does not apply when windowless classrooms open directly to an exit corridor and have access (through an adjoining classroom or directly) to an exit corridor which is separated by one-hour rated construction from the primary exit corridor.

406.4 Subdivision of Building Spaces

406.4.1 School buildings shall be subdivided into compartments by smoke barriers meeting the requirements of Sections 409.1.2.2, 409.1.2.3, 409.1.2.4, 409.1.2.5, and 409.1.2.7. The maximum area of a smoke compartment shall not exceed 30,000 sq ft with no dimension exceeding 300 ft. Door width required by Section 409.1.2.3 shall comply with Table 1103.

EXCEPTIONS:

1. Where all classrooms have a· door opening to the outside.
2. One story buildings which are equipped with an approved supervised automatic sprinkler system.

407 FACTORY-INDUSTRIAL OCCUPANCY – GROUP F

407.1 Scope

407.1.1 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.

407.1.2 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 408.

Manufacturing Plant	Processing Plan
Factory	Mill
Assembly Plant	

407.1.3 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 408.

408 HAZARDOUS OCCUPANCY – GROUP H

408.1 General Provisions

408.1.1 General

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.

408.1.2 Classification

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

H1: 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 408.1.2A.

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 408.1.2B.

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, 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 408.1.2C.

H4: Buildings or parts thereof used for the manufacturing, processing, generation or storage of materials which are health hazards. Health hazards include highly 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 408.1.2D.

EXCEPTIONS TO 408.1.2.1:

1. The quantities of alcoholic beverages in retail sales uses are unlimited provided the liquids are packaged in individual containers not exceeding 1 gal (0.004 m3).
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 (0.004 m3).
3. Mercantile occupancies: In rooms or areas accessible to the public, storage of flammable and combustible liquids shall be limited to quantities needed for display and normal merchandising purposes but shall not exceed 2 gal per sq ft (0.08 m3/m2) of gross floor area. The gross floor area used for computing the maximum quantity permitted shall be considered as that portion of the store actually being used for merchandising flammable and combustible liquids.
4. Explosives, Blasting Agents and Ammunition

   4.1 Mercantile - possession, storage and sale of not more than 25 lb (11 kg) black powder, 100 lb (45 kg) smokeless propellants, 25,000 small arms primers on display, and no quantity limitation for small arms ammunition.

   4 2 Residential - possession, storage and use of not more than 5 lb (2.3 kg) black powder, 20 lb (9 kg) smokeless propellants, and 10,000 small arms primers.

   4.3 Storage - possession and storage of not more than 750,000 small arms primers.
5. Refrigeration systems.
6. Storage, use and handling of 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.

8. Control areas containing hazardous material not exceeding the exempt quantities shall be permitted in all occupancies except for assembly occupancy. 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 703.4.2.3. 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.
9. Corrosives, irritants and sensitizers shall not include commonly used building materials.
10. Corrosives, irritants and sensitizers shall not include personal or household products in their original packaging for retail display.

408.1.2.2 When the stored amount of any hazardous material listed in tables 408.1.2A through 408.1.2D 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.

TABLE 408.1.2A
EXEMPT QUANTITIES OF H1 MATERIALS

Conditions	Explosives and Blasting Agents		Liquids And Solids Oxidizers[2,3,4] (Lbs)	Organic Peroxides[2,5] (Lbs)	Unstable (Reactive) Material (Detonatable)[2,5]			
					CLASS 3		CLASS 4	
	Solids (lbs)	Liquids (gals)	Class 4	UD	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. Storage of pyrotechnic special effect materials in motion picture, television, theatrical and group entertainment production when under permit amount as specified in Chapter 20, 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 office 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 A occupancies.

UD = Unclassified Detonatable.

TABLE 408.1.2B
EXEMPT QUANTITIES OF H2 MATERIALS

Conditions	Flammable and Combustible Liquids in Open Containers Or Containers Pressurized At More Than 15 Psig (Gal)[1] Class IA	IB	IC	IA IC[2]	IB	II	IIIA	Combustible Dusts Stored In Piles Or Open Containers (Lbs)	Liquid and Solid Oxidizers (lbs)[3,5] Class 3	Organic Peroxides (lbs)[3,5] Class 1	Pyrophoric Materials[3,5] Solid & Liquid (lbs)	Gases (cu ft)	Unstable Reactives5 (Nondetonatable) Class 3 Solid & Liquid (lbs)	Gases (cu ft)	Flammable Cryogenic 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	1320		500	40	20	8	100	20	200	90

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, 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, material is not permitted in Group A, B, E, I, M and R occupancies.

TABLE 408.1.2C
EXEMPT QUANTITIES OF H3 MATERIALS

Conditions	Flammable and Combustible Liquids in Open Containers Or Containers Pressurized At More Than 15 Psig (Gal)[1]							Flammable Solids (lbs)	Liquid & Solid Oxidizer (lbs)[3,5]		Organic Peroxides[3] (lbs)			Unstable Materials				Water Reactives[3] (lbs)			Flammable or Oxidizing Cryogenic Fluids (gals)
	Class								Class		Class			Class 1		Class 2					
	IA	IB	IC	IA IC[2]	IB	II	IIIA		1	2	II	III	IV	Solid & Liquid (lbs)	Gases (cu ft)	Solid & Liquid (lbs)	Gases (cu ft)	1	2	3	
unprotected by sprinklers or cabinet	30	60	90	120	120	330	13200	125	1000	250	50	125	500	125	750	50	250	NL	50	5	45
within cabinet in unsprinklered building	60	120	180	240	240	660	26400	250	2000	500	100	250	1000	250	1500	100	500	NL	100	10	45
in sprinklered building, not in cabinet	60	120	180	240	240	660	NL	250	2000	500	100	250	1000	250	1500	100	500	NL	100	10	90
in sprinklered building, within cabinet	120	240	360	480	480	1320	NL	500	4000	1000	200	500	2000	500	3000	200	2000	NL	200	20	90

1. For storage requirements see Chapter 9 of the Standard Fire Prevention Code.
2. Containing not more than the exempt amounts of Class I-A, Class I-B, or Class I-C flammable liquids.
3. A conversion of 10 lbs/gal shall be used.
4. For baled combustible fibers the exempt quantities shall be 1000 cu lt, 2000 cu ft and 4000 cu lt for the respective conditions.

TABLE 408.1.2D
EXEMPT QUANTITIES OF H4 MATERIALS

Conditions	Highly Toxic Gases1,2,4 (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	Liquids	Gases
unprotected by sprinklers or cabinet	0	650	1	500	5000	500	650
within cabinet in unsprinklered building	20	1300	2	1000	10000	1000	1300
in sprinklered building, not in cabinet	0	1300	2	1000	10000	1000	1300
in sprinklered building, within cabinet	40	2600	4	2000	20000	2000	2600

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 l0 lbs/gal shall be used.
4. Compressed chlorine gas shall have an exempt amount of 810 cu ft.

408.1.3 Mixed Occupancies

408.1.3.1 The separation of a hazardous occupancy from other occupancies shall be in accordance with Table 408.1.3.

TABLE408.1.3
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

NP - H1 occupancies not permitted to be attached to other occupancies or other H subgroups.

408.1.3.2 The separation of a hazardous occupancy subclassification shall only apply to storage areas.

408.1.3.3 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.

408.1.3.4 Accessory areas, other than assembly occupancies, that do not exceed 10% of the allowable area for the hazardous occupancy subclassification in Table 400 and that do not exceed 1500 sq ft (139m2) shall not be required to comply with 403. When 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 703.4.2.3.

408.1.3.5 Assembly occupancies not exceeding 750 sq ft (70m2) shall have partitions not less than 1-hour fire resistance rating with an opening protection rating of not less than 3/4-hour. Opening protection shall be either self-closing or automatic closing in accordance with 703.4.2.3.

408.2 Special Requirements

408.2.1 General.

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

408.2.1.2 An increase in the allowable areas or heights as set forth in Table 400 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.

408.2.2 Automatic Protection Systems.

408.2.2.1. 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 3000 sq ft (279 m2) a density for 3000 sq ft (279 m2) shall be used.

EXCEPTIONS:

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

408.2.2.2 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 water-tight containers.

408.2.2.3 Highly Toxic and Toxic Compressed Gas. Gas cabinets 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.

408.2.2.4 Highly Toxic Solids and Liquids. Exterior storage of highly toxic solids and liquids shall be in fire-resistive 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.

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

408.2.2.6 Vehicle Loading Racks and Exterior Storage. Flammable hazardous materials dispensing or use areas located within 50 ft (15 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.

408.3 Storage and Dispensing Areas

408.3.1 General. This division shall apply to the storage and dispensing of hazardous materials in excess of the exempt amounts specified in Tables 408.l.2A through 408.1.2D.

EXCEPTIONS:

1. Hazardous materials regulated by other chapters in the *Standard Fire Prevention Code* unless specifically indicated in 408.5 through 408.19.
2. All indoor storage of liquid and solid oxidizers, organic peroxides, unstable (reactive) and water-reactive materials shall be as specified in 408.5 through 408.19.

408.3.2 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 (4.8 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 non-relieving portions of the building.
5. Vents shall be designed to relieve at a maximum internal pressure of 20 psf (960 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 (3 m) vertically and 20 ft (6.1 m) horizontally from window openings or exits in the same or adjoining buildings or structures.

   EXCEPTIONS TO 408.3.2:

   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, or 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.

408.3.3 Spill Control, Drainage, and Containment.

408.3.3.1 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 (3.8 I) capacity, or used in open containers or systems exceeding 5 gal (19 l) capacity, or in closed systems exceeding 55 gals (3.8 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.

408.3.3.2 Spill Control. Floors shall be recessed a minimum of 4 inches (102 mm) or shall be provided with a liquid-tight raised sill to a minimum height of 4 inches (102 mm) so as to prevent the flow of liquids to adjoining areas. When liquid-tight 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.

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

1. 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.

408.3.3.4 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, or irritants, sensitizers and health hazard solids, liquids and gases. Secondary containment in open system dispensing areas shall be provided when the aggregate of multiple tanks or containers exceeds 1000 gals (4 m3). In closed system dispensing areas, secondary containment shall be provided when the capacity of an individual container exceeds *55* gals (0.21 m3) or the aggregate of multiple containers exceeds I 00 gals (0.4 m3).
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 liquid-tight 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 now 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.

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

408.3.4 Ventilation.

408.3.4.1 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.

408.3.4.2 Exhaust ventilation systems shall comply with the following:

1. Installation shall be in accordance with the provisions of *Standard Mechanical Code.*
2. Mechanical ventilation shall be at a rate of not less than 1 cfm per sq ft (0.005 m3/s/m2) of floor area over the storage area.
3. Systems shall operate continuously.
4. A manual shut-off 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 Shut-Off'.
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 in (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.

408.3.5 Alarm and Detection.

408.3.5.1 Emergency Alarm. A local fire alarm manual pull station or approved emergency signal device shall be installed outside of each interior egress door to a storage room. Activation of the emergency alarm shall sound a local 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 alarm station or an approved signaling device at not more than 150-foot (46 m) intervals and at each exit doorway throughout the transport route. The signal shall be relayed to an approved central, proprietary or remote station service or constantly attended on-site location and shall also initiate a local audible alarm.

408.3.5.2 Smoke Detection. An approved supervised smoke detection system shall be provided in rooms or areas where highly toxic compressed gases, liquid or solid oxidizers, or unclassified detonatable, Class I or Class II organic peroxides are stored. Smoke detection shall be provided where Class III or Class IV organic peroxides are stored in quantities exceeding the exempt amounts specified in Table 408.3.5. Activation of the detection system shall sound a local alarm.

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

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

TABLE 408.3.5[1,2]
EXEMPT AMOUNTS OF ORGANIC PEROXIDES (lb)

Condition	UD	CL I	CL II	CL III	CL IV
Unprotected by sprinklers or cabinets	0	5	50	125	500
Within cabinet in unsprinklered building	0	10	100	250	1000
In sprinklered building, not in cabinet	1	10	100	250	1000
In sprinklered building, within cabinet	2	20	200	500	2000

UD: Unclassified Detonatable

1. For organic peroxide liquids, a conversion of 10 lbs per 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.

408.3.6 Floors.

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

408.3.6.2 Liquid-Tight Floor. Floors of storage areas shall be of liquid-tight construction.

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

408.3.7 Weather Protection.

408.3.7.1 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.

408.3.7.2 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 1500sq ft (139 m2).
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.

408.3.8 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 *Standard Fire Prevention Code.*

408.3.9 Electrical Wiring and Equipment.

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

408.3.9.2 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 I, Group D locations.

408.3.9.3 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.

408.3.9.4 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, and
6. other electrically operated systems.

EXCEPTIONS:

1. 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.

408.3.10 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.

408.3.11 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.*

408.4 Dispensing, Use And Handling

When the amount of hazardous materials dispensed or used in one control area exceeds that specified in Tables 408.4A and 408.4B 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 408.5 through 408.19.

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

TABLE 408.4A
EXEMPT AMOUNTS OF HAZARDOUS MATERIALS PRESENTING A PHYSICAL HAZARD
Maximum Quantities Per Control Area[7]

		Closed Systems			Open Systems	
Material	Class	Solid lbs or (cu ft)	Liquid gal (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	(1000)	-	-	(200)	-
Cryogenics (Flammable or Oxidizing)		-	45[1]	-	-	10
Explosives		1/4[4]	(1/4)[4]	-	1/4[4]	(1/4)[4]
Flammable Gas	Gaseous	-	-	750	-	-
	Liquefied	-	15[1,5]	-	-	-
Flammable Liquid	IA	-	30			10[1]
	IB	-	60			15
	IC	-	90	-	-	20
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	1000[1]	(1000)[1]	-	200[1]	(200)[1]
Oxidizer-Gas	Gaseous	-	-	1500[1,5]	-	-
	Liquefied	-	15[1,5]	-	-	-
Pyrophoric		1[4]	(1)[4]	10[4,5]	0	0
Unstable (reactive)	4	1/4[1]	(1/4)[1]	2[4,5]	1/4[1]	(1/4)[1]
	3	1[1]	(1)[1]	10[1]	1[1]	(1)[1]
	2	50[1]	(50)[1]	250[1]	10[1]	(10)[1]
	1	125[1]	(125)[1]	750[1,5]	25[1]	(25)[1]
Water Reactive	3	5[1]	(5)[1]	-	1[1]	(1)[1]
	2	50[1]	(50)[1]	-	10[1]	(10)[1]
	1	125[1]	(125)[1]	-	25[1]	(25)[1]

- Not applicable.
NL: No1 limited.
UD: Unclassified detonatable.

FOOTNOTES TO TABLE 408.4A:

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 1lb or more of combustible dust per 1000 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 408.4B
EXEMPT AMOUNTS OF HAZARDOUS MATERIALS
PRESENTING A HEALTH HAZARD
Maximum Quantities Per Control Area

	Closed Systems			Open Systems	
	Solid	**Liquid**	**Gas**	**Solid**	**Liquid**
Material	lbs	gal or (lbs)	cu ft	lbs	gal or (lbs)
Corrosive	5000	500	650	1000	100
Highly Toxic	1	(1)	20	1/4	(1/4)
Irritant	5000	500	650	1000	100
Sensitizer	5000	500	650	1000	100
Toxic	500	(500)	650	125	125
Other Health Hazards	5000	500	650	1000	100

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 2000 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.

408.5 Explosives and Blasting Agents - Indoor Storage

Indoor storage of explosives and blasting agents shall be in accordance with 408 and Chapter 19 of *Standard Fire Prevention Code.* Indoor storage of fireworks shall be in accordance with 408 and Chapter 20 of *Standard Fire Prevention Code.*

408.6 Highly Toxic and Toxic Compressed Gases- Indoor Storage

408.6.1 General. Indoor storage of compressed gases shall be in accordance with the provisions of Chapter 15 of *Standard Fire Prevention Code.* Storage of highly toxic or toxic compressed gases shall be in accordance with 408.

408.6.2 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.

408.6.3 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:

1. 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 Office of Health and Human Services/National Institute of Occupational Safety and Health (OHHS/NIOSH) 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.

408.6.4 Exhaust Ventilation.

408.6.4.1 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.

408.6.4.2 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 200 ft 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 not1ess than 0.105-inch (2.67 mm) steel.

408.6.4.3 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 venti1ation to a treatment system.

408.6.5 Treatment Systems.

408.6.5.1 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.

408.6.5.2 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: 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.

408.6.6 Distance from Storage to Exposures. Exterior storage of highly toxic or toxic compressed gases shall comply with the following:

408.6.6.1 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 hrs 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.

408.6.6.2 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 50ft (15 m) horizontally from the storage area whether or not shielded by a protective structure.

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

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

1. Pressure relief devices shall be vented to a treatment system designed in accordance with the provisions of 408.6.5.
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 408.6.5.
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 arc designed to preclude backflow.
   2. Pressure relief devices.

408.6.8 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 Section 511.

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 now 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.

408.6.9 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 cylinder if all cylinders are stored within gas cabinets or exhausted enclosures or under exhaust hoods.

408.6.10 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 408.6.5. 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.

408.7 Flammable/Combustible Liquids- Indoor Storage.

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

408.8 Flammable Solids.

408.8.1 Indoor Storage. Indoor storage of flammable solids shall be in accordance with 408. Storage of combustible fibers shall be in accordance with the provisions of Chapter 33 of *Standard Fire Prevention Code.* Storage of cellulose nitrate plastics shall be in accordance with the provisions of Chapter 23 of *Standard Fire Prevention Code.*

408.8.2 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 *Standard Fire Prevention Code.*

408.8.3 Distance from Storage to Exposures. Exterior storage of flammable solids shall not be permitted within 20ft (6.1 m) of any building, property line, street, alley, public way, or exit to a public way.

EXCEPTION: An unpierced 2-hour fire-resistive 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.

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

408.9 Liquid and Solid Oxidizers.

408.9.1 Indoor Storage. Indoor storage of liquid and solid oxidizers shall be in accordance with 408.

EXCEPTION: For mercantile display areas displaying nonflammable solid and nonflammable or noncombustible liquid Class 1, 2 and 3 oxidizers, see 2201.8 of *Standard Fire Prevention Code.*

408.9.2 Detached Storage. Storage of liquid and solid oxidizers in quantities in excess of those specified in Table 408.9A 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 408.9A
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 408.1.2A, B and C

408.9.3 Distance from Detached Storage Buildings to Exposures. Detached storage buildings shall be located in accordance with Tables 408.9B and 408.9C.

TABLE 408.9B
CLASS 1, 2 OR 3 OXIDIZERS
SEPARATION OF DETACHED STORAGE FROM OTHER BUILDINGS PROPERTY LINES, STREETS, ALLEYS, PUBLIC WAYS OR EXITS TO A PUBLIC WAY

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

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

TABLE 08.9C
CLASS 4 OXIDIZERS
SEPARATION OF DETACHED STORAGE FROM OTHER BUILDINGS, PROPERTY LINES, STREETS, ALLEYS, PUBLIC WAYS OR EXIT TO A PUBLIC WAY

Weight (lbs)	Minimum Distance (ft)
Less than 10	50
11 to 100	75
101 to 500	100
501 to 1000	125
1001 to 3000	200
3001 to 5000	300
5001 to 10,000	400
Over 10,000	As determined by the Building Official

408.9.4 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.

408.10 Organic Peroxides.

408.10.1 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.*

408.10.2 Detached Storage. Storage of organic peroxides in quantities exceeding those specified in Table 408.10A 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 408.10A
REQUIRED DETACHED STORAGE OF ORGANIC PEROXID

Class	Detached Storage Required When Amount Exceeds (tons)
UD	See Chapter 19 of the Standard Fire Prevention Code
I	Exempt Amount Specified in Tables 408.1.2A, B and C
II	25
III	50
IV	No Requirement

UD: Unclassified detonatable

408.10.3 Distance from Detached Storage Buildings to Exposures. Detached storage buildings shall be located in accordance with Tables 408.10B and 408.10C.

TABLE 408.10B
SEPARATION OF DETACHED STORAGE FROM OTHER BUILDINGS, PROPERTY LINES, STREETS, ALLEYS, PUBLIC WAYS OR EXIT TO A PUBLIC WAY

Class	50 ft	100 ft	150 ft
I	2,000	20,000	175,000
II	100,000	200,000	Unlimited
III	200,000	Unlimited	Unlimited
IV	Unlimited	Unlimited	Unlimited

TABLE 408.10C
SEPARATION BETWEEN INDIVIDUAL DETACHED STORAGE BUILDINGS OR AREAS

Class	50 ft	100 ft	150 ft
I	2,000	20,000	175,000
II, II, IV		Footnote 1	

1. When the amount of organic peroxide stored does not exceed the amount indicated in Table 408.10B, minimum separation shall be 20ft; when the amount of organic peroxide stored exceeds the amount indicated in Table 408.10B minimum separation shall be 50 ft.

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

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

408.11 Pyrophoric Materials.

408.11.1 Indoor Storage. Indoor storage of pyrophoric solids, liquids and gases shall be in accordance with 408.

408.11.2 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 703.

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

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

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

408.12 Unstable (Reactive) Materials.

408.12.1 Indoor Storage. Indoor storage of unstable (reactive) materials shall be in accordance with 408.

EXCEPTIONS:

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

408.12.2 Detached Storage. Detached storage shall be provided when the amount of materials stored exceeds that specified in Table 408.12. Detached storage buildings shall be single story and without basement or crawl space.

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

408.12.4 Distance from Storage to Exposures. Exterior storage of unstable (reactive) materials shall not be permitted within 20ft (6.1 m) of any building, property line, street, alley, public way or exit to a public way.

EXCEPTIONS:

1. An unpierced 2-hour fire-resistive 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 *Standard Fire Prevention Code.*

TABLE 408.12
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 Tables 408.1.2A, B, C	
3	2,000	2,000
2	50,000	10,000

408.13 Water-Reactive Materials

408.13.1 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 2201.8 of the *Standard Fire Prevention Code.*

408.13.2 Detached Storage. Detached storage shall be provided when the amount stored exceeds 2000 lb (907 kg) of Class 3 material or 50,000 lb (22680 kg) of Class 2 material. Detached storage buildings shall be single story and without basement or crawl space.

408.13.3 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.

408.13.4 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.

408.13.5 Distance from Storage to Exposures. Exterior storage of water-reactive materials shall not be permitted within 20 ft (6.1 m) 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.

408.14 Cryogenic Fluids.

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

408.15 Highly Toxic and Toxic Solids and Liquids.

408.15.1 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 2201.8 of *Standard Fire Prevention Code.*

408.15.2 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 *Standard Mechanical Code.* Emission control shall conform to the requirements of the local air quality authority.

408.15.3 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.

408.15.4 Exterior Storage. Exterior storage of highly toxic or toxic solids and liquids shall be in accordance with this section and *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.

408.15.5 Distance from Storage to Exposures. Exterior storage of highly toxic or toxic solids and liquids shall not be permitted within 20ft (6.1 m) of any building, property line, street, alley, public way or exit to a public way.

EXCEPTION: An unpierced 2-hour fire-resistive 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.

408.16 Corrosives.

408.16.1 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 2201.8 of *Standard Fire Prevention Code.*

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

408.16.3 Distance from Storage to Exposures. Exterior storage of corrosive liquids shall not be permitted within 20 ft (6.1 m) of any building, property line, street, alley, public way or exit to a public way.

EXCEPTION: An unpierced 2-hour fire-resistive wall extending not less than 30 inches (162 mm) above and to the side of the storage area may be provided in lieu of such distance.

408.17 Irritants, Sensitizers, Other Health Hazard Solids, Liquids and Gases.

408.17.1 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 nonflammable solid and noncombustible or nonflammable liquid other health hazard materials, see 2201.8 of *Standard Fire Prevention Code.*

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

408.17.3 Distance from Storage to Exposures. Exterior storage of irritants, sensitizers or other health hazard solids, liquids, and gases shall not be permitted within 20ft (6.1 m) 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.

408.17.4 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 m3). Aisle widths between piles shall be not less than one-half the height of the piles or 10 ft (3 m), whichever is greater.

408.18 Dry Cleaning Plants.

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

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

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

408.18.4 General.

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.
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.
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.

4. A mechanical system of ventilation shall be installed in dry cleaning areas and drying rooms conforming to the provisions of *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.

408.19 HPM Facilities. See 511.

409 INSTITUTIONAL OCCUPANCY – GROUP I

409.1 Group I Unrestrained Occupancy

409.1.1 General

409.1.1.1 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:

Hospitals, nursing homes (both intermediate care facilities and skilled nursing facilities), mental hospitals and detoxification facilities. Facilities such as the above with five or less persons not ancillary to other uses shall be classified as a residential occupancy.

409.1.1.2 Group 1 Unrestrained buildings may be either sprinklered or unsprinklered. To qualify for the sprinkler option buildings shall be fully protected in accordance with NFiPA 13 and the sprinkler system shall be electronically supervised in accordance with 901.8. Table 409.1 identifies the building features or systems required under either option. There shall be no co-mingling of the two options.

409.1.1.3 All doorways to areas housing bedridden patients, and doorways between patient occupied spaces and the required exit, and all exit doorways leading to the exterior shall be not less than 44 inch door except that exit doors so located as not to be subject to use by patients, may be not less than 36 inch door. Required corridors, ramps, or passageways shall be not less than 8 ft in clear width in all areas occupied by patients or serving as part of the means of egress from patient areas. Doors and corridors in Day Care Centers shall be not less than 36 inches and 6 feet respectively.

409.1.2 Smoke Barriers

409.1.2.1 All Group I - Institutional unrestrained occupancies shall have smoke barriers to divide into at least two compartments every story used by inpatients for sleeping or treatment and every story having an occupant load of 50 or more persons. 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, of which neither the length nor width shall be more than 150 ft. At least 30 net sq ft per occupant shall be provided for bed and litter patients on each side of the smoke partition in adjoining compartments, and on stories not housing bed and litter patients at least 6 sq ft per occupant in adjoining compartments.

409.1.2.2 Smoke barriers shall have a minimum of 1-hour fire resistance. Such barriers 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. Transfer grilles, whether equipped with fusible link-operated dampers or not, shall not be used in these partitions. See *Standard Mechanical Code* 510.4.

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.

409.1.2.3 Doorways separating corridors in adjoining smoke compartments shall be equipped with either horizontal sliding doors conforming with 1114.5 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 for hospital corridors and 32 inches for residential custodial care institutions. Other doors in smoke barriers shall be swinging type of required width or horizontal sliding doors conforming with 1114.5.

409.1.2.4 Doors in smoke barriers shall have a fire resistance rating of 20 minutes except as required in 409.1.6.1. Double egress corridor doors shall have, and other doors shall be permitted to have, vision panels of l/4-inch labeled wire glass or fire rated glass mounted in steel frames. The glass areas shall be limited to 1296 sq in 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 as well as upon the application of a maximum manual pull of 50 lb against the hold-open device.

409.1.2.6 Patient rooms in Group I occupancies shall be provided with not less than two egress doorways opening from the room to the exit access, when the room has provisions for six or more beds. When provision for less than six beds is made, only one egress doorway need be provided.

409.1.2.7 A smoke damper shall be provided at each point a duct penetrates a smoke barrier. The damper shall close upon detection of smoke by an approved smoke detector located within the duct.

EXCEPTION: Dampers may be omitted in buildings equipped with an approved engineered smoke control system. The smoke control system shall respond automatically preventing the transfer of smoke across the barrier.

409.1.3 Corridor Partition

409.1.3.1 In buildings equipped throughout with a complete automatic sprinkler system, 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 partition shall comply with 1203.5 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 on a patient sleeping floor may be open to the corridor, provided:

1. The area does not exceed 250 sq ft, and
2. The area is located to permit direct visual supervision by the facility staff, and
3. The area is equipped with an electrically supervised automatic smoke detector system, and
4. Not more than one such waiting area is permitted in each smoke compartment, and
5. The area is arranged not to obstruct access to required exits.

409.1.3.3 Waiting areas on floors other than patient sleeping floors may be open to the corridor, provided:

1. Each area does not exceed 600 sq ft, and

2. The area is located to permit direct visual supervision by the facility staff, and
3. The area is arranged not to obstruct access to required exits, and
4. The area is equipped with an electrically supervised, automatic smoke detection system.

409.1.3.4 Buildings protected throughout by an approved automatic sprinkler system may have spaces which are unlimited in size 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 409.1.6.1, 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 electrically supervised automatic smoke detection system, and
4. The space is arranged not to obstruct access to required exits.

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

409.1.3.6 In nonsprinklered buildings, exit access corridors shall provide a minimum 1-hour fire resistance rating and shall comply with 702.1, except that all corridor walls shall extend from the floor to the underside of the floor/roof deck above.

409.1.4 Corridor Doors

409.1.4.1 In buildings equipped throughout with a complete automatic sprinkler system, 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.

409.1.4.2 In nonsprinklered buildings, doors in corridor partitions shall comply with 703.4.2.2. All doors, other than patient room doors, shall be self-closing or automatic closing by smoke detection. If automatic closing devices are used and more than one door is designed to close upon detection of a fire condition, a means of identifying the room of fire origin shall be provided.

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

409.1.5 Smoke and Heat Detectors

409.1.5.1 Staff sleeping rooms shall be equipped with smoke detectors in accordance with NFiPA 74 permanently connected to house current.

409.1.5.2 Corridors shall be provided with approved smoke detectors connected to the building fire alarm system.

409.1.5.3 Spaces open to the corridor shall be provided with approved smoke detectors in accordance with 409.1.3.2, 409.1.3.3 and 409.1.3.4. Such detectors shall be connected to the building fire alarm system.

409.1.5.4 Heat detectors shall be provided in unsprinklered specific use areas listed in 409.1.6.1 and shall sound a local alarm at a constantly attended location.

TABLE 409.1
REQUIREMENTS FOR GROUP I UNRESTRAINED OCCUPANCIES

Building Systems	Sprinklered Buildings[1]	Nonsprinklered Buildings
Height & Areas	Table 400	
Smoke Partitions	Required 409.1.2	Required 409.1.2
Interior Finish Rooms (max.4 persons) Rooms (5 or more persons)	C	B
Means of Egress	B	A
Corridor Partitions	409.1.3.1 & 2	409.1.3.6
Corridor Doors	409.1.4.1	409.1.4.2
Manual Fire Alarms	903	903
Smoke Detectors	409.1.5, 903.2	409.1.5, 903.2
Protection From Hazardous Areas	409.1.6.1	409.1.6.1 & 2
Smoke Enclosure	409.1.7.1, 1104.5	409.1.7.2
Exit Capacity Level travel Stairs	 0.5”/person 0.6”/person	 0.7”/person 1”/person
Travel Distance	200 ft	150 ft

1. Sprinklered buildings are those equipped throughout with a complete approved automatic sprinkler system designed and installed in accordance with NFiPA 13.

409.1.6 Protection From Hazardous Areas

409.1.6.1 In both sprinklered and nonsprinklered buildings, hazardous areas listed in the following table shall be protected as shown. All doors shall be self-closing or automatic closing by smoke detection. Where sprinkler protection without fire-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 assembly or to the floor/roof deck above.

Separation/Protection	Area
2-hr or 1-hr and sprinklers	Boiler and Heater rooms Paint shops employing hazardous substances and materials in quantities less than that which would cause classification as an H use Physical plant maintenance shop
1-hr and sprinklers	Laundries greater than 100 sq ft Soiled linen room Storage rooms more than 100 sq ft storing combustible material Trash collection rooms
1-hr or sprinklers with separation per 409.1.6.1	Employee locker room Gift/retail shop Handcraft shops Kitchens Laboratories which employ hazardous materials but such materials are quantities less than that which would cause classification as an H use. Storage rooms more than 50 sq ft in area but not more than 100 sq ft in area storing combustible material

409.1.6.2 In nonsprinklered buildings, sprinkler piping in tabled areas only serving not 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 or floor area throughout the entire enclosed area. An indicating shutoff valve shall be installed in an accessible location. A waterflow alarm shall be provided to sound the building fire alarm system where more than two sprinklers are installed in a single area.

409.1.7 Smokeproof Enclosure

409.1.7.1 In buildings equipped throughout with an automatic sprinkler system the smokeproof enclosure required by 1104.5 may be omitted when all required exit stairways are pressurized in accordance with 506.2.

409.1.7.2 Nonsprinklered buildings more than three stories in height shall be provided with at least one smokeproof enclosure complying with 1104.5.

409.1.8 Emergency Egress. Patient sleeping rooms in unsprinklered nursing homes shall have outside windows as required for residential sleeping rooms. See 1104.4.

409.1.9 Building Fire Alarm. A building fire alarm system shall be provided. The alarm system shall be activated by manual pull stations and by sprinkler activation and when permitted by the jurisdiction shall have an alarm to the fire department.

409.1.10 Supervision. The building fire alarm system and the sprinkler system shall be electrically supervised.

409.1.11 Fixed Furnishings Tests. Fixed furnishing shall comply with the requirements in Chapter 43 of the *Standard Fire Prevention Code*.

409.2 Group I Restrained Occupancy

409.2.1 General

409.2.1.1 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 occupants control and shall include among others:

Jails
Detention Centers
Correctional Institutions
Reformatories

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

409.2.1.2 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.

409.2.1.3 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 403.

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

409.2.1.5 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 Special Definitions

409.2.2.1 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.

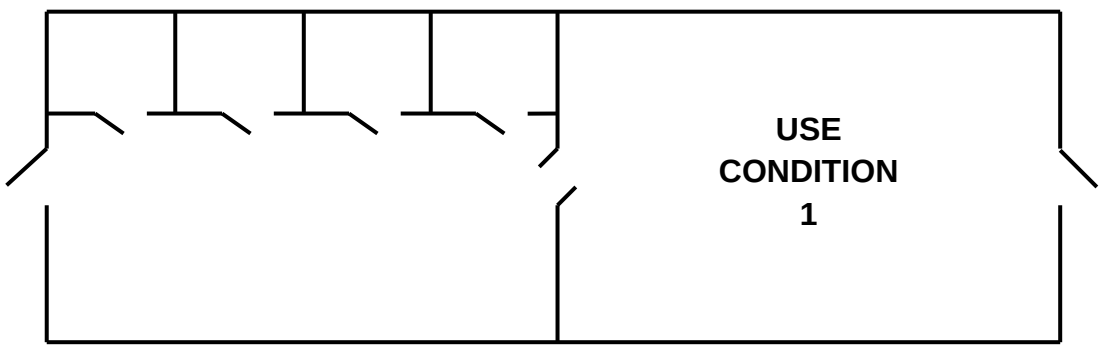
409.2.2.2 Residential Housing Areas. Includes sleeping areas and any contiguous day room, group activity space or other common spaces for customary access of residents.

409.2.3 Subclassification Of Occupancy

409.2.3.1 Group I Restrained shall be categorized as one of the following Use Conditions:

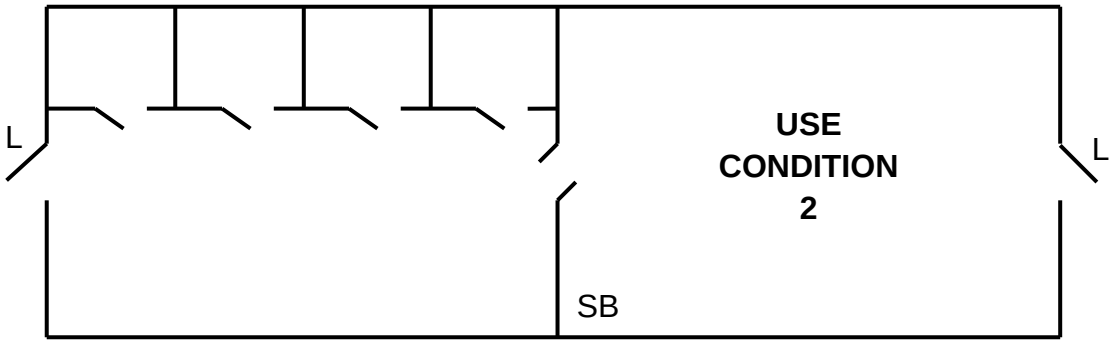
1. Use Condition 1 - Free Egress

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.



2. Use Condition 2 - Zoned Egress

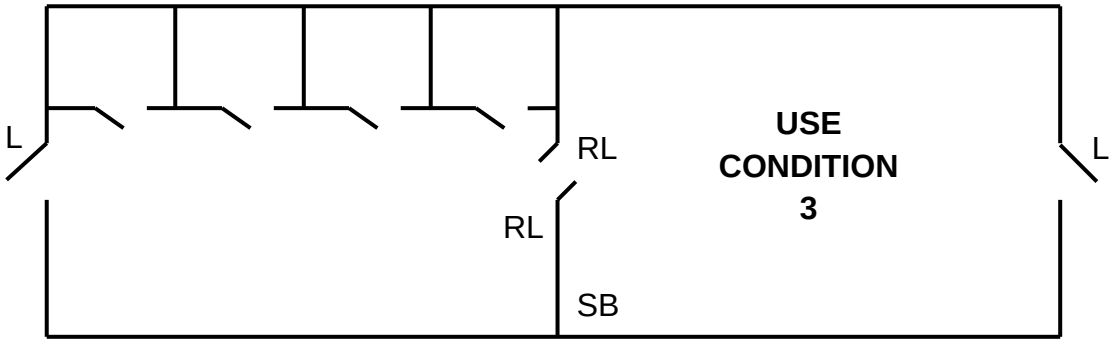
Free movement is allowed from sleeping areas and any other occupied smoke compartment to one or more other smoke compartments.



L =Locked
SB = Smoke Barrier or Horizontal Exit

3. Use Conditions 3 - Zoned Impeded Egress.

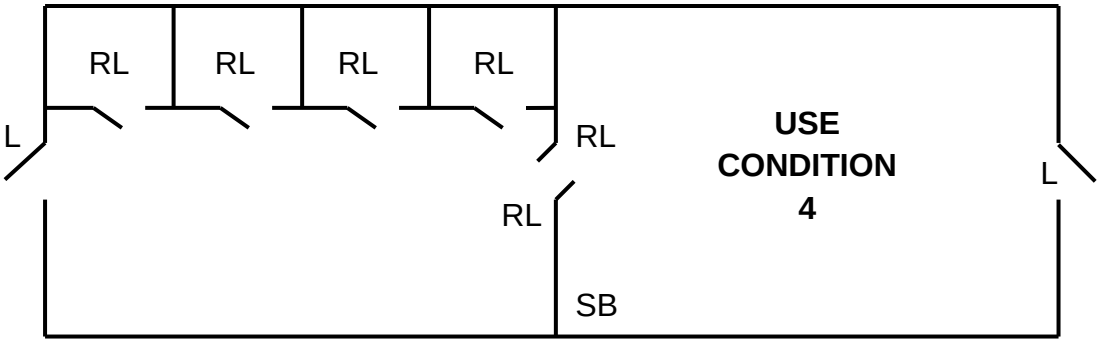
Free movement is allowed within individual smoke compartments, such as within a residential unit comprised of individual sleeping rooms and group activity space, with egress impeded by remote control release of means of egress from such smoke compartment to another smoke compartment.



L =Locked
RL = Locked - Remote Release or Equivalent
SB = Smoke Barrier or Horizontal Exit

4. Use Condition 4 - Impeded Egress

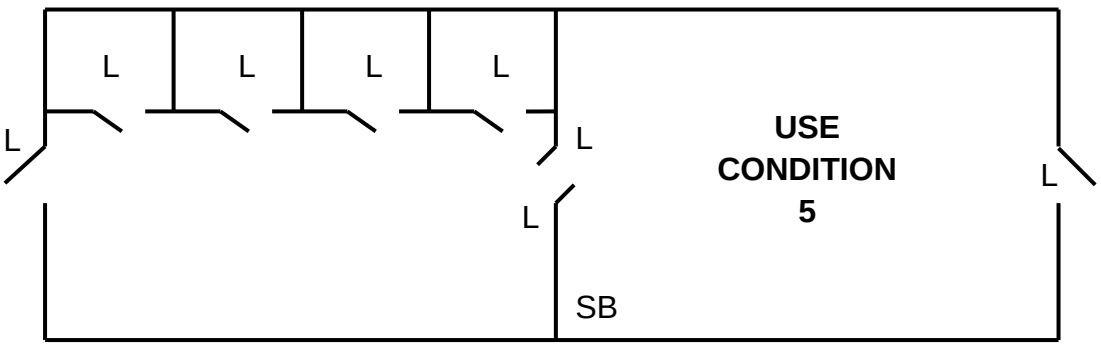
Free movement is restricted from an occupied space. Remote controlled release is provided to permit movement from all sleeping rooms, activity spaces and other occupied areas within the smoke compartment to other smoke compartments.



L = Locked
RL = Locked - Remote Release or Equivalent
SB = Smoke Barrier or Horizontal Exit

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 spares and other occupied areas within the smoke compartments.



L =Locked
SB =Smoke Barrier or Horizontal Exit

409.2.3.2 To classify as Use Condition 3 or 4 the arrangement, accessibility and security of the release mechanism used for emergency egress shall be such that the minimum available staff, at any time, can promptly release the locks.

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 400.

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 of persons intended to occupy that floor, but not less than that projected by calculations using the tabular values of 1105.

409.2.5.2 For resident housing areas the minimum occupant load shall be based upon 120 sq ft per occupant using gross floor area.

409.2.6 Means of Egress

409.2.6.1 Except as modified or provided for in this section, the provisions of Chapter 11 shall apply.

409.2.6.2 Doors to resident sleeping rooms shall be at least 28-inch clear width.

409.2.6.3 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 with a perpendicular force against the door of 50 lb.

409.2.6.4 Horizontal exits may comprise 100% of the exits required. At least 6 sq ft 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.

409.2.6.5 Spiral stairs meeting the requirements of 1112.3.4 are permitted for access to and between staff locations.

409.2.6.6 Exits may discharge into a fenced or walled courtyard, provided that not more than two walls of the courtyard are the building walls from which exit is being made. Enclosed yards or courts shall be of sufficient size to accommodate all occupants a minimum of 50 ft from the building with a net area of 15 sq ft per person.

409.2.6.7 Solid risers, intermediate handrails, latticework or similar facilities required by 1112.1.2 and 1112.5.4, which would interfere with visual supervision of residents, are not required.

409.2.6.8 Alternating tread stairways meeting the requirements of 1112.3.8 are permitted for access to and between staff locations.

409.2.7 Capacity of Means of Egress. The capacity of any required means of egress shall be based on the provisions of 1105.3 and 1105.4.

409.2.8 Number of Exits

409.2.8.1 A minimum of two exits located remote from each other shall be accessible from each floor, fire compartment, or smoke compartment of the building.

409.2.8.2 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 zone of fire origin.

409.2.9 Arrangement of Means of Egress

409.2.9.1 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.

409.2.9.2 All exits may discharge through the level of exit discharge. The requirements of 1120 may be waived provided that not more than 50% of the exits discharge into a single fire compartment.

409.2.9.3 No exit or exit access shall contain a corridor, hallway or aisle having a pocket or dead end exceeding 50 ft for Use Conditions 2, 3, 4 and 20 ft for Use Condition 5.

409.2.9.4 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.

409.2.9.5 Aisles, corridors, and ramps required for access or exit shall be at least 4ft wide.

409.2.10 Measurement of Travel Distance to Exits

Travel distance shall be determined in accordance with 1103, but shall not exceed:

1. l00 ft between any room door required as exit access and an exit.
2. 150 ft between any point in a room and an exit.
3. 50 ft between any point in a sleeping room and the door of that room.

EXCEPTION: The travel distance above may be increased by 50 ft in rooms other than sleeping rooms when the building is protected throughout by an approved automatic sprinkler system or smoke control system.

409.2.11 Illumination and Marking of Means of Egress

409.2.11.1 Illumination shall be in accordance with 1118.

409.2.11.2 Emergency lighting shall be provided in accordance with 1118.1.2.

409.2.11.3 Exit marking shall be provided in areas accessible to the public in accordance with 1118.2.

EXCEPTION: Exit signs may be omitted in sleeping room areas.

409.2.12 Locks

409.2.12.1 Doors from areas of refuge to the exterior may be locked with key lock in lieu of locking methods described in 409.2.12.4. The locks shall be operable from the outside.

409.2.12.2 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, except as provided in 409.2.3.2.

EXCEPTION: Provisions for remote unlocking in Use Condition 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.

409.2.12.3 All power-operated sliding doors or power-operated locks for swinging doors shall be operable by a manual release mechanism at the door and by either of the following:

1. Remote mechanical operating release mechanism.
2. Emergency power except for facilities with ten locks or by complying with the exception in 409.2.12.2.

409.2.12.4 Remote release mechanically operated sliding doors or remote release mechanically operated locks shall be provided with a mechanically operated release mechanism at each door or shall be provided with a redundant remote release control.

409.2.12.5 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.

409.2.13 Protection of Vertical Openings

409.2.13.1 Any stairway, ramp, elevator, hoistway, light, or ventilation shaft, chute or other vertical opening between stories shall be enclosed in accordance with 701.1.

409.2.13.2 Two communicating floor levels are permitted without enclosure protection between levels provided all the following conditions are met:

1. The entire normally occupied area, including all communicating floor levels, is sufficiently open and unobstructed so that it may be assumed that a fire or other dangerous condition in any part will be immediately obvious to the occupants or supervisory personnel in the area.

2. Exit capacity is sufficient to provide simultaneously for all the occupants of all communicating levels and areas, all communicating levels in the same fire area being considered as a single floor area for purposes of determination of required exit capacity.
3. Each floor level, considered separately, has at least one-half of its individual required exit capacity accessible by exit access leading directly out of that level without traversing another communicating floor level.

409.2.14 Protection from Hazards.

409.2.14.1 An area used for general storage, boiler or furnace rooms, fuel storage, janitor's closets, maintenance shops including woodworking and painting areas, laundries and kitchens shall be separated from other parts of the building with construction having not less than a 1-hour fire resistance rating and all openings shall be protected with self-closing fire doors, or such area shall be provided with automatic sprinkler protection. Where the hazard is severe, both the fire resistance separation and automatic sprinklers shall be provided.

409.2.14.2 Padded cells are severe hazard areas. Doors to padded cells shall be 3/4-hour self-closing and self-latching fire door assemblies.

409.2.14.3 Cooking facilities shall be protected in accordance with NFiPA 96.

409.2.15 Interior Finish

409.2.15.1 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 704.3.

409.2.15.2 Interior floor finish shall be in accordance with 704.7.

409.2.16 Detection, Alarm and Communication Systems

409.2.16.1 Every building shall have a manually operated fire alarm system in accordance with 903.1 and such system shall be electrically supervised.

EXCEPTIONS:

1. Manual fire alarm boxes may be locked.
2. Manual fire alarm boxes may be located at staff locations in lieu of being located in the sleeping room areas.

409.2.16.2 Operation of any fire alarm activating device shall automatically, without delay, accomplish general alarm indication and control functions. Zoned or coded systems shall be permitted to be used.

409.1.16.3 The fire alarm system shall be arranged to transmit an alarm automatically to the fire department legally committed to serve the area in which the facility is located by the most direct and reliable method approved by the local Building Official.

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.

409.1.16.4 An approved automatic smoke detection system shall be installed in all sleeping areas and in areas not separated from sleeping area by fire resistive construction in Use Condition 4 and *5* areas and in sleeping rooms occupied by more than four persons in Use Condition 3. Such systems shall be installed in accordance with NFiPA 71, NFiPA 72A, NFiPA 72B, NFiPA 720, NFiPA 72E as appropriate, but in no case shall smoke detectors be spaced farther apart than 30 ft on centers or more than 15 ft from any wall. All automatic smoke detection systems required by this section shall be electrically interconnected to the fire alarm system.

EXCEPTIONS:

1. Buildings protected by a complete automatic fire extinguishing system in accordance with 409.2.17 shall install a smoke detection system in all corridors with smoke detectors spaced no farther apart than 30 ft on centers or more than 15 ft from any wall.

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 above. 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.

409.2.16.5 An approved automatic smoke detection system shall be installed in all corridors and common spaces of Use Condition 2 and 3. Such systems shall be installed in accordance with the applicable standards listed in 409.2.16.4, but in no case shall smoke detectors be spaced farther apart than 30 ft on centers or more than 15 ft from any wall.

EXCEPTION: 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 above. 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.

409.2.16.6 Any fire detection device or system required by this section shall be electrically interconnected with the fire alarm system.

409.2.16.7 Any alarm system and any detection system required in this section shall be provided with a secondary power supply in accordance with 2-6.4 of NFiPA 72A.

409.2.17 Extinguishing Requirements

409.2.17.1 When required by Table 400, facilities shall be protected throughout by an approved automatic sprinkler system in accordance with NFiPA 13.

409.2.17.2 Where exceptions are stated in the provisions of this Code (including those specified in 409.2.19) 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.

409.2.17.3 The sprinkler system shall be electrically supervised in accordance with 901.8.

409.2.17.4 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 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 409.2.14.

409.2.17.5 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.

409.2.17.6 Except as modified in this section, standpipe and hose systems shall be provided in accordance with 902 as follows:

1. Class I standpipe systems shall be provided for any building over two stories high.
2. Class III standpipe and hose systems shall be provided for all unsprinklered buildings over two stories high.

   EXCEPTIONS to 409.2.17.6(2):

   1. l-inch diameter formed hose in lieu of hose requirements of NFiPA 14 may be used.
   2. Separate Class I and Class II systems may be used in place of Class III.

409.2.18 Subdivision of Building Spaces

409.2.18.1 Smoke barriers shall be provided as follows:

1. To divide every story used by residents for sleeping, or any other story having an occupant load of 50 or more persons, into at least two compartments, and
2. To limit the housing of a maximum of 200 residents in any smoke compartment, and
3. To limit the travel distance to a door in a smoke barrier from any room door required as exit access to 100 ft and from any point in a room to 150 ft.

   EXCEPTIONS:

   1. Protection may be accomplished with horizontal exits. See 409.2.6.4.
   2. Spaces having direct exit to (a) a public way, (b) a building separated from the resident housing area by 2-hour fire resistance or 50 ft of open space, or (c) an enclosed area having a holding space 50ft from the housing area that provided 6 sq ft or more of refuge area per person (resident, staff, visitors, etc.) that may be present at the time of the fire fulfills the requirements for subdivision of such spaces provided the locking arrangement of doors involved meets the requirements for doors at the compartment barrier for the use condition involved.

409.2.18.2 Any required smoke barrier shall be continuous from outside wall to outside wall, from floor to floor, from smoke barrier to smoke barrier, or a combination thereof, including continuity through all concealed spaces such as those found above a ceiling, however smoke barriers are not required in interstitial spaces designed and constructed with ceilings that can resist the passage of smoke equivalent to that provided by smoke barriers. Barriers shall be of plate steel or 1-hour construction. Fixed wired glass vision panels shall be permitted in such barriers provided they do not individually exceed an area of 1296 sq in and are mounted in approved steel frames. There is no restriction on the total number of such panels in any barrier.

409.2.18.3 At least 6 net sq ft 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.

409.2.18.4 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.

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 with a perpendicular force against the door of 50 lb. The door shall be reasonably tight fitting.

409.2.18.5 Doors in smoke barriers shall comply with 703.4.2.2 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.

409.2.18.6 Doors in smoke barriers shall conform with the requirements for doors in means of egress as specified in 409.2.6 and 409.2.12 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 partition.
2. For Use Conditions 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 409.2.12.
3. For Use Condition V (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 409.2.12.

409.2.18.7 Vision panels of approved transparent wired glass not exceeding 1296 sq in with steel frames shall be provided in each door in a smoke barrier.

409.2.18.8 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.

409.2.19 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 409.2.19.

TABLE 409.2.19
SEPARATION REQUIRED FOR RESIDENT HOUSING AREAS

Features	Use 2		Use 3		Use 4		Use 5	
	NS	AS	NS	AS	NS	AS	NS	AS
Room to Room Separation	NR	NR	NR		ST	NR	FR(1/2)	ST
Room Face to Corridor Separation	ST	NR	ST		ST	NR	FR	ST
Room Face to Common Space Separation	NR	NR	NR ST <50 ft * >50 ft*	NR ST <50 ft * >50 ft*	ST	NR	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	

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 – ½-hour

NOTES TO TABLE 409.2.19

1. Doors in openings in partitions required to be fire resistive 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 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.

409.2.20 Windowless Buildings.

409.2.20.1 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.

409.2.20.2 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.

409.2.21 Building Services.

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

409.2.21.2 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.

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

409.2.21.4 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.

409.2.22 Standby Power and Light.

409.2.22.1 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-premise 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.

409.2.22.2 The following loads are classified as essential emergency operations:

1. Emergency egress illumination in accordance with 1118.
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. Fire detection and alarm systems.
7. Power for electric door operation and lock release.
8. Fire pumps where required.
9. All equipment required to provide smoke control.

409.2.22.3 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.

409.2.23 Fire Access Openings. Openings for fire department use in 703.2, 718 and 901.5 are not required.

410 MERCANTILE OCCUPANCY – GROUP M

410.1 Scope

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
Shopping centers
Sales rooms
Wholesale stores (other than warehouses)

411 RESIDENTIAL OCCUPANCY – GROUP R

411.1 Scope

411.1.1 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.

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

R 1: Residential occupancies where the occupants are primarily transient in nature (less than 30 days) including:

Hotels
Motels
Boarding housing (transient)

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

Apartment houses
Boarding houses (not transient)
Convents
Fraternities and sororities
Monasteries

Dormitory facilities which accommodate six or more persons of more than 2 1/2 years of age who stay more than 24 hours.

R3: One and two family dwellings where the occupants are primarily permanent in nature and not classified as R1, R2, or I.

411.2 Special Provisions For Type VI Group R2 Buildings

411.2.1 For buildings two stories or more in height, there shall be at least one window meeting Section1104.4 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.

411.2.2 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).

411.2.3 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 1 foot to each side of unprotected openings.

411.2.4 With a single exit as permitted in 1103.2.3. 1, all exit way wall and roof/ceiling assemblies shall be constructed as follows:

1. The separation wall between the unit and the exit way 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.

411.2.5 For sprinklered buildings (see 901.9.2) with the 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 411.2.4 shall be waived.
2. The limitation of 1103.2.3. 1 (1) shall be 40 feet.
3. The limitations of 1103.2.3.1 (2) and 1103.2.3.1 (3) shall be waived.
4. The maximum building height listed in 1103.2.2(4) shall be two stories above the level of exit discharge.
5. The protection of wall openings listed in 703 shall be waived.

412 STORAGE OCCUPANCY – GROUP S

412.1 Scope

412.1.1 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 or used for the purpose of sheltering animals.

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

412.1.3 S2 Low Hazard Storage shall include among others 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:

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

412.1.4 Portions of Group S occupancy involving highly combustible, flammable or explosive products or materials shall be properly ventilated, protected and properly 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.

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

412.2 Aircraft Hangars

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

412.2.2 The floor areas of hangars shall not exceed those permitted for Group S in Table 400 as modified.

412.2.3 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.

412.2.4 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.

412.2.5 Heating equipment other than unit heaters suspended at least 10 ft 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 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 above the hangar floor level or through a vestibule providing two door separation.

412.2.6 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 901.

412.2.7 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.

412.2.8 Residential aircraft hangars shall comply with the following:

1. 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 703 with at least a 4-inch noncombustible raised sill.
2. 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.
3. 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.
4. 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.
5. Hangars shall not exceed 2000 sq ft in area and 20ft in height.

412.3 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.

412.4 Private Garages

412.4.1 Garages which are provided for the storage of motor vehicles owned by tenants of buildings on the premises, and with maximum undivided space used for storage of not more than four automobiles, or trucks of 1 ton or less capacity, but not exceeding 850 sq ft, shall be considered private garages. All other garages shall be considered public garages.

412.4.2 Private garages may be of any type construction, but a private garage shall not occupy space above the first floor of a Type VI building nor be erected in the Fire District except as provided in 305(2). Private garages shall not be located within, or attached to, a building occupied for any other purpose unless it is separated from such other occupancy by walls, partitions, and floor/ceiling assemblies that have a fire resistance rating as specified in 403. Walls, floors, partitions and floor/ceiling assemblies that effect such separation shall be continuous and unpierced. A single flush-type solid core wooden door of not less than 1 3/4-inch nominal thickness, equipped with a self-closing device, may be permitted provided the sill is raised at least 8 inches above the garage floor when the doorway connects directly with any room in which there is any direct-fired heating device or gas fixture. In no case, however, shall a garage have an opening directly into a room used for sleeping purposes.

412.5 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.

412.6 Automobile Parking Structures

412.6.1 Automobile parking structures shall be either open or enclosed as defined in this section and shall meet the appropriate criteria of this section.

412.6.2 Open automobile parking structures, with roof parking, may be constructed to the allowable heights and areas specified in Table 412.6. To be considered open, the automobile parking structure must meet all of the following:

412.6.2.1 The exterior and interior walls of the structure 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 if 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.

412.6.2.2 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 wide extending full width to a street, shall not exceed 200ft.

412.6.2.3 When such structures are within 10 ft of a common property or building line, they 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 703.4 shall be permitted.

412.6.2.4 No parking spaces shall be located within 10ft of an open stairway. The travel distance shall be measured from the most remote point on each tier along the natural path of travel to the first riser of an approved open stairway.

412.6.3 Pedestrian guardrails shall be provided in accordance with 1121 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. 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 1207.2.3. Impact guardrails not less than 2 ft 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.

TABLE412.6
OPEN AUTOMOBILE PARKING STRUCTURES
ALLOWABLE HEIGHTS AND AREAS

Construction Type	Allowable Area 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 or 75 ft

412.6.4 Enclosed automobile parking structures and portions thereof which do not meet the definition of open automobile parking structures may be constructed to the allowable heights and areas specified in Table 400 for Group S buildings. Roof parking is permitted.

412.6.5 A mechanical ventilation system for the removal of the products of combustion shall be provided in enclosed automobile parking structures. The mechanical system shall be capable of providing at least 6 air changes per hour each level. Under normal use the ventilation of the enclosed automobile parking structure shall comply with the ventilation requirements of 412.7.5.

412.6.6 The clear height of each floor level in vehicle and pedestrian traffic areas shall not be less than 7 ft. See North Carolina State Building Code, Volume 1-C, Accessible Code, for special requirements.

412.7 Public Garages

412.7.1 A public garage is any building or part wherein is kept or stored motor vehicles having any flammable fuel in their tanks, which is:

1. Over 850 sq ft in area; or,
2. 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, or automobile parking structures as defined.

412.7.2 Public garages of Type VI construction may be used only for dead storage and display of automobiles.

412.7.3 A public 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 403, but in no case by walls having fire resistance less than 2 hours. 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 703.

EXCEPTION: Minimum separation between an automobile parking structure 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 403.1 shall be 2 hours.

412.7.4 Unenclosed ramps shall not be considered as providing required exit facilities. Enclosed ramps shall be in accordance with the exit requirements of Chapter 11.

412.7.5 Basement garages shall be continuously ventilated by a mechanical system with positive means for both inlet and exhaust of at least 1 cu ft of air per minute per square foot of floor area, controlled from a location close to the entrance door.

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

412.7.7 Heating equipment, other than unit heater, suspended at least 8 ft above the garage floor, shall be placed in a separated room cut off by 4-hour fire rated construction and 4-inch reinforced concrete floor and ceiling construction.

412.7.7.1 Entrance shall be from the outside or by means of a doorway with sill raised at least 8 inches above the garage floor level or through a vestibule providing two doorway separations.

412.7.7.2 Doors for the protection of the interior openings shall have a minimum fire protection rating of 3 hours.

412.8 Helistops

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

412.8.2 The touchdown or landing area for helicopters of less than 3500 lb shall be a minimum of 20 ft 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 but with no width less than 5 ft.

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

412.8.4 Exits and stairways from helistops shall comply with the provisions of Chapter 11, 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 long, or less than 2000 sq ft in area, the second exit may be a fire escape or ladder leading to the floor below.

TABLE 400 – 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. NL = No Limit
Allowable building area is shown in thousands of square feet per floor. UA – Unlimited Area

	TYPE CONSTRUCTION																	
	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V				TYPE VI			
							1-Hour		Unprot.		1-Hour		Unprot.		1-Hour		Unprot.	
Maximum Height in Feet:	No Limit		80’		65’		65’		55’		65’		55’		50’		40’	
OCCUPANCY	uns	spr k	uns h	spr k	uns h	spr k	uns h	spr k	uns h	spr k	uns h	spr k	uns h	spr k	uns h	spr k	uns h	spr k
A-1 ASSEMBLY – LARGE (working stage) a, b Max. No. of Stories: Area: Multi-story: One Story only	NL UA UA	NL UA UA	NL UA UA	NL UA UA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-1 ASSEMBLY – LARGE (without working stage) a, b Max. No. of Stories: Area: Multi-story: One Story only	NL UA UA	NL UA UA	NL UA UA	NL UA UA	1 12.0	1 36.0	1 12.0	1 36.0	1 8.0	1 24.0	1 12.0	1 36.0	1 8.0	1 24.0	0	0	0	0
A-2 ASSEMBLY – SMALL (working stage) a, b Max. No. of Stories: Area: Multi-story: One Story only	NL UA UA	NL UA UA	NL UA UA	NL UA UA	1 10.0	1 30.0	1 10.0	1 30.0	1 6.0	1 18.0	1 10.0	1 30.0	1 6.0	1 18.0	1 4.5	1 13.5	1 3.0	1 9.0
A-2 ASSEMBLY – SMALL (without working stage) a, b Max. No. of Stories: Area: Multi-story: One Story only	NL UA UA	NL UA UA	NL UA UA	NL UA UA	1 12.0 12.0	1 24.0 36.0	2 12.0 12.0	2 24.0 36.0	2 8.0 8.0	2 16.0 24.0	2 12.0 12.0	2 24.0 36.0	2 8.0 8.0	2 16.0 24.0	1 7.5	1 22.5	1 5.0	1 15.0
B BUSINESS a, b Max. No. of Stories: Area: Multi-story: One Story only	NL UA UA	NL UA UA	NL UA UA	NL UA UA	5 25.5 25.5	5 51.0 76.5	5 25.5 25.5	5 51.0 76.5	2 17.0 17.0	5 34.0 51.0	5 21.0 21.0	5 42.0 63.0	2 14.0 14.0	5 28.0 42.0	2 13.5 13.5	2 27.0 40.5	2 9.0 9.0	2 18.0 27.0
E EDUCATIONAL a,b Max. No. of Stories: Area: Multi-story: One Story only	NL UA UA	NL UA UA	NL UA UA	NL UA UA	2 18.0 18.0	2 36.0 54.0	2 18.0 18.0	2 36.0 54.0	1 12.0	1 36.0	2 18.0 18.0	2 36.0 54.0	1 12.0	1 36.0	2 12.0 12.0	2 24.0 36.0	1 8.0	1 24.0

TABLE 400 – 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. NL = No Limit
Allowable building area is shown in thousands of square feet per floor. UA – Unlimited Area

	TYPE CONSTRUCTION																	
	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V				TYPE VI			
							1-Hour		Unprot.		1-Hour		Unprot.		1-Hour		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
		k	h	k	h	k	h	k	h	k	h	k	h	k	h	k	h	k
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
H-1 HAZARDOUS b,c																		
Max. No. of Stories:	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0	0
Area: Multi-story:																		
One Story only		15.0		12.0		7.5		7.5		5.0		7.5						
H-2 HAZARDOUS b,c																		
Max. No. of Stories:	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0
Area: Multi-story:																		
One Story only		15.0		12.0		7.5		7.5		5.0		7.5		4.0		2.5		
H-3 HAZARDOUS b,c																		
Max. No. of Stories:	0	4	0	3	0	2	0	2	0	1	0	2	0	1	0	1	0	0
Area: Multi-story:		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 b,c																		
Max. No. of Stories:	0	NL	0	6	0	3	0	3	0	2	0	3	0	2	0	1	0	1
Area: Multi-story:		UA		UA		18.0		18.0		16.0		18.0		12.0				
One Story only		UA		UA		18.0		18.0		16.0		18.0		12.0		9.0		6.0

TABLE 400 – 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. NL = No Limit
Allowable building area is shown in thousands of square feet per floor. UA – Unlimited Area

	TYPE CONSTRUCTION																	
	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V				TYPE VI			
							1-Hour		Unprot.		1-Hour		Unprot.		1-Hour		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
		k	h	k	h	k	h	k	h	k	h	k	h	k	h	k	h	k
I INSTITUTIONAL-RESTRAINED							i				i				i			
Max. No. of Stories:	NL	NL	NL	NL	1	2	2	3	0	2	2	3	0	2	2	3	0	2
Area: Multi-story:	UA	UA	UA	UA		24.0	15.0	30.0		20.0	10.5	21.0		14.0	7.5	15.0		10.0
One Story only	UA	UA	UA	UA	12.0	36.0	15.0	45.0		30.0	10.5	31.5		21.0	7.5	22.5		15.0
I INSTITUTIONAL-UNRESTRAINED b	j																	
Max. No. of Stories:	NL	NL	NL	NL	0	2	1	3	0	1	0	2	0	0	0	1	0	0
Area: Multi-story:	UA	UA	UA	UA		24.0		30.0				21.0						
One Story only	UA	UA	UA	UA		36.0	15.0	45.0		30.0		31.5				22.5		
M MERCANTILE a,b	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	2	2	2
Area: Multi-story:	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
R RESIDENTIAL a,b																		m
Max. No. of Stories:	NL	NL	NL	NL	3	3	5	5	2	5	5	5	2	5	3	3	2	2
Area: Multi-story:	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: Multi-story:	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

TABLE 400 NOTES

a. For height modifications and limitations by Occupancy, see:

1. Mezzanines 402.2.3
2. Basements 402.2.4
3. Assembly-Basements 402.2.5
4. Business 506.1.2
5. Educational-Basements 402.2.5
6. Mercantile 506.1.2
7. Residential 402.2.2

b. For area modifications and limitations by Occupancy see:

1. Area increase for separation (All occupancies except H) 402.3.2
2. Assembly 402.4.3. 4.4, 4.6
3. Business 402.4.1
4. Educational 402.4.7
5. Hazardous 402.4.8
6. Factory-Industrial 402.4.1
7. Mercantile ..... 402.4.1 & 4.9
8. Storage ..... 402.4.1 & 4.10

c. Modifications in height and area shall not be permitted in Group H occupancies.
d. See 408.6 for allowable floor area for tire recapping.
e. See 412.6.2 for allowable height and floor areas of Open Automobile Parking Structures.
f. Total area for unsprinklered Group M occupancies after increase permitted by 402.3 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 901.2, the height of buildings listed under this column may be increased one story.
i. Automatic sprinkler protection required throughout all buildings greater than one story where Use Condition 5 is used. See 409.2.3.
j. Maximum height 80 ft.
k. When all portions of buildings are sprinklered in accordance with the standards listed in 901.2, the allowable heights and areas of buildings shall be as listed under this column.
m. See 901.9.2.

CHAPTER 5

SPECIAL OCCUPANCY REQUIREMENTS

501 TEMPORARY STRUCTURES

A special building permit for a limited time shall be obtained before the erection of temporary structures such as construction sheds, seats, canopies, tents and fences used in construction work or for temporary purposes such as reviewing stands. Such structures shall be completely removed upon the expiration of the time limit stated in the permit.

502 GREENHOUSES

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

502.2 Greenhouses more than 35 ft high shall have a noncombustible structural frame. Greenhouses not over 400 sq ft in area and not over 15 ft 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 from an adjoining structure or property line.

502.3 Refer to Table 1210.1 for deflection limits.

503 REVIEWING STANDS, GRANDSTANDS AND BLEACHERS

503.1 Scope

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

503.2 Height Of Grandstands And Bleachers

503.2.1 Grandstands and bleachers may be of the types of construction permitted for Group A occupancy with nonworking stage shown in Table 400. There shall not be more than three seating terraces or balconies in a single story.

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

503.2.3 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 20 ft. See 604.

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

504 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 1210.1 for deflection limits.

505 COVERED AND ENCLOSED WALKWAYS AND TUNNELS

505.1 Scope

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.

505.2 Construction

505.2.1 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.

505.2.2 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 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 40 ft, or five stories or 55ft when sprinklered.

505.2.3 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.

505.3 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.

506 SPECIAL PROVISIONS FOR HIGH RISE BUILDINGS

506.1 General Requirements

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

506.1.2 Minimum Construction. Construction shall be of Type I or Type II in accordance with Tables 400 and 600. For Business, Mercantile, and Residential occupancies. Type II construction may be used where Type I construction may be required by Table 400.

506.1.3 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 10ft 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 20ft wide strip nearest the building. Public streets and sidewalks meeting these requirements may be used for this area.

506.1.4 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.

506.1.5 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 506.8.1. 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 506.1.3 if all of the other requirements of this section are met.

506.1.6 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.

506.1.7 High Rise Requirements Preemptive. All high rise buildings shall comply with the requirements of applicable Sections of the North Carolina State Building Code, Volume I - 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.

506.1.8 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.

506.1.9 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.

506.1.10 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 requirements: (Note: Exposed materials shall meet the requirements of Table 506.7 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 (1) 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 f1ame spread rating of 25 and a maximum smoke developed rating of 50 when tested and listed in accordance with ASTM E84.

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 506.1.10 (5), non-metallic piping materials, other than that used for acid waste systems, which do not meet the requirements of 506.1.10(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 506.1.9.
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.

506.1.11 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.

506.1.12 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.

506.1.13 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.

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

506.1.15 Section 406.2.1.2 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.

506.2 Smoke Control

506.2.1 Smokeproof Stairs. All required exit stairways shall be smokeproof in accordance with Section 1104.5.

EXCEPTION: A maximum of 50% of the stairs may be pressurized in accordance with 506.2.1.1 and 506.2.1.2.

506.2.1.1 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 1104.5.2.

506.2.1.2 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 506.2.1.1(1), 506.2.1.1(2) and 506.2.1.1(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 1104.5.2.

506.2.2 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 506.2 for elevator shaft air requirements.

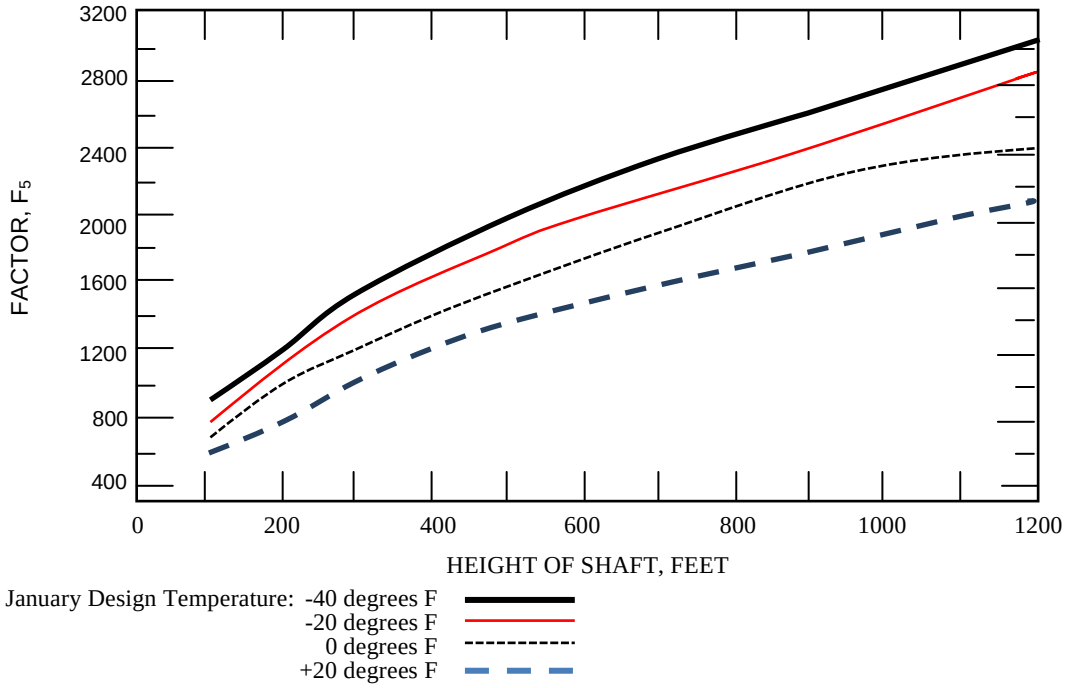


FIGURE 506.2
FACTOR FOR AIR SUPPLY TO AN ELEVATOR SHAFT

Notes to Figure 506.2

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 506.2
   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.

506.3 Sprinklers And Standpipes

506.3.1 All buildings shall be provided with an approved sprinkler system in accordance with NFPA 13, standpipes in accordance with NFPA 14, and 506.3.1.1 thru 506.3.1.4. See Section 901.5 for rooms and areas which are exempted from having sprinkler heads.

EXCEPTION:
Parking structures complying with Section 412.6.2.1 (2) when of Type I or Type II construction and which are within buildings or occupancies referenced in Section 506.1.2 (Business, Mercantile or Residential) are not required to be provided with automatic sprinkler protection.

506.3.1.1 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 1103 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.

506.3.1.2 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.

506.3.1.3 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.

506.3.1.4 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 outlets of each of the other standpipes up to a maximum flow of 2500 gpm flowing.

506.3.2 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 NFPA 13. High temperature sprinkler heads may be used with this system.

506.4 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 506.4.1, 506.4.2, or 506.4.3.

506.4.1 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 506.4.2 or 506.4.3 shall be used for venting.

506.4.2 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.

506.4.3 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 506.4A. Leakage characteristics of the shaft shall be determined by Table 506.48. Damper leakage shall be determined by Table 506.4C.
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 stairshaft, 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 506.4A

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 506.4A 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 506.4B and for dampered openings obtained from Table 506.4C.
2. Leakage area is the total of the leakage area of smoke shaft wall obtained from Table 506.4B and the leakage area of dampered opening in smoke shafts obtained from Table 506.4C.

TABLE 506.4B

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 506.4C

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.

506.5 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 506.5A and 506.5B for vestibule air supply requirements.

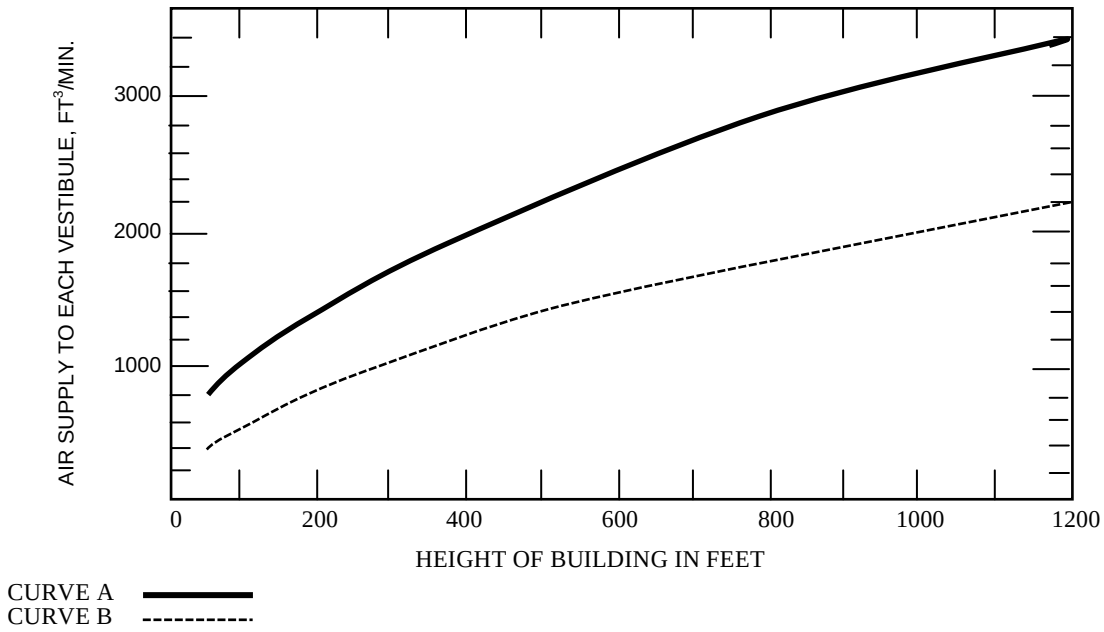


FIGURE 506.5A
AIR SUPPLY TO VESTIBULE IN A DIVIDED BUILDING

Notes to Figure 506.5A

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.

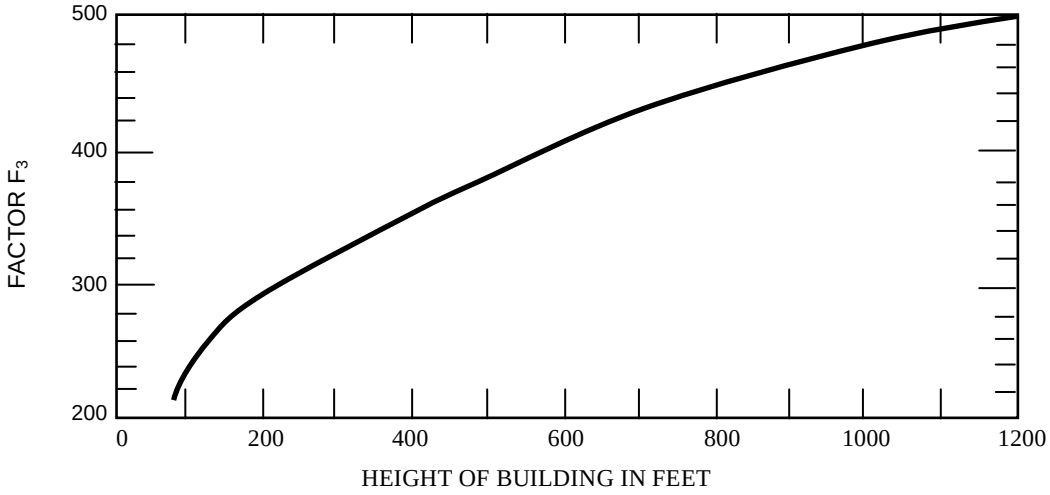


FIGURE 506.5B
FACTOR FOR MECHANICAL AIR SUPPLY TO A VESTIBULE

Notes to Figure 506.5B

1. Air supply to each vestibule in cubic feet per minute

$$= F_3d + 150e + 200s$$

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 stairshaft.

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.

506.6 Elevators

506.6.1 Standards. All elevators for high rise buildings shall comply with the "Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks", ANSI A17.1.

506.6.2 Additional Requirements for Controls and Pressurization of Hoistways. In addition to conforming to the ANSI A17.1, 506.6.2.1 thru 506.6.2.7 shall be met:

506.6.2.1 Elevator Lobby Separation. All public elevators on all floors except those separated from the main building with exterior walkways shall open into useable 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.

506.6.2.2 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 hoistway shall remain available for emergency operation.

506.6.2.3 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 elevator shall flash. The phrase shall be red on a white background in color and be a minimum of l/2inch block letters.

506.6.2.4 Machine Protection. Elevator hoistways shall not be vented into an elevator machine room.

506.6.2.5 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 "Primacy 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 primacy 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 506.6

Capacity Lbs	Clear Width	Clear Depth	Door Opening 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.

506.6.2.6 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 primacy 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 primacy emergency and/or other designated elevator become inoperable.

506.6.2.7 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 elevators 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 2402.1.3 for access openings required for bottom level hoistways.

506.7 Interior Finish

The interior finish for all walls, partitions, and ceilings including all rooms or spaces, 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 506.7.

TABLE 506.7
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 704.7.

506.8 Central Control Room

506.8.1 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 1/10 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 506.9.
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.

506.8.2 The Central Control Room shall be available to the Fire Department at all times.

506.8.3 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.

506.9 Communication

506.9.1 All buildings shall be provided with a one-way voice communication system complying with NFPA 72F. 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.

506.9.2 Two Way System. A two-way voice communication system complying with NFPA 72F 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.

506.9.3 The two way elevator voice communication system shall be incorporated in this system. Telephone jacks are not an acceptable means of communication.

506.9.4 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.

506.9.5 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.

506.10. Emergency Electrical Power Supply

506.10.1 All conductors furnishing electrical power and control circuits to all required emergency equipment and systems shall he 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.

506.10.2 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 he provided. The emergency generator shall he 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 detection, voice communication systems and central alarm and control facility.
8. Motor operated fire dampers and air relief dampers in smoke shafts.

506.10.3 Automatic Transfer. Provision shall he 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.

506.10.4 The emergency generator location shall be such that manual starting or servicing can he 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.

506.11 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.

506.12 Smoke Detection And Manual Fire Alarm Systems

506.12.1 In all high rise buildings an electrically supervised smoke and fire alarm system complying with NFiPA 72A, and 72E shall be installed when 24 hour surveillance is provided. When 24 hour surveillance is not provided, systems shall comply with NFiPA 72B, 72C, or 71.

506.12.2 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 506.6.2.2.
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.

506.12.3 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.

506.12.4 Audible and visual alarm devices shall be provided. Audible devices shall be located to be effectively heard in all occupied areas of the building.

506.12.5 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.

506.12.6 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.

506.12.7 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.

506.13 Interior Partitions

506.13.1 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 506.7.

506.13.2 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.

506.14 Special Exit Requirements

506.14.1 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.

506.14.2 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.

506.14.3 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.

506.15 Gaseous Fuel Systems

506.15.1 Natural and LP gas fuel systems operating at a maximum of 20 psi may be installed to serve high rise buildings.

506.15.2 Main gas meters shall be located outside the building. At each main gas meter, a manual shutoff valve shall be provided.

506.15.3 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 he used. Piping penetrating the shaft wall shall be sleeved and sealed. The shaft shall contain gas piping only.

506.15.4 The entire gas piping system shall be air tested to 100 psig for one hour with no drop in pressure.

506.15.5 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 112 psi.

506.15.6 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 vapors to an explosive level in case of a gas leak. Pressure reducing valves shall be vented into the shaft or to the outside.

506.16 Outside Air

506.16.1 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.

506.16.2 A single outside air intake located on the roof a minimum of 10 ft from the edge of the roof is acceptable.

507 COVERED MALLS

507.1 Scope

507.1.1 The provisions of 507 shall apply to buildings or structures defined in 202 as covered mall buildings, except when approved by the Building Official. The following uses need not comply with the provisions of 507:

1. Terminals for transportation facilities.
2. Foyers and lobbies of hotel, apartment and office buildings.

507.2 Tenant Separation

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.

507.3 Exits

507.3.1 The occupant load for the covered mall building, assuming all portions including individual tenant spaces and the mall to be occupied at the same time, shall be determined by dividing the gross leasable area by 30 for covered mall buildings containing up to 150,000 sq ft of gross leasable area, by 40 for covered mall buildings containing between 150,001 and 350,000 sq ft of gross leasable area, and by 50 for covered mall buildings containing more than 350,000 sq ft of gross leasable area. Exit requirements for the gross leasable area of the covered mall building shall be based on the occupant load thus determined. 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.

507.3.2 For exit purposes the mall may be considered to be a public way.

507.3.3 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 200 ft.

507.3.4 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 to the mall.

507.3.5 Egress Doors.

507.3.5.1 One-half of the required units of exit width for tenant spaces connected to a covered mall shall lead to the outside by means other than through the mall, except that when a tenant space does not exceed 2250 sq ft in area and the distance of travel from any point in the space to the entrance to the mall does not exceed 75 ft, only one egress door shall be required.

507.3.5.2 When a tenant space is located at the intersection of two covered malls or has exposure on two different covered malls, such tenant space when in excess of 2250 sq ft in area shall have at least two separate egress doors both of which may lead through the covered malls providing the egress doors are located as remote from each other as practical.

507.3.5.3 The covered mall connecting tenant spaces shall have not less than two independent exits located as remotely as practical from each other and shall have a total number of units of exit width equal to that required for the exits from the tenant spaces which are within 100 ft travel distance to the exit from the mall plus that required for one person per foot of mall width.

507.3.6 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.

507.3.7 The dead end length of a mall shall not exceed twice its width.

507.3.8 The total width of exit doors from a covered mall building shall be sufficient to accommodate the entire calculated occupant load exclusive of the anchor stores.

507.3.9 The minimum exit width from a mall shall be 66 inches.

507.3.10 The aggregate required width of exits shall be divided approximately equally around the mall.

507.3.11 When exit passageways are present to provide a secondary exit from a tenant space, doors to the corridor shall be 1-hour fire doors. Such doors shall be self-closing and be so maintained or shall be automatic closing by smoke detection.

507.3.12 Storage is prohibited in exit corridors which are also used for service to the tenants. Such corridors shall be posted with conspicuous signs so stating.

507.3.13 Tenant spaces, requiring more than one exit, may have one of the exits through an adjoining or intervening room which provides a direct, obvious and unobstructed means of travel to an exit corridor, exit enclosure or until egress is provided from the building, provided the exit does not pass through restrooms, kitchens, closets or spaces used for similar purposes.

507.4 Mall Width

507.4.1 The minimum width of the mall shall be 20ft.

507.4.2 There shall be a minimum of 10 ft clear exit width to a height of 8 ft 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.

507.4.3 The mall width shall be sufficient to accommodate the occupant load emptying into the immediately adjacent mall as determined by 1105.1.

507.5 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.

507.6 Occupancy

507.6.1 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 contain an area not exceeding the sprinklered area permitted by Table 400 of this Code for the type of construction and the occupancy involved. The aggregate area of all accessory uses within a covered mall building shall not exceed 25% of the gross leasable area.

507.6.2 All occupancies shall be separated from adjacent tenants by a 1-hour fire resistant occupancy separation.

EXCEPTION: The side or sides which border the mall need have no separation.

507.6.3 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.

507.7 Automatic Fire Suppression Systems

The covered mall building shall be provided with an automatic fire suppression system conforming to the provisions of NFiPA 13. In addition to these provisions, the automatic fire suppression system shall comply with the following:

1. All automatic fire suppression system control valves shall be electrically supervised by an approved central station, proprietary or remote station alarm service which will give an audible signal at a constantly attended station. See NFiPA 71 or 72.
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.

507.8 Hose Connections

507.8.1 There shall be a hose outlet connected to a supply capable of delivering 250 gpm 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.

507.8.2 Hose outlets shall be installed to comply with the requirements of NFiPA 14 with regard to materials, installation methods and testing.

EXCEPTIONS:

1. 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.

507.9 Fire Extinguishers

Fire extinguishers shall be provided as required by the *Standard Fire Prevention Code*.

507.10 Smoke Control Requirements

507.10.1 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.

507.10.2 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.

507.10.3 The mall shall have smoke removal capability installed in or near the roof. Such facility may be either natural or mechanical.

507.10.4 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 507.10.

507.11 Public Address System

When a public address system is provided, the system shall be made accessible to and usable by the fire department.

507.12 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.

507.13 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 except that if the sign is vertical then the height shall not exceed 96 inches and the width shall not exceed 36 inches.
3. They shall be located a minimum distance of 18 inches from adjacent tenants.
4. All edges and backs shall be fully encased in metal.

508 ACCESSIBILITY FOR THE PHYSICALLY HANDICAPPED

Every building or structure shall have all levels and areas made accessible to the physically handicapped in accordance with the North Carolina State Building Code, Volume 1-C, making Buildings and Facilities Accessible To and Usable By the Physically Handicapped.

509 ATRIUMS

509.1 General

Vertical openings through three or more floor levels may be unenclosed in all buildings other than Group H when meeting the requirements of this section. Stair enclosures, utility chases, elevator hoist ways and escalators shall not be classified as an atrium.

509.2 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.

509.3 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 55 ft above the floor, sprinkler protection at the ceiling of the atrium may be omitted when approved by the Building Official.

509.4 Smoke Control

509.4.1 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 non-fire 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.

509.4.2 In atriums 55 ft or less in height with a volume of 600,000 cu ft or less, a smoke exhaust system shall be located at the ceiling of the atrium. Such systems shall exhaust 40,000 cfm. When the volume of the atrium exceeds 600,000 cu ft the exhaust system shall be sized to provide a minimum of four air changes per hour.

509.4.3 Supply air inlets may be provided at the lowest level of the atrium. These inlets shall be sized to provide 75% of the exhaust.

509.4.4 For purposes of this section, the volume of the atrium shall include all spaces not separated from the atrium as provided in 509.5.

509.4.5 When the height of the atrium exceeds 55 ft, an exhaust system shall be provided as required in 509.4.2; 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.

509.5 Enclosure Of Atriums

Atrium spaces shall be separated from adjacent spaces by a 1-hour fire resistant wall. A glass wall forming a smoke partition may be used in lieu of the required fire resistant wall where automatic sprinklers are spaced 6 ft 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 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 in a gasketed frame so installed that the framing system may deflect without breaking (loading) the glass before the sprinkler system operates.

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.

509.6 Smoke Detectors

In addition to such smoke detection as may be required by the *Standard Mechanical Code*, smoke detectors shall be provided at the ceiling of the atrium and on the underside edge portion of the floor area projecting into the atrium space. Detectors shall be located in accordance with their listing. The actuation of two detectors shall actuate the atrium smoke removal system. The actuation of any one detector shall cause an alarm to be sounded at a constantly manned location.

509.7 Standby Power

All equipment required to provide smoke control shall be connected to a standby power system.

509.8 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 506.4.

509.9 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.

509.10 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.

509.11 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.

510 UNDERGROUND BUILDINGS

510.1 General

Any portion of Group A, B, E, F, I, M, R other than one and two family dwellings, and S other than mass transit facilities, mining and parking, having a floor level more than 30 ft below grade or completely enclosed by earth such that any required point of access is more than 30 ft to the outside and has an occupant load greater than 30 shall be subject to the following requirements.

510.2 Requirements

510.2.1 The underground portion of the building shall be of Type I or Type II construction.

510.2.2 The entire underground building and the level of exit discharge shall be provided with an automatic sprinkler system complying with Chapter 9.

510.2.3 Each level below the level of exit discharge shall be divided into not less than two compartments which are entirely independent of each other. The separation between the two compartments shall be of minimum 1-hour fire resistant construction. 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.

510.2.4 Each compartment shall have an independent air supply and exhaust system. The system shall have smoke exhaust capability which will provide a minimum of six air changes per hour.

510.2.5 At least one approved smoke detector suitable for the intended use shall be installed in:

1. Every mechanical equipment, electrical, transformer, telephone equipment, elevator machine, or similar room.
2. In every elevator lobby.
3. In 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 5000 cfm and serving not more than ten air inlet openings.

510.2.6 The actuation of any detector or automatic sprinkler shall cause the smoke exhaust system to operate and to sound an alarm throughout the entire underground building.

510.2.7 Each compartment shall be provided with a minimum of one exit in addition to the connecting doorway into the adjoining compartment. The exit enclosure shall be 1-hour fire resistant construction when serving three floors or less and 2-hour fire resistant construction when serving four floors or more.

510.2.8 On-Site Generated Power

510.2.8.1 A permanently installed 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.

510.2.8.2 An on-premise fuel supply sufficient for not less than 2 hours full demand operation of the system shall be provided. All power lighting, signal and communication facilities provided under the requirements of this section shall be transferable to the standby power system.

EXCEPTION: If the building design utilizes standby equipment fueled by pipeline natural gas and acceptable to the Building Official.

510.2.9 Standby Power Loads

The following loads are classified as standby power loads. The transition time from the instant of failure of the normal power source to the generator source shall not exceed 60 seconds. The standby power load shall be sized to supply the following:

1. The mechanical air handling systems required to be operating during an emergency.
2. Fire pumps.

510.2.10 Emergency Power Loads

The transition time from the instant of failure of the normal power source to the generating source shall not exceed 10 seconds. The following loads are classified as emergency power loads:

1. Voice alarm system.
2. Voice communication system.
3. Fire alarm systems.
4. Fire detection systems.
5. Elevator car lighting.
6. Escape route lighting and exit sign illumination.

510.2.11 All vertical runs of alarm and communication systems shall be installed in a 2-hour fire resistant shaft, provided for that purpose, with protected access openings. These enclosures shall be aligned vertically and be accessible from common or public areas.

510.2.12 A public address system which may also serve as an alarm system shall be provided for the entire underground building.

510.2.13 When elevators are provided, the elevator lobby shall be separated by 1-hour fire resistant construction and a 3/4-hour C label door which is automatic closing by smoke detection.

510.2.14 Standpipes shall he installed in accordance with 902.1.

511 HAZARDOUS PRODUCTION MATERIAL FACILITIES

511.1 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 provision of 402.4.1, 402.4.8, 403.1.6 and 1104.3.2 and Tables 400 and 403.1 applicable to Groups H, Hazardous Occupancies shall not apply unless stated herein.

511.1.1 Automatic Sprinkler System. An approved automatic sprinkler system shall be provided throughout all buildings containing HPM facilities in accordance with 901.2, 901.8 and 901.7.4

511.1.2 All stairways shall be enclosed in accordance with 1106.1.2.

511.2 Fabrication Areas

511.2.1 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 arc supplemental to those processes.

511.2.2 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 511.2.1.

TABLE 511.2.1
ALLOWABLE HEIGHTS AND BUILDING AREAS FOR HAZARDOUS PRODUCTION MATERIAL FACILITIES

	TYPE OF CONSTRUCTION								
	TYPE I	TYPE II	TYPE III	TYPE IV		TYPEV		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: Multi-story	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

NOTES
1. The increases permitted in 402.3 shall apply.
2. The provisions of 402.4.1 and 402.4.8 and Table 400 shall not apply.
3. The area limitations are based on the building facing on one street of public space not less than 30 ft wide.
4. Allowable building area is shown in thousands of square feet per floor.
5. UA- Unlimited Area.

511.2.3 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 511.2.3. The total quantity of HPM permitted shall be based on the densities in Table 511.2.3 or the quantities in Table 511.2.2, whichever is the larger amount.

TABLE 511.2.2
PERMITTED QUANTITIES OF HAZARDOUS PRODUCTION MATERIAL IN A SINGLE FABRICATION AREA[2]

Material	Maximum Quantity
Flammable liquids	
Class 1-A	90 gal
Class 1-B	180 gal
Class 1-C	2700 gal
Combination flammable liquids	360 gal[1]
Combustible liquids	
Class II	360 gal
Class III-A	750 gal
Flammable gases	9000 cu ft at one atmosphere of pressure at $70^{O}F$
Liquefied flammable gases	180 gal
Flammable solids	1500 lbs
Corrosive liquids	165 gal
Oxidizer material	
Gases	18,000 cu ft
Liquids	150 gal
Solids	1500 lbs
Organic Peroxide	30 lbs
Highly toxic material, highly toxic and toxic gases	Included in the aggregate for flammable as noted above.

1. Containing not more than the exempt amounts of Class I-A, I-B, I-C 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, 401.2 shall be used to establish the appropriate occupancy.

TABLE 511.2.3
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	3.000

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 (I-A) + (I-B) + (I-C) (Combination flammable liquids) 0.025

   however, Class 1-A shall not exceed 0.0025

   Class II ..... =0.01

   Class III A ..... = 0.02
3. Highly toxic material, highly toxic and toxic gases shall be limited by the maximum quantities specified in Table 511.2.2.

511.2.4 Separation

511.2.4.1 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 1001.1, with not less than 3/4 hour opening protectives.

511.2.4.2 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 hour.

511.2.4.3 Floor forming part of the required separation shall be liquid-tight.

511.2.5 Floors. Floors within fabrication areas shall be of noncombustible construction. Unprotected openings through 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.

511.2.6 Ventilation

511.2.6.1 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 of floor area.

511.2.6.2 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.

511.2.6.3 Smoke Detectors. Smoke detectors shall be installed in the recirculating air-stream and shall initiate a signal at the emergency control station.

511.2.6.4 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.

511.2.6.5 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.

511.2.6.6 Transporting Hazardous Production Material. HPM shall be transported to fabrication areas through enclosed piping or tubing systems that comply with 511.6 through HPM service corridors or in exit access corridors as permitted in the exception in 511.3. The handling or transporting of HPM within HPM service corridors shall comply with the *Standard Fire Prevention Code*.

511.2.6.7 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 of floor area and when the number of air changes at any location is not less than 3 cfm per sq ft.

511.3 Exit Access Corridors

511.3.1 Exit access corridors shall be separated from fabrication areas as specified in 511.2.4. Exit access corridors shall not be used for transporting HPM except as provided herein and in 511.6.2.

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:

1. Corridors adjacent to the fabrication area under alteration shall comply with 511.2.4 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 l-hour fire resistant construction and the cabinet is internally fire sprinklered.

511.4 HPM Service Corridors

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

511.4.2 Separation. HPM service corridors shall be separated from exit access corridors as required by 511.2.4.

511.4.3 Ventilation. HPM service corridors shall be mechanically ventilated as required by 511.2.6.

511.4.4 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.

511.4.5 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 75 ft. Dead ends shall not exceed 4ft in length.

511.4.6 Alarms. Alarms shall be provided as required in 511.5.6.

511.5 Storage Of Hazardous Production Material

511.5.1 General. Rooms used for the storage of HPM in quantities greater than that set forth in Table 511.2.2, 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.

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

511.5.3 Hazardous 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.

511.5.4 Means of Egress. There shall be two egress doors from an HPM separate inside storage room when the rooms exceed 200 sq ft 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.

511.5.5 Ventilation. Exhaust ventilation shall be provided in accordance with 511.2.6 for all categories of HPM.

511.5.6 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.

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

511.6 Piping And Tubing

511.6.1 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 installed in accordance with ANSI 831.3. 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.

511.6.2 Installation in Exit Corridors and Above Other Occupancies. Hazardous Production Materials 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 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 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 the NFiPA 70.
8. Gas detection shall be provided in accordance with 511.2.6.5.

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.

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

512 MEMBRANE STRUCTURES

512.1 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 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 512.4.1 and 512.7.1.

512.2 Definitions

For the purpose of this section the following terms shall have the meanings indicated in this section. Other terms shall be as defined in this Code or shall have their ordinarily accepted meanings as the context may imply.

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.

512.3 Materials

512.3.1 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.

512.3.2 Membrane. All membranes shall be classified as either Class I or II.

512.3.2.1 A Class I membrane shall comply with the requirements of 512.4.1, 512.4.2, 512.4.3 and 512.4.4.

512.3.2.2 A Class II membrane shall comply with the requirements of 512.4.1, 512.4.3 and 512.4.4.

512.3.3 Interior Liners. All interior liners installed for decorative, acoustical, thermal insulation or other purposes shall comply with the requirements of 512.4.1.

512.4 Membrane Testing. All membranes shall be tested for flammability per the provisions of 512.4.

512.4.1 Flame Resistance.

512.4.1.1 Membranes shall perform as specified in Table 512.4 when tested in accordance with the provisions of the large and small scale tests of NFiPA 70I. Membranes shall be tested both as produced and after accelerated weathering per Section 4-6 of NFiPA 701.

512.4.1.2 The test report shall contain the actual performance of the fabric for each criteria.

512.4.1.3 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 square (12903 mm2) with a freestanding thickness of 0.25 inch (6 mm).
2. No test specimen shall drip molten or flaming particles that ignite the cotton.

TABLE 512.4
NFIPA 701 CRITERIA

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

512.4.2 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 3000 Btu/sq ft (9455 Wfm2) as determined by tests conducted in accordance with NFiPA 259.

512.4.3 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 512.4.4 and 512.4.5.

512.4.4 Test Decks

512.4.4.1 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.

512.4.4.2 Membranes limited to use for air supported structures 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.

512.4.4.3 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.

512.4.5 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 6ft (1829 mm) for Class A, 8ft (2438 mm) for Class B, nor 13ft (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.

512.4.6 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.

512.5 Design

512.5.1 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.

512.5.2 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 1 hour. The exterior wall shall extend from ground level to the height where the slope of the tangent to the membrane structure exceeds 30 from the vertical, but in no case less than 8 ft (2438 mm) above the first floor level.

512.5.3 Heights and Areas

512.5.3.1 Membrane structures shall be limited to one story in height but shall not be limited in number of feet of height.

512.5.3.2 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 400 for Type IV unprotected construction.

512.5.3.3 Area increases permitted by 402.3 shall be permitted.

512.5.4 Occupancy Separation. A membrane structure building which is occupied by more than one use group shall comply with 403.

512.6 Mixed Construction

512.6.1 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.

512.6.2 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 mm) from the edge of the membrane.

512.6.3 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 20 ft (6096 mm) above any floor, balcony or gallery and has a horizontal separation greater than 15ft (4577 mm) from the edge of the membrane.

512.7 Structural

512.7.1 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.

512.7.2 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.

513 DAY CARE STANDARDS

513.1 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.

513.2 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 distinct 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 of the N.C. State Building Code, Volume I- General Construction).
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 Chapter 20 of N.C. State Building Code, Volume I- General Construction.
8. 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.

513.3 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.

513.4 Special Care Facilities (Existing Prior to 12-13-88)

513.4.1 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.

513.4.2 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.

513.4.3 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 is 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.

514 RESIDENTIAL CARE FACILITIES

514.1 Classification

Institutional (I) Occupancy - Unrestrained. Buildings in which more than three people are harbored for medical, charitable or other care or treatment shall be classified as Institutional - Unrestrained. Institutional Occupancy-Unrestrained shall include, among others, the following:

Hospitals

Homes for the Aged

Nursing Homes

Psychiatric Hospitals

Facilities for the Mentally Retarded

Facilities for the Developmentally Disabled

Mental Health Residential Acute Treatment Facilities

Substance Abuse Nonhospital Medical Detoxification Facilities

Residential Care Facilities for Children and Adults

Day Care Facilities (with children under three years of age)

EXCEPTIONS:

1. Residential Care facilities keeping no more than six ambulatory adults or unrestrained ambulatory children who are able to respond and evacuate the facility without assistance, determined by the State Agency having jurisdiction to be licensable under G.S. 131D-2 or G.S. 122C-26 may be classified as Residential (Volume VII), provided all walls and ceilings are protected with plaster, gypsum wallboard, or fire retardant treated wood, or all combustible wall and ceiling finishes are painted with an approved fire retardant paint.
2. Residential Care facilities keeping no more than six adults or no more than six unrestrained children with no more than three unable to respond and evacuate without assistance and determined by the State Agency having jurisdiction to be licensable under G.S. 131D-2 or G.S. 122C-26 may be classified as Residential Care Facilities, Section 514.2.
3. Residential Care facilities keeping no more than five adults or no more than five children who are unable to respond and evacuate without assistance and determined by the State Agency having jurisdiction to be licensable under G.S. 122C-26, certifiable for Medicaid reimbursement, and staffed 24 hours per day with at least two staff awake at all times may be classified as Residential Care Facilities, Section 514.2.
4. Residential Care facilities keeping more than six and less than ten ambulatory retarded or similarly developmentally disabled adults who are able to respond and evacuate without assistance and determined by the State Agency having jurisdiction to be licensable under G.S. 122C-26 or G.S. 131D-2 may be classified as Residential Care Facilities, Section 514.2.
5. Residential Care facilities keeping as many as seven and less than ten children who are dependent, neglected, abandoned, destitute, orphaned, delinquent, or children who are separated temporarily from their parents shall be classified as Group R - Residential Occupancy provided the facility meets the requirements of 514.2.

514.2 Special Requirements For Group A-Residential

514.2.1 These requirements apply to the following types of residential care facilities:

1. Those keeping as many as six and less than ten children who are dependent, neglected, abandoned, destitute, orphaned, delinquent and not involuntarily retained, and

2. Those keeping as many as six and less than ten adults who are mildly or moderately retarded or similarly developmentally disabled as determined by the state agency having licensure jurisdiction, trainable, ambulatory and not involuntarily detained, and
3. Those facilities keeping up to 6 adults with no more than three of this total classified as non-ambulatory or semi-ambulatory. The facility must be licensed by a state agency which has a responsibility to periodically reinspect the facility to make sure that the number being cared for is no more than the license calls for.

514.2.2 All residential care facilities keeping as many as six and less than ten persons not involuntarily detained, when of other than Type I construction or Type II construction, shall not exceed two stories in height and shall not exceed 1800 square feet per floor and if wood frame construction and one story in height shall not exceed 2500 square feet in area for existing buildings. Any occupied attic shall be counted as an additional story in determining permissible building height. Basement areas used as habitable space count as a story. A basement is not counted as a story if at least 50% of its clear height is below grade.

514.2.3 All walls, partitions, and ceilings shall be of non-combustible materials or of 1-hour fire resistance.

514.2.4 Occupants must have access to two remotely located outside exits. Access from room doors to the two remotely located outside exits must not have a dead end distance of more than 20 feet measured from the room door to the point at which two separate outside exits can be reached. Occupants of all rooms above the first floor shall have unobstructed access to two separate and distinct ways to egress extending from the upper-most floor to the ground, such ways to egress to be so arranged in reference to rooms that in case of fire on one stairway, the other stairway can be reached by the occupant without having to pass the stairway involved. Stairways must be enclosed on one floor level with one hour fire rated walls and a minimum of solid core door equipped with self closer. Basement stairs, whether used for habitable space or not, shall be enclosed with one hour fire rated walls and solid core door equipped with self closer. (Exterior metal fire escapes meeting requirements of the Code are acceptable as exit stairs.)

514.2.5 All rooms for sleeping purposes shall have an outside window that can be opened without the use of tools to provide a clear opening not less than 16" in least dimensions and 432 square inches in area, or if of fixed glass, must be at least 24" x 24" with the bottom of the opening not more than 4' above the floor.

514.2.6 If a residential care facility keeping six to nine persons is of other than Type I or Type II construction, occupants younger than six years of age shall sleep on the first floor with an adult.

514.2.7 Fuel burning space heaters, floor furnaces and portable electric space heaters are prohibited.

514.2.8 When of other than Type I or Type II construction, all residential care facilities keeping six to nine persons shall be equipped with U.L. approved smoke detection devices or a U.L. approved automatic fire detection system in addition to other requirements specified in Section 901.

514.2.9 All residential care facilities keeping six to nine persons must install a manual fire alarm or signal system which is audible throughout the building.

514.2.10 For every 1800 square feet of floor area and for each floor there shall be at least one fire extinguisher. Fire extinguisher shall be provided in accordance with the standards of the National Fire Protection Association for First Aid Fire Fighting Appliances. Fire extinguishers shall be inspected regularly and kept charged and filled at all times.

514.2.11 All electrical and heating equipment shall be approved by Underwriters' Laboratories or other nationally recognized testing laboratories and shall be installed according to manufacturers' instructions and approved by the local inspector.

514.2.12 Flammable liquids, such as gasoline, kerosene, fuel oil, etc. shall be stored outside the building.

514.2.13 No locks, bolts or fasteners shall be installed on exit and room doors which would prevent occupants from getting out by the simple operation of a single knob or leaver.

514.2.14 All habitable rooms must have at least 8% of its floor area composed of windows with one-half of these windows openable.

514.2.15 Every home 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.

515 SPECIAL OCCUPANCY REQUIREMENTS

515.1 Scope

This Section shall apply to all exhibition facilities.

EXHIBITION 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.

515.2 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 l0 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 403 for occupancy separation requirements.

CHAPTER 6

CLASSIFICATION OF BUILDINGS BY CONSTRUCTION

601 CLASSIFICATION BY TYPE OF CONSTRUCTION

601.1 Types

601.1.1 Every building shall be classified by the Building Official into one of the types of construction us 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

601.1.2 Materials for any one of the six types of construction may be used as specified in Table 600, or as permitted in this chapter.

601.2 Fire Resistance Requirements

601.2.1 All fire resistance requirements are expressed in terms of the number of hours of satisfactory performance in accordance with ASTM E 119.

601.2.2 Construction required to have a fire resistance rating shall be supported by construction of equal or greater fire resistance except as provided in 608.4.

601.3 Materials and Construction Approved for Fire Protection

601.3.1 The degree of fire resistance and the materials, assemblies, and constructions providing such resistance shall be defined in Chapter 10 of this Code, except that other materials, assemblies, and construction 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 Chapter 31.

601.3.2 Where structural requirements necessitate assemblies providing greater fire resistance than specified in this chapter, such structural requirements shall govern.

601.4 Fire District

See 301.

602 TYPE I CONSTRUCTION

Type I is construction in which the structural members including exterior walls, interior bearing walls, columns, floors and roofs are of noncombustible material and are protected so as to have fire resistance not less than that specified for the structural elements as specified in Table 600.

603 TYPE II CONSTRUCTION

Type II is construction in which the structural members including exterior walls, interior bearing walls, columns, 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.

604 TYPE III CONSTRUCTION

604.1 General

Type Ill 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.

604.2 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.

604.2.2 Columns shall be continuous or superimposed throughout all stories by means of reinforced concrete or metal caps with brackets, or shall be connected by property 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.

604.3 Floor Framing

604.3.1 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.

604.3.2 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.

604.3.3 Framed timber trusses supporting floor loads shall have members of not less than 8 inches nominal in any dimension.

604.4 Roof Framing

604.4.1 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 of the height and not less than 6 inches nominal in any dimension for the upper half of the height.

604.4.2 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.

604.5 Construction Details

604.5.1 Wall plate boxes of self-releasing type, or approved hangers, shall be provided where beams and girders enter masonry. An air space of l/2 inch shall be provided at the top, ends and sides of the member unless approved durable or treated wood is used.

604.5.2 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.

604.5.3 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.

604.5.4 Columns, beams, girders, arches and trusses of material other than wood shall have a fire resistance rating of not less than 1 hour.

604.5.5 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 of solid masonry between their ends and the outside face of the wall, and between adjacent beams.

604.5.6 Adequate roof anchorage shall be provided.

604.6 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 plywood. Planks and flooring shall not extend closer than 1/2 inch to walls to provide an expansion joint, and the joint shall be covered at top or bottom.

604.7 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 tongue and grooved plywood bonded with exterior glue. Other types of decking may be used when approved by the Building Official.

604.8 Walls

604.8.1 Bearing portions of exterior and interior walls shall be of approved noncombustible materials and shall provide fire resistance ratings in accordance with Table 600.

604.8.2 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 is provided, wood columns, arches, beams and roof decks conforming to heavy timber sizes may be used externally.

605 TYPE IV CONSTRUCTION

Type IV is construction in which the structural members including exterior walls, interior bearing walls, columns, 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.

606 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 floors, roofs and interior framing are wholly or partly of wood or other approved materials. 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.

607 TYPE VI CONSTRUCTION

Type VI is construction in which the exterior bearing and nonbearing walls and partitions, 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.

608 EXCEPTIONS TO FIRE PROTECTION

608.1 Elevator Frames

Structural members of frames for elevators will not be required to have the fire protection required for structural steel, provided such members are erected within an enclosure of the prescribed fire resistance rating. See 701.

608.2 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 protection 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 or less.

608.3 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.

608.4 Tenant Separation and Corridor Walls

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.

See 811.6.7 for Wood Veneers on Exterior Wall Panels.

609 MIXED TYPES OF CONSTRUCTION

609.1 Area Limitations

When 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.

609.2 Height Limitations

When 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 occupancy for the types of construction used in the building.

609.3 Open Parking Structures

Open parking structures which comply with 412.6 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 412.6 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 403.1 and Table 400,
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 403, and
6. All exits for the upper occupancy shall be protected to the exterior of the building in accordance with Chapter 11.

610 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.

611 AREA SEPARATION FIRE WALL

611.1 Construction

611.1.1 Fire walls shall be of noncombustible material having a fire resistance rating of not less than 4 hours, and have sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall.

611.1.2 Walls constructed of solid masonry units or of reinforced concrete shall be considered as meeting the above requirements for structural stability under fire conditions.

611.1.3 Fire walls shall start at the foundation and extend continuously through all stories to and above the roof, except where the roof is of fire-resistive construction, the wall may be carried up tightly against the underside of the roof slab.

611.1.4 In multi-family dwellings of Type VI construction, fire walls shall meet the provisions of 611.1.1 and the following:

1. The fire walls shall extend not less than 18 inches past any combustible projection or veneer nor less than 6 inches beyond any roof eave, and
2. The fire wall shall extend 18 inches beyond any combustible projection located within 5 ft horizontally of the fire wall.

611.2 Thickness of 75% Solid Masonry Walls

611.2.1 Fire walls of 75% solid masonry shall be not less than 12 inches thick for the uppermost 35 ft of their height and shall be increased 4 inches in thickness for each successive 35 ft or fraction thereof measured downward from the top of the wall.

611.2.2 Where solid 75% masonry fire walls are stiffened at distances not greater than 12 ft apart by masonry cross walls or by reinforced concrete floors or roof, they may be 12 inches thick for the uppermost 70 ft, measured downward from the top of the wall, and shall be increased 4 inches in thickness for each successive 70 ft or fraction thereof.

611.2.3 Fire walls of 75% solid masonry may be not less than 8 inches thick for one story buildings of Group R, B, E, I and A occupancy when building on both sides of wall is Type I, Type II, or Type IV construction.

611.3 Fire Walls Constructed of Materials Other Than Masonry

Fire walls constructed of non-masonry materials which have a 4 hour rating when tested in accordance with ASTM E 119 may be used as a fire wall if test data is submitted to document that the wall will have sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall.

TABLE 600 – FIRE PROTECTION REQUIREMENTS
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	(m)					(i)	(i)		
Supporting more than one floor, columns or other bearing walls	4	3	2	1	NC	1	0	1	0
Supporting one floor only	3	2	1	1	NC	1	0	1	0
Supporting a roof only	3	2	1	1	NC	1	0	1	0
INTERIOR NONBEARING PARTITIONS	See 403, 701 and 702								
COLUMNS (e)	(m)		See 604						
Supporting more than one floor or other columns	4	3	H(d)	1	NC	1	0	1	0
Supporting one floor only	3	2	H(d)	1	NC	1	0	1	0
Supporting a roof only	3	2	H(d)	1	NC	1	0	1	0
BEAMS, GIRDERS, TRUSSES & ARCHES (e)	(m)		See 604						
Supporting more than one floor or other columns	4	3	H(d)	1	NC	1	0	1	0
Supporting one floor only	3	2	H(d)	1	NC	1	0	1	0
Supporting a roof only	1 1/2(f)	1(f)(g)	H(d)	1(f)	NC(f)	1	0	1	0
FLOOR/CEILING CONSTRUCTION	(m) 3	2	See 604 H (p)	(o) 1	(n)(o)(p) NC	(o) 1	(n)(o)(p) 0	1	(p) 0
ROOF/CEILING CONSTRUCTION (h)	1 1/2(f)	1 (f)(g)	See 604 H (d)	1(f)	NC(f)	1	0	1	0

NC – Noncombustible

H – Heavy Timber Sizes

TABLE 600 – FIRE PROTECTION REQUIREMENTS – (Continued)

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
EXTERIOR BEARING WALLS (h) (j) (k)	(% indicates percent of protected and unprotected wall openings permitted. See 703.1 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	4(NL)	3(NL)	1(NL)	1(NL)	NC(NL)	1(NL)	1(NL)	1(NL)	0(NL)
EXTERIOR NONBEARING WALLS (h) (j) (k)	(% indicates percent of protected and unprotected wall openings permitted. See 703.1 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	NC(NL)	NC(NL)	NC(NL)	NC(NL)	NC(NL)	NC(NL)	NC(NL)	0(NL)	0(NL)

NC – Noncombustible
(NL) – No Limit
H – Heavy Timber Sizes

TABLE 600-REFERENCE NOTES

a. Party walls and fire walls shall extend not less than 3 ft above the roof, except that fire walls need not extend above the roof where the roof is of noncombustible construction in Types I, II and IV construction or fire retardant treated wood in Types III, V and VI construction for an area within 40ft of each side of the wall. Party walls and fire walls shall extend not less than 18 inches past exterior intersecting walls of combustible construction or exterior noncombustible walls with combustible projections or veneers. The party or fire walls shall extend not less than 18 inches past any combustible projection or veneer.

b. Exterior walls shall extend not less than 18 in above the roof, except that parapet walls need not be constructed on buildings where the roof slopes more than 4:12 from the back of the exterior wall of such buildings or where the exterior walls of such building is located 15 ft or more distant from the common property line or the centerline of a public way.

c. See 703 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. Columns, beams, trusses and girders supporting masonry or concrete walls 8 ft or more high shall have the fire resistance required for the wall they support, but in no case less than 1 hour.

f. In buildings not over two stories approved fire retardant treated wood may be used. In buildings of Group A and Group E occupancies, fire protection may be omitted where structural members support a roof only and are 20ft or more clear above any floor or balcony.

g. 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 areas with heavy timber wood dome roofs arc 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.

h. See 716 for penthouses and roof structures.

i. The use of combustible construction for interior bearing partitions shall be limited to the support of not more than two floors and a roof.

j. Exterior walls shall be fire tested in accordance with 601.2. 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.

k. See 302.2.6 for fire resistance requirements for exterior walls of Type IV buildings in Fire District.

l. Walls or panels shall be of noncombustible material or exterior grade fire retardant treated wood, except for Type VI construction.

m. For Group A- Large Assembly without working stage, Group A- Small Assembly, Group E, Group F, 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.

n. Group A - Large Assembly without a working stage and Group A - Small Assembly occupancies of Type IV Unprotected or Type V Unprotected construction shall have 1 hour fire resistant floor.

o. 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.

p. 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.

CHAPTER 7

FIRE PROTECTION REQUIREMENTS

701 PROTECTION OF VERTICAL OPENINGS, STAIRS AND ELEVATORS

701.1 General Requirements For Enclosure Of Vertical Openings And Shafts

701.1.1 All openings, including vertical shafts, in floors or roofs, shall be enclosed or otherwise protected to prevent spread of fire from story to story, unless specifically exempted in this Code.

EXCEPTIONS:

1. Openings in floors or roofs of one and two family dwellings need not be enclosed.
2. In other than Group E, I and R occupancies, an enclosure is not required for openings which serve only one adjacent floor and are not connected with openings serving other floors and are not concealed within the building construction. Two levels may communicate within a single dwelling unit, apartment or hotel suite.
3. In any building with low hazard occupancy such as storage of noncombustible or with ordinary hazard occupancy (such as residential, mercantile, etc.) with automatic sprinkler protection up to three communicating floor levels are permitted without enclosing protection between floors, provided all the following conditions are met:
   1. The lowest or next to the lowest level is a street floor.
   2. The entire area including all communicating floor levels is sufficiently open and unobstructed so that it may be assumed that a fire or other dangerous condition in any part will be immediately obvious to the occupants of all communicating levels and areas.
   3. Exit capacity is sufficient to provide simultaneously for all the occupants of all communicating levels and areas, all communicating levels in the same fire area being considered as a single floor area for purposes of determination of required exit capacity.
   4. Each floor level considered separately, has at least one-half of its individual required exit capacity provided by an exit or exits leading directly out of that area without traversing another communicating floor level or being exposed to the spread of fire or smoke therefrom.
4. Open stairways shall be permitted as specified in Chapter 11.
5. Stairs located in unenclosed openings permitted in 507, 509 and 70l.1 need not be enclosed, provided such stairs are not required exits.
6. An enclosure shall not be required for a flight of "monumental" stairs (as used in public buildings, stores, hotels, office buildings, etc.) from the main street entrance floor to the floor next above or floor next below or for stairs leading to a mezzanine or balcony from the main floor when such stairs are not a required part of the building exit facilities and when such stairs are separated from corridors providing access to exits.
7. 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 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.

701.1.2 Vertical shafts, shall be enclosed throughout their length with construction of not less than that specified in Table 700.

701.1.2.1 A shaft that does not extend through the roof shall have its top enclosed with construction having fire resistance at least equal to that of the enclosing walls.

701.1.2.2 When a shaft extends through a combustible roof, the shaft enclosure shall extend at least 36 inches above the highest part of the roof that is within 5 ft of the opening. The enclosure wall or combination of enclosure wall and guardrail shall be at least 42 inches high.

701.1.2.3 When a shaft extends through a noncombustible roof, a noncombustible guardrail at least 42 inches high may be used around the opening instead of a wall.

701.1.3 Inner court walls shall be constructed to provide the fire resistance rating required in Table 600 for interior bearing or nonbearing walls depending on the type of inner court walls.

701.1.4 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.

701.1.5 Openings in all shaft enclosures shall be limited to those necessary for the purposes of the shaft. Openings in shaft enclosures shall be protected with approved fire doors, fire windows, fire shutters or fire dampers.

EXCEPTION: In fully sprinklered buildings, which are supervised, fire dampers may be omitted.

701.1.6 Floor penetrations by pipe or conduit are required to be enclosed in shafts as in the foregoing or shall be protected in accordance with 1001.3.1.

701.1.7 Special Provisions for Refuse and Laundry Chutes

701.1.7.1 General. Refuse and laundry chutes, access and termination rooms, and incinerator rooms shall be constructed in accordance with 701.1.7.2 through 701.1.7.6.

EXCEPTION: Group R3 occupancies.

701.1.7.2 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 701.1.4. Refuse chute material shall be noncombustible meeting Part 1 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.

701.1.7.3 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.

701.1.7.4 Termination Room. Refuse and laundry chutes shall discharge into an enclosed termination room completely separated from the remainder of building by construction and opening protectives in accordance with Table 700. Refuse chutes shall not terminate in an incinerator room.

701.1.7.5 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.

701.1.7.6 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.

TABLE 700
MINIMUM FIRE RESISTANCE OF WALLS, PARTITIONS AND OPENING PROTECTIVES[1]

Components	Walls and Partitions (hours)	Opening Protectives (hours)
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
occupancy separation	See 403	
within tenant space	See 702.4	
tenant space (see also 403.4)	1	3/4 C
horizontal exit	2	1 1/2 B
corridors, exit access[4,5,7]	1	20 min.
smoke partitions	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 use separation	See 408	
high rise buildings	See 506	
mall buildings	See 507	
assembly buildings	See 404	
bathrooms & restrooms	See Note 6	

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 1 112-hour B door assemblies.
3. See a1so 402.1.2.
4. See 702.3.
5. See 409 for sprinklered Group I buildings.
6. Fire rated bathroom/restroom doors are not required when opening onto fire rated halls, corridors, exit access provided:
   1. No other rooms open off of the bathroom/restroom and
   2. No gas or electric appliances are located in the bathroom/restroom and
   3. The walls, partitions, floor and ceiling or the bathroom/restroom have a fire rating at least equa1 to the rating of the hall, corridor or exit access and
   4. The bathroom/restroom is not used for any other purpose than it is designed for.
7. See 702.4.2.

702 INTERIOR WALL AND PARTITION FIRE SEPARATION REQUIREMENTS

702.1 General

702.1.1 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.

702.1.2 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. 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.

702.1.3 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.

702.1.4 Where a greater degree of fire resistance is required by other sections of this Code, the provisions of 702.2 and 702.3 shall not apply.

702.1.5 View panels in 1-hour fire resistant partitions shall be limited to either 1/4-inch 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 1296 sq in with no dimension greater than 54 inches. The glass block shall be limited to 120 sq ft with no dimension greater than 12ft. Neither assembly shall exceed 25% of the wall area separating a tenancy from a corridor.

702.1.6 Corridor partitions, smokestop partitions, horizontal exit partitions, exit enclosures, and fire rated walls 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."

702.2 Partition Requirements by Type of Construction

702.2.1 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.

702.2.2 All nonbearing partitions shall conform to the requirements of this section and have the fire resistance specified in Table 700 except as specified elsewhere in this Code.

702.2.2.1 Type I and Type II Construction. Partitions shall be constructed of noncombustible materials except that framing members of fire retardant treated wood may be used.

EXCEPTION: Pocket doors and their frames may be of wood.

702.2.2.2 Type III Construction. Partitions may be of any material permitted by this Code.

702.2.2.3 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, maybe of any material permitted by this Code.

702.2.2.4 Type V and Type VI Construction. Partitions may be of any material permitted by this Code.

702.3 Partition Requirements By Occupancy

702.3.1 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 403.4.

702.4 Partition Within Tenant Space

702.4.1 Partitions dividing portions of stores, offices or similar places occupied by one tenant only, which do not establish a corridor serving an occupant load of 30 persons or more, may be partial or full height, temporary or permanent and constructed in accordance with 702.2 without fire resistance, provided that:

1. They do not block required exits (without providing alternate conforming exits) and they do not establish an exit corridor.
2. Their location is restricted by means of permanent tracks, guides or other approved methods.
3. Flammability shall be limited to materials having a flame spread classification as set forth in Table 704.3 for rooms or areas.

702.4.2 Group B building exit access corridors are not required to be rated on any single tenant floor or in any single tenant space.

703 PROTECTION OF WALL OPENINGS

703.1 Protection of Openings in Exterior Walls

703.1.1 Every exterior wall within 15 ft of a property line shall be equipped with approved opening protective.

EXCEPTIONS:

1. One and two family dwellings.
2. Exterior walls not required by Table 600 to have a fire resistance rating.
3. Show windows fronting on a street or public space.
4. Open parking structures meeting the requirements of 412.6.

703.1.2 Openings in exterior walls that are above and less than 15 ft from any part of a neighboring combustible roof shall be equipped with approved opening protectives, except one and two family dwellings.

703.1.3 Where openings in an exterior wall are above and within 5 ft laterally of an opening of the story below, such openings shall be separated by an approved noncombustible flame barrier extending 30 inches beyond the exterior wall in the plane of the floor or by approved vertical flame barriers not less than 3 ft 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.

703.2 Exterior Walls Without Access Openings For High Piled Combustible Storage

Automatic sprinklers shall be installed throughout every building which does not have access to each story above grade on at least one accessible side of the building up to a height of 75 ft. Such access shall be openings for fire department use through the wall at each story, a minimum of 32 inches wide and 48 inches high and with the bottom of the opening not more than 32 inches above the floor. Openings shall be so spaced that there will be one opening in each 50 ft of exterior wall on the accessible side of the building. See *Standard Fire Prevention Code*, Chapter 36.

EXCEPTION: Buildings equipped with an automatic sprinkler system throughout shall have access panels as set forth above for each 200 ft of wall.

703.3 Protection of Openings in Interior Walls and Floors

703.3.1 Openings in walls and partitions, except in one and two family dwellings, shall be protected in accordance with Table 700.

703.3.2 When proof satisfactory to the Building Official is furnished that a larger size of opening than prescribed herein is necessary, the area may be increased if such opening is provided with protective devices that meet the approval of the Building Official.

703.3.3 See North Carolina State Building Code, Volume III-Mechanical, For Fire Dampers.

703.3.4 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 partitions.

703.4 Approved Types of Fire Windows, Doors and Shutters

703.4.1 Wall openings required to be protected by Table 700 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.

703.4.2 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.

703.4.2.1 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 703.4.2.2 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.

703.4.2.2 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 Restrained, with approved automatic sprinklers, corridor doors other than those in walls for:

1. laundries greater than 100 sq ft,
2. soiled linen rooms,
3. storage rooms greater than 100 sq ft storing combustible material,
4. trash collection rooms, and
5. enclosure of vertical opening

are not required to be rated but shall provide an effective barrier to limit the transfer of smoke. All doors except those to sleeping rooms shall be self-closing or automatic closing by smoke detection.

703.4.2.3 When approved by the Building Official, any door required to have a level of fire resistance and which is permitted to be automatic closing by smoke detection or which is self-closing, shall not have a delay in closing or reclosing of more than 10 seconds. Door assemblies shall be identified in accordance with their listing. Said doors shall not have louvers.

EXCEPTION: Doors from classrooms in group E occupancies opening directly into a 1-hour fire rated corridor, may be installed without self-closing devices.

703.4.3 The maximum size of fire doors shall not exceed that specified in Appendix C, NFiPA 80, except as may be modified by 703.3.2.

703.4.4 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 at the end of 30 minutes of standard fire test exposure.

703.4.5 Fire doors shall be equipped with an approved closer. See 1116.2.2 for doors in smoke barriers, horizontal exits.

EXCEPTION: Doors located in common walls separating guest rooms in Group R 1 hotels and motels may be installed without automatic or self-closing devices.

703.4.6 1/4-inch thick wired glass labeled for fire protection purposes may be used in approved opening protectives with the maximum sizes shown in Table 703.4.

TABLE 703.4
LIMITING SIZE OF WIRED GLASS PANELS

Rating, opening	Max. area (sq in)	Max. height (sq in)	Max. width (sq 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	1296	54	54
1 1/2 hour, Class D door	0	0	0
3/4 hour, Class E door	1296	54	54

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.

703.5 Fire Shutters

703.5.1 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.

703.5.2 Fire shutters of the rolling type shall be carefully counterbalanced and so arranged that they can be readily opened from the outside.

703.6 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 lose one door, all doors serving that stairway shall close.

704 RESTRICTIONS ON INTERIOR FINISHES

704.1 General

704.1.1 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.

704.1.2 Interior finish means the exposed interior surfaces of buildings including, but not limited to, fixed or movable walls and partitions, columns, and ceilings. 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 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.

704.2 Classification

Interior finish materials shall be classified in accordance with ASTM E 84. 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 0450. 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.

704.3 Interior Finish Requirements Based On Occupancy

704.3.1 The minimum flamespread classification of interior finish shall be based on the use or occupancy as set forth in Table 704.3.

TABLE 704.3
MINIMUM INTERIOR FINISH CLASSIFICATION

Occupancy	Unsprinklered			Sprinklered		
	Exits	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	C	B	C	B	C	C
F	C	C	C	C	C	C
H	Sprinklers required			B	C	C
I Restrained	A	A	B[2]	A	A	B[2]
I Unrestrained	A	A	B	B	C	C
M	B	B	C	C	C	C
R	B	B	C	C	C	C
S	C	C	C	C	C	C

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 in administrative areas.

704.3.2 Exceptions To Table 704.3:

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 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 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.

704.4 Foam Plastics

Foam plastics shall not be used as interior finish.

EXCEPTIONS:

1. As provided in 717.
2. Foam plastic of low density such that its weight is not greater than 2 oz/sq ft may be used as ceiling finish when the flamespread is not greater than 25 and the foam plastic is mounted in such a way that it will remain in place at an ambient room temperature of 175° F for a period of not less than 15 minutes.

704.5 Carpet On Walls And Ceilings

704.5.1 Textile materials having a napped, tufted, looped, woven, nonwoven, or similar surface may be used as interior finish on ceilings only when they have a flamespread rating of 25 or less in accordance with ASTM E 84.

704.5.2 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 E84 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.

704.6 Floor Finish

704.6.1 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 firestopped 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 1/2 inches, such space shall be filled with noncombustible material so that such space is not more than 2 1/2 inches.

704.6.2 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 thick and cemented directly to the floor slab or secured to wood sleepers firestopped as called for above and covered with approved finish flooring.

704.7 Floor Covering

704.7.1 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.

704.7.2 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.

704.7.3 Carpet 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.

EXCEPTION: In buildings equipped with an approved automatic sprinkler system, 0.45 watts/sq cm may be reduced to 0.22 watts/sq cm.

704.7.4 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.

704.7.5 The carpet shall be identified by a hang tag or other suitable method as to manufacturer or supplier and style and shall indicate the critical radiant flux level.

704.8 Application of Interior Finish

704.8.1 Interior finish materials applied to walls and ceilings shall be tested as specified in 704.2 and regulated for purposes of limiting flamespread.

704.8.2 When walls and ceilings are required by any provision in this Code to be of fire resistant, noncombustible, or fire retardant treated wood construction, Class B or C finish materials shall be applied directly against such construction or to furring strips not exceeding 1 3/4-inch 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 firestopped not to exceed 8 ft in any direction.

704.8.3 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 704.8.2, 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 704.8.2. 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.

704.8.4 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 704.8.2.

704.8.5 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 for 25 minutes.

704.9 Plumbing, Electrical and Air Handling Systems in Rated Assemblies

704.9.1 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 1001.3, 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 1001.1.

704.9.2 For specific requirements relative to the use of duct and piping insulation material in plenum chambers, refer to Sections 512 and 610.1 of the *Standard Mechanical Code*.

704.10 Wiring in Environmental Air Spaces

Single and multiconductor low voltage and power limited electrical wire and cables tested in accordance with UL 910 and having a peak optical density not greater than 0.50, an average optical density not greater than 0.15 and a flamespread of 5 ft or less and classified as having adequate fire resistance and low smoke producing characteristics shall be permitted in concealed spaces such as spaces over suspended ceiling, plenums, ducts and other spaces used for environmental air handling purposes.

705 FIRE STOPPING AND DRAFT STOPPING

705.1 Firestopping

705.1.1 Firestopping 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 1704.1.

705.1.2 Firestopping shall not be covered or concealed until inspected by the Building Official.

705.1.3 Walls and stud partitions shall be firestopped at floors, ceilings and roofs. Firestopping shall consist of approved noncombustible materials securely fastened in place. Materials specified in 1704.1 may be used in wood frame construction and masonry walls furred with combustible material.

705.1.4 All openings around pipes, conduits, cables, cable trays, etc., shall be firestopped in accordance with Chapter 10.

705.1.5 Chimneys shall be firestopped in accordance with 802, 803, and 1704.

705.1.6 Any openings between the edge of a floor deck and an exterior wall shall be sealed with noncombustible material for non-rated assemblies. Sealing of rated assembly openings shall be of materials designed and tested for this purpose which will provide a fire resistance rating equivalent to the rating of the floor. 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.

705.2 Draftstopping

Enclosed attic and floor spaces formed of combustible construction shall be divided in accordance with 1704.2.

706 ROOF COVERINGS

706.1 General

Roof coverings shall be divided into the classes defined below, whose use within the Fire District shall be governed by the requirements of 302.2.4. All Class A, B and C roof coverings 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 the SBCCI Standard for the Installation of Roof Coverings or other approved nationally recognized standards.

706.2 Class A Roof Coverings

Class A roof coverings shall include brick, concrete, slate, tile, corrugated asbestos cement or assemblies listed and identified as Class A by an approved testing agency.

706.3 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 agency.

706.4 Class C Roof Coverings

Class C roof coverings shall include the assemblies listed and identified as Class C by an approved testing agency.

706.5 Requirements for Roofs Outside Fire District

Roofs on buildings outside the Fire District, as established in Chapter 3, shall have Class A, Class B or Class C roof coverings, as specified herein. Wood shingles or shakes may be used as provided in 706.6. Private detached garages, carports and farm buildings as defined in 504 are not regulated by this section.

706.6 Wood Shingles and Shakes

706.6.1 Outside the Fire District, buildings three stories or less in height or 9000 sq ft (for allowable area increases see 402.3 for horizontal separation modifications) in area and located not less than 6 ft from the property line may be roofed with 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. Singles and hip and ridge units shall be manufactured in accordance with the grading rules of the Cedar Shake 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. Taper-sawn shakes of naturally durable wood shall be of 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 taper-sawn shakes of Southern Yellow Pine shall be 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.

Assemblies listed and identified as Class B by an approved testing agency may be used as permitted by the Class B rating.

706.6.2 Wood shingles and shakes may be applied to roofs with solid or spaced sheathing boards. Sheathing boards shall be not less than 1x4 spaced not more than 4 inches clear between boards for shingles and for all 18-inch shakes. Sheathing boards for all 24-inch shakes shall be not less than 1x6, spaced not more than 4 1/2 inches clear between boards. Shingles and shakes shall be applied in accordance with recommendations of the Cedar Shake and Shingle Bureau or the Southern White Cedar and Cypress Products Inspection Bureau and the exposures in Table 706.

TABLE 706
WEATHER EXPOSURE AND ROOF PITCH

Roofing Material	Length (in)	Grade	Exposure (in)	
			3:12 pitch (minimum) to < 4:12	4:12 pitch (minimum) and steeper
Shingles	16	No. 1 No. 2 No. 3	3 3/4	5
		No. 1 No. 2 No. 3		
		No. 1 No. 2 No. 3		
Shakes	18		Not Permitted	8
	24		Not Permitted	10[1]

1. For 24 x 3/8 inch handsplit shakes, the maximum exposure is 7 1/2 inches for roof pitches of 4:12 and steeper only.

706.7 Weather Protection

Roof coverings shall provide weather protection for the building at the roof.

706.8 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.

707 SLOPED GLAZING

707.1 Scope

Sloped glazing includes any installation of glass or other transparent, translucent, or opaque glazing material installed at a slope of 15° or more from the vertical plane. Glazing materials in skylights, roofs and sloped walls are included within this definition.

707.2 Allowable Glazing Materials

707.2.1 Sloped glazing shall be any of the following materials, subject to the limitations specified in 707.3 and the exceptions specified in 707.4:

1. For monolithic glazing systems, the glazing material of the single lite or layer shall be laminated glass with a minimum 30 mil 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.

707.2.2 See 2605 for additional requirements for plastic skylights.

707.3 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 707.4, 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 of the glass. They shall be constructed of a noncombustible material not thinner than 0.0808-inch (12 B&S ga) diameter with a mesh not larger than 1 by 1 inch. 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.

707.4 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° or less from the vertical plane if the highest point of the glass is 10 ft 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 area 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 commercial or detached greenhouses used exclusively for growing plants and not accessible to the public provided the height of the greenhouse at the ridge does not exceed 20 ft above grade.

707.5 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 buildings, 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 1203.6. All skylights set at an angle of less than 45°from the horizontal plane shall be mounted at least 4 inches 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° from horizontal.

EXCEPTION: Curbs for skylights may be omitted on roofs with a minimum slope of 3:12 in one and two family dwellings.

708 DORMER WINDOWS

Dormer windows shall be of the same type of construction as the roof on which they are placed, or of the side walls of the building. The top and sides shall be covered with roofing materials conforming with the requirements governing the roofing of the building.

709 ARCHITECTURAL TRIM, BALCONIES, BAY WINDOWS

709.1 Architectural Trim

709.1.1 All architectural trim on buildings located in the Fire District shall be constructed of approved noncombustible materials or fire retardant treated wood.

709.1.2 Outside the Fire District, such trim on buildings of Type I, II and IV construction not more than three stories or 40 ft 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.

709.1.3 For wood veneers on exterior walls, see 811.6.8.

709.1.4 For projection over public property, see 2202.

709.2 Cornices

Continuous exterior cornices of wood, or of wood frames, shall be draft stopped at intervals not exceeding 20 ft.

709.3 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. On buildings more than three stories in height, all exterior balconies shall be of noncombustible construction**.**

709.4 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 into the areas where openings are prohibited.

710 CANOPIES ON EXTERIOR WALLS

710.1 Over Public Property

Canopies extending over public property shall comply with the requirements of Chapter 22.

710.2 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 in the Fire District or less than 30 ft 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.
2. The canopy shall have one long side open.
3. The maximum horizontal width of the canopy shall not exceed 15 ft.
4. The fire resistance of exterior walls shall not be reduced.

711 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 1406, 1510, 1609 and 1709 for parapet wall relief openings requirements and see the *Standard Plumbing Code* for the sizing of vertical leaders and horizontal storm drains.

712 TOWERS, SPIRES, CUPOLAS, AERIAL SUPPORTS, POLES, DOMES

712.1 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 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 or when it is used for any purpose other than a belfry or an architectural embellishment.

712.2 Minimum Noncombustible Construction

712.2.1 Any tower, spire, dome or cupola which exceeds 25 ft in height above the highest point at which it comes in contact with the roof or which exceeds 200 sq ft 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 he separate 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 he of an approved fire resistant type.

712.2.2 All structures, except aerial supports not over 12ft high, flag poles, water tanks and cooling towers, placed above the roof of any building within the Fire District, or above the roof of any building more than 50ft in height, wherever located, shall be of noncombustible material and shall be supported by construction of noncombustible material.

712.3 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.

713 TANKS

713.1 Tanks Exceeding 500 Gal

713.1.1 Tanks of more than 500 gal 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.

713.1.1.1 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.

713.1.1.2 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.

713.2 Unenclosed Roof Tanks

All unenclosed roof tanks shall have covers sloping toward the outer edges.

713.3 Hoops

When hoops are used in the construction of tanks, they shall be of metal, and provision shall be made to guard against corrosion.

714 COOLING TOWERS

Cooling towers in excess of 250 sq ft in base area or in excess of 15 ft high when located on buildings more than 50 ft high in or out of the Fire District, shall be of noncombustible construction, except that drip boards may be of wood not less than 1-inch nominal thickness and the enclosing frame work 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.

715 DRYING ROOMS

715.1 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°F. If enclosure is of metal, it shall be insulated from all combustible material by not less than a 12-inch air space, 1/4- inch asbestos or other approved insulation. All drying rooms shall have approved ventilation.

715.2 Heating Pipes

Heating pipes, not located overhead, shall be shielded to maintain not less than 2 inches clearance between them and the contents.

716 PENTHOUSES AND ROOF STRUCTURES

716.1 General Requirements

716.1.1 A penthouse or other projection above the roof in structures of other than Type I construction shall not exceed 28 ft 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 above the roof.

716.1.2 The aggregate area of all penthouses and other roof structures shall not exceed one-third the area of the supporting roof.

716.1.3 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.

716.2 Types of Construction Required

716.2.1 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 and less than 20 ft from a common property line shall be of at least 1-hour noncombustible construction. Walls and roofs which are over 20ft 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 and less than 20 ft from a common property line shall be at least 1-hour construction. Walls which are over 20 ft from a common property line may be of heavy timber construction or noncombustible construction. Roofs 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 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 from adjacent property lines and when not exceeding 4 ft in height above the roof surface.

716.2.2 The restrictions of this section shall not prohibit the placing of wood flagpoles or similar structures on the roof of any building.

717 FOAM PLASTIC INSULATION

717.1 General

717.1.1 The provisions of this section shall govern the requirements and uses of foam plastic insulation in all buildings and structures regardless of type of construction.

717.1.2 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.

717.1.3 Foam plastic, except where otherwise provided shall be separated from the interior of a building by an approved thermal barrier of 1/2-inch gypsum wallboard or equivalent thermal barrier material which will limit the average temperature rise of the unexposed surface to not more than 250°F after 15 minutes of fire exposure complying with the ASTM E 119 standard time-temperature curve. This equivalency may be determined through the use of the "Small Scale Horizontal Exposure Furnace'" of Underwriters Laboratories Inc.

717.1.4 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.

717.1.5 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.

717.2 Specific Requirements

717.2.1 The following requirements shall apply to all uses of foam plastic unless specifically approved in 717.3 or by other sections of this Code.

717.2.2 Masonry or concrete construction. Foam plastics may be used without the thermal barrier described above when the foam plastic is protected by a minimum of 1-inch thickness of masonry or concrete.

717.2.3 Cold Storage Construction. Foam plastic, when tested in a thickness of 4 inches may be used in a thickness up to 10 inches when the building is equipped with an approved automatic fire suppression system. The approved automatic fire 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 717.2.5.2.

717.2.4 Walk-in coolers. Foam plastics having a maximum flamespread of 75 may be used up to 4 inches thick in freestanding walk-in coolers or freezer units with an aggregate area not exceeding 400 sq ft in floor area without a thermal barrier and without an automatic fire suppression system when the foam plastic is covered by a metal facing not less than 0.032- inch thick aluminum or corrosion-resistant steel having a minimum base metal thickness of 0.016 inch. When protected by a thermal barrier, the foam plastic may be used in a thickness up to 10 inches.

717.2.5 Exterior Walls. Exterior walls in buildings of fire resistant or noncombustible construction.

717.2.5.1 One story buildings: Foam plastic insulation having a flame spread of 25 or less may be used without thermal barriers in or on walls in a thickness of not more than 4 inches when the foam plastic is covered by a thickness of not less than 0.032-inch aluminum or corrosion resistant steel having a base metal thickness of 0.0160 inch and the insulated area is protected with automatic sprinklers.

717.2.5.2 Multistory buildings:

1. Where walls face a street or permanent open space of 30 ft or more, foam plastic insulation may be used in a nonfire rated exterior wall assembly. Where a separation of less than 30 ft exists, foam plastic may be used within exterior walls, provided the wall assembly affords the required fire resistance.
2. Any foam plastic insulation shall be separated from the building interior by a thermal barrier meeting the provisions of 717.1 unless a specific approval is obtained on the basis of 717.3.
3. The potential heat of foam plastic in any portion of the wall or panel shall not exceed 6000 Btu/ sq ft of projected area as determined by tests conducted in accordance with NFiPA 259.
4. The foam plastic core, coatings and facings shall have a flamespread rating of 25 or less and a smoke developed rating of 450 or less as determined in accordance with ASTM E 84.
5. Results of diversified or full scale fire tests reflecting an end use configuration shall be submitted to the Building Official demonstrating 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.

717.2.5.3 Marking of Foam Plastic. 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 or definitive information describing the product or materials performance characteristics and approved agency's identification.

717.2.6 Veneer. The limitations contained within Chapter 26 dealing with veneer materials do not apply to this section.

717.2.7 Roofing. Foam plastic may be used in a roof covering assembly without the thermal barrier when the foam is separated from the interior of the building by plywood sheathing not less than 15/32-inch 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 717.1. For all roof applications, the smoke developed rating shall not be limited.

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

717.2.9 Doors. Where doors are permitted without a fire resistance rating, foam plastic having a flamespread rating 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 aluminum or sheet steel having a minimum thickness of 0.016 inch. The thermal barrier requirement is waived.

EXCEPTION: In one and two family dwelling, foam filled exterior entrance doors not requiring a fire resistance rating may be face with wood.

717.2.10 Siding backer board. Foam plastic of not more than 2000 Btu/ sq ft as determined by NFiPA 259 may be used as siding backer board with a maximum thickness of 1/2 inch, provided it is separated from the interior of the building by not less than 2 inches of mineral fiber insulation or equivalent in lieu of the thermal barrier or when applied as insulation with residing over existing wall construction.

717.2.11 Interior Trim. Foam plastic trim, defined as picture molds, chair rails, baseboards and handrails, ceiling beams, door trim and window trim, may be used provided:

1. The minimum density is 20 lb/cu ft.
2. The maximum thickness of the trim is 1/2 inch and the maximum width is 4 inches.
3. The trim constitutes no more than l 0% 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.

717.3 Special Approval

717.3.1 Plastic foam, having a flamespread rating of not more than 75 and a smoke developed rating of not more than 450, not meeting the requirements of Sections 717.1 and 717.2 may be specifically approved on the basis of approved tests such as, but not limited to, a tunnel test in accordance with ASTM E 84, FM 4880, UL 1040, UL 1715, ASTM E 152 or fire tests related to actual end use configuration. The specific approval may be based on the end use, quantity, location and similar consideration where such tests would not be applicable or practical.

717.3.2 Foam plastics which are used as interior finish shall also meet the flamespread requirements for interior finish.

718 FIREMAN'S ACCESS PANELS IN WINDOWLESS WALLS FOR HIGHPILED COMBUSTIBLE STORAGE

718.1 General

An access door or covered opening with suitable hardware and identifying marking shall be installed in the veneered facing on each floor above the main floor, with free access into the building. See *Standard Fire Prevention Code*, Section 3609.2.

718.2 Size, Marking and Location

718.2.1 Opening shall be of sufficient size to permit ready access of firefighting personnel and hand carried firefighting equipment.

718.2.2 Exterior of the opening shall have distinctive markings for purpose of ease in locating panels.

718.2.3 Such access opening 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 aisleway.

719 THERMAL INSULATING MATERIALS

719.1 General

Insulating materials, including vapor barriers, breather papers, and similar coverings, 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.

719.2 Concealed Installation

719.2.1 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.

719.2.2 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, provided that the facing is installed in contact with the unexposed surface of the ceiling, wall or floor finish.

719.3 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.

719.4 Roof Insulation

The use of combustible roof insulation not complying with 719.2 or 719.3 shall be permitted in any type construction provided it is covered with approved roof coverings directly applied thereto.

719.5 Duct Insulation

Duct linings and coverings shall conform to the appropriate requirements of the *Standard Mechanical Code*.

719.6 Foam Plastics

Foam plastics shall comply to 717.

719.7 Cellulose Fiber Thermal insulation

Cellulose fiber thermal insulation shall be tested in accordance with and shall comply with the requirements of CPSC Standard 16 CFR, Parts 1209 and 1404. Each package of such insulating material shall be clearly labeled as meeting the requirements of the CPSC Standard.

CHAPTER 8

APPURTENANCE REQUIREMENTS

801 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*.

802 CHIMNEYS

802.1 General.

802.1.1 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.

802.1.2 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.

802.1.3 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.

802.1.4 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.

802.2 Chimney Construction

802.2.1 A chimney shall not carry any load other than its own dead weight.

802.2.2 Chimney crickets of metal or other roofing materials shall be laid or installed on solid roof decking consistent with the construction of the roof.

802.2.3 All chimneys which are or become unsafe or dangerous shall be made safe or taken down.

802.2.4 Chimneys shall extend at least 3 ft above the highest point where they pass through the roof of the building and at least 2 ft higher than any portion of the roof or building located within l0 ft horizontally of such chimney.

802.2.5 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.

802.3 Raising Adjoining Chimneys

802.3.1 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 10 ft of any portion of the wall extending above such chimney or flue.

802.3.2 The construction of such chimney shall conform to all requirements of this Code. Such a chimney shall be carried up simultaneously with the walls.

802.3.3 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.

802.4 Factory Built Chimneys

802.4.1 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.

802.4.2 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 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.

802.4.3 All chimney installations shall conform with the height requirements of this Code.

803 MASONRY CHIMNEYS

803.1 General Requirements

803.1.1 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.

803.1.2 Masonry chimneys shall not be corbeled from a wall or foundation more than 6 inches, nor shall a chimney be corbeled from a wall or foundation which is less than 12 inches 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. Corbeling shall not exceed 1 inch projection for each course of brick projected. Corbeled smoke chambers shall be parged with fireclay mortar or refractory mortar.

803.1.3 A chimney or chimney flue shall not change in size or shape within 6 inches above or below where the chimney passes through floor components, ceiling components or roof components.

803.1.4 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.

803.1.5 All spaces between chimneys and floors and ceilings through which chimneys may pass shall be firestopped with noncombustible material. The firestopping of spaces between chimneys and wood joists, beams, or headers shall be to a depth of 1 inch only, placed on strips of metal or metal lath laid across the spaces between combustible material and the chimney.

803.1.6 Masonry chimneys shall be proved tight by a smoke test after erection and before being put into use.

804 FIREPLACES

804.1 Factory Built Fireplaces

804.1.1 Factory built fireplaces shall be listed and shall be installed in accordance with the conditions of the listing.

804.1.2 Factory built fireplaces shall be tested in accordance with and meet the requirements of UL 127.

804.1.3 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 804.3.5. The hearth extension shall be readily distinguished from the surrounding area.

804.1.4 Factory built fireplaces shall be installed in accordance with 804.3.8.

804.2 Factory Built Fireplace Stoves and Solid Fuel Room Heaters

804.2.1 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.

804.2.2 Factory built fireplace stoves shall also be installed in accordance with 804.1.2 and 804.3.8.

804.3 Masonry Fireplaces

804.3.1 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 804.1. Where a lining of firebrick at least 2 inches thick or other approved lining is provided, the total thickness of back and sides, including the lining, shall be not less than 8 inches 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 of solid masonry or reinforced concrete.

804.3.2 Steel fireplace units incorporating a firebox liner of not less than 1/4-inch 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, not less than 4 inches of which shall be solid masonry.

804.3.3 Warm air ducts employed with steel fireplace units of the circulating air type shall be constructed of metal or masonry.

804.3.4 Fireplace hearth extensions of approved noncombustible material shall be provided for all fireplaces. Where the fireplace opening is less than 6 sq ft, the extension of the hearth in front of the fireplace shall be at least 16 inches and at least 8 inches beyond each side of the fireplace opening. Where the fireplace opening is 6 sq ft or larger, the extension of the hearth in front of the fireplace shall be at least 20 inches, and at least 12 inches 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.

804.3.5 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 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 from the face of the fireplace.

804.3.6 All combustible wood beams, joists and studs shall be maintained a minimum of 2 inches from the outside face of chimney or fireplace masonry. Headers supporting trimmer arches at fireplaces shall not be less than 20 inches from the face of the chimney breast. Trimmers shall be not less than 6 inches from the inside face of the nearest flue lining.

804.3.7 Woodwork shall not be placed within 4 in of the back of a fireplace, but this shall not prevent plastering directly on the masonry or on metal lath and metal furring.

804.3.8 All combustible mantles and similar trim shall be kept at least 6 inches 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 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 from the fireplace opening shall not be placed less than 12 inches from the top of the fireplace opening.

804.4 False Fireplaces

False fireplaces may be used in connection with listed gas or electric heaters, provided such fireplaces are constructed of noncombustible materials.

805 BARBECUES

805.1 Factory Built

Factory built barbecues shall be of an approved type and shall be installed in accordance with the manufacturer's instructions.

805.2 Masonry Built

Masonry built barbecues shall meet the applicable requirements of 804.3.

806 BOILER ROOMS

806.1 Central Heating Boilers

806.1.1 Every central heating boiler as defined in the *Standard Mechanical Code* with an input capacity of 250,000 Btu (264 MJ) or more, installed in any building other than a one or two family dwelling, shall be separated from the rest of the building by not less than 1-hour fire resistant construction.

806.1.2 A central heating boiler installed in a Group A, H or I occupancy shall be separated from the rest of such building construction having a fire resistance rating of not less than 2 hours.

806.2 Steam Boilers

Every steam boiler carrying more than 15 psi (103 kPa) pressure with a rating in excess of 10 boiler (98 kW) horsepower 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.

807 GAS APPLIANCES

Gas appliances shall be installed and vented in accordance with the requirements of the *Standard Gas Code*.

808 PLUMBING INSTALLATIONS

All plumbing fixtures and plumbing installations shall conform to the *Standard Plumbing Code*. See 2002.

809 FRESH AIR INTAKES

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 and shall be screened with a corrosion resistant material not larger than 1/2-inch mesh. Fresh air intakes shall not be taken from a location closer than 10ft from any chimney or vent outlet, or sanitary sewer outlet, unless such vent is not less than 24 inches above the fresh air vent.

810 PLENUM FLOOR SYSTEMS

Plenum floor systems shall comply with the requirements of the *Standard Mechanical Code*.

811 VENEERED WALLS

811.1 General

811.1.1 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.

811.1.2 Veneer shall not be assumed as supporting any load other than its own, weight, neither shall it be assumed to add to the strength of the wall.

811.1.3 Veneered walls shall provide weather protection for the building at the walls.

811.1.4 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.

811.2 Anchored Masonry Veneer

811.2.1 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 14. Anchored veneer units shall not be less than 1 5/8 inches in actual thickness for solid masonry units and not less than 2 5/8 inches in actual thickness for hollow masonry units.

811.2.2 Anchored veneer shall be supported on footings, foundation walls or other approved noncombustible structural supports. The weight of all anchored veneer installed on structures more than 30 ft in height above the noncombustible foundation or support shall he supported by noncombustible structural framing. The structural framing shall have horizontal supports located at each story height above the initial 30ft.

EXCEPTION: These height restrictions may be increased for noncombustible structural framing when special design techniques, approved by the Building Official, are used in construction.

811.2.3 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 required by 811.2 and 811.2.3 shall not exceed 1/600 of the span under full load of the anchored veneer.

811.2.4 Masonry veneer anchored to wood framing shall be attached with corrosion resistant corrugated sheet metal and shall be not less than 0.029 inch (No. 22 ga) by 7/8-inch wide or corrosion resistant ties of strand wire and shall not be less than 0.148 inch (No.9 W&M ga) wire with ends of the wire bent to a 90° angle to form a hook not less than 2 inches 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 of wall area with a maximum spacing of 16 inches vertically and 32 inches horizontally. When anchored veneer is applied over wood frame, the studs shall be spaced a maximum of 24 inches on center horizontally and be backed with solid sheathing on both sides. A 1-inch minimum air space shall be maintained between the anchored veneer and the solid sheathing. Moisture protection shall be provided as required by 1702.3.

811.2.5 Masonry veneer anchored to corrosion resistant steel framing shall be attached with corrosion resistant ties of strand wire and shall not be less than 0.148-inch (No. 9 W&M ga) wire with the ends of the wire bent to a 90° angle to form a hook not less than 2 inches long. The wire ties shall be embedded in the mortar joint a minimum of one-half the veneer thickness.

Masonry veneer anchored to corrosion resistant steel studs shall be attached with approved two piece corrosion resistant adjustable tie assemblies. Corrosion resistant coatings for all ties and anchors shall comply with ASTM A 153, Hot Dipped Galvanization After Fabrication Class B-3 (1.5 ounces per square foot). Ties shall be not less than 3/16-inch diameter wire and comply with ASTM A 82 for cold drawn steel wire. Anchor plates, if used, shall be not less than 14 gage and shall be made with backplate to uniformly distribute positive tie loads to studs. Anchor bolts and screws used to fasten plates shall be non-corrosive and compatible with surrounding metals. Tie spacing shall be limited to 2 sq ft of wall surface area per tie, with maximum spacing horizontally or vertically of 24 inches.

Flashing shall be provided as necessary to prevent entrance of water at all locations where exterior walls are interrupted (at lintels, shelf angles, window and door heads and sills, etc.), at foundation levels and at wall caps. A weep hole, formed by omitting mortar in head joints at 24 inches on center, shall be placed at all flashing locations where water can collect.

Rigid sheathing shall be nail or screw applied to both sides of non-rigid backup assemblies. One-half inch minimum gypsum board may be used as interior rigid sheathing with attachments per manufacturer's instructions. Caulk periphery of sheathing at interface with structure, windows, doors, and other openings. Apply 15 lb asphalt felt or equivalent over sheathing with weatherboard laps onto flashing.

Air space between the back of the brick and the exterior face of the rigid sheathing must be a minimum 2 inches for a steel stud backup assembly. Air spaces wider than 3 inches requires rational analysis of the spacing.

811.2.6 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 (No. 22 ga) by 7/8 inch wide or corrosion resistant ties of strand wire and shall be not less than 0.148 inch (No. 9 W&M ga) wire with ends of the wire bent to a 90° angle to form a hook not less than 2 inches 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 of wall area with a maximum spacing of 16 inches vertically and 32 inches horizontally. A 1-inch minimum air space shall be maintained between the anchored veneer and the supporting masonry or concrete walls.

811.2.7 Stone veneer units not exceeding 10 inches 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 No. 12 ga 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 in length bent at right angles and laid in the mortar joint and spaced so that the eyes or loops are 12 inches maximum on center in both directions. There shall be provided not less than a No. 12 ga corrosion resistant wire tie, or approved equal, threaded through the exposed loops for every 2 sq ft of stone veneer. This tie shall be a loop having legs not less than 15 inches in length bent so that it will lie in the stone veneer mortar joint. The last 2 inches of each wire leg shall have a right angle bend. One inch of cement grout shall be placed between the backing and the stone veneer.
2. With stud backing, a 2-inch by 2-inch No. 16 ga corrosion resistant wire mesh with two layers of waterproof paper backing shall be applied directly to wood studs spaced a maximum of 16 inches on center. On studs the mesh shall be attached with 2-inch long corrosion resistant steel wire furring nails at 4 inches on center providing a minimum 1 1/ 8-inch penetration into each stud and with 8d common nails at 8 inches 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 No. 12 ga corrosion resistant wire, or approved equal, looped through the mesh for every 2 sq ft of stone veneer. This tie shall be a loop having legs not less than 15 inches in length, so bent that it will lie in the stone veneer mortar joint. The last 2 inches of each wire leg shall have a right angle bend. One-inch minimum thickness of cement grout shall be placed between the backing and the stone veneer.

811.2.8 Slab-type veneer units not exceeding 2 inches 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 apart around the periphery of each unit with not less than four ties per veneer unit. Units shall not exceed 20 sq ft in area.

If the dowels are not tight fitting, the holes may be drilled not more than 1/16 inch 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 No. 22 ga by 1 inch or, if made of wire, not smaller in diameter than No. 9 ga wire.

811.2.9 Anchored terra cotta or ceramic units not less than 1 5/8 inches 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 thick with projecting dovetail webs on the back surface spaced approximately 8 inches 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 nor more than 18 inches on center; these anchors shall be secured to 1/4-inch 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 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.

811.3 Adhered Masonry Veneer

811.3.1 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 14. Adhered veneer units shall be less than 1 5/8 inches 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 after curing 28 days.

811.3.2 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.

811.3.3 Exterior adhered veneer shall not be attached to wood frame construction at a point more than 30 ft in height above the noncombustible foundation. The 30 ft limit may be increased when special design techniques, approved by the Building Official, are used in construction.

811.3.4 Adhered veneer units shall not exceed 36 inches in the greatest dimension nor more than 720 sq inches in total area and shall not weigh more than 15 psf unless approved by the Building Official.

EXCEPTION: Adhered veneer units weighing less than 3 psf shall not be limited in dimension or area.

811.3.5 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 nor more than 1 1/4 inch.
2. Units of masonry, stone or terra cotta, not over 1 inch in thickness shall be restricted to 81 sq inches 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 2x2x3/8 inches 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 18. Mortar as described in Table 811.3 shall be applied to the backing as a setting bed. The setting bed shall be a minimum of 3/8 inch thick and a maximum of 3/4 inch 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 811.3
ADHERED VENEER SETTING MORTAR

Wall Area	Coat	Volume Type 1 Portland Cement	Volume Type S Hydrated Lime	Volume Sand Dry	Volume Sand Damp	Maximum Thickness Of Coat	Minimum Interval Between Coats
Walls over 10 sq ft	Scratch	1	1/2	4	5	3/8"	24 hrs
		1	0	3	4	3/8"	24 hrs
	Float or leveling	1	1/2	4	5	3/4"	24 hrs
		1	1	6	7	3/4"	24 hrs
Walls 10 sq ft or less	Scratch And float	1	1/2	2 1/2	3	3/8" 3/4"	24 hrs

811.3.6 Adhered veneer units of ceramic tile shall be bonded to the backing as provided in 1402.10.

811.3.7 Adhered veneer over wood frame shall be backed by solid sheathing covered with waterproof building paper except where the sheathing is water repellent.

811.4 Metal Veneers

811.4.1 Metal veneers may be formed metal not less than 0.0149-inch (28 ga). Aluminum siding shall conform to AAMA 1402.

811.4.2 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 either vertically or horizontally, but where units exceed 4 sq ft 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 0.148-inch (9 W&M ga) wire. 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.

811.4.3 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 1703 against decay.

811.4.4 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.

811.4.5 Masonry backup shall not be required for metal veneer except as is necessary to meet the fire resistance requirements of this Code.

811.4.6 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.

811.5 Glass Veneer

811.5.1 The area of a single section of thin exterior structural glass veneer shall not exceed 10 sq ft where it is not more than 15 ft above the level of the sidewalk or grade level directly below, and shall not exceed 6 sq ft where it is more than 15 ft above that level.

811.5.2 The length or height of any section of thin exterior structural glass veneer shall not exceed 48 inches.

811.5.3 The thickness of thin exterior structural glass veneer shall be not less than 11/32 inch.

811.5.4 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 thick and not more than 5/8 inch thick. Bond coat and mastic shall preferably be from the same manufacturer and shall bond firmly together.

811.5.5 Where glass extends to sidewalk surface, each section shall rest in an approved metal molding, and set at least 1/4 inch above the highest point of the sidewalk. The space between the molding and the sidewalk shall be thoroughly caulked and made watertight.

811.5.6 Joints:

811.5.6.1 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.

811.5.6.2 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 by an approved nonrigid substance or device.

811.5.6.3 Where thin exterior structural glass veneer abuts nonresilient material at sides or top, expansion joints not less than 1/4 inch wide shall be provided.

811.5.7 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 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 (18 ga) thick and not less than 2 inches 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.

811.5.8 Mechanical Fastenings:

811.5.8.1 All thin exterior structural glass veneer installed above the level of the heads of show windows and all such veneer installed more than 12 ft 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.

811.5.8.2 Fastenings shall be secured to the wall or backing with expansion bolts, toggle bolts, or by other methods.

811.5.8.3 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.

811.5.9 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.

811.6 Wood

811.6.1 Wood siding patterns known as rustic drop siding or shiplap shall have an average thickness in place of not less than 19/32 inch and shall have a minimum thickness of not less than 3/8 inch. Bevel siding shall have a minimum thickness measured at the butt section of not less than 7/16 inch and a tip thickness of not less than 3/16 inch. Siding of lesser dimensions may be used provided such wall covering is placed over sheathing which conforms to the provisions of 1707.2.

811.6.2 Board siding applied vertically shall be nailed to horizontal nailing strips or blocking set 24 inches on center. The nails shall penetrate 1 1/2 inches into studs, blocking, studs or blocking and sheathing combined, or nailing strips.

811.6.3 Wood shingles or shakes attached to sheathing other than wood, plywood, structural-use panels or 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. Wood shingles or shakes may be applied over fiberboard shingle backer and fiberboard sheathing with approved corrosion resistant annular grooved nails or may be nailed directly to fiberboard nailbase sheathing with corrosion resistant annular grooved nails. The minimum thickness of wood shingles or shakes between nailing boards shall be 3/8 inch.

811.6.4 Plywood and structural-use panels shall be of the exterior type and shall have a thickness of 3/8 inch, except as provided in Table 1707.1C. All plywood joints shall be backed solidly with nailing pieces not less than 2 inches wide, unless wood, plywood or particleboard sheathing is used, or otherwise made waterproof as required in 1702.3.

EXCEPTION: The framework is not required to be protected in accordance with 1702.3 when the joints are protected by a continuous wood batt, caulking, flashing or vertical or horizontal shiplap.

811.6.5 Fiberboard siding shall be medium density not less than 1/2 inch nominal thickness.

811.6.6 Hardboard siding shall conform with the requirements of ANSI/AHA A135.4, ANSI/AHA A 135.5 or ANSI/AHA Al35.6 and shall be identified as to classification.

811.6.7 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 1705.1 and Table 811.6. Nails shall be spaced not less than 3/8 inch from edges and ends. Joints shall occur over framing members unless particleboard panel siding is applied over 5/8-inch net wood sheathing or 15/32-inch plywood or structural-use panel sheathing or 1/2-inch particleboard sheathing. The framework shall be protected as required in 1702.3.

EXCEPTION: The framework is not required to be protected in accordance with 1702.3 when the joints are protected with a continuous wood batt, caulking, flashing or vertical or horizontal shiplap.

TABLE 811.6
ALLOWABLE SPANS FOR
EXPOSED PARTICLEBOARD PANEL SIDING

		Minimum Thickness (Inches)		
		Siding		Exterior Ceilings and Soffits
Grade	Stud Spacing (in)	Direct to Studs	Continuous Support	Direct to Support
2-M-W and 2-M-F	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	

811.6.8 Wood veneers on exterior wall panels of types I, II, III, IV and V construction:

811.6.8.1 Wood veneers of not less than l-inch nominal thickness, 7/16-inch exterior hardboard siding or 3/8-inch exterior type plywood or structural-use panels or particleboard may be used in or out of the Fire District 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 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 from the building wall.

811.6.8.2 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 and the space thereby created shall be firestopped in accordance with 1704 and arranged so that there will be no open space exceeding 100 sq ft. Where wood furring strips are used, they shall be of approved wood of natural decay resistance or pressure treated wood.

811.6.9 Structural-use panel siding shall be classified Exterior and shall be span-rated in accordance with 1701.4.13. Fastening shall be in accordance with Table 1707.1 C.

811.7 Asbestos Shingles

Asbestos shingles attached to sheathing other than wood, plywood or 2-M-W by particleboard shall be secured with approved mechanically bonding nails or 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.

811.8 Stucco

Stucco or exterior plaster shall conform to requirements of 1803.

811.9 Rigid Vinyl

Rigid vinyl siding shall conform with the requirements of ASTM D 3679 and is limited to Type VI construction.

812 COMPUTER/DATA PROCESSING EQUIPMENT ROOMS

Computer/data processing equipment rooms shall comply with the requirements of NFiPA 75.

CHAPTER 9

SPRINKLERS, STANDPIPES AND ALARM SYSTEMS

901 SPRINKLERS

901.1 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.

901.2 Requirements

Every automatic sprinkler system required by this Code shall conform to NFiPA 13, 13D, or 13R, 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, 13D, or 13R.

For the purpose of this code, sprinkler systems meeting the following standards shall be considered meeting the 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.

901.3 Material

Piping shall be as specified in NFiPA 13, 13D, or 13R.

901.4 Hose Threads

All hose threads in connections shall be uniform with that used by the fire department of the applicable governing body.

901.5 General

901.5.1 Approved automatic sprinkler equipment meeting the requirements of 901 shall be installed in buildings as follows:

1. Basements having floor areas exceeding 2500 sq ft 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 402.4.1, Exception 2.
2. In buildings which do not have suitable access, as set forth in 703.2, 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 408.2.5, 412.2.6 and 412.2.7.
5. Spray finishing booth, area or room shall comply with Chapter 10 of the *Standard Fire Prevention Code*.

901.5.2 Automatic fire sprinklers may be omitted in the following rooms or areas when such rooms or areas are protected with an approved automatic fire detection system which will respond to visible or invisible particles of combustion:

1. Generator, transformer and electrical equipment rooms.

2. Elevator machine rooms, elevator hoistways, and communication equipment rooms under the exclusive control of a public utility provided the equipment areas are separated from the remainder of the building by construction equivalent to a 2-hour fire resistant wall and 2-hour fire resistant floor/ceiling assemblies provided the rooms are not used for other equipment or other purposes.

901.6 Garages

Approved automatic sprinkler systems shall be provided in the following garages:

1. Enclosed parking garages over 65 ft high and exceeding 10,000 sq ft per floor.
2. Repair garages two stories or more high. and exceeding 10,000 sq ft in a single floor area located below another occupancy.
3. One story repair garages exceeding 15,000 sq ft.
4. Basement garages 5000 sq ft in area or repair garages in a basement exceeding 2500 sq ft.
5. Garages used for the storage of commercial trucks and having an area exceeding 5000 sq ft.
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.

901.7 Other Occupancy Sprinkler Requirements

901.7.1 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.

901.7.2 Group A - Large Assembly Occupancy

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.

901.7.2.2 An approved automatic sprinkler system shall be provided under the roof and gridiron in the tri and fly galleries and in all places behind the proscenium wall of stages, over enclosed platforms more than 500 sq ft in area, and in dressing rooms, workshops and store rooms accessory to such stages and platforms.

EXCEPTIONS:

1. Stages or enclosed platforms open to the auditorium room on three or more sides.
2. Altars, pulpits or similar platforms and their accessory rooms.
3. Stage gridirons, when side wall sprinklers with 135° F rated heads with heat baffle plates are installed around the entire perimeter of the stage except for the proscenium opening at points not more than 30 inches below the gridiron nor more than 6 inches below the baffle plate.
4. Under stage or under enclosed platform area less than 4 ft in clear height used exclusively for chair or table storage and lined on the inside with materials approved for 1-hour fire resistant construction with a solid backing.

901.7.3 High Piled Combustible Stock. An approved automatic sprinkler system shall be provided throughout buildings having a contiguous area (minimum separation between storage areas of 60 ft) used for high piled combustible storage, as defined in the *Standard Fire Prevention Cod*e, exceeding 20,000 sq ft.

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.

901.7.4 Hazardous Production Material (HPM) Facility. The design of an approved automatic sprinkler system for an HPM Facility, as defined in 511, shall be in accordance with NFiPA 13 and not less than that required for the special fire hazard areas shown in Table 901.7.4.

TABLE 901.7.4
HAZARDOUS PRODUCTION MATERIAL FACILITIES
SPECIAL FIRE HAZARD AREA REQUIREMENTS

Location	NFiPA Hazard Group
Fabrication Areas	Ordinary Hazard Group 3
HPM Service Corridors	Ordinary Hazard Group 3
HPM Separate Inside Storage Rooms without Dispensing	Ordinary Hazard Group 3
HPM Separate Inside Storage Rooms with Dispensing	Extra Hazard Group 2
Exit Access Corridors	Ordinary Hazard Group 3

901.8 Supervisory Facilities

901.8.1 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 adequately supervised to assure reliable operation.

901.8.2 The extinguishing system shall be electrically connected, either directly or through a central station facility or other approved equal, to the fire department legally committed to serve the area in which the building is located. System actuation shall initiate alarm sequence.

EXCEPTION: R2 buildings shall be supervised in accordance with NFiPA 13R.

901.8.3 Where a system may be disabled by closing of valves, interruption of power, etc., adequate supervision shall be provided to sound at least a local trouble alarm when the system is deactivated and a trouble signal to the central station facility. In HPM Facilities, as defined in 511, all valves shall be provided with supervisory tamper switches with the trouble signal to go to the emergency control station.

901.8.4 Where building fire alarm facilities are provided, actuation of the extinguishing system shall cause the building alarm to sound.

901.8.5 See NFiPA 71, NFiPA 72D and NFiPA 1221.

901.9 Group R2-Multi-Family Dwellings

901.9.1 Townhouses

901.9.1.1 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.

901.9.1.2 The separation between townhouses listed in 403.5(1) shall be reduced to one hour.

901.9.2 R-2 Type VI Unprotected Sprinklered Buildings

901.9.2.1 The provisions of Section 402.3 shall not apply.

901.9.2.2 Building story height listed in Table 400 may be increased to three stories. For single exit provisions, see 411.2.5.

901.9.2.3 The tenant separations required by Section 403.4 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.

901.9.2.4 The finish grade requirement for emergency access listed in Section 411.2.1 shall be waived.

901.9.2.5 The exterior storage room protection listed in Section 411.2.2 shall be waived when the storage room is sprinklered.

901.9.2.6 The soffit protection listed in Section 411.2.3 shall be waived.

902 STANDPIPES

902.1 Requirements

Unless otherwise provided herein, standpipes, standpipe systems, hose, water supply, pumps, connections, etc., shall be constructed and installed to meet NFiPA 14.

902.2 Approval

The complete layout of the standpipe and hose system shall be submitted to the Building Official before installation.

902.3 Standpipes Required

902.3.1 Buildings two stories or more and exceeding 50 ft in height shall be provided with a Class I or Class III standpipe system as determined by the Fire Official.

902.3.2 Group R hotels, dormitories and motels three stories or more in height shall be provided with a Class I or Class III standpipe system.

902.3.3 When a building is completely sprinklered and a standpipe is required, either a Class I or combined system shall be provided.

902.3.4 Group A - Large Assembly with working stage. A standpipe outlet with hose attached shall be provided on each side of the rear of each balcony and gallery, on each side of the stage, on each tier of dressing rooms, and within 50 ft of all property rooms, store rooms and work rooms. Hose attachment shall be at the discretion of the Fire Official.

902.3.5 Class III standpipes are not required in the following cases:

1. Completely sprinklered building.
2. Basements equipped with a complete automatic sprinkler system.

902.4 Dry Standpipe

In buildings requiring standpipes in accordance with 902.3, 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.

902.5 Hose and Nozzle

Each hose outlet of a Class III standpipe system shall be supplied with not more than 100ft of approved 1 1/2-inch lined hose capable of withstanding 500 psi test pressure. Such hose shall be equipped with an approved nozzle.

902.6 Standpipes During Construction

See 2101.9.3 for requirements.

902.7 Supervisory Facilities

Where building fire alarm facilities are provided, the closing of any standpipe water supply control valve including any valves associated with a fire pump installation shall cause an audible trouble alarm to sound at the fire alarm annunciator or at a place of constant attendance. If the building does not have fire alarm facilities, locks shall be provided on all valves and shall be of a type acceptable to the Building Official.

903 FIRE ALARM

903.1 Manual Fire Alarm Systems

903.1.1 A manual fire alarm system in accordance with NFiPA 72A shall be installed in all the following buildings (capacities listed below shall be determined from Table 1105.1):

Group A having a capacity of 300 persons or more.

Group B having a total occupancy of 500 or more persons or more than 100 persons above or below the level of exit discharge.

Group E Schools.

EXCEPTION: Individual one room classroom buildings.

Group F Factory-Industrial occupancies of buildings having a total capacity of 100 or more persons or 25 or more persons above or below the level of exit discharge.

Group I (sec 409).

Group H.

Group M having a total occupancy of 500 or more persons or more than 100 persons above or below the level of exit discharge.

Group R hotels having accommodations for more than 15 guests, apartment houses four or more stories in height, and dormitories, lodging or rooming houses having more than 15 sleeping accommodations.

EXCEPTION: Where each guest room or apartment has a direct exit to the outside of the building and the building is three stories or less in height.

903.1.2 Except in Group I occupancies, the manual fire alarm system required in 903.1 may be omitted in buildings equipped with an automatic fire alarm or automatic sprinkler system covering all areas. Actuation of the automatic fire alarm or automatic sprinkler system shall sound an internal evacuation alarm. Provision shall be made to manually activate the internal evacuation alarm at a minimum of one centrally located station.

903.1.3 Each floor shall be zoned separately. No one zone may exceed 15,000 sq ft. 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. Zoning for an automatic fire alarm system using a sprinkler system shall have at least one zone per system. If a manual fire alarm system does not require at least two zones, a zone indicator panel located at the above locations is not required.

903.2 Smoke Detector Systems

903.2.1 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, shall be provided with an approved listed smoke detector, installed in accordance with the manufacturer's recommendation and listing.

903.2.2 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.

903.2.3 In dwellings or dwelling units with split levels, a smoke detector need be installed only on the upper level, provided the lower level is less than one full story below the upper level, except that if there is a door between levels then a detector is required on each level. Such detectors shall be connected to a sounding device or other detector to provide an alarm which will be audible in the sleeping areas.

903.2.4 Detectors shall be listed and meet the installation requirements of NFiPA 74 and NFiPA 72E.

903.2.5 Any complete automatic fire alarm system using automatic smoke detectors shall be installed in accordance with NFiPA 72A and NFiPA 72E.

903.2.6 All Group R buildings, day care facilities and residential care facilities shall have installed in all interior, enclosed exit access corridors approved listed smoke detection devices. Such smoke detection devices shall be installed on or near the ceiling and in accordance with the listing and the manufacturer's recommendations, but in no case shall smoke detectors be spaced farther apart than 30 feet on centers in corridors or more than 15 feet from any wall.

903.2.6.1 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 alarm system when required by Section 903. System smoke detectors must be tested and listed in accordance with the "Standard for Smoke Detectors for Fire Protective Signaling Systems," ANSI/UL 268.

903.2.6.2 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 Multiple Station, ANSI/UL 217. They shall be powered from the bui1ding electrical system via a permanent connection as specified in the North Carolina State Electrical Code.

CHAPTER 10

FIRE RESISTANCE STANDARDS FOR MATERIALS AND CONSTRUCTION

1001 GENERAL

1001.1 Tests

1001.1.1 Fire protection 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 Chapter 31 shall be accepted by the Building Official for specific ratings.

EXCEPTION: In determining the fire resistance rating of exterior bearing walls, compliance with the ASTM E 119 criteria for unexposed surface temperature rise and ignition of cotton waste due to passage of flame or gases, is required only for a period of time corresponding to the required fire resistance rating of an exterior, nonbearing wall with the same horizontal separation distance, and in a building of the same type of construction. When the fire resistance rating determined in accordance with this exception exceeds the fire resistance rating determined in accordance with ASTM E1 19, the fire exposure time period, water pressure and application duration criteria for the hose stream test of ASTM Ell9 shall be based upon the fire resistance rating determined in accordance with this exception.

1001.1.2 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.

1001.1.3 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.

1001.1.4 Combustible materials shall not enter into the construction of assemblies except as provided in the foregoing prescribed tests.

1001.2 Opening Protection

Fire doors, curtains, shutters, windows, or other protection required for openings in fire resistant walls, shall be in accordance with the requirements of 703.

1001.3 Penetrations of Fire Resistant Construction

1001.3.1 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 1001.3.1.1 and the opening does not exceed 100 square inches.

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.

1001.3.2 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 will not be reduced.

EXCEPTION: Fixtures which are listed for such installation are permitted.

1001.3.3 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.

1001.3.4 Penetrations of nonrated walls, partitions and floors of noncombustible construction shall be firestopped with noncombustible materials.

1001.3.5 Penetrations of nonrated walls, partitions and floors of combustible construction shall be firestopped with materials equivalent to two inches of wood.

1001.4 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 f or other such provisions of this Code.

1002 MATERIALS FOR FIRE PROTECTION

1002.1 Scope

Materials prescribed herein for fire resistance and fire protection shall conform with the requirements of this Chapter.

1002.2 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.

1002.3 Clay or Shale Tile

Hollow clay or shale tile shall be laid in Type M, S, N, O or gypsum mortar. Clay or shale tile used in nonbearing partitions and for fire protection 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.

1002.4 Gypsum

1002.4.1 Poured gypsum used for fire protection 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.

1002.4.2 Fibered plaster may be used where unsanded or neat gypsum plaster is prescribed.

1002.4.3 All plaster mixes for sanded gypsum plasters shall be measure by dry weight.

1002.4.4 When gypsum plaster is used with an aggregate, the proportions shall be as required in 1803.1.

1002.5 Gypsum Lath, Wallboard and Sheathing Board

1002.5.1 Gypsum lath shall comply with the provisions of ASTM C 37.

1002.5.2 Gypsum lath shall be nailed to wood studs or joists in all constructions required to be fire resistant, with 1 1/8-inch, 13 ga, 19/64-inch flat head blued nails at intervals not exceeding 4 inches on centers (five nails per lath for support of 16-inch lath) or equivalent attachment.

1002.5.3 Gypsum wallboard shall comply with the provisions of ASTM C 36.

1002.5.4 Gypsum sheathing board shall comply with the provisions of ASTM C 79.

1002.5.5 Gypsum veneer base shall comply with the provisions of ASTM C 588.

1002.5.6 Gypsum veneer plaster shall comply with the provisions of ASTM C 587.

1002.5.7 Exterior gypsum soffit board shall comply with the provisions of ASTM C 931.

1002.5.8 Water resistant gypsum backing board shall comply with the provisions of ASTM C 630.

1002.6 Metal or Wire Lath

1002.6.1 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 1/2 lb per sq yd when used in vertical position, and not less than 2 3/4 lb per sq yd when used in horizontal position. Wire lath shall not be lighter than 2 1/2 meshes per inch, or equivalent.

1002.6.2 Weight tags shall be left on all metal lath or wire lath until inspected and approved by the Building Official.

1002.6.3 Metal lath for ceilings below wood joists in construction which is required to be fire resistant shall be attached with 1 1/2-inch, 11 ga, 7/16-inch head barbed roofing nails spaced at intervals not to exceed 6 inches on centers, or equivalent attachment.

1002.6.4 Welded wire lath shall comply with the provisions of ASTM C 933.

1002.6.5 Woven wire lath shall comply with ASTM C 1032.

1002.7 Concrete Block

Hollow concrete masonry units used in exterior walls and in all walls or partitions shall comply with ASTM C 90 and C 129. Solid loadbearing concrete masonry units shall comply with ASTM C 145.

1002.8 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 nor more than 10 pcf as determined by measurement in a cubic-foot box, using the shoveling procedure as outlined in ASTM C 29.

1002.9 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 nor more than 15 pcf, as determined by measurement in a cubic-foot box, using the shoveling procedure as outlined in ASTM C 29.

1002.10 Glass Block

Glass block shall be labeled to conform to ASTM E 163 or UL 9.

1002.11 Sprayed Fire Resistant Materials

1002.11.1 Sprayed fibrous and cementitious materials used for structural fire resistance and fire protection shall provide the fire resistance ratings set forth in this Code. The density and thickness shall be determined in accordance with 1002.11.2 and 1002.11.3.

1002.11.2 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 of area.
4. The average thickness as determined by this procedure shall not be less than that specified in inches subject to a tolerance of ± l/8 inch. The acceptance of measurements with a minus tolerance greater than 1/8 inch shall not be permitted. Measurements greater than 1/8 inch above the required shall not be used to determine the thickness average.
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.

1002.11.3 Density measurement and acceptance criteria:

l. There shall be density test specimens taken from a column, a beam and a deck for each 10,000 sq ft of floor area or fraction thereof or from each floor if the floor area is smaller than 10,000 sq ft 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.

1003 FIRE RESISTANCE REFERENCES

1003.1 Reference Tables

1003.1.1 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 1001.

1003.1.2 Appropriate fire resistant materials, constructions and assemblies of constructions as listed in Appendix B and the following publications may be accepted as if herein listed:

FM Specification Tested Products Guide, 1986.

GA Fire Resistance Design Manual.

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 Manual124-77.

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.

1003.1.3 Other fire resistance ratings may be accepted by the Building Official for fire protection on evidence of compliance with 1001.

1004 MAINTAINING FIRE RESISTANCE RATINGS

1004.1 Floors, Roofs, Floor-Ceiling or Roof-Ceiling Assemblies

1004.1.1 Holes in floors, necessary for the installation of soil pipe and waste pipe for bathtubs, showers, urinals, and water closets, are permitted provided the pipes are enclosed beneath the floor through which they pass. The enclosure shall be in the form of a cage or box, and shall be of a design and construction which is approved for beam protection providing a fire resistance rating of not less than 1 hour. When the enclosure is adjacent to a beam or girder, it shall be in addition to the protection required for the beam or girder. When the floor through which the pipes pass is part of an approved floor-ceiling assembly utilizing a fire resisting ceiling, the enclosure is not required, provided the ceiling is not pierced by the piping.

1004.1.2 No holes or openings for pipes, wires, cables, conduits, ducts, vents, recessed light fixtures, or similar items are permitted in the fire resisting ceiling of a floor-ceiling or roof-ceiling assembly, except in buildings 1 story in height, not having basements, or as permitted by the provisions of 1 and 2.

1. One electrical outlet box not exceeding 16 square inches in area is permitted for light fixtures in such ceilings, in each 90 square feet of ceiling area.
2. Holes in fire resisting ceilings, for automatic sprinkler heads or other fire extinguishing or smoke detection system components, are permitted.

1004.2 Wall or Partition Assemblies

1004.2.1 Openings for steel electrical outlet, switch, or junction boxes not exceeding 16 square inches in area, in hollow wall or partition assemblies utilizing wood or metal studs or metal framing or channels are permitted, provided such openings are not less than 24 inches O.C. at a side of the assembly and are staggered not less than 24 inches O.C. when openings are provided on both sides of the assembly.

1004.2.2 Openings for electrical outlet, switch, or junction boxes in wall or partition assemblies constructed of hollow masonry units are permitted, provided the void space(s) exposed by such an installation are filled with concrete, mortar, or grout within not less than 4 inches of the boxes.

CHAPTER 11

MEANS OF EGRESS

1101 GENERAL PROVISIONS

1101.1 Scope

1101.1.1 In every building hereafter erected means of egress shall comply with the minimum requirements of this chapter.

1101.1.2 Means of egress shall consist of continuous and unobstructed paths of travel to the exterior of a building at all times. Means of egress shall not be permitted through kitchens, closets, restrooms and similar areas nor through adjacent tenant spaces.

1101.1.3 Where unusually hazardous conditions exist, additional means of egress facilities shall be provided as required by the Building Official, when necessary to assure the safety of the occupants.

1101.2 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.

1101.3 Exit Construction

Stairways, ramps and passageways used for required exits shall be of noncombustible construction except where otherwise specifically permitted by 1112, 1113, and 1115.

1102 DEFINITIONS

See 202 for definitions of Means of Egress, Exit, Exit Access, Occupant Load, Public Way and Panic Hardware.

1103 ARRANGEMENT AND NUMBER OF EXITS

1103.1 Arrangement of Exits

1103.1.1 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 not be more than specified in Table 1103.

1103.1.2 Where more than one exit or exit access door is required, at least two of the exit doors 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 doors. The two 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 corridor construction, the exit separation may be measured along a direct line of travel within the corridor.

TABLE 1103 TRAVEL DISTANCE, DEADEND LENGTH, EXIT AND MEANS OF EGRESS WIDTH

Occupancy Classification	Maximum Travel Dist. To Exit (ft)		Maximum Dead End Corridor	Egress Width Per Person Served (in)		Minimum Corridor/ Aisle Width[11]	Minimum Clear Op'g Of Exit	Minimum Stair Width
	Insprk.	Sprk.	Length (ft)	Level[1,3]	Stairs	(in)	Doors (in)	(in)
Group A	200	250	20	0.2	0.37	44[2]	32	44
Group B	200	250	20	0.2	0.37	44	32	44
Group E	200	250	20	0.2	0.37	72[3]	32	44
Group F	200	250[8]	20	0.2	0.37	44	32	44
Group H	NP	75[14]	20	0.4	0.7	44	32	44
Group I Restrained	Varies[12]	Varies[12]	20	0.2	0.37	48	32	44
Group I Unrestrained	150	200	20	0.2[1]	0.4[1]	44[4]	36[10]	44
Group M	200	250	20	0.2	0.37	44[5]	32	44
Group R	200	250	20[9]	0.2	0.37	44[6]	32	44
Group S	200[7]	250[7]	20	0.2	0.37	44	32	44

1. See 409.1 for minimum opening widths. In unrestrained occupancies where occupants may need help in responding to an emergency situation the coefficients become: level, 0.7 and stairs, 1.0 when unsprinklered. When sprinklered they become: level, 0.5 and stairs, 0.6.
2. See also 404 and 1122.
3. For occupant loads less than 100 persons in Day Care facilities, aisles in assembly areas and school administrative offices, 44 in. may be used.
4. 96 in. shall be provided in areas requiring the movement of beds. See Section 409.1.1.3 for exceptions for Day Care Centers.
5. Sec 507 for covered mall buildings.
6. 36 in may be used in one and two family dwellings.
7. 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 412.
8. See 1103.1.4 for exceptions.
9. See 1103.2.3.1 for exceptions.
10. 44 in door required in areas requiring movement of beds.
11. 36 in acceptable if stair serves occupancy load of less than 50.
12. See 409.2.10.
13. Applies to ramps, doors and corridors.
14. For HPM Facilities, as defined in 511, the maximum travel distance shall be 100 ft.

1103.1.3 Where open stairways or ramps are permitted as a path of travel to required exits, such as between mezzanines or balconies and the floor below, the distance shall include the travel on the stairway or ramp, and the travel from the end of the stairway or ramp to reach an outside door or other exit, in addition to the distance to reach the stairway or ramp.

1103.1.4 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. Smoke and heat vents shall be constructed and installed in a manner approved by the Building Official.

1103.1.4.1 Smoke and heat vents shall open automatically by activation of a heat responsive device rated at 100° F to 220° F 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 within *5* minutes. Vents shall be capable of being opened by an approved manual operation.

1103.1.4.2 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 board location and depth shall comply with Table 1103.1.4.

EXCEPTION: When a smoke and heat venting system complies with the guidelines of NFiPA 204M.

1103.1.4.3 Maximum spacing of roof vents and vent area shall comply with Table 1103.1.4.

EXCEPTION: When a smoke and heat venting system complies with the guidelines of NFiPA 204M.

TABLE 1103.1.4
ROOF VENT SIZE AND SPACING

Occupancy	Hazard Classification[1]	Vent Height H[2]	Minimum Curtain Board Depth[3]	Maximum Area Formed by Curtain Boards	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 sq ft	1:100	120 ft	60 ft	8H but ≤250'
S	I thru IV	20 ft or less	6 ft	10,000 sq ft	1:100	100 ft	60 ft	8H
S	I thru IV	Over 20 ft to 40ft	6 ft	8000 sq ft	1:75	100 ft	55 ft	8H but ≤250'
S	I thru IV	20 ft or less	4 ft	3000 sq ft	1:75	100 ft	55 ft	8H
S	I thru IV	Over 20 ft to 40ft	4 ft	3000 sq ft	1:50	100 ft	50 ft	8H but ≤250'
S	V	20 ft or less	6 ft	6000 sq ft	1:50	100 ft	50 ft	8H
S	V	Over 20 ft to 30ft	6 ft	6000 sq ft	1:40	90 ft	45 ft	8H
S	V	30 ft or more	4 ft	2000 sq ft	1:30	75 ft	40 ft	8H but ≤100'

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.

1103.2 Minimum Number of Exits

1103.2.1 There shall be not less than two approved independent exits, accessible to each tenant area, serving every story, except in one and two family dwellings and as modified in 1103.2.3.

1103.2.2 The minimum number of exits for all occupancies, except as modified by Section 1103.2.3, based on occupant load, shall be as follows:

Minimum Number of Exits	Occupancy Load per Story
2	1 - 500
3	501 - 1000
4	more than 1000

1103.2.3 In the following exceptions, a single exit is permitted:

1103.2.3.1 In Group R 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.
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 3500 square feet per floor.
4. Maximum building height shall be one story above the level of exit discharge.

1103.2.3.2 In Group B occupancies having a per floor area not over 3500 sq ft served by that exit and not over two stories in height, provided the occupant content shall not exceed 40 persons above the street floor. Maximum distance of travel to 1the exit shall not exceed 75 ft.

1103.2.3.3 In Group M occupancies at street floor level having a floor area less than 2250 sq ft and a travel distance to an exit not exceeding 50 ft.

1103.2.3.4 In Group S occupancies, one story only, and having a floor area less than 2500 sq ft with a travel distance 50 ft or less.

1103.2.4 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 1105.1.

1103.2.5 It 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.

1103.2.6 Two means of egress shall be required from theater balconies when the occupancy exceeds 50.

1104 SPECIAL EXIT REQUIREMENTS

1104.1 Boiler, Incinerator, Furnace Rooms

Except in one and two family dwellings, two exits shall be provided from all boiler, incinerator, and furnace rooms that exceed 500 sq ft in area and the largest installed piece of fuel-fired equipment exceeds 400,000 Btu input capacity. When two exits are required, one may be fixed ladder. Exits shall be separated by horizontal distance not less than one-half the maximum horizontal dimensions of the room. A 6-inch sill (dike) shall be provided where oil fired equipment is used. Interior openings between a Group H occupancy and a boiler, incinerator, furnace or similar room shall not be permitted. Maximum travel distance to an exit shall not exceed 50 ft.

1104.2 Dead End Pockets or Hallways

Exits and exit access shall be so arranged that dead end pockets or hallways in excess of 20 ft long shall not occur.

1104.3 Exit Access Corridors

1104.3.1 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.

1104.3.2 Except in Group I or Group R occupancies, 1104.3.1 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.

1104.4 Emergency Egress openings

1104.4.1 Every sleeping room on the first and second story of Group R occupancies shall have at least one operable window or exterior door approved for emergency egress or rescue. The units must be operable from the inside to a full clear opening without the use of separate tools. Where windows are provided as a means of egress or rescue, they shall have a sill height of not more than 44 inches above the floor.

1104.4.2 The minimum net clear opening height dimension shall be 22 inches. The minimum net clear opening width dimension shall be 20 inches. The net clear opening area shall in no case be less than 4 sq ft.

1104.4.3 Each egress window from sleeping rooms must have a minimum total glass area of not less than 5 sq ft in the case of a ground floor window and not less than 5.7 sq ft in the case of a second story window.

1104.5 Smokeproof Enclosures

1104.5.1 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.

1104.5.2 All mechanical equipment (i.e., smoke exhaust and supply as well as electrical power) used to comply with the requirements of this section shall be totally separated from other building systems and each other.

1104.5.3 DELETED

1104.5.4 Stairs in smokeproof enclosures shall be of noncombustible construction.

1104.5.5 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.

1104.5.6 A stairway in a smokeproof enclosure shall not continue below the grade level unless a 2 hour rated barrier is provided at the ground level to prevent persons from continuing into the basement.

1104.5.7 Access to the stairway shall be by way of a vestibule or by way of an open exterior balcony of noncombustible materials.

1104.5.8 Smokeproof Enclosures by Natural Ventilation

1104.5.8.1 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 shal1 have closing devices as specified in 1104.5.9.10. Wired glass 1/4-inch thick may be installed not to exceed 100 sq in with neither dimension exceeding 12 inches.

1104.5.8.2 The vestibule shall have a minimum of 16 sq ft of opening, in a wall facing an exterior court, yard or public way at least 20 ft wide. The vestibule shall be a minimum of 44 inches wide and 72 inches in the direction of travel.

1104.5.8.3 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 1104.5.9.10.

1104.5.9 Smokeproof Enclosures by Mechanical Ventilation

1104.5.9.1 Stair pressurization systems shall be independent of other building ventilation systems.

1104.5.9.2 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.

1104.5.9.3 The door from the building into the vestibule shall have a 1 1/2-hour fire resistance rating have closing devices as specified in 1114.1.7. The door from the vestibule to the stairway shall have a minimum 20 minute fire resistance rating and have closing devices as specified in 1114.1.7. Wired glass, if provided, shall not exceed 100 sq in and shall be set in a steel frame. The door shall be provided with a drop sill or other provision to minimize air leakage.

1104.5.9.4 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 1104.5.9.10.

1104.5.9.5 The vestibule shall have a minimum dimension of 44 inches wide and 72 inches in direction of exit travel.

1104.5.9.6 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 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 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.

1104.5.9.7 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 2500 cfm 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.

1104.5.9.8 The vestibule ceiling shall be at least 20 inches 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 height requirement may be reduced proportionally if the minimum vestibule size described in 1 104.5.9.2 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.

1104.5.9.9 The stair shaft shall be provided with mechanical supply and exhaust air. There shall be a minimum of 2500 cfm 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 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. 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 in an unsprinklered building.

1104.5.9.10 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 1104.5.9.6 and 1104.5.9.9.

1105 OCCUPANT LOAD AND MEANS OF EGRESS CAPACITY

1105.1 Occupant Load

1105.1.1 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 1105.1.

TABLE 1105.1
MINIMUM OCCUPANT LOAD

Use	Area per[2,3] Occupant (sq ft)
Assembly without fixed seats	
Concentrated (includes among others, auditoriums, churches, dance floors, lodge rooms, reviewing stands, stadiums)	7 net
Standing 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
Small restaurants (without fixed seats)	15 net
Small restaurants (with fixed seats)	Note 1
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
Library	
Reading rooms	50 net
Stack area	100 gross
Malls	Section 507
Mercantile	
Basement and grade floor areas	30 gross
Areas on other floors	60 gross
Storage, stock, shipping area	300 gross
Parking garage	200 gross
Residential	200 gross
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. For booths, one person per 24 in.

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.

1105.1.2 The area per occupant listed in Table 1105.1 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 1103. The occupant content shall not be more than the number determined by dividing the floor area by 3 sq ft per person.

1105.1.3 The occupant load of any occupancy may be determined as provided above 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.

1105.2 Occupant Content Posted

Signs stating the maximum occupant shall be conspicuously posted by the owner of the building or premises 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.

1105.3 Measurement of Means of Egress

1105.3.1 The width of the means of egress shall be determined from occupants served in accordance with Table 1103.

1105.3.2 The width shall be measured in the clear at its narrowest point. Handrails may project 3 1/2 inches and door jambs 1 inch on each side of the measured width.

1105.4 Capacity of Means of Egress

1105.4.1 The width of the means of egress shall be not less than the required capacity based on occupant load from Table 1105.1.

1105.4.2 The minimum aggregate width of main entrance doorways for Group A Assembly occupancies shall be sufficient to accommodate 50% of the occupant content. 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 two- thirds of the total occupant load served by that level. The total exits from any level shall be of sufficient capacity to accommodate seven-sixths of the occupancy load.

1105.4.3 The capacity of exit stairways constructed in accordance with 1112 shall not exceed the limits specified herein and may 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 content and not the total occupant content of the building.

1105.4.4 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.

1105.4.5 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.

1105.4.6 Where exits serve more than one floor, only the occupant content of each floor, considered individually, need be used in computing the required capacity of the exits at that floor, provided that such capacity shall not be decreased at any point along the exit facility in the direction of exit travel. When exits from floors above and below converge at an intermediate floor, the capacity of the exit from such intermediate floor shall not be less than the sum of the widths of the exits converging on such intermediate floor. There shall be no reduction in the capacity of the exits along the means of egress from the building.

1105.4.7 The minimum width of exitway access corridors shall be in accordance with Table 1103.

1105.4.8 Exit access corridors shall have fire resistance ratings as specified in Table 700.

1105.5 Capacity of Escalators or Moving Stairs

The width and exit capacity of escalators complying with the requirements of Chapter 4 shall be as specified for stairways except that the maximum width of escalators shall not exceed 48 inches.

1106 STAIRWAY PROTECTION

1106.1 Enclosed Stairways

1106.1.1 All exit stairways between floors in Group E. Group H and Group I occupancies shall be enclosed in or separated by fire resistant construction in accordance with 701 and Table 700.

1106.1.2 Exit stairways in Group A, B, F, M, R and S occupancies shall be enclosed in or separated by fire resistant construction in accordance with 701 and Table 700.

EXCEPTIONS:

1. Stairways serving and contained within a single dwelling unit, apartment or hotel suite.
2. Stairways in a one and two family dwelling.
3. Exterior stairways conforming to 1106.2
4. Stairways within unprotected vertical openings as permitted in 701.1.1, Exception 3.
5. Required exit stairs in open automobile parking structures need not be enclosed when the stair is on an open side as defined in Section 412.6.2.
6. In open parking structures having all sides open, exit stairways need not be enclosed.

1106.1.3 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.

1106.1.4 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 occupied spaces and for egress from the enclosure.

1106.1.4.1 Penetrations into and openings through a stairway enclosure assembly are prohibited except for required exit doors, ductwork and equipment necessary for independent stair pressurization, sprinkler piping, standpipes, and electrical conduit serving the stairway and terminating at a steel box not exceeding 16 sq in. Such penetrations shall be protected in accordance with 1001.3.1. There shall be no penetrations or communicating openings, whether protected or not, between adjacent stair enclosures.

1106.1.4.2 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 enclosure walls within 10 ft horizontally of the nonrated 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 above the topmost landing of the stairway or to the roof line, whichever is lower.

1106.1.5 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.

1106.1.6 The space under a stairway may be used if it is separated from the stairway by fire resistant construction as required by 1106.1.

EXCEPTION: Separation is not required from those stairways exempted from enclosure in 1106.1.2.

1106.2 Exterior Exitway Stairs

1106.2.1 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 in height for other than Group I buildings.

1106.2.2 Exterior stairways may be utilized 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 grade, except a single stairway shall be allowed when the provisions of 1103.2.3 are met. Such porches and stairways shall comply with the requirements for interior exitway stairways as specified in 1108 and 1112. Porches and balconies shall be not less than 4 1/2 ft wide. The stairways shall be located remotely (1/2 diagonal) from each other. The maximum travel distance from any tenant space to the nearest stairway shall be specified in Table 1103. Porches and stairways shall be located at least 10 ft 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.

1106.2.3 Guardrails and handrails shall be as specified in 1121 and 1112.5 respectively.

1106.2.4 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 above the topmost landing or the roof line, whichever is lower, and horizontally 10 ft from each side of the stairway. Openings within the 10ft 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 remote exterior stairways.
2. Such protection is not required in two story buildings where there is a remote second exit.

1106.2.5 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 1120.

1106.2.6 Exterior stairways shall not project beyond the street lot line.

1106.2.7 Exterior stairs, porches and balconies shall be constructed of materials consistent with the types of materials permitted for the type of construction of the building to which the stairway is attached.

1106.2.8 Exterior stairways in climates subject to snow or ice shall be protected against the accumulation of snow and ice.

1107 MONUMENTAL STAIRS

Refer to 701.1.1, Exception 6, for monumental stair provisions.

1108 BALCONIES, PORCHES, GALLERIES

1108.1 General

1108.1.1 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 this section.

1108.1.2 All porches, balconies, raised floor surfaces or landings located more than 30 inches above the floor or grade below shall have guardrails as in 1121.

1108.1.3 Balconies, porches or galleries serving as means of egress in climates subject to snow or ice shall have a roof to protect against the accumulation of snow and ice.

1108.1.4 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.

1108.1.5 Balconies, porches or galleries having structural concrete floors shall have all supporting framing members of noncombustible materials.

1108.2 Private Balconies

Exterior private balconies not used as a means of egress and extending beyond the exterior walls shall conform to the following requirements:

1. Projections from walls of Type I or II construction shall be of noncombustible materials.
2. Projections from walls of Type III, IV or V construction may be of any approved materials.
3. Combustion projections from walls located where protection of openings is required shall be 1-hour fire resistant or heavy timber construction.
4. Projections shall not extend more than 12 inches into the areas where openings are prohibited.

1108.3 Projections

Balconies projecting over 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 above grade less than 8 ft - no projection is permitted.
2. Clearance above grade more than 8 ft - 1 inch projection is permitted for each additional inch of clearance, provided that no such projection shall exceed a distance of 4 ft.
3. The fire resistance rating of the balcony floor shall have the same rating as the adjacent floor.

1109 INTERIOR BALCONY AND GALLERY

1109.1 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.

1109.2 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.

1109.3 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.

1110 STAGE AND DRESSING ROOM AREAS OF GROUP A-1

Not less than one exit, 3 ft or more wide to a street, exit court, or passageway to a street, shall be provided from each side of the stage of every Group A-1 occupancy and from each side of the sub-stage or basement under the stage. An exit not less than 30 inches wide shall be provided from each flygallery and from the gridiron. An iron ladder shall be provided from the gridiron to a scuttle in the stage roof. Such scuttle shall be not less than 2 ft x 3 ft in size and shall be provided with a metal-covered or noncombustible trap door. Each tier of dressing rooms shall be provided with at least two means of egress, each not less than 2 ft 6 in wide, one of which shall lead directly into an exit court or street. All exit stairs shall be constructed of noncombustible material as prescribed in 1112. Stair exits from stage and dressing rooms need not be enclosed.

1111 EXIT OUTLETS

Every required exit shall provide continuous and protected egress discharging into a street, an open space leading to a street, or into an exit court having a passageway leading to a street or into open space having access to a street. Such exit courts or passageways shall comply with the following:

1. Such exit courts or passageways shall be enclosed with construction providing fire resistance consistent with that required for exit stairways in Table 700.
2. The width of such courts or passageways shall be not less than the required capacity of the means of egress tributary thereto based on occupancy load. There shall be no reduction of width in the direction of exit travel. Such courts or passageways shall be not less than 8 ft high.
3. Slope of floors in exits shall not exceed 1:12.
4. All exit courts and passageways shall have approved opening protectives with a minimum fire resistance rating of 3/4-hour when 10 ft or less in width.

1112 STAIRWAY CONSTRUCTION

1112.1 General

1112.1.1 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.

1112.1.2 Except when located in a required fire resistant enclosure, all stairways shall be permitted to have open risers.

1112.1.3 Interior stairs constructed of wood, except those with open risers, shall be firestopped as specified in 705.

1112.1.4 Closets shall not be located beneath stairs unless such stairs are protected as required by 1106.1.

EXCEPTION: Protection is not required for those stairways exempted from enclosure in 1106.1.2.

1112.1.5 Except when located within a dwelling unit, the underside of interior stairways, if of combustible construction, shall be protected to provide not less than 1-hour fire resistance.

1112.2 Basement Stairs

In Group A occupancies, an exit stair from a lower story shall not lead to an exit doorway serving an exit stair from an upper story. 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.

1112.3 Treads and Risers

1112.3.1 Treads and rises 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 nor more than 25 inches. The height of riser shall not exceed 7 3/4 inches, and treads, exclusive of noising, shall be not less than 9 inches wide. Every tread less than 10 inches wide shall have a nosing, or effective projection, of approximately 1 inch over the level immediately below that tread, except in circulars, winders or spirals a nosing of approximately 1 inch or more may be used with open risers.

1112.3.2 Treads shall be of uniform depth and riser of uniform height in any stairway between two floors. There shall be no variation exceeding 3/16 inch in the depth of adjacent treads or in the height of adjacent riser and the tolerance between the largest and smallest riser or between the largest and smallest tread shall not exceed 3/8 inch in any flight. 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: 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 for every 3 ft of stairway width is permitted.

1112.3.3 Winders shall not be permitted in exit stairways, except one and two family dwellings and stairways serving a single family dwelling unit. The minimum tread depth of a winder is limited to 6 inches and must have a minimum depth of 9 inches at a point 12 inches from the narrow edge.

1112.3.4 Spiral stairways are acceptable in one and two family dwellings and within a single dwelling unit, and from a mezzanine not more than 250 sq ft and serving not more than five occupants. A spiral stairway must have a 7 1/2-inch minimum clear tread depth at a point 12 inches from the narrow edge. All treads risers must be sufficient to provide a headroom of 6 ft 6 in minimum but riser height shall not be more than 9 1/2 inches. The minimum stairway width is 26 inches.

1112.3.5 Circular stairs may be used as an exit providing the minimum depth of tread is not less than 10 inches and the smaller radius is not less than twice the width of the stairway.

1112.3.6 In buildings of Group A occupancy, flights of less than three risers shall not be used in stairways, interior or exterior, passageways, at entrance or elsewhere in connection with required exits. To overcome lesser differences in level, gradients not exceeding 1:8 may be used. See 1122 for additional aisle and stair information in assembly occupancies.

1112.3.7 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. Such aisles shall comply with the following:

1112.3.7.1 Tread depths shall be a minimum of 11 inches and be uniform within each aisle.

EXCEPTION: Nonuniformities shall not exceed 3/16 inch between adjacent treads.

1112.3.7.2 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 nor more than 8 inches 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 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.

1112.3.7.3 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 wide and a maximum of 2 inches 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.

1112.3.8 Alternating tread stairways in Group F, H, I and S are permitted from a mezzanine not more than 250 sq ft in area serving not more than five occupants. The minimum projected tread exclusive of nosing shall be 8 1/2 inches within a minimum total tread depth of 10 1/2 inches. The rise to the next alternating tread surface shall be a maximum of 8 inches. Distance between handrails shall be a minimum of 17 inches and maximum of 24 inches. A minimum distance of 6 inches shall be provided between the stair handrail and any other object. A minimum of 12 inches shall be provided between the stair handrails of adjacent alternating tread stairways.

1112.3.9 Alternating tread stairs meeting the requirements of 1112.3.8 in R occupancies within dwelling and dwelling units are acceptable from a mezzanine not more than 250 sq ft in area serving not more than five occupants.

1112.4 Landings

1112.4.1 A flight of stairs shall not have a vertical rise of more than 12 ft between floors or landings.

1112.4.2 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 when the stair has a straight run.

1112.4.3 Stairway landings shall have guardrails as specified in 1121 on any open and unenclosed edges.

EXCEPTION: A guardrail shall not be required for the inside open or unenclosed edge of an intermediate landing where the stairs reverse direction when the horizontal distance between the stair flights is one ft or less and when a continuous handrail as specified in 1112.5 is provided.

1112.5 Handrails

1112.5.1 All stairways having more than three risers above a floor or grade, and 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 nor more than 34 inches above the leading edge of a tread.

EXCEPTION: Handrails that form part of a guardrail may be 42 inches high.

1112.5.2 Handrails shall have a circular cross section with a diameter of 1.5 inches plus or minus 0.25 inch or provide a cross section with equivalent graspability performance.

1112.5.3 Stairways less than 44 inches wide and having a wall immediately adjacent to the treads on one or both sides may have handrails on one side only, which shall be the side without a wall where such condition exists. Stairways lacking adjacent walls on either side shall have handrails on both sides regardless of width. Stairways 44 inches wide or greater shall be equipped with handrails at least on both sides.

1112.5.4 When the required width of a flight of stairs exceeds 88 inches, 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 between such adjacent handrails.

1112.5.5 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 Chapter 12. They shall include intermediate rails or ornamental patterns such that a 6-inch diameter sphere cannot pass through any openings.

EXCEPTIONS:

1. For areas not accessible to the public in Groups F, H, S and I Restrained occupancies, the clear distance between rails measured at right angles to the rails shall not exceed 21 inches.
2. Stairways which are part of or connected to the facilities described in 1121, Exception 6, and not more than 6 ft above the grade below shall be required to have only one intermediate railing located between 14 and 18 inches above the leading edge of the tread.

1112.5.6 On monumental stairs, handrails shall be located along the most direct path of egress travel.

1112.6 Width

1112.6.1 Stairs serving as required means of egress shall be clear of all obstructions except that handrails attached to walls may project not more than 3 1/2 inches at each side within the required width, and stringers may project 1 1/2 inches at each side within the required width.

1112.6.2 Width of stairs shall not decrease in the direction of exit travel.

1112.6.3 The minimum width of any stair serving as a means of egress shall be in accordance with Table 1103.

1112.7 Headroom

Stairs serving as required means of egress shall have a minimum headroom clearance of 6 ft 8 in, measured vertically from the nearest nosing to the nearest soffit. This minimum shall be maintained for the full required width of stairs and landings,

1113 FIRE ESCAPES

1113.1 General

1113.1.1 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.

1113.1.2 When located on the front of the building and projecting beyond the building line, the lowest landing shall be not less than 7 nor more than 12 ft above grade, equipped with a counterbalanced stairway to the street in alleyways and thoroughfares less than 30 ft wide, the clearance under the lowest landing shall be not less than 12ft.

1113.2 Design

1113.2.1 The fire escape shall be designed to support a live load of 100 psf and shall be constructed of steel or other approved noncombustible materials. Fire escapes may be constructed of wood not less than 2 inches thick on buildings of Type VI construction.

1113.2.2 Stairs shall be at least 22 inches wide with risers not more and treads not less than 8 inches and with landings at foot of stairs not less than 40 inches wide by 36 inches long, located not more than 8 inches below the access window or door.

1113.2.3 All openings located within 10 ft 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 1113.3.

1113.3 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 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.

1114 DOORS

1114.1 General

1114.1.1 Egress doors used as an exit door shall provide a clear opening of not less than the widths shown in Table 1103 and 6 ft 8 in high. The maximum leaf width of the door shall not exceed 48 inches. Egress doors used in the exit access shall provide a clear opening of not less than 32 inches wide, except interior doors within a dwelling unit, and 6 ft 8 in high.

1114.1.2 Egress doors shall be side swinging type doors. All doors shall swing in the direction of egress when serving an occupant load of 50 or more persons or a high hazard occupancy. The door latch shall release when subjected to a 15 lb force. The door shall be set in motion when subjected to a 30 lb force. The door shall swing to a full open position when subjected to a 15 lb force. Forces shall be applied to the latch side.

EXCEPTIONS:

1. Private garages, factory and storage areas with an occupant load of 10 or less.
2. Group I - Restrained when used as a place of detention.
3. Revolving doors conforming with 1114.4.
4. 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.
5. Horizontal sliding doors conforming with 1114.5 when used in smoke partitions in Group I Unrestrained occupancy.
6. Horizontal sliding doors conforming with 1114.5 when used in a means of egress serving an occupant load of less than 50 people.

1114.1.3 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 content 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 shall have not less than two egress doors. When two egress doors are required they shall be located as remote from each other as practicable and where such doors serve an occupant load of 50 persons or more shall swing in the direction of exit travel.

EXCEPTION: There shall be not less than two egress doors provided for any HPM Facility or subdivision larger than 200 sq ft.

1114.1.4 All egress doors in Group H occupancies shall swing in the direction of exit travel.

1114.1.5 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 into the required width of a corridor or a landing.

1114.1.6 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.

1114.1.7 All doors in smoke barriers, horizontal exits, stairway enclosure 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.

1114.1.8 Required exit door 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. A night latch, dead bolt 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 above the finished floor.

1114.1.9 For required width of doorways serving exit stairways and the exit capacity of doorways, see 1105.3 and I 105.4.

1114.1.10 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, Group B, Group F, Group M and 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 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 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.

1114.1.11 Locking devices may be used in Group I Restrained occupancies.

1114.2 Panic and Fire Exit Hardware

1114.2.1 The exit doors of Group A occupancies having more than 100 occupants and Group E occupancies (except doors of individual rooms) shall be equipped with panic hardware or fire exit hardware where latches are provided. This hardware shall release when pressure of no more than 15 lb 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 nor more than 44 inches above the floor.

1114.2.2 lf balanced doors are used and panic hardware is required, the panic hardware shall he of the pushpad type and the pad shall not extend more than one-half the width of the door measured from the latch side.

1114.3 Power Operated Doors

1114.3.1 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.

1114.3.2 Power operating sliding doors may be used provided the sliding leaf is equipped with an emergency swing (panic release) feature.

1114.3.3 Power operated doors shall comply with ANSI/BHMA Al56.10.

1114.4 Revolving Doors

1114.4.1 Each revolving door shall be capable of collapsing into a bookfold position with parallel egress paths providing an aggregate width of 36 inches.

1114.4.2 A revolving door shall not be located within 10ft of the foot of or top of stairs or escalators. A dispersal area shall be provided between the stairs or escalators and the revolving doors.

1114.4.3 The revolutions per minute for a revolving door shall not exceed the following:

Inside Diameter (ft and in)	Power0Driven Type Speed Control (rpm)	Manual0Type 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

1114.4.4 Each revolving door shall have a conforming side-hinged swinging door in the same wall as the revolving door and within 10ft.

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.

1114.4.5 A revolving door to be credited as a component of a means of egress shall comply with 1114.4.1 through 1114.4.4 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 is applied within 3 inches of the outer edge of a wing.

1114.4.6 A revolving door not used as a component of a means of egress shall have a collapsing force of not more than 180 lb.

EXCEPTION: A revolving door may have a collapsing force set in excess of 180 lb if the collapsing force is reduced to not more than 130 lb 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 of the revolving doors.
4. There is the actuation of a manual control switch which reduces the holding force to below the 130 lb level. Such switch shall be in an approved location and shall be clearly identified.

1114.5 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 to set the door in motion and 15 lb 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 when a force of 250 lb 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 703.4, and
6. The door assembly shall have an integrated standby power supply, and
7. The door assembly power supply shall be electrically supervised.

1114.6 Special Doorway Requirements

1114.6.1 A door, when opening or when fully open, shall not project beyond the building line. See Chapter 22.

1114.6.2 Patient rooms or tenant space egress doors in Group I occupancies shall not be lockable except in places of restraint or detention.

1114.7 Special Locking Arrangements

1114.7.1 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 <u>or disablement</u> of the approved supervised automatic smoke detection system or automatic sprinkler system, and
2. Unlock upon loss of power controlling the locking device, and

3. Initiate an irreversible process which will free the latch within 15 seconds whenever a force of not more than 15 lb is applied to the release device and not relock until the door has been opened. Operation of the release device shall activate a signal in the vicinity of the door for assuring those attempting to exit that the system is functional.

   EXCEPTION: The Building Official may approve a delay not to exceed 30 seconds provided that reasonable life safety is assured.

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 3ft 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 1114.7.2 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.

1114.7.2 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 high.

1114.7.3 Emergency lighting shall be provided at the door.

1114.8 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.

1115 RAMPS

1115.1 General

1115.1.1 The requirements for ramps used as exits, such as enclosure, headroom, handrails, etc. shall comply with 1106, 1111 and 1112. The width of ramps used as a means of egress shall be identical to minimum corridors. See Table 1103.

1115.1.2 Ramps shall comply with all requirements for stairways so far as those requirements are applicable.

1115.1.3 Where changes in elevations exist in exit access corridors, exits and exit outlets, ramps shall be used when the difference in elevation is less than 21 inches.

1115.2 Construction

1115.2.1 The slope of ramps shall not exceed 1:8.

1115.2.2 Surface of ramps shall be of nonslip material.

1115.2.3 Exit ramps shall be of noncombustible construction except as otherwise permitted for stairs.

1115.2.4 Handrails shall be provided on at least one side of every ramp having a slope steeper than 1:15, and shall be not less than 34 inches nor more than 38 inches high, measured from the surface of the ramp. Handrails shall be smooth and shall extend 1 ft beyond the top and bottom of the ramp and return to walls or posts at the ends.

EXCEPTIONS:

1. Handrails for ramps for physically handicapped accessibility shall conform to North Carolina State Building Code, Volume I-C, Accessibility Code.
2. Ramps serving fixed seating.

1116 HORIZONTAL EXITS

1116.1 General

1116.1.1 Horizontal exits shall not comprise more than one-half 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.

EXCEPTIONS:

1. Horizontal exits may comprise two-thirds the required exits from any building or floor area in Group I Unrestrained occupancies.
2. Horizontal exits may comprise 100% of the exits required in accordance with 409.2.6.4 in Group I Restrained occupancies.

1116.1.2 Ramps meeting the requirements of 1115 shall be used where there is a difference of level between connected areas.

1116.2 Doors

1116.2.1 The width of horizontal exits shall not be less than required for exit doorways. The exit capacity of horizontal exits shall be as specified in 1105.3.

1116.2.2 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.

1116.2.3 Doors in horizontal exits shall be kept unlocked and unobstructed.

1116.3 Discharge Area

1116.3.1 The discharge area of a horizontal exit shall be of sufficient size to accommodate the occupancy at 3 sq ft per occupant except for nonambulatory institutional areas which shall be 30 sq ft per occupant.

1116.3.2 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.

1116.4 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 for each occupant to be accommodated therein, not including areas of stairs, elevators and other shafts or courts, as follows:

1. 30 sq ft per patient for hospitals and nursing homes.
2. 15 sq ft per resident for ambulatory Group I - Unrestrained uses.
3. 6 sq ft per occupant for Group I - Restrained uses and on stories not housing bed or litter patients in Group I - Unrestrained uses.
4. 3 sq ft per occupant in all other cases.

1117 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. See 506.14.3 for high rise requirements.

1118 EXIT ILLUMINATION AND SIGNS

1118.1 Means of Egress Illumination

1118.1.1 Means of egress shall be illuminated at all times when the building is occupied with light of not less than 1 footcandle intensity at the floor level, except theatres which shall have not less than 1/5 footcandle 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.

1118.1.2 A separate or emergency source of illumination shall be provided for the occupancies at the occupant content listed in Table 1118. Duration of the emergency power source shall be not less than 1 1/2 hours.

1118.2 Exit Signs

1118.2.1 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 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.

1118.2.2 All exit and directional signs shall have letters at least 6 inches high with a minimum stroke of 3/4 inch. The word "EXIT" shall have letters having a width not less than 2 inches except the letter "I" and the minimum spacing between letters shall be not less than 3/8 inch. Signs larger than the minimum established in this paragraph shall have letter widths, strokes and spacing in proportion to their height.

1118.2.3 Externally illuminated signs shall be illuminated by not less than 5 footcandles and shall employ contrast ratio of not less than 0.5.

1118.2.3.1 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 footlamberts. Approved self-luminous or electroluminescent signs which operate in the 5000 to 6000 angstrom range and which provide evenly illuminated letters shall have a luminance of not less than 0.06 footlamberts.

1118.2.3.2 All exit signs for egress elements that require illumination by an emergency source of power, shall also be provided an emergency source of power, in accordance with 1118.1.2 and Table 1118.

EXCEPTION: Approved self-luminous signs.

1118.2.3.3 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.

1118.2.4 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.

1118.2.5 An independent and separate source of power shall be provided for exit signs in occupancies at the occupant content listed in Table 1118.

TABLE 1118
SPECIAL POWER FOR EXIT SIGNS AND ILLUMINATION

Occupancy	Minimum Occupant Content
Group A	All
Group I	All
Group R	Greater than 100
Group B & M	Greater than 150
Group E	Greater than 300

1118.3 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.

1118.4 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 above the floor landing in a position which is readily visible when the door is in the open or closed position.

1119 EXIT OBSTRUCTIONS

Where floor space is occupied by tables, chairs or other movable furniture, aisles not less than 36 inches clear width shall be maintained to provide ready access to egress doors.

1120 GRADE PASSAGEWAYS AND LOBBIES

1120.1 Enclosure of Passageways

Every required interior and exterior exitway element which does not adjoin a street shall be directly connected to the street or to an open court leading to the street by an enclosed passageway, corridor, lobby or other unobstructed exitway element constructed as provided in this section and in 1106.

1120.2 Width and Height

The effective width of the lobby or other enclosed passageway shall be not less than three-fourths of the aggregate width of all required exitway stairways leading thereto and all required exitway doorways opening into the passageway. Such passageway shall have a minimum width of 44 inches and a minimum clear ceiling height of 8 ft.

1120.3 Exit Discharge

Not more than 50% of the exits may discharge through areas on the level of discharge provided all of the following are met:

1. Such exits discharge to a free and unobstructed way to the exterior of the building, which way is readily visible and identifiable from the point of discharge at the exit.
2. The entire area on the level of discharge is separated from areas below by construction having a minimum 2-hour fire resistance rating.
3. The discharge is protected throughout by an approved automatic sprinkler system and any other portion of the level of discharge with access to the discharge area is protected throughout by an approved, automatic sprinkler system or separated from it in accordance with the requirements for the enclosure of exitways.

   EXCEPTION: The requirements of 1120.3(3) may be waived if the discharge area is a vestibule or foyer arranged and separated in accordance with 1120.5.

1120.4 Construction

When required exit stairs terminate in a grade passageway or lobby, the grade passageway or lobby shall be provided with an automatic fire suppression system. Any other portion of the floor with access to the grade passageway or lobby shall also be provided with an automatic fire suppression system or shall be separated therefrom in accordance with the requirements for the enclosure of exitways.

1120.5 Foyers

An exit may discharge into an interior vestibule or foyer, other than a grade passageway or lobby, which meets the following criteria:

1. The depth from the exterior of the building is not greater than 10 ft and the length is not greater than 20 ft.
2. The foyer is separated from the remainder of the level of discharge by self-closing doors and the equivalent of 1/4-inch thick wired glass in steel frames.

1121 GUARDRAILS

All unenclosed floor and roof openings, open and glazed sides of landings and ramps, balconies or porches which are more than 30 inches above grade or a floor below shall be protected by a guardrail. Guardrails shall form a vertical protective barrier not less than 42 inches high. Open guardrails shall have intermediate rails or ornamental pattern such that a 6-inch diameter sphere cannot pass through any opening. A bottom rail or curb shall be provided that will reject the passage of a 2-inch diameter sphere. Construction of guardrails shall be adequate in strength, durability and attachment for their purpose as described in 1207.

EXCEPTIONS:

l. Guardrails need not be provided on the loading side of loading docks.

2. Guardrails for dwellings and within individual dwelling units or guest rooms shall be a minimum of 36 inches high.

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 high. Guardrails 42 inches 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 high where the aisle terminates.

4. A guardrail shall not be required at the front of any stage.

5. For areas not accessible to the public in Groups F, H, S and I Restrained occupancies, the clear distance between rails measured at right angles to the rails shall not exceed 21 inches.

6. For one and two family dwellings, only one intermediate rail between 14 and 18 inches above floor level shall be required between the top 36 inches high guardrail and the floor level of boat docks, piers, landings, decks on beach fronts and dune walkovers, providing the floor or deck level is not more than 6 ft 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.

1122 ASSEMBLY AISLES AND SEATING

1122.1 General

1122.1.1 Provisions in 1122 shall apply to all assembly aisle and seating except for special provisions relating to seating for reviewing stands, grandstands and bleachers.

1122.1.2 Every portion of any building which contains seats, tables, displays, equipment, or other material shall be provided with aisles leading to exits.

1122.2 Aisle Width

1122.2.1 Aisle width shall provide sufficient egress capacity for the number of persons accommodated by the catchment area served by the aisle. See 1122.4. 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. Where aisles converge to form a single path of egress travel the required egress capacity of the path shall be not less than the combined required capacity of the converging aisles.

1122.2.2 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.

1122.2.3 Those portions of aisles, where egress is possible in either of two directions, shall be uniform in required width.

1122.2.4 In all balconies and galleries having more than 20 rows of seats, there shall be provided a cross-aisle not less than 4 ft wide leading directly to an exit.

1122.2.5 The minimum clear width of aisles shall be:

1. 48 inches for stairs having seating on each side (42 inches for existing aisles).
2. 36 inches for stairs having seating on only one side (30 inches for existing aisles serving fewer than 60 seats).
3. 23 inches (20 inches on narrow existing aisles) between a stair handrail or guardrail and seating when the aisle is subdivided by a handrail. See 1112.5.
4. 42 inches for level or ramped aisles having seating on both sides.
5. 36 inches for level or ramped aisles having seating only on one side (30 inches for existing aisles serving 60 or fewer seats on one side).
6. 23 inches between a stair handrail and seating when an aisle does not serve more than five rows on one side.

1122.3 Clear Width of Rows

1122.3.1 Where seating rows have 14 or fewer seats, the row minimum clear width shall be not less than 12 inches 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 measurement 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.

1122.3.2 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 shall be increased by 0.3 inch for every additional seat beyond 14 but the minimum clear width need not exceed 22 inches.

1122.3.3 For rows of seating served by an aisle or doorway at one end only, minimum clear width of 12 inches between rows shall be increased by 0.6 inch for every additional seat beyond seven but the minimum clear width need not exceed 22 inches.

1122.3.4 For rows of seating served by an aisle or doorway on one end only, the path of travel shall not exceed 30 ft from any seat to a point where a person has a choice of two paths of travel to two exits.

1122.4 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 of width for each person served shall be provided on stairs having riser heights 7 inches or less and tread depths 11 inches or greater, measured horizontally between tread nosings.
2. At least 0.005 inches of additional stair width for each person shall be provided for each 0.10 inch of riser height above 7 inches.
3. Where egress requires stair descent, at least 0.075 inch 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.
4. Level or ramped means of egress, with slopes less than 1:8, shall have at least 0.22 inch of clear width for each person served.
5. Doorways shall have at least 0.2 inch of clear width per person served.

1122.5 Travel Distance

Exits and aisles shall be so located that the travel distance to an exit door shall not be greater than 200 ft measured along the line of travel. Travel distance may be increased to 250 ft in sprinklered buildings.

1122.6 Aisle Slope

Aisles shall not have a slope of more than 1:8.

1122.7 Aisle Termination

1122.7.1 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 20 ft 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 plus 0.6 inch for each additional seat above seven in the row.

1122.7.2 Each end of a cross aisle shall terminate at an aisle, foyer, doorway or vomitory giving access to an exit.

1122.8 Aisle Obstructions

There shall be no obstructions in the required width of aisles except for handrails as provided in 1112.5 and 1122.2.5.

1122.9 Guardrails in Front of a Row of Seals

The fascia or railing of boxes, balcony and galleries shall be a guardrail not less than 26 inches above the adjacent floor immediately in front of a row of seats.

1122.10 End Guardrails

Guardrails shall be provided at the ends of aisles where they terminate at a fascia of boxes, balconies and galleries. The top of such guardrails shall extend for the width of the aisle and be no closer than 42 inches to the closest surface of the aisle where there are steps and 36 inches otherwise.

1122.11 Guardrails

1122.11.1 Assembly aisles located more than 30 inches above the floor or grade below shall have guardrails in accordance with 1121.

1122.11.2 Where an elevation change of 30 inches 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 above the aisle floor shall be provided.

EXCEPTION: Where the backs of seats on the front of the cross aisle project 24 inches or more above the adjacent floor of the aisle, a guardrail need not be provided.

1122.12 Main Exit

Where there is a single main entrance it shall be capable of serving as the main exit and shall provide an egress capacity for at least one-half of the total occupant load.

1122.13 Other Exits

In addition to having access to a main exit, each level of a Group A occupancy shall be provided with additional exits which shall provide an egress capacity for at least two-thirds of the total occupant load served by that level.

1122.14 Steps in Aisles

Steps shall not be used in aisles where differences of level can be overcome by gradients not exceeding those permitted herein. Where steps are used in aisles, such steps shall extend across the full width of aisles and shall be illuminated; treads and risers shall be as required elsewhere in the Code for exit stairs. Where seating is on stepped platforms, one tread in each seat platform width may have a greater width to accommodate access to seats. Isolated steps shall not be permitted. Flights of less than three risers are not permitted.

1122.15 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 multi-purpose 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.

1122.16 Other Provisions

Other stair and ramp provisions are found in 1112.

1123 SEATING FOR REVIEWING STANDS, GRANDSTANDS AND BLEACHERS

1123.1 Scope

The provisions shall apply to buildings or structures of an assembly occupancy which provides permanent, temporary or portable seating facilities.

1123.2 Smoke-Protected Assembly Seating

1123.2.1 The lowest portion of the roof shall not be less than 15 ft (4572 mm) above the highest aisle or aisle accessway.

1123.2.2 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 1000 sq ft (93 m2) in outdoor seating facilities when all seating and means of egress are essentially open to the outside.

1123.2.3 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.

1123.3 Travel Distance

The travel distance shall comply with Table 1103. 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 passageways 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 ft (122 m). The travel distance shall not be limited in facilities of Type I or II construction.

1123.4 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 board and footboards are at the same elevation.
4. The number of rows does not exceed 16 in (406 mm) 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. Set boards provide a walking surface with a minimum width of 11 inches (229 mm).
8. Egress from seating is not restricted by rails, guards or other obstructions.

1123.5 Aisle Width

1123.5.1 Aisle width shall provide sufficient egress capacity for the number of persons accommodated by the catchment areas 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.

1123.5.2 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.

1123.5.3 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.

1123.5.4 Where egress is possible in either of two directions, aisles shall be uniform in required width.

1123.5.5 The minimum clear width of aisles shall be:

l. 48 inches (1219 mm) for stairs having seating on each side (42 inches (1067 mm) for existing aisles).
2. 36 inches (914 mm) for stairs having seating on only one side (30 inches (762 mm) for existing aisles serving fewer than 60 seats).
3. 23 inches (584 mm) between a stair handrail or guardrail and seating when the aisle is subdivided by a handrail (20 inches (508 mm) on existing aisles).
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 (30 inches (762 mm) for existing aisles serving 60 or fewer seats 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.

1123.6 Aisle Termination

1123.6.1 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 20ft (6096 mm).
2. Where seats served by the dead end aisle are not more than 24 seats from another aisle. The aisle accessway serving those seats shall have a minimum clear width of 12 inches (305 mm) plus 0.6 inch (15 mm) for each additional seat above seven in the row.
3. For smoke-protected assembly seating where seats served by the dead end aisle are no more than 40 seats from another aisle. The aisle accessway serving those seats shall have a clear minimum width of 12 inches (305 mm) plus 0.3 inch (8 mm) for each additional seat above seven in the row.
4. For smoke-protected assembly seating dead ends in vertical aisles shall not exceed a distance of 21 rows.
5. When seats are without backrests, dead ends in vertical aisles shall not exceed a distance of 16 rows.

1123.6.2 Each end of a cross aisle shall terminate at an aisle, foyer, doorway or vomitory giving access to an exit.

1123.7 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 a uniform within each aisle.

   EXCEPTION: Nonuniformities shall not exceed 3/16 inch (5 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 (I 02 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 non uniformities exceed 3/16 inch (5 mm) between adjacent risers, the exact location of such nonuniformities shall be indicated with a distinctive marking strip on each tread at the nosing or leading edge adjacent to the nonuniform risers.
3. A contrasting marking strip 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 strip shall be a minimum of 1 inch (25 mm) wide and a maximum of 2 inches (51 mm) wide.

   EXCEPTION: The marking strip may be omitted where tread surfaces are such that the location of each tread is readily apparent when viewed in descent.

1123.8 Aisle - Handrails

1123.8.1 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.

EXCEPTIONS:

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 compiles with graspability requirements for handrails.

1123.8.2 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. Those 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.

1123.8.3 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.

1123.9 Rows

1123.9.1 Seating rows shall have aisle accessways with minimum clear width measured in accordance with 1123.9.2 and increased, for row length, in accordance with 1123.9.3.

1123.9.2 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.

1123.9.3 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 (8 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 1123.9.3.

1123.9.4 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 mm) for every additional seat beyond seven, but the minimum clear width need not exceed 22 inches (559 mm).

EXCEPTION: See exception to 1123.9.3.

1123.9.5 For rows of seats served by an aisle or doorway on one end only, the path of travel shall not exceed 30 ft (9144 min) from any seal 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 (15 m) from any seat to a point where a person has a choice of two directions of egress travel.

TABLE 1123.9.3
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 clear width aisle accessway	
	Aisles or doorway	Aisle or doorway
<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

1123.10 Capacity of Means of Egress

1123.10.1 The minimum clear width of aisles and other means of egress shall comply with 1120.10.2 in the case without smoke-protected assembly seating and with 1120.10.3 in the case of smoke-protected assembly seating. The clear width shall be measured to intermediate handrails, edges of seating, tread edges and walls.

1123.10.2 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 (8 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 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 (3 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 mm) of clear width for each person served. Ramps with slopes exceeding 1:10 shall have at least 0.22 inch (6 mm) of clear width per person.
5. Doorways shall have at least 0.2 inch (5 mm) of clear width per person served.

1123.10.3 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 1123.10.3
MINIMUM EGRESS WIDTHS FOR SMOKE-PROTECTED ASSEMBLY SEATING

	Inches Of Clear Width Per Set Served			
Number Of Seats in The Space	Stairs With Handrail[1] Within 30 Inches	Stairs Without Handrail[1] Within 30 Inches	Passageways, Doorways, and Ramps Not Steeper Than 1:10 Slope	Ramps Steeper Than 1:10 Slope
≤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. 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.

1123.11 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 (600 mm).

1123.12 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 2ft (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 mm) between footboards and seatboards. At aisles, there shall be no horizontal gaps exceeding 1/4-inch (6 mm) between footboards.

CHAPTER 12

MINIMUM DESIGN LOADS

1201 GENERAL

1201.1 Structural Safety

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. Structural systems shall have a defined load path transferring loads to the resisting elements.

1201.1.1 Stability

Structures shall be designed such that forces resisting sliding, overturning, and/or uplift, other than caused by seismic, shall be at least 1.5 times the forces attempting to cause these movements. Seismic overturning stability shall meet procedure given in 1206.6.

1201.1.2 Serviceability

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.

1201.1.3 Load Combination - Working Stress

Every structure, foundation, component and element shall be provided with sufficient strength to resist the most critical effects resulting from the following load combinations[4 5]

1. Dead + Live[1] + (Roof Live or Snow[2])
2. Dead + Live[1] + (Wind or Seismic)
3. Dead + Live[1] +Wind+ 1/2 Snow[2]
4. Dead + Live[1] + 1/2 Wind+ Snow[2]
5. Dead + Live[l] + Snow[3] +Seismic

NOTES:

1. Live load shall not be included where its inclusion results in lower stresses in the building elements 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 may be reduced 75% upon approval of the Building Official. Snow loads 30 psf or less need not be combined with seismic.
4. Loads, forces, and effects due to contraction or expansion resulting from temperature changes, shrinkage, moisture changes, creep in component materials, movement due to differential settlement or combination thereof shall be considered.
5. 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 time duration of the load) may be used, in addition to the above referenced combination factors, to design members but not connections.

Where a choice of loadings is listed the loading producing the most unfavorable conditions shall be used. Fluid, earth, ponding and crane loads shall be considered as either dead or live depending on their duration.

1201.1.4 Load Combinations - Load Factor Design

Load factors, combination factors and duration factors shall be based on the recommendations of the referenced material design standards.

1201.1.5 Horizontal Bracing Systems

Floors, roofs, or other horizontal bracing systems shall be designed and constructed to transfer horizontal forces to the parts of the structural frame designed to carry the forces to the ground. Where horizontal or vertical shear resisting elements are designed to transfer forces through diaphragm action, the analysis shall include the design of chord members at or near the extremities of the diaphragm and the method by which the forces are transferred to the resisting elements. The total shear in any horizontal plane shall be distributed to the various elements of the lateral force resisting system in proportion to their rigidities, taking into consideration the rigidity of the horizontal bracing system or diaphragm.

1201.2 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.

1201.3 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 have been installed, as required by Section 105. Changes in the occupancy of a building now existing or hereafter erected shall not be made until a revised occupancy permit has been issued by the Building Official certifying that the floors are suitable for the loads characteristic of the proposed occupancy.

See Chapter 25 for load test requirements.

1201.4 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.

1201.5 Progressive Collapse

Buildings and structural systems shall provide such structural integrity that the hazards associated with progressive collapse, such as that due to local failure caused by severe overloads or abnormal loads not specifically covered herein, are reduced to a level consistent with good engineering practice.

1202 DEAD LOADS

1202.1 Weights of Materials and Construction

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. For information on dead loads, see Appendix R.

1202.2 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 shall be added to the dead load in the areas supporting them, except in the case of light partitioning.

1202.3 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.

1203 LIVE LOADS

1203.1 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 1203.1.

1203.2 Reduction of Uniform Floor Live Load

Floor live loads in 1203.1 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, or for roof live loads or lateral loads.
2. A reduction shall not be permitted when the live load exceeds 100 psf except that the design live load for columns may be reduced 20%.
3. For live loads not exceeding 100 psf, the design live load for any structural member supporting 150 sq ft 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.

1203.3 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 1203.1, whichever produces the greater stresses. Concentrated loads shall be equal to the machinery, vehicle, equipment, or apparatus anticipated but shall not be less than the loads specified in Table 1203.3.

1203.4 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 1203.6.

EXCEPTION: The distribution of live loads on reinforced concrete structures shall be in accordance with ACI 318.

1203.5 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 applied perpendicular to the walls, except for decorative screen walls.

TABLE 1203.1
MINIMUM UNIFORMLY 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
Platforms (assembly)	100
Balcony and decks (exterior)	
Same as occupancy but not less than	60
On one and two family residences	40
Residential (100 s.f. and less)	40
Residential (more than 100 s.f.)	60
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

TABLE 1203.1 (Continued)
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS

Occupancy or Use	Live Load (psi)
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
Residential:	
Multifamily houses:	
Private apartments	40
Public rooms	100
Corridors	80
Dwellings:	
Sleeping Rooms	30
Attic with storage	30
Attic 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:	
First floor, rooms	75
Upper floors	75
Wholesale	100

TABLE 1203.1 (Continued)
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS

Occupancy or Use	Live Load (psi)
Theaters:	
Aisles, corridors and lobbies	100
Orchestra floors	50
Balconies	50
Stage floors	150
Yards and terraces, pedestrians	100

1. American Association of State Highway and Transportation Officials.
2. For detailed recommendations, see ANSI Z20.3 (NFiPA 102).

TABLE 1203.3
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	2000
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. 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 1203.1 or the following concentrated loads: (1) for passenger cars accommodating not more than nine passengers, 2000 lb acting on an area of 20 sq in; (2) mechanical parking structures without slab or deck, passenger cars only, 1500 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.

1203.6 Roof Live Loads

1203.6.1 The design roof live loads shall take into account the effects of occupancy and water but shall not be less than the minimum roof live loads as set forth in Table 1203.6.

1203.6.2 Rain loads shall be designed for in accordance with the following:

1. Roof drainage systems shall be designed in accordance with the provisions 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 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 and shall terminate above grade in a location which would normally be observed by the building occupants or maintenance personnel.
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 that elevation. 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.

1203.6.3 Roofs designed as future floors, for the parking of automobiles or for other occupancy loadings shall comply with the provisions of 1203.1 and 1203.3.

1203.6.4 Snow loads shall comply with the provisions of 1204.

1203.6.5 Wind loads shall comply with the provisions of 1205.

TABLE 1203.6
MINIMUM ROOF LIVE LOAD
(Pounds per square foot)

County	Lbs./Sq. Ft.	County	Lbs./Sq. Ft.
Counties not listed	20	Iredell	25
Alexander	25	Jackson	30
Alleghany	30	Macon	30
Ashe	30	Madison	30
Avery	30	McDowell	25
Buncombe	30	Mitchell	30
Burke	25	Polk	25
Caldwell	25	Rockingham	25
Catawba	25	Rutherford	25
Caswell	25	Stokes	25
Cherokee	30	Surry	25
Clay	30	Swain	30
Davie	25	Transylvania	25
Forsyth	25	Watauga	30
Graham	30	Wilkes	25
Haywood	30	Yancey	30
Henderson	25	Yadkin	25

Note: The loads shall be assumed to act vertically upon the area projected upon a horizontal plane. Consult local weather records in regions of high altitude.

1203.7 Impact Loads

1203.7.1 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.

1203.7.2 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.

1203.8 Supports for Walkways

Where walkways are to be installed above ceilings, supports shall be designed to carry a load of 200 lb occupying a space 2 1/2 sq ft, so placed as to produce maximum stresses in the affected members.

1203.9 Sidewalks

Sidewalks shall be designed to carry either a uniformly distributed load of 200 psf or a concentrated load of 8000 lb on a space 2 1/2 ft square and placed in any position, whichever will produce the greater stresses. This does not apply to sidewalks on grade.

1204 DRIFT SNOW LOADS

1204.1 Minimum Snow Loads

Minimum ground snow loads shall be as set forth in Figure 1204.1 or as estimated by local records when exceeding the ground snow loads shown.

1204.2 Roof Snow Loads

1204.2.1 Basic Design Load. The basic design roof snow load shall be determined in accordance with the formula:

$$p_f = C_e \, I \, P_g$$

where

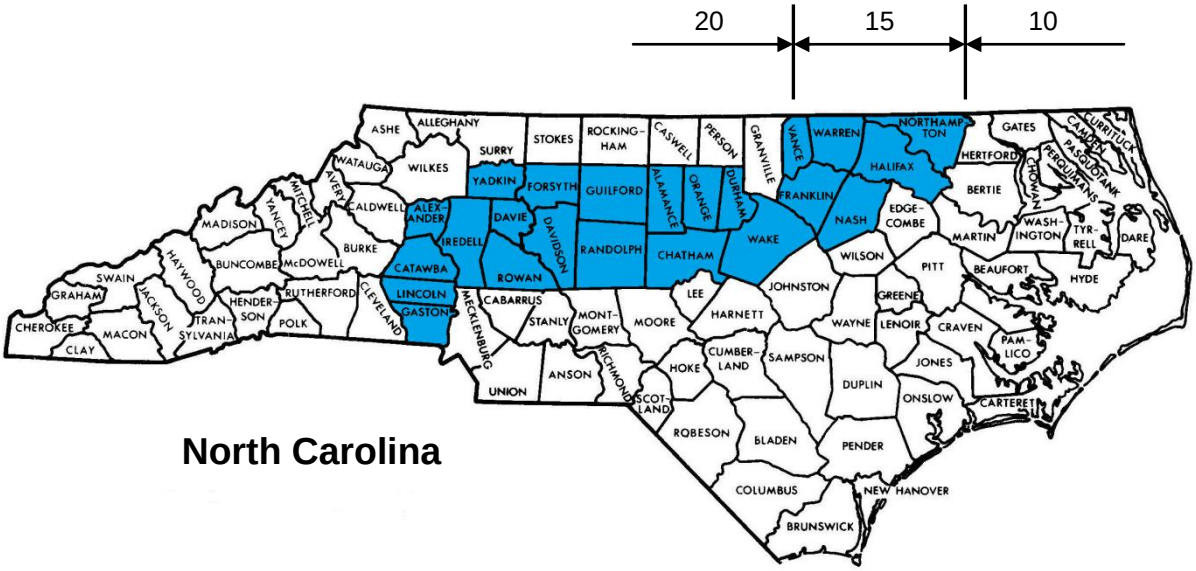
P_f = Roof snow load in pounds per foot (psf)

C_e = Snow exposure factor from Table 1204.2A

I = Importance factor from Table 1204.28

P_g = 50-year mean recurrence ground snow load (psf) given in Figures 1204.1 A to 1204.1 C.

FIGURE 1204.1
GROUND SNOW LOADS, P_g (psf) FOR 50-YR MEAN RECURRENCE INTERVAL



NOTES:
1. In these 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.

TABLE 1204.2A
SNOW EXPOSURE FACTOR (C_e)

Roofs located in generally open terrain extending one-half mile or more from the structure	0.6
Structure located in densely forested or sheltered areas	0.9
All other structures	0.7

TABLE 1204.2B
IMPORTANCE FACTOR (I)

All buildings and structures not listed below	1.0
Buildings and structures where the primary occupant load is 300 or more in any one room	1.1
Buildings and structures designated as essential facilities, including but not limited to: 1. Hospital and other medical facilities having surgery or emergency treatment areas 2. Fire or rescue and police stations 3. Primary communication facilities and disaster operation centers 4. Power stations and other utilities required in an emergency 5. Structures having critical national defense capabilities	1.2
Buildings and structures that represent a low hazard to human life in the event of failure, such as agricultural buildings, certain temporary facilities, and minor storage facilities	0.8

1204.2.2 Sloped-Roof Snow Loads. Snow loads acting on a sloping surface shall be considered to act on the horizontal projection of that surface. The sloped-roof snow load on roofs having a slope greater than 30° shall be calculated using the following formula:

$$P_s = C_s pf$$

where C_s is determined by the following formula:

$$C_s = 1 - \frac{(a - 30)}{40}$$

and a is the angle of the roof in degrees.

The above reduction formula shall not apply where snow cannot slide from roof because of obstructions such as parapets or valley conditions in multi-gabled roofs.

1204.2.3 Unbalanced Roof Snow Loads

1. Gable Roofs - Unbalanced loads shall be considered for all gable roofs with slopes between 1/2:12 and 12:12 in accordance with the following loading cases:

   Case I: Roofs with slopes 1/2:12 to 3:12 shall be designed to sustain a uniformly distributed load of 0.5 pf acting on one slope and 1.0 pf on the opposite slope except that this case need not be considered for solid web, single span beams, or clear span frames with solid webs.

   Case II: Roofs with slopes greater than 3:12 but less than or equal to 12:12 shall be designed to sustain a uniformly distributed load equal to 1.5 pf applied to one slope only.

2. Multiple Gable Roofs - For roof slopes exceeding 2:12, the roof snow load shall be increased from one-half the applicable uniform roof load (0.5 pf) at the ridge to three times the uniform load at the valley (3.0 pf); the maximum height of snow at the valley shall not exceed the least height of adjacent ridges.

1204.3 Drifts on Lower Roofs and Roof Projections

In areas where ground snow load (P_g) is greater than 10 psf multi-level roofs or roofs adjacent to projections all be designed to sustain localized loads from snow drifts caused by wind flowing over higher portions of the same structure and adjacent structures within 20ft.

1204.3.1 Drift Load. The geometry of the surcharge load produced by snow drifting shall be taken as the triangular load distributions shown in Figures 1204.3B through 1204.3F. The height of the drift, h_d, is given in Figure 1204.3A or may be calculated from the formula:

where $$h_d = 0.43 \sqrt[3]{w_b} \quad \sqrt[4]{P_g + 10} - 1.5$$

h_d = Height of drift above uniform roof snow (ft); the value of h_d shall not exceed (h_r - h_b)

h_r = Difference in height between the upper and lower roofs or height of projections (ft).

h_b = Height of uniform snow on lower roofs or adjacent to projection (ft).

W_b = Horizontal dimension of upper roof normal to line of change in roof level (ft); $w_b \geq 25$ ft.

D = Snow drift density (pcf) as given by the formula:

$$D = 0.13\ P_g + 14.0 \leq 35 \text{ pcf}$$

The width of the drift, W_d, shall be taken as the smaller of $4h_d$ or $4(h_r - h_b)$. Drift loads need only be considered when:

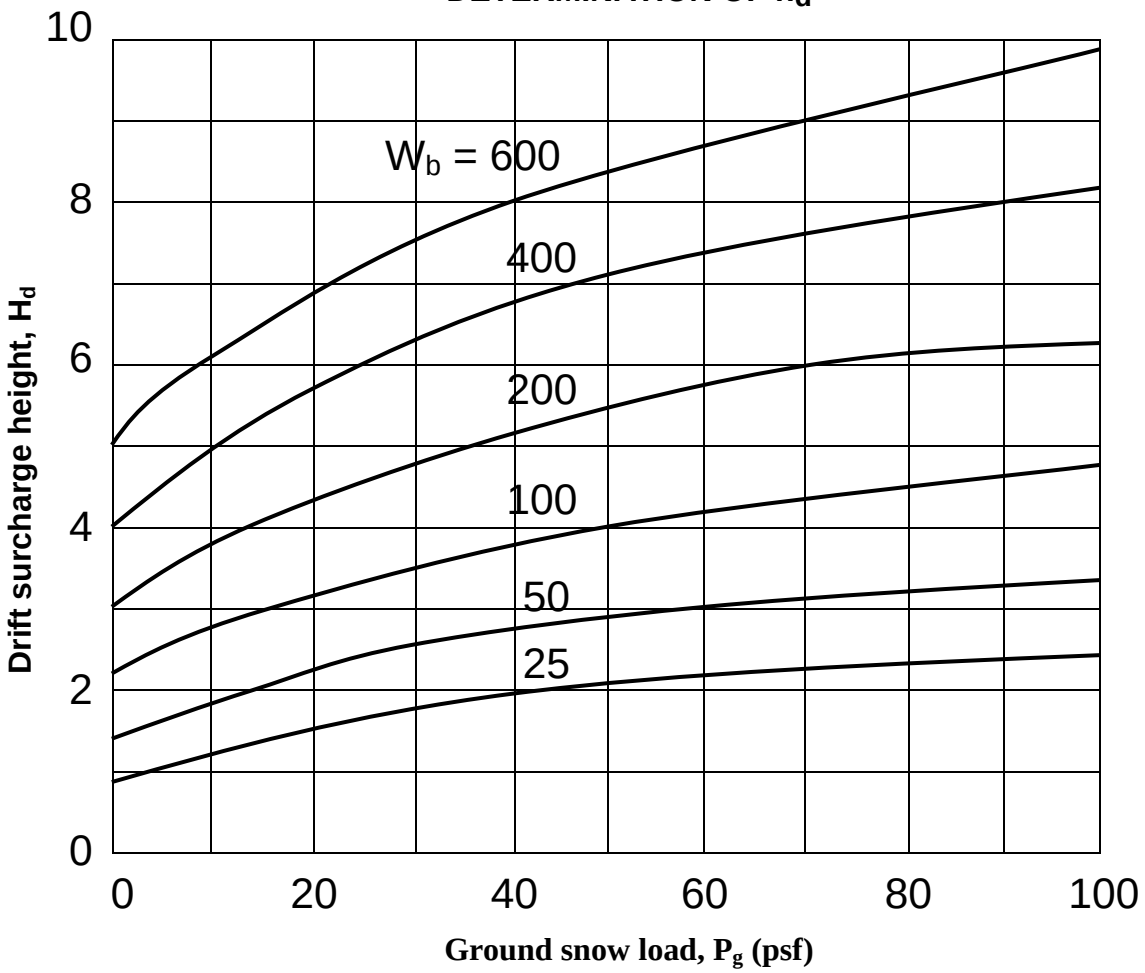
$(h_r - h_b) / h_b > 0.2$ $\qquad$ $h_b = P_{fl} / D$

P_{f1} = Roof snow load on the lower roof (psf)

The maximum intensity of the snow load P_t at the high point of the drift (psf) is given by:

$$Pt = D(h_d + h_b) \leq Dh_r$$

FIGURE 1204.3A
DETERMINATION OF h_d



1204.3.2 Roof of an Adjacent, Lower Structure. Drifts may occur on lower roofs of structures sited within 20 ft of a higher structure as depicted in Figure 1204.3C. The design load shall be determined using the procedure set forth in 1204.3.1. The factor (20-S)/20 shall be applied to the maximum intensity of the drift to account for the horizontal separation between structures, S (ft).

1204.3.3 Sliding Snow. Lower roofs which are located below roofs having a slope greater than 2:12 shall be designed for an increase in drift height of 0.4 h_d, except that the total drift surcharge (h_d + 0.4 h_d) shall not exceed the height of the roof above the uniform snow depth (h_r-h_b). Sliding snow need not be considered if the lower roof is separated a distance S greater than h_r or 20ft as shown in Figures 1204.3C, D.

1204.3.4 Roof Projections. Mechanical equipment, penthouse and other projections above the roof with horizontal dimensions exceeding 15 feet can produce drifting as depicted in Figure 1204.3E. The procedure set forth in Section 1204.3.1 shall be used to compute the loads that can occur on both sides of such projections. The value of W_b to be used in Section 1204.3.1 shall be taken as the maximum distance from the projection to the edges of the roof, or 50 ft, whichever is less.

Drifts created at the perimeter of the roof by a parapet wall shall be computed using half the drift height from Section 1204.3.1 (i.e. 0.5 h_d) with W_b equal to the length of the roof upwind of the parapet.

1204.3.5 Intersecting Drifts. When one snow drift intersects another at an angle as depicted in Figure 1204.3F, the maximum unit pressure of the drift shall be taken as the greater of the two individual drifts, but not the sum of the two. The total load on the area of intersection is increased, however, because of the assumed geometry of the intersecting drifts.

FIGURE 1204.3B
DRIFTING SNOW DUE TO HIGH AND LOW ROOFS

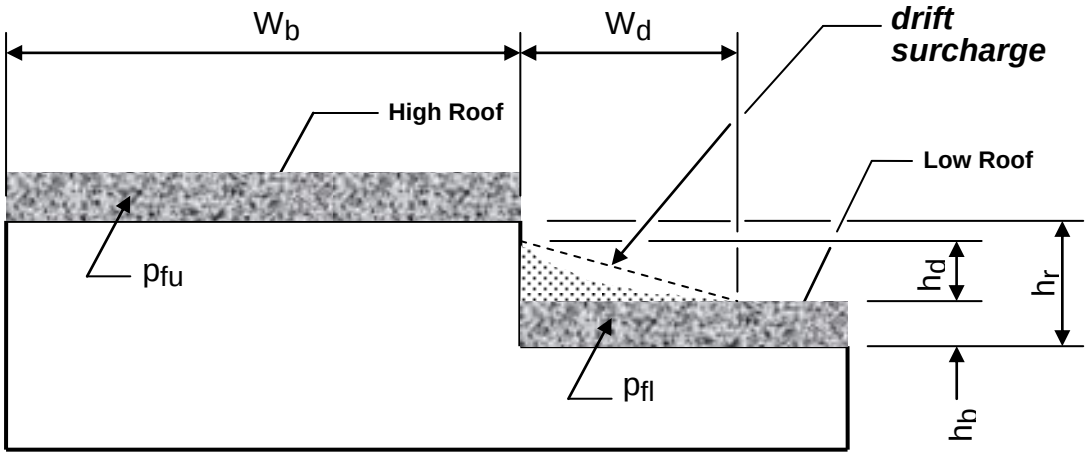


FIGURE 1204.3C
DRIFTING SNOW ONTO ADJACENT LOW STRUCTURES

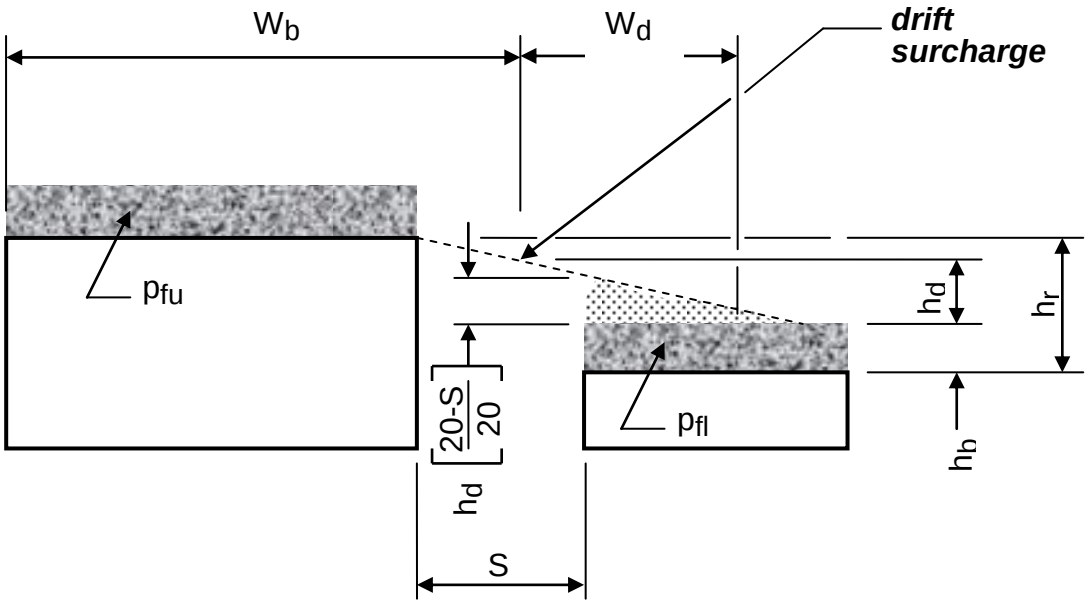


FIGURE 1204.3D
ADDITIONAL SURCHARGE DUE TO SLIDING SNOW

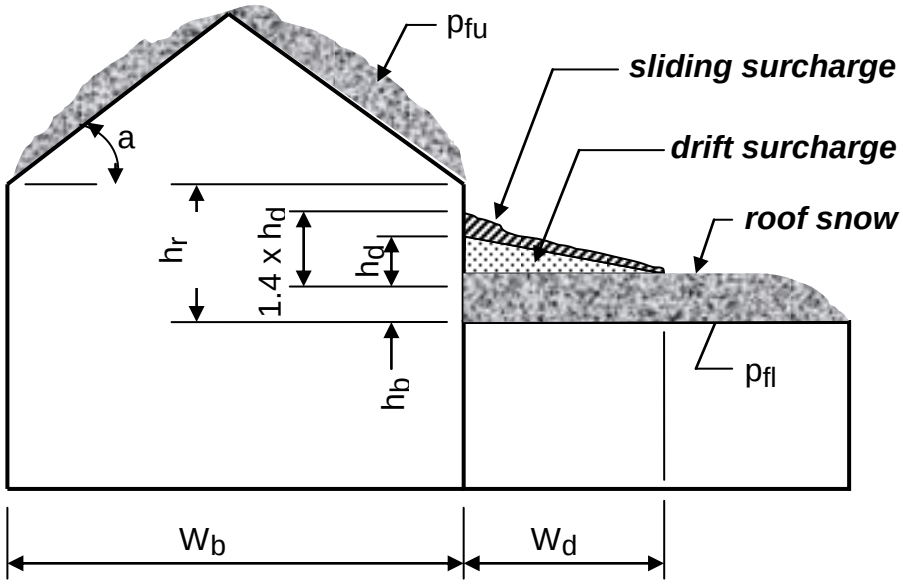


FIGURE 1204.3E
SNOW DRIFTING AT ROOF PROJECTION

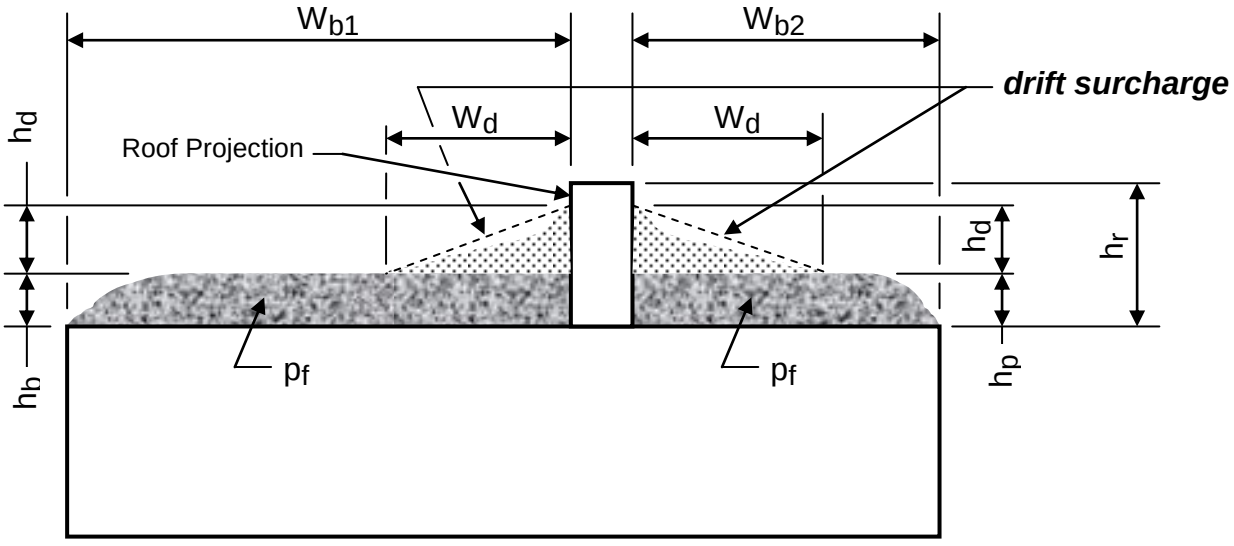
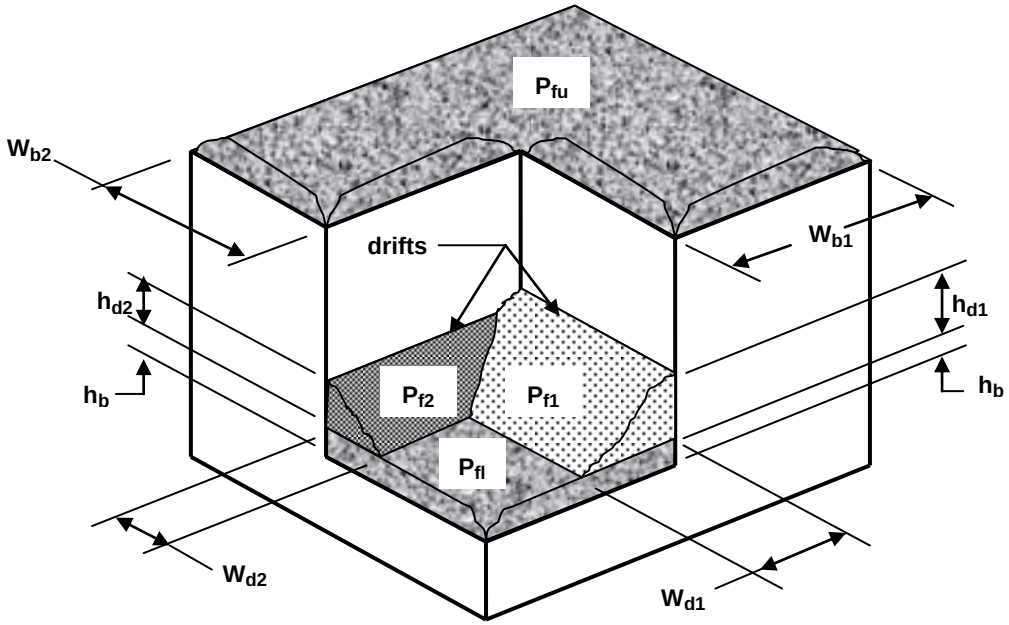


FIGURE 1204.3F
INTERSECTING SNOW DRIFTS



$$h_{d1} = 0.43 \sqrt[3]{w_{b1}} \quad \sqrt[4]{P_g + 10} - 1.5$$

$$h_{d2} = 0.43 \sqrt[3]{w_{b2}} \quad \sqrt[4]{P_g + 10} - 1.5$$

1205 WIND LOADS

1205.1 General

Every building or structure and every portion thereof shall be designed and constructed to resist the wind effects determined in accordance with the requirements of this section. Wind shall be assumed to come from any horizontal direction. No reduction in wind pressure shall be taken for the shielding effect of adjacent structures.

1205.1.1 Wind Loads During Erection and Construction Phases. Adequate temporary bracing shall be provided to resist wind loading on structural and non-structural components and assemblages during the erection and construction phases.

1205.1.2 Anchorage. Anchorage of the roof and floors to walls and columns, and of walls and columns to foundations, shall be provided to resist the uplift and sliding forces which result from the application of the prescribed forces.

1205.2 Definitions

The following definitions apply only to the provisions of this section:

BASIC WIND SPEED, V - fastest-mile wind speed at 33 feet above the ground of terrain Exposure C (see ASCE 7) and associated with a 50-year mean recurrence interval.

COMPONENTS AND CLADDING - structural elements that are directly loaded by the wind or receive wind loads originating at relatively close locations and that transfer those loads to the main wind-force resisting system. Examples include curtain walls, exterior glass windows and panels, roof sheathing, purlins, girts, studs, and roof trusses.

DESIGN PRESSURE, p - equivalent static pressure to be used in the determination of wind loads.

IMPORTANCE FACTOR, I - a factor that accounts for the degree of hazard to human life and damage to property.

MAIN WIND FORCE RESISTING SYSTEM (MWFRS) - an assemblage of major structural elements assigned to provide support for secondary members and cladding. The system primarily receives wind loading from relatively remote locations. Examples include rigid and braced frames, space trusses, roof and floor diaphragms, shear walls, and rod-braced frames.

TRIBUTARY AREA, A - that portion of the surface area receiving wind loads assigned to be supported by the structural element considered. For a rectangular tributary area, the width of the area need not be less than one-third the length of the area.

1205.3 Symbols and Notation

The following symbols and notations apply only to the provisions of this section:

a = width of pressure coefficient zone, in feet.

C = pressure coefficient to be used in determination of wind loads, including external and internal effects for enclosed buildings.

G = gust response factor.

h = mean roof height of a building or height of other structure, except that eave height may be used for roof slope of less than 2: 12, in feet.

I = importance factor.

p = design pressure, in pound per square foot.

q = velocity pressure, in pounds per square foot.

1205.4 Determination of Wind Forces

Wind forces shall be determined by the provisions of ASCE 7.

EXCEPTIONS:

1. Provisions of 1205.6 may be used for buildings or other Structures 60 feet high or less, whose height does not exceed five time the least horizontal dimension.
2. Provisions of 1205.7 are required for buildings and structures having irregular geometric shapes, wind sensitive response characteristics, or site locations for which channeling effects or buffeting in the wake of upwind obstructions may warrant special consideration, and for which no reliable documentation pertaining to wind effects is available.

1205.5 Basic Wind Speed

The basic wind speed used in the determination of design wind loads on buildings and other structures shall be given as in Figure 1205 and Table 1205A.

1205.5.1 Special Wind Region. Special consideration shall be given to mountainous terrain and gorges for higher local wind speeds. The minimum basic wind speed for mountain regions shall be given as in Table 1205B.

1205.6 Alternative Method for Buildings and Structures 60 Feet High or Less

1205.6.1 Design wind pressures for structures or elements of structures shall be determined in accordance with the following formula:

$$p = qGCI^2$$

where qG is from Table 1205.6A;
C is from Table 1205.6C. 1205.6D, or 1205.6E; and
I is from Table 1205.6F.

1205.6.2 Main Wind Force Resisting System (MWFRS).

Design wind pressures for MWFRS shall be determined from Table 1205.6.1 and values of C from Table 1205.6C. Pressures shall be assumed to act simultaneously on windward, leeward, and side wall surfaces and on roof surfaces in a direction normal to the surface. The pressure acting on the windward wall may vary with the height of the building as indicated in Figure 1205.6A or shall be based on the mean roof height. Pressures on leeward and side wall surfaces and on roof surfaces shall be based on the mean roof height and applied for the entire height of the building.

1205.6.2.1 Exposure D. The values in Table 1205.6A are based on ground surface characterized by open terrain with scattered obstructions having heights generally less than 30 feet. Where flat unobstructed areas are exposed to wind blowing over open sea or coastal sounds for a distance exceeding one mile, multiply values from Table 1205.6A by the appropriate factor from Table 1205.6B. This exposure shall extend inland for a distance of 1500 feet from the mean low-water shoreline.

1205.6.2.2 Roof Overhangs. A positive roof pressure on the bottom surface of roof overhangs corresponding to C = +0.8 shall be applied in combination with other pressures.

1205.6.3 Components and Cladding. Design wind pressures for individual components and cladding shall be determined from 1205.6.1 and values of C from Table 1205.6D. Pressures shall be assumed to act normal to the surface. Design wind pressures shall be based on mean roof height and applied for the entire height of the building. Pressures for local areas at discontinuities such as corners, eaves, and ridges shall extend for a distance from the discontinuity as indicated in Figure 1205.6B. For tributary areas greater than 700 square feet, structural elements may be designed using the provisions of 1205.6.2 for MWFRS.

1205.6.4 Other Structures. Design wind pressures for unenclosed structures shall be determined from 1205.6.1 and values of C from Table 1205.6E, and varies with the height of the structure. The design wind force shall be calculated by applying the design pressure on the projected area of a plane normal to the wind direction. The force shall be assumed to act parallel to the wind direction.

1205.7 Wind Tunnel Test

1205.7.1 Wind tunnel tests or similar tests employing fluids other than air may be used for the determination of design wind loads in lieu of the provisions of 1205.

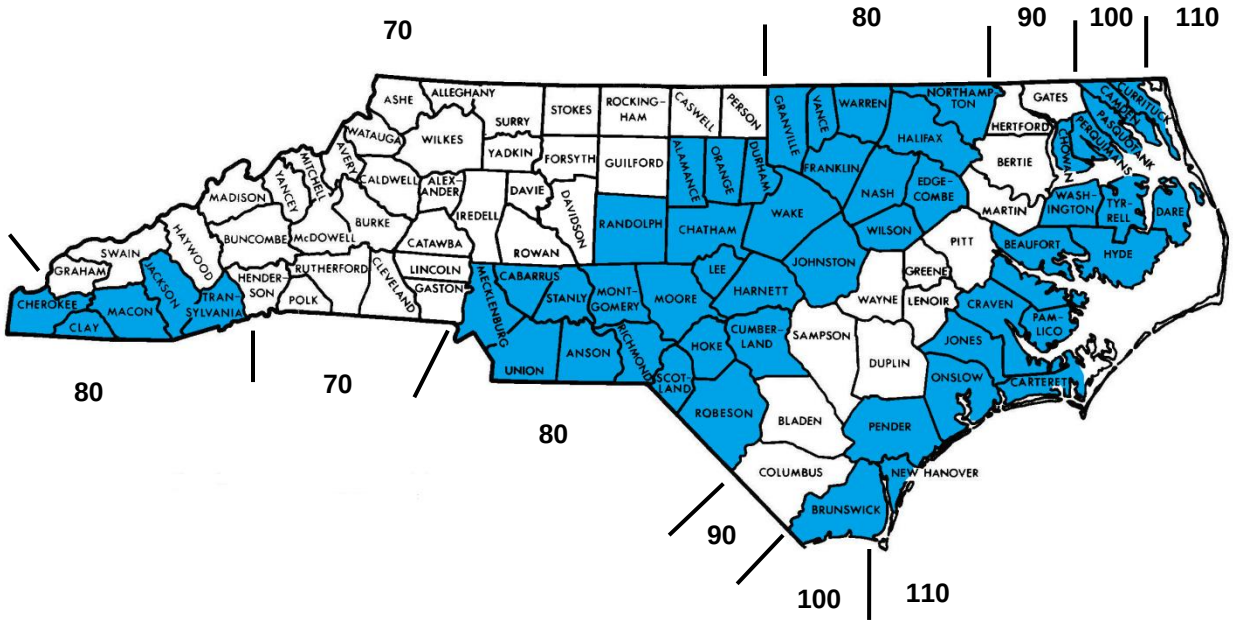
1205.7.2 Tests for the determination of mean and fluctuating forces and pressures shall be considered to be properly conducted only if:

1. The natural wind has been modeled to account for the variation of wind speed with height;
2. The natural wind has been modeled to account for the intensity of the longitudinal component of turbulence;
3. The geometric scale of the structural model is not more than three times the geometric scale of the longitudinal component of turbulence;

4. The response characteristics of the wind tunnel instrumentation are consistent with the measurements to be made;
5. Due regard is given to the dependence of forces and pressures on the Reynolds number;
6. The basic wind speed shall not be less than that prescribed in 1205.5; and
7. Test results shall be sealed by a North Carolina Professional Engineer or Architect.

1205.7.3 Test for the purpose of determining the dynamic response of a structure shall be considered to be properly conducted only if the provisions of 1205.7.2 are satisfied and the structural model is scaled with due regard to length, mass distribution, stiffness, and damping.

FIGURE 1205
BASIC WIND SPEED IN 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 1205A
BASIC WIND SPEED, V

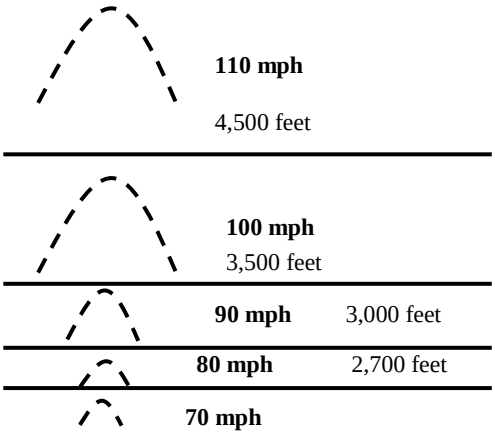
Counties not listed	70	Jones	100
Alamance	80	Lee	80
Anson	80	Lenoir	90
Beaufort	100	Macon	80
Bertie	90	Martin	90
Bladen	90	Mecklenburg	80
Brunswick	100	Montgomery	80
Cabarrus	80	Moore	80
Camden	100	Nash	80
Carteret	100	New Hanover	100
Chatham	80	Northampton	80
Cherokee	80	Onslow	100
Chowan	100	Orange	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.

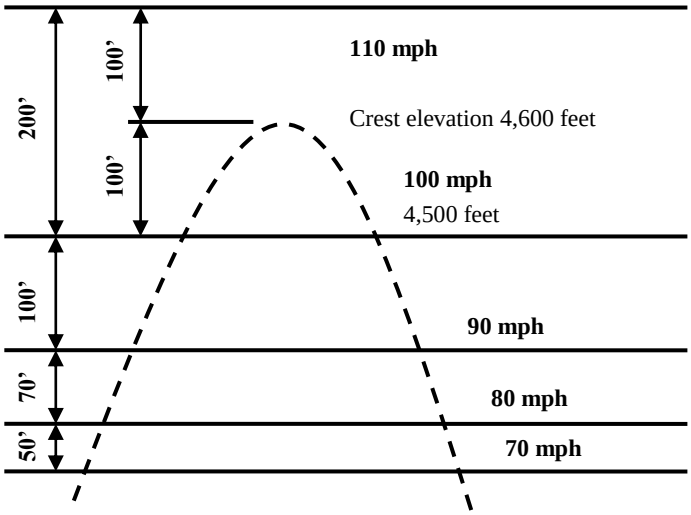
TABLE 1205.2C
BASIC DESIGN WIND VELOCITIES FOR MOUNTAIN REGIONS

Controlling Elevation in Feet [1,2,3,4,5]	Design Wind (MPH)
2,700 or lower	70
2,700 to 3,000 feet	80
3,000 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.

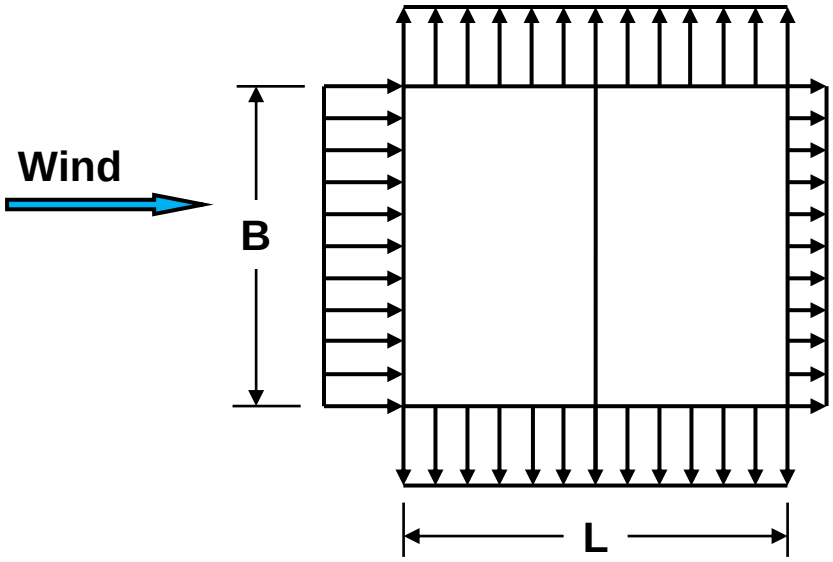


Wind Velocity Diagram

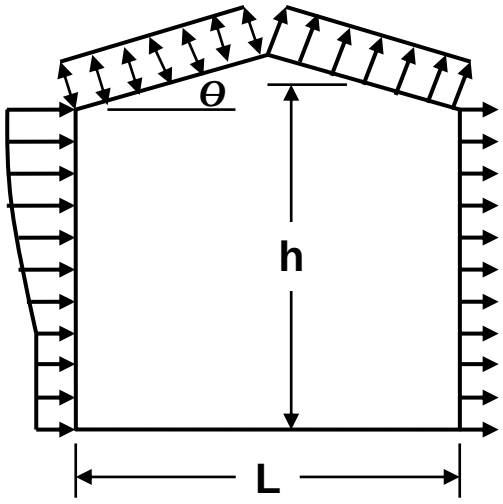


Example
Note #2 Modification
Note 3, 4, and 5 Similar

FIGURE 1205.6A
EXTERNAL PRESSURE FOR AVERAGE LOADS ON MWFRS

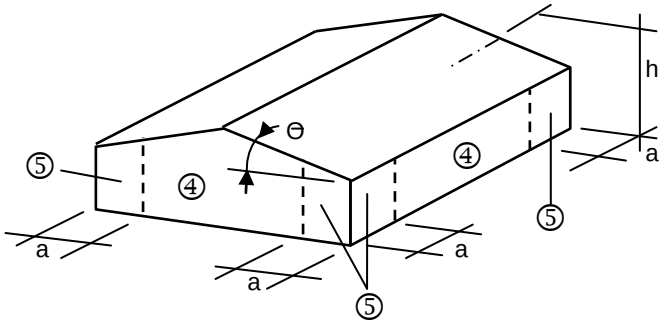


PLAN

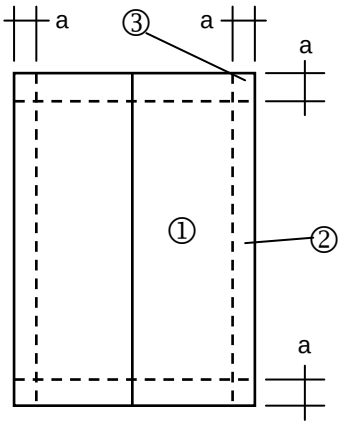


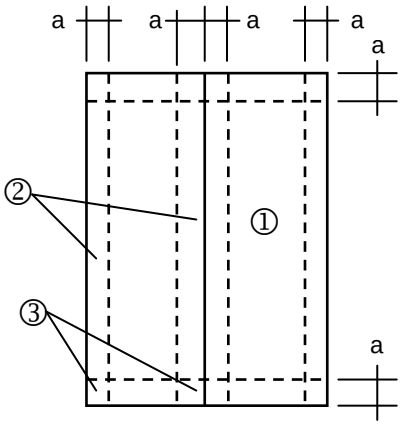
ELEVATION

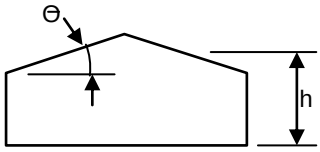
FIGURE 1205.6B
EXTERNAL PRESSURE ZONES FOR LOADS ON BUILDING COMPONENTS AND CLADDING



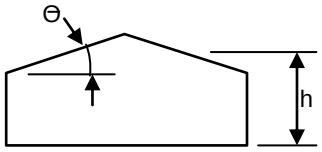
(a) Walls







SLOPE LESS THAN 2:12



SLOPE 2:12 TO 12:12

(b) Roofs

NOTES:

1. Distance a: 10% of least horizontal dimension or 0.4h, whichever is smaller, but not less than 4% of least horizontal dimension or 3 feet.

TABLE 1205.6A
COMBINED VELOCITY PRESSURE AND GUST RESPONSE FACTOR, qG (psf)

Mean Roof Height (ft)[1]	Basic Wind Speed				
	70	80	90	100	110
0 – 15	13.2	17.3	21.9	27.0	32.7
20	14.1	18.4	23.3	28.7	34.8
30	15.5	20.2	25.6	31.6	38.3
40	16.4	21.4	27.0	33.4	40.4
60	17.9	23.4	29.6	36.6	44.2

1. Values for intermediate heights above 15 feet may be interpolated.

TABLE 1205.6B
MULTIPLIER FOR EXPOSURE CATEGORY D (FOR USE WITH MWFRS ONLY)

Mean Roof Height (ft)[1]	Exposure D Factor
0 – 15	1.30
20	1.28
30	1.25
40	1.24
60	1.21

1. Values for intermediate heights above 15 feet may be interpolated.

TABLE 1205.6C
PRESSURE COEFFICIENT FOR AVERAGE LOADS ON MWFRS, C

	NET EXTERNAL SURFACE PRESSURE	
	WITH POSITIVE INTERNAL PRESSURE	**WITH NEGATIVE INTERNAL PRESSURE**
WALL SURFACE		
Windward Wall	+0.18	+1.01
Leeward Wall	-1.12	-0.29
Side Walls	-1.32	-0.49
ROOF SURFACE		
1. WIND DIRECTION NORMAL TO RIDGE		
1.1 Windward roof		
Slope <2:12	-1.32	-0.49
Slope 2:12 to <7:12	-1.52 TO -0.32	-0.69 to -+0.51
Slope 7:12 to 12:12	-1.52 TO -0.18	-0.69 to +0.66
Slope >12:12	-0.70 TO +0.28	+0.13 to +1.11
1.2 Leeward or flat roof	-1.32	-0.49
2. WIND DIRECTION PARALELL TO RIDGE AND FLAT ROOFS	-1.32	-0.49

NOTES:

1. Net external pressure is the algebraic combination of external and internal pressures.
2. Plus and minus signs signify pressures acting toward and away from the external surfaces, respectively.
3. Load cases with positive and negative internal pressure shall be considered to ascertain the critical load requirement. For each load case, both upper and lower values of a range, if specified, shall be considered in determining the critical load requirement.

TABLE 1205.6D
PRESSURE COEFFICIENTS FOR COMPONENTS AND CLADDING, C[1, 2, 3, 4]

	TRIBUTARY AREAS	
WALL SURFACE	**A ≤ 10 sf**	**A ≥ 500 sf**
Zone 4	-1.88 to +1.38	-1.54 to +1.04
Zone 5	-2.29 to +1.38	-1.54 to +1.04
ROOF SURFACE	**A ≤ 10 sf**	**A ≥ 100 sf**
ZONE 1		
Slope <2:12	-1.79	-1.62
Slope 2:12 to <7:12	-1.71	-1.54
Slope 7:12 to 12:12	-1.79 to +1.29	-1.62 to +1.12
ZONE 2		
Slope <2:12	-2.79	-1.88
Slope 2:12 to <7:12	-3.12	-2.29
Slope 7:12 to 12:12	-2.04 to +1.29	-1.79 to +1.12
ZONE 3		
Slope <2:12	-3.96	-1.88
Slope 2:12 to <7:12	-3.12	-2.29
Slope 7:12 to 12:12	-2.04 to +1.29	-1.79 to +1.12

NOTES:

1. Plus and minus signs signify pressures acting toward and away from the external surfaces, respectively.
2. Each component shall be designed for both upper and lower values of the specified range, if applicable.
3. Values for intermediate tributary areas may be interpolated.
4. For roof slopes greater than 12:12, use values for wall components.

TABLE 1205.6E
PRESSURE COEFFICIENTS FOR OTHER STRUCTURES, C

Chimneys, Tanks and Similar Structures	
Square or rectangular	1.4 any direction
Hexagonal or octagonal	1.2 any direction
Round or elliptical	1.0 any direction
Solid Signs and Freestanding Walls [1,2,3]	1.5
Open Signs and Lattice Frameworks [1,4]	
FLAT SIDED MEMBERS	
More than 70% open	2.0
30% to 70% open	1.6
ROUNDED MEMBERS	
More than 70% open	1.3
30% to 70% open	1.5

NOTES:

1. Signs with openings comprising 30% or more of the gross area shall be considered as open signs.
2. The ratio of larger dimension to smaller dimension shall not exceed 20 for above ground signs. Signs for which the distance from the ground to the bottom edge is less than 0.25 times the vertical dimension shall be considered to be at ground level.
3. To allow for both normal and oblique wind directions, two load cases shall be considered:
   a) resultant force acts normal to sign at geometric center: and
   b) resultant force acts normal to sign at level of geometric center and at a distance from the center of 0.2 times the horizontal dimension.
4. The tributary area for open signs and lattice frameworks is the net solid area projected normal to the wind direction.

TABLE 1205.6F
IMPORTANCE FACTOR, I

COUNTY	CATEGORY CLASSIFICATION		
	I	II	III
Counties not listed	1.00	1.07	1.07
Beaufort	1.05	1.11	1.11
Bertie	1.03	1.09	1.09
Bladen	1.03	1.09	1.09
Brunswick	1.05	1.11	1.11
Camden	1.05	1.11	1.11
Carteret	1.05	1.11	1.11
Chowan	1.05	1.11	1.11
Columbus	1.05	1.11	1.11
Craven	1.05	1.11	1.11
Cumberland	1.03	1.09	1.09
Currituck	1.05	1.11	1.11
Dare	1.05	1.11	1.11
Duplin	1.03	1.09	1.09
Edgecombe	1.03	1.09	1.09
Gates	1.03	1.09	1.09
Greene	1.03	1.09	1.09
Halifax	1.03	1.09	1.09
Harnett	1.03	1.09	1.09
Herford	1.03	1.09	1.09
Hoke	1.03	1.09	1.09
Hyde	1.05	1.11	1.11
Johnston	1.03	1.09	1.09
Jones	1.05	1.11	1.11
Lenoir	1.03	1.09	1.09
Martin	1.03	1.09	1.09
Nash	1.03	1.09	1.09
New Hanover	1.05	1.11	1.11
Northampton	1.03	1.09	1.09
Onslow	1.05	1.11	1.11
Pamlico	1.05	1.11	1.11
Pasquotank	1.05	1.11	1.11
Pender	1.05	1.11	1.11
Perquimans	1.05	1.11	1.11
Pitt	1.03	1.09	1.09
Robeson	1.03	1.09	1.09
Sampson	1.03	1.09	1.09
Scotland	1.03	1.09	1.09
Tyrrell	1.05	1.11	1.11
Washington	1.05	1.11	1.11
Wayne	1.03	1.09	1.09
Wilson	1.03	1.09	1.09

NOTE: The building and structure classification categories are listed in Table 1205.6G.

TABLE 1205.6G
CLASSIFICATION OF BUILDINGS AND OTHER STRUCTURES FOR WIND LOADS

Nature of Occupancy	Category
All buildings and structures except those listed below	I
Group A in which more than 300 congregate in one room	II
Building and structures having essential facilities which are required for post-hurricane recovery, including 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. Hurricane emergency preparedness centers. 4. Post-hurricane recovery vehicle garages. 5. Power generation stations and other utilities required as emergency back-up facilities. 6. Designated shelters for hurricanes.	III

1206 EARTHQUAKE LOADS

1206.1 General

Every building and structure and portion thereof shall be designed and constructed to resist the earthquake effects determined in accordance with the requirements of this section. Seismic zones shall be determined by location in Figure 1206.1. Where wind load requirements of 1205 would produce higher stresses, such stresses shall be used in lieu of the stresses resulting from earthquake forces.

EXCEPTIONS:

1. Buildings or structures in Use Group R-3 located in Seismic Zones 0, 1 or 2 are exempt from the requirements of this section.
2. All buildings or structures in Zone 0 and buildings or structures in Zone 1 having an importance factor I in Table 1206.1 of less than 1.5, shall only be required to comply with 1206.11.1 and 1206.11.2.
3. Buildings and structures that represent a low hazard to human life in the event of failure, such as agricultural buildings, certain temporary facilities, and minor storage facilities are exempt from the requirements of this section.

The determination of forces in this section depends on the ability of a structure to remain stable when members are strained into the inelastic range during a major earthquake. Structural concepts other than those set forth in this section shall be permitted when evidence is submitted showing that equivalent ductility and capacity for energy dissipation are provided. While the requirements in this section refer primarily to an equivalent static force method, other procedures used to establish the seismic forces and their distribution shall be permitted if the corresponding internal forces and deformations in the members are determined using a model consistent with the procedure adopted. Principles governing the use of dynamic analysis are given in 1206.8.

1206.1.1 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 is 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.

1206.1.2 Change of Occupancy. When a change of occupancy results in an existing building being reclassified to Seismic Hazard Exposure Group III, the building shall conform to the seismic requirements for new buildings.

1206.1.3 Stress Increases. The requirements of this section presume that allowable stresses are increased by one-third for earthquake loadings.

1206.1.4 Combined vertical and horizontal forces. In computing the effect of seismic forces in combination with vertical loads, gravity load stresses induced in members by dead load plus design live loads, except roof live load, shall be considered. Consideration shall also be given to minimum gravity loads acting in combination with lateral forces.

TABLE 1206.1
OCCUPANCY IMPORTANCE FACTOR (I) AND
SEISMIC HAZARD EXPOSURE GROUP

Group Type	Nature of Occupancy	I Factor
Group I		1.00
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 5000.	1.25
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 408.1.2 as an H4 occupancy where the quantity of material exceeds the exempt amounts of Table 408.1.2D.	1.50

1206.2 Definitions

The definitions listed below apply only to the provisions of this section.

BASE - the level at which the earthquake motions are considered to be imparted to the structure or the level at which the structure as a dynamic vibrator is supported.

BRACED FRAME - a truss system or its equivalent which is provided to resist lateral forces in the frame system and in which the members are subjected primarily to axial stresses.

DIAPHRAGM - a horizontal or nearly horizontal system designed to transmit seismic forces to the vertical elements of the lateral force-resisting system.

ESSENTIAL FACILITIES - as listed in Table 1206.1.

LATERAL FORCE-RESISTING SYSTEM - that part of the structural system to which the lateral forces prescribed in 1206.4 are assigned.

MINOR STORAGE - Normally unoccupied storage occupancy, with no accessory occupancy, which is limited to one story in height (20 ft maximum) and with a roof/ceiling dead load less than 15 psf.

SHEAR WALL - a wall designed to resist lateral forces parallel to the wall.

SEISMICALLY REINFORCED MASONRY SHEAR WALL - a masonry shear wall in compliance with the provisions of ACI/ASCE 530 including Appendix A.

Other masonry shear walls: reinforced and plain masonry shear walls which are not covered above.

SPACE FRAME - a three-dimensional structural system without bearing walls, composed of interconnected members, laterally supported so as to function as a complete self-contained unit with or without the aid of horizontal diaphragms or floor bracing systems.

MOMENT-RESISTING SPACE FRAME - a vertical load-carrying space frame in which the members and joints are capable of resisting forces primarily by flexture.

SPECIAL MOMENT-RESISTING SPACE FRAME - a moment-resisting frame complying with the requirements for a ductile moment-resisting space frame as given in 1206.9.3.3.

SEMI-DUCTILE MOMENT-RESISTING SPACE FRAME - a moment-resisting frame complying with the requirements for a semi-ductile moment-resisting space frame as given in 1206.9.3.4.

VERTICAL LOAD-CARRYING SPACE FRAME - a space frame designed to carry all vertical loads.

1206.3 Symbols And Notation

The following symbols and notations apply only to the provisions of this section:

A_v = Coefficient representing the effective peak velocity-related acceleration determined from Figure 1206.1

C = Numerical coefficient as defined in 1206.4.4

C_p = Numerical coefficient as defined in 1206.10 and set forth in Table 1206.10.

D = The dimension of the structure (ft) in a direction parallel to the applied forces (see also 1206.5.1).

D_s = The longest dimension of a shear wall or braced frame in the direction parallel to the applied forces (ft).

F_i,F_n,F_x = Lateral forces applied to level i, n, or x, respectively.

F_p = Lateral force on a part of the structure, and in the direction under consideration.

F_{px} = Force on floor diaphragms and collectors.

F_t = That portion of V considered concentrated at the top of the structure in addition to Fn.

f_i = Distributed portion of a total lateral force at level i for use in the equation in 1206.4.5.1.

g = Acceleration due to gravity.

h_i,h_n,h_x = The height above the base to level i, n, or x, respectively (ft).

I = Occupancy importance factor (see Table 1206.1).

K = Numerical coefficient as set forth in Table 1206.4.3.

k = Numerical coefficient for reduction of the overturning moment in tall buildings.

Level i = Level of the structure referred to by the subscript i; i = 1 designates the first level above the base.

Level n = That level which is uppermost in the main portion of the structure.

Level x =That level which is under design consideration; x = 1 designates the first level above the base.

S = Soil factor (see Table 1206.4.6).

T = Fundamental elastic period of vibration of the building or structure in the direction under consideration (sec).

V = The total lateral force or shear at the base.

W = In buildings and structures of Group S, W shall be equal to the total dead load as defined in 1202, including partition loading, plus 25% of the floor live load.

Where the ground snow load, as determined by 1204, is 30 psf or less, design snow load need not be included in the value of W. Where the ground snow load is greater than 30 psf, the design snow load shall be included. However, in areas subject to short duration snow loads, snow load reductions of up to 75% shall be permitted.

In all buildings and structures of other than Group S, W shall be equal to the total dead load as defined in 1202 including partition loading.

w_i, w_x = That portion of W which is located at or is assigned to level i or x, respectively.

w_{px} = The weight of the floor or roof diaphragms and collectors and elements tributary thereto at level x plus 25% of the floor live load for buildings or structures of Use Group S.

W_p = The weight of a portion of a structure or nonstructural component.

σ_i = Deflection at level i relative to the base, due to applied lateral forces Σf_i, for use in the equation in 1206.4.5.1.

1206.4 Minimum Earthquake Forces For Structures

Except as provided in 1206.8 and 1206.10, every structure shall be designed and constructed to resist minimum total lateral seismic forces assumed to act nonconcurrently in the direction of each of the main axes of the structure in accordance with the following formula:

$$V = 2.5A_vIKCSW$$

1206.4.1 A_v Factor. The factor A_v shall be determined from Figure 1206.1 or Table 1206.4.1.

1206.4.2 I Factor. The factor I shall be as shown in Table 1206.1.

1206.4.3 K Factor. The value of K shall be not less than set forth in Table 1206.4.3.

1206.4.4 C Factor. The value of C shall be as indicated in the equation in this subsection. The product CS (see 1206.4.6 for S values) need not exceed 0.14, for Soil Profile 3 in Seismic Zones 3 and 4, the product need not exceed 0.11.

The value of C shall be determined in accordance with the following formula:

$$C = \frac{1}{15\sqrt{T}}$$

The value of C need not exceed 0:12.

1206.4.5 T Factor. The value of T shall be determined using the methods described in 1206.4.5.1 and 1206.4.5.2.

Table 1206.4.1

County	Seismic Zone	A_v
Counties not listed	0	0.050
Alamance	1	0.075
Alexander	2	0.125
Alleghany	2	0.125
Anson	2	0.125
Ashe	2	0.150
Avery	2	0.150
Bladen	1	0.075
Brunswick	1	0.075
Buncombe	2	0.150
Burke	2	0.150
Cabarrus	2	0.125
Caldwell	2	0.150
Caswell	1	0.075
Catawba	2	0.125
Chatham	1	0.075
Cherokee	2	0.150
Clay	2	0.150
Cleveland	2	0.125
Columbus	1	0.075
Cumberland	1	0.075
Davidson	1	0.100
Davie	1	0.100
Duplin	1	0.075
Durham	1	0.075
Forsyth	1	0.100
Gaston	2	0.125
Graham	2	0.150
Guilford	1	0.100
Harnett	1	0.075
Haywood	2	0.150
Henderson	2	0.150
Hoke	1	0.100
Iredell	2	0.125
Jackson	2	0.150
Johnston	1	0.075
Lee	1	0.075
Lincoln	2	0.125
Macon	2	0.150
Madison	2	0.150
McDowell	2	0.150
Mecklenburg	2	0.125
Mitchell	2	0.150
Montgomery	1	0.100
Moore	1	0.100
New Hanover	1	0.075
Orange	1	0.075
Pender	1	0.075
Person	1	0.075
Polk	2	0.150
Randolph	1	0.100
Richmond	1	0.100
Robeson	1	0.100
Rockingham	1	0.100
Rowan	2	0.125
Rutherford	2	0.150
Sampson	1	0.075
Scotland	1	0.100
Stanly	2	0.125
Stokes	1	0.100
Surry	1	0.100
Swain	2	0.150
Transylvania	2	0.150
Union	2	0.125
Wake	1	0.075
Watauga	2	0.150
Wilkes	2	0.125
Yancey	2	0.150
Yadkin	1	0.100

FIGURE 1206.1
MAP OF SEISMIC ZONES AND EFFECTIVE PEAK VELOCITY-RELATED ACCELERATION (A_V)

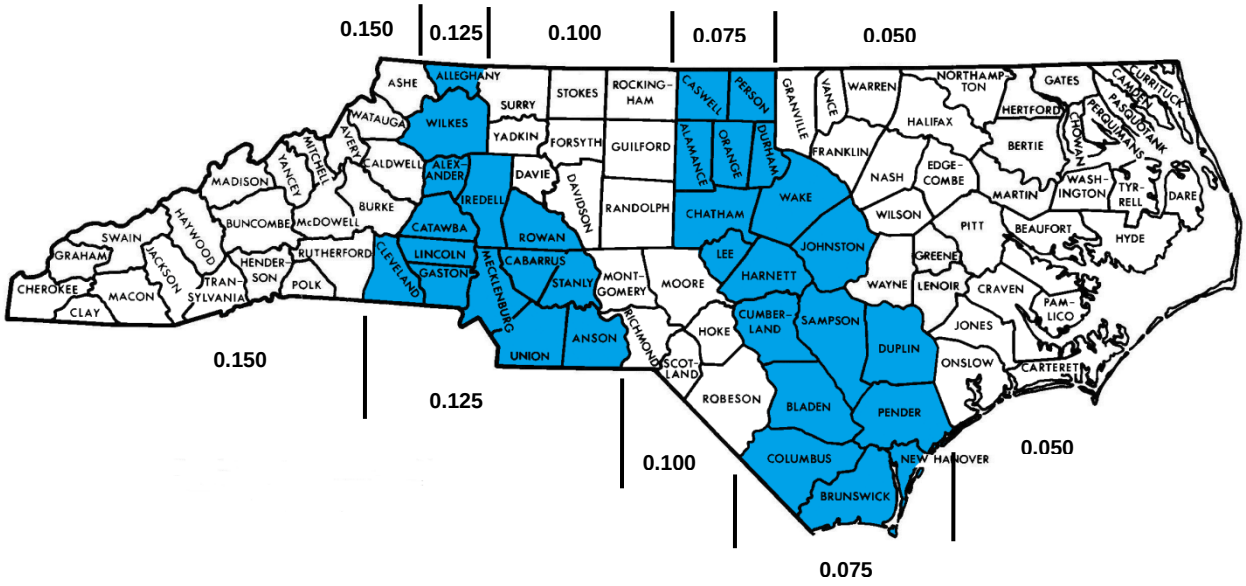


TABLE 1206.4.3
HORIZONTAL FORCE FACTOR, K, FOR BUILDINGS OR OTHER STRUCTURES

Arrangement of lateral force-resisting elements	Value of K
Bearing wall system. A structural system with bearing walls providing support for all, or major portions of, the vertical loads. Seismic force resistance is provided in accordance with 1206.9.1, utilizing:	
Seismically reinforced masonry shear walls[1]	1.33
Other masonry shear walls[1]	2.50
Reinforced concrete shear walls or braced frames	1.33
One-, two-, or three-story light wood or metal frame wall systems	1.00
Building framing system: 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 in accordance with 1206.9.2.	1.00
Moment-resisting frame system: A structural system with an essentially complete space frame providing support for vertical loads. Seismic force resistance is provided by a moment-resisting frame system in conformance with:	
Requirements for ordinary concrete frames	1.50
1206.9.3.1 and 1206.9.3.2 for ordinary steel frames	1.00
1206.9.3.4 for semi-ductile concrete frames	1.00
1206.9.3.1 and 1206.9.3.3 for special frames	0.67
Dual system: A structural system with an essentially complete space frame providing support for vertical loads. Seismic force resistance is provided by a combination of:	
A special moment-resisting frame system and shear walls or braced frames in accordance with 1206.9.4.1	0.80
or a semi-ductile moment-resisting concrete frame system and shear walls or braced frames in accordance with 1206.9.4.2	1.00
Elevated tanks: Tanks plus full contents, where tanks are supported on four or more cross-braced legs and not supported by a building.	2.50[2]
Structures other than buildings: Structures other than buildings and other than those set forth in Table 1206.10	2.00

1. Defined in 1206.2 (See Shear Wall).

2. The minimum value of KC shall be 0.12 and the maximum value of KCS need not exceed 0.29 or 0.23 for Soil Profile 3 in Seismic Zones 3 and 4. The tower shall be designed for an accidental torsion of 5% as specified in 1206.5.5. Elevated tanks that are supported by buildings or do not conform to the type or arrangement of supporting elements as described above shall be designed in accordance with 1206.10 using $C_p = 0.3$.

1206.4.5.1 T Formula. T is the fundamental period which shall be established using the structural properties and deformational characteristics of the resisting elements using the following formula or the appropriate formula in 1206.4.5.2.

$$T = 2\pi \sqrt{\left(\sum_{i=1}^{n} w_i \sigma_i^2\right) / \left(g \sum_{i=1}^{n} f_i \sigma_i\right)}$$

where the values of f_i represent any lateral force distributed approximately in accordance with the principles of the equation in 1206.5.1 or any other rational distribution. The elastic deflections σ_i shall be calculated using the applied lateral forces f_i. The value of C when calculated using the period T as determined by the equation in this section shall not be less than 80% of the value of C based on the period T estimated using the appropriate equation in 1206.4.5.2.

1206.4.5.2 Alternative T formulas. In the absence of a determination of the value of T in accordance with 1206.4.5.1, the value of T for buildings shall be determined by the following appropriate formula:

1. For shear walls or exterior concrete frames utilizing deep beams or wide piers, or both

$$T = \frac{0.05\, h_n}{\sqrt{D}}$$

2. For isolated shear walls not interconnected by frames or for braced frames:

$$T = \frac{0.05\, h_n}{\sqrt{D_s}}$$

3. In buildings in which the lateral force-resisting system consists of moment resisting space frames capable of resisting 100% of the required lateral forces and such system is not enclosed by or adjoined by more rigid elements tending to prevent the frame from resisting lateral forces:

$$T = C_T h_n^{3/4}$$

where $C_T = 0.035$ for steel frames and 0.030 for concrete frames.

1206.4.6 S Factor. The value of S shall be determined from Table 1206.4.6. The soil profile types are defined as follows:

1. Soil profile types, is a profile with:
   a. Rock of any characteristic, which is either shalelike or crystalline in nature. Such material is characterized by a shear wave velocity greater than 2500 fps, or
   b. Stiff soil conditions where the soil depth is less than 200 ft and the soil types overlaying rock are stable deposits of sands, gravels, or stiff clays.
2. Soil profile types S_2 is a profile with deep cohesionless deposits or stiff clay conditions, including sites where the soil depth exceeds 200 ft and the soil types overlying rock are stable deposits of sands, gravels, or stiff clays.
3. Soil profile type S_3 is a profile with soft-to medium-stiff clays and sands characterized by 30 ft or more of soft to medium-stiff clays without intervening layers of sand or other cohesionless soils.

In locations where the soil properties are not known in sufficient detail to determine the soil profile type or the profile does not fit any of the three types, soil profile S_2 or soil profile S_3 shall be used, whichever gives the larger value of CS.

TABLE 1206.4.6
SOIL PROFILE COEFFICIENT, S

Soil profile type	S
S_1	1.0
S_2	1.2
S_3	1.5

1206.5 Distribution Of Lateral Forces

The imposed lateral forces shall be applied in accordance with 1206.5.1 through 1206.5.6.

1206.5.1 Structures Having -Regular Shapes Or Framing Systems. The total lateral force, V, shall be distributed over the height of the structure in accordance with the following formulas:

$$V = F_t + \sum_{i=1}^{n} F_1$$

Where the concentrated force at the top, F_t, shall be determined according to the formula:

$$F_t = 0.07\ TV$$

The maximum required value of F_t shall be 0.25 V. When T is 0.7 sec or less, the minimum required value of F_t shall be zero. The remaining portion of the total base shear V shall be distributed over the height of the structure, including level n, according to the formula:

$$F_x = (V - F_t)\ w_x h_x \Big/ \sum_{i=1}^{n} w_i h_i$$

At each level designed as x, the force F_x shall be applied over the area of the building in accordance with the mass distribution on that level.

1206.5.2 Setbacks. Buildings having setbacks wherein the plan dimension of the tower in each direction is at least 75% of the corresponding plan dimension of the lower part shall be considered as uniform buildings without setbacks, provided that other irregularities as defined in this section do not exist.

1206.5.3 Structures having irregular shapes or framing systems. The distribution of the lateral forces in structures that have highly irregular shapes, large differences in lateral resistance or stiffness between adjacent stories, or other unusual structural features shall be determined considering the dynamic characteristics of the structure.

1206.5.4 Distribution of horizontal shear. Total shear in any horizontal plane shall be distributed to the various elements of the lateral force-resisting system in proportion to their rigidities, considering the rigidity of the horizontal bracing system or diaphragm. Rigid elements incorporated into the building that are not assumed to be part of the lateral force-resisting system shall be permitted if their effect on the action of the system is considered and provided for in the design.

1206.5.5 Horizontal torsional moments. The design shall provide for the torsional moment resulting from the location of the building masses plus the torsional moments 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.

1206.5.6 Diaphragms. Floor and roof diaphragms and collectors shall be designed to resist the forces determined in accordance with the formula:

$$F_{px} = \left(\sum_{i=x}^{n} F_i / \sum_{i=x}^{n} w_i\right) w_{px}$$

The force F_{px} need not exceed $0.75\ A_v\ l_w$.

When the diaphragm is required to transfer lateral forces from the vertical resisting elements above the diaphragm to other vertical resisting elements below the diaphragms, due either to offsets in the placement of the elements or to changes in stiffness in the vertical elements, these forces shall be added to the value determined for F_{px}. However, the lateral force on the diaphragm shall not be less than $0.35\ A_v\ IW_{px}$.

Diaphragms providing lateral support to concrete or masonry walls shall have continuous ties between diaphragm chords to distribute into the diaphragm the anchorage forces specified in this section. Chords added to form subdiaphragms to transmit the anchorage forces to the main crossties shall be permitted. Diaphragm deformations shall be considered in the design of the supported walls.

1206.6 Overturning

1206.6.1 Every building or structure shall be designed to resist the overturning effects caused by the earthquake forces specified in this section. The overturning moment at each story x shall be calculated as follows:

$$M_x = F_t\ (h_n - h_x) + \sum i\ F_i\ (h_i - h_x)$$

The increment of overturning moment at each story shall be distributed to the resisting elements in the same proportion as the distribution of the horizontal shears. In tall buildings, the maximum overturning moment in any element shall be determined by multiplying M_x by a factor k depending on the location of the clement, as follows:

k = 1.0 for the top 10 stories.

k = 0.8 for the 20th story from the top and those below.

k = A value between 1.0 and 0.8 determined by straight line interpolation for stories between the 10th and 20th stories below the lop.

1206.6.2 Where other vertical members are provided which are capable of partially resisting the overturning moments, a redistribution to these members shall be permitted if framing members of sufficient strength and stiffness to transmit the required loads are provided. Where a vertical resisting elements is discontinuous, the overturning moment carded by the lowest story of that element shall be carried down as a load to the foundation.

1206.7 Drift and Building Separation

Lateral deflections or drift of a story relative to adjacent stories, including any portions thereof caused by deflection of horizontal resisting elements, shall not exceed 0.005 times the story height (0.0025 in buildings with unreinforced masonry), unless it can be demonstrated that greater deformation can be tolerated. The horizontal displacement calculated from the application of the lateral forces shall be multiplied by 1/K to obtain the drift. The ratio 1/K shall be not less than 1.0.

All portions of structures shall be designed and constructed to act as an integral unit in resisting horizontal forces unless separated structurally by a distance sufficient to avoid contact under deflection from seismic action.

1206.8 Alternative Determination and Distribution of Seismic Forces

Nothing in 1206 shall be deemed to prohibit the submission of properly substantiated technical data for establishing the lateral forces and their distribution by elastic or inelastic dynamic analyses. In such analyses, the dynamic characteristics of the structure shall be considered, and the following principles shall be observed:

1. Base shear shall be not less than 90% of that computed in 1206.4.
2. Values of base shear consistent with K = 0.67 to 2.5 are applicable only if the structure is designed and detailed to be consistent with the requirements in 1206.9. Otherwise, the structure shall be designed for a base shear consistent with its ability to dissipate energy by inelastic cyclic straining.
3. The requirements of 1206.7 shall be satisfied using the force prescribed in 1206.4.
4. The input to the dynamic analyses shall be either a smoothed response spectrum or a set of ground-motion-time histories that reflect the characteristics of the structure and site and are approved by the Building Official. In either case, the input shall be scaled in accordance with the above three principles.

1206.9 Structural Systems

The design of structural systems shall comply with the applicable provisions of 1206.9.1 through 1206.9.6. Reinforced concrete members shall comply with the applicable provisions of Appendix A of ACI 318 as specified in this section and 1601.2. All masonry construction shall comply with the special provisions of Appendix A of ACI/ASCE 530. Other reinforcing configurations shall be permitted provided sufficient evidence of equivalent ductility is submitted.

1206.9.1 Bearing wall systems. Bearing wall systems shall use walls or braced frames as vertical elements for resistance to lateral seismic force. Horizontal elements of the seismic force-resisting system shall be diaphragms or trusses. The factor K depends on the type of wall, as shown in Table 1206.4.3. Where the framing systems along two orthogonal axes are different, the factor K for both directions shall be taken as 1.0, 1.33 or 2.5 as appropriate.

1206.9.2 Building-frame systems. Building-frame systems designed using a factor K = 1.0 shall have an essentially complete frame conforming to the requirements of the AISC Specification for the Design. Fabrication and Erection of Structural Steel for Buildings, or ACI 318 supporting all gravity loads, and shall have shear walls or vertical bracing trusses to resist the earthquake lateral force.

1206.9.3 Moment-resisting frame systems. Moment-resisting frame systems shall be designed in accordance with the applicable provisions of 1206.9.3.1 through 1206.9.3.4.

1206.9.3.1 Connections in steel frames. Beam-to-column connections in steel moment-resisting frames shall develop the joint capacity determined by the strength of members framing into the joint unless it can be shown that adequate rotation can be obtained by deformations of the connection materials and that the added drift is taken into account.

1206.9.3.2 Ordinary steel frames. Moment-resisting steel frame systems designed using a factor K = 1.0 shall have a frame conforming to the requirements of the AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.

1206.9.3.3 Special frames. Systems designed using a factor K = 0.67 shall have special moment-resisting space frames conforming to the requirements of AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings Part II, Sections 2.7, 2.8 and 2.9, or Sections A.2 through A.8 of ACI 318. Steel members in special moment-resisting frame systems shall be composed of A36, A441, A500 (Grades B and C), A501, A529, A572 (Grades 42 through 55), or A588 structural steel.

1206.9.3.4 Semi-ductile concrete frames. Buildings in Seismic Zone 2, and buildings in Seismic Zone 1 with an importance factor I of 1.5 using a semi-ductile concrete moment-resisting space frame conforming to the requirements of Section A.9 of ACI 318, shall use a K of not less than 1.0.

1206.9.4 Dual systems. Dual systems shall be designed in accordance with the applicable provisions of 1206.9.4.1 and 1206.9.4.2.

1206.9.4.1 Dual systems with special frames using a factor K = 0.8 shall have special moment-resisting space frames conforming to 1206.9.3.3 that are capable of supporting all gravity loads and resisting at least 25% of the prescribed seismic forces. The total seismic force shall be distributed to the various resisting systems and elements in proportion to their relative rigidities.

1206.9.4.2 Dual systems with semi-ductile concrete frames - In Seismic Zone 2, and for buildings having an importance factor I of 1.5 in Seismic Zone 1, dual systems designed using a factor K = 1.0 shall have semi-ductile moment-resisting concrete space frames conforming to the requirements of 1206.9.3.4 that are capable of supporting all gravity loads and resisting at least 25% of the prescribed seismic forces. The total seismic force shall be distributed to the various resisting systems and elements in proportion to their relative rigidities.

1206.9.5 Braced frames. In Seismic Zones 3 and 4, and for buildings having an importance factor I greater than 1.0 and located in Seismic Zone 2, all members in braced frames shall be designed for 1.25 times the force determined in accordance with 1206.4. Steel members in braced frames shall be limited those grades listed in 1206.9.3.3. Reinforced concrete members in braced to frames shall be provided with the transverse confinement reinforcement required in 1206.9.3.3.

1206.9.6 Substructures. In structures where K = 0.67 or 0.80, the special ductility requirements for structural steel or reinforced concrete specified in 1206.9.3.3 shall apply to all structural elements at the base level and in the first story below the base which are required to transmit to the foundation the forces resulting from lateral loads.

In structures containing semi-ductile concrete frames where K = 1.0, the ductility requirements specified in 1206.9.3.4 shall apply to all frame elements at the base level and in the first story below the base which are required to transmit to the foundation the forces resulting from lateral loads.

1206.10 Lateral Forces On Elements of Structures and Nonstructural Components

Parts or portions of buildings or structures, nonstructural components, and their anchorage to the main structural system shall be designed for lateral forces in accordance with the following formula:

$$F_p = 2.5A_vIC_pW_p$$

The values of C_p are given in Table 1206.10. The value of I shall be as given in Table 1206.1. The value of I for anchorage of machinery and equipment required for life safety systems shall be 1.5 for all buildings.

The distribution of these forces shall be according to the gravity loads pertaining thereto.

TABLE 1206.10
HORIZONTAL FORCE FACTOR C_p, FOR ELEMENTS OF STRUCTURES AND NONSTRUCTURAL COMPONENTS

Part of portion of building	Direction of horizontal force	Value of C_p
Exterior bearing and nonbearing walls, interior bearing walls and partitions, interior nonbearing walls and partitions, masonry or concrete fences over 6 feet in height	Normal to flat surface	0.3[1]
Cantilever elements: Parapets	Normal flat surface	0.8
Chimneys or stacks	Any direction	0.8
Exterior and interior ornamentation and appendages. When connected to part of, or housed within, a building	Any direction	0.8
Penthouses, anchorage and supports for chimneys, and stacks and tanks, including contents	Any direction	0.3[2,3]
Storage racks with upper storage level at more than 8 ft in height, plus contents	Any direction	0.3[2,3]
All equipment or machinery	Any direction	0.3[2,3,6]
Supports and bracing, equipment racks and piping for HPM as defined in 511	Any direction	0.45[2,3]
Suspended ceiling framing systems (applies to Seismic Zones 2, 3 and 4 only)	Any direction	0.3[4]
Connections for prefabricated structural elements other than walls, with force applied at center of gravity of assembly.	Any direction	0.3[5]

NOTES TO TABLE 1206.10

1. C_p required for elements laterally self-supported only at the ground level shall be two-thirds of value shown.
2. W_p for storage racks shall be the weight of the racks plus contents. The value of C_p for racks over two storage support levels in height shall be 0.24 for the levels below the top two levels.

   Where a number of storage rack units are interconnected so that there are a minimum of four vertical elements in each direction on each column line designed to resist horizontal forces, the minimum design coefficients shall be the same as for a building with K values from Table 1206.4.3, CS = 0.2 for use in the formula $V = 2.5A_vIKCSW$ and W is equal to the total dead load plus 50% of the rack-rated capacity.
3. For flexible and flexibly-mounted equipment and machinery, the appropriate values of C_p shall be determined with consideration given to both the dynamic properties of the equipment and machinery and to the building or structure in which it is placed but shall be not less than the listed values. The design of the anchorage of the equipment and machinery is an integral part of the design and specification of such equipment and machinery.

   For essential facilities described in Table 1206.1 and life safety systems described in 506.12, the design and detailing of equipment that must remain in place and be functional following a major earthquake shall consider drifts in accordance with 1206.14.
4. Ceiling weight shall include all light fixtures and other equipment that is laterally supported by the ceiling. For purposes of determining the lateral force, a ceiling weight of not less than 4 psf shall be used.

5. The force shall be resisted by positive anchorage and not by friction.
6. Seismic restraints shall not be required for the following installations:
   a. Gas piping less than l-inch inside diameter.
   b. Piping in boiler and mechanical rooms less than 1 1/4 inch inside diameter.
   c. All other piping less than 2 1/2 inch inside diameter.
   d. All electrical conduit less than 2 1/2 inch inside diameter.
   e. All rectangular air-handling ducts less than 6 sq ft in cross-sectional area.
   f. All round air-handling ducts less than 28 inches in diameter.
   g. All piping suspended by individual hangers 12 inches or less in length from the top of the pipe to the bottom of the support for the hanger.
   h. All ducts suspended by hangers 12 inches or less in length from the top of the duct to the bottom of the support for the hanger.

1206.11 Connections

Connections shall comply with the requirements of 1207.11.1 through 1206.11.5.

1206.11.1 Anchorage of concrete or masonry walls. Concrete or masonry walls shall be anchored to all floors and roofs that provide lateral support for the wall. Such anchorage shall provide a positive direct connection capable of resisting the horizontal forces specified in 1206.10.

1206.11.2 Load paths. All parts of the building or structure that transmit seismic force shall be connected through a continuous path to the resisting element. At a minimum, the connection and the elements along the path to the resisting element shall be capable of resisting a force equal to $0.375A_vI$ or 0.05, whichever is greater, times the weight of the portion being connected.

1206.11.3 Exterior panels. Exterior nonbearing, nonshear wall panels or similar elements that are attached to or enclose the exterior shall be designed to resist the forces determined in 1206.10, and shall accommodate movements of the structure resulting from lateral forces or temperature changes. Such elements shall be supported by means of cast-in-place concrete or mechanical connections and fasteners in accordance with the following provisions:

1. Connections and panel joints shall allow for a relative movement between stories of not less than 3.0/K times the calculated elastic story displacement caused by required seismic forces or 1/2 inch, whichever is greater. Connections to permit movement in the place of the panel for story drift shall be properly designed sliding connections using slotted or oversized holes or connections that permit movement by bending of steel or other connections providing equivalent sliding or ductility capacity, or both.
2. Bodies of connectors shall have sufficient ductility and rotation capacity so as to preclude fracture of the concrete or brittle failures at or near welds.
3. The body of the connector shall be designed for one and one-third times the force determined in 1206.10. Fasteners attaching the connector to the panel or the structure, such as bolts, inserts, welds, dowels, and similar fasteners, shall be designed to ensure ductile behavior of the connector or shall be designed for four times the load determined in 1206.10.
4. Fasteners embedded in concrete shall be attached to or hooked around reinforcing steel or otherwise terminated so as to effectively transfer forces to the reinforcing steel.
5. The value of the factor I for the entire connector assembly shall be 1.0 when applying the requirements of 1206.10.

1206.11.4 Foundation ties. Individual pile caps and caissons of every building or structure in Seismic Zones 2, 3 and 4 shall be interconnected by ties at approximately right angles, unless it can be demonstrated that equivalent restraint can be provided by frictional and passive soil resistance or other approved methods. The design of the piles or ties shall carry the induced lateral forces, with a minimum horizontal force equal to $0.25A_vI$ times the vertical loading on the pipe cap or caisson.

1206.11.5 Braced frames. In braced frames, connections shall be designed to develop the full capacity of the members or shall be based on the forces specified in 1206.9.5 without the one-third increase usually permitted for stresses resulting from earthquake forces.

1206.12 Nonseismic-Resisting Structural Members

In Seismic Zones 3 and 4, and for buildings with an importance factor I greater than 1.0 located in Seismic Zone 2, all framing elements not required by design to be part of the lateral force-resisting system shall be investigated and shown to be adequate for vertical load-carrying capacity and induced moment due to 3/K times the distortions resulting from the code-required lateral forces. The rigidity of other elements shall be considered in accordance with 1206.5.4.

EXCEPTION: Concrete framing elements not required by design to be part of the lateral force-resisting system shall comply with the requirements of Table 1601.2.

1206.13 Moment-Resisting Frames

Where ordinary and special moment-resisting space frames are enclosed by, or adjoined by, more rigid elements that would tend to prevent the space frame from resisting lateral forces, substantiating information shall be submitted to show that the action or failure of the more rigid elements will not impair the vertical and lateral load-resisting ability of the space frame.

1206.14. Essential Facilities

The design and detailing of equipment that must remain in place and be functional following a major earthquake shall be based on the requirements of l206.10 and Table l206.10. In addition, their design and detailing shall consider effects induced by structure drifts of not less than 2.0/K times the story drift caused by required seismic forces. Special consideration shall also be given to relative movements at separation joints.

1207 SPECIAL LOADS

1207.1 Soil Pressures On Basement Walls And Floors

1207.1.1 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.

1207.1.2 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.

1207.2 Railings

1207.2.1 Handrail Design and Construction

1207.2.1.1 Handrails shall be designed and constructed for a concentrated load of 200 lb applied at any point and in any direction.

1207.2.1.2 Handrails located other than within dwelling units shall also be designed and constructed for a load of 50 plf applied in any direction.

1207.2.1.3 Loading conditions in 1207.2.1 and 1207.2.1.2 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.

1207.2.2 Guardrail System Design and Construction.

1207.2.2.1 Guardrail systems shall be designed and constructed for a concentrated load of 200 lb applied at any point and in any direction at the top of the guardrail.

1207.2.2.2 Guardrail systems located other than within dwelling units shall be designed and constructed for a load of 50 plf applied horizontally at the required guardrail height and a simultaneous load of 100 plf applied vertically downward at the top of the guardrail.

1207.2.2.3 The guardrail system shall also be designed and constructed to resist a 200 lb concentrated horizontal load applied on a 1 ft square area at any point in the system including intermediate rails or other elements serving this purpose.

1207.2.2.4 Loading conditions in 1207.2.2.1, 1207.2.2.2 and 1207.2.2.3 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.

1207.2.3 Parking Guardrails. Impact guardrails and walls acting as impact guardrails in parking structures shall be designed for a minimum horizontal ultimate load of 10,000 lb applied 18 inches above the floor at any point along the guardrail.

1207.3 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 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 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.

1208 LOAD COMBINATIONS
DELETED. (SEE 1201.1.3).

1209 FLOOD PLAIN

For construction located within the regulatory flood plain, refer to Chapter 34.

1210 DEFLECTIONS

Deflections of structural members shall not exceed that shown in Table 1210.1.

TABLE 1210.1
DEFLECTION LIMITS

Construction	LL	DL + LL
Roof members supporting plaster, or floor member	L/360	L/240
Roof Members supporting nonplastered ceiling	L/240	L/180
Roof members not supporting ceilings	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

EXCEPTIONS:

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 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 2704 for glass supports.

CHAPTER 13

FOUNDATIONS EXCAVATIONS AND WALLS, FOOTINGS, PILES, CAISSONS

1300 INTRODUCTION

1300.1 General

1300.1.1 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.

1300.1.2 The term "designer" as used in this chapter of the Code shall be interpreted as meaning a Professional Engineer, or Registered Architect qualified in Geotechnical Analysis, registered in North Carolina or his authorized representative.

1300.1.3 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 Building Officials. Higher design soil stresses and structural material stresses may be allowed by the Building Official 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.

1300.2 Inspection

1300.2.1 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 inspection of the construction, of all retaining walls, shallow footings, piles, caissons, or other foundation support systems shall be the responsibility of the designer of record.

1300.2.2 Reports. The reports of all inspections and any field or laboratory test data shall be submitted to the Building Official at his request.

1300.2.3 Retaining wall. Inspection of retaining wall construction shall consist of observation and, in the case of walls exceeding 5'" in height, testing as required for: (1) The foundation support system as outlined in 1300.2.4, 1300.2.5, and 1300.2.6; (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.

1300.2.4 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 changes to the design drawings shall be documented and submitted to the Building Official at his request.

1300.2.5 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 Building Official 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 Building Official at his request.

1300.2.6 Drilled Piers.

1300.2.6.1 The installation of all caisson or drilled piers shall be inspected by the designer. The designer shall enter 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.

1300.2.6.2 The designer shall 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 Building Official at his request.

1301 EXCAVATION AND WALLS

1301.1 General

1301.1.1 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 properly assured against any danger to life and property.

1301.1.2 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.

1301.1.3 limits Of 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.

1301.2 Support of Adjoining Structures

1301.2.1 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.

1301.2.2 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 premises where the excavation is to be made, and at his own expense, shall provide the necessary underpinning or protection.

1301.2.3 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 permanent lateral support is provided, the method used must satisfy the requirements of the Building Official. 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.

1301.2.4 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.

1301.2.5 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.

1301.2.6 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.

1301.2.7 Backfill. Only approved granular materials shall be used for backfill under this section. It shall be sufficiently compacted to have a strength not less than that of the adjacent soil mass to prevent lateral displacements of the soil of the adjoining property after the removal of the shores or braces.

1301.2.8 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.

1301.3 Foundation Walls

1301.3.1 Minimum Thickness

1301.3.1.1 Foundation walls shall be not less in thickness than the wall immediately above them and not less than 12 inches for unit masonry walls, or 7 1/2 inches for cast-in-place concrete walls; except that solid masonry walls extending not more than 5 feet, and hollow walls of masonry or walls of hollow units extending not more than 4 feet below the adjacent finished ground level may be 8 inches in thickness. These depths may be increased to a maximum of 7 feet with the approval of the Building Official when he is satisfied that soil conditions will allow such an increase. The total height of 8 inch foundation wall and wall supported shall not exceed that permitted by this Code for 8 inch walls. In all cases, however, foundation walls shall have sufficient strength and thickness to resist all lateral pressures required by this Code.

1301.3.1.2 Foundation walls of 8 inch thickness (except as provided above and conforming to the provisions following) may be used as foundations for dwellings with walls of brick veneer on frame walls or with 10 inch cavity walls, provided that the dwelling is not more than two stories in height and the total height of the walls, including the gable, is not more than 20 feet. Foundation walls of 8 inch thickness supporting brick veneer or cavity walls shall be corbelled with solid units to provide a bearing the full thickness of the wall above. The total projection shall not exceed 2 inches with individual corbels projecting not more than 1/3 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.

1301.3.1.3 Foundation walls of cast-in-place concrete when supporting one story basementless structures may be 6 inches 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 walls.

1301.3.2 Wood Foundations. Wood foundations are permitted for buildings of Type VI construction when the requirements of 1301.3.2.1 through 1301.3.2.3 are met.

1301.3.2.1 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 soils and 50 pounds per cubic foot for clayey soils or as determined by a Professional Engineer registered in North Carolina 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.

1301.3.2.2 Design shall be performed by a Professional Engineer registered in the State of North Carolina whose seal shall be affixed to all foundation drawings.

1301.3.2.3 Materials, fabrication and installation shall be inspected and a certificate of compliance furnished by either a Professional Engineer registered in North Carolina or by an independent third party inspection agency approved by the North Carolina Building Code Council for this type of service.

1301.3.3 Vents and Crawl Space. Foundation vents and crawl spaces shall be provided as specified in Chapter 32.

1301.4 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 shall not be used.

1302 FOOTINGS, COMBINED FOOTINGS AND MATS

1302.1 General

1302.1.1 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.

1302.1.2 Design. The base areas of all footings and foundations shall be proportioned as specified in 1302.3. Footings and foundations shall be constructed of masonry, reinforced concrete, or plain concrete.

1302.1.3 Definition. The terms used in this Code shall be interpreted in accordance with generally accepted engineering nomenclature. In addition, the following more specific definitions are used for earth materials in the Piedmont Region.

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.

DISINTEGRATED ROCK - 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 30 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.

1302.2 Bearing Capacities of Solid and Rock

1302.2.1 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 Building Official 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 beating pressures:

1302.2.2 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 and attached by the designer. All such foundations shall be founded on stable natural soil or controlled compacted fill below the frost line and no less than 12" below finished grade.

1302.2.3 Presumptive Bearing Capacity.

1302.2.3.1 Presumptive bearing pressures may be used, not exceeding the values shown in Table 1302, 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 100 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 performance are available from adjoining sites for similar loading conditions.

1302.2.3.2 All such foundations shall be founded on stable natural soil or controlled compacted fill, below the frost line and no less than 12 inches below finished grade.

1302.2.3.3 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.

1302.2.3.4 Where the bearing capacity is judged to be suspect by the Building Official, 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.

1302.3 Footing Design

1302.3.1 Size. 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 1302.2. The total reduced live load occurring in the column immediately above the footing shall be the live load used in the above computation. Column footings shall not be less than 24 x 24 inches and wall footings shall not be less than 16 inches in width.

1302.3.2 Materials. Concrete in footings shall have a specified compressive strength (f'_c) of not less than 2500 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.

1302.3.3 Concrete Design. The procedure used to design footings shall be in accordance with Chapter 16.

1302.3.4 Masonry Design. Procedure design of footings shall be in accordance with 1403.6. 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.

TABLE 1302
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	Weathered Rock[3]	40
4	Disintegrated Rock[3] (assume similar to dense sand)	10[2]
5	Residual silt/sand[3] (assume similar to loose sand)	1 to 32
6	Dense Sand	3[2]
7	Stiff Clay	2[2]
8	Loose Sand	1[2]
9	Soft Clay	1[2]
10	Compacted controlled fill	1.5[2]

1. The allowable bearing value given in this section or when determined in accordance with the provisions of 1302.2.2 will assure that the soils will be stressed within limits that lie safely below their strength. However, such allowable bearing pressures for class 5 and classes 7 through 10 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 1302.1.3.

1303 PILES

1303.1 General

1303.1.1 Investigation. A subsurface investigation shall be conducted at the site to examine both the materials 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 tests.

1303.1.2 Pile Cap Design. The design and details of pile caps shall be in accordance with Chapter 16 of this Code and ACI 318.

1303.1.3 Special Types of Foundations. Proprietary or special types of deep foundations not specifically covered in this code may be used if, in the judgment of the Building Official, 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 1303.

1303.2 Allowable Loads

1303.2.1 General. All piles used to support any building or part thereof shall be constructed in such a manner as not to impair their strength. The allowable load on single piles may be determined from an analysis of subsurface conditions as described in 1303.2.2 or, for granular soils, by the pile driving formula given in 1303.2.3 or by pile load tests as described in 1303.2.4 or by the presumptive pile capacity values given in 1303.2.5.

1303.2.2 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 selected 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 1303.2.2 shall not exceed 60 tons for piles driven end bearing to materials of class 1 nor 40 tons for other soil conditions. If higher design capacities arc desired, they shall be determined by the provisions of 1303.2.4.

1303.2.3 Driving Resistance.

1303.2.3.1 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 Rd obtained from the following formula. If higher design capacities are desired, they shall be determined by the provisions of 1303.2.4. 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.

$$Rd = \frac{2E_n}{s + 0.1} \times \frac{Wr + K\,W_p}{Wr + W_p}$$

in which

Rd = 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

En = Manufacturer's maximum rated energy, foot-pounds

Wr = Weight of hammer ram, pounds

Wp =Weight of pile (including driving appurtenances), pounds

K = Shall be taken as 0.4 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.

1303.2.3.2 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.

1303.2.3.3 Drop hammer may be used when the pile capacity does not exceed 10 tons as calculated from the following formula:

$$P = \frac{2WH}{S + 0.7\,\frac{(H)}{15}} \quad \text{for gravity hammer:}$$

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.

1303.2.4 Pile Load Test.

1303.2.4.1 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 Paragraph 5.6-Quick Load Test for Individual Piles. Piles whose design load has been predetermined shall be justified by proof testing by loading the piles to at least two times the design load. Acceptance of the pile shall require that the head movement of the pile shall not exceed the elastic shortening of the pile (PLIAE) plus a value of 0.25 inches at a test load of two times the design load. Load and head movement shall be measured as specified below.

1303.2.4.2 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 (PUAE) of the pile and a tangent to the plotted curve drawn at a slope of 0.05 inches/ton.

1303.2.4.3 Pile capacities determined under this paragraph shall in no case produce stresses in the pile in excess of the maximum allowable stresses given in 1305 through 1311.

1303.2.5 Presumptive Pile Capacity

1303.2.5.1 Presumptive pile capacities may be used, not exceeding the values shown in Tables 1302 and 1303, 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 100 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.

1303.2.5.2 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.

1303.2.5.3 Piles may be loaded to the values shown in Table 1303 provided that the exploratory borings show no soft or significantly compressible strata below the proposed pile tip elevation. See 1302.2.3 for presumptive capacity values for various classes of earth materials.

TABLE 1303
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 1302	

NOTE: For H piles the surface area shall be taken as the area of the enclosing rectangle times the embedded length. The end area shall be the actual steel area.

1303.3 Design

1303.3.1 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 those strata determined by the provisions of 1302.2.

1303.3.2 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 3, Table 1302, the minimum spacing shall not be less than 2'-0". For piles driven into materials of Classes 4 through 8, the minimum spacing shall not be less than 2'-6". Classes 9 and 10 are considered not suitable for pile support.

1303.3.3 Bracing. 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. A single row of piles without lateral bracing may be used for private dwellings not exceeding two stories in height, provided the centers of all piles are located within the width of the foundation wall.

1303.3.4 Uplift and Horizontal Loads. Loadings other than axial compression may be carried by piling provided that the design capacity values are determined by an engineering analysis of soil properties as described in 1302.2.

1303.3.5 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.

1303.3.6 Protection. Piles shall be adequately protected by approved preservatives or by impervious encasements that will not be rendered ineffective by driving to such depths or at such horizons as boring records or site conditions indicate possible deleterious action on pile materials because of soil constituents or water levels.

1303.3.7 Predrilling, Jetting, and Spudding. Piles may be placed in holes preformed by boring, jetting or spudding or combination of these methods. Such preformed holes should not extend to a depth greater than 5 feet above the top of the design bearing strata except for rolled steel sections or open end steel pipe driven into drilled sockets in rock. Piles shall be inserted into the preformed holes as soon as the hole is completed and driving shall commence immediately.

1303.3.8 Redriving. Observations and measurements shall be made during the process of driving piles to determine whether any previously driven pile has been lifted from its original seat by the action of adjacent piles. When such observations indicate that one or more piles have heaved, they shall be redriven to the originally specified resistance.

1304 DRILLED PIERS AND CAISSONS

1304.1 General

1304.1.1 Investigation. A subsurface investigation shall be conducted at the site to examine both the material through which the caisson or pier will be drilled and the underlying materials that will be significantly stressed by the foundation unit. The design bearing elevation and bearing and friction capacities shall be selected on the basis of a reasonable number of soil or rock tests.

1304.1.2 Minimum Size. If 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 belled pier or caisson be less than 2.0' minimum horizontal dimensions or of a straight shaft pier or caisson be less than 2'-6" minimum horizontal dimension unless a permanent steel shell is left between concrete and soil. Foundation elements with shaft diameters less than specified above shall be designed in accordance with Section 1307, Cast-In-Place Concrete Piles.

1304.1.3 Design. The shafts of 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 Section XVI of this Code and ACI 318.

1304.2 Allowable Loads

1304.2.1 General. All caissons or piers used to support any building or part thereon shall be constructed in such a manner as not to impair their strength. The allowable load on individual units may be determined from an analysis of subsurface conditions as described in Section 1304.2.2 or by caisson load test as described in Section 1304.2.3 or by the presumptive caisson capacity values given in Section 1304.2.4. The provisions of Section 1303.3.3 shall not apply to caissons constructed as spcci1ied under Section 1304 of this Code.

1304.2.2 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 planned to ensure that the material tested is continuous to a depth of at least one caisson bottom diameter below the bottom of the excavation. The bearing pressure so selected shall not produce stresses in the shaft in excess of those provided in Section 1304. 1.3.

1304.2.3 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 Section 1303.2.4 of this Code.

1304.2.4 Presumptive Caisson Capacity. Presumptive capacities may be used, not exceeding the values given below provided the following criteria are satisfied:

1. Presumptive caisson capacities are acceptable only for lightly loaded structures where column loads are less than 100 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.

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 types shall be shown on the plans for field verification. The design bearing pressure may be determined from the presumptive bearing values given in Table 1302 provided that exploratory borings show that no softer or more compressible strata lies below the design bottom elevation. The bearing area of the caisson or pier shall not be less than that determined by dividing the sum of the applied column load (dead load plus full live load plus wind load) and the total weight of the pier or caisson by the presumptive bearing pressure. A caisson designed under this paragraph shall in no case be less than 2'-6" in diameter.

1304.3 Construction

1304.3.1 Dry Method. Construction of drilled piers or caissons shall be by nondisplacement methods. Except as noted in paragraph 1304.3.2 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.

1304.3.2 Wet Method. With the approval of the Building Official, the concrete for drilled piers or caissons may be placed below the surface of still water by means of a properly operated tremie tube, concrete pump, or bottom dump bucket. 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 shall be pumped out and the rest of the caisson concreted as in paragraph 1304.3.1.

1304.3.3 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 place. 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.

1305 STRUCTURAL STEEL PILES

1305.1 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 A252, ASTM A283, ASTM A 572, ASTM A 588, ASTM A 690.

1305.2 Allowable Stresses

The allowable design compressive stress shall not exceed 12,000 psi except the allowable design stress may be increased up to 50% of the minimum specified yield strength of steel where substantiated by 1300.1.3.

1305.3 Minimum Dimensions

1305.3.1 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.

3. Flanges and web shall have a minimum nominal thickness of 3/8 inch.

1305.3.2 Steel Pipe Piles. Steel pipe piles driven open ended shall have a nominal outside diameter of not less than 10 inches and a minimum wall thickness of 0.25 inch for diameters less than 14 inch and a minimum wall thickness of 0.375 inch for diameters 14 inches and over. Pipe of less wall thickness may be driven open ended if a suitable cutting shoe is provided.

1306 CONCRETE FILLED STEEL PIPE AND TUBE PILES

1306.1 Material

1306.1.1 Steel pipe and tube piles shall conform to one of the following specifications: ASTM A 252, ASTM A 283.

1306.1.2 Concrete shall conform to 1307.1.1. The maximum size coarse aggregate shall be 3/4 inch.

1306.2 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 12,600 psi 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 1300.1.3.

1306.3 Minimum Dimensions

Piles shall have a nominal outside diameter of not less than 8 inches and a minimum wall thickness in accordance with 1305.3.2 except that for mandrel driven pipe piles the minimum wall thickness may be 0.10 inch.

1306.4 Reinforcement

Reinforcement steel shall conform to 1307.1.2. Reinforcement shall not be placed within 1 inch of the steel casing.

1306.5 Placing Concrete

Placing concrete shall conform to 1307.1.3.

1307 CAST-IN-PLACE CONCRETE PILES

1307.1 General

1307.1.1 Material. All concrete shall have a 28 day specified compressive strength f'_c of not less than 2500 psi. When concrete is 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 and not more than 6 inches. If concrete is to be pumped, the mix design including slump shall be adjusted to produce a pumpable concrete.

1307.1.2 Reinforcement. Except for steel dowels embedded 5 ft or less in the pile and as provided in 1307.2, 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.

1307.1.3 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 Building Official. 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.

1307.2 Drilled or Augered Uncased Piles

1307.2.1 Allowable Stresses. The allowable design stress in the concrete of drilled uncased piles shall not exceed 0.33 f'_c. The allowable design stress in the concrete of augered cast-in-place piles shall not exceed 0.25 f'_c.

1307.2.2 Dimensions. The pile length shall not exceed 30 times the average diameter. The minimum diameter shall be 12 inches.

EXCEPTION: The length of pile shall be permitted to exceed 30 times the diameter, provided the design and installation of the pile foundation is under the direct supervision of a professional engineer or his authorized representative knowledgeable in the field of soil mechanics and pile foundations.

1307.2.3 Installation.

1307.2.3.1 If pile shafts are formed through unstable soils and concrete is placed in open drilled hole, a steel liner shall be inserted in the hole prior to placing concrete. If the steel liner is withdrawn during concreting, the level of concrete shall be maintained above the bottom of the liner a sufficient height to offset any hydrostatic or lateral soil pressure.

1307.2.3.2 If concrete is placed by pumping through a hollow-stem auger, the auger shall not be permitted to rotate during withdrawal and shall be withdrawn in a steady continuous motion. Concerning 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 pipe is interrupted or a loss of concreting pressure occurs, the pipe 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 Building Official. If the concrete level in any completed pile drops, the pile shall be rejected and replaced.

1307.2.3.3 A pile load test shall be performed if 400 psi shaft stress is exceeded. Pile load test shall be in accordance with 1303.2.4.

1307.2.3.4 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 lineal foot or number of pump strokes per 5 lineal 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 Code Official 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:
    a. Pile Identification
    b. Pile Length
    c. Date
    d. Rate of Auger Withdrawal (grouting time)
    e. Grout volume in cubic feet per lineal foot or cubic feet per 5 foot section.

1307.2.4 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.

1307.3 Driven Uncased Piles

1307.3.1 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.

1307.3.2 Dimensions. The pile length shall not exceed 30 times the average diameter. The minimum diameter shall be 12 inches.

1307.3.3 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 Building Official. 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.

1307.3.4 Concrete Cover. All pile reinforcement shall have a concrete cover of not less than 2 1/2 inches measured from the inside face of the drive casing or mandrel.

1307.4 Enlarged Base Piles

1307.4.1 Materials. The maximum size for coarse aggregate for all concrete shall be 3/4 inch. Compacted concrete shall have a zero slump.

1307.4.2 Allowable Stress. The allowable design compressive stress in the concrete shall not exceed 0.25 f'_c except that where the concrete is placed in a permanent steel casing the allowable concrete stress may be increased to 0.33 f'_c.

1307.4.3 Installation. Enlarged bases formed either by compacting concrete or driving a precast base shall be formed in or 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 peat or other organic soil shall be encased in a permanent steel casing. If a case 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 re-establish the lateral support of the soil. If pile heave occurs, the pile shall be rejected unless it can be demonstrated that the pile is undamaged and capable of carrying twice its design load.

1307.4.4 Bearing Capacity. Pile bearing capacity shall be verified by load tests in accordance with 1302.2.

1307.4.5 Concrete Cover. The minimum concrete cover shall be 2 1/2 inches for uncased shafts and 1 inch for cased shafts.

1307.5 Steel Cased Piles

1307.5.1 Material. Pile shells or casings shall be of steel and shall be sufficiently strong to resist collapse and sufficiently water tight 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.

1307.5.2 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 (14 ga) 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.

1307.5.3 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 Building Official. Concrete shall not be placed in steel shells within heave range of driving.

1307.5.4 Reinforcement. Reinforcement shall not be placed within 1 inch of the steel shell. Reinforcing shall be considered necessary only for unsupported pile lengths or when the pile is designed to resist uplift or unbalanced lateral loads.

1308 PRECAST CONCRETE PILES

1308.1 General

1308.1.1 Design and Manufacture. All piles 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. 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 apart center-to-center for a distance of 2 ft from the ends of the pile and not more than 6 inches elsewhere except that at the ends of each pile the first five ties or spirals shall be spaced 1 inch center-to-center.

1308.1.2 Installation. All piles shall be handled and driven so as not to cause injury or overstressing which will affect their durability or strength.

1308.2 Reinforced Piles

1308.2.1 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 and shorter and 1 1/2% for piles longer than 40 ft and shall consist of at least four bars.

1308.2.2 Material. All concrete shall have a 28 day specified strength f'_c of not less than 4000 psi.

1308.2.3 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.

1308.2.4 Concrete Cover.

1308.2.4.1 Reinforcement for piles cast in the field shall have a concrete cover of not less than 2 inches.

1308.2.4.2 Reinforcement for piles manufactured under plant control conditions shall have a concrete cover of not less than 1 1/4 inches for #5 bars and smaller, and not less than 1 1/2 inches for #6 through #11 bars except that longitudinal bars spaced less than 1 1/2 inches 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.

1308.2.4.3 Reinforcement for piles not manufactured under plant control conditions shall have a concrete cover of not less than 2 inches.

1308.2.4.4 Reinforcement for piles exposed to seawater shall have a concrete cover of not less than 3 inches.

1308.2.5 Installation. A precast concrete pile shall not be driven before the concrete has attained a compressive strength of at least $0.75f'_c$ except that in all cases the concrete strength shall he sufficient to withstand handling and driving forces.

1308.3 Prestressed Plies

1308.3.1 Design. The effective prestress in the pile shall he not less than 700 psi.

1308.3.2 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 5000 psi.

1308.3.3 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.

1308.3.4 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.

1308.3.5 Concrete Cover. All prestressing steel and pile reinforcement shall have a concrete cover of not less than 1 1/4 inches for square piles of 12 inches or smaller size and 1 1/2 inches for larger piles except that for piles exposed to seawater, the minimum protective concrete cover shall be not less than 2 1/2 inches.

1309 TIMBER PILES

1309.1 Materials

Timber piles shall conform to ASTM D 25.

1309.2 Preservative Treatment

1309.2.1 Timber piles used to support permanent structures shall be treated in accordance with this section unless it is established that the tops of untreated timber piles will be below lowest ground water level assumed to exist during the life of the structure.

1309.2.2 Preservative and minimum final retention shall be in accordance with AWPA Standard C 3.

1309.2.3 Preservative and minimum final retention for sawn timber piles shall be in accordance with AWPA Standard C24.

1309.2.4 When timber piles are used in sail water, the treatment shall conform to AWPA-C18.

1309.2.5 Pile cut-offs shall be treated in accordance with AWPA M4.

1309.3 Allowable Stresses

The allowable stresses for treated round timber piles shall not exceed those set forth in Table 1309.3.

TABLE 1309.3

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]	**1250**	**2450**	**115**	**230**	**1,500,000**
Southern Pine[1,2]	**1200**	**2400**	**110**	**250**	**1,500,000**
Red Oak[3]	**1200**	**2450**	**135**	**350**	**1,250,000**
Red Pine[5]	**900**	**1900**	**85**	**155**	**1,280,000**

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.

1309.4 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.

1310 COMPOSITE PILES

1310.1 Design

Composite piles consisting of two or more approved pile types shall be designed to meet the conditions of installation.

1310.2 Limitation of Load

The maximum allowable load shall be limited by the capacity of the weakest section incorporated in the pile.

1310.3 Splices

Splices between concrete section 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.

1311 CAISSON PILES

1311.1 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.

1311.2 Design

The depth of the rock socket shall be sufficient to develop the full load bearing 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 and the diameter of the rock socket shall be approximately equal to the inside diameter of the pipe.

1311.3 Material

Pipe and steel cores shall conform to the material requirements in 1305. Pipe shall have a minimum wall thickness of 3/8 inch and shall be fitted with a suitable steel driving shoe welded to the bottom of the pipe. All concrete shall have a 28 day specified compressive strength f'_c of not less than 4000 psi. 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.

1311.4 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. If cores are to be spliced, the ends shall be milled or ground to provide full contact and shall be full depth welded.

1311.5 Allowable Stresses

The allowable design compressive stresses shall not exceed the following: concrete, 0.33 f'_c; steel pipe, 0.35 fy; structural steel core, 0.50 fy.

1311.6 Installation

The rock socket and pipe shall be thoroughly cleaned of all foreign materials before filling with concrete. Steel cores 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 Building Official.

1312 WATERPROOFING AND DAMPPROOFING

1312.1 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 1312.2. Where hydrostatic pressure conditions do not exist, dampproofing and perimeter drainage shall be provided in accordance with 1312.3.

EXCEPTION: See 1301.3.2 for dampproofing of wood foundations.

1312.2 Waterproofing

1312.2.1 Surfaces to be waterproofed shall be prepared in accordance with the waterproofing manufacturers recommendations.

1312.2.2 Waterproofing shall be applied from the top of the footing to not less than 6 inches above finish grade.

1312.2.3 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 per square foot.
3. 50 mil rubberized asphalt sheet or liquid.
4. 40 mil polymer modified asphalt.
5. 40 mil polyurethane rubber.
6. 20 mil single ply vulcanized rubber or thermoplastic sheet.
7. Acrylic modified cement base coating at a total minimum thickness of 3 lb per square yard.
8. Other approved methods or materials capable of bridging nonstructural cracks.

1312.2.4 Wall and floor joints and penetrations shall be made watertight using approved methods and materials.

1312.3 Dampproofing

1312.3.1 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.

1312.3.2 Dampproofing shall be applied to the exterior surface of walls from a point 12 inches below the top of the lowest slab to not less than 6 inches above finish grade.

1312.3.3 Dampproofing applied beneath the floor slab shall consist of 6 mil minimum polyethylene with joints lapped not less than 6 inches and taped, or other approved materials having a maximum perm rating of 0.5. Where installed on top of the floor slab, dampproofing shall consist of mopped-on bitumen, 4 mil minimum polyethylene, or other approved materials having a maximum perm rating of 0.5, with joints lapped and sealed in accordance with the dampproofing manufacturers recommendations.

1312.3.4 Wall dampproofing shall consist of one of the following systems:

1. 3/8-inch portland cement parging with a 1/16-inch bituminous coating
2. 1/8-inch bituminous coating
3. 1/8-inch cementitious coating
4. 1/8-inch surface bonding mortar
5. 40 mil acrylic latex coating
6. 1/16-inch bituminous coating over concrete
7. 6 mil polyethylene
8. Any material approved for waterproofing in 1312.2.3.

1312.3.5 When dampproofing is required, perimeter drainage shall be provided in accordance with either 1312.3.5.1 or 1312.3.5.2. The foundation perimeter drain shall have a minimum slope of 0.33% and 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.

1312.3.5.1 Method I. 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 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 above the top of the footing. The top of the gravel or crushed stone drain shall be covered with an approved filter membrane material.

1312.3.5.2 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 top of joints or the top of perforations shall be protected with an approved filter membrane material. The pipe or tile shall be placed on not less than 2 inches 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 of the same material. The gravel or crushed stone shall extend 12 inches minimum beyond the outside edge of the footing. The top of the gravel or crushed stone shall be covered with an approved filter membrane.

1312.4 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 14

MASONRY CONSTRUCTION

1401 GENERAL

All masonry construction shall conform to the provisions of this chapter and other applicable sections of this code.

1401.1 Dimensions, Materials and Tests

1401.1.1 In all cases, masonry shall be of adequate thickness, strength and proportions to support all superimposed loads within the allowable working stresses prescribed.

1401.1.2 All masonry materials are required to meet the specifications as outlined in 1402.

1401.1.3 The wall thickness and other specified dimensions are nominal dimensions.

1401.2 Second-Hand Units

1401.2.1 Second-hand masonry units which are to be re-used shall be approved as to the quality, conditions and compliance with the requirements for new masonry units as outlined in 1402. The units shall be of whole, sound material, free from cracks and other defects that would interfere with their proper laying or use and shall be cleaned free of old mortar before re-use.

1401.2.2 Masonry units to be re-used as structural units in areas subject to the action of the weather or soil shall not be permitted unless representative samples are tested for compliance with the applicable requirements of 1402.

1401.3 Weepholes

Weepholes shall be provided in masonry veneer and in the outside wythe of masonry walls at a maximum spacing of 4 ft on centers 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.

1401.4 Construction

All solid masonry units shall be laid with full head and bed joints and all interior vertical joints that are designed to receive mortar shall be filled. The average thickness of head and bed joints shall not exceed 1/2 inch. For hollow masonry units, all head and bed joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell.

1402 MATERIALS

1402.1 Brick Units

1402.1.1 Brick of clay, shale or calcium silicate (sand/lime) shall conform to standards listed in Chapter 30, as follows: ASTM C 216 for solid units of facing brick, ASTM C 62 for solid units of building brick, ASTM C 652 for hollow units, and ASTM C 73 for calcium silicate face brick.

1402.1.2 Grade requirements for brick units in contact with the ground or subject to water, frost and freezing action shall be governed by the applicable provisions of the ASTM standards listed in 1402.1.1.

1402.2 Concrete Masonry Units

1402.2.1 Concrete masonry units shall conform to standards listed in Chapter 30 as follows: ASTM C 90 for hollow loadbearing units; ASTM C 129 for nonloadbearing units, ASTM C 145 for solid load bearing units and ASTM C 55 for concrete brick.

1402.2.2 Grade requirements for units in contact with the ground or subject to moisture or weather shall be governed by the applicable provisions of the ASTM standards listed in 1402.2.1.

1402.3 Structural Clay Tile Units

1402.3.1 Structural clay wall tile shall conform to the standards for structural clay tile units listed in Chapter 30, as follows: ASTM C 34 for structural clay loadbearing wall tile, ASTM C 212 for structural clay facing tile, ASTM C 56 for structural clay nonloadbearing tile, and ASTM C 530 for structural clay nonloadbearing screen tile.

1402.3.2 Grade requirements for units subjected to weather or contact with the ground shall be governed by the applicable provisions of the ASTM standards listed in 1402.3.1.

1402.3.3 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 of the standards listed above. The fire resistance ratings shall be determined in accordance with 1001 and comply with the requirements of Table 600.

1402.4 Glazed Masonry Units

Glazed masonry units shall conform to standards listed in Chapter 30, as follows: ASTM C 126 for ceramic glazed 'structural clay facing tile, facing brick and solid masonry units, or ASTM C 744 for prefaced concrete and calcium silicate masonry units.

1402.5 Stone

1402.5.1 Natural stone for masonry shall be sound and free from loose or friable inclusions, and shall meet the strength, fire resistance, durability and impact resistance requirements for the proposed use. The Building Official may require satisfactory written evidence to this effect.

1402.5.2 All cast stone shall be fabricated of concrete or other approved materials of required strength, durability and fire resistance for the intended use and shall be reinforced where necessary to comply with Chapter 16.

1402.6 Architectural Terra Cotta and Ceramic Veneer

All architectural terra cotta and ceramic veneer shall have a strong, homogeneous body and shall conform to the applicable requirements of 1402.3. All units of the anchor type shall have the necessary anchor holes and shall be so formed as to engage properly with the supporting structure. All units of the adhesion type shall have keyed or scored back surfaces.

1402.7 Structural Glass Block Units

Structural glass block shall comply with the provisions of 1411.

1402.8 Mortar and Grout

1402.8.1 Mortar for use in masonry construction shall comply with ASTM C 270 and this chapter.

1402.8.1.1 Mortar shall conform to the proportion specification of Table 1402.8A or the property specification of Table 1402.8B.

1402.8.2 Grout for use in masonry construction shall comply with ASTM C 476 and this chapter.

1402.8.2.1 Grout shall conform to the proportion specifications of Table 1402.8C.

1402.9 Types of Mortar Permitted

Masonry shall be laid in mortar of the types listed in Table 1402.9, and shall comply with the mortar proportions specified in Table 1402.8A, or the mortar properties specified in Table 1402.8B.

1402.10 Ceramic Tile

1402.10.1 Ceramic tile units shall be as defined in ANSI A137.1 and shall be of quality at least equal to "Standard Grade", graded and marked in conformance with that specification.

1402.10.2 Ceramic tile set in cement mortar shall be installed in accordance with ANSI A108.1 with mortar mixes as specified therein for particular uses.

1402.10.3 Organic adhesives to be used in installing ceramic tile shall conform to the requirements of ANSI A136.1. Installation of ceramic tile with such adhesives shall conform to ANSI A108.4.

1402.10.4 Ceramic tile set in dry-set or latex-portland cement mortar shall be installed in accordance with ANSI A108.5, and the dry-set mortar shall conform to the requirements of ANSI A118.l. The latex-portland cement mortar shall conform to the requirements of ANSI A118.4.

1402.10.5 Ceramic tile set in epoxy shall be installed in accordance with ANSI A108.6, and the epoxy shall conform to ANSI A118.3.

1402.10.6 Electrically conductive ceramic tile set in conductive dry-set mortar 5 shall be installed in accordance with ANSI A108.7 and conductive dry-set mortar shall conform with ANSI A118.2.

1402.10.7 Ceramic tile set in furan mortar and grout shall be installed in accordance with ANSI A108.8, and the furan shall conform with ANSI A118.5.

1402.10.8 Ceramic tile set in modified epoxy emulsion mortar and grout shall be installed in accordance with ANSI A108.9, and the modified epoxy shall conform with ANSI A118.8.

1402.10.9 Installation of portland cement grouts in tile work shall be in accordance with ANSI AI08.10, and cement grouts shall conform with ANSI A118.6.

1402.10.10 Static coefficient of friction of ceramic tile walking surfaces shall be evaluated in accordance with ASTM C 1028.

TABLE 1402.8A
MORTAR PROPORTIONS[1]

Mortar Type	Portland Cement (cu ft)	Masonry Cement (cu ft)	Hydrated Lime or Lime Putty (cu ft)	Aggregate Measured in Damp, Loose Condition (cu ft)
M	1	None	1/4	Not less than 2 1/4 and not more than 3 times the sum of the volumes of cement and lime used.
	1	1	None	
S	1	None	Over 1/4 to 1/2	
	1/2	1	None	
N	1	None	Over 1/2 to 1 1/4	
	None	1	None	
O	1	None	Over 1 1/4 to 2 1/2	
	None	1	None	

[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

TABLE 1402.8B
MORTAR PROPERTIES

Type	Minimum Compressive Strength[1, 2] at 28 days, psi
M	2500
S	1800
N	750
O	350

1. Average of three 2-inch cubes of laboratory prepared mortar, in accordance with ASTM C 270.
2. The volume of aggregate in mortar shall be not less than 2 1/4 times and not more than 3 1/2 times the volume of cementitious material.

TABLE 1402.8C
GROUT PROPORTIONS BY VOLUME FOR MASONRY CONSTRUCTION

Type	Portland Cement or Blended Cement Slag Cement	Hydrated Lime or Lime Putty	Aggregate Measured in a Damp, Loose Condition	
			Fine	Coarse
Fine	1	0 to 1/10	2 1/4 to 3 times the sum of the volume of the cementitious materials	---
Course	1	0 to 1/10	2 1/4 to 3 times the sum of the volume of the cementitious materials	1 to 2 times the sum of the volume of the cementitious materials

1403 WORKING STRESSES

1403.1 General Requirements

1403.1.1 In determining the stresses in masonry, the effects of all loads and conditions of loading and the influence of all forces affecting the design and strength of the several parts shall be taken into account.

1403.1.2 The thickness of masonry walls shall be sufficient at all points to withstand all vertical and horizontal loads as specified in Chapter 12. Masonry shear walls in seismic zones 3 and 4 shall comply with the requirements of 1411.

1403.1.3 The maximum allowable stresses in masonry shall not exceed those set out in this chapter, unless it can be determined by accepted engineering analysis that the design meets all safety requirements; see 1403.3, 1403.6 and 1411.1. Stresses shall be calculated on actual rather than nominal dimensions.

1403.2 Working Stresses In Unreinforced Masonry

Except as permitted in other sections of this Code, the compressive stresses in unreinforced masonry shall not exceed the values given in Table 1403.2.

1403.3 Higher Working Stresses

Higher stresses than herein specified may be used, but only if it is clearly established to the satisfaction of the Building Official, by test or other approved evidence, that material of a higher grade or a Superior Workmanship than is generally provided in accepted practice will be employed under approved inspection. The use of higher stresses, however, shall not be allowed until a statement, giving the reasons for such permission together with the facts and circumstances on which it is based, has been placed on file and made a part of the official record of the permit.

TABLE 1402.9
TYPES OF MORTAR REQUIRED

Type of Masonry	Types of Mortar Permitted
Foundations: (below grade masonry and retaining walls)	
Footings	M or S
Walls of Solid Units	M, S or N
Walls of Hollow Units	M or S
Hollow Walls	M or S
Walls of Natural Stone	M or S
Masonry Other Than for Foundations	
Piers of Solid Units	M, S or N
Piers of Hollow Units	M or S
Walls of Solid Units	M, S, N or O
Walls of Hollow Units	M, S or N
Hollow Walls and Cavity Walls	
(a) Design Wind Pressure Exceeds 20 psf	M or S
(a) Design Wind Pressure 20 psf or less	M, S or N
Glass Block Masonry	M, S or N
Nonbearing Partition and Fire Protection	M, S, N or O
Fire Brick/Fire Clay Tile Flue Liners	Refractory Air Setting Mortar
Masonry Other Than Above	M, S or N

1403.4 Allowable Stresses In Composite Walls

In composite walls or other structural members composed of different kinds or grades of masonry units or mortars, the maximum stress shall not exceed the allowable stress for the weakest of the units and mortars of which the wall or member is composed.

1403.5 Concentrated Loads

1403.5.1 A 50% increase in the allowable working stresses shown in Table 1403.2 shall he permitted for concentrated loads meeting the bearing requirements of 1409.3 where such loads are supported upon not less than a 4-inch height of solid masonry units or hollow masonry units with the cells filled solidly with mortar or grout. The clear distance between the application of two adjacent concentrated loads on a wall shall be not less than the sum of the widths of the bearings or bearing plates.

TABLE 1403.2
ALLOWABLE COMPRESSIVE STRESSES IN UNIT MASONRY

Construction and Grade of Unit	Allowable Compressive Stresses Gross Cross Section Area (except as noted)			
	Type M Mortar (psi)	Type S Mortar (psi)	Type N Mortar (psi)	Type O Mortar (psi)
Solid masonry of brick and other solid units of clay or shale; sand-lime or concrete brick:				
8000 plus, psi	400	350	300	200
4500 TO 8000 psi	250	225	200	150
2500 to 4500 psi	175	160	140	110
1500 to 2500 psi	125	115	100	75
Grouted[1] solid masonry of brick and other solid units of clay or shale; sand-lime or concrete brick:				
4500 plus psi	350	275	200	.....
2500 to 4500 psi	275	215	155	.....
1500 to 2500 psi	225	175	125	.....
Solid masonry of solid concrete masonry units:				
1800 plus psi	175	160	140	100
1200 to 1800 psi	125	115	100	75
Masonry Hollow Units	85	75	70	.....
Piers if hollow units, cellular spaces filled, as in 1405.6	105	95	90	.....
Hollow walls (cavity or masonry bonded)[2] Solid units:				
2500 plus psi	140	130	110	.....
1500 to 2500 psi	100	90	80	.....
Hollow Units	70	60	55	.....
Stone ashlar masonry:				
Granite	800	720	640	500
Limestone or Marble	500	450	400	325
Sandstone or cast stone	400	360	320	250
Rubble stone, coursed, rough or random	140	120	100	80

1. See 1410.
2. On gross cross-sectional area of wall minus area of cavity between wythes (leaves). The allowable compressive stresses for cavity walls are based upon the assumption that the floor loads bear upon one of the two wythes. When hollow walls are loaded concentrically, the allowable stresses may be increased by 25%

1403.5.2 For piers and columns the bearing plate shall not exceed 60% of the cross-sectional area of the pier or column and the resultant reaction of all vertical and horizontal loads shall fall within the middle one-third of the member.

1403.5.3 Concentrated loads shall not be considered as distributed in masonry laid in stacked bond unless one continuous 1/4-inch round reinforcing bar or its equivalent is placed in the horizontal bed joints for each 4 inches of wall thickness and spaced not more than 16 inches on centers vertically.

1403.6 Structural Analysis of Unreinforced Masonry

1403.6.1 Where wall thickness and lateral support requirements are determined by a structural analysis based upon accepted engineering practice, the requirements contained in 1404 and 1405 may be waived. The Building Official may require a copy of the structural analysis by the architect or engineer and he may require the designer or other qualified person to inspect the construction.

1403.6.2 Masonry designed and constructed in accordance with the provisions of ACI/ ASCE 530 with the exception of Chapter Nine of ACI/ ASCE 530 may be used as an alternate to the provisions of Chapter 14.

1403.6.3 For brick masonry of solid masonry units made from clay or shale, the design and construction may conform to the provisions of BIA Building Code Requirements for Engineered Brick Masonry, or ACI/ ASCE 530.

1404 WALL THICKNESS

1404.1 General

The minimum thickness of all masonry bearing or nonbearing walls shall be sufficient to resist or withstand all vertical or horizontal loads required by this Code and the fire resistance requirements set out in Chapter 10. See 1403.6.

1404.2 Thickness of Bearing Walls

1404.2.1 General. The minimum thickness of masonry bearing walls shall be at least 12 inches for the uppermost 35 ft of their height and shall be increased 4 inches for each successive 35 ft or fraction thereof measured downward from the top of the wall unless specified otherwise in 1404.2.

1404.2.2 Stiffened Walls. Where solid masonry bearing walls are stiffened at distances not greater than 12 ft apart by masonry cross walls or by reinforced concrete floors, they may be 12 inches thick for the uppermost 70ft, measured downward from the top of the wall, and the thickness shall be increased 4 inches for each successive 70ft or fraction thereof.

1404.2.3 Top Story Walls. The top-story bearing wall of a building not exceeding 35 ft high may be 8 inches thick, provided the roof construction imparts no lateral thrust to the walls, and providing the walls meet lateral support requirements of 1405.

1404.2.4 One Story Walls. The walls of a one story building may be not less than 6 inches thick, provided the masonry units meet the minimum compressive strength requirements of 2500 psi for the gross area and that the masonry be laid in Type M, S or N mortar.

EXCEPTION: The walls of one story single family dwellings and private garages may be not less than 6 inches thick provided the masonry units meet the minimum requirements of 1402 for masonry units and mortar.

1404.2.5 Walls of Residence Buildings. In residence buildings not more than three stories high, walls other than coursed or rough or random rubble stone walls, may be 8 inches thick when not over 35 ft high, provided the roof is designed to impart no horizontal thrust. Such walls in one story buildings or private garages may conform to 1404.2.4 and the provisions of 1405.1

1404.2.6 Penthouses and Roof Structures. Masonry walls above roof level, 12 ft or less in height, enclosing stairways, machinery rooms, shafts, or penthouses, may be 8 inches thick and may be considered as neither increasing the height nor requiring any increase in the thickness of the wall below.

1404.2.7 Walls of Plain Concrete. Plain concrete walls may be 2 inches less in thickness than required otherwise in this section but not less than 8 inches except that they may be 6 inches thick when meeting the provisions of 1404.2.4.

1404.2.8 Cavity Walls. Cavity walls shall not exceed 35 ft in height. The cavity between wythes shall be not less than 2 inches (actual) nor more than 4 inches wide, and the minimum wythe thickness shall be not less than 4 inches, except where 3 inches thick wall wythes are specifically permitted. The backing wythe shall be at least as thick as the facing wythe. See 1401.

1404.2.8.1 Where both the facing and backing wythes have a thickness of 4 inches, the height of such cavity walls shall not exceed 25 ft.

1404.2.8.2 Where both the facing and backing wythes are composed of solid masonry units, the wythes may be 3 inches thick but the height of such cavity walls shall not exceed 20 ft.

1404.2.9 Masonry Bonded Hollow Walls. Masonry bonded hollow walls shall not exceed 35 ft in height. The cavity between wythes shall not be less than 2 inches (actual) nor more than 4 inches wide, and the minimum wythe thickness shall not be less than 3 inches. The backing wythe shall be at least as thick as the facing wythe. See 1401.

1404.2.10 Composite or Faced Walls. Neither the height of faced (composite) walls nor the distance between lateral supports shall exceed that prescribed for the masonry of either of the types forming the facing or the backing.

1404.2.11 Stone Walls. Rough or random or coursed rubble stone walls shall be 4 inches thicker than required for solid masonry walls of the same height, but in no case less than 16 inches thick.

1404.3 Thickness of Nonbearing Walls

1404.3.1 Nonbearing exterior masonry walls may be 4 inches less in thickness than required for bearing walls but the thickness shall be not less than 8 inches except where 6-inch walls are specifically permitted.

1404.3.2 Exterior Panel, Apron or Spandrel Walls. Panel, apron or spandrel walls that do not exceed 13 ft in height above their support shall not be limited in thickness, provided they meet the fire resistance requirements of Chapter 10 and are so anchored to the structural frame as to insure adequate lateral support and resistance to wind or other lateral forces. See Table 600.

1404.4 Foundation Walls

See 1301.3.

1405 LATERAL SUPPORT

1405.1 Exterior Walls

Exterior masonry walls, whether they be bearing or nonbearing, shall be supported either horizontally or vertically at right angles to the face of the wall at intervals not exceeding those shown in Table 1405.1 except that an additional 6 ft will be permitted for gables in residential structures and private garages that do not exceed one story in height. See 1403.6.

1405.2 Bearing Partitions

Masonry bearing partitions shall be supported either vertically or horizontally (whichever distance is the lesser) at right angles to the face of the wall at intervals not exceeding 24 times the wall thickness for solid masonry units, and 20 times the wall thickness for hollow masonry units when laid in Type M, S or N mortar.

TABLE 1405.1
H/t[1] LATERAL SUPPORT RATIOS FOR EXTERIOR MASONRY WALLS[2]

	Design Wind Pressure, psf[2]							
Wall Construction[3]	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
Grouted, solid brick or plain concrete walls								
Solid Concrete Masonry Units	24	24	22	20	18	17	16	14
Hollow concrete Masonry Units or Masonry Bonded Hollow Units	20	18	16	14	13	12	11	10
Cavity - Brick or Solid Concrete Mas. Unit[4]	20	17	15	14	13	12	11	10
Cavity - Hollow Concrete Masonry Units or Brick and Hollow Concrete Masonry Units[4]	15	13	12	10	10	9	8	7

l. H = clear height or length between lateral support.
t = nominal wall thickness.

2. Lateral support ratios may be determined by straight line interpolation between the nearest upper and lower design wind pressure values listed above.
3. All masonry units shall be laid in Type M, S or N mortar unless otherwise required (see Table 1402.9). Where Type N mortar is used and the wall spans in the vertical direction, the ratios shall be reduced by 10%.
4. In computing the H/t ratio for cavity walls, "t" shall be the sum of the nominal thicknesses of the inner and outer wythes.
5. These wind pressures include shape factors from 1205.

1405.3 Nonbearing Partitions

Nonbearing partitions shall be supported either vertically or horizontally at right angles to the face of the walls at intervals not exceeding 36 times the nominal wall thickness exclusive of plaster. Sec 1403.6.

EXCEPTION: Cantilever walls not exceeding 18 times the nominal wall thickness.

1405.4 Method of Support

1405.4.1 Lateral support shall be provided by intersecting walls, pilasters, columns, or other vertical members of sufficient strength to provide the required support when the distance between supports is measured horizontally; or by floors, roofs or other horizontal structural elements which are of sufficient strength to provide the required support when the distance between supports is measured vertically.

1405.4.2 Sufficient bonding or anchorage shall be provided between the walls and their supports to resist the assumed wind or other horizontal forces acting either inward or outward. All structural elements relied upon for lateral support shall have sufficient strength and stability to transfer the horizontal force acting in either direction to adjacent structural members or to the ground. When floors or roofs are depended upon for receiving horizontal forces, provisions shall be made in the buildings to transfer the lateral forces to the ground.

1405.4.3 When horizontal structural elements of a building (such as floors, roof, spandrel beams) are depended upon for lateral support, vertical bracing of bearing or nonbearing walls shall also be provided at intervals of not more than 75 times the wall thickness. Such vertical bracing may be provided by cross walls, pilasters, buttresses or other equivalent structural members.

1405.5 Pilasters

When relied upon to provide the required lateral support, the width of pilasters shall be not less than 1/10 the spaces between such pilasters. All pilasters shall be not less than 4 inches thicker than the wall supported. In no case shall the distance between such pilasters exceed the lateral support provisions of Table 1405.1.

1405.6 Piers

1405.6.1 The unsupported height of masonry piers shall not exceed 10 times their least dimension. When structural clay tile or hollow concrete masonry units are used for isolated piers to support beams and girders, the cellular spaces shall be filled solidly with concrete or Type M or S mortar, except that unfilled hollow piers may be used if their unsupported height is not more than four times their least dimension. When hollow masonry units are solidly filled with concrete or Type M, S or N mortar, the allowable compressive stress may be increased as provided for in Table 1403.2.

1405.6.2 Hollow piers shall be capped with 4 inches of solid masonry or concrete or shall have cavities of top course filled with concrete or grout or other methods approved by the Building Official.

1406 PARAPET WALLS

1406.1 General

1406.1.1 Parapet walls of plain solid masonry, hollow masonry units, cavity wall design or reinforced masonry shall be as provided in this section.

1406.1.2 All parapet walls shall be properly coped with noncombustible, weatherproof material of a width not less than the thickness of the parapet wall.

1406.1.3 Proper flashings shall be installed in such a manner as to prevent moisture entering the wall through the joints in the coping.

1406.1.4 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 Appendix S for the particular type of covering specified for the building. For other type materials follow manufacturer's specifications.

1406.1.4.1 A scupper shall be sized in accordance with the *Standard Plumbing Code*.

1406.1.4.2 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 nor more than 4 inches above the roof deck and shall be located as close as practical to required vertical leaders or downspouts or walls and parapets scuppers. An overflow scupper shall be sized in accordance with the *Standard Plumbing Code*.

1406.2 Solid Masonry and Hollow Masonry Parapet Walls

Parapet walls of plain solid masonry construction shall be not less than 8 inches thick and their height shall not exceed four times the nominal wall thickness.

1406.3 Cavity Wall Parapets

Cavity wall parapets may be used when the facing and backing are constructed of solid masonry units and when they conform to all of the other requirements for cavity walls, except their height shall not exceed four times the combined nominal thickness of the facing and backing masonry units.

1406.4 Reinforced Masonry Parapet Walls

Unless reinforced to withstand safely wind loads to which they may be subjected, reinforced masonry parapet walls may be considered adequate if they conform to one of the following:

1. When solid masonry parapet walls are reinforced both horizontally and vertically with not less than 1/4-inch rods spaced not more than 2 ft on centers, the height shall be not more than six times the nominal wall thickness.
2. When solid masonry parapet walls are reinforced both horizontally and vertically with a minimum of 1/4-inch round rods horizontally on 16-inch centers and 3/8-inch round rods vertically on 24-inch centers, the height shall not exceed eight times the nominal wall thickness.

1407 BONDING

1407.1 General

The facing and backing of multiple-wythe masonry walls and partitions shall be bonded in such a manner to provide for common action of the wythes of the material used. Bonding shall comply with one of the methods in 1407.

1407.2 Bonding With Headers

When the facing and backing are bonded by means of masonry headers, no less than 4% of the wall surface of each face shall be composed of headers extending not less than 3 inches into the backing. The distance between adjacent full length headers shall not exceed 24 inches either vertically or horizontally. In walls in which a single header course does not extend through the wall, headers from opposite sides shall overlap at least 3 inches, or headers from opposite sides shall be covered with another header course overlapping the header course below at least 3 inches.

1407.3 Bonding With Metal Ties

1407.3.1 When the facing and backing of masonry walls are bonded with corrosion-resistant 3/16-inch diameter steel ties or metal wire ties of equivalent stiffness embedded in the horizontal mortar joints, there shall be at least one metal tie for each 4 1/2 sq ft of wall area. Ties in alternate courses shall be staggered, the maximum vertical distance between ties shall not exceed 24 inches and maximum horizontal distance shall not exceed 36 inches. The ends of ties shall be bent to 90" angles to provide hooks not less than 2 inches long or ties bent to a rectangular shape shall be used. Additional bonding ties shall be provided at all openings spaced not more than 3 ft apart around the perimeter and within 12 inches of the opening. Ties bent to a rectangular shape shall be used with hollow masonry units and laid with cells vertical.

1407.3.2 The wythes of cavity walls shall be bonded as required in 1407.3.1 where the cavity does not exceed 3 1/2 inches in actual width. Where the cavity width exceeds 3 1/2 inches there shall be one metal tie for not more than each 3 sq ft of wall area. Ties bent to a rectangular shape shall be used with hollow masonry units and laid with the cells vertical.

1407.3.3 In nonreinforced masonry where units are laid in stack bond, continuous steel bars or prefabricated joint reinforcement shall be corrosion resistant and embedded in the horizontal mortar beds at vertical intervals not to exceed 16 inches. The longitudinal bars or wires of such reinforcement shall be not less than 9 ga and at least one longitudinal bar or wire shall be provided for each 6 inches of wall thickness or fraction thereof.

1407.3.4 Walls shall conform to allowable stress, lateral support, thickness (excluding cavity), height and mortar requirements for cavity walls unless the collar joint in such walls are filled with mortar.

1407.4 Bonding With Hollow Masonry Units

Where two or more hollow masonry units are used to make up the thickness of a wall, the inner and outer courses may be bonded at vertical intervals not exceeding 34 inches by lapping at least 3 inches over the units below, or by lapping at vertical intervals not exceeding 17 inches with units at least 50% greater in width than the unit below.

1407.5 Ashlar, Natural or Cast Stone

1407.5.1 In ashlar masonry, bonder stones, uniformly distributed, shall be provided to the extent of not less than 10% of the wall area. Such bonder stones shall extend not less than 4 inches into the backing wall.

1407.5.2 Rubble stone masonry, 24 inches thick or less, shall have bond stones with a maximum spacing of 3 ft vertically and 3 ft horizontally and, if the masonry is of greater thickness than 24 inches, shall have one bond stone for each 6 sq ft of wall surface on both sides.

1407.5.3 Stone masonry walls shall not in any case have a minimum thickness of less than 16 inches.

1407.6 Masonry Bonded Hollow Walls

1407.6.1 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 into the backing. The distance between adjacent bonders shall not exceed 24 inches either vertically or horizontally.

1407.6.2 Where the bonding units have a compressive strength of 4500 psi, based on the gross area, the facing and backing may be bonded so that not less than 2% of the wall area is composed of bonders.

1407.7 Bonding With Joint Reinforcement

1407.7.1 Prefabricated joint reinforcement for bonding masonry walls shall be corrosion-resistant and shall have at least one 9 ga cross-wire for each 2 sq ft of wall area. The vertical spacing of the reinforcement shall not exceed 16 inches. The joint reinforcement shall engage all wythes and the longitudinal wires shall be embedded in mortar.

1407.7.2 Adjustable prefabricated joint reinforcement for bonding masonry walls shall be corrosion-resistant and shall have at least one 3/ 16-inch eye and pintle section for each 2 sq ft of wall area. The vertical reinforcement shall not exceed 16 inches. The joint reinforcement shall engage all wythes and the longitudinal wires shall be embedded in mortar. The pintle section shall be embedded a minimum of 2 inches in the exterior masonry wythe.

1407.7.3 Walls shall conform to allowable stress, lateral support, thickness (excluding cavity), height and mortar requirements for cavity walls unless the collar joint in such walls are filled with mortar.

1408 ANCHORAGE

1408.1 General

All structural elements depending upon one another for continuity or support shall be securely anchored in such a manner as to resist all forces which might tend to separate the structural elements.

1408.2 Roof Anchorage

1408.2.1 Roof structures shall be securely anchored to load bearing masonry walls. Anchorage shall be considered adequate if provided in accordance with 1408.2.2 or 1408.2.3.

1408.2.2 Anchorage may be provided by 1/2-inch bolts extending a minimum of 15 inches into the masonry and spaced not more than 6 ft on centers. A steel plate having a minimum surface area of 6 sq in shall be securely attached to the head of the bolt and completely embedded in the masonry.

1408.2.3 Where a continuous bond beam at least 8 inches deep and having a minimum continuous reinforcing of 0.2 sq in is provided at the top of the wall, anchorage may be provided by one of the following methods:

1. Welding 1/2-inch anchor bolts to longitudinal reinforcing.
2. Hooking tightly around the longitudinal reinforcing through 180°.

Bolts shall extend into the wall a minimum of 6 inches.

1408.3 Floor Anchorage

1408..3.1 Wood floor joists or beams resting on masonry walls shall be anchored at intervals of not more than 6 ft by approved metal fasteners attached in a manner to be self-releasing. Joists parallel to the wall shall be anchored with metal straps spaced not more than 6 ft on centers, extending over or under and secured to at least three joists.

1408.3.2 Steel floor joists not supporting a concrete slab floor shall be anchored in a manner providing anchorage equivalent to that required for wood floor joists. Concrete slabs bearing on masonry walls shall be considered to provide adequate anchorage without additional anchorage.

1408.4 Anchoring Intersecting Walls and Partitions

1408.4.1 Intersecting bearing walls may be bonded either by laying 50% of the units at the intersection in an overlapping masonry bonding pattern, with alternating units having a bearing of not less than 3 inches on the unit below or by using corrosion-resistant metal ties embedded in the bed joints. When metal ties are used for such bonding, they shall be corrosion-resistant 3/16-inch diameter steel rods, bent to a rectangular shape and spaced at intervals not exceeding 16 inches vertically. They shall be placed in such a manner as to extend at least 3 inches into each intersecting wall.

1408.4.2 Nonbearing partitions, when intersecting walls or partitions, shall be anchored with metal ties or clips at least 7/8-inch wide and not less than 0.058-inch galvanized steel at intervals of not more than 32 inches vertically.

1408.4.3 Brick or tile facing against concrete shall be anchored to the concrete by the use of dovetail anchors inserted into slots built into the concrete. Anchors shall be at least 7/8-inch wide and not less than 0.058-inch galvanized steel. They shall be spaced not more than 18 inches vertically and 24 inches horizontally.

1408.4.4 2-inch split furring and 2-inch open back (split) tile (soaps) shall be anchored to the backing with hardware cloth ties consisting of 1/2-inch mesh, 20 ga galvanized steel fabric, at least 4 inches wide and extending at least 3 inches into the masonry and to within 1/2 inch of the face of the furring, or by other approved ties. Ties shall be spaced not more than 24 inches vertically and 36 inches horizontally.

1409 MISCELLANEOUS DETAILS

1409.1 Change in Wall Thickness

Except for permissible chases and recesses, walls shall not vary in thickness between their lateral supports. Where cavity walls or walls of hollow masonry units are decreased in thickness, a course of solid masonry not less than 4 inches thick shall be interposed between the wall below and the thinner wall above, or the hollow units in the top course of the thicker wall shall be filled with concrete or Type M, S or N mortar.

1409.2 Chases

1409.2.1 Chases in masonry walls shall not be deeper than one-third the wall thickness, nor longer than 4 ft horizontally, except that chases below windows may equal the width of the opening above.

1409.2.2 No chase shall be cut or built in an 8-inch wall or within the required area of a pier, except that in buildings of residential occupancy not more than two stories high, chases not more than 4 inches deep may be built in 8-inch walls.

1409.2.3 Chases shall not be cut in cavity walls, hollow walls or walls of hollow units but, when permitted, may be built in.

1409.2.4 Masonry directly above chases wider than 12 inches shall be supported on lintels.

1409.3 Supported Structural Members

1409.3.1 When combustible structural members frame into walls of thicknesses not greater than 12 inches, they shall project not more than 4 inches into the wall and shall be so spaced that the distance between embedded ends is not less than 4 inches. The space above, below, and between such members shall be filled solidly with burnt-clay materials, mortar, concrete, or equivalent fire resistant material to a depth of not less than 4 inches on all sides of the members.

1409.3.2 Beams, joists, girders or other concentrated loads supported by a wall or pier shall have bearing at least 3 inches long upon solid masonry or upon a bearing plate of adequate design and dimensions to distribute safely the loads on the wall or pier. In no case shall the stresses be greater than allowed in 1403.

1409.4 Support on Wood

Masonry shall not be supported on combustible construction.

EXCEPTION: Prefabricated partitions weighing not more than 30 psf 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.

1409.5 Corbeling

In nonreinforced masonry, the maximum horizontal projection of the corbeling from the plane of the wall shall not exceed one-half of the wall thickness of solid walls, or one-half of the wythe thickness for cavity walls. Individual corbels or the maximum projection of one unit hall not exceed one-half the height of the unit nor one-third its bed depth. For corbeling of chimneys, see 803.1.2.

1409.6 Arches and Lintels

The masonry above openings shall be supported by well buttressed arches or lintels of noncombustible materials which shall bear on the wall at each end for not less than 4 inches. In addition, the bearing area shall be sufficient to prevent compressive stresses greater than those allowed in Table 1403.2.

1409.7 Cold Weather Construction

Masonry may be laid when the temperature of the outside air is below 40°F when the construction and protection requirements are in compliance with ACI/ASCE 530.

1409.8 Wetting of Masonry Units

1409.8.1 Brick of clay or shale, at the time of laying, shall require wetting if the unit's initial rate of absorption exceeds 0.035 oz per sq in or 30 grams per 30 sq in per minute, as determined by ASTM C67.

1409.8.2 Structural clay tile having absorptions (1-hour boil) of 12% or more shall be wetted before laying.

1409.9 Construction Precautions

Except when carried independently by girders at each floor, a wall shall not be built up more than 25 ft high in advance of other wall of the building. Walls shall be adequately braced during erection. Masonry walls in locations where they may be exposed to high winds during erection shall not be built higher than 10 times their thickness unless adequately braced or until provision is made for the prompt installation of permanent bracing at the floor or roof level immediately above the story under construction. Back fill shall not be placed against foundation walls until they have been braced to withstand the horizontal pressure.

1409.10 Use of Existing Walls

An existing wall may be used in the alteration or extension of a building, provided that under the new conditions it meets the requirements of this Code and is structurally sound or can be made so by repairs. An existing wall shall not be used for the alteration or extension of a building, or increased in height without specific written permission from the Building Official.

1410 GROUTED AND FILLED-CELL MASONRY

1410.1 General

Grouted and filled-cell masonry is a form of construction made with clay, shale or concrete units in which the interior vertical spaces are filled with grout. The interior vertical spaces shall consist of continuous cavity spaces between masonry wythes, or aligned, unobstructed vertical cells of hollow units. Grouted masonry shall conform to all requirements of 1401 to 1409 inclusive, except as modified by 1410.

1410.2 Mortar and Grout

1410.2.1 Mortar for masonry shall conform to ASTM C270 and this chapter. Grout shall conform to the requirements of ASTM C 476 and Table 1402.8C.

1410.2.2 Where the minimum continuous clear openings of a grout space exceeds 6 inches, it may be filled and treated as unreinforced monolithic concrete.

1410.3 Bond

Where all interior cavity spaces are filled with grout in double wythe construction, masonry headers shall not be used. Metal wall ties or joint reinforcement shall be used, in accordance with 1407.3 or 1407.7, respectively, to prevent spreading of the wythes and to maintain the vertical alignment of the wall.

1410.4 Construction Requirements

1410.4.1 Low-Lift Grouted Construction.

1410.4.1.1 All units in the two outer wythes shall be laid with full head and bed joints. Only Type M or Type S mortar shall be used. Mortar shall not protrude into spaces designed to be filled with grout.

1410.4.1.2 All longitudinal vertical (collar) joints to be grouted shall not be less than 3/4-inch thick.

1410.4.1.3 In walls of three or more withes, interior masonry units shall be placed or floated in grout poured between the two outer wythes so that at least 3/4 inch of grout surrounds the sides and ends of each unit.

1410.4.1.4 In grout spaces less than 2 inches in both horizontal dimensions, fine grout, as specified in ASTM C 476-AND 1402.8.2, shall be used. When such grout spaces are 2 inches or more in dimension, coarse or fine grout may be used.

1410.4.1.5 Metal ties or joint reinforcement, as required in 1407.3.1 or 1407.7, may be used to prevent spreading of the wythes. One exterior wythe may be carried up 16 inches before grouting, but the other exterior wythe shall be laid up and grouted in lifts not to exceed 12 inches.

1410.4.1.6 Each pour of grout shall be stopped at least 1 1/2 inches below the top of the last course laid and rodded or puddled immediately after pouring. If the work is to be stopped for 1 hour or longer, all masonry and grout shall be brought to the same level before stopping.

1410.4.2 High-Lift Grouted Construction.

1410.4.2.1 In high-lift construction, the masonry shall consist of two wythes with all units laid with full head and bed joints of either Type M or Type S mortar. The grout space (longitudinal vertical joint) shall be not less than 2 1/2 inches wide.

1410.4.2.2 The two wythes shall be tied together with metal ties. The ties shall be 3/16-inch diameter wire in the form of rectangles or Z shapes 2 inches less in length than the overall wall thickness.

1410.4.2.3 The spacing of ties shall not exceed 24 inches on center horizontally nor more than 16 inches vertically for walls laid in running bond. For stack bond, the tie spacing shall not exceed 12 inches on center in the vertical direction. Prefabricated joint reinforcement may be used as an alternate to individual metal ties in accordance with 1407.7.

1410.4.2.4 Mortar fins and other foreign matter shall be removed from the grout space prior to pouring grout. Vertical grout barriers or dams shall be built of solid masonry units across the grout space not more than 25 ft apart for the entire height of the wall to control flow of grout horizontally.

1410.4.2.5 The masonry walls shall cure at least three days to gain strength before pouring or pumping the grout. Grout shall be placed by pumping or by an approved alternate method, and no more than 2 hours after water has been added.

1410.4.2.6 Grouting shall be done in a continuous pour in lifts not exceeding 4 ft and shall be consolidated by rodding, puddling or mechanical vibrating during placing and reconsolidated after excess moisture has been absorbed by the masonry, but before plasticity has been lost.

1410.4.2.7 Grouting of any section of wall between vertical grout barriers shall be completed in one day, with no interruptions greater than 1 hour.

1410.4.2.8 Aluminum piping shall not be used to transfer grout.

1410.4.3 Filled Cell Masonry.

1410.4.3.1 All filled cell masonry shall be built to preserve the unobstructed vertical continuity of the cells to be filled with grout.

1410.4.3.2 Units shall be laid with full face shell mortar beds. All head (end) joints shall be continuously filled with mortar for a distance from the face of the wall or unit not less than the thickness of the longitudinal face shells. Cross webs adjacent to vertical cores to be filled shall be fully bedded with mortar to prevent leakage of grout.

1410.4.3.3 Bond of masonry units shall be provided by lapping units in alternate courses or by equivalent mechanical anchorage when units are laid in stack bond.

1410.4.3.4 All mortar fins or other obstruction or debris shall be removed from the insides of the walls of the cells to be filled with grout. All cells to be filled shall be filled solidly with grout.

1410.4.3.5 Grout shall be poured or pumped in lifts of 8 ft maximum height and shall be consolidated at time of pouring by rodding or vibrating, followed by reconsolidation later, before plasticity is lost. When total grout pour is to exceed 8 n high, it shall be done in 4 ft lifts.

1410.4.3.6 When grouting is to be stopped for 1 hour or longer between lifts, horizontal construction joints shall be formed by stopping the pour 1 1/2 inches below the top of the uppermost unit.

1411 REINFORCED MASONRY

1411.1 General

Reinforced masonry, other than that regulated by 1411.2, shall conform to the provisions of ACI/ASCE 530.

1411.2 Reinforced Solid Brick Masonry

Reinforced brick masonry using solid clay and/or shale units shall conform to the provision of BIA Building Code Requirements for Engineered Brick Masonry or ACI/ ASCE 530.

1412 STRUCTURAL GLASS BLOCK

1412.1 Where Permitted

Masonry of glass blocks may be used in nonloadbearing exterior or interior walls and in openings which might otherwise be filled with windows, either isolated or in continuous bands, provided the glass block panels have a thickness of not less than 3 1/2 inches at the mortar joint and the mortared surfaces of the blocks are satisfactorily treated for mortar bonding.

1412.2 Size of Panels

Glass block panels for exterior walls shall not exceed 144 sq ft of unsupported wall surface nor 25 ft in length nor 20 ft in height between supports. For interior walls, glass block panels shall not exceed 250 sq ft of unsupported area nor 25 ft in one direction between supports.

1412.3 Reinforcement of Exterior Panels

1412.3.1 Exterior glass block panels shall be held in place in the wall opening to resist both external and internal pressures due to wind. Panels shall be set in recesses at the jambs and, for panels exceeding 10 ft in horizontal dimension between supports, at the head as well, so as to provide a bearing surface at least 1 inch wide along the panel edges; except that when approved by the Building Official for panels not exceeding 100 sq ft in area nor 10 ft in either horizontal or vertical dimension, and situated four stories or less, anchorage may be provided by means of noncorrodible perforated metal strips.

1412.3.2 Glass block panels shall have reinforcement in the horizontal mortar joints, extending from end to end of mortar joints, but not across expansion joints, with any unavoidable joints spliced by lapping the reinforcement not less than 6 inches. The reinforcement shall be spaced not more than 2 ft apart vertically. In addition reinforcements shall be placed in the joint immediately below and above any openings within a panel. The reinforcement shall consist of two parallel, longitudinal, galvanized steel wires, 9 ga or larger, spaced 2 inches apart, and having welded thereto 14 ga or heavier cross wires at intervals not exceeding 8 inches, or the equivalent approved by the Building Official.

1412.4 Mortar

Glass block shall be laid in Type M, S or N mortar. Both vertical and horizontal mortar joints shall be at least 1/4-inch and not more than 3/8-inch thick and shall be completely filled.

1412.5 Expansion Joints

Every exterior glass block panel shall be provided with expansion joints at the sides and top. Expansion joints shall be entirely free of mortar, and shall be filled with resilient material.

CHAPTER 15

STEEL CONSTRUCTION

1501 GENERAL

The quality, design, fabrication and erection of steel and iron used structurally in buildings or structures shall conform to the provisions of this chapter and Chapter 30.

1502 STRUCTURAL STEEL CONSTRUCTION

The design, fabrication and erection of structural steel for buildings shall conform to the requirements of either the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings or the AISC Load and Resistance Factor Design Specification for Structural Steel Buildings.

1503 COLD-FORMED STEEL CONSTRUCTION

The design, fabrication and erection of cold-formed steel construction shall conform to the AISI Specification for the Design of 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.

1504 COLD-FORMED STAINLESS STEEL CONSTRUCTION

The design, fabrication and erection of cold-formed stainless steel construction shall conform to the AISI Specification for the Design of Cold-Formed Stainless Steel Structural Members.

1505 OPEN WEB STEEL JOIST CONSTRUCTION

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.

1506 STRUCTURAL STEEL CABLES

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.

1507 WELDING

Details of design, workmanship and technique for welding, inspection of welding, and qualification of welding operators shall conform to the following specifications:

1. AWS Structural Welding Code.
2. ANSI Specification for the Design of Cold-Formed Steel Structural Members.

1508 HIGH STRENGTH BOLTS

The design and assembly of structural joints and connections using high strength steel bolts shall conform to the Specification for Structural Joints Using ASTM A 325 or A 490 Bolts, approved by the Research Council on Structural Connections of the Engineering Foundation.

1509 MATERIAL STANDARDS

Steel for structural applications in buildings shall conform to ASTM A 6.

1510 PARAPET WALLS

Parapet walls framed of steel shall be designed as provided in the following:

1. All parapet walls shall be properly coped with noncombustible, weatherproof materials of a width not less than the thickness of the parapet wall.
2. 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.
3. 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 the SBCCI Standard for the Installation of Roof Coverings for the particular type of covering specified for the building. For other type materials follow manufacturer's specifications.

A scupper shall be sized in accordance with the Standard Plumbing Code. 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 nor more than 4 inches 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 the *Standard Plumbing Code*.

1511 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.

CHAPTER 16

CONCRETE CONSTRUCTION

1601 GENERAL

1601.1 Scope

1601.1.1 Structural members of reinforced concrete, including prestressed concrete, shall be designed and constructed in accordance with the provisions of this chapter and ACI 318.

1601.1.2 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.

1601.2 Special Provisions for Seismic Design

Appendix A of ACI 318, which contains special design requirements for reinforced concrete, shall be applied as required by 1206.9 and Table 1601.2. In Seismic Zones 0, 1 and 2, the requirements of Chapters 1 through 18 of ACI 318 shall also apply. In Seismic Zones 3 and 4 the requirements of Chapters 1 through 17 of ACI 318 shall also apply.

TABLE 1601.2
SECTION OF APPENDIX A OF AC1318 TO BE SATISFIED FOR SEISMIC DESIGN

	Seismic Zone (see Figure 1206.1)			
Structural element	**0**	**1**	**2**	**3,4**
Frame members resisting earthquake effects	None	A.9[1]	A.9	A.2, A.3, A.4, A.6, A.7
Walls, diaphragms and trusses resisting earthquake effects	None	None	None	A.2, A.5, A.6, A.7
Frame members not resisting earthquake effects	None	None	A.8[2]	A.8

1. A.9 for buildings in Seismic Zone 1 with an Importance Factor, I, of 1.5 only. For other buildings, none.
2. A.8 for buildings in Seismic Zone 2 with an Importance Factor, I, of greater than 1.0 only. For other buildings, none.

1602 MATERIALS

1602.1 General

Materials used to produce concrete and admixtures for concrete shall comply with the requirements of this section and ACI 318.

1602.2 Cements

Cement shall conform to ASTM C-150 or to such other cements listed in ACI 318.

1602.3 Aggregates

1602.3.1 Concrete aggregates shall conform to ASTM C 33 or to ASTM C 330.

1602.3.2 Aggregates failing to meet the specifications listed in 1602.3.1, 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.

1602.3.3 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 may be waived if, in the judgment of the Engineer, workability and methods of consolidation are such that concrete can be placed without honeycomb or voids.

1602.4 Water

1602.4.1 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.

1602.4.2 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 1603.5.4.

1602.4.3 Nonpotable water shall not be used in concrete unless specific requirements of ACI 318 allowing the use of nonpotable water are satisfied.

1602.5 Metal Reinforcement

1602.5.1 Reinforcement shall be deformed reinforcement, except that plain reinforcement may be used for spirals or tendons; and reinforcement consisting of structural steel, steel pipe, or steel tubing may be used as specified in ACI 318.

1602.5.2 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.

1602.5.3 Reinforcement shall conform to any of the several ASTM specifications listed in ACI 318.

1602.6 Admixtures

1602.6.1 Admixtures to be used in concrete shall be subject to prior approval by the Engineer.

1602.6.2 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 1603.2.

1602.6.3 Calcium chloride or admixtures containing chloride from other than impurities from admixture ingredients shall not he used in prestressed concrete, in concrete containing embedded aluminum, or in concrete cast against stay-in-place galvanized metal forms. See 1603.5.3 and 1603.5.4.

1602.6.4 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 specifications listed in ACI 318.

1602.6.5 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.

1602.6.6 Ground granulated blast-furnace slag used as an admixture shall conform to ASTM C 989.

1602.7 Storage of Materials

1602.7.1 Cement and aggregate shall be stored in such manner as to prevent deterioration or intrusion of foreign matter.

1602.7.2 Any material that has deteriorated or has been contaminated shall not be used for concrete.

1602.8 Tests of Materials

1602.8.1 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.

1602.8.2 Tests of materials and of concrete shall be made in accordance with ASTM standards listed in ACI 318.

1602.8.3 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 he preserved by the inspecting Engineer or Architect for that purpose.

1603 CONCRETE QUALITY

1603.1 General

1603.1.1 Concrete shall he proportioned to provide an average compressive strength as prescribed in 1603.3.2. Concrete shall he produced to minimize frequency of strengths below f'_c as prescribed in 1603.7.2.3. The specified compressive strength f'_c for concrete designed and constructed in accordance with this chapter shall be not less than 2500 psi.

1603.1.2 Requirements for f'_c shall be based on tests of cylinders made and tested as prescribed in 1603.7.2.

1603.1.3 Unless otherwise specified, f'_c shall he based on 28-day tests. If other than 28 days, test age of f'_c shall be as indicated in design drawings or specifications.

1603.2 Selection of Concrete Proportions

1603.2.1 Proportions of materials for concrete shall he 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 1603.5.
3. Conformance with strength test requirements of 1603.7.

1603.2.2 Where different materials are to be used for different portions of proposed work, each combination shall be evaluated.

1603.2.3 Concrete proportions, including water-cement ratio, shall be established on the basis of field experience and/or trial mixtures with materials to be employed as required by 1603.3, except as permitted in 1603.4 or required by 1603.5.

1603.3 Proportioning On The Basis Of Field Experience And/Or Trial Mixtures

1603.3.1 Standard Deviation:

1603.3.1.1 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 1000 psi 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 1603.7.1.4, except as provided in 1603.3.1.2.

1603.3.1.2 Where a concrete production facility does not have test records meeting requirements of 1603.3.1.1, 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 1603.3A. To be acceptable, test record must meet requirements 1 and 2 of 1603.3.1.1 and represent only a single record of consecutive tests that span a period of not less than 45 calendar days.

1603.3.2 Required average strength:

1603.3.2.1 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 1603.3.1.1 or 1603.3.1.2.

$$f'_{cr} = f'_c + 1.34s \text{ or} \quad (1)$$

$$f'_{cr} = f'_c + 2.33s - 500 \quad (2)$$

where s is the standard deviation, psi.

1603.3.2.2 When a concrete production facility does not have field strength test records for calculation of standard deviation meeting requirements of 1603.3.1.1 or 1603.3.1.2, required average strength f'_{cr} shall be determined from Table 1603.3B and documentation of average strength shall be in accordance with requirements of 1603.3.3.

TABLE 1603.3A
MODIFICATION FACTOR FOR STANDARD DEVIATION WHEN LESS THAN 30 TESTS ARE AVAILABLE

No. of tests[1]	Modification factor[2] for standard deviation
less than 15	Use Table 1603.3B
15	1.16
20	1.08
25	1.03
30 or more	1.00

1. Interpolate for intermediate numbers of tests.
2. Modified standard deviation to be used to determine required average strength f'_{cr} from 1603.3.2.1.

TABLE 1603.3B
REQUIRED AVERAGE COMPRESSIVE STRENGTH WHEN DATA ARE NOT AVAILABLE TO ESTABLISH A STANDARD DEVIATION

Specified compressive strength f'_c (psi)	Required average compressive strength f'_{cr} (psi)
less than 3000	$f'_c + 1000$
3000 to 5000	$f'_c + 1200$
Over 5000	$f'_c + 1400$

1603.3.3 Documentation of average strength:

Documentation that proposed concrete proportions will produce an average compressive strength equal to or greater than required average compressive strength (1603.3.2) may consist of a field strength test record, several strength test records, or trial mixtures.

1603.3.3.1 When test records are used to demonstrate that proposed concrete proportions will produce the required average strength f'_{cr} (1603.3.2), 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 may be used provided test records encompass a period of time not less than 45 days. Required concrete proportions may be established by interpolation between the strengths and proportions of two or more test records each of which meets other requirements of 1603.3.

1603.3.3.2 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-cement ratios or cement 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 in of maximum permitted, and for air-entrained concrete, within ±0.5% of maximum allowable air content.
4. For each water-cement ratio or cement 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-cement ratio or cement content and compressive strength at designated test age.
6. Maximum water-cement ratio or minimum cement content for concrete to be used in proposed work shall be that shown by the curve to produce the average strength required by 1603.3.2, unless a lower water-cement ratio or higher strength is required by 1603.5.

1603.4 Proportioning By Water-Cement Ratio

1603.4.1 If data required by 1603.3 are not available, permission may be granted by the building official to base concrete proportions on water-cement ratio limits shown in Table 1603.4.

1603.4.2 Table 1603.4 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.

1603.4.3 Concrete proportioned by water-cement ratio limits prescribed in Table 1603.4 shall also conform to special exposure requirements of 1603.5 and to compressive strength test criteria of 1603.7.

1603.5 Special Exposure Requirements

1603.5.1 Normal weight and lightweight concrete exposed to freezing and thawing or deicer chemicals shall be air-entrained with air content indicated in Table 1603.5A. Tolerance on air content as delivered shall be ±1.5%. For specified compressive strength f'_c greater than 5000 psi, air content indicated in Table 1603.5A may be reduced 1%.

When finely divided materials of fly ash or natural pozzolans are used as mineral admixtures (see 1602.6.5) 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 1603.5A.

1603.5.2 Concrete that is intended to be watertight or concrete that will be subject to freezing and thawing in a moist condition shall conform to requirements of Table 1603.5B.

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 1603.5 or deicer chemicals, shall comply with the requirements of Table 1603.5B1.

1603.5.3 Concrete to be exposed to sulfate-containing solutions shall conform to requirements of Table 1603.5C or be made with a cement that provides sulfate resistance and used in concrete with maximum water-cement ratio or minimum specified compressive strength from Table 1603.5C. 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 1603.5C.

1603.5.4 For corrosion protection, maximum water soluble chloride ion concentrations in hardened concrete at an age of 28 days contributed from the ingredients including water, aggregates, cementitious materials and admixtures shall not exceed limits of Table 1603.5D. When testing is performed to determine chloride ion content, test procedures shall conform to FHWA-RD-77-85.

1603.5.5 When reinforced concrete will be exposed to deicing salts, brackish water, seawater, or spray from these sources, requirements of Table 1603.5B for water-cement ratio or concrete strength and minimum concrete cover requirements of 1606.6 shall be satisfied.

1603.6 Average Strength Reduction

As data become 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 1603.3.2.1 using a standard deviation calculated in accordance with 1603.3.1.1, or
2. 15 to 29 test results are available and average of test results exceeds that required by 1603.3.2.1 using a standard deviation calculated in accordance with 1603.3.1.2, and
3. special exposure requirements of 1603.5 are met.

TABLE 1603.4
MAXIMUM PERMISSIBLE WATER-CEMENT RATIOS FOR CONCRETE WHEN STRENGTH DATA FROM FIELD EXPERIENCE OR TRIAL MIXTURES ARE NOT AVAILABLE

Specified compressive strength, f'_c (psi)[1]	Absolute water-cement ratio by weight	
	Non-air-entrained concrete	Air-entrained concrete
2500	0.67	0.54
3000	0.58	0.46
3500	0.51	0.40
4000	0.44	0.35
4500	0.38	[2]
5000	[2]	[2]

1. 28-day strength. With most materials, water-cement ratios shown will provide average strengths greater than indicated in 1603.3.2 as being required.
2. For strengths above 4500 psi (non-air-entrained concrete) and 4000 psi (air-entrained concrete), concrete proportions shall be established by methods of 1603.3.

TABLE 1603.5A
TOTAL AIR CONTENT FOR FROST-RESISTANT CONCRETE.

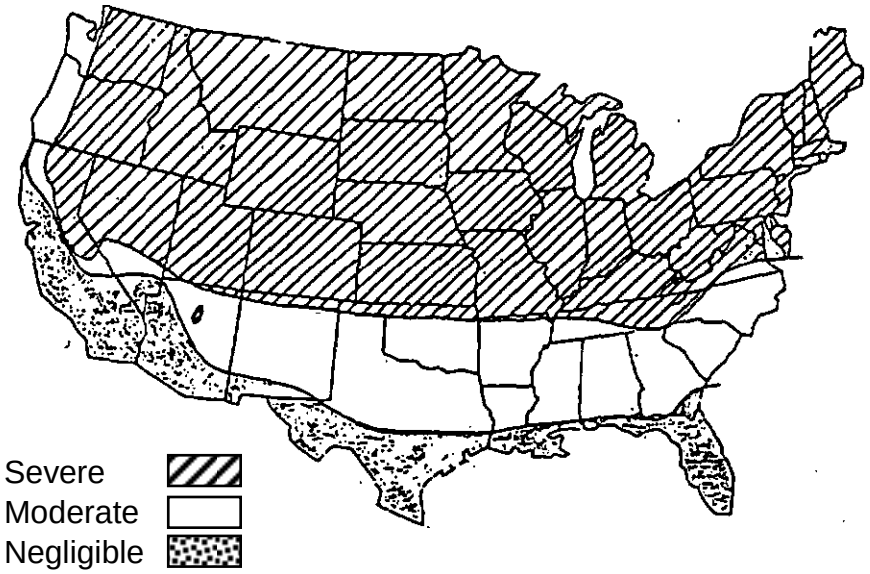
Maximum nominal[1] aggregate size (in)	Air content (%)	
	Severe exposure[3]	Moderate exposure[3]
3/8	7 1/2	6
1/2	7	5 1/2
3/4	6	5
1	6	4 1/2
1 1/2	5 1/2	4 1/2
2[2]	5	4
3[2]	4 1/2	3 ½

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 1603.5. 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 salts 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.

FIGURE 1603.5
WEATHERING PROBABILITY MAP FOR CONCRETE!
(For Use With Table 1603.5B1 Only)



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 1603.5B
REQUIREMENTS FOR SPECIAL EXPOSURE CONDITIONS

Exposure condition	Maximum water cement ratio, normal weight aggregate concrete	Minimum f'_c lightweight aggregate concrete (psi)
Concrete intended to be watertight:		
(a) Concrete exposed to fresh water	0.50	3750
(b) Concrete exposed to brackish water or seawater	0.45	4250
Concrete exposed to freezing and thawing in a moist condition:		
(a) Curbs, gutters, guardrails or thin sections	0.45	4250
(b) Other elements	0.50	3750
(c) In presence of deicing chemicals	0.45	4250
For corrosion protection for reinforced concrete exposed to deicing salts, brackish water, sea-water or spray from these sources	0.40[1]	4750[1]

1. If minimum concrete cover required by 1606.6 is increased by 0.5 in, water-cement ratio may be increased to 0.45 for normal weight concrete, or f'_c reduced to 4250 psi for lightweight concrete.

TABLE 1603.5B1
MINIMUM SPECIFIED COMPRESSIVE STRENGTH OF CONCRETE (f'_c) SUBJECT TO WEATHERING AND/OR DEICER CHEMICALS

Type and/or Location of Concrete Element	Minimum Specified Compressive Strength (f'_c)[1]		
	Weathering Probability[2]		
	Negligible	Moderate	Severe
Basement walls and foundations not exposed to the weather	2500	2500	2500[3]
Basement slabs and interior slabs and interior slabs-on-grade, except garage floor slabs	2500	2500	2500[3]
Basement walls, foundation walls, exterior walls, and other vertical concrete surfaces exposed to the weather	2500	3000[4]	3000[4]
Porches, carport slabs, and steps exposed to the weather, and garage floor slabs	2500	3000[4]	3500[4]

1. At 28 days, psi.
2. See Figure 1603.5 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 1603.5A.
4. Concrete shall be air trained in accordance with Table 1603.5A.

TABLE 1603.5C
REQUIREMENTS FOR CONCRETE EXPOSED TO SULFATE-CONTAINING SOLUTIONS

Sulfate exposure	Water soluble Sulfate (SO_4) in soil (% by weight)	Sulfate (SO_4) in water (ppm)	Cement type	Normal weight aggregate concrete: Maximum[1] water-cement ratio by weight	Lightweight aggregate concrete: Minimum[1] compressive strength, f'_c (psi)
Negligible	0.00-0.10	0-150			
Moderate[2]	0.10-0.20	150-1500	II, IP (MS}, IS (MS}	0.50	3750
Severe	0.20-2.00	1500-10,000	v	0.45	4250
Very severe	Over 2.00	Over 10,000	V plus pozzolan[3]	0.45	4250

1. A lower water-cement ratio or higher· strength may be required for watertightness or for protection against corrosion of embedded items or freezing and thawing (Table 1603.5B).
2. Seawater.
3. Pozzolan that has been determined by test or service record to improve sulfate resistance when used in concrete containing Type V cement.

TABLE 1603.5D
MAXIMUM CHLORIDE ION CONTENT FOR CORROSION PROTECTION

Type of member	Maximum water soluble chloride ion (Cl^-) in concrete (% by weight of concrete)
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

1603.7 Evaluation Of Acceptance Of Concrete

1603.7.1 Frequency of testing:

1603.7.1.1 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 of concrete nor less than once for each 5000 sq ft of surface area for slabs or walls.

1603.7.1.2 On a given project, if total volume of concrete is such that frequency of testing required by 1603.7.1.1 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.

1603.7.1.3 When total quantity of a given class of concrete is less than 50 cu yd, strength tests may be waived by the Building Official, if in his judgment evidence of satisfactory strength is provided.

1603.7.1.4 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.

1603.7.2 Laboratory-cured specimens:

1603.7.2.1 Samples for strength tests shall be taken in accordance with ASTM C 172.

1603.7.2.2 Cylinders for strength tests shall be molded and laboratory-cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39.

1603.7.2.3 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.

1603.7.2.4 If either of the requirements of 1603.7.2.3 is not met, steps shall be taken to increase the average of subsequent strength test results. Requirements of 1603.7.4 shall be observed if requirement of 1603.7.2.3(2) is not met.

1603.7.3 Field-cured specimens:

1603.7.3.1 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.

1603.7.3.2 Field-cured cylinders shall be cured under field conditions in accordance with ASTM C 31.

1603.7.3.3 Field-cured test cylinders shall be molded at the same time and from the same samples as laboratory-cured test cylinders.

1603.7.3.4 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.

1603.7.4 Investigation of low-strength test results:

1603.7.4.1 If any strength test (1603.7.1.4) of laboratory-cured cylinders falls below specified value of f'_c by more than 500 psi (1603.7.2.3(2)) or if tests of field-cured cylinders indicate deficiencies in protection and curing (1603.7.3.4) steps shall be taken to assure that load-carrying capacity of the structure is not jeopardized.

1603.7.4.2 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 below specified value of f'_c.

1603.7.4.3 If concrete in the structure will be dry under service conditions, cores shall be air dried (temperature 60 to 80° F, 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.

1603.7.4.4 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. To check testing accuracy, locations represented by erratic core strengths may be retested.

1603.7.4.5 If criteria of 1603.7.4.4 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.

1604 MIXING AND PLACING CONCRETE

1604.1 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.

1604.2 Mixing

1604.2.1 All concrete shall be mixed until there is a uniform distribution of materials and shall be discharged completely before mixer is recharged.

1604.2.2 Ready-mixed concrete shall be mixed and delivered in accordance with requirements of ASTM C 94 or ASTM C 685.

1604.2.3 Job-mixed concrete shall be mixed in accordance with ACI 318.

1604.3 Conveying

1604.3.1 Concrete shall be conveyed from mixer to place of final deposit by methods that will prevent separation or loss of materials.

1604.3.2 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.

1604.4 Depositing

1604.4.1 Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or flowing.

1604.4.2 Concreting shall be carried on at such a rate that concrete is at all times plastic and flows readily into spaces between reinforcement.

1604.4.3 Concrete that has partially hardened or been contaminated by foreign materials shall not be deposited in the structure.

1604.4.4 Retempered concrete or concrete that has been remixed after initial set shall not be used unless approved by the Engineer.

1604.4.5 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 1605.4.

1604.4.6 Top surfaces of vertically formed lifts shall be generally level.

1604.4.7 When construction joints are required, joints shall be made in accordance with 1605.4.

1604.4.8 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.

1604.5 Curing

1604.5.1 Concrete (other than high-early-strength) shall be maintained above 50°F and in a moist condition for at least the first 7-days after placement, except when cured in accordance with 1604.5.3.

1604.5.2 High-early-strength concrete shall be maintained above 50°F and in a moist condition for at least the first 3 days, except when cured in accordance with 1604.5.3.

1604.5.3 Accelerated curing shall conform to the following:

1. Curing by high pressure steam, steam at atmospheric pressure, heat and moisture, or other accepted processes, may be employed 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 1604.5.1 or 1604.5.2.
4. Supplementary strength tests in accordance with 1603.7.3 may be required to assure that curing is satisfactory.

1604.6 Cold Weather Requirements

1604.6.1 Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing weather.

1604.6.2 All concrete materials and all reinforcement, forms, fillers and ground with which concrete is to come in contact shall be free from frost.

1604.6.3 Frozen materials or materials containing ice shall not be used.

1604.7 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.

1605 FORMWORK, EMBEDDED PIPES, AND CONSTRUCTION JOINTS

1605.1 Design Of Formwork

1605.1.1 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.

1605.1.2 Forms shall be substantial and sufficiently tight to prevent leakage of mortar.

1605.1.3 Forms shall be properly braced or tied together to maintain position and shape.

1605.1.4 Forms and their supports shall be designed so as not to damage the previously placed structure.

1605.1.5 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.

1605.1.6 Forms for prestressed concrete members shall be designed and constructed to permit movement of the member without damage during application of prestressing force.

1605.2 Removal Of Forms And Shores

1605.2.1 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.

1605.2.1.1 Sufficient strength shall be demonstrated by structural analysis considering proposed loads, strength of forming and shoring system, and concrete strength data. Concrete strength data may 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.

1605.2.2 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.

1605.2.3 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.

1605.2.4 Form supports for prestressed concrete members may be removed when sufficient prestressing has been applied to enable prestressed members to carry their dead load and anticipated construction loads.

1605.3 Conduits And Pipes Embedded In Concrete

1605.3.1 Conduits, pipes and sleeves of any material not harmful to concrete and within limitations of 1605.3 may be embedded in concrete with approval of the Engineer, provided they are not considered to replace structurally the displaced concrete, except as provided in 1605.3.6.

1605.3.2 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.

1605.3.3 Conduits, pipes, and sleeves passing through a slab, wall, or beam shall not impair significantly the strength of the construction.

1605.3.4 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.

1605.3.5 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.

1605.3.6 Conduits, pipes, and sleeves may 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 and are spaced not less than three diameters on centers.

1605.3.7 In addition to other requirements of 1605.3 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. Temperature of liquid, gas, or vapor shall not exceed 150° F.
3. Maximum pressure to which any piping or fittings shall be subjected shall not exceed 200 psi above atmospheric pressure.
4. All piping and fittings except as provided in 1605.3.7(5) shall be tested as a unit for leaks before concrete placement. Testing pressure above atmospheric pressure shall be 50% in excess of pressure to which piping and fittings may be subjected, but minimum testing pressure shall not be less than 150 psi above atmospheric pressure. Pressure test shall be held for 4 hours with no drop in pressure except that which may be caused by changes in air temperature.
5. Drain pipes and other piping designed for pressures of not more than 1 psi above atmospheric pressure need not be tested as required in 1605.3.7(4).
6. Pipes carrying liquid, gas, or vapor that is explosive or injurious to health shall again be tested as specified in 1605.3.7.4 after concrete has hardened.
7. No liquid, gas, or vapor, except water not exceeding 90°F nor 50 psi pressure, shall be placed in the pipes until the concrete has attained its design strength.
8. In solid slabs, piping, unless it is for radiant heating or snow melting shall be placed between top and bottom reinforcement.
9. Concrete cover for pipes and fittings shall not be less than 1 1/2 inches for concrete exposed to earth or weather, nor 3/4 inch for concrete not exposed to weather or in contact with ground.
10. Reinforcement with an area of not less than 0.002 times area of concrete section shall be provided normal to piping.
11. Piping shall be so fabricated and installed that cutting, bending or displacement of reinforcement from its proper location will not be required.

1605.4 Construction Joints

1605.4.1 Surface of concrete construction joints shall be cleaned and laitance removed.

1605.4.2 Immediately before new concrete is placed, all construction joints shall be wetted and standing water removed.

1605.4.3 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.

1605.4.4 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.

1605.4.5 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.

1605.4.6 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.

1606 DETAILS OF REINFORCEMENT

1606.1 General

Details of reinforcement shall comply with the requirements of this section and ACI 318.

1606.2 Bending Reinforcement

1606.2.1 All reinforcement shall be bent cold, unless otherwise approved by the Engineer.

1606.2.2 Reinforcement partially embedded in concrete shall not be field bent except as shown on the design drawings or approved by the Engineer.

1606.3 Surface Conditions Of Reinforcement

1606.3.1 At time concrete is placed, metal reinforcement shall be free from mud, oil, or other nonmetallic coatings that adversely affect bonding capacity.

1606.3.2 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 ASTM specification requirements.

1606.3.3 Prestressing tendons shall be clean and free of oil, dirt, scale, pitting and excessive rust. A light oxide is permissible.

1606.4 Placing Reinforcement

1606.4.1 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 1606.4.2.

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 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.

1606.4.2 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 d	Tolerance on Minimum Concrete Cover
d ≤ 8 in	± 3/8 in	- 3/8 in
d > 8 in	± 1/2 in	- 1/2 in

Except that tolerance for the clear distance to formed soffits shall be minus 1/4 inch 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 except at discontinuous ends of members where tolerance shall be ± 1/2 inch.

1606.4.3 Welded wire fabric (with wire size not greater than W5 or D5) used in slabs not exceeding 10 ft 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.

1606.4.4 Welding of crossing bars shall not be permitted for assembly of reinforcement unless approved by the Engineer.

1606.5 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.

1606.6 Concrete Protection For Reinforcement

1606.6.1 The following minimum concrete cover, in inches, shall be provided for reinforcement in cast-in-place concrete (non-prestressed)

Concrete cast against and permanently exposed to earth	3
Concrete exposed to earth or weather:	
#6 through #18 bars	2
#5 bar, W31 or D31 wire, and smaller	1 1/2
Concrete not exposed to weather or in contact with ground:	
Slabs, walls, joists:	
#14 and #18 bars	1 1/2
#11 bar and smaller	3/4
Beams, columns:	
Primary reinforcement, ties, stirrups, spirals	1 1/2
Shells, folded plate members:	
#6 bar and larger	3/4
#5 bar, W31 or D31 wire, and smaller	1/2

1606.6.2 The minimum cover for reinforcement in precast concrete manufactured under plant control conditions, and prestressed concrete shall be in accordance with ACI 318.

1606.6.3 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.

1606.6.4 Exposed reinforcement, inserts and plates intended for bonding with future extensions shall be protected from corrosion.

1606.6.5 When this Code requires a thickness of cover for fire protection greater than the minimum concrete cover specified in 1606.6.1 or ACI 318, such greater thicknesses shall be used.

1607 MINIMUM SLAB THICKNESS

The minimum thickness of concrete floor slabs supported directly on the ground shall not be less than 3 1/2 inches unless designed by an architect or engineer. A vapor retarder consisting of 6 mil minimum polyethylene with joint lapped 6 inches and taped, or other approved materials having a maximum perm rating of 0.5 shall be installed underneath the slab.

EXCEPTIONS: The vapor retarder may be omitted:

l. 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, or
4. where approved by the Building Official, based upon local site conditions.

1608 GFRC EXTERIOR WALL PANELS

The minimum thickness of glass fiber reinforced concrete (GFRC) exterior wall panels shall be 3/8 inch.

EXCEPTIONS:

l. Sandwich wall panels
2. Glass fiber reinforced concrete wall forms which are left in place.

1609 PARAPET WALLS

Parapet walls constructed or framed of concrete shall be designed as provided in the following:

l. All parapet walls shall be properly coped with noncombustible weatherproof materials of a width not less than the thickness of the parapet wall.
2. 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.
3. 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 the SBCCI Standard for the Installation of Roof Coverings for the particular type of covering specified for the building. For other type materials follow manufacturer's specifications.

A scupper shall be sized in accordance with the *Standard Plumbing Code*. 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 nor more than 4 inches 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 the *Standard Plumbing Code*.

CHAPTER 17

WOOD CONSTRUCTION

1701 SCOPE

1701.1.1 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 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 in 1701.2.5 shall be accepted as good engineering practice.

1701.1.2 For heavily loaded or engineered timber construction, structural design based on the recommendations of the standards listed in 1701.2.5 shall be accepted as conformance with good engineering practices.

1701.1.3 Other sections of this chapter which are applicable shall apply to heavily loaded or engineered timber construction as well as light frame construction.

1701.2 Design

1701.2.1 The quality and design of wood members and their fastenings used for load supporting purposes shall conform to good engineering practice.

1701.2.2 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.

1701.2.3 Preparation, fabrication and installation of wood members and the glues, connectors, and mechanical devices for the fastening thereof shall conform to good engineering practices.

1701.2.4 For engineered plywood structural diaphragm design, provisions of 1710 shall apply. For engineered particle board structural diaphragm design, provisions of 1711 shall apply.

1701.2.5 The following standards shall be accepted as conformance 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 Roof Decking

AITC 113: Standard for Dimensions of Glued Laminated Structural Member

AITC 117: Structural Glued Laminated Timber of Softwood Species

AITC 119: Standard Specifications for Hardwood Glued Laminated Timber

American Plywood Association:

Design and Fabrication Specifications for Plywood-Lumber Components

APA Design/Construction Guide- Residential & Commercial

Cantilevered In-Line Joist System

Plywood Design Specifications

PRP- 108 Performance Standards and Policies for Structural-Use Panels

Truss Plate Institute, Inc.

Design Specifications For Light Metal Plate Connected Wood Roof Trusses

American Wood Preservers Institute:

Pole Building Design

National Particleboard Association:

How To Install Particleboard Underlayment

1701.3 Determination Of Required Sizes

1701.3.1 All wood structural members shall be of sufficient size to carry the dead and required live loads without exceeding the allowable working stresses as contained in the standards listed in 1701.2.5.

1701.3.2 Where applicable as determined by end use, allowable working stresses may be determined by machine stress rating as approved by the American Lumber Standards Committee.

1701.3.3 Where minimum sizes 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 the American Lumber Standards.

1701.3.4 For convenience, nominal sizes may be shown on the plans. If rough sizes or finished sizes greater or smaller than American Lumber Standard 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.

1701.4 Quality Of Materials

1701.4.1 All lumber used for load-supporting purposes, including end-jointed or edge-glued lumber, shall be identified by the grade mark of an approved lumber grading or inspection agency. Grading practices and identification shall be in accordance with rules published by an approved agency. In lieu of a grade mark on the material, a certificate of inspection as to species and grade issued by an approved lumber grading or inspection agency may be accepted for precut, remanufactured, or rough-sawn lumber, and for sizes larger than 3 inches nominal thickness.

1701.4.2 Structural glued laminated timber shall be manufactured and identified as required in ANSI/AITC A190.l.

1701.4.3 Wood structural panels when used structurally (including among others that 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 or APA PRP-108. Wood structural panels shall include plywood, oriented strand board (OSB), waferboard 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 1701.2.5 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.

1701.4.4 Wood shingles and shakes shall be identified by the grademark of a grading or inspection bureau or agency recognized as being competent.

1701.4.5 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.

1701.4.6 Particleboard shall conform to ANSI A208.1. Particleboard shall be identified by the grade mark or certificate of inspection issued by an approved agency.

1701.4.6.1 Particleboard floor underlayment shall conform to Type 1-M-1 or Sanded Type 2-M-W of ANSI A208.l. Type l-M-1 underlayment shall be not less than 1/4-inch 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 thick and shall be installed in accordance with the installation instructions of The Waferboard Association and the manufacturer.

1701.4.6.2 Particleboard subfloor or combination subfloor-underlayment shall conform to one of the grades in Table 1706.6B.

1701.4.7 All lumber, sawn timber, plywood and poles supporting permanent structures required by 1703 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 quality control standards listed in Appendix C. Quality control inspection agencies for pressure treated wood shall be certified as to competency and performance by an approved organization.

1701.4.8 Hardwood and decorative plywood shall be manufactured and identified as required in ANSI/HPMA HP.

1701.4.9 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]) - National Oak Flooring Manufacturers Association

Mosaic-Parquet Hardwood Slat Flooring, ANSI/APA 1

Hard Maple Flooring Standard Specification (Hard Maple, Beech and Birch) - Maple Flooring Manufacturers Association.

1701.4.10 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 or 1/4-inch service class hardboard planed or sanded on one side to a uniform thickness of not less than 0.200 inch. Prefinished hardboard paneling shall meet the requirements of ANSI/AHA A135.5. Other basic hardboard products shall meet the requirements of ANSI/AHA A135.4.

1701.4.11 Wood veneer and flakeboard core composite framing consisting of wood veneer facings laminated to an oriented flakeboard core shall conform to the Performance and Quality-Control Standards for Composite Floor, Wall, and Truss Framing published by the USDA-Forest Service in General Technical Report SE-33-1985. Manufacturers of composite structural framing shall provide the North Carolina Building Code Council with their names, the name of the product, and the name of the certifying agency annually or whenever there is a change in the certifying agency. These certifying agencies shall provide information to the North Carolina Building Code Council that shows conformance with the definition of a qualified inspection and testing agency as described in Part 11, Section 2 of the USDA-Forest Service's General Technical Report SE-33. This composite framing is for interior use only. The stiffness of the flakeboard in composite structural framing to be at least four times greater in the lengthwise direction than in the widthwise direction.

EXCEPTION: Average dry tension shear strength of the laminating adhesive veneer-to-veneer bond test specimen shall be acceptable if 50 psi or greater.

1701.4.12 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. Manufacturers are required to furnish to the North Carolina Building Code Council fastener information as outlined in paragraphs, 3.4.10, 3.4.11, 3.4.12, and 3.4.13 on Technical Report SE-33.

1701.4.13 All structural-use panels shall conform to performance criteria for their end use, as well as to applicable qualification and quality assurance policies, defined in PRP-108 Performance Standards and Policies for Structural Use Panels. Each panel shall be identified for end-use grade, span rating and exposure durability classification by the trademark of an approved testing and grading agency. Structural-use panels, when permanently exposed in outdoor applications, shall be classified Exterior, except that roof sheathing of Exposure I durability classification may be exposed to the outdoors on the underside.

1701.5 Minimum Lumber Grades

1701.5.1 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 roof and ceiling loads only.
3. For nonloadbearing studs: Utility Grade.

1701.6 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.

1701.7 Moisture Content

All dressed dimensional lumber 2 inches and less in thickness including pressure preservatively treated lumber and plywood used for interior construction shall contain not more than 19% moisture at the time of permanent incorporation in a building.

1702 CONSTRUCTION PRACTICES

1702.1 Preparation of Building Site and Removal of Debris

1702.1.1 All building sites shall be graded so as to provide drainage under all portions of the building not occupied by basements.

1702.1.2 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.

1702.1.3 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.

702.2 Foundations

1702.2.1 Foundations shall be designed and constructed in accordance with the provisions of 1205.7 and 1302. Where spot piers are used, spacing shall not exceed 8ft o.c. unless engineering analysis indicates a greater spacing is acceptable.

1702.2.2 A one story building, except a dwelling, which does not exceed 400 sq ft 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 1205.7. Mud sills shall be not less than a 2x6 or 3x4.

1702.3 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. Where vertical joints occur, felt or paper shall be lapped not less than 6 inches.

EXCEPTIONS: The approved barrier is not required:

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.
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.

1703 PROTECTION AGAINST DECAY AND TERMITES

1703.1 Protection

1703.1.1 Where protection of wood members is required by this section, protection shall be provided by using naturally durable or pressure treated wood.

1703.1.1.1 The expression "naturally durable wood" refers to the heartwood of the following species with the exception that an occasional piece 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.

1703.1.1.2 The expression "pressure treated wood" refers to wood meeting the retention, penetration and other requirements applicable to the species, products, treatment and conditions of use in the approved standards of the American Lumber Standards Committee, as listed in Table 1703.

TABLE 1703
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]	C2/C9
Ground Contact	10	0.40	C2/C9
In Salt Water	25	2.5	C2/C9
Round Piles[3]			
Land or Freshwater Use	12	0.8	C3
In Salt Water	20	2.5	C18
Square Piles[4]			
Land or Freshwater Use	12	0.8	C24
In Salt Water	20	2.5	C18
Poles[5]			
Utility	9	0.6	C4
Structural	9	0.6	C4

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

1703.1.1.3 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 1703. The competency and performance of quality control inspection agencies for pressure treated wood shall be approved by the North Carolina State Building Code Council. The Southern Pine Inspection Bureau and inspection agencies approved by the Board of Review of the American Lumber Standard Committee shall be deemed as approved. All lumber shall be permanently marked so that the approved inspection agency, preservative, retention, treating company and year of treatment can be identified in service. Marking shall be as follows:

1. All rough lumber, 6x6 inch pilings and larger, 6 inch diameter and larger pilings and dressed dimensional lumber thicker than 2 inch shall be marked legibly with indelible ink, branding or non-corrosive metal tags.

2. All dressed dimensional lumber 2 inches and less in thickness and dressed dimensional 4 x 4 inch shall be legibly marked with indelible ink, branding or non-corrosive tags. If tags are used, after construction is completed, the contractor shall insure that 20% to 30% of the lumber used has an identification tag in an accessible location. This may require reattaching tags on the end or bottom of a portion of the lumber used.
3. Treating plants during normal working hours shall permit members of the North Carolina State Building Code Council or their staff access to its plant to monitor the performance of the third party agency by inspecting the operating of the facility and examining all records of the certification program.

1703.1.1.4 Wood subject to damage from both decay and termites shall be a naturally durable species resistant to termites or pressure treated.

1703.1.2 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.

1703.1.3 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.

1703.1.4 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 columns.

1703.1.5 When in contact with the ground, foam plastic shall be treated to resist termites. A 1-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.

1703.2 Wood In Ground Contact Or Exposed To The Weather

1703.2.1 Where wood is embedded in or in contact with the ground for support of permanent structures, it shall have an approved pressure preservative treatment suitable for ground contact use except where continuously below the groundwater line or continuously submerged in fresh water.

1703.2.2 Round or rectangular posts, poles, and sawn timber columns supporting permanent structures which are embedded in concrete in direct contact with earth or embedded in concrete exposed to the weather shall be approved pressure treated wood.

1703.2.3 Posts or columns supporting permanent structures which are closer than 8 inches 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.

1703.2.4 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 above concrete or masonry floors or decks and 6 inches above exposed earth and separated therefrom by an approved impervious barrier except when approved naturally durable or pressure treated wood is used.

1703.2.5 Clearance between wood siding and earth on the exterior of a building shall be not less than 6 inches except where siding, sheathing and wall framing are of approved pressure treated wood or approved naturally durable wood.

1703.2.6 Those portions of glued laminated timbers 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 preservatively treated or be manufactured from naturally durable wood.

1703.3 Crawl Space Construction

1703.3.1 Crawl spaces under buildings without basements shall be ventilated in accordance with 3201.3.3.

1703.3.2 Usable crawl spaces under buildings without basements shall be provided with a minimum of one access opening not less than 18 x 24 inches. Access openings shall be readily accessible and provided with a door or device that may be easily removed or operated.

1703.3.3 All wood framing and sheathing less than 8 inches from exposed earth in exterior walls that rest on treated wood, concrete or masonry foundations shall be approved naturally durable or pressure treated wood.

1703.3.4 When the bottoms of wood structural floor elements, including joists, girders and subfloor, are less than 8 inches above the horizontal projection of the outside grade level and extend toward the outside grade beyond the plane represented by the interior face of the foundation wall studs, such elements shall be approved naturally durable or pressure treated wood.

1703.3.5 When wood joists or the bottom of wood structural floors without joists are closer than 18 inches or wood girders are closer than 12 inches 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.

1703.4 Slabs

1703.4.1 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.

1703.4.2 Wood structural member 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.

1703.5 Walls

1703.5.1 Ends of wood girders entering exterior masonry or concrete walls shall be provided with 1/2-inch air space on tops, sides and ends unless approved naturally durable or pressure treated wood is used.

1703.5.2 Wood furring strips or other wood framing members attached directly to the interior of exterior masonry of concrete walls below grade shall be approved naturally durable or pressure treated wood.

1703.5.3 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 2ft 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 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 high and is separated from the property line or a permanent building by a minimum distance equal to the height of the wall.

1704 FIRE PROTECTION

1704.1 Firestopping

1704.1.1 Firestopping shall be provided to cut off all vertical and horizontal concealed draft openings. Firestopping shall be as indicated in this section and as provided in 705.

1704.1.2 Firestopping, when of wood, shall be not less than 2 inches thick and shall effectively fill all spaces for the entire width or depth of the framing or structural member.

1704.1.3 Firestopping, when of other materials as provided in 705, 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.

1704.1.4 Firestopping 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 noncombustible materials, except in the case of approved metal chimney installations as set forth in 802.4.
5. In concealed spaces created by an assembly of floor joists, firestopping shall be provided for the full depth of the joists at the ends and over the supports.

1704.1.5 Except as provided in 1704.1.4(4), firestopping shall consist of 2-inch nominal lumber, or two thicknesses of l-inch nominal lumber with broken lap joints, or one thickness of 23/32-inch plywood or structural-use panel with joints backed by 23/32-inch plywood or structural-use 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.

1704.2 Draftstopping

1704.2.1 Draftstopping shall be provided in wood frame construction in the locations listed in 1704.2.2 and 1704.2.3.

1704.2.2 Floor/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. Draftstopping shall be provided parallel to the main framing members.
2. Multifamily (two or more) dwellings, motels, hotels. 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 1000 sq ft.

1704.2.3 Attics:

1. Single family dwellings. None required.
2. Multifamily (two or more) dwellings, motels, hotels. 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, draft-stopping 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, 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 3000 sq. ft. of attic space.
   4. 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 3000 sq ft.
   EXCEPTIONS:
   l. 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.

1704.2.4 Ventilation of concealed roof spaces shall be maintained in accordance with 1708.8.

1704.2.5 Draftstopping materials shall be not less than 1/2-inch gypsum board, 15/32-inch plywood or structural-use panel, 1/2-inch particleboard or other approved materials adequately supported.

1704.2.6 The integrity of all draftstops shall be maintained.

1704.3 Fire Resistance Ratings

1704.3.1 When fire resistance ratings are specified by this Code, they shall be provided in conformance with the requirements of Chapter 10.

1704.3.2 Where fire resistance ratings are involved, wood spacers, backup cleats or other devices shall not be used unless specifically approved for such use.

1704.4 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 or provided with wall plate boxes of self-releasing type or approved hangers, and if located in a required fire resistant wall shall be separated from the opposite side of the wall by at least 4 inches of solid masonry.

1705 FASTENINGS

1705.1 Nailing And Stapling Requirements

The number and size of nails or staples connecting wood members shall not be less than those specified in Table 1705.1. 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.

1705.2 Other Fastenings

Where framing anchors, clips, staples, glues, or other methods of fastening are used, they shall be installed in accordance with the manufacturer's instructions.

TABLE 1705.1
FASTENING SCHEDULE

Connection	Fastener	Number if Spacing
Joist to sill or girder, toe nail	8d common	3
Bridging to joist, toe nail each end	8d common	2
Ledger strip	16d common	Below each joist at 2” o.c.
1x6 subfloor or less 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” 0.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 sheathing or less 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
Plywood, structural-use panel and Particleboard Subflooring[5]		
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 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

TABLE 1705.1
FASTENING SCHEDULE (Continued)

Connection	Fastener	Number if Spacing
19/32", 5/8"		2 1/2" o.c. edges and 4" o.c. intermediate
Plywood, structural-use 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	8d 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 plywood or particleboard thickness	4" o.c. edges and 8" o.c. intermediate
19/32" – 3/4"		2" o.c. edges and 5" o.c. intermediate
1/2" fiberboard sheathing*	1 ½" galvanized roofing nail 6d common wall	3" o.c. edges and 6" o.c. intermediate
25/32" Fiberboard Sheathing*	1 3/4" galvanized roofing nail 8d common nail	3" o.c. edges and 6" o.c. at other bearings
1/2" or 5/8" Gypsum Sheathing	12 ga 1 1/4" large head corrosion resistant	4" o.c. edges and 8" o.c. at other bearings
Gypsum Wallboard		
1/2"	1 3/8" drywall nail**	7" o.c. on ceilings 8" o.c. on walls
5/8"	1 1/2" drywall nail**	7" o.c. on ceilings 8" o.c. on walls
Particleboard Siding		
3/8" – 1/2"	6d[2]	
5/8" [3]	8d[2]	
3/4" [4]	8d[2]	

* Fiberboard sheathing may be stapled using 16 ga galvanized staples 1 1/8" long for 1/2" sheathing and 1 ½" long for 25/32" sheathing. Staples to have minimum crown if 7/16" and spaced 3" o.c. at edges and 6" o.c. at other bearings.

** Drywall nails shall conform to ASTM C 514.

1. Siding applied to 5/8" net wood sheathing, 15/32" plywood or structural-use panel, or 1/2" particleboard.
2. 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".
3. Siding applied to studs spaced 16" on center maximum.
4. Siding applied directly to studs spaced 24" on center maximum.
5. Use annular or spiral thread nails for combination subfloor/underlayment.

1706 FLOOR FRAMING

1706.1 Sills On Foundation

Sills on continuous foundation walls shall be not less than 2 inches thick and shall be anchored thereto by 1/2-inch bolts spaced not more than 6 ft span and which are embedded at least 6 inches in concrete or 8 inches 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.

1706.2 Beams And Girders

Beams and girders shall be designed in accordance with 1701.1 or 1701.2.5. The Building Official shall require the seal of a registered architect or professional engineer on any laminated timber design, bracing and anchor, if the span is over 20 feet. 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.

1706.3 Floor Joists

1706.3.1 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 1701.2 or 1701.3.1.

1706.3.2 Spans for field-glued plywood-lumber and structural-use 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.

1706.3.3 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 bearing on wood or metal nor less than 3 inches bearing on masonry.

1706.3.4 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, shall be supported laterally by bridging or blocking installed at intervals not exceeding 8 ft.

1706.3.5 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.

1706.3.6 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 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.

1706.3.7 Joists framing from opposite sides of a beam, girder or partition shall be lapped at least 3 inches and fastened, or the opposing joists shall be tied together in an approved manner.

1706.3.8 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.

1706.4 Framing Around Openings

Trimmer and header joists shall be doubled when the span of the header exceeds 4 ft. The ends of header joists more than 6 ft 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 long shall be supported at header by framing anchors or on not less than 2x2 ledger strips.

1706.5 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.

1706.6 Subfloors

1706.6.1 Except as provided in 1706.6.2, all floor joists shall be covered with subflooring of lumber as shown in the following table, plywood or structural-use panels applied in accordance with Table 1706.6A and fastened in accordance with Table 1705.1, or particleboard applied in accordance with Table 1706.6B and fastened in accordance with Table 1705.1.

	Minimum Net Thickness (in) For Lumber Placed:	
Joist Spacing (in)*	**Perpendicular to Joists**	**Diagonally to Joists**
24	11/16	3/4
16	5/8	5/8
12	5/8	5/8

*Joints in subflooring shall occur over supports unless end-matched lumber is used, in which case each piece shall bear on at least two joist.

1706.6.2 Subflooring may be omitted when joist spacing does not exceed 16 inches and nominal l-inch tongue and grooved wood strip flooring is applied perpendicular to the joists.

1706.6.3 When resilient flooring is applied directly to plywood subfloor, the subfloor shall be applied in accordance with Table 1706.6C and fastened in accordance with Table 1705.1.

1706.6.4 When resilient flooring is applied directly to structural-use panel subfloor, the panel shall be identified for single-floor use and shall be applied over joists spaced no farther apart than the rating indicated on the panel. Structural-use panels for single-floor use at rated spans of 32" or less support 85 psf floor live load plus 25 psf dead load at rated maximum span. Panels with rated span of 48" support 65 psf total load. Panels shall be fastened in accordance with Table 1705.1.

1706.7 Plank-And-Beam Framing

1706.7.1 Beams supporting plank floors shall not exceed the limitations set forth in 1706.2.

1706.7.2 The allowable span for 2-inch planks shall be determined in accordance with 1701.2 or 1701.3.1.

1706.8 Floor Framing To Masonry Walls

Wood floor construction which rests on masonry walls shall be anchored thereto in accordance with 1408.3.

1706.9 Stair Framing

1706.9.1 Stair framing shall be supported adequately on floor framing or on walls or partitions.

1706.9.2 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.

1706.9.3 Unless stringers are supported on walls or partitions, the minimum effective depth at each notch shall be not less than 3 1/2 inches (927 mm).

TABLE 1706.6A
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)[7]	Maximum Span (in)[7]		Load (psf)[7]		
Roof/Floor Span		With Edge Support[2]	Without Edge Support	Total Load	Live Load	Maximum Span
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
32/16	15/32, 1/2, 5/8	32	28	40	30	16[5]
40/20	19/32, 5/8, 3/4, 7/8	40	32	40	30	20[4,5]
48/24	23/32, 3/4, 7/8	48	36	45	35	24
Single Floor Grade		**Roof**				**Floor**
Span Rating	Panel Thickness (in)[7]	Maximum Span (in)[7]		Load (psf)[7]		
Roof/Floor Span		With Edge Support[2]	Without Edge Support	Total Load	Live Load	Maximum Span
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. 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 1-1/2 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 joist.
6. Shall apply only to panels 24 inches or wider.
7. 1 inch= 25.4mm: 1 psf = 4.882 kg/m^2

TABLE 1706.6B
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-F	3/4	20	20
2-M-3	3/4	20	20

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: 3/160th of the span under 100 psf minimum load.
3. Edges shall have tongue-and-groove joints or shall be supported with blocking unless 1/4" minimum thickness underlayment or 1-1/2” approved cellular or lightweight concrete is installed, or finish floor is 3/4" wood strips.

TABLE 1706.6C
ALLOWABLE SPANS FOR WOOD STRUCTURAL PANEL COMBINATION SUBFLOOR/UNDERLAYMENT (SINGLE FLOOR)[1]
Panels Continuous over Two or More Spans and Long Grain Panel Dimension Perpendicular to Supports

Identification	Maximum Spacing of Joists (in)[4]				
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. Spans shall be limited to values shown because of possible effect of concentrated loads. Allowable uniform load based on 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" approved cellular or lightweight concrete is installed, or finish floor is 3/4-inch wood strip. If wood strips are perpendicular to supports, thicknesses shown for 16" and 20” spans shall have a maximum span of 24".
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.
4. 1 inch = 25.4mm.

1706.10 Exterior Decks

Exterior decks shall be structurally designed by a professional engineer or registered architect.

EXCEPTIONS:

1. Group R2 occupancies with deck area of 100 sq ft or less shall meet the requirements of Appendix A.

2. Group R3 and townhouses shall meet the requirements of the *North Carolina State Building Code, Volume VII-Residential*.

1707 VERTICAL FRAMING

1707.1 Exterior Wall Framing

1707.1.1 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 first story shall be not less than 3x4 or 2x6. Studs shall be spaced not more than the following:

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

1707.1.2 Utility grade studs shall not be spaced more than 16 inches (407 mm) on center, support more than a roof and ceiling and exceed 8ft (2438 mm) in height for exterior load bearing walls.

1707.1.3 Heights listed in 1707.1.1 are distances between points of horizontal lateral support placed perpendicular to the plane of the wall. Heights may be increased where justified by analysis.

1707.1.4 Where floor trusses, floor joists or roof trusses are spaced more than 16 inches (407 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.

1707.1.5 Sheathing, where required for exterior walls, shall be applied solidly over the wall surface and shall be one or more of the following materials, installed in accordance with the manufacturer's recommendations:

1. Wood boards and sheathing panels 5/8-inch minimum thickness.
2. Plywood complying with Table 1707.1 A shall be not less than 5/16 inch thick for 16 inch stud spacing or not less than 3/8 inch for 24-inch stud spacing. Plywood of exterior type complying with 811.6.4, including Table 1707.1C, may also serve as siding. Sheathing paper may be omitted over plywood except where exterior stucco finish, brick veneer, and exterior wall coverings which permit passage of water are used.
3. Fiberboard not less than 7/16-inch thick.
4. Gypsum not less than 1/2-inch thick.
5. Particleboard when it conforms to ANSI A208.1 grades in Table 1707.1B.

6. Structural-use sheathing panels with a rated wall span of 16 inches or roof span of 16 inches or roof span of 16 or 20 inches shall have a maximum stud spacing of 16"; panels with a rated wall or roof span of 24 inches shall have a maximum stud spacing of 24". Panels may be installed either vertically or horizontally, and shall be fastened in accordance with Table 1705.1. Structural-use panels of exterior type complying with Section 1701.4.13 may also serve as siding. Sheathing paper may be omitted over structural-use panels except where exterior stucco finish, brick-veneer, and exterior wall coverings which permit passage of water are used.

TABLE 1707.1A
ALLOWABLE SPANS FOR WOOD STRUCTURAL PANEL WALL SHEATHING[1,2]

Panel Span Rating	Panel thickness (in)[4] and Construction	Maximum Stud Spacing (in)[4] Exterior covering nailed to:	
		Stud	Sheathing
12/0, 16/0, 20/0 or Wall-16oc	5/16	16	16[3]
24/0, 24/16, 32/16 or Wall-24oc	3/8, 7/16, 15/32, 1/2	24	24[5]

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. 1 inch; 25.4mm.
5. 3-ply plywood panels shall be applied with long dimension across studs.

TABLE 1707.1B
ALLOWABLE SPANS FOR PARTICLEBOARD WALL SHEATHING
Not Exposed to the Weather, Long Dimensions of the Panel Parallel or Perpendicular to Studs

		Stud Spacing (in)	
Grade	Thickness (in)	Siding Nailed to Studs	Sheathing Under Coverings Specified in 811.6.3 and 811.7 Parallel or Perpendicular to Studs
2-M-W	5/16	16	---
and	3/8	24	16
2-M-F	7/16	24	24
2-M-1	3/8	16	---
and			
2-M-2	1/2	16	16

TABLE 1707.1C
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	3/8	6d	Noncorrosive, box or casing nails	4	One nail per stud on widths 12 or less, 8 for widths greater than 12
	1/2 & thicker	8d			
303 Specialty Siding[3]	11/32, 15/32,	6d	Noncorrosive, box or casing nails	6	12 on each stud
	19/32 & thicker	8d		6	12 on each stud
Texture 1-11[4]	19/32	8d	Noncorrosive, box or casing nails	6	12 on each stud

1. Panel thickness shall be not less than 3/8” 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 be not less than 5/16". Nailing of plywood shall be as indicated.
2. Minimum edge distance of 3/8'.
3. Special Requirement: Nails on ship-lap edges 3/8' from exposed edge and slant driven towards it; do not set.
4. In direct-to-stud applications 4 and 5-ply panels of 15/32” 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” o.c. or with face grain horizontal on studs spaced 24” o.c. Five ply panels having a nominal thickness of 19/32" or more, grooves no wider than 1 1/2" and space no closer than 12” o.c. may also be applied direct to studs spaced 24" o.c.

TABLE 1707.1C
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[3]	11/32, 15/32,	6d	Noncorrosive, box or casing nails	6	12 on each stud
	19/32 & thicker	8d		6	12 on each stud
Texture 1-11[4]	19/32	8d	Noncorrosive, box or casing nails	6	12 on each stud

1. Panel thickness shall be not less than 3/8" 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 be not less than 5/16". Nailing of plywood shall be as indicated.
2. Minimum edge distance of 3/8'.
3. Special Requirement: Nails on ship-lap edges shall be 3/8' from exposed edge and slant driven towards it; nail shall not be set.
4. For direct-to-stud applications panel siding with a 16 oc Span Rating shall be applied vertically with a maximum stud spacing of 16 inches. Veneer faced siding panels with a 16 oc Span Rating shall have a maximum stud spacing of 24 inches when applied horizontally. For direct-to-stud applications panel siding with a 24 oc Span Rating shall be applied vertically or horizontally with a maximum stud spacing of 24 inches.
5. Nails shall be applied along bottom edge.
6. 1 inch = 25.4mm.

1707.1.6 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. In lieu of double top plates, a continuous header may be used.

EXCEPTION: A single 2x6 top plate may be 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 3 x 6 x 0.036-inch 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. Top plates may be omitted over lintels which are adequately tied to adjacent wall section as previously described or with 1 x4 x 12-inch wood members splice nailed to each wall section by three 8d nails or equivalent.

1707.1.7 For platform frame construction, studs shall rest on a single bottom plate.

1707.2 Bracing Of Exterior Stud Walls

1707.2.1 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 thick plywood 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.

1707.2.2 Stud walls shall be braced by one of the following methods:

1. Nominal 1 x4 continuous diagonal strips set into the face of the studs and top and bottom plates at each comer of building.

2. Wood boards of 5/8-inch (net) minimum thickness, applied diagonally.
3. Wood sheathing panels 2 x 8 ft of 5/8-inch minimum thickness applied horizontally.
4. Plywood structural-use panel, and particleboard sheathing panels not less than 4 ft wide and 8 ft long applied either vertically or horizontally, and fastened in accordance with Table 1705.1.
5. Fiberboard sheathing and gypsum sheathing as specified in 1707.1.5 when applied vertically in panels 4 ft wide and no less than 8 ft long and properly installed in accordance with Table 1705.1.

1707.2.3 Sheathing shall be applied on the exterior walls of all Type VI buildings, more than one story in height, except when back-plastered stucco construction is used.

1707.3 Openings In Exterior Walls

1707.3.1 Headers shall be provided over each opening in exterior bearing walls. The spans in Tables 1707.3A through J may be used for one and two family residences. Headers for other buildings shall be designed in accordance with 1701.2 or 1701.3.1. 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.

1707.3.2 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 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 3 ft but not more than 6 ft wide each end of the header shall rest on a single header stud.
3. For openings more than 6ft wide each end of the header shall rest on two header studs.

NOTES TO TABLES 1707.3A THROUGH 1707.3J

*Sheathing or combined sheathing/siding having a minimum density of 18 pcf.

** Minimum 1/2" 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 and nailed to the header, top plates, cripples and studs - 6" o.c. at the edges and 12" o.c. at intermediate framing.

Note: Linear interpolation for house widths not in table is permitted. For example, assume a 26' wide house with 1/2" plywood sheathing - roof load - 2 x 6 header: allowable header span= 7'-5".

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.


Supporting beam or bearing wall below floor.


Location of header.

TABLE 1707.3A
HEADER DESIGN CHART

(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

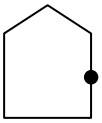
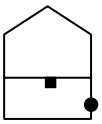
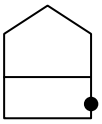
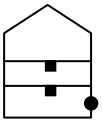
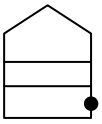
Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Non. Struct. Sheath.			1/2" Insul. Bd. Sheath.*			1/2" Plywood Sheath.**			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	4-7	4-6	4-3	4-11	4-8	4-6	5-7	5-4	5-1	
	2-2x6	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	
	2-2x6	4-8	4-4	4-0	4-10	4-5	4-2	5-3	4-11	4-7	
	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	

TABLE 1707.3B
HEADER DESIGN CHART

(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

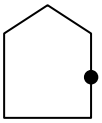
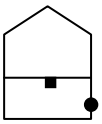
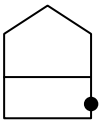
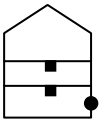
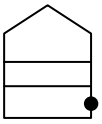
Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Non. Struct. Sheath.			1/2" Insul. Bd. Sheath.*			1/2" Plywood Sheath.**			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	4-2	3-11	3-8	4-5	4-3	4-1	5-1	4-10	4-8	
	2-2x6	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	
	2-2x6	6-3	5-10	5-6	6-6	6-1	5-8	6-11	6-7	6-3	
	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	
	2-2x6	5-5	5-1	4-9	5-8	5-3	4-11	6-2	5-9	5-5	
	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	
	2-2x6	5-5	5-1	4-9	5-8	5-3	4-11	6-2	5-9	5-5	
	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	

TABLE 1707.3C
HEADER DESIGN CHART

(Hem Fir No. 2, Roof Load = 20LL + 10DL, Floor Load = 40LL + 10DL)

F_b = 1000 E = 1,400,000 F_v = 75

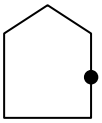
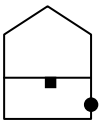
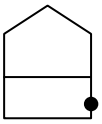
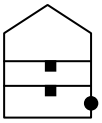
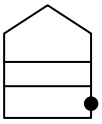
Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Non. Struct. Sheath.			1/2" Insul. Bd. Sheath.*			1/2" Plywood Sheath.**			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	4-5	4-2	3-11	4-8	4-5	4-3	5-4	5-1	4-11	
	2-2x6	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	

TABLE 1707.3D
HEADER DESIGN CHART

(Hem Fir No. 2, Roof Load = 30LL + 10DL, Floor Load = 40LL + 10DL)

F_b = 1000 E = 1,400,000 F_v = 75

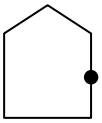
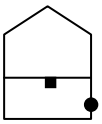
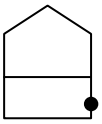
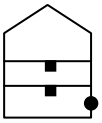
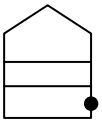
Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Non. Struct. Sheath.			1/2" Insul. Bd. Sheath.*			1/2" Plywood Sheath.**			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	3-10	3-7	3-5	4-2	3-11	3-8	4-10	4-7	4-5	
	2-2x6	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	

TABLE 1707.3E
HEADER DESIGN CHART

(Spruce-Pine-Fir No. 2, Roof Load = 20LL + 10DL, Floor Load = 40LL + 10DL)

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

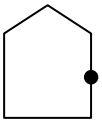
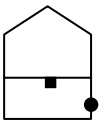
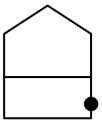
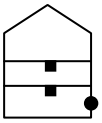
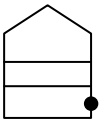
Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Non. Struct. Sheath.			1/2" Insul. Bd. Sheath.*			1/2" Plywood Sheath.**			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	4-2	3-11	3-8	4-5	4-3	4-0	5-2	5-0	4-9	
	2-2x6	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	

TABLE 1707.3F
HEADER DESIGN CHART

(Spruce-Pine-Fir No. 2, Roof Load = 30LL + 10DL, Floor Load = 40LL + 10DL)

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

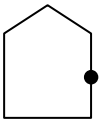
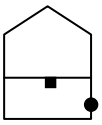
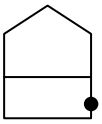
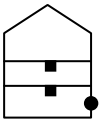
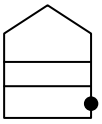
Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Non. Struct. Sheath.			1/2" Insul. Bd. Sheath.*			1/2" Plywood Sheath.**			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	3-7	3-4	3-2	3-11	3-8	3-5	4-10	4-6	4-3	
	2-2x6	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	

TABLE 1707.3G
HEADER DESIGN CHART

(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

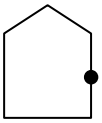
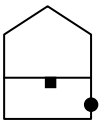
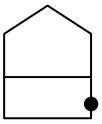
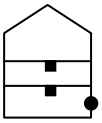
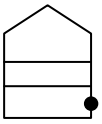
Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Non. Struct. Sheath.			1/2" Insul. Bd. Sheath.*			1/2" Plywood Sheath.**			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	3-9	3-6	3-4	4-1	3-10	3-7	4-8	4-6	4-4	
	2-2x6	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	

TABLE 1707.3H
HEADER DESIGN CHART

(Hem Fir No. 2, Roof Load = 40LL + 10DL, Floor Load = 40LL + 10DL)

F_b = 1000 E = 1,400,000 F_v = 75

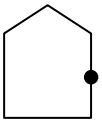
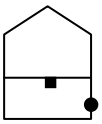
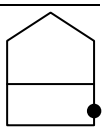
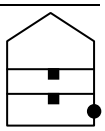
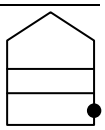
Header Supporting:	Header Size:	Maximum Allowable Header Span (ft-in)									
		Non. Struct. Sheath.			1/2" Insul. Bd. Sheath.*			1/2" Plywood Sheath.**			
		House Depth (ft)			House Depth (ft)			House Depth (ft)			
		24	28	32	24	28	32	24	28	32	
Roof	2-2x4	3-5	3-3	3-0	3-9	3-6	3-4	4-6	4-3	4-0	
	2-2x6	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	

TABLE 1707.3I
MAXIMUM ALLOWABLE HEADER SPAN (ft-in)
Design Procedure: Single Top Plate Construction: Interior Bearing Walls

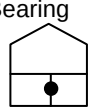
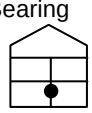
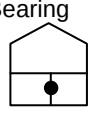
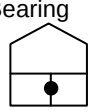
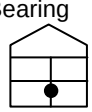
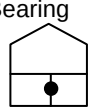
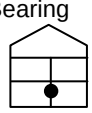
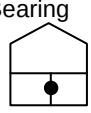
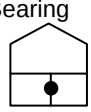
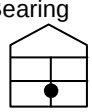
Species, Grade Properties	Header Supporting	Header Size:	Non. Struct. Sheath.			1/2" Insul. Bd. Sheath.*			1/2" Plywood Sheath.**		
			House Depth (ft)			House Depth (ft)			House Depth (ft)		
			24	28	32	24	28	32	24	28	32
Douglas Fir Larch Southern Pine No. 2 E = 1,600,000 F_b = 1200 F_v = 90	One Story 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

TABLE 1707.3J
MAXIMUM ALLOWABLE HEADER SPAN (ft-in)
Design Procedure: Double Top Plate Construction: Interior Bearing Walls

Species, Grade Properties	Header Supporting	Header Size:	Non. Struct. Sheath.			1/2" Insul. Bd. Sheath.*			1/2" Plywood Sheath.**		
			House Depth (ft)			House Depth (ft)			House Depth (ft)		
			24	28	32	24	28	32	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

1707.4 Post And Beam Framing

1707.4.1 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 1701.2 or 1701.3.1.

1707.4.2 Intermediate framing shall be attached to the posts and braced in the manner specified in 1705.2.

1707.5 Interior Bearing Partitions

1707.5.1 Studs in one and two story buildings shall be not less than 2x4 with the wide face perpendicular to the partitions. In three story buildings, studs in the first story shall be not less than 3x4 or 2x6.

1707.5.2 Studs shall be spaced not more than the following:

Stud	Supporting roof and ceiling only (in)	Supporting 1 floor, roof and ceiling (in)	Supporting 2 floors, roof and ceiling (in)
2x4	24	16	---
3x4	24	24	16
2x5	24	24	---
2x6	24	24	16

1707.5.3 Headers shall be provided over each opening in interior bearing partitions as required in 1707.3.

1707.5.4 Studs shall be capped with double top plates installed to provide overlapping at corners and at intersections with exterior walls. End joints in double top plates shall be offset at least 24 inches. For platform frame construction, studs shall rest on a single bottom plate.

EXCEPTION: A single top plate may be installed in accordance with 1707.1.6.

1707.6 Interior Nonbearing Partitions

1707.6.1 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 inches o.c. and may be set with the long dimension parallel to the wall.

1707.6.2 Openings in the nonbearing partitions may be framed with single studs and headers.

1707.7 Cutting, Notching And Bored Holes

1707.7.1 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.

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

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

1.707.7.2 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.

1707.7.3 In no case shall the edge of the bored hole be nearer than 5/8 inch to the edge of the stud. Bored holes shall not be located at the same section of stud as a cut or notch.

For Exterior Wall Coverings See 811.6.

1708 ROOF AND CEILING FRAMING

1708.1 Ceiling Joist And Rafter Framing

1708.1.1 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 1701.2 or 1701.3.1.

1708.1.2 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 thick, and not less in depth than the cut end of rafters.

1708.1.3 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.

1708.1.4 Ceiling joists shall be continuous or securely joined where they meet over interior partitions to provide a continuous tie across the building.

1708.1.5 Where ceiling joists are not parallel to rafters, sub-flooring or metal straps attached to the ends of the rafters shall be installed in a manner to provide a continuous tie across the building.

1708.1.6 Valley and hip rafters shall be 2 inches deeper than the jack rafters.

1708.1.7 Collar beams of 1 x6 boards shall be installed in the upper third of the roof height to every third pair of rafters.

1708.1.8 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 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.

1708.2 Trussed Rafters

1708.2.1 Trussed rafters shall be designed in accordance with accepted engineering practice. The Building Official shall require the seal of a registered architect or professional engineer on any truss design, bracing, and anchor, if the truss spans over 30 feet. Members may be joined by nails, glue, bolts, timber connectors or other approved framing devices.

1708.2.2 The design of metal plate connected wood roof trusses shall comply with TPI Design Specifications For Light Metal Plate Connected Wood Roof Trusses**.**

1708.2.3 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 "Bracing Wood Trusses, BWT-76".

1708.2.4 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., HV AC equipment, water heater) shall be permitted without such additional load being incorporated in the engineering design.

1708.3 Roof Joists

1708.3.1 Maximum spans for roof joists shall be in accordance with NFoPA Span Tables for Joists and Rafters, or may be designed in accordance with 1701.2 or 1701.3.1

1708.3.2 Joists shall be supported laterally at the ends by solid blocks or diagonal struts. Such bridging may be omitted where ends of joists are nailed to a header, band joist or to an adjoining stud.

1708.3.3 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 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.

1708.4 Roof Sheathing

1708.4.1 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 (net) minimum thick, or spaced sheathing of wood boards 3/4-inch (net) minimum thick.
2. Plywood or structural-use panels applied in accordance with the provisions of Tables 1706.6A, 1708.4A and nailed in accordance with Table 1705.1.
3. Fiberboard insulating roof deck not less than 1-inch nominal thickness.
4. Particleboard applied in accordance with the provisions of Table 1708.4B and nailed in accordance with Table 1705.1.

1708.4.2 Joints in lumber sheathing shall occur over supports unless endmatched lumber or approved clips are used in which case each piece shall bear on at least two rafters or joists.

TABLE 1708.4A

ALLOWABLE LOADS (psf) FOR PLYWOOD AND STRUCTURAL-USE PANELS ROOF SHEATHING CONTINUOUS OVER TWO OR MORE SPANS AND FACE GRAIN PARALLEL TO SUPPORTS

Grade	(in)	No. of Plies[2]	Thickness Span (in)	Total Load	Live Load
Structural I	15/32	4	24	30	20
	15/32	5	24	45	35
	1/2	4	24	35	25
	1/2	5	24	55	40
Other grades covered in PS 1 or PRP-108	15/32	5	24	25	20
	1/2	5	24	30	25
	19/32	4	24	35	25
	19/32	5	24	50	40
	5/8	4	24	40	30
	5/8	5	24	55	45

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. Structural-use panels containing no veneer shall be considered as 5-ply for purposes of this table.

TABLE 1708.4B
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 and 2-M-F	3/8[3]	16	45	65
	7/16	16	105	105
	7/16[3]	24	30	40
	1/2	16	110	150
	1/2	24	40	55

1. Panels are continuous over two or more spans.
2. Uniform load deflection 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.

1708.5 Plank And Beam Roofs

Beams shall be supported on posts, piers or other beams and shall conform to 1706.2. Roof planks shall conform to 1706.7.

1708.6 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 1408.2.

1708.7 Access To Attic Space

Attic spaces shall be provided with an interior access opening not less than 22 x 36 inches. Access opening shal1 be readily 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, and only interior access is to be provided, the access opening shall be not less than specified above, but in no case less than the size required to install or remove the largest major component of the unit without disassembly. Access is not required when the clear height of the attic space, measured at the roof peak, is less than 24 inches.

1708.8 Ventilation Of Attic Space

1708.8.1 For gabled and hipped roofs ventilation shall be provided to furnish cross ventilation of each separate attic space with weather protected vents. 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 3 ft above eave or cornice vents) with the balance of the required ventilation provided by eave or cornice vents.

1708.8.2 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.

For Roof Coverings see 706.

Refer to 804.3 for minimum clearances to combustible materials.

1709 PARAPET WALLS

1709.1 Framing. Parapet walls framed of wood shall be designed as provided in this section.

1709.2 Coping. All parapet walls shall be properly coped with noncombustible, weatherproof materials of a width no less than the thickness of the parapet wall.

1709.3 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.

1709.4 Scuppers

1709.4.1 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 the SBCCI Standard for the Installation of Roof Coverings for the particular type of covering specified for the building. For other type materials follow manufacturer's specifications.

1709.4.2 A scupper shall be sized in accordance with the *Standard Plumbing Code*.

1709.4.3 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 nor more than 4 inches 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 the *Standard Plumbing Code*.

1710 PLYWOOD AND STRUCTURAL-USE PANEL DIAPHRAGMS

1710.1 General

1710.1.1 Plywood and structural-use 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.

1710.1.2 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.

1710.1.3 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.

1710.1.4 Size and shape of diaphragms shall be limited as set forth in Table 1710.1. 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 plywood and structural-use panel diaphragms. In masonry or concrete buildings, plywood diaphragms and structural-use panel shall not be considered as transmitting lateral forces by rotation.

TABLE 1710.1
MAXIMUM DIAPHRAGM DIMENSION RATIOS

Type	Horizontal Diaphragms Maximum Span-Width Ratios	Vertical Diaphragms Maximum Height-Width Ratios
Nailed all edges	4:1	3 1/2:1
Blocking omitted at intermediate joints	4:1	2:1

1710.2 Design

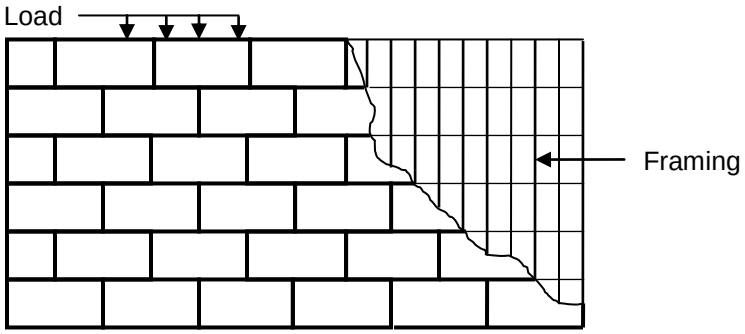
1710.2.1 Horizontal and vertical diaphragms sheathed with plywood or structural-use panels may be used to resist horizontal forces not exceeding those set forth in Table 1710.2A and 1701.2B, or may be calculated by principles of mechanics without limitations by using values for nail strength and panel shear strength given elsewhere in this code. Panel thickness for horizontal diaphragms shall not be less than set forth in Tables 1706.6A and 1708.4A for corresponding joist spacing and loads, except that 1/4-inch may be used where perpendicular loads permit.

TABLE 1710.2A
ALLOWABLE SHEAR (plf) FOR HORIZONTAL PLYWOOD AND STRUCTURAL-USE PANEL DIAPHRAGMS WITH FRAMING OF DOUGLAS FIR, LARCH OR SOUTHERN PINE[1] FOR WIND OR SEISMIC LOADING[4]

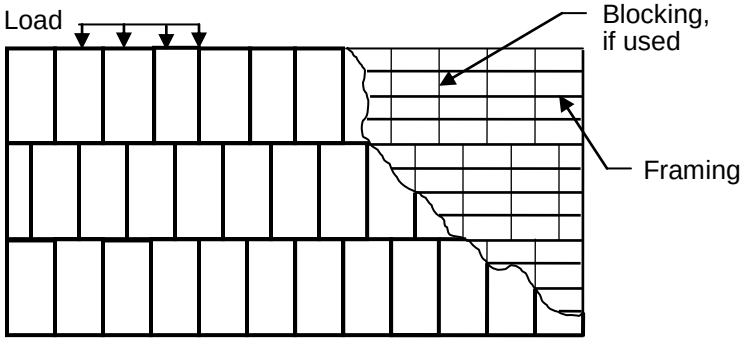
Panel Grade	Common Nail Size	Minimum Nominal Penetration in Framing (in)	Minimum Nominal Panel Thickness (in)	Minimum Nominal Width of Framing Member (in)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
					Nail Spacing (in) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 3 & 4) and at all panel edges (Cases 5 & 6)				Nails spaced 6" max. at support edges	
					6	4	2 1/2[3]	2[3]	Case 1 (No Unblocked Edges or Continuous Joints Parallel to Load	All other configurations (Cases 2, 3, 4, 5 & 6)
					Nail Spacing (in) at other panel edges (Cases 1, 2, 3 & 4)					
					6	6	4	3		
Structural 1 Sheathing EXP 1 or EXT	6d	1 1/4	1/4 or 5/16	2	185	250	375	420	165	125
				3	210	280	420	475	185	140
	8d	1 1/2	3/8	2	270	360	530	600	240	180
				3	300	400	600	675	265	200
	10d[5]	1 5/8	15/32	2	320	425	640	730	285	215
				3	360	480	720	820	320	240
			1/4 or 5/16	2	170	225	335	380	150	110
				3	190	250	380	430	170	125
Sheathing, Single Floor and other grades covered in PS 1, PS 2 or PRP-108	6d	1 1/4	3/8	2	185	250	375	420	165	125
				3	210	280	420	475	185	140
			3/8	2	240	320	480	545	215	160
				3	270	360	540	610	240	180
	8d	1 1/2	15/32	2	270	360	530	600	240	180
				3	300	400	600	675	265	200
C-D Sheathing, C-C Exterior, Structural II and other grades covered in PS 1 or PRP-108	10d	1 5/8	15/32	2	290	385	575	655	255	190
				3	325	430	650	735	290	215
			19/32	2	320	425	640	730	285	215
				3	360	480	720	820	320	240

1. For framing of other species: (1) Find species group of lumber in NFoPA National Design Specification. (2) Find shear value from table for nail size, and for Structural I panels (regardless of actual grade). (3) Multiply value by 0.82 for Lumber Group III or 0.65 for Lumber Group IV.
2. Space nails 12" o.c. along intermediate framing members.
3. Framing at adjoining panel edges shall be 3" nominal or wider and nails shall be staggered where nails are spaced 2" or 2 1/2" o.c.
4. These values are for short-term loads due to wind or earthquake and must be reduced 25% for normal loading.
5. Framing at adjoining panel edges shall be 3 nominal or wider and nails shall be staggered where 10d nails having penetration into framing of more than 1 5/8 are spaced 3" or less on center.

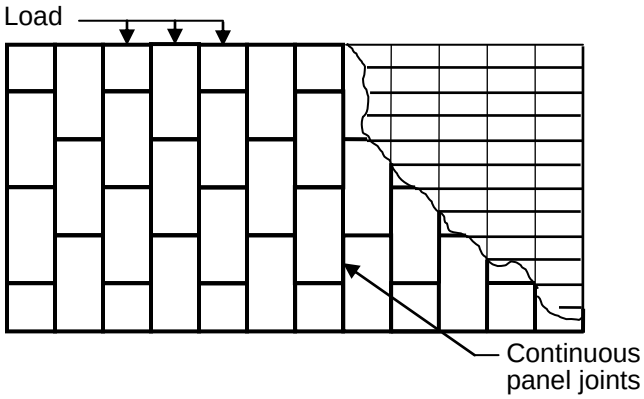
Case 1



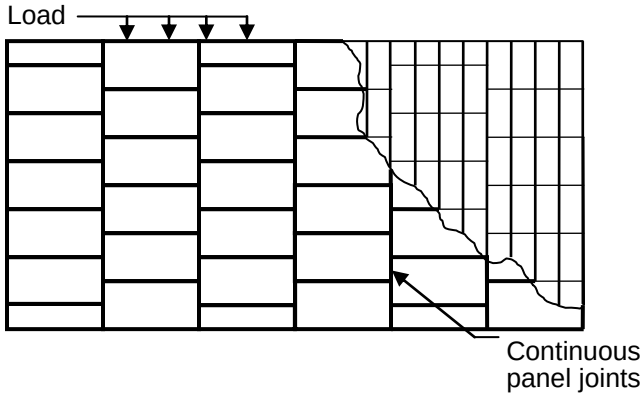
Case 2



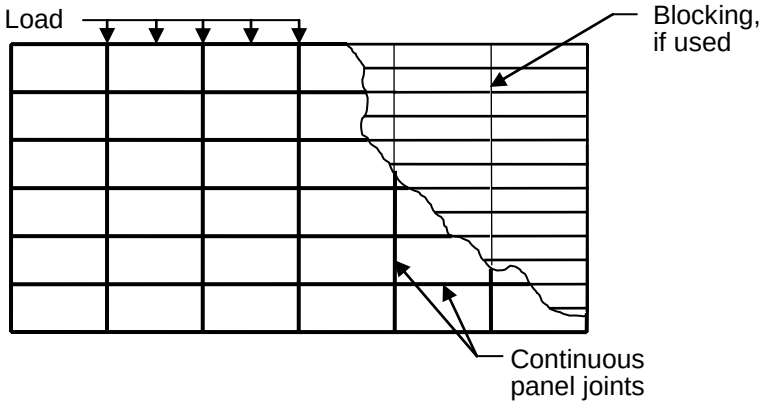
Case 3



Case 4



Case 5



Case 6

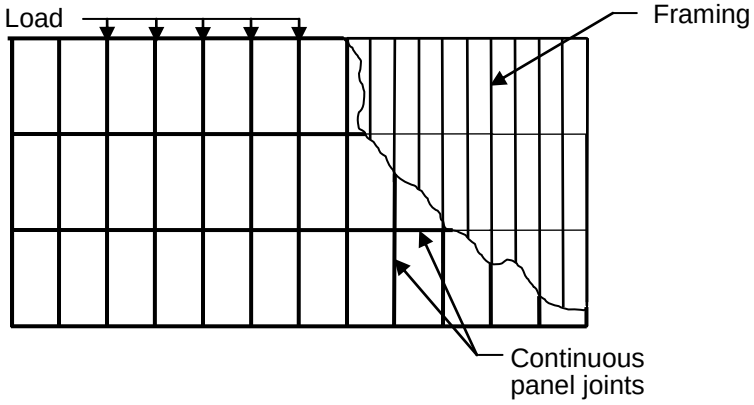


TABLE 1710.2B
ALLOWABLE SHEAR (plf) FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH FRAMING OF DOUGLAS FIR, LARCH OR SOUTHERN PINE FOR WIND OR SEISMIC LOADING

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

1710.2.2 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 from the panel edge, not more than 12 inches apart along intermediate supports, and 6 inches along panel edge-bearings, and shall be firmly driven into the framing members. No unblocked panel less than 12 inches wide shall be used.

1710.3 Wood Structural Panel Floor and Roof

1710.3.1 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 1710.2A and by the provisions of 1710.3.2 through 1710.3.5. Nails of the same size shall be placed along all intermediate framing members at 12 inches on center.

1710.3.2 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 species with a specific gravity greater than or equal to 0.42 and less than 0.49; and by 0.65 for species with a specific gravity less than 0.42.

1710.3.3 The orientation of the structural framing and wood structural panels shall comply with Case 1, 2, 3, 4, 5 or 6 of Table 1710.2A. For blocked diaphragms, the maximum shear for Cases 3, 4, 5 and 6 shall not exceed 1200 pounds per linear foot.

1710.3.4 Where either 2 inch or 2 1/2 inch fastener spacings are used with 2 inch wide framing members in accordance with Table 1710.2A, the framing member adjoining panel edges shall be 3 inch nominal width and nails at panel edges shall be staggered in two lines.

1710.3.5 Unblocked 1 1/8 inch panels with tongue-and-groove edges are permitted to use the blocked diaphragm shear capacities for 19/32-inch minimum nominal panel thickness where 1 inch by 3/8-inch crown by No. 16 ga staples are driven through the tongue-and-groove edges 3/8 inch 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.

1710.4 Wood Structural Panel Shear Wall Construction

1710.4.1 Nail size and spacing at the edge of each panel shall be provided as shown in Table 1710.2B. For 3/8-inch and 7/16-inch panels, installed on studs spaced 24 inches on center, nails shall be spaced at 6 inches 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 on center. All panel edges shall be backed with 2-inch or wider framing members.

1710.4.2 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 1710.2B.

1710.4.3 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 species with a specific gravity greater than or equal to 0.42 and less than 0.49; and by 0.65 for species with a specific gravity less than 0.42.

1710.4.4 Framing shall be 3-inch nominal or wider and the nails shall be staggered where nails are spaced 2 inches on center or where 10d nails, having a penetration into framing of more than 1 5/8 inches, are used with a 3-inch nail spacing.

1710.4.5 Nail spacings given in Table 1710.2B are for common or galvanized box nails as noted in the table, and galvanized casing nails used with plywood panel siding in grades included in PS 1.

1710.4.6 An increase in shear values shall be permitted for 3/8-inch and 7/16-inch panels with 8d nails to those shown for 15/32-inch sheathing with same nailing, provided (1) studs are spaced a maximum of 16 inches o.c. or (2) panels are applied with long dimension across studs.

1711 PARTICLEBOARD DIAPHRAGMS

1711.1 General

1711.1.1 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.

1711.1.2 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.

1711.1.3 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.

1711.1.4 Size and shape of diaphragms shall be limited as set forth in Table 1711.1. 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 1711.1
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

1711.2 Design

1711.2.1 Horizontal and vertical diaphragms sheathed with particleboard may be used to resist horizontal forces not exceeding those set forth in Table 1711.2A for horizontal diaphragms and Table 1711.2B for vertical diaphragms.

1711.2.2 Particleboard for horizontal diaphragms shall be as set forth in Table 1708.4B for roofs and Table 1706.6B for floors.

1711.2.3 Particleboard for shear walls shall be as set forth in Table 1707.1B.

1711.2.4 Grades of particleboard and maximum spans for subfloor underlayment shall be as set forth in Table 1706.6B.

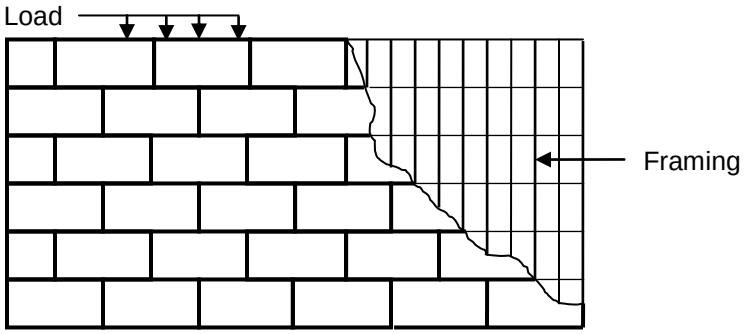
1711.2.5 All boundary members shall be proportioned and spliced where necessary to transmit direct stresses. Framing members shall be at least 2-inch nominal in the dimension to which the particleboard is attached. In general, panel edges shall bear on the framing members and butt along their center lines. Nails shall be placed not less than 3/8 inch from the panel edge, shall be spaced not more than 6 inches on center along panel edge bearings, 12 inches apart along intermediate supports, and shall be firmly driven into the framing members. No unblocked panels less than 12 inches wide shall be used.

TABLE 1711.2A
ALLOWABLE SHEAR (plf) FOR HORIZONTAL PARTICLEBOARD DIAPHRAGMS WITH FRAMING OF DOUGLAS FIR, LARCH OR SOUTHERN PINE[1,4]

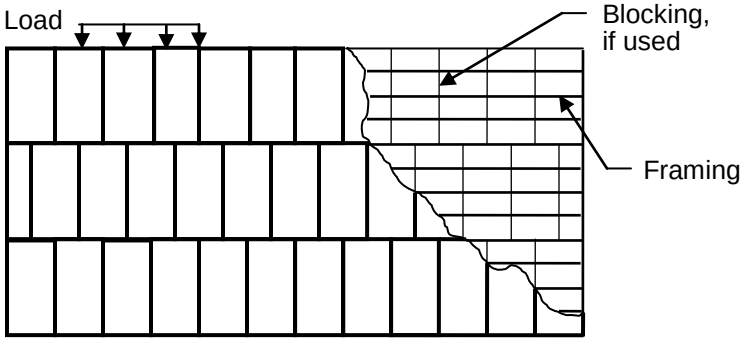
Panel Grade	Common Nail Size	Nail Penetration in Framing (in)	Minimum Nominal Panel Thickness (in)	Minimum Nominal Width of Framing Member (in)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
					Nail Spacing (in) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 3 & 4) and at all panel edges (Cases 5 & 6)[2]				Nails spaced 6" max. at support edges	
					6	4	2 1/2[3]	2[3]	Case 1 (No Unblocked Edges of Continuous Joints Parallel to Load	All other configurations (Cases 2, 3, 4, 5 & 6)
					Nail Spacing (in) at other panel edges (Cases 1, 2, 3 & 4)					
					6	6	4	3		
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[5]	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[5]	1 5/8	3/4	2	320	425	640	730	285	215
				3	360	480	720	820	320	240

1. Allowable shear values for nails in framing members of other species set forth in the NFoPA National Design Specification shall be calculated for all grades by multiplying the values by the following factors: Group III, 0.82, and Group IV, 0.65.
2. Space nails 12" on center along intermediate framing members.
3. Framing at panel edges shall be 3" nominal or wider and nails shall be staggered where nails are spaced 2" or 2 1/2" on center.
4. These values are for short term loads due to wind or earthquake and must be reduced 25% for normal loading.
5. Framing at adjoining panel edges shall be 3" nominal or wider and nails shall be staggered where 10d nails having penetrations into framing of more than 1 5/8" are spaced 3" or less on center.

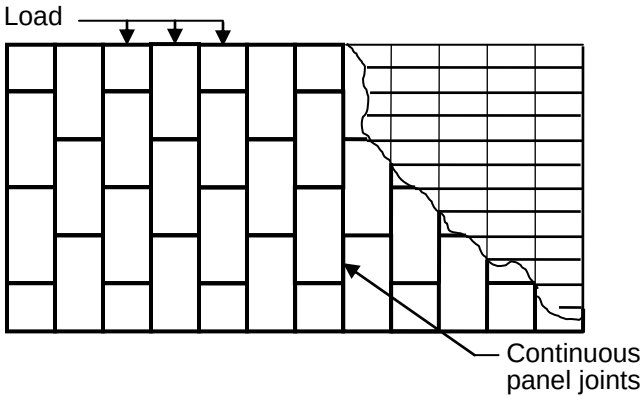
Case 1



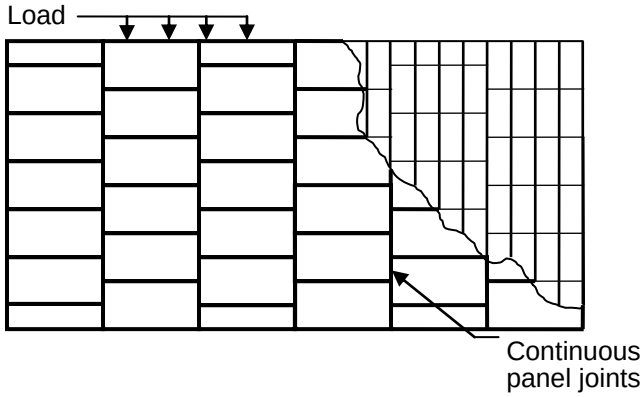
Case 2



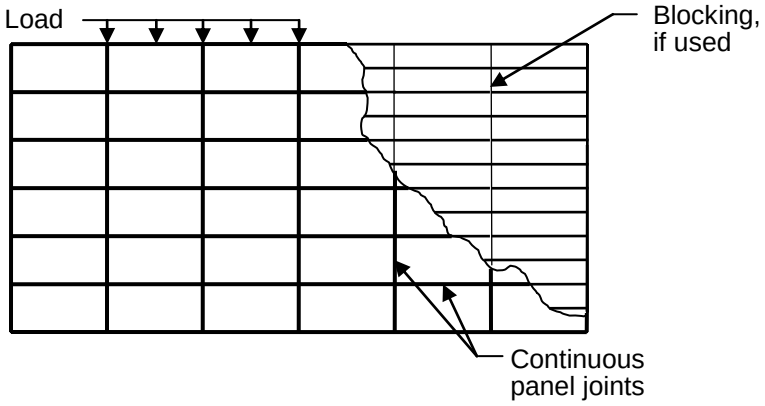
Case 3



Case 4



Case 5



Case 6

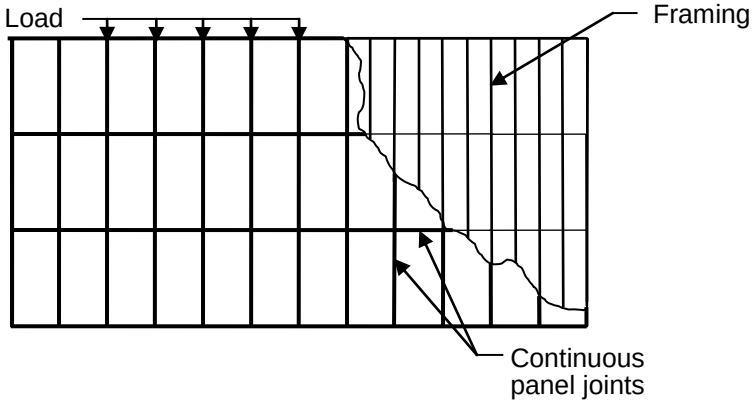


TABLE 1711.2B
ALLOWABLE SHEAR FOR WIND OR SEISMIC FORCES (plf) FOR PARTICLEBOARD SHEAR WALLS WITH FRAMING OF DOUGLAS FIR, LARCH OR SOUTHERN PINE[1,6]

Panel Grade	Minimum Nominal Panel Thickness (in)	Minimum Nail Penetration in Framing (in)	Panels Applied Direct To Framing					Panels Applied Over 1/2-in Gypsum Sheathing				
			Nail Size (Common or Galvanized Box)	Nail Spacing at Panel Edges[2] (in)				Nail Size (Common or Galvanized Box)	Nail Spacing at Panel Edges[2] (in)			
				6	4	3	2[5]		6	4	3	2[5]
2-M-W And 2-M-F	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 1/2	1-1/2	8d	220[3] 240[3] 260	320[3] 350[3] 380	410[3] 450[3] 490	530[3] 585[3] 640	10d	260	380	490[5]	640
	1/2 5/8	1 5/8	10d[4]	310 340	460 510	600[5] 665[5]	770 870	--- ---	--- ---	--- ---	--- ---	--- ---

1. For framing of other species, find species group of lumber in the NFoPA National Design Specification. Find shear value from above Table for nail size. Multiply this value by 0.82 for Lumber Group III or 0.65 for Lumber Group IV.
2. All panel edges backed with 2” nominal or wider framing. Install panels either horizontally or vertically. Space nails 6” o.c. along intermediate framing members for 3/8” and 7/16” panels installed on studs spaced 24” o.c. For other conditions and panel thickness, space nails 12” o.c. on intermediate supports.
3. The allowable shear values may be increased to the values shown for 1/2" thick sheathing with the same nailing, provided the studs are spaced a maximum of 16” on center.
4. Framing at adjoining panel edges shall be 3” nominal or wider and nails shall be staggered where 10d nails having penetration into framing of more than 1 5/8” are spaced 3” or less o.c.
5. Framing at panel edges shall be 3” nominal or wider. Nails shall be staggered where nails are spaced 2” o.c.
6. These values are for short-term loads doe to wind or earthquake and must be reduced 25% for normal loading.

CHAPTER 18

LATHING, PLASTERING AND GYPSUM CONSTRUCTION

1801 GENERAL

1801.1 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 10.

1801.2 No plaster shall be applied until the lathing has been inspected and approved by the Building Official.

1801.3 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.

1801.4 Joint treatment of gypsum wallboard shall not be applied until the wallboard application has been approved by the Building Official.

1802 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
Joint Reinforcing Tape and Adhesive Materials	ASTM C 474 ASTM C 475
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 board; types G, S and W)	ASTM C 1002
Screws (for Loadbearing Steel Framing)	ASTM C 954

1803 APPLICATION

1803.1 Interior Lathing And Plastering

1803.1.1 Installation of interior gypsum lathing and furring shall comply with ASTM C 841.

1803.1.2 Interior gypsum plastering shall comply with ASTM C 842.

1803.1.3 Portland cement plaster shall comply with ASTM C 926.

1803.2 Exterior Lathing And Plastering

1803.2.1 Exterior use of portland cement plaster shall comply with the application requirements of ASTM C 926.

1803.2.2 Installation of exterior lathing and framing shall comply with ASTM C 1047.

1803.3 Pneumatically Placed Portland Cement Plaster

1803.3.1 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.

1803.3.2 Rebound material may be screened and reused as aggregate in an amount not greater than 25% of the total sand in any batch.

1803.3.3 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.

1803.4 Application Of Gypsum Wallboard

1803.4.1 Interior and exterior applications and finishing of gypsum board, other than gypsum veneer base and plaster, shall be done in accordance with 1003, 1805 or GA 216.

1803.4.2 Gypsum veneer base and veneer plaster shall be applied and finished in compliance with 1003, 1805, or ASTM C 844 and ASTM C 843.

1803.5 Application Of Steel Studs

1803.5.1 Nonloadbearing steel framing shall be installed in compliance with the provisions of ASTM C 754.

1803.5.2 Load bearing (Transverse and Axial) Steel Studs and Related Accessories shall be installed in compliance with the provisions of ASTM C 1007.

1804 ALLOWABLE PARTITION HEIGHTS

Composite partitions of gypsum wallboard and steel studs shall be limited in height in accordance with Table 1804.

1805 VERTICAL GYPSUM BOARD DIAPHRAGMS

1805.1 General

1805.1.1 Gypsum wallboard, gypsum sheathing and gypsum veneer base may be used on wood studs for vertical diaphragms if applied in accordance with 1805. Shear-resisting values shall not exceed those set forth in Table 1805.

1805.1.2 The shear values tabulated shall not be cumulative with the shear value of other materials applied to the same wall. The shear values may be doubled when identical materials applied as specified in 1805.3 are applied to both sides of the wall.

TABLE 1804
ALLOWABLE PARTITION HEIGHTS BASED ON WALLBOARD AND NO. 25 GAGE STUDS ACTING AS A COMPOSITE SECTION[1,2]

Stud Spacing (in)	Facing on Each Side	Stud Depth					
		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"

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.

1805.2 Wall Framing

1805.2.1 Framing for vertical diaphragms shall comply with 1707.2 for bearing walls. Studs shall be spaced no farther apart than 16 inches center to center. Marginal studs and plates shall be anchored to resist all design forces.

1805.2.2 The maximum allowable height to length ratio for the construction shall be 1 1/2:1.

1805.3 Application

1805.3.1 End joints of adjacent courses of gypsum board sheets shall not occur over the same stud.

1805.3.2 Where required in Table 1805, blocking having the same cross-sectional dimensions as the studs shall be provided at all joints that are perpendicular to the studs.

1805.3.3 The size and spacing of nails shall be as set forth in Table 1805. Nails shall be spaced not less than 3/8 inch from edges and ends of gypsum boards or sides of studs, blocking and top and bottom plates.

1805.3.4 Gypsum sheathing 4 ft wide may be applied parallel or perpendicular to studs. Pieces 2 ft wide shall be as set forth in Table 1805.

1805.3.5 Gypsum wallboard or veneer base may be applied parallel or perpendicular to studs. Maximum allowable shear values shall be as set forth in Table 1805.

1805.4 Masonry And Concrete Construction

Gypsum board shall not be used in vertical diaphragms to resist forces imposed by masonry or concrete construction.

TABLE 1805
ALLOWABLE SHEAR FOR WIND OR SEISMIC FORCES IN POUNDS PER FOOT FOR GYPSUM BOARD VERTICAL DIAPHRAGMS[1]

Material	Size	Wall Construction	Nail Spacing[2] (in)	Shear Value	Minimum Nail Size
Gypsum Sheathing Board	1/2" x 2' x 8'	Unblocked	4	75	No. 11 gage, 1 3/4" long, 7/16" head, diamond-point, Galvanized
	1/2" x 4' 1/2" x 4'	Blocked Unblocked	4 7	175 100	
Gypsum Wallboard or Veneer Base	1/2"	Unblocked	7	100	5d cooler nails
			4	125	
		Blocked	7	125	
			4	150	
	5/8"	Blocked	4	175	6d cooler nails
		Blocked	Base Ply 9	250	Base Ply – 6d cooler nails
		Two-Ply	Face Ply 7		Face Ply – 8d cooler nails

1. These vertical diaphragms shall not be used to resist loads imposed by masonry or concrete walls. Values are for short-time 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.

1806 REINFORCED GYPSUM CONCRETE

1806.1 Standard 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.

1806.2 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 19

SAFETY TO LIFE REQUIREMENTS FOR EXISTING BUILDINGS

1901 SCOPE

The provisions of this chapter shall apply to all existing buildings not covered by *Volume IX - Existing Buildings Code* as follows;

1. Hazardous Occupancies,
2. High Rise buildings,
3. Institutional Occupancies,
4. Day Care Centers, and
5. Residential Care Facilities.

1902 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 12.

1903 INTERIOR FINISH

The interior finish of every existing building shall comply with 704.3 in the areas and spaces where that section requires the interior finish to have a 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 704.3.

1904 ROOF COVERING REPAIRS

1904.1 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 706.

1904.2 The placing of new roof covering conforming to 706 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.

1905 CHIMNEYS AND VENTS

1905.1 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 a cement mortar and otherwise repaired if necessary or they shall be removed.

1905.2 Existing chimneys and vents of metal which are corroded or improperly supported shall be replaced, unless suitable repairs are made.

1906 HEAT PRODUCING APPLIANCES

In case the installation of an existing heat producing appliance, heating, ventilating, air conditioning, blower or exhaust system does not conform to the code requirements for new installations, the building official may order such changes in the installation as may be necessary to remove existing fire hazards.

1907 MEANS OF EGRESS

1907.1 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 building official, 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.

1907.2 Number and Location of Exitways

1907.2.1 Every story for 100 or more occupants as determined by 1105 shall have at least 2 separate exitways (as defined in 1103.2). A single exitway may be permitted under the conditions outlined in 1907.2.2.

1907.2.2 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 1907 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 1907.2.2:

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 Code Enforcement Official 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 life 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 when complying with either of 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 506.2.1.1 and 506.2.1.2.
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 506.2.1.1 and 506.2.1.2.
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 the sprinkler system water flow in compliance with Section 506.2.1.1 and 506.2.1.2.
4. Travel distance does not exceed 125 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 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 systems including exit and emergency lighting, fire and smoke alarm systems, fire pumps, pressurization fans and one elevator.

1907.2.3 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 rooms.
2. Where the building is protected by an approved automatic sprinkler system; or where the building is either of Type I, Type II or Type IV construction occupied exclusively by stocks of non-combustible material, not packed or crated in combustible material; the distances to an exit doorway may be increased 50 percent.

1907.2.4 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 11 for one exitway.

1907.2.5 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.

1907.2.6 Every place of assembly having a capacity greater than 200 occupants shall have exit ways conforming as to number and width with 1103.2 and 1105.4. In applying 1105.4 a stairway 40 inches wide may be accepted as two units.

1907.2.7 Institutional occupancies shall be provided with at least two exit ways in accordance with 409.

1907.3 Minimum Requirements for Existing Exit Stairways

1907.3.1 The stairways in one of the required exit ways from any 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.

1907.3.2 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.

1907.4 Fire Escapes

Exterior fire escapes on existing buildings used for educational, institutional or assembly occupancies shall conform to the requirements for exterior stairways in 1106.2. 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 exit way 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.

1907.5 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 1907.6 and 1907.7 except:

1. Vertical openings which are not required to be enclosed in new construction. See 1106.
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.

1907.6 Required Protection For Vertical Openings

1907.6.1 Except as provided in 1907.6.2 and 1907.6.3, required enclosures 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.

1907.6.2 In any building of Type I or Type II construction, or of other types of construction not over 4 stories 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.

1907.6.3 In any building not over 4 stories high and in any sprinklered building, existing enclosures or parts 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.

1907.6.4 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.

1907.6.5 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 1907.6.1, 1907.6.2, and 1907.6.3.

1907.6.6 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.

1907.6.7 The installation of approved automatic sprinkler systems in historic buildings shall permit the acceptance of existing walls and partitions that do not comply with the provisions of 1907.6.2 or 1907.6.3, 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.

1907.7 Door and Window Openings in Required Enclosures For Vertical Openings

1907.7.1 All openings in required enclosures for vertical openings except window opening to the exterior of the building, shall be protected with doors in accordance with the following paragraphs. Movable transoms in such enclosures are prohibited.

1907.7.2 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.

1907.7.3 Doors in such enclosures, except doors opening into apartments, shall be automatic or self-closing.

1907.7.4 The installation of approved automatic sprinkler systems in historic buildings shall permit the acceptance of doors that do not comply with the provisions of 1907.7.1 or 1907.7.2, 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.

1907.8 Path of Exit Travel From Stairway to Street

1907.8.1 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.

1907.8.2 The enclosure of such passageway shall conform to the requirements applying to the stair enclosure. The enclosure shall separate from the exit way 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.

1907.8.3 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.

1907.9 Exit Doors

1907.9.1 Doorways opening on to an exit stairway, street or to a court or open space communicating with a street, and serving as a required exit way 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.

1907.9.2 All doors serving in a required exit way or leading to a required exit way from rooms occupied by 50 or more occupants and all doors serving in a required exit way or leading to a required exit way from places of assembly shall be hung to swing open in the direction of exit travel. Panic hardware shall be installed in accordance with 1114.2.

1907.9.3 Revolving doors shall be used in exit ways only under the conditions specified in 1114.4.

1907.10 Exit Signs, Lighting, and Maintenance

Exit ways shall be equipped with signs and be lighted and maintained in accordance with 1118.

1908 SPECIAL SAFETY TO LIFE REQUIREMENTS APPLICABLE TO EXISTING HIGH RISE BUILDINGS

Section 1908 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*).

1909 HISTORIC BUILDINGS

For Historic Buildings, see *North Carolina State Building Code, Volume IX - Existing Buildings*.

CHAPTER 20

LIGHT, VENTILATION AND SANITATION

2001 LIGHT AND VENTIALTION

2001.1 Minimum Requirements

2001.1.1 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 chapter shall be considered as minimum requirements supplementary to all state laws regulating light and ventilation.

2001.1.2 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 not be less than one-half the required window area.

EXCEPTION: Group I occupancies equipped with an engineered smoke control system may have fixed glazing in windows of sleeping rooms.

2001.1.3 Attics not used for habitational purposes shall have provisions for the emission of excess heat.

2001.1.4 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.

2001.1.5 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 rooms - windows shall have an area not less than 1/20 of the floor area served.
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.
3. Year around mechanically ventilating conditioned air systems may be substituted for windows, as required herein, in rooms other than rooms used for sleeping purposes. Window type air conditioning units are not included in this exception.

2001.1.6 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.

2001.2 Room Dimensions

2001.2.1 Habitable (space) rooms other than kitchens, storage rooms and laundry rooms shall have a ceiling height of not less than 7 ft 6 inches. Hallways, corridors, bathrooms, water closet rooms and kitchens shall have a ceiling height of not less than 7 ft measured to the lowest projection from the ceiling.

2001.2.2 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 from the finished floor to the finished ceiling shall be included in any computation of the minimum area thereof.

2001.2.3 If 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.

2001.2.4 Every dwelling unit shall have at least one room which shall have not less than 150 sq ft of the floor area. Other habitable rooms except kitchens shall have an area of not less than 70 sq ft.

2001.2.5 No habitable room other than a kitchen shall be less than 7 ft in any dimension.

2001.3 Alcoves

2001.3.1 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.

2001.3.2 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, whichever is greater.

EXCEPTION: The limit on one-half the area of the common wall does not apply to existing buildings.

2001.4 Toilets

2001.4.1 Toilet rooms shall not open directly into a room used for the preparation of food for service to the public.

2001.4.2 Every toilet room containing more than one flushing type fixture shall have windows as specified for habitable rooms providing in no case less than 3 sq ft of open space, or shall have approved equivalent mechanical ventilation.

2001.5 Mechanical Ventilation

Where mechanical ventilation is to be provided, the system shall have the capability to provide ventilation in accordance with the *North Carolina State Building Code, Volume III - Mechanical*.

2002 SANITATION

2002.1 Fixtures

The quality, number and type of fixtures and the number and division of facilities shall be determined by the *North Carolina State Building Code, Volume II - Plumbing*.

2002.2 Surrounding Materials

The walls and floors of all public restrooms shall be lined with nonabsorbent material to a height of 4 ft above the floor.

2002.3 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 above the compartment floor at the drain.

2002.4 Joints

Built-in tubs with showers shall have waterproofed joints between the tub and water resistant wall.

2003 COURTS

2003.1 General.

All courts required to serve rooms for natural light or ventilation purposes shall comply with the requirements of this section.

2003.1.2 Minimum Width. Every such court shall have a minimum width of 3 inches for each 1 foot of height or fraction thereof, but not less than 5 feet for outer courts and twice these values for inner courts.

2003.1.3 Irregular Court Width. In the case of irregular shaped courts, the average width shall not be less than the required width of a court in accordance with Section 2003.1.2, but shall not be less than 5 feet at any point.

2003.1.4 Area of Court. The cross-sectional area of a required court shall not be less than one and one-half times the square of its width; nor shall the length of any court be more than twice its width.

2003.1.5 Access to Court. A door or other means of access shall be provided at the bottom of every court that is not otherwise conveniently accessible for purposes of cleaning.

2003.1.6 Air Intakes. Every court which serves one or more habitable rooms and which does not open for its full height on one or more sides to a street or legal yard, shall be connected at or near the bottom with a street or yard by a horizontal intake or passage of fire resistive construction. Such intake or passage shall have a cross-sectional area of not less than 21 square feet and shall remain fully open at both ends and unobstructed for its full size and length, except that grilles of non-combustible construction are permitted at the ends of the intake.

2003.1.7 Fire Resistance Rating. The walls, floors and ceilings of such intakes or passages shall have a fire resistance rating complying with the requirements of Section 701.1.3.

2003.1.8 Court Walls. Where windows facing on courts do not receive adequate direct light by reason of peculiar arrangement or orientation, the code official shall require the walls to be constructed of light-colored masonry, or to be painted and maintained a light color to furnish additional reflected light, or shall require other approved means of providing additional light.

2003.1.9 Court Drainage. The bottom of every court shall be properly graded and drained to a storm sewer or other approved system complying with the plumbing code.

CHAPTER 21

SAFEGUARDS DURING CONSTRUCTION

2101 GENERAL

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 this chapter,

2101.1 Allowable Use Of Public Property During Construction

2101.1.1 The amount of space and conditions under which public property may be used for construction or demolition purposes shall be as set forth below:

2101.1.2 One-third of the width of street that is adjacent to the curb in front of the building being erected and for which a permit has been issued. If street in front of property adjoining such building is to be used for similarly limited storage, a due waiver of claim against the applicable governing authority for damages on account of such use, issued by the owner of such property, shall be filed with the Building Official before such use shall be permitted.

2101.1.3 Street or sidewalk space may be used in accordance with the following provisions:

1. That such one-third allocated space or any portion thereof shall not come within 5 ft of a rail or railway track.
2. That a walkway be constructed in the outer portion of the permissible occupied street space, conforming to the requirements of 2101.3.
3. That building material, fence, shed or any obstruction of any kind shall not be placed so as to obstruct free approach to any fire hydrant, lamp post, 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.
4. That a 10 ft clear roadway be maintained through any alley located along the building site.
5. That proper precaution shall be made during construction to prevent concrete, mortar washings, or any other material from entering a sewer.
6. 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.

2101.2 Where Covered Walkways Are Required

2101.2.1 During the erection or demolition of any building exceeding one story in height that is located at a distance less than 10 ft 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.

2101.2.2 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 2101.3.

2101.3 Construction Of Walkways, Fences And Protective Coverings

2101.3.1 Before any construction work is commenced the owner or his agent shall construct a temporary walkway in conformity with this section.

2101.3.2 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.

2101.3.3 Walkways shall be riot less than 4 ft 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. A smooth handrail of substantial construction, not less than 3 ft 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.

2101.3.4 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 high shall be provided on the building side of the walkway.

2101.3.5 Roof coverings over walkways, as required by 2101.2, shall be considered of not less than one layer of 2-inch nominal dimension wood plank spanning not over 3 ft between supports, or equivalent decking. The framework supporting the walkway covering shall be well braced and designed to support at least 150 psf but the top deck shall be designed to carry not less than 250 psf. The roof covering shall be of width sufficient to cover the entire walkway or sidewalk, and shall be made water tight. 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 shall be maintained above walkways.

2101.4 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, provided with suitable ramps at each end, Such walkways shall be provided with a fence and handrails on each side.

2101.5 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.

2101.6 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.

2101.7 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.

2101.8 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.

2101.9 Safety Requirements During Construction

2101.9.1 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 flame proofing of tarpaulins may also be required by the Building Official where, in his opinion, the fire hazard warrants such precaution.

2101.9.2 Suitable toilet facilities shall be provided in accordance with the provisions of *North Carolina State Building Code, Volume II - Plumbing*, Section 419.

2101.9.3 During the construction of a building, standpipe systems shall be provided in accordance with this section and Chapter 9.

2101.9.3.1 In every building six stories or more high, not less than one Class I standpipe system shall be provided for fire department use. Such standpipe shall be installed when the progress of construction is not more than 50ft high above grade 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. All outlets shall be not less than 2 1/2 inches. Where construction height requires installation of a Class II or III standpipe, fire pumps and water main connections shall be provided to serve the standpipe.

2101.9.3.2 Temporary standpipes may be provided in place of permanent systems if they are designed to furnish 100 gpm of water at 65 psi pressure with a standpipe size of not less than 4 inches. Pumping equipment sufficient to provide this volume and pressure shall be available at all times.

2101.9.4 Required exits shall be maintained at all times during remodeling or alterations and additions to any building.

2101.10 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.

CHAPTER 22

USE OF PUBLIC PROPERTY

2201 GENERAL

The use of public property or any portion thereof, shall be in accordance with the provisions of this chapter, except signs which shall conform to the requirements of Chapter 23, and allowable use of public property during construction in 2101.1.

2201.1 Doors And Windows

Doors shall not open or project upon public property. Exit doors, as specified in Chapter 11, which are required to open in the direction of exit travel, shall be set back from the property line by means of vestibules or similar enclosures. Windows which swing over public property shall have a clearance of not less than 8 ft above the sidewalk or ground level.

2201.2 Marquees, Canopies Or Fixed Awnings

2201.2.1 Fixed awnings, marquees or canopies shall be entirely supported from the building.

2201.2.2 All combustible materials 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 10. All glazing in marquees, canopies, or fixed awnings shall be of wired glass.

2201.2.3 Every fixed awning, canopy or marquee shall be at least 8 ft in the clear, between the lowest point or projection and a sidewalk immediately below. See 2303.5. The fixed awning, canopy or marquee shall not extend or occupy more than two-thirds of the width of sidewalk measured from the building, except that such fixed awning, canopy or marquee may occupy the entire width of the sidewalk, provided it is 14ft in the clear above the sidewalk. The overall height of any marquee or canopy, including signs, shall not exceed 8 ft 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 flexible valance be less than 7 feet in height above a public way.

2201.2.4 Fabric structures serving as marquees, canopies or fixed awnings shall be designed for the ground snow loads of Figure 1204.1. Coefficients from Table 1204.2A and Table 1204.28 should not be applied to the ground snow loads.

2201.3 Movable Awnings

Metal or canvas awnings may extend over public property for a distance of not more than 5ft, provided such awnings or any part thereof maintain a clear height of 8 ft above the sidewalk. All such movable awnings shall be supported on metal frames attached to the building.

2201.4 Prohibited Locations

2201.4.1 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.

2201.4.2 Awnings, marquees or canopies shall not be used as a landing for any fire escape or exterior stair.

2201.5 Construction Requirements

Marquees, canopies and awnings shall be so constructed and anchored to the building so as to support all live and dead loads as specified in Chapter 12.

2201.6 Roof Drainage Required

The roof of every fixed awning, marquee or canopy shall be sloped to down spouts at the building, which shall conduct all drainage under the sidewalk to the curb.

2202 OTHER PROJECTIONS

2202.1 General

2202.1.1 Every projection of any character over or upon public property shall maintain a clear height above the sidewalk or ground level of not less than 8 ft. The allowable projection over public property shall not exceed the following measurements from the building.

1. Bay windows, porches, balconies, fire escapes - 3 ft.
2. Cornices, belt courses, sills, pilasters, water tables or any decorative features - 6 inches.

2202.1.2 See 709 for fire protection requirements.

2202.2 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.

2203 SPACE UNDER PUBLIC PROPERTY

2203.1 Space Under Sidewalk

Where space under the sidewalk is used for any purpose a special permit shall be required.

2203.2 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 l/2-inch thick. Where such glass is over 12 sq in, 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 1203.3.

2204 MOVING OF BUILDINGS

2204.1 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.

2204.2 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.

2204.3 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.

2204.4 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.

2204.5 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.

2204.6 Public Safety Requirements

2204.6.1 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.

2204.6.2 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.

2204.6.3 There shall be placed in addition to the red lights on the building, flares at regular intervals for a distance of 200 ft up the street on each side of the building.

2204.6.4 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.

2204.7 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.

CHAPTER 23

SIGNS AND OUTDOOR DISPLAYS

2301 GENERAL

2301.1 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.

2301.2 Classifications

2301.2.1 For the purpose of this chapter and the regulations and provisions thereof, outdoor advertising displays shall be classified into one of the following type signs:

2301.2.1.1 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. They may be built upon the ground, attached to a wall, or above the roof, or projecting from a wall, provided that such spectacular 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.

2301.2.1.2 Ground sign - an outdoor advertising display sign supported by uprights or braces in the ground.

2301.2.1.3 Roof Sign - an outdoor advertising display sign erected, constructed, or maintained above the roof of any building.

2301.2.1.4 Wall Sign - an outdoor advertising display sign affixed to the wall of any building, projecting not more than 12 inches from the building.

2301.2.1.5 Projection Sign - an outdoor advertising display sign affixed to any building wall or structure and extending beyond the building wall, structure, building line or property line more than 12 inches.

2301.2.1.6 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.

2301.2.1.7 Shingle Sign - a projection or wall sign not over 6 sq ft in area, constructed of metal or other noncombustible material attached securely to a building and not projecting more than 24 inches over public property.

2301.3 Permits Required

2301.3.1 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 and the applicable fee paid.

2301.3.2 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 in area.

2301.4 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.

2301.5 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.

2301.6 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 with in 10 days, the Building Official shall remove such sign at the expense of the owner or lessee thereof.

2301.7 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.

2301.8 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 therefore, 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.

2301.9 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.

2301.10 Signs Projecting Over Public Property

Signs projecting from a building or extending over public property shall maintain a clear height of 9 ft above the sidewalk and all such signs shall extend not more than within 18 inches of the curbline.

2302 STRUCTURAL REQUIREMENTS

2302.1 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.

2302.2 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 1205.

2302.3 Working Stresses

In all outdoor advertising display signs, the allowable working stresses shall conform with the requirements of 1205, except as specified below.

1. The allowable working stresses for steel and wood shall be in accordance with the provisions of Chapter 15 and Chapter 17.
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 rods.

2303 CONSTRUCTION

2303.1 Ground Signs

2303.1.1 Lighting reflectors may project beyond the face of the sign.

2303.1.2 The bottom coping of every ground sign shall be not less than 3ft above the ground or street level, which space may be filled with platform decorative trim or light wooden construction.

2303.1.3 Every ground sign shall provide rigid construction to withstand wind action from any direction.

2303.1.4 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.

2303.1.5 Wherever anchors or supports consist of wood embedded in the soil, the wood shall be pressure treated with an approved preservative.

2303.2 Roof Signs

2303.2.1 All roof signs shall be so constructed as to leave a clear space of not less than 6 ft between the roof level and the lowest part of the sign and shall have at least 5 ft 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.

2303.2.2 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.

2303.2.3 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.

2303.2.4 A roof sign having a tight or solid surface shall not· be at any point over 24 ft above the roof level.

2303.2.5 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 on buildings of Type I or Type II construction and on other type buildings to a height of 40 ft. 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 2301.7.

2303.3 Wall Signs

2303.3.1 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 diameter and shall be embedded at least 5 inches. 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.

2303.3.2 Temporary cloth signs with wood frames may be kept in place for a period not exceeding 30 days.

2303.4 Projecting Signs

2303.4.1 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.

2303.4.2 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 diameter. Such supports shall be erected or maintained at an angle of at least 45° with the horizontal to resist the dead load and at an angle of 45° or more with the face of the sign to resist the specified wind pressure. If such projecting sign exceeds 30 sq ft in one facial area, there shall be provided at least two such supports on each side not more than 8 ft apart to resist the wind pressure.

2303.4.3 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 bolt or lag screw, by an expansion shield. Turn buckles shall be placed in all chains, guys or steel rods supporting projecting signs.

2303.4.4 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.

2303.4.5 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, may be erected to a height not exceeding 2 ft 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.

2303.5 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 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 does not extend more than 6 ft above, nor 1 ft below such marquee, but under no circumstances, shall the sign or signs have a vertical dimension greater than 8ft.

2304 USE OF PLASTIC MATERIALS

2304.1 Notwithstanding any other provisions of this Code, plastic materials which burn at a rate no faster than 2 1/2 inches per minute 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, provided that in the Fire District the structure of the sign in which the plastic is mounted or installed is noncombustible.

2304.2 Individual plastic facings of electric signs shall not exceed 200 sq ft in area.

2304.3 If the area of a display surface exceeds 200 sq ft, the area occupied or covered by approved plastics shall be limited to 200 sq ft plus 50% of the difference between 200 sq ft and 2000 sq ft. The area of plastic on a display surface shall not in any case exceed 1100 sq ft.

2304.4 Letters and decorations mounted upon an approved plastic facing or display surface may be made of approved plastics.

CHAPTER 24

ELEVATORS, DUMBWAITERS, ESCALATORS, MOVING WALKS

2401 GENERAL

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, A17.1A, and A17.1B, except as otherwise provided for in this Code.

2402 ELEVATORS

2402.1 Elevator Enclosures

2402.1.1 All openings in elevator or dumbwaiter shafts shall be protected as required by the standard specified in 2401 and they shall not in any case be less than the requirements of 701 of this Code.

2402.1.2 Where four or more elevators serve all or the same portion of a building, they shall be located in not less than two hoistways, but in no case shall more than four elevators be located in any one hoistway. Such hoist way enclosure shall have fire resistance as specified in Table 700.

2402.1.3 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 36ft apart at least 30 inches wide and 78 inches high conforming to the requirements of 703.6.

2402.1.4 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.

2402.1.5 When elevator lobbies are enclosed, the lobby doors shall be openable without the use of a key, tool, special knowledge or effort.

EXCEPTIONS:

1. Lobby doors providing access to an exit shall have the capability of being unlocked simultaneously without unlatching upon activation of the elevator's emergency recall.
2. Elevator lobby has access to an exit which does not require the use of a key, tool, special knowledge or effort.

2402.1.6 Construction at top and bottom of hoist way.

2402.1.6.1 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 above the top surface of the roof if the roof is of nonfire resistant construction.

2402.1.6.2 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 enclosures.

2402.1.6.3 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 thick sheet steel in strength and stiffness with openings therein essential for ropes, drums, sheaves and other elevator equipment.

2402.1.7 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 hoist way.
2. Overhead sheaves, governors and other equipment where the elevator machine is located below or at the side of the hoistway, provided that:
   1. Means 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.

2402.1.8 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 diameter ball.
2. If of perforated sheet metal or of fabricated openwork construction, the openings shall reject a 1-inch diameter ball.

2402.1.9 Hoistways of elevators serving more than three floors shall be provided with means for 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 hoist ways 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 hoist way.

2402.1.10 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 hoistway.

2402.2 Emergency Exit

Every elevator shall have an emergency exit as required by ANSI/ASME A17.1, A17.1A, and A17.1B.

2402.3 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 high.

2402.4 Stretcher Requirements

In all structures four or more stories in height, at least one elevator serving all floors shall have a minimum inside car platform 51 x 80 inches with a minimum clear opening width of 42 inches, unless otherwise designed to provide equivalent utility, to allow the entrance and exit of an ambulance stretcher (minimum size 22 x 78 inches) 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.

2402.5 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.

2402.6 Vents

2402.6.1 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 hoist ways 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 hoist way.

2402.6.2 Vents shall be located in the side of the hoistway enclosure directly 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.

2402.6.3 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 for each elevator car, whichever is greater. Of the total required vent area, not less than one-third shall be permanently open or automatically opened by a damper.

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 is 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 hoistway does not extend to the top of the building.
4. The hoistway or machine room exhaust fan is automatically reactivated by thermostatic means.

2402.6.4 Closed portions of the required vent area shall consist of windows, skylights or duct openings glazed with plain glass not more than 1/8-inch thick.

2402.6.5 Elevator hoistways shall not be vented into an elevator machine room. Cable slots entering the machine room shall be sleeved beneath the machine room floor and extend to not less than 12 inches below the shaft vent to inhibit the passage of smoke into the machine room.

2402.7 Access To Machine Rooms And Machinery Spaces

2402.7.1 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.

2402.7.2 Access Across Roofs

Where passage over roofs is necessary to reach the means 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 1112 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 Section 1112.

2403 ESCALATOR ENCLOSURES

Protection of floor openings shall be as required by ANSI A17.1, Section 800, Rule 800.1.

2404 MANLIFTS

Manlifts shall be installed in accordance with ANSI A90.1

CHAPTER 25

STRUCTURAL TESTS

2501 GENERAL

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.

2502 ALLOWABLE LOADS AND ALLOWABLE STRESSES

2502.1 Allowable Loads

2502.1.1 For a specific in-place construction the allowable load may be determined by testing provided the testing is in conformance with this Chapter.

2502.1.2 Load tests may be used to determine the allowable load for a construction or construction components that will be manufactured in quantities provided the established allowable load is such that at least 95% of the construction or construction components have allowable loads that are equal to or greater than the established allowable load. Where standards exist, the established allowable load shall not exceed the allowable load determined by the standard.

2502.2 Allowable Stresses

2502.2.1 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.

2502.2.2 Load tests may be used to determine the allowable stresses for a construction or construction components that will be manufactured in quantities provided the established allowable stresses is such that at least 95% of the construction or construction components have allowable stresses that are equal to or greater than the established allowable stresses. Where standards exist the established allowable stresses shall not exceed the allowable stresses determined by the standard.

2502.3 Inclusion Limit

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.

2503 LOAD AND DEFLECTION

2503.1 Load

The live load, dead load, wind load shall be at least equal to that required in Chapter 12. The construction shall sustain, without structural failure or excessive deflection, a superimposed load equal to two times the live load.

2503.2 Deflection

The maximum deflection of the construction shall be limited by Table 1210.1. The construction shall recover at least 75% of its maximum deflection within 24 hours after the load is removed.

2504 TEST PROCEDURE

2504.1 Established 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

2504.2 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.

2505 MATERIALS REQUIREMENTS

2505.1 Concrete

The test procedure, test load, and acceptance criteria of ACI 318 shall be used for reinforced concrete structures.

2505.2 Glass

The test procedure, test load, and acceptance criteria for glass subjected to either impact loads or wind loads shall be in accordance with 2703.

2505.3 Wood

2505.3.1 Allowable normal duration direct load capacity for mechanical fasteners in wood other than nails, staples, screws, or bolts tested under ASTM D 1761 shall be the lower value determined by 2505.3.1.1, 2505.3.1.2, or 2505.3.1.3.

2505.3.1.1 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.

2505.3.1.2 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.

2505.3.1.3 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 in any test.

2505.3.2 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 based on a minimum of at least three tests.

2505.3.3 Wood structural panels shall conform to U.S. Product Standard PS 1, PS 2, or PRP 108. Wood structural panels of species not covered in PS 1, when used structurally, shall meet the performance standards in U. S. Product Standard PS 2 for its type.

2505.4 Exterior Window And Door Assemblies

The design window pressure shall be calculated in accordance with Chapter 12. Each assembly shall be tested 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 1205. The time period shall include a 10 second period at a load equal to 1.5 times the design pressure.

2506 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 rest report shall identify the test procedure used, a detailed description of the construction tested, the various loads capacities for which the construction was tested.

CHAPTER 26

LIGHT-TRANSMITTING PLASTICS

2601 GENERAL

2601.1 Scope

2601.1.1 The provisions 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 704.3. 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.

2601.1.2 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 shall be given subject to the limitations specified in this chapter.

2601.1.3 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.

2601.2 Definitions

For definitions see 202.

2601.3 Design And Installation

2601.3.1 All plastic materials and their assemblies shall be of adequate strength and durability to withstand the loads and forces specified in Chapter 12 for their approved use.

2601.3.2 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.

2602 GLAZING OF UNPROTECTED OPENINGS

2602.1 General

Doors, sash, and openings which are not required to be fire protected may be glazed with approved plastic materials in Group R buildings and in all types of Group E buildings. In other classes of construction and occupancy, such openings not required to be fire protected may 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.
2. The area of a pane of glazing installed above the first story shall not exceed 16 sq ft and the vertical dimension of a pane shall not exceed 4ft. There shall be a minimum 3 ft vertical spandrel wall between stories.
3. Approved plastics shall not be installed more than 75 ft above grade level.

2602.2 Exceptions

2602.2.1 Approved plastic materials may be installed in areas up to 50% of the wall area of each story in structures less than 75 ft high which are provided on each floor above the first floor with continuous architectural projections constituting an effective fire canopy extending at least 3 ft 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.

2602.2.2 When complete automatic sprinkler protection is provided in the building, the permissible area of glazing permitted by 2602.1(1) may be increased to a maximum of 50% of the wall face of the story in which it is installed, and shall be exempt from the provisions of 2602.1 (2) and (3).

2602.2.3 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 wall panel installations.

2603 EXTERIOR WALL PANELS

2603.1 .General

Approved plastic materials may be used as wall panels in exterior walls not required to have a fire resistance rating, except Group I, Group A-1 and Group H occupancies, subject to the following requirements:

1. Area limitation and separation requirements of exterior wall panels shall be as provided in Table 2603.1.
2. Vertical spandrel wall separation between stories shall be as follows:

   3 ft for CC 1 plastic wall panels.

   4 ft for CC 2 plastic wall panels.
3. Approved plastics shall not be installed more than 75 ft above grade level.

2603.2 Exceptions

2603.2.1 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 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.

2603.2.2 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 2603.1 may be increased 100%, but in no case shall the area of plastic wall panels exceed 50% of the wall area. These uses shall be exempt from height limitations.

TABLE 2603.1
AREA LIMITATIONS AND SEPARATION REQUIREMENTS
FOR PLASTIC WALL PANELS[1]

Fire Separation (ft)	Class of Plastic	Max. % area of Ext. Walls in Plastic Panels	Max. sq ft Single Area	Minimum Separation of Panels (ft)	
				Vertical	Horizontal
6 ft or less	---	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]	0
	CC 2	25	100	6[2]	3

1. See 2602.2.3 for combination of glazing and wall panel areas permitted.
2. See 2602.1 (2).

2604 ROOF PANELS

2604.1 General

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.

2604.2 Limitations

2604.2.1 Individual roof panels or units shall be separated from each other by a distance of not less than 4 ft 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.

2604.2.2 Where exterior wall openings are required to be fire resistance rated, a roof panel or unit shall not be installed within 6 ft of such exterior wall.

2604.2.3 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.

EXCEPTION: The tabular area limits may be increased 100% in buildings provided with an automatic fire suppression system.

TABLE 2604
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

2604.3 Exceptions

2604.3.1 Low hazard uses such as swimming pool shelters, greenhouses, etc., are exempt from the area limitations of 2604.2 provided they do not exceed 5000 sq ft in area and are not closer than 11 ft to the property line of adjacent buildings.

2604.3.2 Roof coverings over terraces and patios of one and two family dwellings shall be permitted with approved plastics.

2605 SKYLIGHTS

2605.1 General

2605.1.1 Skylight assemblies may be glazed with approved plastic materials in accordance with the provisions of 2605.

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 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.

2605.1.2 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.

2605.2 Mounting

The glazing shall be mounted at least 4 inches above the plane of the roof on a curb constructed consistent with the requirements for the type of construction classification. Edges 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.

2605.3 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.

EXCEPTION: Skylights which pass the Class B burning brand test specified in ASTM E 108.

2605.4 Maximum Area Of Skylight Unit

Each skylight unit shall have a maximum area of 100 sq ft 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.

2605.5 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.

2605.6 Separation

Skylights shall be separated from each other by a distance of not less than 4 ft 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 measured in a horizontal plane.

2605.1 Location

Where exterior wall openings are required to be fire resistance rated, a skylight shall not be installed within 6 ft of such exterior wall.

2606 LIGHT DIFFUSERS IN CEILINGS

2606.1 Light Diffusing Systems

2606.1.1 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.

2606.1.2 Approved plastic materials shall comply with 704.3, unless the plastic panels meet the following requirements:

1. Fall from their mounting at an ambient temperature of at least 200° F below the ignition temperature of the plastic material as measured by ASTM D 1929.
2. Remain in place at an ambient room temperature of l75°F for a period of not less than 15 minutes.
3. The maximum length of any single plastic panel shall not exceed 10 ft and the maximum area of any single light diffuser shall not exceed 30 sq ft.

2606.1.3 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.

2606.2 Electrical Lighting Fixtures

Plastic light transmitting panels and light diffuser panels installed in approved electrical lighting fixtures shall comply with 704 unless the plastic panels meet the requirements of 2606.1.2.

2606.3 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.

2607 PARTITIONS

Refer to control of partitions in the applicable section of this Code.

2608 EXTERIOR VENEER

2608.1 General

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 above grade in locations other than in the Fire District.
2. Sections of plastic veneer shall not exceed 200 sq ft in area.
3. Sections of plastic veneer shall be separated by a minimum of 4 ft vertically.

2609 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.

2610 GREENHOUSES

Approved plastic may be used in lieu of plain glass in greenhouses.

2611 SIGNS AND OUTDOOR DISPLAYS

The use of plastics in signs, outdoor displays and similar structures shall be governed by provisions of Chapter 23.

2612 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.

2613 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.

CHAPTER 27

GLASS

2701 LABELING

2701.1 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 the approved plans and specifications.

2701.2 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 exempted from permanent labeling. This type of glass shall be identified with a removable paper label by the manufacturer.

2702 LOUVERED WINDOWS OR JALOUSIES

Regular plate, sheet or patterned glass in jalousies and louvered windows shall be no thinner than nominal 7/32 inch and no longer than 48 inches. When other glass types are used, design shall be submitted to the Building Official for approval. Exposed glass edges shall be smooth. Wired glass with wire exposed on longitudinal edges shall not be used in jalousies or louvered windows.

2703 IMPACT AND WIND LOADS

2703.1 General

Individual glazed areas in hazardous locations such as those indicated in 2703.2 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 for use in fire doors, fire windows and view panels in 1-hour fire resistant walls and hazardous locations in 2703.2.1 (6) and 2703.2.1 (7) shall comply with ANSI Z97.1.
2. Approved plastic materials used as glazing in hazardous locations shall comply with ANSI Z97.1.

2703.2 Hazardous Locations

2703.2.1 The following shall be considered specific hazardous locations for the purposes of glazing:

1. Glazing in ingress and egress doors except wired glass in required fire doors and jalousies.
2. Glazing in fixed and sliding panels of sliding type door (patio and mall type).
3. Glazing in storm doors.
4. Glazing in all unframed swinging doors.
5. Glazing in shower and bathtub doors and surrounding walls.
6. Glazing, operable or inoperable, adjacent to a door in all buildings and within the same wall plane as the door whose nearest vertical edge is within 12 inches of the door in a closed position and whose bottom edge is less than 60 inches above the floor or walking surface.

7. Glazing, operable or inoperable, having a glazed area in excess of 9 sq ft with lowest edge less than 18 inches above the finish floor level or walking surface within 36 inches of such glazing. In lieu of safety glazing such glazed panels may be protected with a horizontal member not less than 1 1/2-inches wide when located between 24 and 36 inches above the walking surfaces.

2703.2.2 The following products, materials and uses are exempt from the above hazardous locations:

1. Openings in doors through which a 3-inch sphere is unable to pass.
2. Leaded glass panels where no individual piece of glass has an area greater than 30 sq in.
3. Glazing materials used as curved glass panels in revolving doors.
4. Commercial refrigerated cabinet glazed doors.
5. Faceted and decorative glass.

2703.3 Wind Loads

2703.3.1 Glass in windows, curtain and window walls, skylights, doors, and other exterior applications shall be chosen to resist the wind loads in 1205.

2703.3.2 Maximum sizes of single regular (annealed) glass may be determined directly from Figure 2703.3. Maximum sizes of other glass types may be determined by first dividing the wind load determined in 1205 by the factors in Table 2703.3.

2703.3.3 Figure 2703.3 is applicable for rectangular glass firmly supported on all four edges.

2703.3.4 When approved by the Building Official, alternate means for selecting glass may be used in place of Table 2703.3 and Figure 2703.3.

2703.4 Glazing Replacement

The installation or replacement of glass shall be as required for new installations.

2703.5 Railings

2703.5.1 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

2703.5.1.1 The panels and their support system shall be designed to withstand the loads specified in 1207.2.1 and 1207.2.2. A safety factor of 4 shall be used. The glass shall meet provisions of 2703.5.4.

2703.5.1.2 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.

2703.5.1.3 Glass balusters shall not be installed without a handrail or guardrail attached.

2703.5.2 Glass in in-fill panels shall be an approved safety glazing material meeting the provisions of 2703.5.4. For all glass types, the minimum nominal thickness shall be 1/4 inch.

2703.5.3 Glazing materials shall not be installed in railings in parking garages except for pedestrian areas not exposed to impact from vehicles.

2703.5.4 Fully-tempered glass and laminated glass shall comply with Federal Law 16 CFR 1201, Category II. Wired glass shall comply with ANSI Z97.1.

2704 GLASS SUPPORTS

2704.1 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.

2704.2 Special Cases

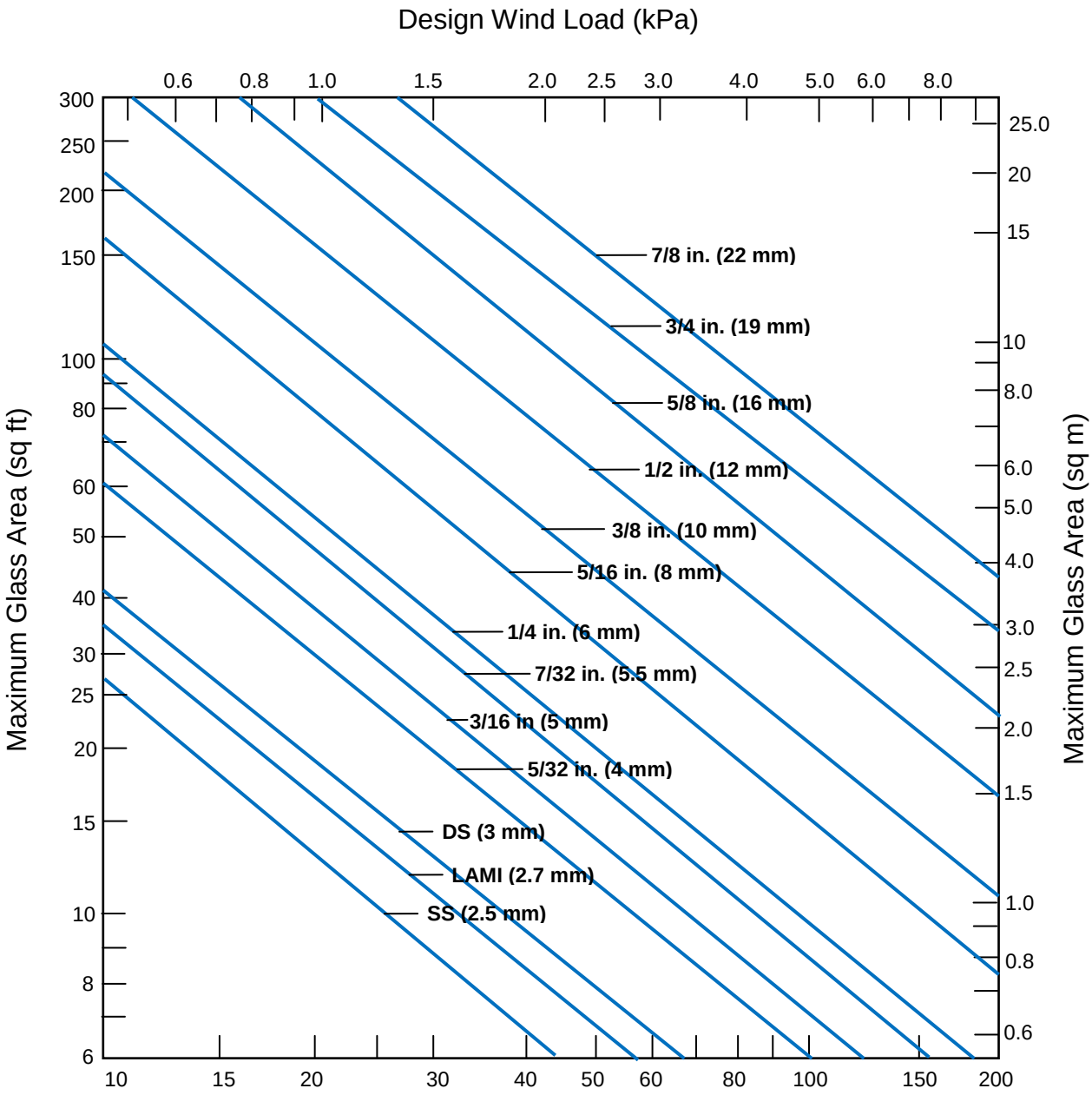
Where other than firm support on all sides is provided, (three sides, two sides, cantilever, or highly flexible, for example), detailed shop drawings, specifications and rational analysis and/or test data assuring safe performance for the specific installation shall be prepared by engineers experienced in this work and shall be submitted for and receive, if warranted, formal approval by the Building Official.

TABLE 2703.3
RELATIVE RESISTANCE TO WIND LOAD

Glass Type	Factor[1]
Laminated[2]	0.75
Wired	0.5
Heat Strengthened	2.0
Fully Tempered	4.0
Insulating glass[3] - 2 panes	1.7
- 3 panes	2.55
Patterned[4]	1.0
Sandblasted[5]	0.4
Regular (annealed)	1.0

1. Wind pressure determined from 1205 should be divided by this factor for use with Figure 2703.3.
2. Applies when two plies are identical in thickness and type; use total glass thickness, not thickness of one ply.
3. Applies when each glass pane is the same thickness and type; use thickness of pane.
4. Use minimum glass thickness, i.e., measured at the thinnest part of the pattern; interpolation of Figure 2703.3 may be required.
5. Factor varies depending upon depth and severity of sand blasting; value shown is minimum.

FIGURE 2703.3
WIND LOAD CHART



Design Wind Load From 1205 (psf)
Design Factor = 2.5
Chart Applies for Width-to-Length Ratios from 1:5 to 1:1

Based on Minimum Glass Thickness Allowed in Federal Specification DD-G-451D

CHAPTER 28

ALUMINUM CONSTRUCTION

2801 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.

2802 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 29

ACOUSTICAL CEILING SYSTEMS

2901 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.

2902 ACOUSTICAL MATERIALS

2902.1 Installation

2902.1.1 Acoustical materials complying with the interior finish requirements of 704 shall be installed in accordance with the manufacturer's recommendations and applicable provisions for applying interior finish.

2902.1.2 Suspended acoustical ceiling systems shall be installed in accordance with the provisions of ASTM C 635 and ASTM C 636.

2902.1.3 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 1001 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, wire or other approved devices shall be installed above the panels to prevent upward displacement under such upward force.

CHAPTER 30

REFERENCE STANDARDS

3001- REFERENCED STANDARDS

Standard Designation	Section
AA Specification for Aluminum Structures, Aluminum Construction Manual, 1970	2802
AAMA 1402-86, Standard Specifications for Aluminum Siding, Soffit and Fascia	811.4.1
AAMA 1602.1, Voluntary Procedure for Determining the Annual Energy Balance of Skylights, 1975	J103.1.2
AASHTO T 260-84, Method of Sampling and Testing for Total Chloride Ion in Concrete and Concrete Raw Materials	1603.5.4
ACI 318-83 with 1986 Supplement, Building Code Requirements for Reinforced Concrete	1203.4, 1206.9, 1206.9.2, 1206.9.3, 1601, 1602, 1603.5.5, 1606.3.2
ACI 318.1-83, Building Code Requirements for Structural Plain Concrete	1304.1, 1601.1.2
ACI/ASCE 530-88, Building Code Requirements for Masonry Structures	1206.2, 1206.9, 1403.6.2, 1403.6.3, 1409.7, 1411.1, 1411.2
AISC Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design, 1989	1206.9.2, 1206.9.3, 1509
AISC Load and Resistance Factor Design Specification for Structural Steel Buildings, 1986	1502
AISI Criteria for Structural Application of Steel Cables for Buildings, 1973	1506
AISI Design for Cold-Formed Steel Structural Members, 1986	1503, 1507
AISI Design for Cold-Formed Stainless Steel Structural Members, 1974	1504
AITC 104-84, Typical Construction Details	1701.2.5
AITC 110-84, Standard Appearance Grades for Structural Glued Laminated Timber	1701.2.5
AITC 112-81, Tongue-and-Groove Heavy Timber Roof Decking	1701.2.5
AITC 113-83, Dimensions of Structural Glued Laminated Timber	1701.2.5
AITC 117-87, Structural Glued Laminated Timber of Softwood Species - Design	1701.2.5
AITC 117-88, Structural Glued Laminated Timber of Softwood Species with Addendum No. 1 - Manufacturing	1701.2.5
AITC 119-85, Hardwood Glued Laminated Timber	1701.2.5

AITC Technical Note No.7, Calculation of Fire Resistance of Glued Laminated Timbers, Sept. 1984, updated 10/9/85	3109.3
ANSI A 13.l-81, Scheme for the Identification of Piping Systems	511.6.3
ANSI A42.2-71	Q105.6
ANSI A42.3.71	Q105.6
ANSI A58.1-82, Minimum Design Loads for Buildings and Other Structures	1201.1.2, 1205.1.1, 1205.3
ANSI A90.1-69, Safety Standard for Manlifts	2404
ANSI A108.1-85, Glazed Wall Tile, Ceramic Mosaic Tile, Quarry Tile and Paver Tile Installed with Portland Cement Mortar	1402.10.2
ANSI A 108.4-85, Ceramic Tile Installed with Organic Adhesives or Water-Cleanable Tile Setting Epoxy Adhesive	1402.10.3
ANSI A108.5-85, Ceramic Tile Installed with Dry-Set Portland Cement Mortar or Latex Portland Cement Mortar	1402.10.4
ANSI A 108.6-85, Ceramic Tile Installed with Chemical-Resistant, Water-Cleanable Tile-Setting-and-Grouting Epoxy	1402.10.5
ANSI A 108.7-85, Electrically Conductive Ceramic Tile Installed with Conductive Dry-Set Portland Cement Mortar	1402.10.6
ANSI A 108.8-85, Ceramic Tile Installed with Chemical-Resistant Furan Mortar and Grout	1402.10.7
ANSI A 108.9-85, Ceramic Tile Installed with Modified Epoxy Emulsion Mortar/Grout	1402.10.8
ANSI A 108.10-85, Installation of Grout in Tile work	1402.10.9
ANSI A 118.1-85, Dry-Set Portland Cement Mortar	1402.10.4
ANSI A 118.2-85, Conductive Dry-Set Portland Cement Mortar	1402.10.6
ANSI A 118.3-85, Chemical-Resistant, Water-Cleanable Tile-Setting and-Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive	1402.10.5
ANSI A 118.4-85, Latex-Portland Cement Mortar	1402.10.4
ANSI A 118.5-85, Chemical-Resistant Furan Mortar and Grout	1402.10.7
ANSI A 118.6-85, Ceramic Tile Grouts	1402.10.9
ANSI A 118.8-85, Modified Epoxy Emulsion Mortar/Grout	1402.10.8
ANSI A 136.1-85, Organic Adhesives for Installation of Ceramic Tile	1402.10.3
ANSI A 137.1 -80, Ceramic Tile	1402.10.1
ANSI A208.1-79, Mat-Formed Wood Particleboard	811.6.6, 1701.4.6, 1707.1.5
ANSI B31.3-84, Chemical Plant and Petroleum Refinery Piping Including Addendum B31.3b-1986	511.6.1

ANSI 297.1-84, Glazing Material Used for Building, Performance Specifications and Methods of Test	2504.1, 2613, 2703.1, 2703.5.4
ANSI/AHA A l35.4-82, Basic Hardboard	811.6.6, 1701.4.10
ANSI/AHA A 135.5-82, Prefinished Hardboard Paneling	811.6.6, 1701.4.10
ANSI/AHA A 135.6-R4. Hardboard Siding	811.6.6, 1701.4.10
ANSI/AHA A 194.1-85, Cellulosic Fiberboard	1701.4.5
ANSI/AITC A 190.1-83. Standard for Structural Glued Laminated Timber	1701.4.2
ANSI/APA 1-84, Floors and Flooring-Mosaic-Parquet Hardwood Slat Flooring	1701.4.9
ANSI/ASME A 17.1-87, with Addenda A 17.1a-88, Standard Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks	2401, 2402, 2403
ANSI/BHMA A 156.10-85, Power Operated Pedestrian Doors	1114.3.3
ANSI/HPMA HP-83, Hardwood and Decorative Plywood	1701.4.8
ANSI/HPMA LHF-82, Laminated Hardwood Flooring	1701.4.9
APA AFG-01-84, Adhesives for Field-Gluing Plywood to Wood Framing	1706.3.2
APA Cantilevered Joist System	1701.2.5
APA Design/Construction Guide-Residential & Commercial, 1990	1701.2.5, 1706.3.2, 1706.6.4
APA Plywood Design Specification. 1986	1701.2.5
APA Plywood Design Specification Supplement 1 - Design and Fabrication of Plywood Curved Panels	1701.2.5
APA Plywood Design Specification Supplement 2- Design and Fabrication of Plywood-Lumber Beams	1701.2.5
APA Plywood Design Specification Supplement 3- Design and Fabrication of Plywood Stressed-Skin Panels	1701.2.5
APA Plywood Design Specification Supplement 4- Design and Fabrication of Plywood Sandwich Panels	1701.2.5
APA Plywood Design Specification Supplement 5 - Design and Fabrication of All Plywood Beams	1701.2.5
APA PRP-108 Performance Standards and Policies for Structural-Use Panels	1701.2.5, 1701.4.13, 2505.3.4
ASCE Specification for the Design and Construction of Composite Slabs, 1984	1511
ASHRAE/IES 90A-80, Energy Conservation in New Building Design	J102
ASHRAE/IES 90B-75, Energy Conservation in New Building Design	J102
ASTM A 6-87d, General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use	1509

ASTM A 36-84a, Structural Steel	1305.1, 1402.11.1
ASTM A 82-85, Steel Wire, Plain, For Concrete Reinforcement	1402.11.1
ASTM A 152-82(1987), Zinc Coating (Hot-Dip) on Iron and Steel Hardware	1402.11.2
ASTM A 252-82, Welded and Seamless Steel Pipe Piles	1305.1, 1306.1.1
ASTM A 283-87, Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars	1305.1, 1306.1.1
ASTM A 366-85, Steel, Carbon, Cold-Rolled Sheet, Commercial Quality	1402.11.1
ASTM A 370-87c, Mechanical Testing of Steel Products	H105
ASTM A 416-87a, Uncoated Seven-Wire Stress-Relieved Strand for Prestressed Concrete	1308.3.2
ASTM A 572-85, High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality	1305.1
ASTM A 588-87, High-Strength Low-Alloy Structural Steel with 50 ksi Minimum Yield Point to 4 Inches Thick	1305.1
ASTM A 641-82, Zinc-Coated (Galvanized) Carbon Steel Wire	1402.11.2
ASTM A 690-87, High-Strength Low-Alloy Steel H-Piles and Sheet Piling for Use in Marine Environments	1305.1
ASTM A 706-84a, Low-Alloy Steel Deformed Bars for Concrete Reinforcement	1602.5.2
ASTM C 5-(1984), Quicklime for Structural Purposes	1802
ASTM C 28-86, Gypsum Plasters	1802
ASTM C 29-87, Test for Unit Weight and Voids in Aggregate	1002.9, 1002.10
ASTM C 31-84, Making and Curing Concrete Test Specimens in the Field	1603.7.2.2, 1603.7.3.2
ASTM C 33-84, Concrete Aggregates	1602.3.1, T. 1603.5A
ASTM C 34-84, Structural Clay Load-Bearing Wall Tile	1002.3, 1402.3.1
ASTM C 35-87, Inorganic Aggregates for Use in Gypsum Plaster	1002.9, 1002.10, 1802
ASTM C 36-85, Gypsum Wallboard	1002.5.3, 1802
ASTM C 37-87, Gypsum Lath	1002.5.1, 1802
ASTM C 39-84, Test for Compressive Strength of Cylindrical Concrete Specimens	1603.7.2.2
ASTM C 42-84a, Obtaining and Testing Drilled Cores and Sawed Beams of Concrete	1603.7.4.2
ASTM C 55-85, Concrete Building Brick	1002.2, 1402.2.1, 3103.1

ASTM C 56-71 (1981), Structural Clay Non-Load Bearing Tile	1002.3, 1402.3.1
ASTM C 61-87, Gypsum Keene's Cement	1802
ASTM C 62-87, Building Brick (Solid Masonry Units Made from Clay or Shale)	1002.2, 1402.1.1
ASTM C 67-87, Sampling and Testing Brick and Structural Clay Tile	1409.8.1, Q103.1.1
ASTM C 73-85, Calcium Silicate Face Brick (Sand-Lime Brick)	1002.2, 1402.1.1, 3103.1
ASTM C 79-87, Gypsum Sheathing Board	1002.5.4
ASTM C 90-85, Hollow Load-Bearing Concrete Masonry Units	1002.8, 1402.2.1, 3103.1
ASTM C 91-87a, Masonry Cement	1402.8, 1802
ASTM C 94-85, Ready-Mixed Concrete	1604.2.2
ASTM C 126-86, Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units	1002.2, 1402.4
ASTM C 129-85, Non-Load-Bearing Concrete Masonry Units	1002.8, 1402.2.1
ASTM C 145-85, Solid Load-Bearing Concrete Masonry Units	1002.8, 1402.2.1, 3103.1
ASTM C 150-R6, Portland Cement	1602.2, 1603.4.2, 1802
ASTM C l72-82, Sampling Fresh Concrete	1603.7.2.1
ASTM C 192-81, Making and Curing Complete Test Specimens in the Laboratory	1603.3.3.2
ASTM C 206-84, Finishing Hydrated Lime	1802
ASTM C 212-60 (1986), Structural Clay Facing Tile	1002.3, 1402.3.1
ASTM C 216-87, Facing Brick (Solid Masonry Units Made from Clay or Shale)	1002.2, 1402.1.1
ASTM C 231-82, Test for Air Content of Freshly Mixed Concrete by the Pressure Method	1603.5.1
ASTM C 270-87a, Mortar for Unit Masonry	1402.8.1, 1410.2.1, T. 1402.8B
ASTM C 317-87, Gypsum Concrete	1412.1
ASTM C 330-82a, Lightweight Aggregates for Structural Concrete	1602.3.1
ASTM C 442-84a, Gypsum Backing Board	1802
ASTM C 474-88, Testing Joint Treatment Materials for Gypsum Wallboard Construction	1802
ASTM C 475-88, Joint Treatment Materials for Gypsum Wallboard Construction	1802

ASTM C 476-83, Grout for Reinforced and Non-reinforced Masonry	1402.8, 1410.2.1
ASTM C 514-84, Nails for the Application of Gypsum Wall Board	T. 1705.1
ASTM C 530-86, Structural Clay Non-Load Bearing Screen Tile	1402.3.1
ASTM C 587-83, Gypsum Veneer Piaster	1002.5.6
ASTM C 588-84a, Gypsum Base for Veneer Plasters	1002.5.5
ASTM C 595-86, Blended Hydraulic Cement	1603.4.2, 1802
ASTM C 618-84a, Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete	1602.6.5
ASTM C 630-85, Water-Resistant Gypsum Backing Board	1002.5.8, 1402.10.11, 1802
ASTM C 631-88, Bonding Compounds for Interior Plastering	1802
ASTM C 635-87, Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings	2902.1.2
ASTM C 636-86, Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels	2902.1.2
ASTM C 645-83, Non-Load (Axial) Bearing Steel Studs, Runners (Track) and Rigid Furring Channels for Screw Application of Gypsum Wallboard	1802
ASTM C 652-87a, Hollow Brick (Hollow Masonry Units Made from Clay or Shale)	1002.2, 1402.1.1
ASTM C 685-85, Concrete Made by Volumetric Batching and Continuous Mixing	1604.2.2
ASTM C 744-73 (1985), Prefaced Concrete and Calcium Silicate Masonry Units	1402.4
ASTM C 754-88, Installation of Steel Framing Members to Receive Screw-Attached Gypsum Wallboard, Backing Board, or Water-Resistant Backing Board	1803.5.1, T. 1804
ASTM C 841-87, Installation of Interior Lathing and Furring	1803.1.1
ASTM C 842-85, Application of Interior Gypsum Plaster	1803.1.2
ASTM C 843-88, Application of Gypsum Veneer Plaster	1803.4.2
ASTM C 844-85, Application of Gypsum Base to Receive Gypsum Veneer Plaster	1803.4.2
ASTM C 847-88, Metal Lath	1002.7.1, 1802
ASTM C 926-86, Application of Portland Cement Based Plaster	1803.1.3, 1803.2.1
ASTM C 931-85, Exterior Gypsum Soffit Board	1002.5.7, 1802
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	1802
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	1802
ASTM C 956-81 (1986), Installation of Cast-in-Place Reinforced Gypsum Concrete	1412.1
ASTM C 960-87, Predecorated Gypsum Board	1802

ASTM C 989-84, Ground Iron Blast-Furnace Slag for Use in Concrete and Mortars	1602.6.6
ASTM C 1002-83, Steel Drill Screws for the Application of Gypsum Board	1802
ASTM C 1007-83, Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories	1803.5.2
ASTM C 1015-84, Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation	J104.1
ASTM C 1028-84 Standard Test Method for Evaluating the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull Meter Method	1402.10.10
ASTM C 1047-85, Accessories for Gypsum Wallboard and Gypsum Base Veneer	1803.2.2
ASTM C 1077-87, Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluations	1602.8.2
ASTM C 1088-88, Thin Brick Veneer Units Made from Clay or Shale	1402.1.1
ASTM D 25-88, Round Timber Piles	1309.1
ASTM D 422-63 (1972), Particle-Size Analysis of Soils	1302.3.2
ASTM D 635-81, Test for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position	202, 2304.1
ASTM D 1143-81 (1987), Testing Piles Under Static Axial Compressive Load	1304.4, 2504.1
ASTM D 1586-84, Penetration Test & Split-Barrel Sampling of Soils	H105.5.2
ASTM D 1761-77, Testing Mechanical Fasteners In Wood	2504.1, 2505.3.1
ASTM D 1929-77(1985), Ignition Properties of Plastics	202, 2606.1.2
ASTM D 2487-85, Classification of Soils for Engineering Purposes	H105.5.2
ASTM D 2843-77, 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	202, 706.1, 706.6.4
ASTM D 3201-86, Hygroscopic Properties of Fire-Retardant Wood and Wood-Base Products	1701.8.3
ASTM D 3679-86, Rigid Poly (Vinyl Chloride) (PVC) Siding	811.9
ASTM D 3689-83, Individual Piles Under Static Axial Tensile Load	1304.7, 2504.1
ASTM D 4318.84, Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils	1302.3.2
ASTM E 72-80, Conducting Strength Tests of Panels for Building Construction	2504.1
ASTM E 84-87, Test for Surface Burning Characteristics of Building Materials	202, 512.4.6, 704.2, 704.5, 717.1.2, 717.2.5.2, 717.2.11, 717.3.1, 719.1

ASTM E 90-87 Laboratory Measurement of Airborne-Sound Transmission Loss of Building Partitions	E102.1
ASTM E 108-87, Fire Tests of Roof Coverings	512.4.3, 706.1, 706.6.4, 2605.3
ASTM E 119-88, Test Methods for Fire Tests of Building Construction and Materials	202, 601.2, 506.1.9, 601.3.1, 705.1.4, 1001.1.1, 1001.3.1
ASTM E 136-82, Test Method for Behavior of Materials in a Vertical Tube Furnace at 750° C.	202, 512.4.2
ASTM E 152-81a, Fire Tests of Door Assemblies	510.2.3, 703.3.3, 703.4.2
ASTM E 163-84, Fire Tests of Window Assemblies	703.4.2, 717.3.1, 1002.11
ASTM E, 196-80 (1985), Gravity Load Testing of Floors and Flat Roofs	2504.1
ASTM E 330-84, Test for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference	2504.1
ASTM E 447-84, Compressive Strength of Masonry Prisms	2504.1
ASTM E 605-77 (1982), Tests for Thickness and Density of Sprayed Fire-Resistive Material Applied to Structural Members	1002.12.2, 1002.12.3
ASTM E 814-83, Standard Method of Fire Tests of Through-Penetration Fire Stops	506.1.9, 506.1.10, 1001.3.1
AWPA Standards of the American Wood Preservers Association	1703.1.1.2, App. C
AWPA C1-92, All Timber Products - Preservative Treatment by Pressure Processes	App C
AWPA C2-92, Lumber, Timbers and Ties - Preservative Treatment by Pressure Processes	706.6.1, App. C
AWPA C3-92, Piles - Preservative Treatment by Pressure Processes	1309.2.2, App. C
AWPA C4-92, Poles - Preservative Treatment by Pressure Processes	App. C
AWPA C9-90, Plywood - Preservative Treatment by Pressure Processes	App. C
AWPA C 18-90, Standard for Pressure Treated Material in Marine Construction	1309.2.4, App. C
AWPA C20-91, Structural Lumber - Fire-retardant Treatment by Pressure Process	1701.8.3
AWPA C22-92, Lumber and Plywood for Permanent Wood Foundations - Preservative Treatment By Pressure Processes	App. C
AWPA C23-92, Round Poles and Posts Used In Building Construction - Preservative Treatment by Pressure Processes	App. C

AWPA C24-86, Sawn Timber Piles Used for Residential Commercial Building	App. C
AWPA C27-91, Plywood - Fire-retardant Treatment by Pressure Process	1701.8.3
AWPA C28-91, 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	App. C
AWPA M4-91, Standard For the Care of Preservative-Treated Wood Products	1309.2.4, 1309.2.5, App. C
AWPA P1, Coal Tar Creosote for Land and Fresh Water Use	App. C
AWPA P2, Creosote and Creosote Solutions	App. C
AWPA P3, Creosote-Petroleum Oil Solution	App. C
AWPA P5, Waterborne Preservatives	App. C
AWPA P8, Oil-Borne Preservatives	App. C
AWPA P9, Solvents and Formulations for Organic Preservative Systems	App. C
AWPA P11, Creosote-Pentachlorophenol Wood Preservative Solution	App. C
AWPI Pole Building Design	1701.2.5
AWS D1.1-79, Structural Welding Code	1507
AWS D1.4-79, Structural Welding Code – Reinforcing Steel	1602.5.2
BIA 5A-70, Technical Notes	App. E
BIA Building Code Requirements for Engineered Brick Masonry, 1969	1403.6.3, 1411.2
CABO Recommended Requirements to Code Officials for Solar Heating, Cooling and Hot Water Systems, June 1980	J102.3
CPSC 16-77, Consumer Product Safety Commission Architectural Glazing Materials, Federal Register	2703.1
CPSC 16 CFR 1201, Category II	2703.5.4
CPSC 16 CFR Part 1209-87, Cellulose Insulation - Interim Safety Standard	719.7
CPSC 16 CFR Part 1404-87, Cellulose Insulation	719.7
FM Specification Tested Products Guide, 1986	1003.1.2
FM 4450-77, Class I Insulated Steel Deck Roofs	717.2.7
FM 4880-72, Building Corner Fire Test	717.1.4
FS DD-G-451D	Fig. 2703.3
GA 216-82, Recommended Specifications for the Application and Finishing of Gypsum Board	1803.4.1
GA-600 Fire Resistance Design Manual, 12th Edition	1003.1.2, E102
IMI Recommended Practices for Cold Weather Masonry Construction	1409.7
MFMA Hard Maple Flooring Standard Specification (Hard Maple, Beech and Birch), 1969	1701.4.9
NCMA-TEK 69-75 Noise Insulation with Concrete Masonry	E102
NFiPA 10-90, Portable Fire Extinguishers	409.2.17.5

NFiPA 13-91, Installation of Sprinkler Systems	402.2.3.3, 409.1.1.2, T. 409.1, 409.2.17, 409.2.21, 506.10.1, 507.7, 901.2, 901.3, 901.7.5, 2402.1.9, 2402.6.1
NFiPA 13D-91, Installation of Sprinkler Systems in One-and Two Family Dwellings and Mobile Homes	901.2
NFiPA 13R-91, Installation of Sprinkler Systems in Residential Occupancies up to Four Stories in Height	901.2
NFiPA 14-90, Installation of Standpipe and Hose Systems	409.2.17.6, 507.8.2, 902.1
NFiPA 30-90, Flammable and Combustible Liquids Code	408.2.6
NFiPA 30A-90, Automotive and Marine Service Station Code	405.2, App. T
NFiPA 33-89, Spray Application Using Flammable and Combustible Materials	408.2.6
NFiPA 34-89, Dipping and Coating Processes Using Flammable or Combustible Liquids	408.2.6
NFiPA 37-90, Installation and Use of Stationary Combustion Engines and Gas Turbines	408.2.6
NFiPA 40-88, Storage and Handling of Cellulose Nitrate Motion Picture Film	404.11.1, 408.7.1.2
NFiPA 40E-86, Storage of Pyroxylin Plastic	408.2.6
NFiPA 43A-90, Storage of Liquid and Solid Oxidizing Materials	408.2.6
NFiPA 45-91, Fire Protection for Laboratories Using Chemicals	408.2.6
NFiPA 49-91, Hazardous Chemicals Data	408.2.6
NFiPA 51-91, Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting and Allied Processes	408.2.6
NFiPA 58-92, Storage and Handling of Liquefied Petroleum Gases	408.2.6
NFiPA 70-93, National Electrical Code with North Carolina Amendments	409.2.21.1, 409.2.22.1, 506.7.1.1, 507.7, 510.2.8.1, 511.2.6.7, 511.5.7, 704.10
NFiPA 71-89, Installation, Maintenance, and Use of Central Station Signaling Systems	409.2.16.4, 507.7, 901.8.5

NFiPA 72-90,	507.7, 903.1.1
NFiPA 72A-85, Installation. Maintenance and Use of Local Protective Signaling Systems	409.2.16.4, 409.2.16.7, 903.2.5
NFiPA 72B-86, Installation. Maintenance and Use of Auxiliary Protective Signaling Systems	409.2.16.4
NFiPA 72D-86, Installation, Maintenance and Use of Proprietary Protective Systems	409.2,16.4, 901.8.5
NFiPA 72E-90, Automatic Fire Detectors	409.2.16.4, 409.2.18.5, 513.2, 903.2.4, 903.2.5
NFiPA 74-89, Household Fire Warning Equipment	409.1.5.2, 513.2, 903.2.4
NFiPA 75-92, Protection of Electronic Computer/Data Processing Equipment	812
NFiPA 80-86, Fire Doors and Windows	703.4.1, 703.4.3, 1114.5
NFiPA 82-90, Incinerators, Waste and Linen Handling Systems and Equipment	409.2.21.4
NFiPA 96-91, Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment	409.2.14.3
NFiPA 99-90, Health Care Facilities	1118.3
NFiPA 102-92, Assembly Seating, Tents and Membrane Structures	512.1, T 1203.1
NFiPA 204M-91, Guide for Smoke and Heat Venting	505.3, 1103.1.4
NFiPA 231C-91, Rack Storage of Materials	901.2
NFiPA 231 D-89, Rubber Tire Storage	408.2.6
NFiPA 231-90, General Storage	901.2
NFiPA 253-90, Test for Critical Radiant Flux of Floor Covering Systems	704.7.2, 704.7.3, 704.7.4
NFiPA 259-87, Test Method for Potential Heat of Building Materials	512.4.2, 717.2.5.2, 717.2.10
NFiPA 651-87, Manufacture of Aluminum and Magnesium Powder	408.2.6
NFiPA 654-88, Prevention of Fire and Dust Explosions in the Chemical, Dye, Pharmaceutical and Plastic Industries	408.2.6
NFiPA 701-89, Fire Test for Flame-Resistant Textiles and Films	404.14.1, 512.4.1
NFiPA 704-90, Identification of the Fire Hazards of Materials	202, 511.6.1

NFiPA 801-91,	
NFiPA 1221-91, Installation, Maintenance and Use of Public Fire Service Communication Systems	901.8.5
NFoPA Design Values for Joists and Rafters, 1991	1701.5.1, 1708.1.1
NFoPA National Design Specification for Wood Construction, 1991 and Design Values for Wood Construction, 1991	1701.2.5, T.1710.2A, T.1710.2B, T.1711.2A, T.1711.2B
NFoPA Span Table for Joist and Rafters, 1991	1706.3.1, 1708.1.1, 1708.3.1
NFoPA Technical Report No.7, The Permanent Wood Foundation System, 1/87	1302.7
NFoPA Wood Construction Data No. 5, Heavy Timber Construction Details, 1974	1701.2.5
NOFMA 1981 "Flooring Grading Rules" (Oak, Pecan, Beech, Birch, Hard Maple), 1981	1701.4.9
NPA How To Install Particleboard Underlayment	1701.2.5, 1701.4.6
NPCA, National Pest Control Association	1703.1.2
PCA Simplified Thermal Design of Building Envelopes for Use with ASHRAE Standard 90A-80 (1981)	J102.2
PCI Design for Fire Resistance of Precast Concrete, 1977	T. 3102.3E
PS 1-83, Construction and Industrial Plywood	1701.4.3, T.1710.2A, T.1710.2B, 2505.3.3
PS 2-92, Performance Standard for Wood-Based, Structural-Use Panels	1701.4.3, 2505.3.3
PTI Design and Construction of Post-tensioned Slabs-On-Ground, 1980	1302.3.3.3
RCSC Structural Joints Using ASTM A325 or A490 Bolts, 1985	1508
Red Cedar Shingle and Handsplit Shake Bureau	706.6.2
SBCCI Standard Building Code with North Carolina Amendments, Appendix B, 1988Edition	1003.1.2
SBCCI Standard Building Code with North Carolina Amendments, Appendix C, 1988 Edition	1701.4.7
SBCCI Standard Building Code with North Carolina Amendments, Appendix G, 1988 Edition	301.2.1
SBCCI Standard Building Code with North Carolina Amendments, Appendix R, 1988 Edition	1202.1
SBCCI Standard Building Code with North Carolina Amendments Appendix S, 1989 Revisions	706.1, 1406.1.4, 1510, 1609, 1709.4.1

SBCCI Standard Fire Prevention Code with Revisions	201.2, 402.4.1, 404.3.3, 404.10, 405.2.7, 405.3.1, 408.2.1, 409.1.11, 412.1.5, 507.9, 511.2.6.6, 703.2, 718.1, 901.5, 901.7.4, T.1103.1.4, 3605
SBCCI Standard for Expansive Soil Tests, 1986	1302.3.2
SBCCI Standard for Proscenium Curtains, 1988	404.9.4.2
SBCC1 Standard Gas Code with North Carolina Amendments, 1988 Edition	201.2, 807
SBCC1 Standard Mechanical Code with North Carolina Amendments, 1988 Edition	201.2, 402.2.3.3, 408.4.1.7, 408.6.3, 409.1.2.2, 507.10.2, 509.6, 511.2.6.1, 703.3.4, 704.9.2, 719.5, 801, 810, 1302.6.3
SBCC1 Standard Plumbing Code with North Carolina Amendments, 1988 Edition	808, 1203.6.2, 1406.1.4.1, 1406.1.4.2, 1510, 1609, 1709, 2002.1, 2002.2
SBCCI Standard Test Method for Evaluating Room Fire Growth Contribution of Textile Wallcovering, 1988	704.5
Southern Pine Inspection Bureau	1703.1.1.3
Southern White Cedar & Cypress Products Inspection Bureau	706.6.2
SJI Joist Girders, 1985	1505
SJI Longspan Steel Joists, LH-Series, and Deep Longspan Steel Joists, DLH-Series, 1985	1505
SJI Open Web Steel Joists, K-Series, 1985	1505

TPI Design Specification for Metal Plate Connected Wood Trusses, TPI-85	1701.2.5, 1708.2.2
TPI Design Specification for Metal Plate Connected Parallel Chord Wood Trusses PTC-80	1701.4.12
UL 9-87, Fire Tests of Window Assemblies	1002.11
UL 103-89. Factory Built Chimneys	802.4.4
UL 127-87, Factory-built Fireplaces	802.4.5, 804.1.2
UL 217-87, Single and Multiple Station Smoke Detectors	409.1.5.1
UL 268-87 Smoke Detectors for Fire Protective Signaling Systems	409.1.5.1
UL 555-86, Fire Dampers and Ceiling Dampers	703.3.3
UL 737-86, Fireplace Stoves	804.2.1
UL 1040-80, Insulated Wall Construction	717.1.4, 717.3.1
UL 1256-85, Fire Test of Roof Deck Construction	717.2.7
UL 1482-83, Room Heaters, Solid-Fuel Type	804.2.1
UL Subject 1715-83, Outline of Investigation for the Classification of Wall and Ceiling Interior Finish Material Assemblies Using a Room Fire Test	717.1.4, 717.3.1
UL Fire Resistance Directory, 1988	1003.1.2
USDA Forest Service General Technical Report SE-33, Performance and Quality-Control Standards for Composite Floor, Wall, and Truss Framing, November 1985	1701.4.11
Waferboard Association	1701.4.6.1
WRI/CRSI Design of Slab-On-Ground Foundations, August 1981	1302.3.3.3

3002 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 818 Connecticut Avenue N.W. Washington, DC, 20006
AAMA	American Architectural Manufacturers Association 2700 River Road Des Plaines, IL 60018
ACI	American Concrete Institute P.O. Box 19150 Detroit, MI 48219-0150

AFPA	American Forest and Paper Association 1250 Connecticut Avenue, N.W., Suite 200 Washington, DC 20036
AHA	American Hardboard Association 520 No. Hicks Road Palatine, IL 60067-3609
AISC	American Institute of Steel Construction, Inc. 8th Floor, Wrigley Bldg., 400 N. Michigan Avenue Chicago, IL 60611-4185
AISI	American Iron and Steel Institute 1000 16th Street N.W. Washington. DC 20036
AITC	American Institute of Timber Construction 333 West Hampden Avenue Englewood, CO 80110
ALSC	American Lumber Standards Committee P. 0. Box 210 Germanton, Md. 20875-0210
ANSI	American National Standards Institute 1430 Broadway New York. NY 10018
APA	American Plywood Association Box 11700 Tacoma, WA 98411
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers 1791 Tullie Circle, N.E. Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103

AWPA	American Wood Preservers Association P.O. Box 849 Stevensville, MD 21666
AWPI	American Wood Preservers Institute 1945 Gallows Road, Suite 405 Vienna, VA 22130
AWS	American Welding Society, Inc. 550 N.W. Lejeune Road Miami, FL 33135
BIA	Brick Institute of America 11490 Commerce Park Drive Reston, VA 22091
CABO	Council of American Building Officials 5203 Leesburg Pike, Suite 708 Falls Church, VA 22041
CPSC	U.S. Consumer Product Safety Commission 5401 Westbard Ave., Room 700 Washington, DC 20207
CSSB	Cedar Shake and Shingle Bureau 515 116th Avenue, N.E., Suite 275 Bellevue, WA 98004
FM	Factory Mutual Research Corp. 1151 Boston Providence-Turnpike Norwood, MA 02060
FS	Federal Specifications Supt. of Documents, Government Printing Office Washington, DC 20234
GA	Gypsum Association 1603 Orrington Avenue, Suite 1210 Evanston, IL 60201
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
NCMA	National Concrete Masonry Association 2302 Horse Pen Road, P.O. Box 781 Herndon, VA 22070
NFiPA	National Fire Protection Association Batterymarch Park Quincy, MA 02269
NOFMA	National Oak Flooring Manufacturers Association 8 North Third, Sterick Building Memphis, TN 38103
NPA	National Particleboard Association 18928 Premiere Court Gaithersburg, MD 20879
NPCA	National Pest Control Association P.O. Box 377, 8100 Oak Street Dunn Loring, VA 22027
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 60077-4321
PCI	Prestressed Concrete Institute 201 N. Wells Street Chicago, IL 60606
PS	Product Standards National Bureau of Standards (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. 1906 West End Avenue Nashville, TN 37203-2371
SJI	Steel Joist Institute 1205 48th Ave. North, Suite A Myrtle Beach, SC 29577
SPI	Society of the Plastics Industry, Inc. 355 Lexington Avenue New York, NY 10017
SPIB	Southern Pine Inspection Bureau 4709 Scenic Highway Pensacola. Fl. 32504-9094
SWCCPIB	Southern White Cedar & Cypress Products Inspection Bureau P.O. Box 98742 Raleigh. NC 27624-8742
TPI	Truss Plate Institute 583 D'onofrio Drive, Suite 200 Madison, WI 53719
UL	Underwriters Laboratories, Inc. 333 Pfingsten Road Northbrook, IL 60062
USDA	United States Department of Agriculture Southeastern Forest Experiment Station Forestry Sciences Laboratory Athens, GA 30602

CHAPTER 31

CALCUALTED FIRE RESISTANCE

Note: See Appendix P for Commentary

3101 GENERAL

3101.1 Scope

This chapter contains 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 chapter and shall not be otherwise used.

3101.2 Definitions

CARBONATE AGGREGATE CONCRETE - concrete made with aggregates consisting mainly of calcium or magnesium carbonate, e.g., limestone or dolomite.

CELLULAR CONCRETE - a lightweight insulating concrete made by mixing a preformed foam with portland cement slurry and having a dry unit weight of approximately 30 pcf.

LIGHTWEIGHT AGGREGATE CONCRETE - concrete made with aggregates of expanded clay, shale, slag, or slate or sintered fly ash, and weighing 85 to 115 pcf.

PERLITE CONCRETE - a lightweight insulating concrete having a dry unit weight of approximately 30 pcf 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.

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.

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.

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.

CERAMIC FIBER BLANKET - a mineral wool insulation material made of alumina-silica fibers and weighing 4 to 10 pcf.

3102 CONCRETE ASSEMBLIES

3102.1 Concrete Walls

3102.1.1 Cast-In-Place Or Precast Walls

3102.1.1.1 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 3102.1 A. For solid walls with flat vertical surfaces, the equivalent thickness is the same as the thickness. The values in Table 3102.1A apply to plain, reinforced, or prestressed concrete walls.

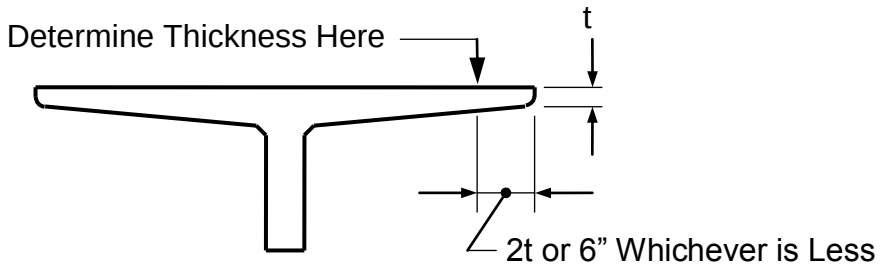
TABLE 3102.1A
MINIMUM EQUIVALENT THICKNESS (IN) OF CAST-IN-PLACE OR PRECAST CONCRETE WALLS, LOADBEARING OR NON-LOADBEARING

	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

3102.1.1.2 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.

3102.1.1.3 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.

3102.1.1.4 The thickness of panels with tapered cross sections shall be that determined at a distance 2t or 6 inches, whichever is less, from the point of minimum thickness, where t is the minimum thickness.



3102.1.1.5 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

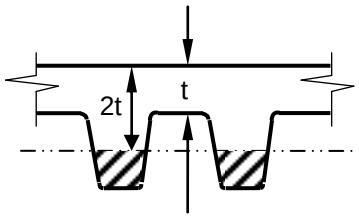
$$t + \left(\frac{4t}{s} - 1\right)(t_e - t)$$

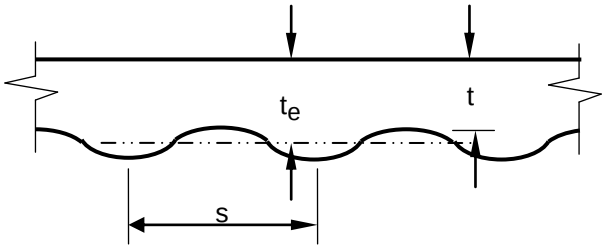
where s = spacing of ribs or undulations

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 Areas
In Calculation Of
Equivalent Thickness





3102.1.2 Multi-Wythe Walls

3102.1.2.1 For walls which consist of two wythes of different types of concrete the fire resistance ratings may be determined from Figure 3102.1 A.

3102.1.2.2 The fire resistance rating for wall panels consisting of two or more wythes may be determined by the formula:

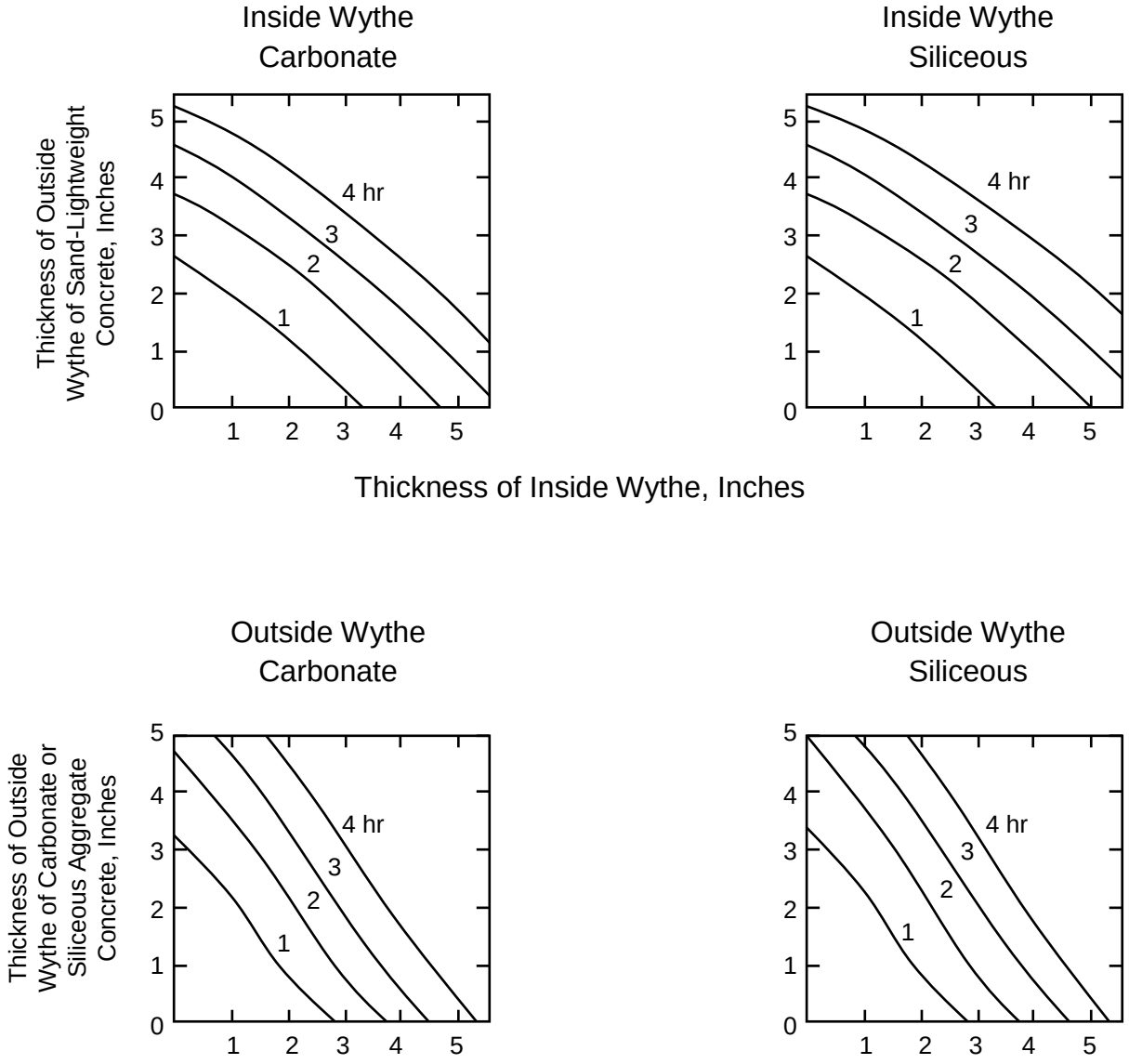
$$R = (R_1^{0.59} + R_2^{0.59} + ... + R_n^{0.59})^{1.7} \qquad \text{(Eq. 3102.1)}$$

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. 3102.1 are given in Table 3102.1B.

FIGURE 3102.1A
FIRE RESISTANCE RATINGS OF TWO-WYTHE CONCRETE WALLS



3102.1.2.3 The fire resistance rating 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. 3102.1. Foam plastic insulation with a total thickness of less than 1 inch 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 $R_n^{0.59} = 2.5$.

TABLE 3102.1B
VALUES OF $R_n^{0.59}$ FOR USE IN EQ. 3102.1

Type of Material	Values of Rn0.50 for use in Eq. 3102.1 for thickness of											
	1 1/2 In	2 In	2 1/2 In	3 In	3 1/2 In	4 In	4 1/2 In	5 In	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]	[3]	[3]	[3]
Lightweight concrete	6.6	8.8	11.2	13.7	16.5	19.1	21.9	24.7	27.8[3]	[3]	[3]	[3]
Insulating concrete[1]	9.3	13.3	16.6	18.3	23.1	26.5[3]	[3]	[3]	[3]	[3]	[3]	[3]
Air Space[2]	---	---	---	---	---	---	---	---	---	---	---	---

1. Dry unit Weight of 35 pcf 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.

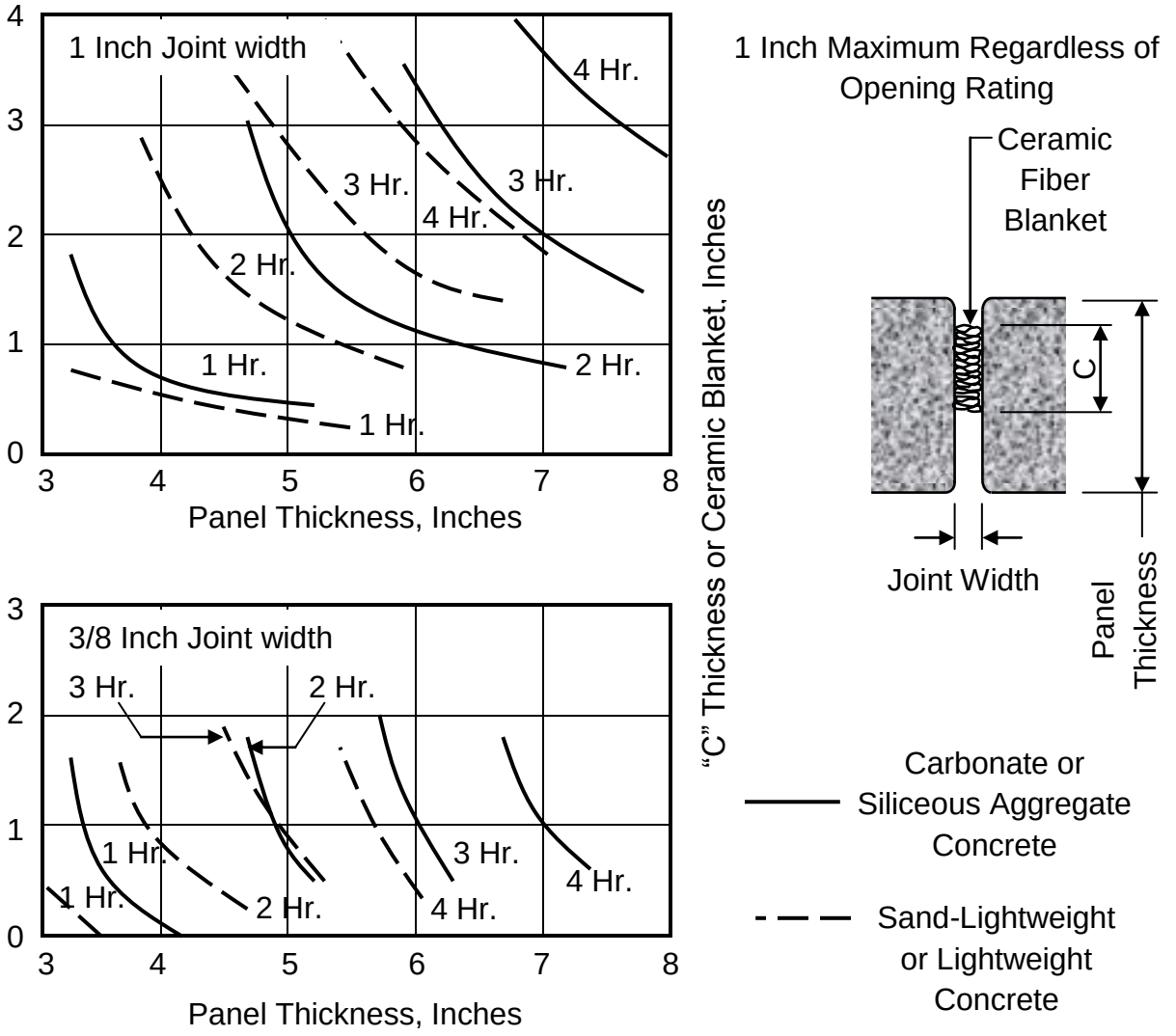
R, minutes	$R^{0.59}$
60	11.20
120	16.85
180	21.41
240	25.37

3102.1.3 Joints Between Precast Wall Panels

3102.1.3.1 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.

3102.1.3.2 Figure 3102.1B 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 and 1 inch for fire-resistance rating of 1 hour to 4 hours. For joint widths between 3/8 inch and 1 inch, 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 3102.1B
CERAMIC FIBER JOINT PROTECTION



3102.1.4 Walls With Gypsum Wallboard Or Plaster Finish

3102.1.4.1 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.

3102.1.4.2 Where the finish of gypsum wallboard or plaster is applied to the non-fire-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 3102.1C 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 the fire resistance rating of the concrete and finish determined from Table 3102.1A, Figure 3102.1A, or Table 3102.1B.

3102.1.4.3 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 3102.1D shall be added to the fire resistance rating determined from Table 3102.1A or Figure 3102.1A, or Table 3102.1B for the concrete alone, or to the rating determined in 3102.1.4.2 for the concrete and finish on the non-fire-exposed side.

3102.1.4.4 For a wall having no finish on one side or having different types or thicknesses of finish on each side, the calculation procedures of 3102.1.4.2 and 3.102.1.4.3 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 calculated.

EXCEPTION: For exterior wall with more than 5 ft of horizontal separation, the fire shall be assumed to occur on the interior side only.

3102.1.4.5 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.

3102.1.4.6 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 3103.1.6.

3102.2 Concrete Floor and Roof Slabs

3102.2.1 Reinforced and Prestressed Floors and Roofs

3102.2.1.1 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 the following table.

	Minimum Slab Thickness, (In) **for Fire Resistance Rating of**				
Concrete Type	**1 hr**	**11/2 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

TABLE3102.1C
MULTIPLYING FACTOR FOR FINISHES ON NON-FIRE-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: Silliceous 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

1. For portland cement-sand plaster 5/8 inch or less in thickness and applied directly to the concrete masonry on the non-fire-exposed side of the wall, the multiplying factor shall be 1.00.

TABLE3102.1D
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

1. The actual thickness of Portland cement-sand plaster, provided it is 5/8 inch or less in thickness, may be included in determining the equivalent thickness of the masonry for use in Table3103.1.

3102.2.1.2 For hollow-core prestressed concrete slabs in which the cores are of constant cross section throughout 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.

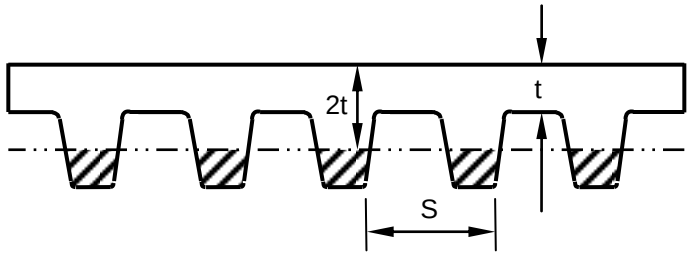
3102.2.1.3 The thickness of slabs with sloping soffits shall be determined at a distance 2t or 6 inches, whichever is less, from the point of minimum thickness, where t is the minimum thickness.

3102.2.1.4 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.



Neglect shaded Area in Calculation Of Equivalent Thickness

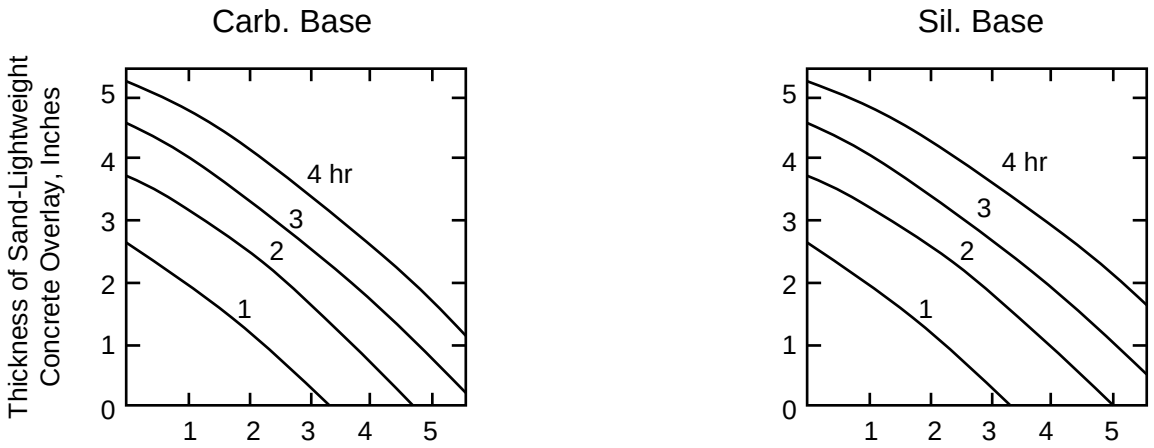
3102.2.2 Multi-Course Floors And Roofs

3102.2.2.1 Figure 3102.2A gives information on the fire resistance ratings of floors which consist of a base slab of concrete with a topping (overlay) of a different type of concrete.

3102.2.2.2 Figure 3102.2B 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 3102.2B (a), (b) and (c), but not to those shown in Figure 3102.2B (d) and (e).

FIGURE 3102.2A
FIRE RESISTANCE FOR TWO-COURSE CONCRETE FLOORS
Carb = Carbonate aggregate concrete
Sil =Siliceous aggregate Concrete



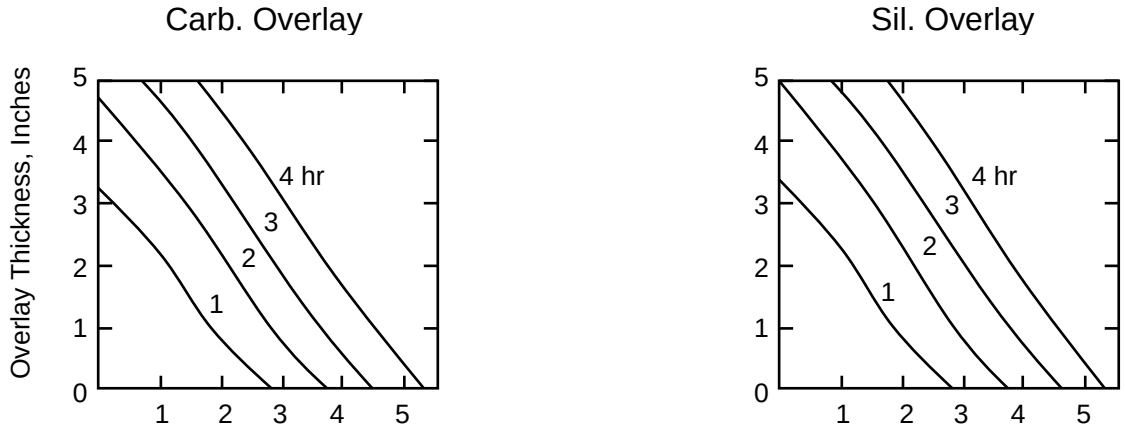
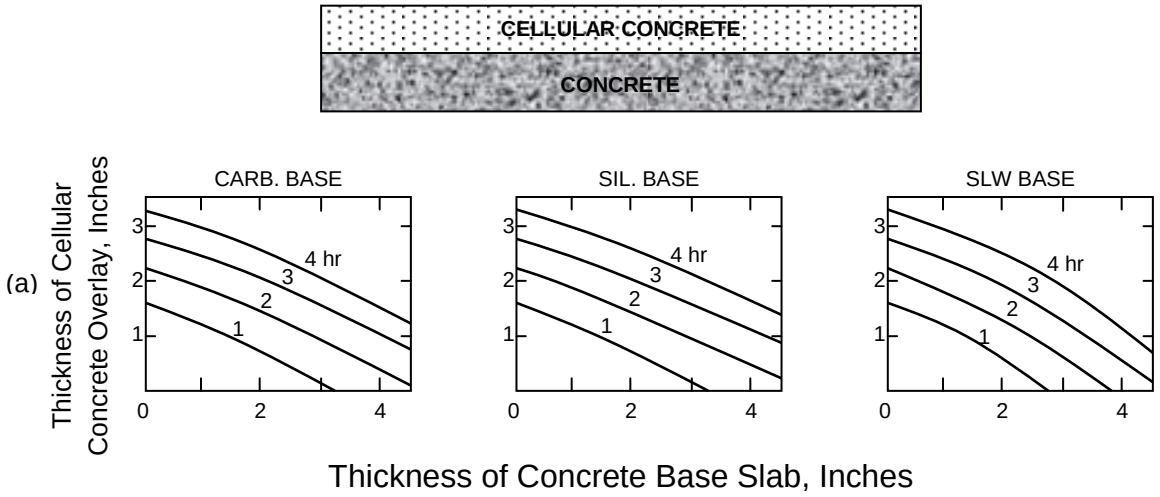


FIGURE 3102.2B
FIRE RESISTANCE RATINGS FOR CONCRETE ROOF ASSEMBLIES
Carb = Carbonate aggregate concrete
Sil = Siliceous aggregate Concrete
SLW = Sand-lightweight concrete



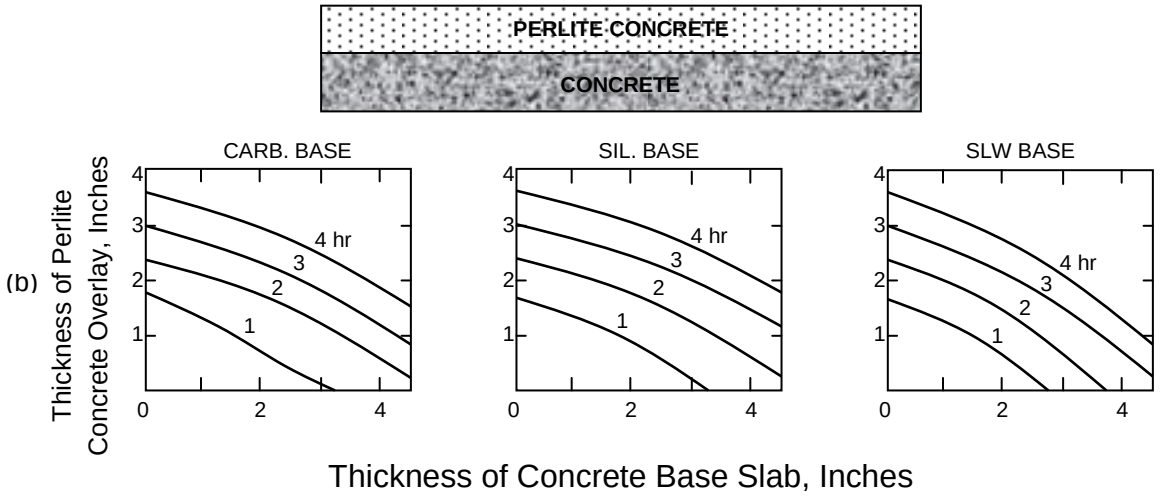
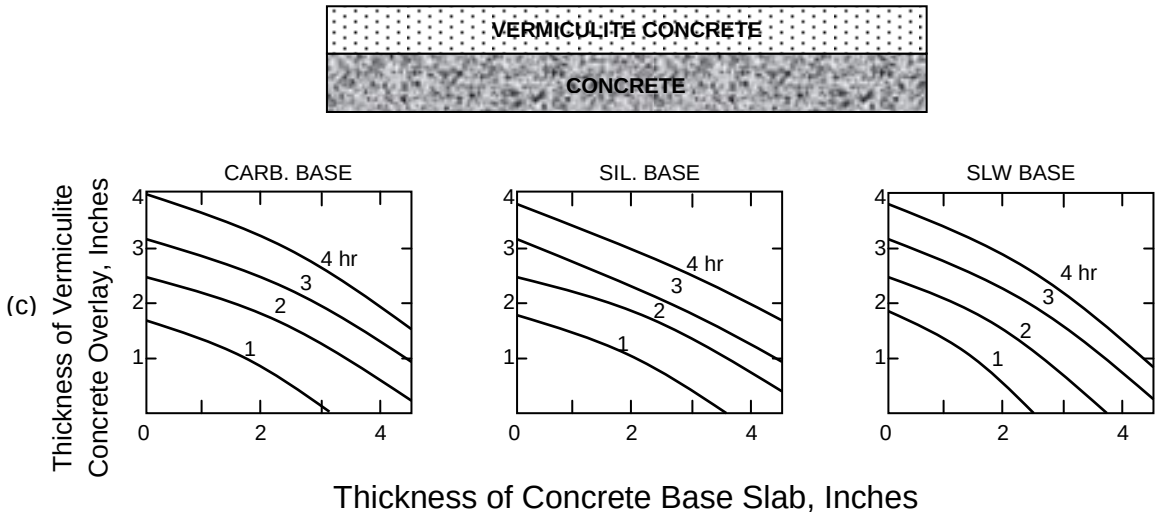


FIGURE 3102.2B (Continued)
FIRE RESISTANCE RATINGS FOR CONCRETE ROOF ASSEMBLIES
Carb = Carbonate aggregate concrete
Sil = Siliceous aggregate Concrete
SLW = Sand-lightweight concrete



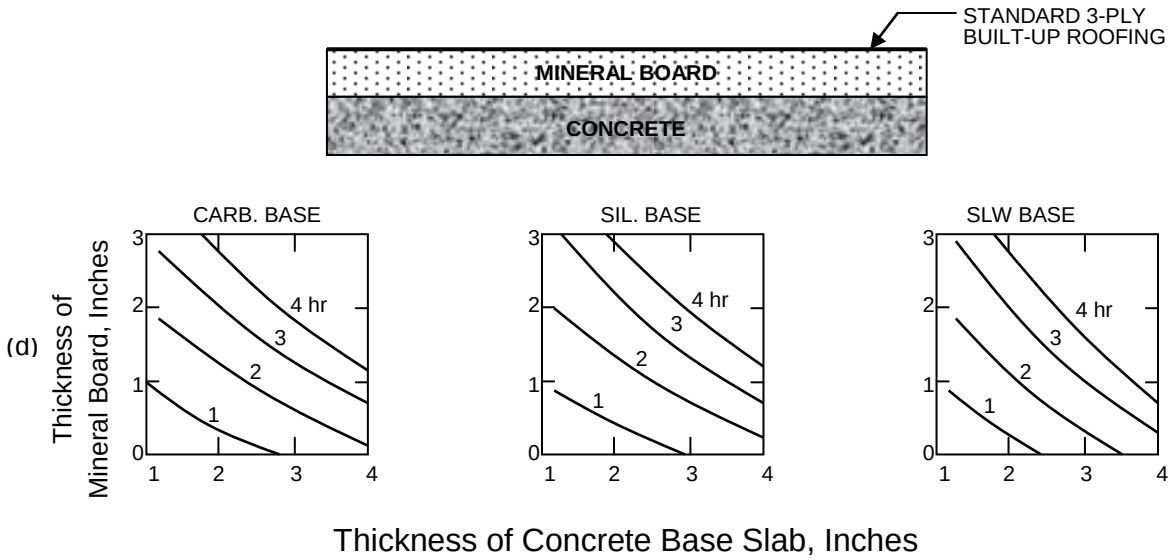
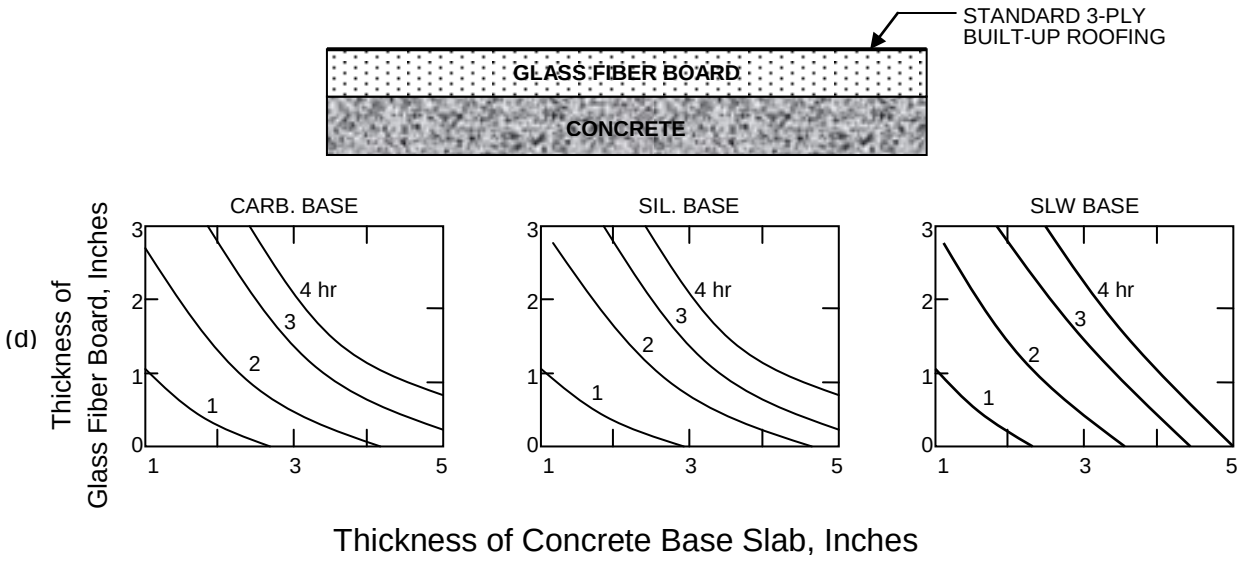


FIGURE 3102.2B (Continued)
FIRE RESISTANCE RATINGS FOR CONCRETE ROOF ASSEMBLIES
Carb = Carbonate aggregate concrete
Sil = Siliceous aggregate Concrete
SLW = Sand-lightweight concrete



3102.2.3 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 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, or the joints must be made fire resistant by other approved methods.

3102.3 Concrete Cover Over Reinforcement

3102.3.1 Slab Cover. The minimum thickness of concrete cover to the positive moment reinforcement is given in Table 3102.3A for reinforced concrete and Table 3102.3B for prestressed concrete. These tables are applicable for solid or hollowcore 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 3102.3A
COVER THICKNESS FOR REINFORCED CONCRETE FLOOR OR ROOF SLABS

Concrete Aggregate Type	Thickness of Cover (in) for Fire Resistance Rating of							
	Restrained*				Unrestrained*			
	1 hr	1 1/2 hr	2 hr	3 hr	1 hr	1 1/2 hr	2 hr	3 hr
Siliceous	3/4	3/4	3/4	3/4	3/4	3/4	1	1 1/4
Carbonate	3/4	3/4	3/4	3/4	3/4	3/4	3/4	1 1/4
Sand-Lightweight or Lightweight	3/4	3/4	3/4	3/4	3/4	3/4	3/4	1 1/4

*See 3102.3E for guidance on restrained and unrestrained assemblies.

TABLE 3102.3B
COVER THICKNESS FOR PRESTRESSED CONCRETE FLOOR OR ROOF SLABS

Concrete Aggregate Type	Thickness of Cover (in) for Fire Resistance Rating of							
	Restrained*				Unrestrained*			
	1 hr	1 1/2 hr	2 hr	3 hr	1 hr	1 1/2 hr	2 hr	3 hr
Siliceous	3/4	3/4	3/4	3/4	1 1/8	1 1/2	1 3/4	2 3/8
Carbonate	3/4	3/4	3/4	3/4	1	1 3/8	1 5/8	2 1/8
Sand-Lightweight or Lightweight	3/4	3/4	3/4	3/4	1	1 3/8	1 1/2	2

*See 3102.3E for guidance on restrained and unrestrained assemblies.

3102.3.2 Reinforced Beam Cover. The minimum thickness of concrete cover to the positive moment reinforcement (bottom steel) for reinforced concrete beams is shown in Table 3102.3C for fire resistance ratings of 1 hour to 4 hour.

Table 3102.3C
MINIMUM COVER TO MAIN REINFORCING BARS FOR REINFORCED CONCRETE BEAMS
(Applicable to All Types of Structural Concrete)

Restrained or Unrestrained[1]	Beam Width[2], in.	Cover Thickness[3] (in) for Fire Resistance Rating of				
		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	5	3/4	1	1 1/4	---	---
"	7	3/4	3/4	3/4	1 3/4	3
"	≥10	3/4	3/4	3/4	1	1 3/4

1. See Table 3102.3E 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 is assumed to be the average of the minimum cover of the individual bars, where the minimum 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 3102.3C nor less than 3/4 inch.

3102.3.3 Prestressed Bearing Cover. The minimum thickness of concrete cover to the positive moment prestressing tendons (bottom steel) for prestressed concrete beams is shown in Table 3102.3D for fire resistance ratings of 1 hour to 4 hours.

TABLE3102.3D
MINIMUM COVER FOR PRESTRESSED[7] CONCRETE BEAMS

Restrained or Unrestrained[1]	Concrete Aggregate Type[2]	Beam Width[3], in.	Cover Thickness[4] (in) for Fire Resistance Rating of				
			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. See Table 3102.3E 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 4-hour ratings or less.
2. Carb = carbonate aggregate concrete; Sil = siliceous aggregate concrete; Sand LW = sand-lightweight concrete.
3. For beam widths between 8 inches and 12 inches, 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 any individual tendon must be not less than one-half of the value given in Table 3102.3D nor less than 1 inch.
5. Not practical for 8 inches 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 3102.3C.

TABLE 3102.3E
CONSTRUCTION CLASSIFICATION, RESTRAINED AND UNRESTRAINED

UNRESTRAINED	
Wall 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, flat slabs, pan joists and waffle 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 restraint 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 system or the adjoining floor or roof construction[2]

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 stab 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.

3102.4 Concrete Columns

3102.4.1 Minimum Size. Table 3102.4 shows the minimum overall dimensions of reinforced concrete columns for fire resistance ratings of 1 hour to 4 hour.

TABLE 3102.4
MINIMUM SIZES OF CONCRETE COLUMNS

Types of Concrete	Minimum Column Dimension (in) for Fire Resistance Rating of				
	1 hr	1 1/2 hr	2 hr	3 hr	4 hr
Siliceous	8	8	10	12	14
Carbonate	8	8	10	12	14
Sand-Lightweight	8	8	9	10.5	12

3102.4.2 Minimum Cover For R/ C Columns. The minimum cover to the main reinforcement in columns for fire resistance ratings of 1 hour, 1 1/2 hour, 2 hour and 3 hour shall be 1 1/2 inches; for 4 hour the minimum cover to the main reinforcement shall be 2 inches for siliceous aggregate concrete and 1 1 /2 inches for carbonate aggregate concrete or sand-lightweight concrete.

3102.4.3 Precast Cover Units For Steel Column. See 3105.4.

3103 CONCRETE MASONRY

3103.1 Concrete Masonry Walls

3103.1.1 The fire resistance rating of walls and partitions constructed of concrete masonry units shall be determined from Table 3103.1. The rating shall be based on the equivalent thickness of the masonry and type of aggregate used.

3103.1.2 Where plaster or gypsum wallboard is applied to the non-fire-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 3102.1C. 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 3103.1.

3103.1.3 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 3102.1D shall be added to the fire resistance rating determined in 3103.1.1 for the masonry alone, or in 3103.1.2 for the masonry and finish on the non-fire-exposed side.

TABLE 3103.1
MINIMUM EQUIVALENT THICKNESS[1] (IN) OF LOADBEARING OR NONLOADBEARING CONCRETE MASONRY WALLS[2]

Types of Aggregate	Fire Resistance Rating (hours)														
	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. Equivalent thickness is the average thickness of the solid material in the unit. It may be found by taking the total volume of a wall unit, subtracting the volume of 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 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.

3103.1.4 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.

3103.1.5 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.

3103.1.6 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 (407 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 10 and Chapter 18.

3103.2 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.

3103.3 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:

$$R_A = (R_1^{0.59} + R_2^{0.59} + ... + R_n^{0.59} + A_1 + A_2 + ... + A_n)^{1.7} \qquad \text{(EQ. 3103.2)}$$

Where:

R_A = Fire endurance rating of the assembly, hours

$R_1, R_2, ..., R_n$ = Fire endurance rating of wythes 1, 2, ... n (hours), respectively

$A_1, A_2, ..., A_n$ = 0.30, factor for each continuous air space 1, 2, ..n, respectively, having a depth of 1/2 inch or more between wythes.

3103.4 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 3103.4, or by approved alternate methods.

TABLE 3103.4
MINIMUM COVER ON MAIN REINFORCING BARS FOR REINFORCED CONCRETE MASONRY LINTELS

Lintel Thickness (Inches)(Nominal)	Thickness (Inches) For Fire-Resistance Rating Period Of:			
	1-hr	2-hrs	3-hrs	4-hrs
6	1	1 1/4	---	---
8	1	1	1 3/4	3
10 or more	1	1	1	1 3/4

3103.5 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 3103.5 or by approved alternate methods.

TABLE 3103.5
MINIMUM SIZES OF CONCRETE MASONRY COLUMNS

Minimum Column Dimensions, Inches, For Fire Resistance Rating Of:			
1 Hour	2 Hour	3 Hour	4 Hour
8	10	12	14

3104 BRICK AND TILE MASONRY

3104.1 Clay Masonry Walls

3104.1.1 The fire resistance ratings of walls or partitions constructed of clay masonry units shall be determined from Table 3104.1 A, 3104.1 B or 31 04.1C.

3104.1.2 Where plaster is applied to the wall, the total fire resistive rating shall be determined by the formula:

$$R = (R_n^{0.59} + pl)^{1.7} \qquad \text{(Eq. 3104.1)}$$

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. 3104.1 are given in Table 3104.2. Coefficients for thickness of plaster shall be selected from Table 3104.3 based on the actual thickness of plaster applied to the wall or partition and whether one or two sides of the wall is plastered.

3104.1.3 Where a continuous air space separates multiple wythes of the wall or partition, the total fire resistance rating shall be determined by the formula:

$$R = (R_1^{0.59} + R_2^{0.59} + R_n^{0.59} + as)^{1.7} \qquad \text{(Eq. 3104.2)}$$

where R = the fire endurance of the assembly, minutes;
R_1, R_2 and 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. 3104.2 are given in Table 3104.2. Coefficients for the thickness of a 1/2 inch to 3 1/2 inch (13 to 88 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.

3104.1.4 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.

3104.2 Hollow Clay Masonry Walls

The fire resistance rating for hollow clay masonry walls and partitions may be determined from Table 3104.4 based on the equivalent thickness of the hollow clay masonry units. The fire resistance rating determined from Table 3104.4 may be used in the calculated fire resistance rating procedures in 3104.1 or 3104.3.

3104.3 Multi-Wythe Walls

3104.3.1 The fire resistance rating for walls or partitions consisting of two or more dissimilar wythes may be determined by the formula:

$$R = (R_1^{0.59} + R_2^{0.59} + R_n^{0.59} + as)^{1.7} \qquad \text{(Eq. 3104.3)}$$

where R = the fire endurance of the assembly, minutes;
and R_1, R_2 and R_n = the fire endurance of the individual wythes, minutes;

Values for $R_n^{0.59}$ for use in Eq. 3104.3 are given in Table 3104.2.

3104.3.2 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 3102.1B for concrete, Table 3103.1 for concrete masonry units, or Table 3104.1A, 3104.1B or 3104.1C for clay and tile masonry units.

Table3104.1A
Minimum Nominal Thickness For Fire Resistance Ratings Of Bearing And Nonbearing Clay Brick Masonry Walls Or Partitions[2]

Wall or Partition Assembly	Members Framed Into Wall or Partition							
	Combustible				Non-combustible			
	4 hr	3 hr	2 hr	1 hr	4 hr	3 hr	2 hr	1 hr
Brick – Clay or Shall Solid	12	12	8	8	8	8	6	4
Brick – Clay or Shale Hollow			8		12	8	8	
Hollow – cells filled with loose fill insulation					8			
CAVITY WALLS								
Two 3-in (actual) brick wythes separated by 2-in air space, masonry joint reinforcement spaced 16 in o.c. vertically						8		
Two wythes (clay or shale) separated by 2-in air space; 1/4 in metal ties for each 3 sq ft of wall area			9[1]	9	9			
Hollow Rolock (clay or shale)		12	12	8	12		8	
Hollow Rolok Bak (clay or shale					8			
Brick, (clay or shale) – 4 in nominal thick units (75% solid) backed with a hat shaped metal furring channel 3/4 in thick formed from 0.021 in sheet metal attached to the brick wall on 24 in centers with approved fasteners; and 1/2 in Type X gypsum wall board attached to the metal furring strip with 1 in long Type S screws spaced 8 in on center.							5	
HOLLOW CLAY TILE, BRICK FACING								
4 in units (40% solid) plus 4 in brick				8		8		
8 in units (40% solid) plus 4 in brick			12		12			

Notes:

1. A 9 inch wall may be used for a 2 hr rating if the hollow spaces near combustible members are filled with fire resistant material for the full thickness of the wall and for at least 4 inches above and below and between the combustible members.
2. Requirements of ASTM C 62, C 126, C 216 or C 652 shall apply.

Table3104.1B
Minimum Nominal Thickness For Fire Resistance Ratings Of Bearing And Nonbearing Clay Tile Masonry Walls Or Partitions[4]

Wall or Partition Assembly	Members Framed Into Wall or Partition							
	Combustible				Non-combustible			
	4 hr	3 hr	2 hr	1 hr	4 hr	3 hr	2 hr	1 hr
HOLLOW CLAY TILE								
1 Unit, 2 cells in wall thickness, 40% solid								8
1 Unit, 2 cells in wall thickness, 43% solid								8
1 Unit, 2 cells in wall thickness, 46% solid				8				8
1 Unit, 2 cells in wall thickness, 49% solid				8			8	
1 Unit, 3 or 4 cells in wall thickness, 40% solid								8
1 Unit, 3 or 4 cells in wall thickness, 43% solid							8	
1 Unit, 3 or 4 cells in wall thickness, 48% solid				8			8	
1 Unit, 3 or 4 cells in wall thickness, 53% solid				8		8		
1 Unit, 3 cells in wall thickness, 40% solid			12				12	
1 Unit, 3 cells in wall thickness, 45% solid			12			12		
1 Unit, 3 cells in wall thickness, 49% solid		12				12		
2 Units, 3 or 4 cells in wall thickness, 40% solid			12			12		
2 Units, 3 or 4 cells in wall thickness, 45% solid			12		12			
2 Units, 3 or 4 cells in wall thickness, 53% solid		12			12			
2 or 3 Units, 4 or 5 cells in wall thickness, 40% solid	16				16			
STRUCTURAL CLAY TILE								
1 Unit, 1 cells in wall thickness, 40% solid[1,3]								4
1 Unit, 1 cells in wall thickness, 30% solid[1,3]							6	
1 Unit, 2 cells in wall thickness, 45% solid[2]								6
1 Unit, 1 cells in wall thickness, 40% solid[2,3]								4
1 Unit, 1 cells in wall thickness, 30% solid[2,3]							6	

Table3104.1B *(Continued)*
Minimum Nominal Thickness For Fire Resistance Ratings Of Bearing And Nonbearing Clay Tile Masonry Walls Or Partitions[4]

Wall or Partition Assembly	Members Framed Into Wall or Partition							
	Combustible				Non-combustible			
	4 hr	3 hr	2 hr	1 hr	4 hr	3 hr	2 hr	1 hr
HOLLOW STRUCTURAL CLAY TILE								
1 Unit, 2 cells in wall thickness, 40% solid								8
1 Unit, 2 cells in wall thickness, 49% solid							8	
1 Unit, 3 or 4 cells in wall thickness, 53% solid						8		
1 Unit, 2 cells in wall thickness, 46% solid				8				
1 Unit, 3 cells in wall thickness, 40% solid							12	
2 Units, 3 cells in wall thickness, 40% solid						12		
2 Units, 3 or 4 cells in wall thickness, 45% solid					12			
1 Unit, 3 cells in wall thickness, 40% solid				12				
1 Unit, 3 cells in wall thickness, 40% solid			12					
1 Unit, 3 cells in wall thickness, 49% solid		12						
2 Units, 4 cells in wall thickness, 43% solid		16						
2 or 3 Units, 4 or 5 cells in wall thickness, 40% solid	16							

Notes:

1. Ratings are for dense-hard burned clay or shale tile.
2. Ratings are for medium burned clay tile.
3. Cells filled with tile, stone, slag, cinders or sand mixed with mortar.
4. Requirements for ASTM C 34. C 56, C 212 or C 530 shall apply.

Table 3104.1C
Fire Resistance Ratings For Bearing Steel Framed Brick Veneer Walls or Partitions

Wall or Partition Assembly	Fire Resistance Rating	
	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 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 in brick veneer attached to steel frame with metal ties every 5th course. Inside facing of studs: 7/8 in 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 of 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 lath.	2	4

Table 3104.2
Values Of $R_n^{0.59}$ For Use In Eq. 3104.1, 3104.2 or 3104.3

R, minutes	$R_n^{0.59}$
60	11.20
120	16.85
180	21.41
240	25.37

Table 3104.3
Coefficients For Plaster[1]

Thickness of plaster, inches	One-Side	Two-Side
1/2	0.3	0.6
5/8	0.37	0.75
3/4	0.45	0.90

Note:
1. Values listed in table are for 1:3 sanded gypsum plaster.

Table 3104.4
Minimum Equivalent Thickness[1] (In) Of Bearing Or Nonbearing Clay Masonry Walls[2,3]

	Fire Resistance Rating (hours)			
Types of Material	**1**	**2**	**3**	**4**
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	5.3	6.6

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 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.

3105 STEEL ASSEMBLIES

3105.1 Structural Steel Columns

3105.1.1 General

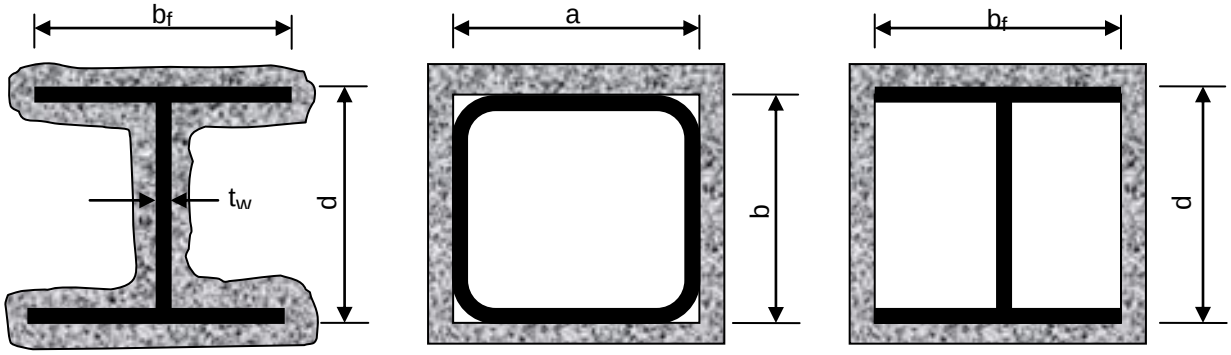
3105.1.1.1 These procedures establish a basis for determining the fire resistance of column assemblies as a function of the thickness of fire protection material and, the weight, W and heated perimeter D of steel columns. As used in these sections, W is the average weight of a structural steel column in pounds per linear foot. The heated perimeter D is the inside perimeter of the fire protection material in inches as illustrated in Figure 3105.1A.

3105.1.1.2 The application of these procedures shall be limited to column assemblies in which the fire protection material is not designed to carry any of the load acting on the column.

3105.1.1.3 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 protection materials.

3105.1.1.4 Table 3105.1A contains weight to heated perimeter ratios (W/D) for both contour and box fire protection profiles, for the wide flange shapes most often used as columns. For different fire protection 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.

FIGURE 3105.1A
DETERMINATION OF THE HEATED PERIMETER OF STRUCTURAL STEEL COLUMNS



$D = 4b_f + 2d - 2t_w$ $D = 2(a + b)$ $D = 2(b_f + d)$

TABLE 3105.1A
W/D RATIOS FOR STEEL COLUMNS

Structural Shape	Contour Profile	Box Profile	Structural Shape	Contour Profile	Box Profile
W14 X233	2.49	3.65	W10 X112	1.78	2.57
X211	2.28	3.35	X100	1.61	2.33
X193	2.10	3.09	X88	1.43	2.08
X176	1.93	2.85	X77	1.26	1.85
X159	1.75	2.60	X68	1.13	1.66
X145	1.61	2.39	X60	1.00	1.48
X132	1.52	2.25	X54	0.91	1.34
X120	1.39	2.06	X49	0.83	1.23
X109	1.27	1.88	X45	0.87	1.24
X 99	1.16	1.72	X39	0.76	1.09
X 90	1.06	1.58	X33	0.65	0.93
X 82	1.20	1.68			
X 74	1.09	1.53	W8 X67	1.34	1.94
X 68	1.01	1.41	X58	1.18	1.71
X 61	0.91	1.28	X48	0.99	1.44
X 53	0.89	1.21	X40	0.83	1.23
X 48	0.81	1.10	X35	0.73	1.08
X 43	0.73	0.99	X31	0.65	0.97
			X28	0.67	0.96
W12 X190	2.46	3.51	X24	0.58	0.83
X170	2.22	3.20	X21	0.57	0.77
X152	2.01	2.90	X18	0.49	0.67
X136	1.82	2.63			
X120	1.62	2.36	W6 X25	0.69	1.00
X106	1.44	2.11	X20	0.56	0.82
X 96	1.32	1.93	X16	0.57	0.78
X 87	1.20	1.76	X15	0.42	0.63
X 79	1.10	1.61	X12	0.43	0.60
X 72	1.00	1.48	X9	0.33	0.46
W12 X 65	0.91	1.35	W5 X19	0.64	0.93
X 58	0.91	1.31	X16	0.54	0.80
X 53	0.84	1.20			
X 50	0.89	1.23	W4 X13	0.54	0.79
X 45	0.81	1.12			
X 40	0.72	1.00			

3105.1.2 Gypsum Wallboard Protection

3105.1.2.1 The fire resistance of structural steel columns with weight to heated perimeter ratios (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:

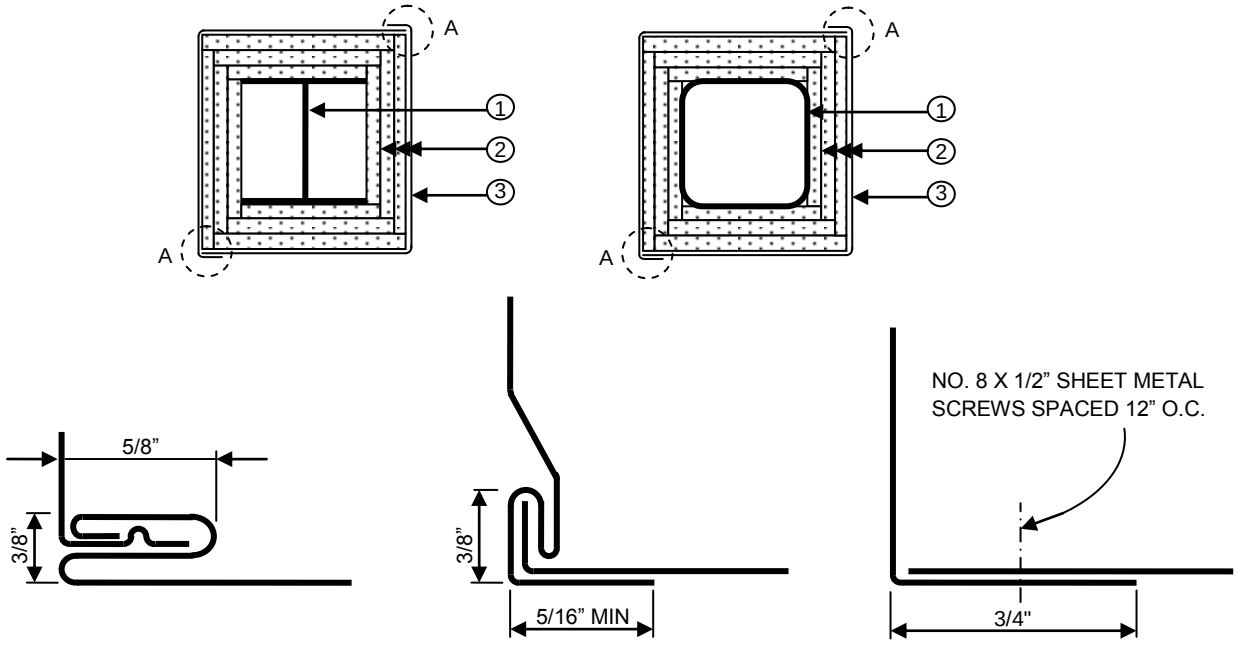
$$R = 130\left[\frac{h\,(W'/D)}{2}\right]^{0.75}$$

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).
or, $W' = W + 50hD/144$

3105.1.2.2 The gypsum wallboard shall be supported as illustrated in either Figure 3105.1B for fire resistance ratings of 4 hours or less, or Figure 3105.1C for fire resistance ratings of 3 hours or less.

3105.1.2.3 The fire resistance of structural steel columns can be determined from Figure 3105.1D 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 3105.1B
GYPSUM WALLBOARD PROTECTED STRUCTURAL STEEL COLUMNS WITH SHEET STEEL COLUMN COVERS



Snap-Lock Pittsburgh Seam Lap

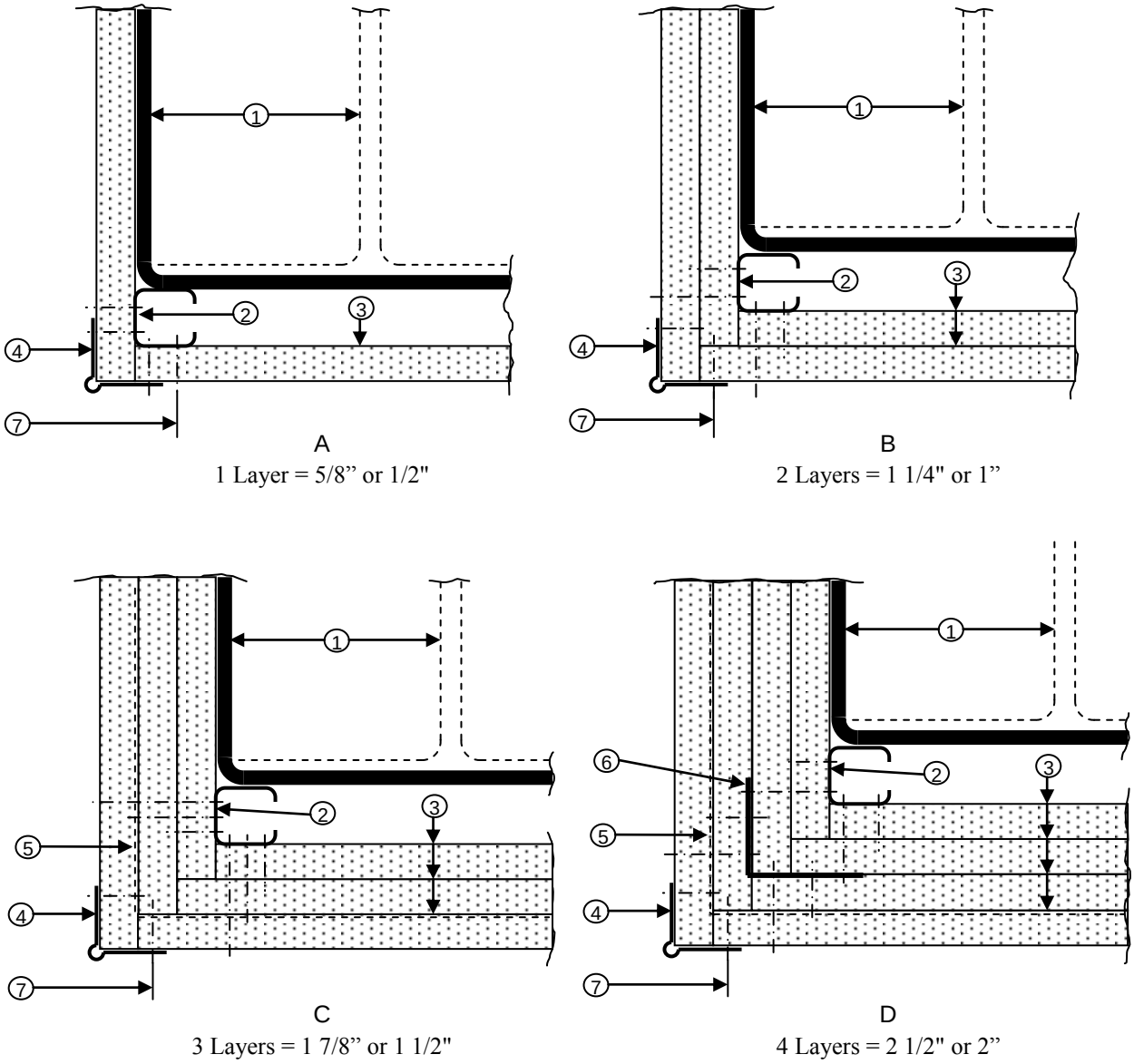
Corner Joint Details (a)

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 provided that the joints in successive layers are staggered at least 12 inches. 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 long Type S screws spaced 1 inch from the wallboard edge and 8 inches on center. For such installations, 0.0149 inch minimum thickness galvanized steel corner beads with 1 1/2-inch legs shall be attached to the wallboard with Type S screws spaced 12 inches on center.
3. For fire resistance ratings of 3 hours or less, the column covers shall be fabricated from 0.0239 inch minimum thickness galvanized or stainless steel. For 4 hour fire resistance ratings, the column covers shall be fabricated from 0.0239 inch 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 long No. 8 sheet metal screws spaced 12 inches on center.

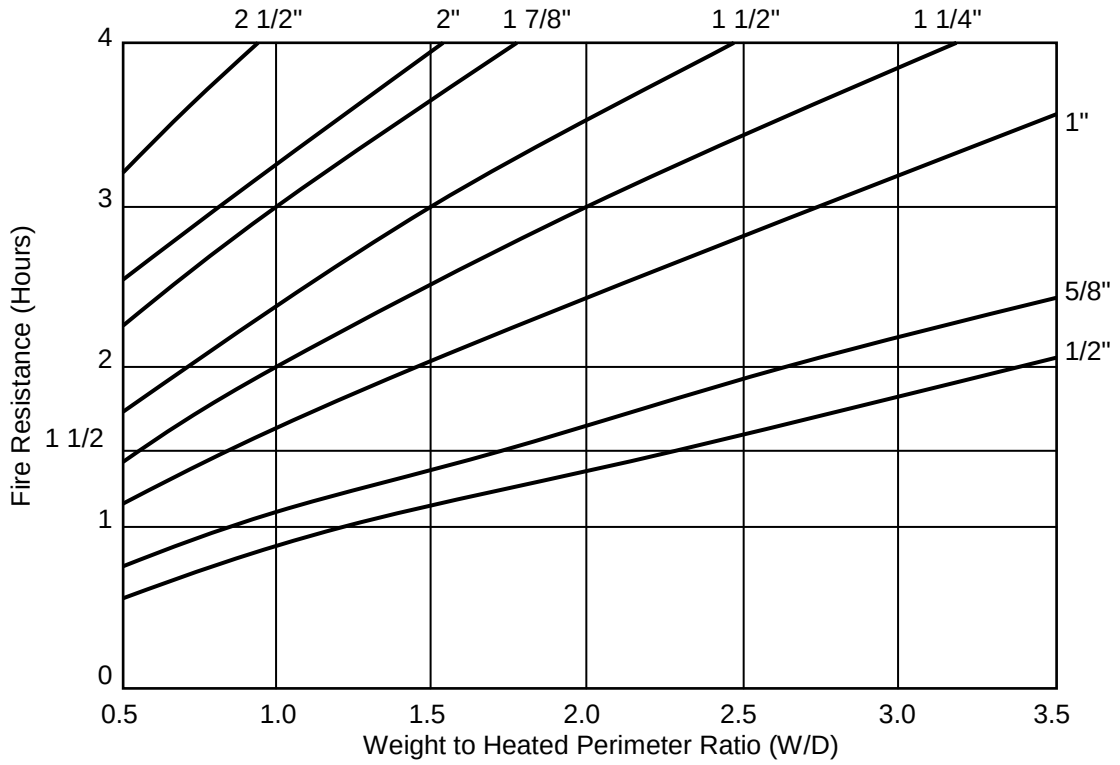
   The column covers shall be provided with a minimum expansion clearance of 1/8 inch per linear foot between the ends of the cover and any restraining construction.

FIGURE 3105.1C
GYPSUM WALLBOARD PROTECTED STRUCTURAL STEEL COLUMNS WITH STEEL STUD/SCREW ATTACHMENT SYSTEM



1. Structural steel column, either wide flange or tubular shapes.
2. 1 5/8 inch deep studs fabricated from 0.0179 inch minimum thickness galvanized steel with 1 5/16 or 1 7/16 inch legs. The length of the steel studs shall be 1/2 inch 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 provided that the joints in successive layers are staggered at least 12 inches. 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 minimum thickness steel corner beads with 1 1/2 inch legs attached to the wallboard with 1 inch long, Type S screws spaced 12 inches on center.
5. No. 18 SWG steel tie wires spaced 24 inches on center.
6. Sheet metal angles with 2 inch legs fabricated from 0.0209 inch minimum thickness galvanized steel.
7. Type S screws 1 inch 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 on center. Type S screws 1 3/4 inches 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 on center. Type S screws 2 1/4 inches long shall be used for attaching the third layer of wallboard to the steel studs at 12 inches on center.

FIGURE 3105.1D
FIRE RESISTANCE OF STRUCTURAL STEEL COLUMNS PROTECTED WITH VARIOUS THICKNESSES OF TYPE X GYPSUM WALLBOARD



NOTE: The W/D ratios for typical wide flange columns are listed in Table 3105.1A. For other column shapes, the W/D ratios shall be determined in accordance with 3105.1.1.

3105.1.3 Spray-Applied Fire Protection

3105.1.3.1 The fire resistance of wide flange structural steel columns protected with spray-applied fire protection materials, as illustrated in Figure 3105.1E, may be determined from the following expression:

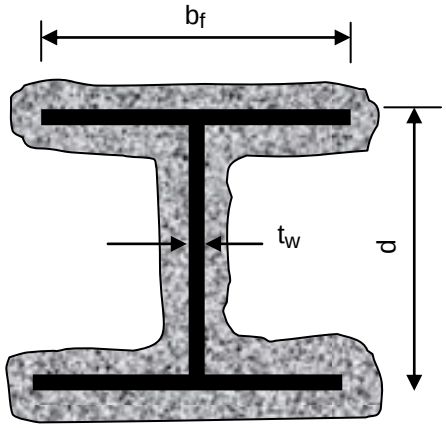
$$R = [\, C_1 (W/D) + C_2]\, h$$

Where R = fire resistance (minutes),
h = thickness of spray-applied fire protection (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)

3105.1.3.2 The material-dependent constants, C_1 and C_2, shall be determined for specific fire protection materials on the basis of standard fire endurance tests in accordance with 1001. Guidelines for determining these constants are given in Appendix P. 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.

3105.1.3.3 Spray-applied fire protection materials shall be identified by density and thickness required for a given fire resistance rating.

FIGURE 3105.1E
WIDE FLANGE STRUCTURAL STEEL COLUMNS WITH SPRAY-APPLIED FIRE PROTECTION



3105.1.4 Concrete Protected Column

3105.1.4.1 The fire resistance of structural steel columns protected with concrete, as illustrated in Figure 3105.1F (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)

3105.1.4.2 For wide flange steel columns completely encased in concrete with all re-entrant spaces filled (Figure 3105.1F(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).

3105.1.4.3 If specific data on the properties of concrete is not available, the values given in Table 3105.1B may be used.

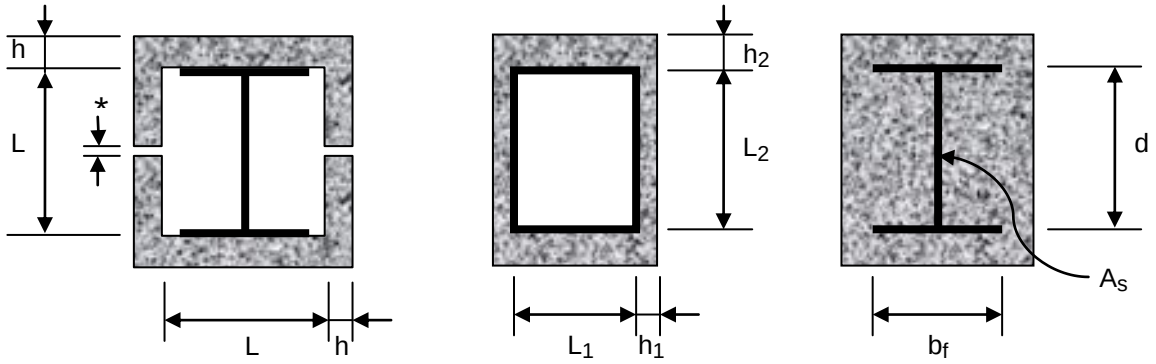
TABLE 3105.1B
PROPERTIES OF CONCRETE

	Normal Weight Concrete	Structural Lightweight Concrete
Thermal conductivity (k_c)	0.95 Btu/hr ft ^{O}F	0.35 Btu/hr ft ^{O}F
Specific heat (c_c)	0.20 Btu/lb ^{O}F	0.20 Btu/lb ^{O}F
Density (p_c)	145 pcf	110 pcf
Equilibrium (free) moisture content (m) by volume	4%	5%

3105.1.4.4 For structural steel columns encased in concrete with all re-entrant spaces filled (Figure 3105.1F(c)), Tables 3105.1C and 3105.1D 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.

3105.1.4.5 For structural steel columns protected with precast concrete column covers as shown in Figure 3105.1F(a), Table 3105.1E 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.

FIGURE 3105.1F
CONCRETE PROTECTED STRUCTURAL STEEL COLUMNS



(a) Precast Concrete Column Covers

(b) Concrete Encased Structural Tube

(c) Concrete Encased Wide Flange Shape

Note: 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.

*Joints shall be protected with a minimum 1 inch thickness of ceramic fiber blanket but in no case less than one-half the thickness of the column cover (See 3102.1.3).

TABLE 3105.1C
MINIMUM COVER (IN) FOR STEEL COLUMNS ENCASED IN NORMAL WEIGHT CONCRETE
(Figure 3105.1F(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="7">1</td><td rowspan="5">1</td><td rowspan="3">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="4">1 1/2</td><td rowspan="3">2</td></tr>
<tr><td>X 90</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="2">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="2">1</td><td rowspan="2">3</td></tr>
<tr><td>X 50</td><td rowspan="2">2 1/2</td></tr>
<tr><td>X 40</td><td>1 1/2</td></tr>
<tr><td>W10 X 88</td><td rowspan="2">1</td><td rowspan="4">1 1/2</td><td rowspan="3">1 1/2</td><td>2</td><td rowspan="3">3</td></tr>
<tr><td>X 49</td><td rowspan="3">2 1/2</td></tr>
<tr><td>X 45</td><td rowspan="3">1</td></tr>
<tr><td>X 39</td><td>3 1/2</td></tr>
<tr><td>X 33</td><td>2</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 rowspan="2">3</td></tr>
<tr><td>X 58</td><td rowspan="5">1 1/2</td></tr>
<tr><td>X 48</td><td rowspan="3">3 1/2</td></tr>
<tr><td>X 31</td><td rowspan="3">2</td></tr>
<tr><td>X 21</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</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>3 1/2</td></tr>
</table>

*The tabulated thicknesses are based upon the assumed properties of normal weight concrete given in Table 3105.1B.

TABLE 3105.1D
MINIMUM COVER (IN) FOR STEEL COLUMNS ENCASED IN STRUCTURAL LIGHTWEIGHT CONCRETE
(Figure 3105.1F(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="4">1</td><td rowspan="4">1</td><td rowspan="2">1</td><td>1 1/2</td><td>2</td></tr>
<tr><td>X 88</td><td rowspan="2">2</td><td rowspan="2">2 1/2</td></tr>
<tr><td>X 60</td><td rowspan="2">1 1/2</td></tr>
<tr><td>X 33</td></tr>
<tr><td>W8 X 35</td><td rowspan="4">1</td><td rowspan="3">1</td><td rowspan="4">1 1/2</td><td rowspan="2">2</td><td>2 1/2</td></tr>
<tr><td>X 28</td><td rowspan="3">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>

*The tabulated thicknesses are based upon the assumed properties of structural lightweight concrete given in Table 3105.1B.

TABLE 3105.1E
MINIMUM COVER (IN) FOR STEEL COLUMNS IN NORMAL WEIGHT PRECAST COVERS
(Figure 3105.1F(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="3">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>

*The tabulated thicknesses are based upon the assumed properties of normal weight concrete given in Table 3105.1B.

TABLE 3105.1F
MINIMUM COVER (IN) FOR STEEL COLUMNS IN STRUCTURAL LIGHTWEIGHT PRECAST COVERS
(Figure 3105.1F(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="8">1 1/2</td><td rowspan="5">1 1/2</td><td rowspan="3">2</td><td rowspan="2">2 1/2</td></tr>
<tr><td>X176</td></tr>
<tr><td>X145</td><td rowspan="5">3</td></tr>
<tr><td>X132</td><td rowspan="4">2 1/2</td></tr>
<tr><td>X109</td></tr>
<tr><td>X 99</td><td rowspan="3">2</td></tr>
<tr><td>X 68</td><td rowspan="2">3 1/2</td></tr>
<tr><td>X 43</td><td>3</td></tr>
<tr><td>W12 X190</td><td rowspan="8">1 1/2</td><td rowspan="8">1 1/2</td><td rowspan="5">1 1/2</td><td rowspan="3">2</td><td rowspan="2">2 1/2</td></tr>
<tr><td>X152</td></tr>
<tr><td>X136</td><td rowspan="5">3</td></tr>
<tr><td>X 106</td><td rowspan="5">2 1/2</td></tr>
<tr><td>X 96</td></tr>
<tr><td>X 87</td><td rowspan="3">2</td></tr>
<tr><td>X 65</td><td rowspan="2">3 1/2</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="4">3</td></tr>
<tr><td>X100</td><td rowspan="4">2 1/2</td></tr>
<tr><td>X 88</td></tr>
<tr><td>X 77</td><td rowspan="4">2</td></tr>
<tr><td>X 60</td><td rowspan="3">3 1/2</td></tr>
<tr><td>X 39</td><td rowspan="2">3</td></tr>
<tr><td>X 33</td><td>2</td></tr>
<tr><td>W8 X 67</td><td rowspan="5">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="4">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>

*The tabulated thicknesses are based upon the assumed properties of structural lightweight concrete given in Table 3105.1B.

3105.2 Structural Steel Beams And Girders

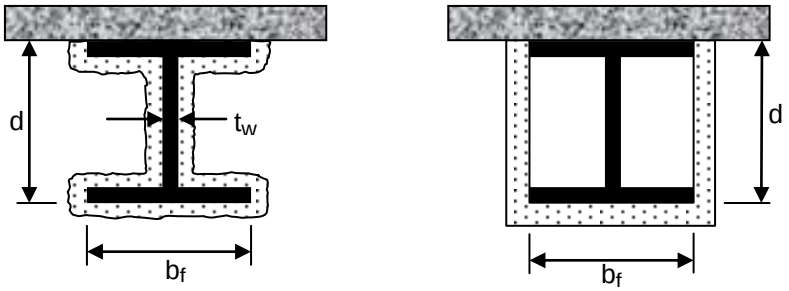
3105.2.1 General

3105.2.1.1 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 protection 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 protection material in inches as illustrated in Figure 3105.2.

3105.2.1.2 The weight to heated perimeter ratios (W/D), for both contour and box fire protection profiles, for the wide flange shapes most often used as beams or girders are given in Table 3105.2. For different shapes, the weight to heated perimeter ratios (W/D) shall be determined in accordance with the definitions given in this section.

3105.2.1.3 Except as provided for in 3105.2.2, 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 heater perimeter ratio *(*W/D) of the substitute beam is equal to or greater than that of the beam specified in the approved assembly.

FIGURE 3105.2
DETERMINATION OF THE HEATED PERIMETER OF STRUCTURAL STEEL BEAMS AND GIRDERS



$D = 3\ b_f + 2d - t_w$ $D = 2d + b_f$

TABLE 3105.2
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
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 3105.2 (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			

3105.2.2 Spray-Applied Fire Protection

3105.2.2.1 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.

3105.2.2.2 The equation in 3105.2.2.1 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.

3105.2.3 Structural Steel

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 3105.1.3. 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 3105.1.1. 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 3105.2.1.

3106 WOOD ASSEMBLIES

3106.1 General

3106.1.1 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 test referenced in 1001.

3106.1.2 Fire resistance ratings calculated using the procedures in this section shall be used only for 1-hour rated assemblies.

3106.1.3 When dissimilar membranes are used on a wall assembly, the calculation shall be made from the least fire resistant (weaker) side.

3106.2 Walls, Floors and Roofs

3106.2.1 These procedures apply to both load bearing and non-load bearing assemblies.

3106.2.2 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.

3106.2.3 Table 3106.2A gives the time assigned membranes on the fire-exposed side.

3106.2.4 For an exterior wall having more than 5 ft of horizontal separation, the wall is assigned a rating dependent on the interior membrane and the framing as described in Tables 3106.2A and 3106.2B. The membrane on the outside or non-fire-exposed side of exterior walls having more than 5 ft of horizontal separation may consist of sheathing, sheathing paper and siding as described in Table 3106.2C.

3106.2.5 In the case of a floor or roof, the standard test provides only for testing for fire exposure from below. Except as noted in 608.3, floor or roof assemblies of wood framing shall have an upper membrane consisting of a subfloor and finish floor conforming to Table 3106.2D or any other membrane that has a contribution to fire resistance of at least 15 minutes in Table 3106.2A.

3106.2.6 Table 3106.2E 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.

3106.2.7 Fastening of wood framed assemblies and the fastening of membranes to the wood framing members shall be done in accordance with Table 1705.1 and 1803.4.1.

TABLE 3106.2A
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. These values apply only when framing members 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 3106.2B
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.
2. All studs shall be nominal 2x4 and all joists shall have a nominal thickness of at least 2 inches.
3. Allowable spans for joists shall be determined in accordance with 1706.3.1 and 1708.1.1.

TABLE 3106.2C
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 plywood 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 plywood

1. Any combination of sheathing, paper and exterior finish listed may be used.

TABLE 3106.2D
FLOORING OR ROOFING OVER WOOD FRAMING[1]

Assembly	Structural Members	Subfloor or Roof Deck	Finish Flooring or Roofing
Floor	Wood	15/32 in. plywood 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. plywood or 11/16 in. T&G softwood	Finish roofing material with or without insulation

1. This table applies only to wood joist construction. It is not applicable to wood truss construction.

TABLE 3106.2E
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

3106.3 Design Of Fire-Resistant Exposed Wood Members

3106.3.1 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 3106,3A

Figure 3106.3A symbols:

K_e = the effective length factor as noted in Figure 3l06.3B

1 = the unsupported length of columns, inches.

3106.3.2 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.

3106.3.3 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.

3106.3.4 Where minimum 1-hour fire resistance is required, connectors and fasteners shall be protected from fire exposure by 1 1/2 inches 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.

3106.3.5 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.

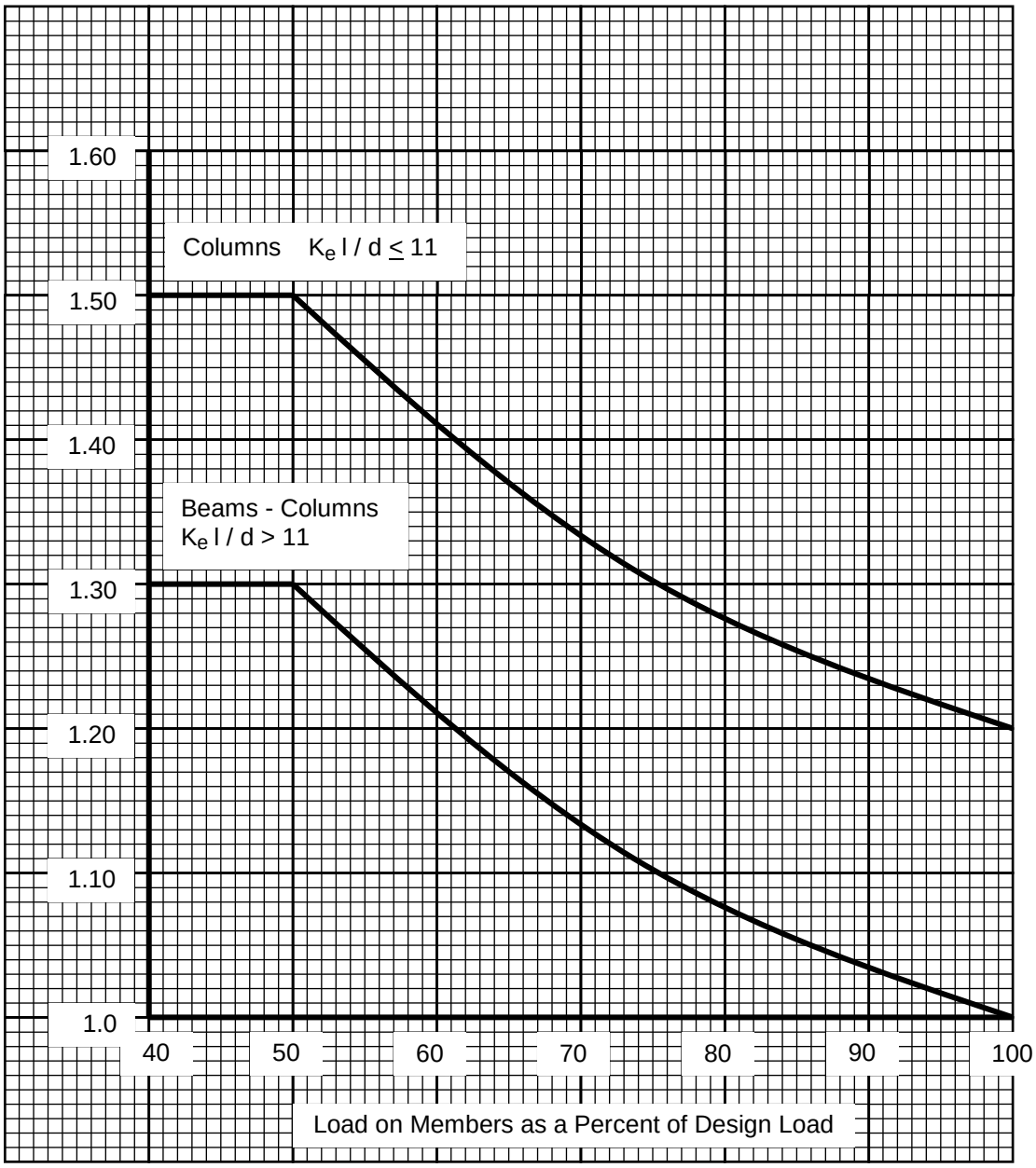
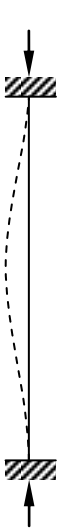
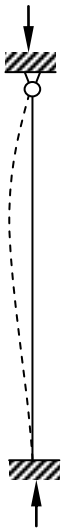
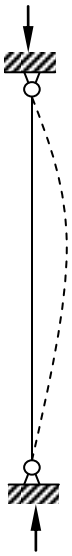
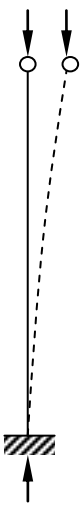
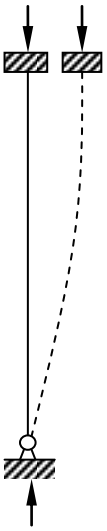


FIGURE 3106.3A
LOAD FACTOR

FIGURE 3106.3B
EFFECTIVE LENGTH FACTORS

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, transition fixed				
		Rotation free, transition fixed				
		Rotation fixed, transition free				
		Rotation free, transition free				

CHAPTER 32

EFFICIENT ENERGY UTILIZATION IN NEW BUILDINGS

3201 REQUIREMENTS FOR DWELLINGS AND APARTMENTS THREE STORIES AND LESS IN HEIGHT

(EFFECTIVE APRIL 1, 1982)

3201.1 General Requirements

3201.1.1 These insulation requirements apply to all new dwellings which are heated and/ or cooled regardless of the type of fuel used (electric, oil, gas, or wood) as follows:

1. All one- and two-family dwellings.
2. All new multiple-family dwellings (apartments and condominiums) three stories and less in height

3201.1.2 It is imperative that close attention he 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 he wedged between pipes and electrical outlets and the external surface of the wall.
2. If unfaced blankets or rolls are used a vapor barrier of at least 4 mil polyethylene, or its equivalent shall he 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 he filled with insulation with a vapor barrier properly installed.
5. Vapor barriers shall he carefully checked to assure that no tears exist and any tear shall he patched.
6. The manufacturers' installation procedures for all insulation shall be strictly adhered to.

3201.1.3 On blanket and roll-type insulation furnished with a vapor facing, the R-Value of the insulation shall be marked at three foot intervals on the exposed facing,

3201.1.4 For unfaced blankets and rolls, the manufacturer shall furnish sufficient identifying markings to indicate the insulation R-Value.

3201.1.5 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 barrier shall be a minimum of 4 mil polyethylene or its equivalent with all penetrations sealed by either taping or caulking. Unless the sheathing manufacturer specifically requires moisture relief vents, no moisture vents are required.

3201.1.6 The required thermal value of any one assembly, such as roof/ceiling, wall, or floor may he increased and the thermal value for other components decreased, provided the overall heat loss from the entire building envelope does not exceed the total resulting from conformance to the required thermal values.

3201.2 Maximum “U” Values For Exterior Walls and Ceilings

3201.2.1 All buildings which are heated or mechanically cooled shall have sections exposed to the exterior or unheated spaces constructed to comply with the maximum "U" value shown in Tables A and B.

TABLE A
MAXIMUM "U" VALUES FOR CEILING AND WALL SECTIONS

Flat Roof Deck[1]	Masonry Wall Construction		Frame Wall Construction		Doors and Windows
	Ceilings	Walls	Ceilings	Walls	
"U"	"U"	"U"	"U"	"U"	
.09	.05	.10	.05	.08	1.13[2]

1. Indicates construction with rigid roof insulation and exposed structural system. Where ceiling cavity exists, use value for ceilings.
2. In any room where 20% or more of the exterior wall is composed of windows and doors their maximum "U" Value shall be 0.65 (This will require insulating glass and doors or storm windows or doors). An exterior wall is any wall that faces to the outside of or is adjacent to any unconditioned space, such as: garages, carports, storage rooms, or porch areas. In any room that has two or more exterior walls, the total percentage of window and door area may be combined and used in any one of these walls.

3201.2.2 Blown or poured type loose fill insulation may be used in attic spaces where the slope of the roof is a minimum of 2 1/2 feet in 12 feet and there is at least 30 inches clear headroom at the roof ridge. (Clear headroom is defined as the distance from the top of the bottom chord of the truss or ceiling joists to the underside of the roof sheathing.)

1. 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 on a 60 degree angle from horizontal.
2. Baffles shall be in place at the time of inspection.

3201.2.3 When loose fill insulation is proposed, the R-value of the material shall be determined in accordance with ASTM C 687, C 236 and C 518.

1. The "R" value shall be shown on the building plans together with the total number of bags required and net coverage per bag.
2. Upon completion of the installation of insulation, an insulation certification card shall be furnished by the insulation applicator and posted at a conspicuous location within the structure.
3. This certification shall indicate the R-value, minimum thickness, maximum net coverage and weight per square foot of the insulation installed.

3201.2.4 Minimum ventilation for roof-ceiling cavities shall conform to the following requirements. The required net free vent area may be reduced 50% if an approved vapor barrier is installed behind the ceiling finish material.

1. Gabled Roofs - Screened louvers having a net free area of 1 square foot for each 300 square feet of ceiling area shall be provided at each gabled end.
2. Hip Roofs - Screened soffit vents having a net free area of 1 square foot for each 900 square feet of ceiling area and screened outlet vents located near the roof peak having a net free area of 1 square foot for each 1600 square feet of ceiling area shall be provided.
3. Flat Roofs - Screened openings having a net free area of 1 square foot for each 250 square feet of ceiling area shall be provided along the overhanging eaves. Blocking and bridging shall be arranged so as not to interfere with the movement of air.
4. Cathedral ceilings with joist cavities shall have a screened soffit intake and a screened outlet at the roof ridge or at the intersection of the roof with a vertical surface. The intake and outlet openings shall each have a net free area of 1 square foot for each 250 square feet of roof surface. There shall be 1 inch minimum clearance between the bottom of the roof deck and the insulation.

3201.3 Maximum "U" Values For Floors

3201.3.1 For floors over unheated basements, unheated garages, breezeways or ventilated crawl spaces with operable vents, the thermal value of the floor section shall not exceed the values shown in Table B. (A basement is considered unheated unless it is provided with a positive heat supply equivalent to at least 15% of the total calculated heat loss of the structure or is provided a positive heat supply to maintain a minimum temperature of 50°F.)

TABLE B
FLOOR SECTION MAXIMUM "U" VALUES'

Structural Slab	Wood and Steel Framing
U	U
0.12	0.08

1. U Value for heat flow down

3201.3.2 Insulation may be omitted from floors over unheated areas if the crawl space foundation walls are insulated. (See Diagram 1)

1. The U value of insulated foundation walls from above a point 12 inches below grade or top of footing shall not exceed 0.17 (R = 5.88). ("Foundation wall insulation for underfloor supply plenums shall have a minimum of R-11. See Volume III".)
2. A minimum of 75 to 80% of the crawl space ground areas shall be covered with a 6 mil polyethylene vapor barrier or its equivalent.

3201.3.3 Crawl spaces under buildings without basements shall be ventilated by approved mechanical means or by openings in the 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 nor more than 1/2 inch in any dimension. Such wall openings shall have a net free area of not less than 2 square feet for each 100 linear feet of exterior wall plus 1/3 square feet net free area for each 100 square feet of crawl space area. Where at least 75 to 80% of the crawl space ground surface is covered with a 6 mil polyethylene vapor barrier or its equivalent the areas specified above may be reduced 50 percent. It is recommended that a maximum of 80% of the crawl space ground surface be covered to prevent excessive drying of the flooring. Vents shall be so placed as to provide ventilation at all points and to prevent dead air pockets.

3201.3.4 When used, crawl space ventilation openings shall not be covered with insulation. Vents shall be of the closeable type and insulation shall be attached to the closing device. When fuel burning equipment is located in crawl space, adequate means for combustion air shall be provided.

3201.3.5 Basement walls below a point 12 inches below grade need not be insulated. Walls above a point 12 inches below grade shall be insulated in accordance with Table A.

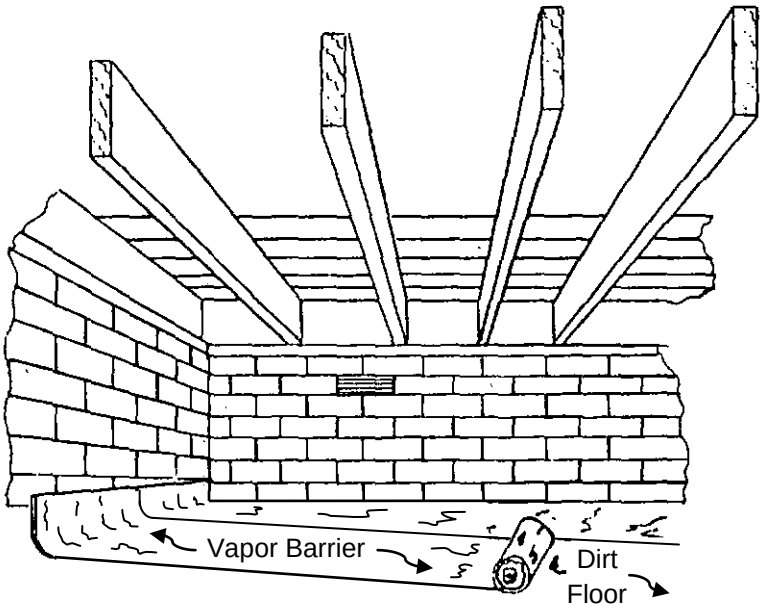
3201.3.6 Slab-on-grade floors shall be insulated around the perimeter of the floor exposed to the outside with rigid insulation having a minimum "R" value of 3.75 and specifically designed and recommended by the manufacturer for this type application. (EFFECTIVE DATE OF THE FOLLOWING CHANGE IS SEPTEMBER 13, 1994) Insulation must be of a type which has been treated to resist termites. A 1-inch inspection strip 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 this 1-inch inspection strip shall be disregarded.

1. The insulation may be installed vertically on the interior or the exterior of the foundation wall with the insulation extending 24 inches below the top of the slab. In areas where the frost line is deeper than 24 inches, the insulation shall extend to the frost line.

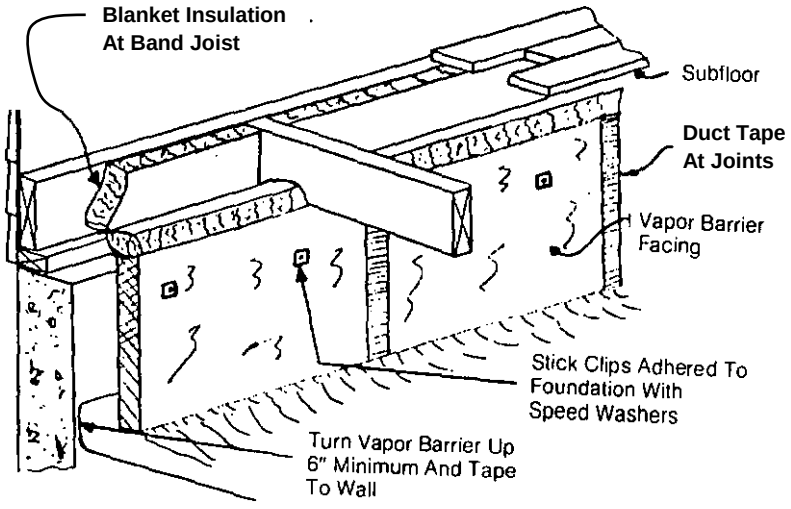
2. Insulation may be installed downward to the bottom of the slab then horizontally beneath the slab for a total distance of 24 inches.
3. Insulation extending above grade shall be protected from physical damage.
4. With either method, the entire slab edge thickness exposed to the outside shall be insulated.

Diagram 1

Stem/Foundation Wall



Stem Wall



3201.4 Weather Stripping of Exterior Doors and Windows

3201.4.1 All doors and windows opening to the exterior or to unconditioned areas such as garages shall be fully weatherstripped, gasketed or otherwise treated to limit infiltration.

3201.4.2 A non-hardening sealant shall be used to caulk around all window and door frames.

3201.5 Conservation of Hot Water

3201.5.1 All shower heads shall be of the water conserving type. Maximum flow rate shall be 3 gpm per head.

3201.5.2 Manufactured automatic electric, gas fired, and oil fired storage water heaters shall be tested, certified, and labeled by the manufacturer as having a performance efficiency equal to or exceeding ANSI/ASHRAE/IES 90A-1980 Standard - 1982 Levels. Gas fired under counter and table top water heaters and gas fired water heaters less than 40 inches in height, including draft diverters, which are designed for and installed beneath a building or other low headroom location are exempt from these efficiency requirements.

3202 REQUIREMENTS FOR NON-RESIDENTIAL

3202.1 General Requirements

3202.1.1 These requirements apply to any building or portion of a building classified according to its use or occupancy as Group R (Residential not covered by Sections 3201.1 through 3201.5), Group B (Business), Group E (Educational), Group M (Mercantile), Group I (Institutional), Group A (Assembly), and Group F (Factory- Industrial) provided with heating and/or cooling. Group S (Storage) shall comply with Group F requirements when provided with other than spot heating and/or cooling.

3202.1.2 Buildings of 15,000 SF gross heated and/or cooled areas or less shall comply with Sections 3202.1 through 3202.7 and with Section 3202.8 (Prescriptive Criteria) or with Section 3202.9 (Performance Criteria). Buildings exceeding 15,000 SF gross area shall comply with Sections 3202.1 through 3202.7 and with Section 3202.9 (Performance Criteria).

3202.1.3 Additions to existing buildings may be made without making the existing building comply.

3202.1.4 The form "Thermal Envelope Criteria" shall be submitted to indicate compliance with Section 3202.8.

3202.1.5 The form "Building Energy Performance Criteria" shall be submitted to indicate compliance with Section 3202.9.

3202.2 Definitions

BUILDING ENVELOPE - The building envelope is considered to include walls, glass, roofs, and floors enclosing heated and/or cooled spaces.

COEFFICIENT OF HEAT TRANSMISSION - The time rate of heat flow expressed in BTU per hour per square foot per degree Fahrenheit difference, (BTU/Hr - Ft^2 - ^{O}F), normally called the U-value. The U-value applies to single materials and to combinations of materials. The U-value shall be calculated in accordance with Chapter 22 of the ASHRAE Handbook of Fundamentals, 1977 Edition.

GROSS GLASS AREA - The gross area of exterior glass consists of all window areas, including sash, exterior glass doors and other non-opaque areas exposed to outdoor air or unconditioned space and enclosing a heated and/or cooled space.

GROSS ROOF AREA - The gross area of the building roof consists of the total interior surface, including skylights, exposed to a heated and/or cooled space.

GROSS WALL AREA - The gross area of exterior walls consists of all areas, including foundation walls, peripheral edges of floors, exterior glass area including sash, and door areas, where such surfaces are exposed to outdoor air or unconditioned space and enclose a heated and/or cooled space.

GROSS FLOOR AREA - The gross floor area is the sum of the areas of the several floors of the building, including basements, mezzanines, and intermediate floored tiers and penthouses of head room height measured from the interior faces of exterior walls.

HEATED AND/OR COOLED SPACE - Space within a building which is provided with positive heat supply designed to maintain a space temperature of 50^{O}F or higher and/or a positive cooling supply designed to maintain a space temperature of 80^{O}F or lower.

PROCESS RELATED ENERGY - Energy expended for the primary purpose of conducting some specific activity for which the building was constructed rather than energy required for maintaining general comfort conditions.

The following energy-consuming loads are not considered to be process related energy; and shall be included with other loads in the analysis of building performance:

Domestic H.W. Heating

General Purpose Receptacles

General Purpose Lighting

Pool Heating (Except for therapeutic purposes in Type I occupancy)

The final determination as to process related energy shall rest with the authority having jurisdiction.

EXTERIOR DECORATIVE LIGHTING - Any exterior lighting for which the major use is other than security, safety, or special signage.

3202.3 Thermal Zones

For the purpose of this Chapter, four thermal zones are established for the State of North Carolina. Table I tabulates the counties in each thermal zone.

TABLE I

ZONE I	Beaufort	Columbus	Lenoir	Sampson
	Bladen	Dare	New Hanover	Scotland
	Brunswick	Duplin	Onslow	Tyrrell
	Carteret	Hoke	Pamlico	Washington
	Chowan	Hyde	Pender	
	Craven	Jones	Robeson	
ZONE II	Anson	Gaston	Mecklenburg	Stanly
	Bertie	Gates	Montgomery	Union
	Cabarrus	Greene	Moore	Wake
	Camden	Harnett	Pasquotank	Wayne
	Cumberland	Hertford	Perquimans	Wilson
	Currituck	Johnston	Pitt	
	Davidson	Lincoln	Randolph	
	Edgecombe	Martin	Richmond	
ZONE III	Alamance	Durham	Nash	Surry
	Alexander	Forsyth	Northampton	Vance
	Burke	Franklin	Orange	Warren
	Caldwell	Granville	Person	Wilkes
	Caswell	Guilford	Polk	Yadkin
	Catawba	Halifax	Rockingham	
	Cleveland	Iredell	Rutherford	
	Davie	McDowell	Stokes	
ZONE IV	Alleghany	Clay	Macon	Watauga
	Ashe	Graham	Madison	Yancey
	Avery	Haywood	Mitchell	
	Buncombe	Henderson	Swain	
	Cherokee	Jackson	Transylvania	

3202.4 Infiltration

Exterior joints around windows and door frames, between wall cavities and window or door frames, between wall and foundation, between wall and roof, between wall panels, at penetrations of utility services through walls, floors and roofs and all other openings in the exterior envelope shall be caulked, gasketed, weatherstripped or otherwise sealed.

3202.5 Heating, Ventilating and Air Conditioning

3202.5.1 Heat gains and losses shall be computed for any building to which this code applies and shall be calculated in accordance with the methodology outlined in Chapters 21, 22, 24, 25 and 26 of the ASHRAE Handbook of Fundamentals, 1977. U-factors for heating calculations may be modified to account for mass effects by multiplying the calculated U-factor by the adjustment factors shown in Table II.

TABLE II

Component WGT (LB/SF)	Mass Adjustment Factor		
	Zones I & II	Zone III	Zone IV
0-15	1.00	1.00	1.00
16-40	0.90	0.95	0.97
41-80	0.83	0.88	0.90
81-120	0.78	0.83	0.85
121+	0.75	0.81	0.83

3202.5.2 Minimum ventilation air quality shall be 33 1/3 percent of the minimum value for each occupancy type from ASHRAE Standard 62-89. The ventilation air quantity may be increased as required to provide sufficient make-up air for necessary exhaust systems plus an amount for building pressurization equal to 5% of total air circulation. Make-up air for kitchen hoods shall not be pre-heated or pre-cooled using non-renewable energy sources unless other measures have already reduced the load to that equivalent to a load not greater than that which would be imposed by exhausting air at the rate of 25 CFM per sq. ft. of hood face area.

EXCEPTION: Requirements do not apply to tested and listed non-canopy backshelf type kitchen exhaust hoods.

3202.5.3 For calculations to certify compliance with this Section of the Code the following shall apply:

1. Outdoor temperatures shall be in accordance with Table III.

TABLE III

ZONE	Winter	Summer	
(see Table I)	DB	DB	WB
I	20^{O}F	92^{O}F	81^{O}F
II	15^{O}F	94^{O}F	78^{O}F
III	10^{O}F	90^{O}F	76^{O}F
IV	0^{O}F	86^{O}F	74^{O}F

2. Indoor design temperatures shall not exceed 68°F for heating nor be less than 78°F for cooling.
3. Temperatures listed in Table III are intended to be used primarily to establish uniformity in certifying code compliance.

The actual design temperature difference (indoor to outdoor) may vary from that resulting from the use of the above code compliance temperatures when building use so dictates and/or prevalent local outdoor temperature conditions deviate from those listed. Justification for such deviation shall be stated on the energy compliance form.

3202.5.4 If self-contained terminal heating and cooling equipment is to be utilized, the installed output capacity shall not exceed 110% of the sum of the space heat loss, plus ventilation air heating requirements, or of the sum of the space heat gain, plus ventilation air cooling requirements, unless specific approval is granted from the authority having jurisdiction.

3202.5.5 If central station equipment is to be utilized, the installed output capacity shall not exceed 100% of the sum of the building heat loss, plus ventilation air heating requirements, or of the sum of the building heat gain, plus ventilation air cooling requirements, unless specific approval is granted from the authority having jurisdiction.

EXCEPTION: Buildings included under occupancy Group E, which are unheated during unoccupied periods, may utilize central station heating systems having a capacity not to exceed 130% of the sum of the building heat loss, plus ventilation air heating requirement. However, if total fossil fuel fired central station heating capacity exceeds, 2,000,000 Btu, output rating multiple units must be installed unless a single unit can be shown to be as energy efficient.

3202.5.6 All energy consuming equipment shall be sized and/or selected on the basis of heating/cooling loads calculated in accordance with 3202.5.1 through 3202.5.5, subject to the following exceptions:

1. Packaged equipment shall be selected on the basis of the closest possible unit rating higher than the actual calculated heating/cooling load.
2. Equipment which is oversized to allow for future addition or building expansion may be approved by the authority having jurisdiction.

3202.5.7 Systems requiring simultaneous heating and cooling are inherently inefficient and are strongly discouraged. When more efficient methods of heating are unable to meet system design objectives, these systems may be used subject to the following restrictions:

1. Single zone reheat systems shall be controlled to sequence reheat and cooling.
2. Systems serving multiple zones shall be equipped with controls to automatically reset the system cold air temperature to the highest temperature level that will satisfy the zone requiring the coldest air or the warm air temperature to the lowest level that will satisfy the zone requiring the warmest air.

3202.5.8 For those buildings designed to be heated to a space temperature below 50°F or cooled to a space temperature above 80°F, the level of energy use shall not exceed the amount that would be consumed in complying with the requirements of Tables IV and V.

3202.5.9 All central air handling systems in buildings required to comply with 3202.9, Performance Criteria, shall be designed to use automatically up to 100% of the fan capacity for cooling with outdoor air whenever such use will result in a lower energy consumption than mechanical cooling. This requirement shall be waived by the authority having jurisdiction under the following conditions:

1. Fan system capacity is less than 5,000 cubic feet/min. or 134,000 Btuh total cooling capacity.
2. The quality of the outdoor air is so poor as to require extensive treatment of the air.
3. The need for humidification or dehumidification requires the use of more energy than is conserved by the outdoor air cooling.
4. If the use of outdoor air cooling affects the operation of other systems so as to increase the overall energy consumption of the building.
5. Internal/external zone heat recovery or other energy recovery is used.
6. When cooling is accomplished by a circulating liquid which transfers space heat directly or indirectly to a heat rejection device such as a cooling tower without the use of a refrigeration system.

3202.6 Lighting

3202.6.1 The maximum allowable load for lighting shall not exceed 2.5 watts per gross square foot.

3202.6.2 For building spaces larger than 200 SF, circuiting and individual switching or dimming shall be provided so that:

1. Lighting energy can be reduced by at least one-half.

2. Lighting can be turned off.

3202.6.3 Exterior decorative lighting shall not exceed 2 percent of the total interior lighting load.

3202.7 Service Water Heating

3202.7.1 Manufactured automatic electric, gas fired, and oil fired storage water heaters shall be tested, certified, and labeled by the manufacturer as having a performance efficiency equal to or exceeding ANSI/ASHRAE/IES 90A-1980 Standard - 1982 Levels. Gas fired under counter and table top water heaters and gas fired water heaters less than 40 inches in height, including draft diverters, which are designed for and installed beneath a building or other low headroom location are exempt from these efficiency requirements.

3202.7.2 Non-storage type water heaters used as hot water generators or boosters shall be installed with automatic controls to prevent any energy usage when there is no demand for hot water.

3202.7.3 All service hot water piping and hot water storage tanks other than automatic manufactured storage water heaters shall be insulated to meet or exceed the following minimum requirements based on ANSI/ASHRAE/IES 90A-1980 Standard - 1982 Levels:

1. Minimum thickness for insulation shall be in accordance with line temperature ranges listed in the following tables. Insulation shall have a maximum K factor of 0.27.
2. Piping - Service Water

Line Temperature Degree F	Runouts Up to 1”	Circulating Mains & Runouts		
		Up to 1 ¼”	1 ½” to 2”	Over 2”
100-130 F	0.5 thick	0.5”	0.5”	1.0”
140-160 F	0.5 thick	0.5”	1.0”	1.5”
170-180 F	0.5 thick	1.0”	1.5”	2.0”

Note: Nominal iron pipe size and insulation thickness

3. Piping - Heating Systems

Line Temperature Degree F	Runouts Up to 1”	Circulating Mains & Runouts		
		Up to 1 ¼”	1 ½” to 2”	Over 2”
120-200 F	0.5 thick	1.0”	1.5”	1.5”
201-250 F	1.0 thick	1.5”	2.0”	2.0”
Above 250 F	1.5 thick	2.0”	2.5”	3.0”

Note: Nominal iron pipe size and insulation thickness

4. Hot Water storage tanks heaters: 2" thick.

3202.7.4 Combination service water heating/space heating boilers may be utilized only if the manufacturer tests, certifies and labels the boiler as having a performance efficiency equal to or exceeding ANSI/ASHRAE/IES/90A-1980 Standard at 1982 Levels, for storage water heaters.

3202.7.5 Conservation of Hot Water.

3202.7.5.1 Showers used for other than therapeutic or safety reasons shall be equipped with flow control devices to limit flow to a maximum of 3 gpm per shower head.

3202.7.5.2 Lavatories in restrooms of public facilities shall:

l. Be equipped with outlet devices which limit the flow of hot water to a maximum of 0.5 gpm or, be equipped with self-closing valves that limit delivery to a maximum of 0.25 gallons of hot water for recirculating systems and to a maximum of 0.50 gallons for non-recirculating systems, and

2. Be equipped with devices which limit the outlet temperature to a maximum of 110"F.

3202.8 Prescriptive Criteria

The total building heat loss, including infiltration and/or ventilation, calculated in accordance with 3202.5, shall not exceed the values shown in Table IV.

Table IV

Thermal Zone	Heat Loss BTU/GSF
I	23
II	26
III	27
IV	30

3202.9 Performance Criteria (Building Exceeding 15,000 GSF in Area)

3202.9.1 The energy-consuming load shall consist of the sum of the peak (maximum normal) ready-state simultaneous loads imposed by the energy consuming items in the building and shall not exceed the values tabulated in Table V. All energy consuming items in the building shall be included except for those items using process related energy.

3202.9.2 Maximum allowable allotment for on-site fuel-fired equipment shall be selected on the basis of the gross output rating of the equipment.

TABLE V
MAXIMUM ALLOWABLE SIMULTANEOUS LOAD
See 3202.9(a)

	Allotment		
Occupancy	Watts/GSF	or	BTUH/GSF
R (Residential) [See 3202.1(a)]	8.5*		29*
B (Business)	7.1		24
M (Mercantile)	6.3		22
E (Educational)	7.5		26
I (Institutional)	8.3		28
A (Assembly)	5.7		19
F (Factory-Industrial)	6.4**		22**

*This figure is intended for environmental systems only. All other usage is excluded.

**Energy allotment is based on assumed 55°F indoor temperature.

3203 PERFORMANCE CRITERIA

3203.1 General

This Section applies to urea-based thermo-setting foam insulation for use in wall, partition and floor cavities in building construction. This material shall not be used in ceiling cavities.

3203.2 Material Characteristics

3203.2.1 Tests. The material shall be certified by the manufacturer to meet the following requirements when tested in accordance with the applicable sections of HUD Materials Bulletin No. 74.

1. Resin Properties
   Free aldehyde content - 1.0 percent maximum
2. Curing Properties
   Setting Time
   Closed cavity - 20-60 seconds
   Open cavity - 10-60 seconds
   Volume Resistivity of Fresh Foam - 5000 ohms - centimeter minimum
   Water Drainage - None
   Shrinkage during curing - 4% maximum
   Fungi Growth Inhibition - Maximum 10% of that in the content test frame
3. Dry Foam Properties
   Density - 0.70-0.9 pounds per cubic foot
   Thermal Resistance - R = 12 for 3 inches
   Corrosiveness
   Aluminum, copper & steel - No Perforations
   Galvanized steel - No pitting and maximum loss of mass of 0.01 ounce.
   Water Absorption
   Floating Test - maximum 15% by volume
   Droplet Test - minimum 1 hour
   Surface Burning Characteristics - maximum 25 flame spread classification (in accordance with ASTM E 84.)
   Ash Content - Maximum 2% of original foam volume.

3203.2.2 Effective Thermal Resistance. The effective thermal resistance values shall be certified as complying with the applicable section of HUD Materials Bulletin No. 74 and shall be supplied to the distributor and/or applicator by the manufacturer.

3203.3 Installation Standards

3203.3.1 Manufacturers' Recommendations. Material shall be installed in strict accordance with the manufacturer's specific installation instructions. These instructions shall be provided to the distributor and/or applicator by the material manufacturer. Unless otherwise specified by the manufacturer, the materials entering the foaming gun shall be within the range of 59 to 86° F. During application and for a period of four (4) days after application the exterior surface of cavities to which foam is supplied shall be within the range of 23 to 86° F.

3203.3.2 Qualified Applicators. The installation of this material shall be performed only by an applicator who has been trained by the foam manufacturer and carries a current certificate of qualification by the manufacturer and identification card issued by the manufacturer. Each manufacturer shall certify that all his approved applicators are properly trained, qualified and certified by him.

3203.3.3 Quality Control. To assure quality control, the applicator shall use either resin shipped in a pre-mixed liquid state by the manufacturer or equipment having quality control devices which will insure proper mixing of the material at the job site.

3203.3.4 Fire Protection. All material exposed to the interior of a structure shall be protected in accordance with 717. No portion of the installed material shall be exposed after construction is completed. Special precautions shall be taken to prohibit prolonged exposure of the installed material to direct sunlight, temperatures above 100^{O}F, oils, solvents and acid vapors.

3203.3.5 Water Vapor. Water present in the installed material shall be permitted to escape from a wall while the material dries in the cavity. In cases where the interior and exterior wall surfaces may restrict water vapor transmission other provisions shall be provided to allow the water vapor to escape.

3203.3.6 Vapor Barrier. Prior to or immediately after foaming exterior walls a vapor barrier equivalent to 6 mil polyethylene shall be installed on the inner side of the wall. The vapor barrier shall not be allowed to bulge and shall be lapped 3 to 6 inches at all corners and seams. Cuts and breaks in the vapor barrier at doors, windows or other areas shall be properly repaired. When material used on the cold side of the wall has a permeability rating of 8 perms or less, vent plugs, vent strips or other suitable means shall be provided to allow cavity moisture to vent to the atmosphere.

3203.4 Material Labeling

Each container of urea-based foaming materials shall bear labels listing the following minimum information:

1. Manufacturer's Name
2. Storage temperature and dates after which materials may not be used.
3. Statement that material is to be installed only by a licensed or qualified applicator.
4. Warning to avoid contact of material with eyes, nose and skin.
5. Flame spread classification.

3203.5 Material Storage

Unless specified otherwise by the manufacturer, urea-based foaming materials shall be stored in temperatures between 50 and 86° F.

3204 NON-DEPLETABLE ENERGY

3204.1 General

This section applies to the use of non-depletable energy sources to reduce the use of depletable energy by new buildings complying with 3201 or 3202.

3204.2 Definitions

DEPLETABLE ENERGY - Energy produced from fossil fuels or nuclear fuel. Fossil fuels are carbonaceous substances which may be oxidized to produce heat or chemically combined to produce electricity (e.g., fuel cell). Nuclear fuels are radioactive substances which, through the process of controlled fusion, produce heat. Heat produced by fuels may be utilized directly or used to produce electricity.

NON-DEPLETABLE ENERGY - Energy derived from one or more of the following sources:

1. Natural sunlighting and/or thermal, chemical, or electrical energy derived directly from conversion of incident solar radiation.
2. Energy derived from wind, waves and tides, and lake or pond thermal differences.
3. Energy derived from the internal heat of the earth.

3204.3 Credit For Use Of Non-Depletable Energy

3204.3.1 Analysis, of annual energy usage shall be performed by a registered Professional Engineer to compare the design complying with 3201 or 3202 and the alternative design utilizing non-depletable energy. The depletable energy consumed by the alternative design shall be less than or equal to the design complying with 3201 and 3202.

3204.3.2 The analysis of the annual energy usage of the standard and the proposed alternative building and system designs shall meet the following criteria:

1. The building heating/cooling load calculation procedure used for annual energy consumption analysis shall be of sufficient detail to permit the evaluation of effect of building data (such as orientation, size, shape, transfer characteristics of mass, air, moisture, and heat) and climatic data.

2. The calculation procedure used shall simulate the operation of the building and its service systems through a full year operating period and shall be of sufficient detail to permit the evaluation of the effect of system design, climatic factors, operational characteristics, and mechanical equipment on annual energy usage.

APPENDIX "B"

CHAPTER 32

THERMAL ENVELOPE CRITERIA FOR BUILDINGS UNDER 15,000 S.F.

PROJECT TITLE _____

_____

LOCATION _____

_____

OWNER _____

_____

DESIGNER _____

_____

PROJECT DATA:

Occupancy Group _____ Thermal Zone _____

Building Gross Area _____ GSF [See 3202.2(f)]

No. of Stories _____

LIGHTING:

Total Lights _____ W/GSF

HEATING: BTU/HR/GSF

Building Heat Loss - including infiltration air _____

Total Installed Capacity _____

Table IV Allowance _____

APPENDIX "B"

THERMAL ENVELOPE CRITERIA (continued)

TABULATION OF THERMAL VALUES USED TO CALCULATE BUILDING HEAT LOSS

BUILDING SECTION	Area (S.F.)	U Value
Walls	_____ _____	_____ _____
Windows	_____ _____	_____ _____
Doors	_____ _____	_____ _____
Roof	_____ _____	_____ _____
Floor	_____ _____	_____ _____

DESIGNER'S STATEMENT:

To the best of my knowledge and belief, the design of this building complies with the applicable requirements of Chapter 32 of the *North Carolina State Building Code.*

SIGNED _____

DATE _____ NAME _____

TITLE _____

APPENDIX "C"

CHAPTER 32

BUILDING ENERGY PERFORMANCE CRITERIA FOR BUILDINGS OVER 15,000 S.F.

PROJECT TITLE _____

LOCATION _____

_____

OWNER _____

_____

DESIGNER _____

_____

PROJECT DATA:

Occupancy Group _____ Thermal Zone _____

Building Gross Area _____ GSF

No. of Stories _____

COOLING: BTU/HR/GSF

Building Heat Gain - including outside air _____

Total Installed Terminal Cooling Capacity (Coils) _____

Total Installed Primary Cooling Capacity (Compressors) _____

HEATING:
Building Heat Loss - including Outside Air _____

Total Installed Terminal Heating Capacity (Coils) _____

Total Installed Primary Heating Capacity (Boilers, etc.) _____

LIGHTING:
Total Lighting _____ W/GSF

ENERGY SUMMARY		
Description	Connected Load/GSF (W or BTU/HR)	Energy Consuming Load/GSF (W or BTU/HR)
Interior Lighting		
Decorative Exterior Lighting		
Domestic Water Heating		
Heating or Cooling		
HVAC Auxiliaries		
Swimming Pool Heating		
Humidification		
Elevators/Escalators		
Cooking and Sanitation		
Manufacturing Process		
Computers		
Sterilizers		
Gen. Purpose Receptacles		
TOTAL		
Allotment from Table V		

NOTE: Designer to list *all* connected energy loads in the building and show peak steady-state simultaneous loads imposed by energy consuming items deleting those items he considers process related energy from the energy consuming load tabulation. Final determination of process related energy loads shall rest with the authority having jurisdiction.

DESIGNER'S STATEMENT:

To the best of my knowledge and belief, the design of this building complies with the applicable requirements of Chapter 32 of the *North Carolina State Building Code.*

SIGNED _____

NAME _____

DATE _____ TITLE _____

APPENDIX "D"

R VALUE CONVERSION CHART	
R VALUE	U VALUE
1	1.000
2	0.500
3	0.333
4	0.250
5	0.200
6	0.167
7	0.143
8	0.125
9	0.111
10	0.100
11	0.091
12	0.083
13	0.076
14	0.071
15	0.067
16	0.063
17	0.059
18	0.056
19	0.053
20	0.050
21	0.048
22	0.045
23	0.044
24	0.042
25	0.040
26	0.038
27	0.037
28	0.036
29	0.034
30	0.033

CHAPTER 33

PIERS, BULKHEADS AND WATERWAY STRUCTURES

3301 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.

3302 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.

3303 MINIMUM DESIGN LOADS

3303.1 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.

3303.2 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.

3303.3 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 Stale 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.

3303.4 Wind Loads

As prescribed in Chapter 12.

3303.5 Impact Loads

As prescribed in Chapter 12 but not less than the 1.25 times the kinetic energy exerted by a striking vessel or vehicle.

3303.6 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.

3303.7 Earth Loads

Lateral earth pressures shall be determined by considering the specific soil properties and applying earth pressure theories generally accepted for soil mechanics in engineering practice. Except for simple and inexpensive structures this normally requires the services of specialists in soil mechanics and/or foundations design. Adequate consideration shall be given for the effect of 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.

3303.8 Erosion

The effects of reasonably predictable erosion and wave induced scour shall be given ample consideration.

3304 ENGINEERED DESIGNS

3304.1 Docks, Piers and Catwalks used by the Public or are intended for use by vehicles shall be designed by a Professional Engineer or Registered Architect.

3304.2 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 Registered Architect.

3304.3 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 Registered Architect.

3305 MATERIALS

3305.1 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 13. Wood components shall comply with applicable provisions of Chapter 17. Concrete components shall comply with applicable provisions of Chapter 16. Steel components shall comply with applicable provisions of Chapter 15. 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 14.

3306 CONSTRUCTION OF PIERS, DOCKS, CATWALKS AND FLOATING DOCKS

3306.1 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. Less 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 loads 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.

3306.2 Metal Barrels Flotation Units

The use of metal barrels not specifically designed for use as flotation devices is prohibited.

3306.3 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.

3306.4 Electrical Service

All electrical service to marine structures shall be in accordance with the current edition of the National Electrical Code.

3306.5 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 50 ft from the dispenser with a shut-off valve at the tank.

3306.6 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 12 for balcony railing.

3306.7 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 Registered 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.

3307 CONSTRUCTION: BULKHEADS, SEAWALLS AND REVETMENTS

3307.1 Bulkheads

3307.1.1 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.

3307.1.2 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 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.

3307.1.3 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 12 for Balcony Railings.

3307.1.4 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 washers.

3307.1.5 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.

3307.2 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.

3307.3 Revetments

3307.3.1 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.

3307.3.2 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.

3308 CONSTRUCTION OF GROINS AND JETTIES

3308.1 Groins

3308.1.1 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.

3308.1.2 Location. Groins shall extend landward a sufficient distance to prevent flanking.

3308.1.3 Types. Groins shall be either (1) very low, impermeable and nonadjustable or (2) impermeable and adjustable.

3308.1.4 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 installations, 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.

3308.2 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 Registered Architect with coastal engineering experience.

3309 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 waves 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.

PIER HEAD 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 34

COASTAL & FLOOD PLAINS CONSTRUCTION STANDARDS

3401 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.

3402 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 Plain": Land below base flood elevation, which of record has in the past been flooded by storm water surface runoffs, or tidal influx: and as defined by the Corps of Engineers' Maps, the Federal Emergency Management Agency Maps, or as approved by 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).

3403 PILING STANDARDS

3403.1 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.

3403.2 The foundation shall be designed (as required by Chapter 12 and Chapter 13) 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 13.

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.

3404 ELEVATION STANDARDS

3404.1 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.

3405 ANCHORING AND BRACING STANDARDS

3405.1 All construction shall be anchored and braced to resist uplift, floatation, collapse, or lateral movement of the structure.

3405.2 The Building Official may require plans sealed by a Professional Engineer or Registered Architect certifying to the building complying with 3403.2(1).

3406 CONSTRUCTION, MATERIALS, AND METHODS STANDARDS

3406.1 All construction and equipment located below the Base Flood Elevation shall be resistant to flood damage.

3406.2 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 U.S. Army Corps of Engineers "Flood-Proofing Regulations" dated June 1972 or other approved methods.
2. A Professional Engineer or Registered Architect shall certify that the floodproofing has been designed to withstand the flood pressure, velocities, impact, and uplift forces.

3406.3 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 Registered Architect submitted on the connection, anchoring and support system documenting its ability to withstand combined storm wind and wave forces.

3406.4 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 tee 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 A.

3407 STABILITY STANDARDS

Calculations to determine overturning forces and moments on the foundation shall be made as set forth in Section 1205.6 including appropriate consideration for increased moments and reduced piling penetration due to erosions.

3408 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 3404 be certified by a Registered Land Surveyor or Professional Engineer.

3409 FIRE AND SAFETY STANDARDS FOR TYPES V AND VI CONSTRUCTION

(RESIDENTIAL OCCUPANCY)

3409.1 Section 3409 applies to all residential occupancy in areas identified as coastal high hazard areas or ocean hazard areas, or areas in 110 MPH wind zone. (Figure 1205.3).

3409.2 All roof covering shall be Class A or Class B covering, or Class C asphalt covering.

TABLE A
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
EXTERIOR WOOD DECK CONSTRUCTION

A101 Decks for residential occupancies, other than townhouses, having an area of 100 sq ft and less shall meet the requirements of this section. Decks 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 Registered Architect.

A102 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 of the post with a minimum thickness of 6 inches for precast concrete or 8 inches for cast-in-place concrete.

A103 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 1703.

A104 When attached to a structure, the structure to which attached shall have a treated wood band for the length of the deck, or metal flashing shall be used to prevent moisture from coming in contact with the untreated framing of the structure. The deck band and the structure band shall be constructed in contact with each other except on brick veneer structures and where plywood sheathing is required and properly flashed. Siding shall not be installed between the structure and the deck band. If attached to a brick veneer structure, neither flashing nor a treated band for the brick structure is required. In addition, the treated deck band shall be constructed in contact with the brick veneer.

A105 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.

[1] Minimum edge distance for bolts is 3 inches.

[2] Nails must penetrate the supporting structure band 1minimum of 1 1/2".

B. Brick Veneer Structures:

Fasteners	8' Max Joist Span	12' Max Joist Span	16' Max Joist Span
3/8" 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]	1 @ 3'-4" o.c.	1 @ 2'-0" o.c.	1 @ 1'-4" o.c.

[1] Minimum edge distance for the bolts is 3 inches.

A106 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 1705. 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.

A107 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)

A108 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"

[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 Registered Architect.

A109 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 A105, 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	25 SF	4'-0"	2'-6"	6'-6"	1'-0"
6 x 6	25 SF	6'-0"	3'-6"	9'-6"	1'-8"
6 x 6	25 SF	8'-0"	3'-6"	11'-6"	1'-8"
8 x 8	25 SF	10'-0"	4'-6"	14'-6"	2'-0"
8 x 8	25 SF	10'-0"	6'-6"	16'-6"	w/o concrete
8 x 8	25 SF	12'-0"	4'-0"	16'-0"	2'-0"
8 x 8	25 SF	12'-0"	6'-0"	18'-0"	w/o concrete

5. For embedment of piles in coastal regions see Chapter 34.

A110 Variations in deck design may be approved by the Local Building Official when designed and sealed by a professional engineer or architect.

APPENDIX B
FIRE RESISTANCE RATINGS FOR MATERIALS AND CONSTRUCTION

Refer to 1003.1.2 and the following reference documents for fire resistance ratings of materials and assemblies:

NBS BMS 71, Fire Tests of Wood- and Metal-Framed Partitions, National Bureau of Standards, 1941.

NBS BMS 92, Fire Resistance Classifications of Building Construction, National Bureau of Standards, 1942.

NBS BMS 143, Fire Tests of Brick Walls, National Bureau of Standards, 1942.

NBS Fire Tests of Building Columns, joint report of Underwriters Laboratories Inc., Associated Factory Mutual Insurance Companies and National Bureau of Standards, 1920.

NBS Research Paper No. 37, Fire Resistance of Hollow Load-Bearing Wall Tile, National Bureau of Standards, 1928.

NBS Technical News Bulletin No. 124, Fire Resistance of Brick Walls, National Bureau of Standards, 1927.

NBS TRBM-44, Fire-Resistance and Sound-Insulation Ratings for Walls, Partitions and Floors, National Bureau of Standards, 1946.

"SCR Brick" Wall Fire Resistance Test, by Ohio State University Engineering Experimental Station, Research Report 2, Structural Clay Products Research Foundation, 1952.

"Fire Endurance of Hollow Brick Walls", Technical News Bulletin, Volume 35, No. 4, National Bureau of Standards, 1951.

"Report of a Standard ASTM Fire Endurance Test and Fire and Hose Stream Test on a Wall Assembly", Building Research Laboratory Report No. T-3660, Engineering Experiment Station, Ohio State University, 1966.

"Report of a Standard ASTM Fire Endurance and Hose Stream Test of an Unsymmetrical Limited Load Bearing Wall Assembly", Building Research Laboratory Report No. 5477, Engineering Experiment Station, Ohio State University, 1973.

"Fire Resistance of a Brick Cavity Wall System", Report No. E.S. 6975, Structural Research Laboratory, Richmond Field Station, University of California at Berkeley, 1968.

APPENDIX C

WOOD PRESERVATIVES

Standards for wood preservatives and methods of pressure treatment required within the scope of this code shall conform to those contained in the Manual of Recommended Practice of the American Wood Preservers' Association (AWPA).

Accepted preservatives include the following:

1. Creosote ……..…… AWPA Standard P1
2. Creosote-Coal Tar Solutions ……...…… AWPA Standard P2
3. Creosote-Petroleum Solution …….. AWPA Standard P3
4. Creosote-Pentachloropenol Solution ……... AWPA Standard P11
5. Oil-Borne Preservatives (Hydrocarbon Solvents) ….…… AWPA Standard P8
6. Oil-Borne Preservatives ……..…… AWPA Standard P9
7. Water-Borne Preservatives …….. AWPA Standard P5

Standards for methods of treatment, by commodity, include the following:

1. General requirements, all wood products, pressure treatment, AWPA Standard Cl.
2. Lumber and Timbers, pressure treatment, AWPA Standard C2.
3. Piles, pressure treated, AWPA Standard C3.
4. Poles, pressure treated, AWPA Standard C4.
5. Plywood, pressure treated, AWPA Standard C9.
6. Piles and Timber, pressure treated, marine construction, AWPA Standard C18.
7. Pole building construction, pressure treatment, AWPA Standard C23.
8. Sawn timber piles, pressure treated, for residential and commercial buildings, AWPA Standard C24.
9. Glued laminated wood, pressure treatment, AWPA Standard C28.
10. Standard for Care of Pressure-Treated Wood Products, AWPA M-4.
11. Softwood Lumber, Timber and Plywood Pressure Treated with Water-Borne Preservatives for Ground Contact Use in Residential and Light Commercial Foundations, AWPB Standard FDN.

APPENDIX D

RESERVED FOR FUTURE USE

APPENDIX E

RECOMMENDED GUIDE FOR SOUND ISOLATION IN MULTI-FAMILY DWELLINGS[1]

E101 SCOPE

This Appendix pertains to the minimum allowable sound isolation that is recommended for partitions that separate adjacent units in multi-family dwellings, and similar partitions that separate a dwelling unit from public areas[2], service areas[3], or commercial facilities.

E102 RECOMMENDATIONS

E102.1 All partitions or walls between adjacent dwelling units or between dwelling units and an adjacent public area, hallway, service area, or commercial facility within the structure should have a minimum airborne sound isolation of 45 STC (Sound Transmission Class), as tested in accordance with ASTM E 90.

E102.2 All partitions should be constructed substantially as tested, and should not be altered by piercing, flanking, or voiding air space in any way that would lower the Sound Transmission Class.

E102.3 Partitions, where recommended to provide resistance to airborne sound shall in addition, provide the structural stability, fire resistance and other performance characteristics required elsewhere in this Code.

1. Appropriate rated systems as listed in the GA Fire Resistance Design Manual or NCMA-TEK 69 may be accepted as if herein listed. BIA Technical Notes 5A contains an acceptable list of Sound Transmission Class (STC) ratings for 15 brick and structural clay tile masonry wall assemblies.
2. Public areas include hallways, lobbies, storage rooms, stairways and similar areas.
3. Service areas include boiler rooms, laundries, mechanical equipment rooms, elevator shafts, incinerator shafts, garages and other such uses.

APPENDIX F

FALLOUT SHELTER CONSTRUCTION

The following amendments to the Standard Building Code are recommended where provisions are desired to apply to the construction of Fallout Shelters.

☐ Add the following definitions to 202:

FALLOUT SHELTER - Any room, structure or space designated as such and providing its occupants with protection at a minimum protection factor of 40 from gamma radiation from fallout from a nuclear explosion as determined by an architect or engineer certified by the Office of Civil Defense as a Qualified Fallout Shelter Analyst.

FALLOUT SHELTER, DUAL-USE - A space having a normal, routine use and occupancy as well as having an emergency use as a fallout shelter.

FALLOUT SHELTER, SINGLE-PURPOSE - A space having no other use or occupancy than as a fallout shelter.

PROTECTION FACTOR - a factor used to express the relation between the amount of fallout gamma radiation that would be received by an unprotected person and the amount that would be received by one in a fallout shelter.

☐ Revise the following definition in 202:

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

☐ Add the following occupancy group to 401.1:

Group N - Fallout Shelters

☐ Add to Table 403.1

Single Purpose Fallout Shelter...No requirement.

☐ Add new Section 413 as follows:

413 FALLOUT SHELTERS- GROUP N

All buildings and structures or parts thereof which are used for fallout shelters and so designated shall be classified in the fallout shelter use group.

Group N-1 Fallout Shelters shall include all dual-use shelters.

Group N-2 Fallout Shelters shall include all single-purpose fallout shelters.

□ Add new Section 517 as follows:

517 FALLOUT SHELTERS

517.1 Scope

The scope of this section extends to a building or to a building space when it is being used as a fallout shelter in time of national emergency or for reasonable periods of drill and instruction. If the space is being used as a shelter, the provisions of this section shall apply, and if it is not being so used, other applicable provisions of this Code shall apply.

517.2 Dual Use

Nothing in these regulations shall be constructed as preventing the dual use or multiple use of normal occupancy space as fallout shelter space, providing the minimum requirements for each such use are met.

517.3 Exit Facilities

There shall be no fewer than two widely spaced exits from a fallout shelter, leading directly to other spaces of the building or outdoors. In no case shall a single exit be less than 24 inches wide. In addition, the following requirements must be met:

1. When requirements in Chapter 11 for normal occupancy of the space in dual-use fallout shelters exceed the preceding, the normal occupancy requirements shall govern.
2. Exits from a single-purpose fallout shelter shall aggregate at least 0.10 inches per occupant. Interior circulation within the fallout shelter shall be governed by requirements of Chapter 11.

517.4 Space And Ventilation

517.4.1 A minimum of 10 sq ft of net floor area shall be provided per fallout shelter occupant. Minor partitions, columns, and area for storage of Federal shelter supplies may be included in net area. A minimum of 65 cu ft of volume shall be provided per fallout shelter occupant. A minimum of 3 cu ft of fresh air per minute per person shall be provided.

517.4.2 Fallout shelter capacity or occupancy time may be limited by the volume of room and not by its net area. The following table shall be used in determining volume space required per person:

Time for Complete Air Change (minutes)*	Volume of Space/Person (cu ft)
1000 or more	500
600	450
400	400
200	300
100	200
60	150
35	100
22	65

*computed as a ratio: Net volume of space (cu ft)/fresh air supply (cfm)

517.5 Windows
No requirements.

517.6 Illumination
No special lighting levels are required.

517.7 Sanitation

Toilets, either flush type operating from the normal water supply system or chemical or other types shall be provided on the basis of one toilet per 50 fallout shelter occupants. 50% of the toilets may be provided outside the fallout shelter area. Empty water containers may be considered as fulfilling this requirement.

517.8 Fire Resistant Partitions

Fire resistant partitions in fallout shelters are not required.

517.9 Travel Distance

Maximum distance of travel to an exit shall be 150 ft for single purpose fallout shelters.

517.10 Occupant Load

For determining the means of egress required, the minimum number of persons for any floor area in fallout shelters shall be no less than 10 sq ft per person.

517.11 Exit Enclosure

Stairways, platforms, landings, and hallways shall be enclosed with walls of not less than 1-hour fire resistance in buildings occupied by more than 40 persons above or below the story at street level when such occupancy is in connection with use of a designated portion of the building as a fallout shelter in times of emergency.

517.12 Minimum Live Loads

517.12.1 Dual-use fallout shelters shall be designed for the live loads specified in 1203. Concentrated loads due to water storage and rations shall also be considered.

517.12.2 Single-purpose fallout shelters shall be designed for a uniform live load of 40 psf. Concentrated loads due to water storage and rations shall also be considered.

APPENDIX G

RECOMMENDED GUIDE FOR THE ESTABLISHMENT OF A FIRE DISTRICT

For the purpose of this Code, the Fire District shall include that territory or area consisting of:

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; theatres, night clubs, 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%.
2. Where four contiguous blocks or more comprise a Fire District there shall be a buffer zone of 200 ft 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 buffer zone.
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 paragraph (1) they may be considered for inclusion in the Fire District, and may form all or a portion of the 200ft buffer zone required in paragraph (2).

APPENDICES H thru O

(DELETED)

APPENDIX P
COMMENTARY ON CALCULATED FIRE RESISTANCE

This commentary contains explanatory material, examples and reference material related to the provisions of Chapter 31 on calculated fire resistance rating.

PC 3102.1.1.1

Even though there have been few fire tests of concrete walls (other than concrete masonry), there have been many fire tests of concrete slabs tested as floors or roofs. Fire tests of floors or roofs are considered to be more severe than those of walls because floors and roofs must support their service loads during fire tests. In addition most ASTM E 119 fire tests of floor or roof assemblies have been conducted while the assembly was supported within restraining frames. As concrete assemblies are heated and tend to expand, the expansion is resisted by the restraining frame. These restraining forces are usually much greater than the superimposed loads supported by load-bearing walls. Thus floor or roof assemblies are subjected to both vertical superimposed loads and horizontal restraining loads during fire tests. By contrast, load-bearing walls are subjected only to superimposed loads.

The fire endurances of masonry or concrete walls are nearly always governed by the ASTM E 119 criteria for temperature rise of the unexposed surface, i.e., the "heat transmission" end point. For flat concrete slabs or panels, the heat transmission fire endurance depends primarily on the aggregate type and thickness, and is essentially the same for floors as for walls.

The data in Table 3102.1A was derived from PCA Research Department Bulletin 223, "Fire Endurances of Concrete Slabs as Influenced by Thickness, Aggregate Type, and Moisture," and PCA Publication T-140, "Fire Resistance of Reinforced Concrete Floors."

PC 3102.1.1.2

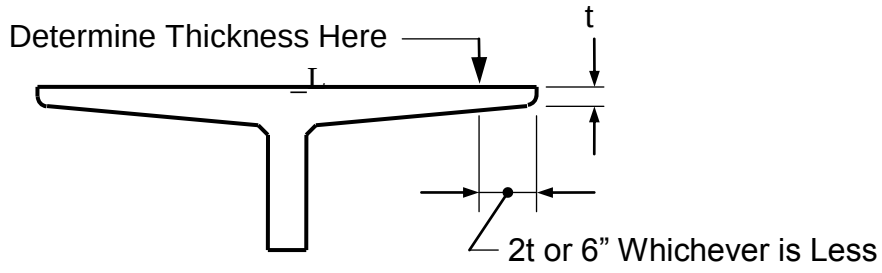
The method for determining "equivalent thickness" of masonry units was developed because the cores in masonry units taper. The method is, of course, applicable to hollow-core precast concrete panels. However, because the cores in hollow-core panels do not taper, the equivalent thickness can be calculated by dividing the net cross sectional area of the panel by its width.

PC 3102.1.1.3

The January 1934 report, "Tests of Fire Resistance and Strength of Walls of Concrete Masonry Units", by Carl A. Menzel, Portland Cement Association, 216 pg., showed that filling cores of concrete masonry units with loose lightweight aggregates increases the fire endurance to a duration significantly longer than that of solid masonry units of the same total thickness. It is reasonable to assume that the same relationship exists for walls made of hollow-core panels.

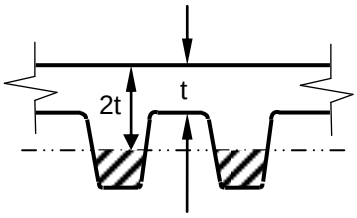
PC 3102.1.1.4

Some precast concrete wall panel sections, e. g., certain single-tee units, have tapered surfaces so the thickness varies, as shown in the figure below. In fire tests it has been customary to monitor the unexposed surface temperature at the location shown below.

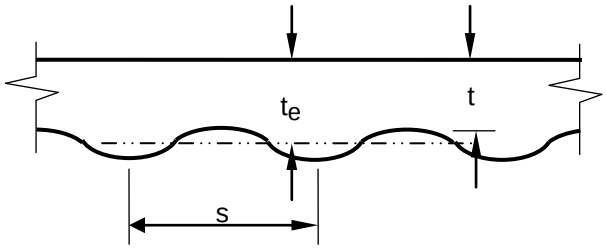


PC 3102.1.1.5

The portion of a ribbed panel that can be used in calculating equivalent thickness, t_e, is shown below. Note that the procedure outlined gives no credit for stems of double tees or of similar ribbed panels and clearly indicates that the minimum thickness must be used for such sections.



Neglect Shaded Areas in Calculation of Equivalent Thickness



PC 3102.1.2.1

The graphs in Figure 3102.1A were derived from a report, "Fire Endurance of Two-Course Floors and Roofs", ACI Journal, February 1969.

PC 3102.1.2.2

Equation 3102.1 was developed by the U.S. National Bureau of Standards in the early 1940's and first appeared in Appendix B of "Fire Resistance Classifications", Building Materials and Structures, Report BMS 92, National Bureau of Standards, 1942. Verification of the accuracy of the equation is given in "Fire Endurance of Two-Course Floors and Roofs", by Abrams and Gustaferro, Journal of the American Concrete Institute, February 1969.

Equation 3102.1 can be restated:

$$R^{0.59} = R_1^{0.59} + R_2^{0.59} + \ldots R_n^{0.59}$$

This form of the equation is useful in determining whether or not an assembly qualifies for a particular classification, when used in conjunction with the following tabulation.

R, minutes	$R^{0.59}$
60	11.20
120	16.85
180	21.41
240	25.37

PC 3102.1.2.3

A fire test was conducted of a panel that consisted of a 2-inch base slab of carbonate aggregate concrete, a l-inch layer of cellular polystyrene insulation, and a 2-inch face slab of carbonate aggregate concrete. The resulting fire endurance was 2 hr 00 min. From Equation 3102.1 the contribution of the l-inch layer of foam polystyrene was calculated to be 5 minutes.

It is likely that the comparable R value for a l-inch layer of foam polyurethane would be somewhat greater than that for a l-inch layer of foam polystyrene, but test values are not available. The above value for polystyrene is probably conservative for foam polyurethane.

Example:

A sandwich wall panel consists of two 2 1/2-inch wythes of normal weight concrete with a 2-inch layer of foam polystyrene in between. Does the panel qualify for a 3-hour fire resistance rating?

Solution: From Table 3102.1B the value of $R_n^{0.59}$ for a 2 1/2-inch wythe of carbonate aggregate concrete is higher than for siliceous aggregate concrete, but because the type of concrete was not given, the value for siliceous should be used. From 3102.1.2.3 the value of R_n for 1 inch or more of foam plastic is 5 minutes, so the value for $R_n^{0.59}$ is 2.5.

$$R^{0.59} = 8.1 + 2.5 + 8.\ 1 = 18.7$$

From the above table $R^{0.59}$ for 3 hours (180 min.) is 21.41;

$18.7 < 21.41$ thus the wall does not qualify for a 3-hour rating.

PC 3102.1.3

Figure 3102.1B was derived from data in a report, "Fire Tests of Joints Between Precast Concrete Wall Units: Effect of Various Joint Treatments", PCI Journal, September - October 1975.

Example

Determine the thickness of ceramic fiber blanket needed for a 2-hour fire resistance rating for joints between 5-inch thick precast concrete wall panels made of siliceous aggregate concrete if the maximum joint width is 3/4 inch.

Solution: Figure 3102.1B gives thicknesses of ceramic fiber blanket for 5-inch panels for 2-hour ratings of 0.7 inch for a 3/8-inch wide joint and 2.1 inch for a 1 inch wide joint. By direct interpolation for a 3/4-inch wide joint, the required thickness is 1.55 inches.

PC 3102.1.4

The information contained in this section is based on “Fire Endurance Tests on Unit Masonry Walls with Gypsum Wallboard" (NRCC 13901) by L.W. Allen, W.W. Stanzak and M. Galbreath of the Division of Building Research, National Research Council of Canada, and “The Supplement to the National Building Code of Canada 1980" (NRCC 17724) issued by the Associate Committee on the National Building Code, National Research Council of Canada.

3102.1.4.1 The fire resistance of concrete walls is generally determined by temperature rise on the unexposed surface, i.e., the "heat transmission" end point (see PC-3102.1.1.1). The time required to reach the heat transmission end point (fire resistance rating) is primarily dependent upon the thickness of the concrete and the type of aggregate used to make the concrete. When additional finishes are applied to the non-fire-exposed side of the wall, the time required to reach the heat transmission end point is delayed and the fire resistance rating of the wall is thus increased. The increase in rating contributed by the finish can be determined by considering the finish as adding to the thickness of concrete. However, since the finish material and concrete may have different insulating properties, the actual thickness of finish may need to be corrected to be compatible with the type of aggregate used in the concrete. The correction is made by multiplying the actual finish thickness by the factor determined from Table 3102.1C, and then adding the corrected thickness to the thickness of concrete. This equivalent thickness is used to determine the fire resistance rating from Table 3102.1A, Figure 3102.1A, or Table 3102.1B.

3102.1.4.2 When finishes are added to the fire-exposed side of a concrete wall, the finish's contribution to the total fire resistance rating is based primarily upon its ability to remain in place, thus affording protection to the concrete wall. Table 3102.1D lists the times which have been assigned to finishes on the fire-exposed side of the wall. These "time assigned" values are based upon actual fire tests. The "time assigned" values are added to the fire resistance rating of the wall alone, or to the rating determined for the wall and any finish on the non-fire-exposed side.

3102.1.4.3 Except for exterior walls having more than 5 ft of horizontal separation, Table 600, Note j of the Code requires that walls be rated for exposure to fire from both sides. Therefore, two calculations must be performed assuming each side to be the fire-exposed side. Two calculations are not necessary for exterior walls with more than 5 ft of horizontal separation, or for other walls which are symmetrical (i.e., walls having the same type and thickness of finish on each side). The calculated fire resistance rating must not exceed the lower of the two ratings determined assuming each side to be the fire-exposed side.

3102.1.4.4 Where gypsum wallboard or plaster finishes are applied to a concrete wall, the calculated fire resistance rating for the concrete alone should not be less than one-half the required fire resistance rating. This limitation is necessary since application of additional finishes serves to delay the heat transmission end point and do not add significantly to the load carrying capability of the wall.

EXAMPLE: An exterior bearing wall of a building of Type V construction with 4 ft or horizontal separation is required to have a 2-hour fire resistance rating. The wall will be cast-in-place with siliceous aggregate concrete. It will be finished on the exterior with 5/8 inch of stucco (portland cement-sand plaster) applied directly to the concrete. The interior will be finished with a 1/2-inch thickness of gypsum wallboard applied to steel furring members. What is the minimum thickness of concrete required?

First calculation: Assume the interior to be the fire exposed side.

l. From Table 3102.1D the 1/2-inch gypsum wallboard has a “time assigned" of 15 minutes, therefore the fire resistance rating that must be developed by the concrete and stucco on the exterior must not be less than 1 3/4 hours (2 hours minus 15 minutes).
2. From Table 3102.1B the multiplying factor for portland cement-sand plaster and siliceous aggregate concrete is 1.00 therefore the actual thickness of stucco can be added to the thickness of concrete for use in Table 3102.1A.
3. Since Table 3102.1A does not have required thicknesses for 1 3/4 hours, direct interpolation between the values for 1 1/2 and 2 hours is acceptable. The interpolation results in a required thickness of 4.65 inches of concrete and stucco. Since the stucco is 5/8 inch thick, the concrete must be at least 4.02 inches (4.65-0.63).

Second Calculation: Assume the exterior to be the fire-exposed side.

l. From Table 3102.1C the multiplying factor for gypsum wallboard and siliceous aggregate concrete is 1.25, therefore the corrected thickness for 1/2 inch of gypsum wallboard is 0.63 inch (1.25 x 0.5).
2. Footnote No. 1 to Table 3102.1D allows 5/8-inch of stucco applied directly to the concrete to be added to the actual thickness of concrete rather than establishing a "time assigned" value.
3. Table 3102.1A requires 5.0 inches of siliceous aggregate concrete for a 2-hour fire resistance rating. Therefore, the actual thickness of concrete required is 3.74 inches (5.00- 0.63 - 0.63).
4. Since the thickness of concrete required when assuming the interior side to be the fire-exposed side is greater (i.e., 4.02 inches), this is the minimum concrete thickness allowed to achieve a 2-hour fire resistance rating.

5. Section 3102.1.4.5 requires that the concrete alone provide not less than one-half the total required rating. Thus, the concrete must provide at least a 1-hour rating. From Table 3102.1A it can be seen that only 3.5 inches of siliceous aggregate concrete is required for one hour, whereas 4.02 inches will be provided.

For a similar example problem, see 3103.1.5.

PC 3102.2

The fire test criteria for temperature rise of the unexposed surface and the ability to resist superimposed loads (heat transmission and structural criteria, respectively) must both be considered in determining the fire resistance of floors and roofs. 3102.2 deals with heat transmission, and 3102.3 deals with structural criteria.

PC 3102.2.1.1

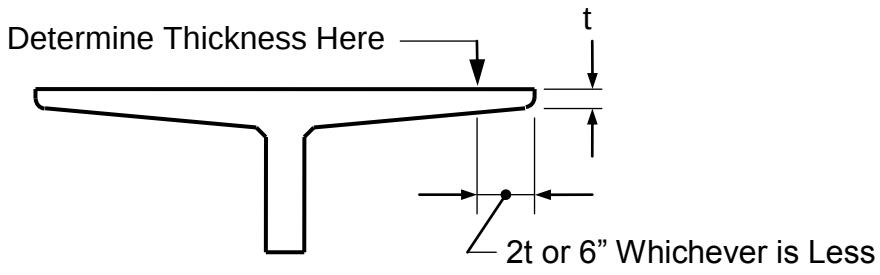
The criterion limiting the average temperature rise to $250^{O}F$ and the maximum rise at one point to 325° is often referred to as the "heat transmission end point". For solid concrete slabs the heat transmission end point is mainly a function of slab thickness and aggregate type. Other factors that affect beat transmission to a lesser degree are moisture content of the concrete, maximum aggregate size, mortar content, and air content. Items that have very little effect on heat transmission are cement content, strength, type, amount, and location of reinforcement, provided these items are within the normal range of usage. The values in Table 3102.2 apply to concrete slabs reinforced with bars or welded wire fabric as well as to prestressed slabs.

PC 3102.2.1.2

The method for determining "equivalent thickness" of masonry units was developed because the cores in masonry units taper. The method is, of course, applicable to hollow-core precast concrete panels. However, because the cores in hollow-core panels do not taper, the equivalent thickness can be calculated by dividing the net cross sectional area of the panel by its width.

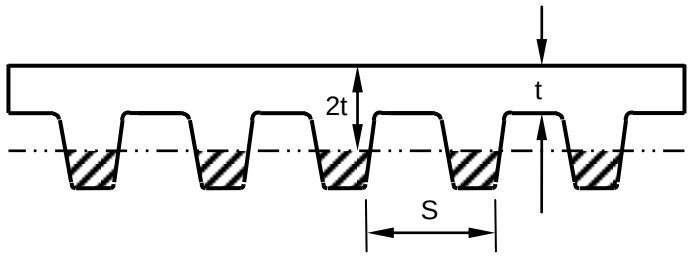
PC 3102.2.1.3

Some precast concrete wall panel sections, e.g., certain single-tee units, have tapered surfaces so the thickness varies, as shown in the figure below. In fire tests it has been customary to monitor the unexposed surface temperature at the location shown in PC 3102.1.1.4.



PC 3102.2.1.4

The portion of a ribbed slab that can be used in calculating equivalent thickness, t_e, is shown below. Note that the procedure gives no credit for joists in one-way or two-way joisted floors or in double tees. For such section, the minimum thickness of the deck slab must be used.



Example

Determine the fire resistance rating of the floor section shown if the units were made of siliceous aggregate concrete.

(a) $t_e = \frac{[\ 4\ (12)\ ] + [((5+7)\ /\ 2)\ 1\ .6]}{12} = \frac{48+9.6}{12} = 4.8$ inches

(b) $t = t + ((4t / s) - 1)\ (t_e - t)$

$t = 4 + [4(4) / 12) - 1]\ (4.8 - 4.0) = 4.26$ inches

(c) From Table 3102.2 the fire resistance rating is about l hour 25 minutes.

PC 3102.2.2

The information in this section is based on a report, "Fire Endurance of Two-Course Floors and Roofs", ACI Journal, February 1969.

PC 3102.2.3

Based on data developed by Underwriters Laboratories where no concrete topping is used over precast concrete floors, joints must be grouted, but if a concrete topping at least l -inch thick is used, the joints need not be grouted.

PC 3102.3

ASTM E 119 differentiates between restrained and unrestrained floors, roof, or beam fire endurance classifications. "Restraint" in this case means the restriction of thermal expansion imposed by a restraining frame during a fire test. Table 3l02.3C, which is taken from Appendix A4 of ASTM E 119, gives guidelines for determining whether or not floors, roofs, or beams in buildings can be considered to be restrained.

In addition ASTM E 119 gives different structural criteria for restrained and unrestrained assemblies. For unrestrained concrete floors, roofs or beams tested in a restrained condition, the fire test end point occurs when the average temperature of the tensile reinforcement reaches 1100^{O} F for hot-rolled reinforcing bars or 800^{O} F for cold-drawn prestressing steel.

For restrained beams spaced more than 4 feet on centers (primary beams), the temperatures noted above must not be exceeded during the first half of the classification period. For example, if a restrained beam withstands an ASTM E 119 fire test for 4 hours, but the average temperature of the tensile reinforcement exceeds the limiting values in l hour, the restrained beam rating will be limited to 2 hours. The temperature limits do not apply to restrained slabs or beams spaced 4 feet or less on centers.

PC 3102.3.1

The temperature of the tensile reinforcement depends on the thickness of cover and aggregate type. For unrestrained slabs, the values shown in Table 3l02.3A and 3102.3B are the cover thicknesses needed to keep the tensile reinforcement below 1100^{O} F and 800^{O} F, respectively. For restrained slabs, the temperature of the tensile reinforcement is not critical and thus, a minimum cover of 3/4 inch is specified. The values for unrestrained slabs were derived from tests reported in PCA Research Department Bulletin 223, "Fire Endurance of Concrete Slabs as Influenced by Thickness, Aggregate Type and Moisture".

PC 3102.3.2

The temperature of reinforcement in concrete beams depends on beam width and cover thickness. For temperatures above about 1000^{O} F, the effect of aggregate type is minimal (see PCA Research Department Bulletin 213), but for lower temperatures, differences in aggregate types are more pronounced.

For reinforced concrete beams, the critical steel temperature is 1100^{O} F, so the effect of aggregate type is minimal (see above). For prestressed concrete, the comparable temperature is 800^{O} F so aggregate type must be considered. The data in Tables 3102.3D and 3102.3E were derived from fire tests of a series of beam specimens which ranged in width between 2 and 24 inches. Other variables in the series included aggregate type and amount of reinforcement. Tests were conducted at the Portland Cement Association and a report "Temperature Distribution in Concrete Beams Subjected to Fire", by T.D. Lin and M.S. Abrams, is in preparation. Results of fire tests of beams conducted at Underwriters Laboratories, Inc. were also analyzed. Charts showing the resulting data graphically are shown as Figure A4 in the PCI manual, "Design for Fire Resistance of Precast Prestressed Concrete".

PC 3102.4

Most U.S. code provisions for reinforced concrete columns are based on two reports, "Fire Tests of Building Columns", Associated Factory Mutual Insurance Companies, 1921, and "Fire Resistance of Concrete Columns" by Hull and Ingberg, Technological Papers of the Bureau of Standards No. 271 , February 24, 1925. Sizes of columns tested were 12, 16 and 18 inches. Nearly all of the columns withstood 4 hour fire tests conducted essentially in accordance with ASTM E 119. Most of the tests were stopped after 4 hours but some were continued to 8 hours. The shortest duration was 3 hours. At the time of the tests, few if any concrete columns were smaller than 12 inches, but smaller columns have been in use for many years since then. Fire tests conducted in Europe on smaller columns indicate that fire endurance is greater for larger columns.

PC 3102.4.1

Table 3102.4 reflects the information in the reports cited above and in reports: “Investigations on Building Fires: Part VI; Fire Resistance of Reinforced Concrete Columns", National Building Studies, Research Paper No. 18, 1953, Her Majesty's Stationary Office, London, England.

Fire tests of loaded concrete columns currently underway (not yet reported) at the National Research Council of Canada Laboratories indicate that the data in Table 3102.4 are reasonable. It is likely that minor changes in the tabulated values will be made after the tests series have been completed.

PC 3102.4.2

Cover thickness values are essentially the same as those in Appendix B of the 1979 Standard Building Code.

PC 3102.4.3

Values were determined by the procedure given in "Fire Endurance of Concrete Protected Columns", by T.T. Lie and T.Z. Harmathy, ACI Journal, Proceedings, Vol. 71, No. 2, 1974.

PC 3103.1.1

It has been accepted practice to determine the fire resistance rating of concrete masonry walls based on the type of coarse aggregate used to manufacture the masonry units and the "equivalent thickness" of solid material in the wall. Equivalent thicknesses shown in Table 3103.1 have been developed and refined through actual fire testing which has been carried out over the past several decades.

PC 3103.1.2 and PC 3103.1.3

The information contained in this section is based on "Fire Endurance Tests on Unit Masonry Walls with Gypsum Wallboard" (NRCC 13901) by L.W. Allen, W.W. Stanzak and M. Galbreath of the Division of Building Research, National Research Council of Canada, and "The Supplement to the National Building Code of Canada 1980" (NRCC 17724) issued by the Associate Committee on the National Building Code, National Research Council of Canada.

PC 3103.1.2

The fire resistance of concrete masonry walls is generally determined by temperature rise on the unexposed surface, i.e., the "heat transmission" end point. The time required to reach the heat transmission end point (fire resistance rating) is primarily dependent upon the equivalent thickness of the masonry and the type of aggregate used to make the concrete. When additional finishes are applied to the non-fire-exposed side of the wall, the time required to reach the heat transmission end point is delayed, thus the fire resistance rating of the wall is increased. The increase in rating contributed by the finish can be determined by considering the finish as adding to the equivalent thickness of masonry. However, since the finish material and masonry may have different insulating properties, the actual thickness of finish may need to first be corrected to be compatible with the type of aggregate used in the concrete. The correction is made by multiplying the actual finish thickness by the factor determined from Table 3102.1C, and then adding the corrected thickness to the equivalent thickness of masonry. This combined equivalent thickness is used to determine the fire resistance rating from Table 3103.1.

PC 3103.1.3

When finishes are added to the fire-exposed side of a concrete masonry wall, the finish's contribution to the total fire resistance rating is based primarily upon its ability to remain in place, thus affording protection to the masonry wall. Table 3102.1D lists the times which have been assigned to finishes on the fire-exposed side of the wall. These "time assigned" values are based upon actual fire tests. The "time assigned "values are added to the fire resistance rating of the wall alone, or to the rating determined for the wall and any finish on the non-fire-exposed side.

PC 3103.1.4

Except for exterior walls having more than 5 ft of horizontal separation, Table 600, Note j of the Code requires that walls be rated for exposure to fire from both sides. Therefore, two calculations must be performed assuming each side to be the fire-exposed side. Two calculations are not necessary for exterior walls with more than 5 ft of horizontal separation, or for other walls which are symmetrical (i.e., walls having the same type and thickness of finish on each side). The calculated fire resistance rating must not exceed the lower of the two ratings determined assuming each side to be the fire-exposed side.

PC 3103.1.5

Where gypsum wallboard or plaster finishes are applied to a concrete masonry wall, the calculated fire-resistance rating for the concrete alone should be not less than one-half the required fire resistance rating. This limitation is necessary since application of additional finishes serves to delay the heat transmission end point and does not add significantly to the load-carrying capability of the wall.

EXAMPLE: A fire wall required to have a 4-hour fire resistance rating will be constructed with concrete masonry units of expanded shale aggregate. The wall will be finished on each side with a layer of 1/2-inch gypsum wallboard. What is the minimum equivalent thickness of concrete masonry required?

Since the wall has the same type and thickness of finish on each side, only one calculation is required.

1. The 1/2 inch gypsum wallboard on the fire-exposed side has a "time assigned" of 15 minutes per Table 3102.1D.
2. Therefore, the fire resistance required to be provided by the masonry and gypsum wallboard on the non-fire-exposed side is 3 hours and 45 minutes (4 hours minus 15 minutes).
3. From Table 3103.1C the corrected thickness of gypsum wallboard on the non-fire-exposed side is 0.50 inches (1.00 x 1/2 inch).
4. From Table 3103.1 the minimum equivalent thickness of masonry, including the corrected thickness of gypsum wallboard, required for a rating of 3 hours and 45 minutes is 4.9 inches.
5. Therefore, the equivalent thickness of masonry required is 4.4 inches (4.9 minus 0.50).
6. From Table 3103.1 it can be determined that 4.4 inches of expanded shale aggregate concrete masonry will provide a fire resistance of 3 hours. Therefore, the requirement that the masonry alone provide at least one-half of the total required rating is satisfied.

For a similar example problem, see PC3102.1.4.4.

PC 3103.2

"Tests of Fire Resistance and Strength of Walls of Concrete Masonry Units," by Carl A Menzel, Portland Cement Association, January 1934, and other data have shown that filling the cores of concrete masonry units with loose lightweight aggregates increases the fire endurance to a duration significantly longer than that of solid masonry units of the same total thickness.

PC 3105.1.3

3105.1E sets forth procedures for determining the fire resistance of structural steel columns protected with spray-applied cementitious or mineral fiber fire protection materials. These procedures are based upon an empirical equation which includes two material-dependent constants. As a result, in order to apply this equation, the values of these two constants must be determined for specific fire protection materials. The purpose of this Appendix is to provide guidance for the determination of these constants so that the resulting equation will be reasonably accurate and yet slightly conservative over the range of column shapes for which test data is available.

Two different techniques are available for determining the two constants. The first requires a knowledge of the thermal conductivity and specific heat of the fire protection material at elevated temperatures. Data of this nature is both difficult and expensive to obtain with any reasonable degree of accuracy. As a result, this technique will probably not be widely used and, accordingly, it will not be described in this Appendix. The second technique involves the use of the equation given in 3105.1.3 as a means for interpolating between ASTM E 119 fire endurance test results on different structural steel columns. Since this technique will undoubtedly be the most widely used, it is described in detail in this Appendix. It is, however, important to recognize that a wide variety of both large and small scale tests can be used to accurately determine the required constants. As a result, this Appendix bas been developed as a guide rather than a specific set of requirements which must be strictly followed.

Equation

The equation given in 3105.1.3 for wide flange structural steel columns protected with spray-applied cementitious and mineral fiber fire protection materials is:

$$R = [C_1 \frac{W}{D} + C_2] h$$

Where R = fire resistance (minutes),
h = thickness of spray-applied fire protection (inches),
W = weight of the structural steel column (pounds per linear foot),
D = heated perimeter of the structural steel column (inches), and
C_1 and C_2 = material-dependent constants.

Inherent in this equation are two general assumptions. The first is that the ratio of fire endurance time to the thickness of fire protection material (R/h) is essentially constant for a given column (W/D) ratio. The second assumption is that the ratio of fire endurance time to the thickness of fire protection material (R/h) varies linearly as a function of the weight to heated perimeter ratio (W/D) of the protected steel column. These concepts are graphically illustrated in Figure 1. It has been found that both of these assumptions are reasonably accurate for lightweight (density less than 50 pcf) spray-applied materials.

If ASTM E 119 fire endurance test results are available for a specific fire protection material on two different structural steel column shapes, the constants C_1 and C_2 can be determined directly. As indicated in 3105.1.3, the resulting equation can then be used to determine the thickness of fire protection material required for any specified fire endurance rating when applied to structural steel columns with weight to heated perimeter ratios (W/D) between the largest and smallest column for which actual test results are available.

Required Fire Endurance Test Data

At least four ASTM E 119 fire endurance tests or, two ASTM E 119 fire endurance tests and six small scale tests (3 foot long specimens) shall be conducted. If the results of small scale tests are used, at least two of the test assemblies shall duplicate the ASTM E 119 test assemblies for the purpose of establishing correlation. Regardless of the combination of small and large scale tests which is selected, at least two shall be conducted on the largest and two on the smallest columns which establish the limits of applicability to the resulting equation. As illustrated in Figure 1, the constants C_1 and C_2 shall be determined on the basis of the lowest ratios of fire endurance time to fire protection thickness (R/h) for these columns.

In addition, the test data shall be evaluated with respect to the assumption that the ratio of fire endurance to fire protection thickness (R/h) is reasonably constant for a given column shape (W/D ratio). The tests conducted on columns of the same shape shall be designed so that the resulting fire endurance times are approximately 1 1/2 hours and 3 1/2 hours. In evaluating the R/h ratios resulting from tests on the same column shape, differences in the range of 10% are typical. Differences greater than 20% may, however, suggest that the equation given in 3105.1.3 is not applicable to the specific fire protection material under consideration and further examination of the test data is warranted.

PC 3105.2.1

3105.2.1 defines a general rule for the substitution of different steel beam and girder shapes in all fire resistant assemblies. In the past, the substitution of "larger" beams has been permitted based upon the thickness of web and flange elements. Extensive research at the Underwriters Laboratories has now proven that the heat transfer to a protected steel beam or girder is a direct function of the weight to heated perimeter ratio (W/D). As a result, beam substitutions should be based upon W/D ratios as defined in this section. The significance of the thickness of web and flange elements is inherently included in the determination of W/D ratios. Figure 3105.2 illustrates the procedure for determining heated perimeters (D) and Table 3105.2 gives W/D ratios for the most commonly used wide flange beam and girder shapes.

PC 3105.2.2

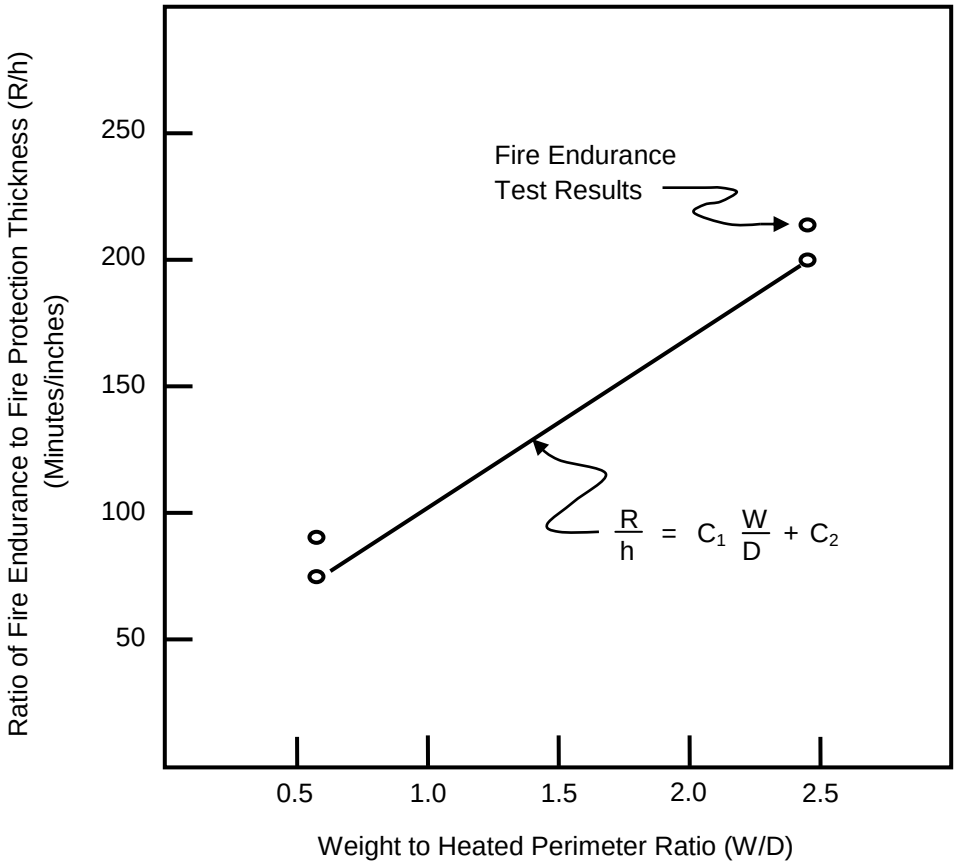
This section defines an equation for adjusting the thickness of spray-applied cementitious and mineral fiber materials as a function of weight to heated perimeter (W/D) ratios. The thickness of protection for larger beams can be reduced based upon W/D ratios. Smaller beams required an increase in the thickness of protection in order to maintain the fire resistance rating of the floor or roof assembly. This equation was developed by the Underwriters Laboratories and appropriate limitations have been included. The minimum W/D ratio of 0.37 will prevent the use of this equation for determining the fire resistance of very small shapes which have not been tested. The 3/8-inch minimum thickness of protection is a practical limit based upon the most commonly used spray-applied fire protection materials.

PC 3105.2.3

This section describes the application of Chapter 31 to structural steel trusses when each of the truss elements are individually protected with spray-applied materials. The thickness of protection is determined using the column equation specified in 3105.1.3. For trusses, the use of the column equation is more technically correct than the beam equation. In general, the column equation will require greater thicknesses of protection than the beam equation. Most truss elements can be exposed to fire on all four sides simultaneously. As a result, in general, the heated perimeter of truss elements should be determined in the same manner as for columns. An exception is, however, included for top chord elements which directly support floor or roof construction. The heated perimeter of such elements should be determined in the same manner as for beams and girders.

FIGURE 1

ILLUSTRATION OF THE PROCEDURE FOR DETERMINING THE MATERIAL DEPENDENT CONSTANTS FOR SPRAY-APPLIED CEMENTITIOUS AND MINERAL FIBER FIRE PROTECTION MATERIAL



PC 3106

The information contained in this section is based on "Fire Endurance of Light Framed and Miscellaneous Assemblies" by Murdock Galbreath, Technical Paper No. 222 of the Division of Building Research Council of Canada and "Fire Resistance Classifications of Building Construction", Report BMS 92, October 7, 1942, U. S. Department of Commerce, National Bureau of Standards. The fire resistance rating is equal to the sum of the time assigned to the membranes (Table 3106.2A), the time assigned to the framing members (Table 3106.2B), and the time assigned for additional contribution by other protective measures, such as insulation (Table 3106.2E). The membrane on the unexposed side is not included in the calculations. It is assumed that once the structural members fail, the entire assembly fails. The times assigned to the individual membranes are the individual contributions to the overall fire resistance rating of the complete assembly. The assigned time is not to be confused with the fire resistance rating of the membranes. Fire resistance rating takes into account the rise in temperature on the unexposed side of the membrane. Times which have been assigned to membranes on the fire exposed side of the assembly are based on their ability to remain in place during fire tests.

The fire resistance rating of wood framed assemblies is equal to the sum of the time assigned to the various components (membranes) on the fire exposed side and the structural members. The fire exposed side is generally assumed to be either side of an interior wall or partition or the interior side of an exterior wall with more than 5 ft separation from a property line or an assumed property line and some shaft walls.

EXAMPLES USING 3106

The following are examples of how to use 3106:

Example 1: Will a wall assembly having a layer of 15/ 32-inch plywood bonded with exterior glue covered with a layer of 5/8-inch gypsum wallboard attached to wood studs on the fire exposed side qualify as a 1-hour fire resistant wall assembly?

Table 3106.2A shows 15/ 32-inch plywood phenolic bonded with exterior glue to have a time of contribution of 10 minutes, and 5/8-inch gypsum wallboard has a time of contribution of 30 minutes. Table 3106.2B shows that a wood stud wall with the studs spaced at 16 inches on center contributes 20 minutes to the fire resistance rating of the assembly. 3106.2.2 allows the adding of the time contribution of the membranes to the time contributed by the framing (10 minutes for the 15/ 32-inch plywood + 30 minutes for the 5/8-inch gypsum board + 20 minutes for the wood stud framing = 60 minutes or 1-hour rating for the assembly).

If the wall is an interior wall, both sides of the wall would be required to be fire protected with at least 40 minutes of membrane covering from Table 3106.2A.

If the proposed wall is an exterior wall with more than 5 ft separation the fire exposed side is assumed to be the interior side which would require a total of 40 minutes of membrane coverings from Table 3106.2A. It should be noted that 3106.2.4 requires the exterior side to be protected in accordance with Table 3106.2C or any membrane that is assigned a time of at least 15 minutes as listed in Table 3106.2A.

It should also be noted that if the wall cavities between the studs had been filled with mineral fiber batts weighing not less than specified in Table 3106.2E that the 15/32-inch plywood membrane layer could be eliminated because the insulation adds 15 minutes of fire resistance as included in 3106.2.6 and Table 3106.2E. Thus adding the contribution times for the 5/ 8-inch gypsum board, the wood framing and the insulation (30 minutes + 20 minutes +15 minutes) the resultant rating for the wall would be 65 minutes and meet a 1-hour fire resistance rating.

Example 2: Would a floor-ceiling assembly using wood joists spaced at 16 inches on center and protected on the bottom side (ceiling side) with two layers of 1/2-inch Type X gypsum board and protected on the upper side (floor side) with a 15/32-inch plywood subfloor, a 3/8-inch panel type underlayment and carpet meet the requirements of a 1-hour fire resistant assembly?

Referring to 3106.2.2 and 3106.2.5, Table 3106.2A shows that the time contribution for each layer of 1/2-inch Type X gypsum wallboard is 25 minutes. The time of contribution for wood joists 16 inches on center is listed in Table 3106.2B is 10 minutes. Adding the two layers of gypsum board (2 x 25 minutes = 50 minutes) to the wood frame (10 minutes) a fire resistance rating of 60 minutes or 1 hour can be obtained. It should be noted that 3106.2.5 requires the upper membrane to be as specified in Table 3106.2D or any membrane that has a time of contribution of at least 15 minutes as listed in Table 3106.2A.

Had the above example been a roof-ceiling assembly, the upper membrane must be treated the same. If the proposed assembly is a ceiling with an attic above, 3106.2.5 notes the exception as found in 608.3 which allows the elimination of the upper membrane.

The fastening requirements for assemblies developed by 3106 should be in accordance with Table 1705.1 and 1002.6.

PC 3106.2.6

Mineral fiber insulation provides additional protection to wood studs by shielding the studs from exposure to the furnace and thus delaying the time of collapse. The use of reinforcement in the membrane exposed to fire also adds to the fire resistance by extending the time to failure. Special care must be taken to insure that all insulation materials used in conjunction with this method satisfy the weight criteria of Table P3106.2E.

APPENDIX Q

SEE NORTH CAROLINA STATE BUILDING CODE, VOLUME-IX, EXISTING BUILDINGS.

APPENDIX R
WEIGHTS QF BUILDING MATERIALS

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.

TABLE R1
DEAD LOAD IN POUNDS PER SQUARE FOOT

Component	Load	Component	Load
CEILING		Plywood (per 1/8-in)	0.4
Acoustical fiber tile	1	Rigid insulation, 1/2-inch	0.75
Gypsum board (per 1/8-in)	0.55	Skylight, metal frame, 3/8-in wire glass	8
Mechanical duct allowance	4	Slate, 3/16-in	7
Plaster on tile or concrete	5	Slate, 1/4-in	10
Plaster on wood lath	8	Waterproofing membranes:	
Suspended steel channel system	2	Bituminous, gravel covered	5.5
Suspended metal lath and cement plaster	15	Bituminous, smooth surface	1.5
Suspended metal lath and gypsum plaster	10	Liquid applied	1.0
Wood furring suspension system	2.5	Single-ply, sheet	0.7
		Wood sheathing (per inch)	3
COVERINGS, ROOF AND WALL		Wood shingles	3
Asbestos-cement shingles	4		
Asphalt shingles	2	FLOOR FILL	
Cement tile	16	Cinder concrete, per inch	9
Clay tile (for mortar add 10 lb.):		Lightweight concrete, per inch	8
Book tile, 2-in	12	Sand, per inch	8
Book tile, 3-in	20	Stone concrete, per inch	12
Ludowici	10		
Roman	12	FLOORS AND FLOOR FINISHES	
Spanish	19	Asphalt block (2-in), 1/2-in mortar	30
Composition:		Cement finish (1-in) on stone-concrete fill	32
Three-ply ready roofing	1	Ceramic or quarry tile (3/4-in) on 1/2-in mortar bed	16
Four-ply felt and gravel	5.5		
Five-ply felt and gravel	6	Ceramic or quarry tile (3/4-in) on 1-in mortar bed	23
Copper or tin	1		
Corrugated asbestos-cement roofing	4	Concrete fill finish (per inch)	12
Deck, metal, 20 gage	2.5	Hardwood flooring, 7/8-in	4
Deck, metal, 18 gage	3	Linoleum or asphalt tile, 1/4-in	1
Decking, 2-in wood (Douglas Fir)	5	Marble and mortar on stone-concrete fill	33
Decking, 3-in wood (Douglas Fir)	8	Slate (per inch)	15
Fiberboard, 1/2-in	0.75	Solid flat tile on 1-in mortar base	23
Gypsum sheathing, 1/2-in	2	Subflooring, 3/4-in	3
Insulation, roof boards (per inch):		Terrazzo (1 1/2-in) directly on slab	19
Cellular glass	0.7	Terrazzo (1-in) on stone-concrete fill	32
Fibrous glass	1.1	Terrazzo (1-inch), 2-in stone-concrete	32
Fiberboard	1.5	Wood block (3-in) on mastic, no fill	10
Perlite	0.8	Wood block (3-in) on 1/2-in mortar base	16
Polystyrene foam	0.2		
Urethane foam with skin	0.5		

TABLE R1 (Continued)
DEAD LOAD IN POUNDS PER SQUARE FOOT

Component	Load
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	
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

Component	Load
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

TABLE R2
DEAD LOADS IN POUNDS PER CUBIC FOOT

Component	Load	Component	Load
Bituminous Products:		Earth (submerged):	
Asphaltum	81	Clay	80
Graphite	135	Soil	70
Paraffin	56	River mud	90
Petroleum, crude	55	Sand or gravel	60
Petroleum, refined	50	Sand or gravel, and clay	65
Petroleum, benzine	46	Gravel, dry	104
Petroleum, gasoline	42	Gypsum, loose	70
Pitch	69	Gypsum wallboard	50
Tar	75	Ice	57.2
Brass	526	Iron	
Bronze	552	Cast	450
Cast-stone masonry (cement, stone, sand)	144	Wrought	480
Cement, portland, loose	90	Lead	710
Ceramic tile	150	Lime	
Charcoal	12	Hydrated, loose	32
Cinder fill	57	Hydrated, compacted	45
Cinders, dry, in bulk	45	Masonry, ashlar:	
Coal		Granite	165
Anthracite, piled	52	Limestone, crystalline	165
Bituminous, piled	47	Limestone, oolitic	135
Lignite, piled	47	Marble	173
Peat, dry, piled	23	Sandstone	144
Concrete plain:		Masonry, brick:	
Cinder	108	Hard (low absorption)	130
Expanded-slag aggregate	100	Medium (medium absorption)	115
Haydite (burned-clay aggregate)	90	Soft (high absorption)	100
Slag	132	Masonry, rubble mortar:	
Stone (including gravel)	144	Granite	153
Vermiculite and perlite aggregate, nonload-bearing	25-50	Limestone, crystalline	147
		Limestone, oolitic	138
Other light aggregate, load-bearing	70-105	Marble	156
Concrete, reinforced:		Sandstone	137
Cinder	111	Mortar, hardened:	
Slag	138	Cement	130
Stone (including gravel)	150	Lime	110
Copper	556	Particleboard	45
Cork, compressed	14.4	Plywood	36
Earth (not submerged):		Riprap (not submerged)	
Clay, dry	63	Limestone	83
Clay, damp	110	Sandstone	90
Clay and gravel, dry	100	Sand	
Silt, moist, loose	78	Clean and dry	90
Silt, moist, packed	96	River, dry	106
Silt, flowing	108		
Sand and gravel, dry, loose	100		
Sand and gravel, dry packed	110		
Sand and gravel, wet	120		

TABLE R2 (Continued)
DEAD LOADS IN POUNDS PER CUBIC FOOT

Component	Load	Component	Load
Slag		Stone, quarried, piled:	
Bank	70	Basalt, granite, gneiss	96
Bank screenings	108	Limestone, marble, quartz	95
Machine	96	Sandstone	82
Sand	52	Shale	92
Slate	172	Greenstone, hornblende	107
Steel	489	Terra cotta, architectural:	
		Voids filled	120
		Voids unfilled	72
		Tin	459

APPENDIX S
INSTALLATION OF ROOF COVERINGS

(Formerly SBCCI Standard for the Installation of Roof Coverings.)

S100 SCOPE

The requirements set forth in this Standard 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 manufacturers recommendations.

It should also be noted that this standard does not deal with the fire ratings nor the minimum design loads of roofing materials. Those requirements, with which all roofing systems must comply, are covered by the Standard Building Code.

S101 GENERAL

S101.1 Covering

S101.1.1 Roof coverings shall provide weather protection for the building at the roof.

S101.1.2 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.

S101.2 Insulation

S101.2.1 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.

S101.2.2 A minimum of 1/2-inch insulation shall be installed over metal decking when a roof covering is installed subject to the manufacturer's flute span table.

S101.3 Fasteners

S101.3.1 Nails, clips or similar fastening devices shall be hot dipped galvanized, stainless steel, non-ferrous metal, or other suitable corrosion resistant material.

S101.3.2 Fasteners for wood shingles shall be rust resistant and of hot dipped zinc coated, aluminum or stainless steel and shall be long enough to penetrate into the sheathing at least 1/2 inch.

S101.3.3 The composition flashing (base flashing) should be fastened either with 1-inch solid cap-head nails or with nails driven through tin tags. The nails should be spaced approximately 8 inches on center.

S101.4 Replacement

Not more than 25% of the roof covering of a building shall be replaced in any period of 12 months unless the entire roof covering is made to conform with the requirements of this Standard, as well as Chapters 7 and 12 of the Standard Building Code.

S101.5 Composition Flashing

Composition base flashing should extend a minimum of 8 inches nominal above the roof line. When using such flashing, wood or fiber cants must be provided at any 90° angle created by rectangular curbs or projections. Wood nailers should be provided on all prefabricated curbs.

S101.6 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.

S102 ALTERNATE MATERIALS AND ALTERNATE METHODS OF CONSTRUCTION

The provisions of this chapter are not intended to prevent the use of any material or method of construction not specifically prescribed by this Standard, provided any such alternate has been approved and its use authorized by the Building Official. The Building Official shall approve any such alternate, provided he finds that the proposed design is satisfactory and complies with the provisions of Chapter 12 of the Standard Building Code, and that the material, method of application or work offered is for the purpose intended and at least the equivalent of that prescribed in this chapter in quality, strength, effectiveness, durability and safety. The Building Official shall require sufficient evidence or proof be submitted to substantiate all claims that may be made regarding its use. If in the opinion of the Building Official, the evidence and proof are not sufficient to justify approval, the applicant may refer the entire matter to the Board of Adjustments and Appeals.

S103 ASPHALT SHINGLES

S103.1 General

S103.1.1 The installation of asphalt shingles used as a roof covering shall comply with the requirements of this section.

S103.1.2 Shingle application shall be as specified in the manufacturer's published application instructions.

S103.2 Application

S103.2.1 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 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 wide sheets of underlayment overlapping successive sheets 19 inches and fastened sufficiently to hold in place. Where January mean temperatures are 30°F or less, coat full width of the 19-inch laps from the eave to a point 24 inches from the inside of the exterior wall line of the building with asphalt based roofing cement.

S103.2.2 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, fastened only as necessary to hold in place.

S103.2.3 Asphalt shingles shall be fastened and cemented in valleys and rakes. Eaves must be cemented or the metal eave drip shall be installed under the felt.

S103.2.4 Fasteners shall penetrate through the roofing material and at least 3/4 inch into or through the roof sheathing.

S103.2.5 When slopes exceed 20:12, special methods of fastening are required. Follow manufacturer's printed instructions.

S104 MINERAL FIBER SHINGLES

S104.1 For a minimum slope of 3:12 up to 4 1/2: 12, underlay 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 process cement solid mopped.

S104.2 For slopes of 4 l/2:12 and greater, underlay shall be one layer of type 30 asphalt saturated felt.

S104.3 Application shall be in accordance with the recommendations of the manufacturer.

S105 Combined with S107

S106 SLATE SHINGLES

S106.1 Slate shingles shall only be used on slopes of 4:12 or greater.

S106.2 Underlay shall be one layer of type 30 asphalt saturated felt.

S106.3 Maximum exposure shall be calculated using the formula:

E= (L- H)/2
where E is the shingle length, and
H is the shingle headlap
(e.g. for an 18-inch shingle with a 3-inch headlap (18-3)/2 = 7 1/2-inch exposure).

S106.4 Minimum headlap of the shingles shall be as shown below:

SLOPE	MINIMUM HEADLAP
4:12to8:12	4 inches (102mm)
8:12 to 20:12	3 inches (76mm)
20:12 and greater	2 inches (51mm)

S107 CONCRETE AND CLAY ROOF TILE

S107.1 General

Each roof tile shall have some type of permanent manufacturer's identification mark.

S107.2 Tiles Using Cemented Application

S107.2.1 Underlay for roof slope from 2:12 and including 6:12 shall be a minimum of one layer of type 30 asphalt saturated felt applied with 2 inch head lap and 6-inch side lap. Type 30 asphalt saturated felt shall be fastened to the roof deck by roofing nails driven through tin tags or with capped nails in staggered double rows 24 inches on center along center of sheet, 12 inches on center along head laps and a minimum of four nails along side laps. Then apply one layer of mineral surface or slate surface roll roofing, having a minimum weight of 74 lb/100 sq ft with 2-inch head lap and 6-inch side lap to the type 30 asphalt saturated felt by mopping hot asphalt adhering a minimum of two thirds of the mineral surface or slate surface sheet backnailing 12 inches on center using roofing nails driven through tin tags or with capped nails.

S107.2.2 On roof slopes greater than 6:12, type 30 asphalt saturated felt shall be installed as described above and one layer of mineral surface or slate surface roll roofing having a minimum weight of 74 lb/100 sq ft applied with a 2-inch head lap and 6-inch side lap, back nailed a maximum of 12 inches on center and all laps sealed with hot asphalt. Plastic cement or other cold applied roof cements may be substituted for asphalt.

S107.2.3 On slopes greater than 6:12, tile shall be installed as described above and shall be fastened to the roof deck with hot-dipped galvanized nails not less than 1 1/2 inches long.

S107.2.4 All tile applied to roofs having a slope up to and including 6:12 shall be set on an island of mortar. Mortar shall be in accordance with ASTM C270, Type M.

S107.2.5 Clay tile to be set in mortar shall be wetted prior to setting in mortar bed.

S107.2.6 Mortar shall be sandwiched along sides of all two-piece barrel tile. The head lap of both shingle and barrel tile shall not be less than 2 inches and 1 1/2 inches on side for barrel tile.

S107.2.7 The tile's written manufacturer's application specifications shall be available and shall include but not be limited to: the tile's placement and spacing; type, amount, and placement of the mortar; and any special fastening requirements necessary to meet the requirements of Chapter 12 of the Standard Building Code.

S107.2.8 Roof tile shall comply with the physical test requirements as follows:

1. Portland cement concrete used for roof tile shall have a minimum strength of 2000 psi in 28 days.
2. Except for an overlapping lip, tile shall have a minimum thickness of not less than 1/2 inch for barrel tile, and 3/8 inch for shingle tile.
3. Barrel tile shall be test loaded by being supported on sand 2 inches deep in a sandbox 4 inches wider than the width of the tile. Shingle tile shall be test cloth tubes parallel to the edge of the tile. Sand tubes shall be 2-inch diameter loosely filled with dry 40/60 silicon and shall be placed under the edge of tile with a center-to-center distance equal to the width of the tile. A test load shall be applied on a 3-inch square steel plate being on a sandbag set at the center of the tile. The breaking load of any individual shingle tile shall not be less than 200 lb and the average breaking load of five shingle shall be not less than 250 lb and the average breaking load of five barrel shall be not less than 300 lb.
4. Absorption: Roof tiles shall absorb not more than 12% of the dry weight on the tile during a 24 hour immersion test.

S107.3 Tile Using Mechanical Fasteners

S107.3.1 A minimum slope of 4:12 may be used when underlay is a minimum of one layer of type 43 asphalt coated felt or equivalent nailed to roof deck.

S107.3.2 Tiles shall be fastened in accordance with the manufacturer's instructions and S101.3. Such written instructions shall be available and shall contain but not be limited to: flashings, underlayment, slope requirements, and fasteners and their placement necessary to comply with requirements of Chapter 12 of the Standard Building Code.

S107.3.3 Tile shall comply with the physical test requirements listed in S107.2.9.

S108 WOOD SHINGLES AND SHAKES

S108.1 General

Wood shingles and shakes used as roof covering shall comply with the requirements of this section and shall be of one of the following materials:

1. Wood shingles and shakes of naturally durable wood, these shingles and shakes must be No. 1, 2, or 3 grades manufactured in accordance with the grading rules of the Red Cedar Shingle and Handsplit Shake Bureau.
2. Preservative treated taper sawn shakes of Southern Yellow Pine. These shakes must be No. 1 grade manufactured in accordance with the grading rules of the Forest Products Laboratory of the Texas Forest Service. These shakes must be preservative treated in accordance with AWPA Standard C2.

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

S108.2 Sheathing

All wood shingles and shakes shall be applied to roofs with solid sheathing or spaced sheathing boards. Spaced sheathing boards shall be not less than 1x4, spaced not more than 4 inches clear between boards for shingles and for all 18-inch shakes. Sheathing boards for all 24-inch shakes shall be not less than 1x6, spaced not more than 4 1/2 inches clear between boards.

S108.3 Shingles

S108.3.1 Shingles shall be laid with a side lap of not less than 1 1/2 inches 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. Each wood shingle shall be fastened to the sheathing with two corrosion-resistant nails (hot dipped zinc coated, aluminum or stainless steel).

S108.3.2 Weather exposure for wood shingles shall not exceed those set forth in Table 108.1. Minimum roof slope shall be 3:12. Hip and ridge weather exposure shall not exceed those permitted for the field of the roof.

TABLE S108.1
WEATHER EXPOSURE AND ROOF PITCH

			Exposure (in)	
Roofing Material	**Length (in)**	**Grade**	**3:13 pitch (minimum) to <4:12**	**4:12 pitch (minimum) and steeper**
Shingles 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	Not Permitted	10[1]
Preservative treated taper sawn shakes	18	No. 1	Not Permitted	7 1/2
	24	No. 1	Not Permitted	10
	18	No. 2	Not Permitted	5 1/2
	24	No. 2	Not Permitted	7 1/2

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.

S108.4 Shakes

S108.4.1 All shakes shall be laid with a side lap of not less than 1 1/2 inches between joints in adjacent courses. Spacing between shakes in the same course shall be approximately 1/2 inch for shakes of naturally durable wood and shall be 1/4 to 3/8 inch for preservative treated taper sawn shakes. Each wood shake shall be fastened to the sheathing with two corrosion-resistant nails (hot dipped zinc coated, aluminum or stainless steel) with a minimum penetration into the sheathing of 1/2 inch. For preservative treated taper sawn shakes 2 inches long, 16-gauge galvanized staples with 7/16 - 1/2 inch wide crown may be used rather than nails. In all 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 wood shakes or wood shingles. 15-inch or 18-inch shakes may be used for the final course at the ridge.

S108.4.2 Shakes of naturally durable wood shall be laid with 18-inch wide strips of minimum type 15 asphalt saturated felt. Preservative treated taper sawn shakes shall be laid with 18-inch wide strips of minimum type 30 asphalt saturated felt. Felt for all shakes shall be non-perforated 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. When layers of preservative treated taper sawn shakes are used throughout the field of the roof, the felt may be omitted.

S108.4.3 Weather exposure for all shakes shall not exceed those set forth in Table S108.1. Hip and ridge weather exposures shall not exceed those permitted for the field of the roof.

S108.5 Fire Retardant Shingles And Shakes

S108.5.1 Fire retardant treated shakes and shingles of naturally durable wood, when impregnated with chemicals by the full-cel1 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.

S108.5.2 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.

S108.5.3 The following installation practices shall be deemed to provide Class B and Class C roofs:

1. Class B - Class B fire retardant treated wood shakes with an asphalt felt interlayment consisting of 18-inch wide strips of Type 30 saturated organic felt over 7/16-inch minimum type 2-M-W particleboard or 15/32-inch plywood.
2. Class C - Class C fire retardant treated wood shingles or shakes. Shakes are to be provided with an interlayment of one layer of 18-inches wide type 15 asphalt saturated organic felt between shake courses.

S109 BUILT UP ROOFS

S109.1 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 the fire limits.

S109.2 Surface Preparation

S109.2.1 Before starting the application of all roofing membranes, all roof decks shall be broom cleaned, parapet walls, vertical walls, penthouses and similar structures above the roof level shall have been completed, and all flat roof decks shall have been provided with a cant strip where the roof deck joins a vertical surface. Cant strips shall be nailable material and shall extend at least 3 1/2 inches 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.

S109.2.2 Gypsum roof decks shall be surface dry before starting application of roofing. In no case should the application be started more than 24 hours after the gypsum pouring. All eave fascias shall be completed by completion of final roofing.

S109.3 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 on center with 2-inch minimum side laps and stagger nailed at 18-inch centers along lines 12 inches from each edge. On non-nailable decks a minimum of 1/2-inch 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.

S109.4 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.

S109.5 Fasteners

Nails in nominal 1-inch lumber shall not be smaller than 12 gage wire nails with heads not less than 3/8-inch diameter driven through tin caps, and not less than 1 inch long. Cap-head nails meeting the above minimum size requirements are also acceptable. Roof decks of cement fiber, poured gypsum, light weight insulating concrete or similar nailable surfaces require fasteners specifically designed for use on the type of deck involved.

S109.6 Surface Treatment

Flood coatings, protective/reflective coatings, aggregates and other surface treatments shall be installed in accordance with manufacturer's requirement. 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. Aggregate shall comply with ASTM D 1863 or local codes.

S109.7 Slopes and Materials

S109.7.1 For roof slopes zero to and including 1/4:12, coal tar pitch (ASTM D 450, Type I) or coal tar bitumen (ASTM D 450, Type III) and No. 15 coal tar saturated felt or asphalt/coal tar impregnated fiberglass felt shall be used.

S109.7.2 For roof slopes zero to and including 1/2:12, dead level asphalt (ASTM D 312, Type I) and No. 15 asphalt saturated felt, No. 15 asbestos felt, or asphalt impregnated glass fiber mat shall be used.

S109.7.3 For roof slopes 1/2:12 up to and including 1 1/2:12, flat asphalt (ASTM D 312, Type II) and No. 15 asphalt saturated felt, No. 15 asbestos felt, or asphalt impregnated glass fiber mat shall be used.

S109.7.4 For roof slopes 1:12 up to and including 3:12, steep asphalt (ASTM D 312, Type III) and No. 15 asphalt saturated felt, No. 15 asbestos felt, or asphalt impregnated glass fiber mat shall be used.

S109.7.5 For roof slopes 2:12 up to and including 6:12, special steep asphalt (ASTM D 312, Type IV) and No. 15 asphalt saturated felt, No. 15 asbestos felt, or asphalt impregnated glass fiber mat shall be used.

S109.7.6 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.

S109.8 Membranes

Red rosin paper shall be used when the membrane is applied directly to a wood deck or cementitious fiber decks.

S110 SLATE OR MINERAL SURFACED ROLL ROOFING

S110.1 Material and Installation

S110.1.1 Mineral surface roll roofing (organic) having a minimum weight of 74 lbs per 100 sq ft or mineral surfaced roll roofing (inorganic) having a minimum weight of 63 lbs per 100 sq ft or slate surfaced roofing shall have a minimum 6-inch end lap and 2-inch side lap mopped or cemented. Minimum slope 1:12. Fasteners securing underlayment felts shall be applied through tin caps having a minimum diameter of 1 5/8 inches.

S110.1.2 The edges of sheathing at eaves and gable ends in all cases shall be covered and protected with a noncorrosive metal.

S110.1.3 Mineral surfaced roof may be two layers of type 46 double coverage rolled roofing, each layer lapped 19 inches and fastened to wood deck with two rows of fasteners through tin caps spaced not more than 18 inches on center through unsurfaced portion of sheet and 6 inches on center at back of each sheet. Mop or cement unsurfaced portion of sheet. Minimum slope 1:12.

S111 METAL ROOFS

S111.1 Materials

S111.1.1 Copper shall weigh not less than 16 oz per sq ft.

S111.1.2 Galvanized sheet metal shall be a minimum of 0.0142-inch (29 ga) zinc coated G-90.

S111.1.3 Lead: hard lead, 2lb per sq ft; soft lead, 3lb per sq ft.

S111.1.4 Terne (tin) and TCS (terne coated stainless); terne coating - 40 lb per double base box, field painted when applicable in accordance with manufacturer's specifications.

S111.1.5 Aluminum, 0.024-inch thick.

S111.2 Fasteners

S111.2.1 Hard copper or copper alloy shall be used for copper roofs.

S111.2.2 Galvanized fasteners for galvanized roofs.

S111.2.3 Aluminum fasteners for aluminum roofs.

S111.2.4 Stainless steel fasteners are acceptable for all types metal roofs.

S111.3 Metal Shingles

S111.3.1 Galvanized shingles, minimum uncoated thickness of 0.0149 inch (28 ga).

S111.3.2 Aluminum shingles, minimum thickness, 0.024 inch. Rosin paper shall be used under metal in addition to underlay.

S111.4 Flat Sheet Roofing

Seams and joints on flat sheet roofing shall be locked and soldered and made watertight.

S111.5 Corrugated Sheeting

Corrugated, Five-V crimp or other type of industrial roofing to be securely fastened with lead head or neoprene-washered fasteners.

S111.6 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.

S111.7 Minimum Slope Nonsoldered Seams

Minimum slope for all lapped, nonsoldered seam metal roofs shall be 3:12.

S112 SYNTHETIC SHEET MEMBRANE ROOFS

S112.1 General

S112.1.1 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.

S112.1.2 Except for one and two family residences, 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.

S112.2 Materials

S112.2.1 There shall be no co-mingling 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.

S112.2.2 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.

S112.2.3 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.

S112.2.4 Membrane: material shall be a minimum 0.040-inch thick.

S112.2.5 Flashing: Elasto/Plastic material, cured or uncured, shall be minimum 0.040-inch thick. Composite flashings shall be minimum 0.030- inch thick.

S112.3 Application

The membrane shall be applied by one or a combination of the following methods:

S112.3.1 Adhered Method

S112.3.1.1 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 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.

S112.3.1.2 Membrane: The membrane shall be free from defects. Lap joints shall be fabricated in accordance with manufacturer's requirements.

S112.3.1.3 Adhesives: Adhesives shall be applied in accordance with manufacturer's requirement, and within the weather limitations prescribed by the manufacturer.

S112.3.1.4 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.

S112.3.1.5 Flashing: Flashing materials shall be compatible with the base membrane materials and substrates to which they are applied.

S112.3.1.6 Protective Coatings: Protective coatings shall be applied in accordance with manufacturer's requirements.

S112.3.2 Partially Adhered and Mechanically Fastened Methods

S112.3.2.1 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 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.

S112.3.2.2 Membrane: The membrane shall be free from defects. Lap joints shall be fabricated in accordance with manufacturer's requirements.

S112.3.2.3 Adhesives: Adhesives shall be applied in accordance with manufacturer's requirements, and within the weather limitations prescribed by the manufacturer.

S112.3.2.4 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.

S112.3.2.5 Flashing: Flashing materials shall be compatible with the base membrane materials and substrate to which they are applied.

S112.3.2.6 Protective Coatings: Protective coatings shall be applied in accordance with manufacturer's requirements.

S112.3.3 Loose Laid/Ballasted Method

S112.3.3.1 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 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.

S112.3.3.2 Membrane: The membrane shall be free from defects. Lap joints shall be fabricated in accordance with manufacturer's requirements.

S112.3.3.3 Adhesives: Adhesives shall be applied in accordance with manufacturer's requirements and within the weather limitations prescribed by the manufacturer.

S112.3.3.4 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.

S112.3.3.5 Flashing: Flashing materials shall be compatible with the base membrane materials and substrates to which they are applied.

S112.3.3.6 Protective Coatings: Protective coatings shall be applied in accordance with manufacturer's requirements.

S112.3.3.7 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.

S112.4 Precautions

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.

S113 REROOFING/RECOVERING

S113.1 Installation

S113.1.1 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.

REROOFING - the practice of removing the existing roofing membrane, repairing any damaged substrate, and installing a new roofing system.

S113.1.2 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/recovering 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

S113.1.3 Reroofing 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 reroofing 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 Red Cedar Shingle & Handsplit Shake Bureau recommendations.
8. Wood shakes may be installed over not more than one existing wood shingle roof.

S113.1.4 All reroofing to be applied in accordance with new roofing specifications.

S113.1.5 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 and one 5-inch wide strips of felt set in plastic cement with the second felt extending 1 inch above the first, finished with a top coating of plastic cement, may be used in lieu of metal cap flashing. Felts to extend over the base flashing a minimum of 2 inches.

S114 VALLEYS AND WALL FLASHINGS

S114.1 General

Valleys and wall flashings shall meet the requirements of this section, except as otherwise specified in the listing.

S114.2 Rigid Shingle Roof Coverings

S114.2.1 Flash and counterflash with sheet metal.

S114.2.2 Valley flashing shall be a minimum of 15 inches wide.

S114.2.3 Valley and flashing metal shall be a minimum uncoated thickness of 0.0179 inch (26 ga).

S114.2.4 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 wide strip of felt set in plastic cement and extending 1 inch above the first felt and a top coating of plastic cement. Felts to extend over the base flashing 2 inches.

S114.3 Asphalt Shingle Roof Covering

S114.3.1 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 thickness or mineral surface roll roofing weighing a minimum of 77 lbs/100 sq ft. Cap flashings shall be corrosion resistant metal of minimum nominal 0.019-inch thickness.

S114.3.2 Valley linings 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 wide and of any of the corrosion resistant metals in Table S114.3.2.
2. For "open valleys," valley lining may be of two plies of mineral surface roll roofing. The bottom layer shall be 18 inches and the top layer a minimum of 36 inches wide.
3. For "closed valleys" (valley covered with shingles), valley lining may be of one ply of smooth roll roofing at least 36 inches wide or types (1) and (2) above.

TABLE S114.3.2
VALLEY LINING MATERIAL

Material	Minimum Thickness	Gage	Weight
Copper			16 oz
Aluminum	0.019 in		
Stainless Steel		28	
Galvanized Steel	0.017 in		
Zinc Alloy	0.027 in		
Lead			3 pounds
Painted Terne			20 pounds

S114.4 Wood Shingles and Shakes

S114.4.1 Wood shingles. Roof valley flashing shall be provided of not less than 0.017-inch corrosion resistant metal and shall extend at least 8 inches from the center line each way. Sections of flashings shall have an end lap of not less than 4 inches.

S114.4.2 Wood shakes. Roof valley flashing shall be provided of not less than 0.017-inch corrosion resistant metal and shall extend at least 11 inches from the center line each way. Sections of flashing shall have an end lap of not less than 4 inches.

S114.5 Built Up Roofs

S114.5.1 Base flash with a bituminous built-up flashing material on cant strips and cap flash with metal or other approved methods.

S114.5.2 Corrosion-resistant metal of a minimum nominal 0.019-inch thickness shall be used for cap or counterflashing.

S114.5.3 When a bituminous base flashing is used, a minimum of two plies of type 15 asphalt saturated felt or glass fiber ply sheets or asbestos felts 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.

S114.5.4 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 or asbestos felt. 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.

S114.6 Gravel Stop

S114.6.1 Shall extend up at least 5/8 inch above roof flange, out on roof a minimum of 3 inches fastened a minimum of 6 inches on center.

S114.6.2 Overlap shall be a minimum of 2 inches or another method of joint construction as approved by the Building Official may be used.

S114.6.3 All joints shall be sealed with plastic cement.

S114.6.4 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 wide and the top strip a minimum of 6 inches wide.

S114.6.5 Metal flashing flanges to be set, nailed and stripped in accordance with gravel guard application specifications.

S114.6.6 An approved nailer is required for gravel stop and metal flashing flanges.

S114.6.7 Gravel stop shall comply with the minimum values listed in Table 114.6.7.

TABLE S114.6.7
GRAVEL STOPS - DIMENSIONS AND MATERIAL

Height of Gravel Stop	Galvanized Steel (gage)	Copper (oz.)	Aluminum (inches)	Zinc Alloy (inches)	Stainless Steel (gage)
4	26	16	0.025	0.020	26
5	24	16	0.032	0.027	26
6	22	20	0.040	0.027	24
7	22	20	0.040		22
8	20	20	0.050		20

S114.7 Eaves and Gables

S114.7.1 Provide drip edge at eaves and gables of all shingle and tile roofs. Overlap to be a minimum of 1 1/2 inches.

S114.7.2 Eaves drip shall extend 1/4 inch below sheathing and extending back on the roof a minimum of 2 inches. This applies to both new and old roofs.

S114.8 Chimneys

Cricket or saddle coverings, if used, shall be sheet metal or of same material as roof covering.

S114.9 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.

S114.10 Openings In Roof

S114.10.1 All plumbing and electrical pipes shall be flashed with an appropriate lead boot, copper or galvanized sheet metal flashing.

S114.10.2 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 thickness.

S114.10.3 Metal flashing flanges to be set, nailed and stripped in accordance with gravel stop applications specifications.

S115 LIQUID APPLIED COATINGS

S115.1 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.

S115.2 Preparation of Surface

S115.2.1 The surface to which the coating is to be applied must be flat with no major fractures. Any fracture 1/16 inch or greater must be penetrated before coating.

S115.2.2 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.

S115.2.3 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.

S115.3 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.

S115.4 Roof Slope

The minimum recommended roof slope is 1/4:12 (2%). Roofs which pond water are not acceptable.

S115.5 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.

S116 FOAMED IN PLACE ROOF INSULATION

S116.1 General

S116.1.1 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.

S116.1.2 When liquid applied surfacing is used, requirements of S115 apply. When elastomeric or plastomeric protection is used, requirements of S112 apply.

APPENDIX T
ABOVE GROUND TANKS AT SERVICE STATIONS

Aboveground Storage Tank. A horizontal or vertical tank that is approved or listed and is intended for fixed installation without backfill, either above or below grade, and is used within the scope of its approval or listing. Aboveground storage tanks may be installed at automotive service stations upon the approval of the local governing body having jurisdiction and as provided for in Appendix T.

T101 Aboveground Storage Tanks at Automotive Service Stations.

T101.1 Except as modified by the provisions of this section, aboveground storage tanks and their piping systems shall comply with the applicable provisions of Chapter 2 and 3 of NFPA 30, Flammable and Combustible Liquids Code.

T101.1.1 Only aboveground storage tanks shall be used. Tanks designed and built for underground use shall not be installed for aboveground use.

T101.2 Tank Location and Capacity.

T101.2.1 Tanks storing Class I and II liquids at an individual site shall be limited to a maximum individual capacity of 12,000 gallons and an aggregate capacity of 40,000 gallons.

T101.2.2 Tanks shall be located at least:

1. 50ft (15m) from the nearest important building on the same property;
2. 50 ft (15 m) from any fuel dispenser;
3. 50ft (15m) from the nearest side of a public way.
4. 100 ft (30 m) from any property line that is or can be built upon, including the opposite side of a public way.

EXCEPTIONS:

1. All distances may be reduced by 50 percent if tanks are installed in vaults that comply with T101.2.4.
2. No minimum distances shall be required for fuel dispensing systems that comply with 9-3.5, of NFPA-30A.

T101.2.3 Control of Spillage. Spill control shall be provided in accordance with 2-3.3 of NFPA 30, Flammable and Combustible Liquids Code.

EXCEPTION: Tanks in vaults that comply with T101.2.4 need not meet this requirement.

T101.2.4 Vaults.

T101.2.4.1 Definition. An enclosure, either above or below grade, that contains an aboveground storage tank and meets the requirements of Section T101.2.4.2.

T101.2.4.2 Vaults may be either above or below-grade and shall comply with the following:

1. The vault shall completely enclose each tank. There shall be no openings in the vault enclosure except those necessary for access to, inspection of, and filling, emptying, and venting of the tank. The walls and floor of the vault shall be constructed of reinforced concrete at least 6 inches (15 cm) thick. The top shall be constructed of noncombustible material. The top and floor of the vault and the tank foundation shall be designed to withstand the anticipated loading. The walls and floor of any vault installed below grade shall be designed to withstand anticipated soil and hydrostatic loading. The vault shall be substantially liquidtight, and there shall be no backfill around the tank.
2. Each vault and its tank shall be suitably anchored to withstand uplifting by ground water or flooding, including when the tank is empty.

3. The vault shall be designed to be wind and earthquake resistant, in accordance with good engineering practice. The vault shall be resistant to damage from the impact of a motor vehicle or suitable collision barriers shall be provided.
4. Each tank shall be in its own vault. Adjacent vaults may share a common wall.
5. Connections shall be provided to permit ventilation of each vault to dilute, disperse, and remove vapors prior to entering the vault.
6. Each vault shall be equipped with a detection system that is capable of detecting liquids, including water, and will activate an alarm.
7. Means shall be provided to recover liquid from the vault. If a pump is used to meet this requirement, the pump shall not be permanently installed in the vault. Portable pumps shall be suitable for use m Class I, Division 1, locations, as defined by Article 500 of NFPA 70, National Electrical Code.
8. Vent pipes that are provided for normal tank venting shall terminate outside the vault and at least 12ft (3.6 m) above adjacent ground level.
9. Each vault shall be provided with a means for personnel entry. At each entry point, a warning sign indicating the need for procedures for safe entry into confined spaces shall be posted. Each entry point shall be secure against unauthorized entry and vandalism.
10. Each vault shall be provided with a suitable means to admit a fire suppression agent.
11. The interior or any vault containing a tank that stores a Class I liquid shall be designated a Class I, Division 1 location, as defined by Article 500 of NFPA 70, National Electrical Code.

T101.2.5 Piping and Ancillary Equipment

T101.2.5.1 Means shall be provided for determining the liquid level in each tank, and this means shall be accessible to the delivery operator. Provisions shall be made either to automatically stop the delivery of liquid to the tank when the liquid level in the tank reaches 98% of capacity or to sound an audible alarm when the liquid level in the tank reaches 95% of capacity.

T101.2.5.2 Liquid shall not be dispensed from the tank by gravity flow or by pressurization of the tank. Means shall be provided to prevent the release of liquid by siphon flow.

T101.2.5.3 Where a tank is at an elevation that produces a gravity head on the dispensing device, the tank outlet shall be equipped with a device (such as a normally closed solenoid valve) that will prevent gravity flow from the tank to the dispenser. This device shall be located adjacent to and downstream of the outlet valve specified by 2.3.7.1 of NFPA 30, Flammable and Combustible Liquids Code. The device shall be installed and adjusted so that liquid cannot flow by gravity from the tank to the dispenser in the event of failure of the piping of hose when the dispenser is not in use.

T101.2.5.4 If a submersible pump system is used, a listed emergency shutoff valve shall be installed at each dispensing device, as required by 4.3.6 of NFPA 30A.

T101.2.5.5 If a suction pump-type dispensing device is used, a listed vacuum actuated shutoff valve, with a shear section, or an equivalent-type valve shall be installed directly under each dispensing device.

EXCEPTION: Tanks installed in below-grade vaults need not comply with this requirement.

T101.2.5.6 Shutoff and check valves shall be equipped with a pressure relieving device that will relieve the pressure, generated by thermal expansion, back to the tank.

T101.2.5.7 Piping shall be routed so that exposure to physical damage is minimized.

T101.2.6 Physical Protection.

T101.2.6.1 Tanks that are not enclosed in vaults shall be enclosed with a chain link fence at least 6 ft (2 m) high. The fence shall be separated from the tanks by at least 10 ft (3 m) and shall have a gate that is properly secured against unauthorized entry.

Aboveground tanks shall be protected against vehicular collision by suitable barriers.

EXCEPTION: Tanks are not required to be enclosed within a fence if the property on which the tanks are located already has a perimeter security fence.

T101.2.6.2 The area within the fence and within any dike shall be kept free of vegetation, debris, and any other material that is not necessary to the proper operation of the tank and piping system.

T101.2.7 Corrosion Protection. Any portion of a tank or its piping system that is in contact with the soil shall be protected from corrosion in accordance with sound engineering practice.

T101.2.8 Tank Filling Operations.

T101.2.8.1 Delivery operations shall comply with applicable requirements of NFPA 385, Tank Vehicles for Flammable and Combustible Liquids and with the requirements of T101.2.8.2 through T101.2.8.5.

T101.2.8.2 The delivery vehicle shall be separated from any aboveground tank by at least 25ft (7.6m).

T101.2.8.3 Tank filling shall not begin until the delivery operator has determined tank ullage (available capacity).

T101.2.8.4 A check valve and a shutoff valve with a quick-connect coupling or a dry-break valve shall be installed in the piping at a point where connection and disconnection is made for delivery from the vehicle to any aboveground tank. This device shall be protected from tampering and physical damage.

T101.2.8.5 If the delivery hose is connected directly to the tank, the fill line at the tank shall be equipped with a tight-fill device for connecting the hose to the tank to prevent or contain any spill at the fill opening during delivery operations.

EXCEPTION: A tank that has a capacity that does not exceed 1,000 gallons need not meet this requirement.

INDEX

CONVERSION FACTORS FOR THE MOST COMMON UNITS USED IN BUILDING DESIGN AND CONSTRUCTION

METRIC TO CUSTOMARY			CUSTOMARYTO METRIC		
LENGTH					
1 km	= 0.621 371	mile (internat'l)	1 mile (internat'l)	= 1.609 344	km
	= 49.7096	chain	1 chain	= 20.1168	m
1 m	= 1.093 61	yd	1 yd	= 0.9144	m
	= 3.280 84	ft	1 ft	= 0.3048	m
1 mm	= 0.039 370 1	in		= 304.8	mm
			1 in	= 25.4	mm
			1 ft (U.S. survey)	= 0.304 801	m
AREA					
1 km^2	= 0.386 101	$mile^2$ (U.S. survey)	1 $mile^2$ (U.S. survey)	= 2.59	km2
1 ha	= 2.47104	acre (U.S. survey)	1 acre (U.S. survey)	= 0.404 687	ha
1 m^2	= 1.195 99	yd^2		= 4046.87	m^2
	= 10.7639	ft^2	1 yd^2	= 0.836 127	m^2
1 mm^2	= 0.001 550	in^2	1 ft^2	= 0.092 903	m^2
			1 in^2	= 645.16	mm^2
VOLUME, SECTION MODULUS					
1 m^3	= 8.107 09x10^{-3}	acre ft	1 acre ft	= 1233.49	m^3
	= 1.307 95	yd^3	1 yd^3	= 0.764 555	m^3
	= 35.3147	ft^3	100 board ft	= 0.235 974	m^3
	= 423.776	board ft	1 ft^3	= 0.028 316 8	m^3
1 mm^3	= 61.0237x10^{-6}	in^3	1 in^3	= 28.3168	L (dm^3)
				= 16 387.1	mm^3
				= 16.3871	mL(cm^3)
FLUID CAPACITY					
1 L	= 0.035 314 7	ft3	1 gal (U.S. liquid)*	= 3.785 41	L
	= 0.264 172	gal (U.S.)	1 qt (U.S. liquid)	= 946.353	mL
	= 1.056 69	qt (U.S.)	1 pt (U.S. liquid)	= 473.177	mL
1 mL	= 0.061 023 7	in^3	1 fl oz (U.S.)	= 29.5735	mL
	= 0.033 814	fl oz (U.S.)			
			* 1 gallon (UK) approx. 1.2 gal (U.S.)		
SECOND MOMENT OF AREA					
1 mm^4	2.402 51x10^{-6}	in^4	1 in^4	= 416 231	mm^4
PLANE ANGLE					
1 rad	= 57^O 17' 45"	(degree)	1^O (degree)	= 0.017 453 3	rad
	= 57.2958^O	(degree)		= 17.4533	mrad
	= 3437.75'	(minute)	1' (minute)	= 290.888	urad
	= 206 265"	(second)	1" (second)	= 4.848 14	urad
VELOCITY SPEED					
1 m/s	= 3.280 84	ft/s	1 ft/s	= 0.3048	m/s
	= 2.236 94	mile/h	1 mile/h	= 1.609 344	km/h
1 Km/h	= 0.621 371	mile/h		= 0.447 04	m/s

CONVERSION FACTORS FOR THE MOST COMMON UNITS USED IN BUILDING DESIGN AND CONSTRUCTION

METRIC TO CUSTOMARY			CUSTOMARYTO METRIC		
VOLUME RATE OF FLOW					
1 m^3/s	= 35.3147	ft^3/s	1 ft^3/s	= 0.028 316 8	m^3/s
	= 22.8245	million gal/d	1 ft^3/min	= 0.471 947	L/s
	= 8.107 09x10^{-4}	acre ft/s	1 gal/min	= 0.063 090 2	L/s
1 L/s	= 2.118 88	ft^3/min	1 gal/h	= 1.051 50	mL/s
	= 15.8503	gal/min	1 million gal/d	= 43.8126	L/s
	= 951.022	gal/h	1 acre ft/s	= 1233.49	m^3/s
MASS					
1 kg	= 2.204 62	lb (avoirdupois)	1 ton (short)	= 0.907 185	met. ton
	= 35.274	oz (avoirdupois)	1 long ton (2240 lb)	= 1016.05	kg
1 metric ton	= 1.102 31	ton (short, 2000 lb)	1 lb	= 0.453 592	kg
	= 2204.62	lb	1 oz	= 28.3495	g
1 g	= 0.035 274	oz	1 pennyweight	= 1.555 17	g
	= 0.643 015	pennyweight	1 long ton (2240 lb)	= 1016.05	kg
MASS PER UNIT AREA					
1 kg/m^2	= 0.204 816	lb/ft^2	1 lb/ft^2	= 4.882 43	kg/m^2
1 g/m^2	= 0.029 494	oz/yd^2	1 oz/yd^2	= 33.9057	g/m^2
	= 3.277 06x10^{-3}	oz/ft^2	1 oz/ft^2	= 305.152	g/m^2
DENSITY MASS PER VOLUME					
1 kg/m^3	= 0.062 428	lb/ft^3	1 lb/ft^3	= 16.0185	kg/m^3
	= 1.685 56	lb/yd^3	1 lb/yd^3	= 0.593 276	kg/m^3
1 t/m^3	= 0.842 778	ton/yd^3	1 ton/yd^3	= 1.186 55	t/m^3
FORCE					
1 MN	= 112.404	tonf (ton-force)	1 tonf (ton-force)	= 8.896 44	kN
1 kN	= 0.112 404	tonf	1 kip (1000 lbf)	= 4.448 22	kN
	= 224.809	lbf (pound-force)	1 lbf (pound-force)	= 4.448 22	N
1 N	= 0.224 809	lbf			
MOMENT OF FORCE, TORQUE					
1 N*m	= 0.737 562	lbf*ft	1 lbf*ft	= 1.355 82	N*m
	= 8.850 75	lbf*in	1 lbf*in	= 0.112 985	N*m
1 kN*m	= 0.368 781	tonf*ft	1 tonf*ft	= 2.711 64	kN*m
	= 0.737 562	kip*ft	1 kip*ft	= 1.355 82	kN*m
FORCE PER UNIT LENGTH					
1 N/m	= 0.068 521 8	lbf/ft	1 lbf/ft	= 14.5939	N/m
1 kN/m	= 0.034 260 9	tonf/ft	1 lbf/in	= 175.127	N/m
			1 tonf/ft	29.1878	kN/m
PRESSURE, STRESS, MODULUS OF ELASTICITY (FORCE PER UNIT AREA)					
1 MPa	= 0.072 518 8	$tonf/in^2$	1 $tonf/in^2$	= 13.7895	MPa
	= 10.4427	$tonf/ft^2$	1 $tonf/ft^2$	= 95.7605	kPa
	= 145.038	lbf/in^2	1 kip/in^2	= 6.894 76	MPa
1 kPa	= 20.8854	lbf/ft^2	1 lbf/in^2	= 6.894 76	kPa
			1 lbf/ft^2	= 47.8803	Pa

CONVERSION FACTORS FOR THE MOST COMMON UNITS USED IN BUILDING DESIGN AND CONSTRUCTION

METRIC TO CUSTOMARY			CUSTOMARYTO METRIC		
WORK, ENERGY, HEATWORK, ENERGY, HEAT IJ = 1N*m = 1W*s					
1 MJ	= 0.277 778	kWh	1 kWh (550 ft*lbf/s)	= 3.6	MJ
1 kJ	= 0.947 817	Btu	1 Btu (Int. Table)	= 1055.06	J
1 J	= 0.737 562	ft*lbf	1 ft*lbf	= 1.355 82	J
COEFFICIENT OF HEAT TRANSFER					
1 W/m^2K	= 0.176 110	$Btu/(ft^2*h.^OF)$	1 $Btu/(ft^2*h.^OF)$	= 5.678 26	W/m^2K
THERMAL CONDUCTIVITY					
1 W/mK	= 0.577 789	$Btu/(ft*h.^OF)$	1 $Btu/(ft*h.^OF)$	= 1.730 73	W/mK
ILLUMINANCE					
lx (lux)	= 0.092 903	lm/ft^2 (footcandles)	1 lm/ft2 (footcandles)	= 10.7639	lx (lux)
LUMINANCE					
1 cd/m^2	= 0.092 903	cd/ft^2	1 cd/ft^2	= 10.7639	cd/m^2
	= 0.291 864	foot lambert	1 foot lambert	= 3.426 26	cd/m^2
1 kcd/m^2	= 0.314 159	lambert	1 lambert	= 3.183 01	kcd/m^2