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ONE AND TWO FAMILY DWELLINGS

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ONE AND TWO FAMILY DWELLING CODE

(This Section is unique to Massachusetts.)

780 CMR 3601.0 GENERAL ADMINISTRATION

3601.1 General: The provisions of *780 CMR 36* shall be known as the One and Two Family Dwelling Code, ***and*** may be cited as such.

3601.1.1 Application of other laws: Nothing herein contained shall be deemed to nullify any provisions of the zoning by-laws or ordinance of any municipality in the Commonwealth of Massachusetts insofar as those provisions deal exclusively with those powers of regulating zoning granted by the provisions of M.G.L. c.40A and 41.

780 CMR 3601.2 PURPOSE

3601.2.1 Minimum standards: The purpose of 780 CMR 36 is to provide minimum standards for the protection of life, limb, health, property, environment and for the safety and welfare of the consumer, general public, and the owners and occupants of residential buildings regulated by 780 CMR 36.

3601.2.2 Scope: 780 CMR 1, in its entirety, shall serve as the administrative requirements of 780 CMR 36.

NON-TEXT PAGE

BUILDING DEFINITIONS

780 CMR 3602.0 GENERAL

3602.1 Scope: ***Unless otherwise expressly stated, the following words and terms shall, for the purposes of 780 CMR 36, have the meaning shown herein.*** Words used in the singular include the plural, and the plural the singular. Words used in the masculine gender include the feminine, and the feminine the masculine.

3602.1.2 Terms defined in other codes: Where terms are not defined in 780 CMR 36, but are defined in the plumbing, fire prevention, or mechanical codes, or other elsewhere in 780 CMR, or its reference standards as listed in Appendix A, such terms shall have the meanings ascribed to them in those codes.

3602.1.3 Terms not defined: Where terms are not defined through the methods authorized by 780 CMR 3602.1.2, such terms shall have the ordinarily accepted meanings such as the context implies.

780 CMR 3602.2 GENERAL BUILDING DEFINITIONS

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

ACCESSORY USE: A use incidental to the principal use of a building as defined or limited by the provisions of the local zoning laws.

APPROVED: Approved ***by the Board of Building Regulations and Standards (BBRS),*** the building official, or by reason of accepted principles or tests by nationally recognized organizations, ***or by accepted engineering practice.***

APPROVED AGENCY: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved ***as defined herein.***

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

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

BOARD OF BUILDING REGULATIONS AND STANDARDS (BBRS): In accordance with M.G.L. c. 143, § 94, the Board responsible for the development and promulgation of 780 CMR (the Massachusetts State Building Code). See M.G.L. c. 143, §§ 95 through 100 for additional responsibilities of the BBRS.

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

BUILDING, EXISTING: A building erected prior to the adoption of this code, or one for which a legal building permit has been issued.

BUILDING OFFICIAL: ***See building code enforcement official 780 CMR 2.***

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

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

DWELLING, ONE FAMILY: A building containing one dwelling unit with not more than five lodgers and boarders.

DWELLING, TWO FAMILY: A building containing two dwelling units with not more than five lodgers or boarders per family.

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.

FOUNDATION: A base constructed to support any building or structure including but not limited to footings, floating foundation, piles and caissons.

FOUNDATION WALL: A wall below the floor nearest grade serving as a support for a wall, pier, column or other structural part of a building.

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

GRADE FLOOR WINDOW: A window located such that the sill height of the window is not more than 44 inches (1118 mm) above or below the finished grade adjacent to the window.

GREENHOUSE: An enclosed detached accessory structure consisting primarily of light-transmitting materials and used exclusively for growing plants. ***In accordance with St. 1973, c. 672, the provisions of the 780 CMR shall not apply to greenhouses covered exclusively with plastic film; provided, however, that the provisions of M.G.L. c. 40A shall continue to apply.***

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

HABITABLE ROOM (SPACE): Habitable room shall mean any room meeting the requirements of 780 CMR 36 for sleeping, living, cooking or dining purposes, excluding such enclosed places as closets, pantries, bath or toilet rooms, hallways, laundries, storage spaces, utility rooms and similar spaces.

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

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

LISTED and LISTING: Terms referring to equipment which is shown in a list published by an approved testing agency qualified and equipped for experimental testing and maintaining an adequate periodic inspection of current productions and whose listing states that the equipment complies with nationally recognized standards, when installed in accordance with the manufacturer's installation instructions.

LOADS, LIVE AND DEAD: *See 780 CMR 2.*

MANUFACTURED HOME: *See 780 CMR 35 and 780 CMR-R3.*

MUNICIPALITY: Any city or town in the Commonwealth of Massachusetts. The word "municipality" shall be construed, where the context requires, as though followed by the words "or combination of municipalities".

OCCUPIED SPACE: *See 780 CMR 2.*

REPAIRS, ORDINARY: See 780 CMR 2.

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

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

1. More than six feet (1829 mm) above grade plane;
2. More than six feet (1829 mm) above the finished ground level for more than 50 percent of the total building perimeter; or
3. More than 12 feet (3658 mm) above the finished ground level at any point.

WALL: See 780 CMR 2.

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

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

BUILDING PLANNING

(This Section is unique to Massachusetts.)

780 CMR 3603.1 STRUCTURAL DESIGN CRITERIA

3603.1.1 Design: Buildings and structures, and all parts thereof, regulated by 780 CMR 36, shall be constructed to support safely all applied dead, live and environmental loads specified in 780 CMR 3603.1.

Exception: One and Two Family Dwellings are exempt from the earthquake load requirements of 780 CMR 1612.

3603.1.2 Dead load: The actual weights of materials and construction shall be used for determining dead load with consideration for the dead load of fixed service equipment.

3603.1.3 Live load: The minimum uniformly distributed live load shall be as specified in Table 3603.1.3. Elevated garage floors shall be designed to support a 2,000 pound (8.90 kN) concentrated load applied over a 20 square inch (0.0129 m^2) area, in addition to the loads specified in table 3603.1.3.

3603.1.4 Roof Live Load: Roofs shall be designed to support the live load specified in Table 3603.1.4, or the snow load specified in 780 CMR 3603.1.5, whichever is greater.

3603.1.5 Basic snow load: Figures 3603.1.5a, 3603.1.5b, 3603.1.5c and 3603.1.5d define four snow load zones. The basic snow load for each zone shall be applied to the horizontal projection of sloped or flat roofs and unenclosed floor areas, as a uniformly distributed load, P_f, in pounds per square foot, as specified in Table 3603.1.5.

3603.1.6 Deflection: The allowable deflection of any structural member under the live load or snow load listed in 780 CMR 3603.1.3, 3603.1.4 and 3603.1.5 shall not exceed the values in Table 3603.1.6.

Table 3603.1.3
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS
(POUNDS PER SQUARE FOOT)

USE	LIVE LOAD (psf)
Balconies and decks	60
Garages (passenger cars only)	50 (1)
Attics (roof slope not steeper than 3 in 12 - no storage)	10
Attics (limited storage)	20
Living Areas (except sleeping rooms)	40
Sleeping Rooms	30
Stairs	40 (2)
Guardrails and Handrails (single concentrated load at any point along the top)	200

Notes:
(1) See also 780 CMR 3603.1.3
(2) In addition to the uniformly distributed live load, individual stair treads shall be designed for a single concentrated load of 300 pounds over an area of four square inches.

Table 3603.1.4
MINIMUM ROOF LIVE LOAD
(POUNDS PER SQUARE FOOT OF HORIZONTAL PROJECTION)

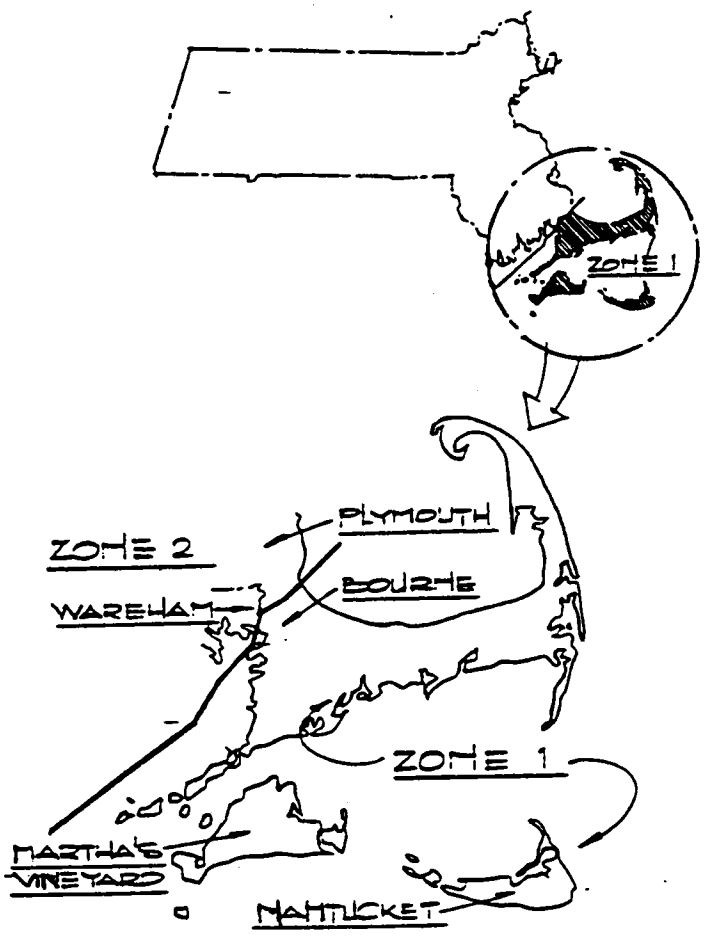
ROOF SLOPE	TRIBUTARY LOADED AREA (square feet) for any structural member		
	0 to 200 sf	201sf to 600 sf	Over 600 sf
Flat, or rise less than 4 inches per foot	20	16	12
Rise 4 inches per foot to less than 12 inches per foot	16	14	12
Rise 12 inches per foot or greater	12	12	12

Table 3603.1.5
BASIC SNOW LOAD, P_f

SNOW LOAD ZONE [1]	BASIC SNOW LOAD P_f
1	25 psf
2	30 psf
3	35 psf
4	40 psf

Notes:
1. See figures 3603.1.5 a through d

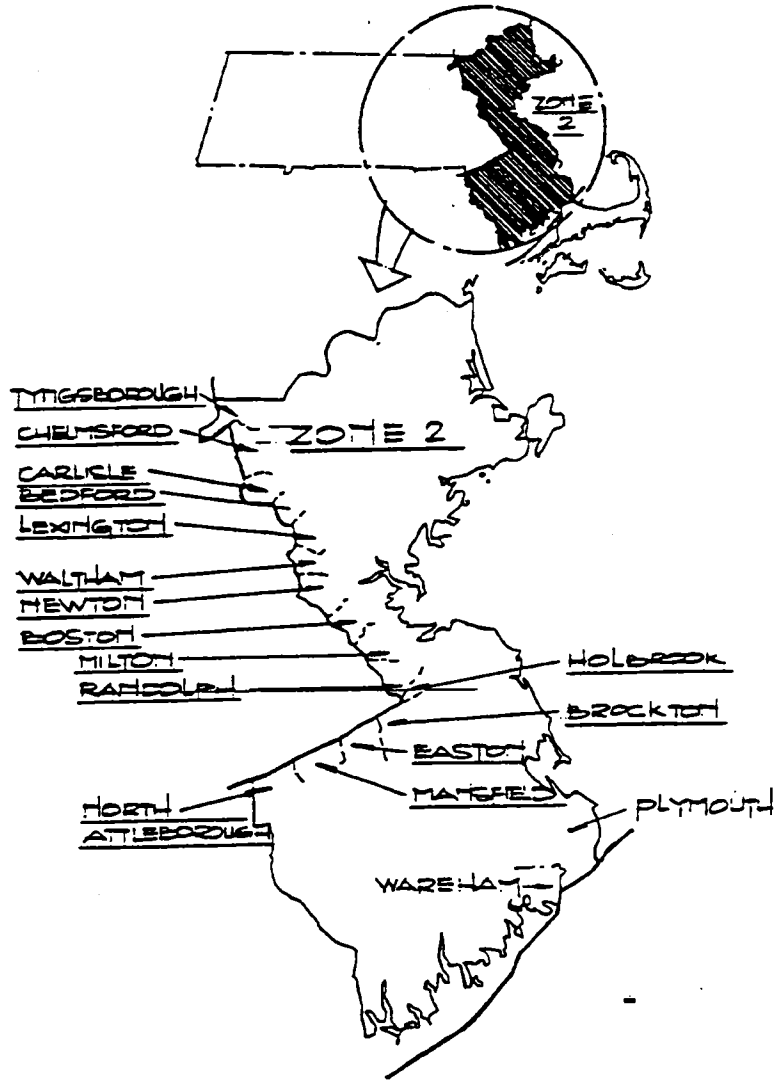
Figure 3603.1.5a
MINIMUM UNIFORM SNOW LOAD MAP
ZONE 1



List of Towns in Minimum Uniform
Snow Load Zones Zone 1

Barnstable	Gay Head	Sandwich
Bourne	Gosnold	
Brewster		Tisbury
	Harwich	Truro
Chatham		
Chilmark	Mashpee	Vineyard Haven
Dennis	Nantucket	Wellfleet
		West Tisbury
Eastham	Oak Bluffs	
Edgartown	Orleans	Yarmouth
Falmouth	Provincetown	

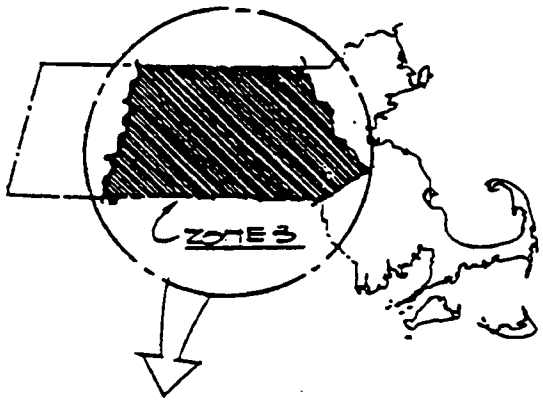
Figure 3603.1.5b
MINIMUM UNIFORM SNOW LOAD MAP
ZONE 2

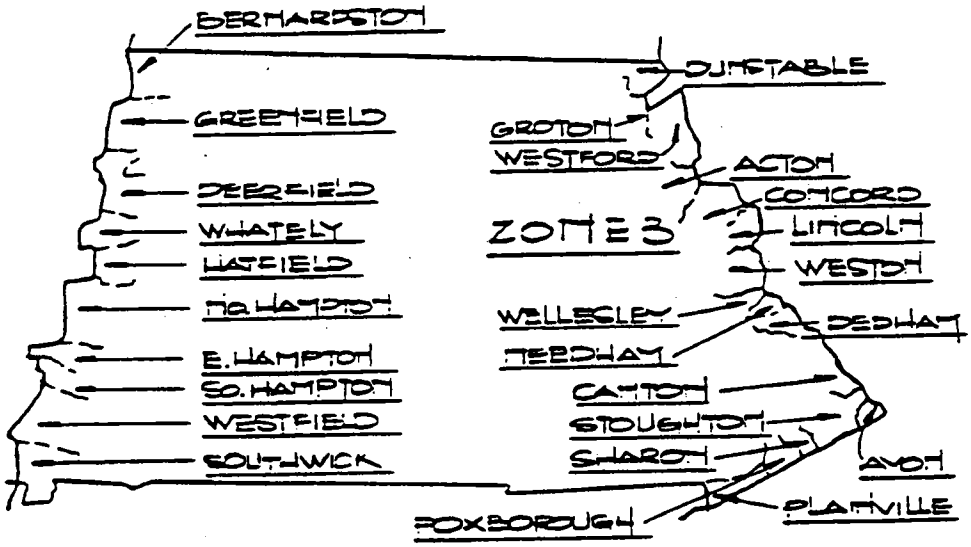


List of Towns in Minimum Uniform Snow Load Zones Zone 2

Abington	Cambridge	Freetown	Lawrence	Milton	Randolph	Taunton
Acushnet	Carlisle		Lexington		Raynham	Tewksbury
Amesbury	Carver	Georgetown	Lowell	Nahant	Reading	Topsfield
Andover	Chemisford	Gloucester	Lynn	New Bedford	Rehoboth	Tyngsborough
Arlington	Chelsea	Groveland	Lynnfield	Newbury	Revere	
Attleboro	Cohasset			Newburyport	Rochester	Wakefield
		Halifax		Newton	Rockland	Waltham
Bedford	Danvers	Hamilton	Malden	N. Andover	Rockport	Wareham
Belmont	Dartmouth	Hanover	Manchester	N. Attleboro	Rowley	Watertown
Berkley	Dighton	Hanson	Mansfield	N. Reading		Wenham
Beverly	Dracut	Haverhill	Marblehead	Norton	Salem	W. Bridgewater
Billerica	Duxbury	Hingham	Marion	Norwell	Salisbury	W. Newbury
Boston		Holbrook	Marshfield		Saugus	Westport
Boxford	E. Bridgewater	Hull	Mattapoisett	Peabody	Scituate	Weymouth
Braintree	Easton		Medford	Pembroke	Seekonk	Whitman
Bridgewater	Essex	Ipswich	Melrose	Plymouth	Somerset	Wilmington
Brockton	Everett		Merrimac	Plympton	Somerville	Winchester
Brookline		Kingston	Methuen		Stoneham	Winthrop
Burlington	Fairhaven		Middleborough	Quincy	Swampscott	Woburn
	Fall River	Lakeville	Middleton		Swansea	

Figure 3603.1.5c
MINIMUM UNIFORM SNOW LOAD MAP
ZONE 3

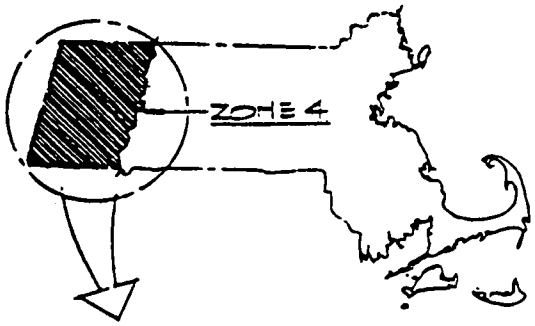


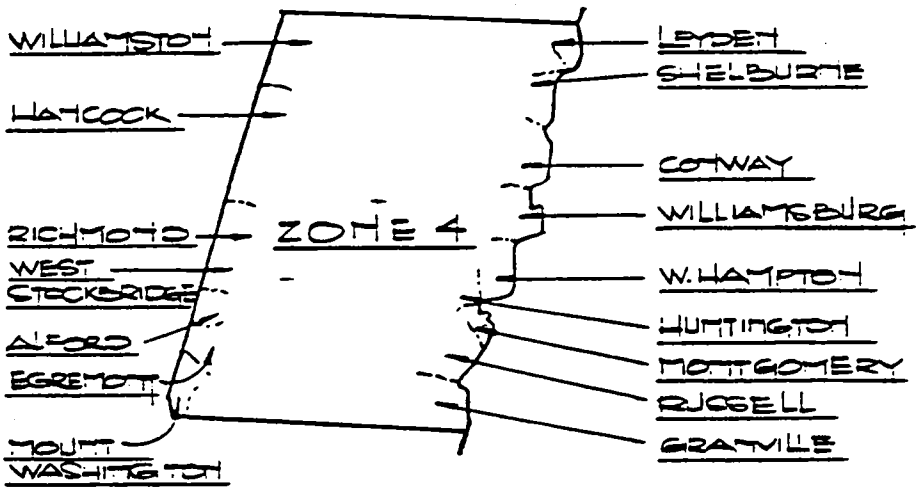


List of Towns in Minimum Uniform Snow Load Zones Zone 3

Acton	Chicopee	Greenfield	Lunenburg	Oakham	Sunderland	Wendell
Agawam	Clinton	Groton		Orange	Sutton	West Boylston
Amherst	Concord		Marlborough	Oxford	Sharon	West Brookfield
Ashburnham		Hadley	Maynard		Sherborn	W. Springfield
Ashby	Dedham	Hampden	Medfield	Palmer	Shirley	Westborough
Ashland	Deerfield	Hardwick	Millbury	Paxton	Shrewsbury	Westfield
Athol	Douglas	Harvard	Millville	Pelham	Shutesbury	Westford
Auburn	Dover	Hatfield	Medway	Pepperell	S. Hadley	Westminster
Avon	Dudley	Holland	Mendon	Petersham	Southampton	Weston
Ayer	Dunstable	Holliston	Milford	Phillipston	Southborough	Westwood
		Holden	Millis	Plainville		Wilbraham
Barre	E. Brookfield	Holyoke	Monson	Princeton	Templeton	Winchendon
Belchertown	Easthampton	Hopedale	Montague		Townsend	Whately
Bellingham	E. Longmeadow	Hopkinton		Royalston		Worcester
Berlin	Erving	Hubbardston	Natick	Rutland	Upton	Wrentham
Bernardston		Hudson	Needham		Uxbridge	
Blackstone	Fitchburg		New Braintree	Southbridge		
Bolton	Foxborough	Lancaster	New Salem	Southwick	Wales	
Boylston	Framingham	Leicester	Norfolk	Spencer	Walpole	
Boxborough	Franklin	Leominster	North Brookfield	Springfield	Ware	
Brimfield		Leverett	Northampton	Sterling	Warren	
Brookfield	Gardner	Lincoln	Northborough	Stoughton	Warwick	
	Gill	Littleton	Northbridge	Stow	Wayland	
Canton	Grafton	Longmeadow	Northfield	Sturbridge	Webster	
Charlton	Granby	Ludlow	Norwood	Sudbury	Wellesley	

Figure 3603.1.5d
MINIMUM UNIFORM SNOW LOAD MAP
ZONE 4





List of Towns in Minimum Uniform Snow Load Zones Zone 4

Adams	Colrain	Hancock	Monterey	Plainfield	Tolland
Alford	Conway	Hawley	Montgomery		Tyringham
Ashfield	Cummington	Heath	Mount Washington	Richmond	
		Hinsdale		Rowe	Washington
Becket	Dalton	Huntington	New Ashford	Russell	W. Stockbridge
Blandford			New Marlborough		Westhampton
Buckland	Egremont	Lanesborough		Sandisfield	Williamsburgh
		Lee	North Adams	Savoy	Williamstown
Charlemont	Florida	Lenox		Sheffield	Windsor
Cheshire		Leyden	Otis	Shelbourne	Worthington
Chester	Goshen			Stockbridge	
Chesterfield	Granville	Middlefield	Peru		
Clarksburg	Great Barrington	Monroe	Pittsfield		

Table 3603.1.6
ALLOWABLE LIVE LOAD DEFLECTION OF STRUCTURAL MEMBERS

STRUCTURAL MEMBER	ALLOWABLE DEFLECTION
Rafters having slopes greater than 3 in 12 -no finished ceiling attached to rafters	L/180
Interior walls and partitions	H/180
Floors and veneer plastered ceilings	L/360
Gypsum panel ceilings and all other structural members	L/240

Notes:
L = Span length
H = Span height

780 CMR 3603.2 CONSTRUCTION IN AREAS SUBJECT TO FLOODING

3603.2.1 Flood Resistant Construction: Construction in areas designated as subject to flooding on the community Flood Insurance Rate Map (FIRM) shall be designed and constructed in accordance with the applicable provisions of 780 CMR 3107.

780 CMR 3603.3 FIRERESISTANCE RATING OF EXTERIOR WALLS

3603.3.1 Exterior walls: Exterior walls located less than three feet (0.914m) from property lines shall have a minimum of one-hour fire-resistive rating. The fire-resistive rating of exterior walls located less than three feet (0.914 m) from a property line shall be rated for exposure from both sides. Projections beyond the exterior wall shall not extend more than 12 inches (0.305 m) into areas where openings are prohibited.

3603.3.2 Openings: Openings shall not be permitted in exterior walls of dwellings located less than three feet (914 mm) from the property line. This distance shall be measured perpendicular to the vertical plane of the wall.

780 CMR 3603.4 DWELLING UNIT SEPARATION

3603.4.1 Two-family dwellings: Dwelling units in two-family dwellings shall be separated by wall and/or floor-ceiling assemblies of not less than one-hour fire-resistive rating when tested in accordance with ASTM E 119, as listed in ***Appendix A***. Fire-resistive-rated floor-ceiling and wall assemblies shall extend to, and be tight against, the exterior wall. Wall assemblies shall extend to the underside of the roof sheathing.

3603.4.2 Supporting construction: When floor assemblies are required to be fire-resistive rated by 780 CMR 3603.4.1, the supporting construction of such assemblies shall have an equal or greater fire-resistive rating.

3603.4.3 Sound transmission: Wall and floor-ceiling assemblies separating dwelling units shall provide airborne sound insulation for walls and both airborne and impact sound insulation for floor-ceiling assemblies.

3603.4.3.1 Airborne noise: Airborne sound insulation for wall and floor-ceiling assemblies shall meet a Sound Transmission Class (STC) of 45 when tested in accordance with ASTM E 90.

3603.4.3.2 Penetrations: Penetrations or openings in the assembly for pipes, ventilation or exhaust ducts shall be sealed, lined, insulated or otherwise treated to maintain the required ratings.

3603.4.3.3 Structural-borne noise: Impact sound insulation for floor-ceiling assemblies shall meet an Impact Insulation Class (IIC) of 45 when tested in accordance with ASTM E 492. Floor covering may be included in the assembly to obtain the required rating.

780 CMR 3603.5 GARAGE SEPARATION

3603.5.1 Opening protection: Openings from a private garage directly into a room used for sleeping purposes shall not be permitted. Other openings between the garage and dwelling shall be equipped with either solid wood doors not less than 1¾ inch (45 mm) in thickness or 20-minute fire-rated doors. Self closing devices and fire resistive rated door frames are not required.

3603.5.2 Fire Separation: The garage shall be separated from the residence and its attic area by means of minimum ⅝ inch (16 mm) type X gypsum board applied to the garage side. Wherever the attic area is continuous between the garage and the dwelling a firestop of ⅝ inch (16 mm) type X gypsum board shall be used to form a barrier to separate the garage and dwelling.

3603.5.3 Floor surface: Garage and carport floor surfaces shall be constructed of concrete or other approved noncombustible material. Slab on grade construction shall be in accordance with the provisions of 780 CMR 3605.5. The minimum floor thickness shall be 3½ inches. The area of floor used for parking of automobiles or other vehicles shall be sloped to facilitate drainage toward the main vehicle entry/exit doorway. All door openings between the garage and the dwelling shall be provided with a raised sill with a minimum height of four inches.

780 CMR 3603.6 LIGHT, VENTILATION AND HEATING

3603.6.1 Light required: Every room or space intended for human occupancy shall be provided with natural or artificial light.

Exception 1: Every bathroom and toilet room shall, as a minimum, be provided with artificial light.

Exception 2: All interior and exterior stairways shall be provided with artificial light providing direct or indirect illumination and capable of illuminating the entire length of the stairway and associated landings. The control for activation of the required interior stairway lighting shall be installed in accordance with the requirements of 527 CMR 12.00, the Massachusetts State Electrical Code, as listed in *Appendix A.* The illumination of exterior stairs shall be controlled from inside the dwelling

3603.6.2 Ventilation required: Every room or space intended for human occupancy shall be provided with natural or mechanical ventilation.

Exception: Every bathroom and toilet room shall be equipped with a mechanical exhaust fan and associated ductwork with the fan exhausting, as a minimum, at 50 cfm if operated intermittently or 20 cfm if continuously operated. Such bathroom exhaust shall vent directly to the outside and no exhaust vent termination to attics or other interior portions of the building are allowed.

3603.6.3 Heating required: One and two family dwellings shall be designed with heating systems complying with the requirements of 780 CMR 3603.21.

3603.6.4 Natural light

3603.6.4.1 General: Should natural lighting be chosen as a lighting option, in the application of the provisions of 780 CMR 3603.0 for habitable and occupiable rooms, unless otherwise specifically required by the provisions of 780 CMR 4 for special occupancies, the requirements of 780 CMR 3603.6.4.2 through 780 CMR 3603.6.4.6 shall apply.

3603.6.4.2 Minimum glazing area: Every room or space intended for human occupancy shall have an exterior glazing area of not less than 8% of the floor area. ½ of the required area of glazing shall be openable. Glazed openings shall be located such that they open directly onto a street or public alley, or a yard or court, or other open space located on the same lot as the building. Glazed openings are permitted to face into a roofed porch where the porch abuts a street, yard or court, or other open area and the longer side of the porch is at least 65% open and unobstructed and the ceiling height of the porch is not less than seven feet (2134 mm).

Exceptions:
1. Glazed areas need not be openable where the opening is not required by 780 CMR 3603.10.4 and an approved mechanical ventilation system is provided which is capable of producing 0.35 air change per hour in the room or a whole-house mechanical ventilation system is installed capable of supplying outdoor ventilation air of 15 cubic feet per minute (cfm) (7.08 L/s) per occupant computed on the basis of two occupants for the first bedroom and one occupant for each additional bedroom.
2. The glazed areas may be omitted in rooms where the opening is not required by 780 CMR 3603.10.4 and an approved mechanical ventilation system is provided capable of producing 0.35 air change per hour in the room or a whole-house mechanical ventilation system is installed capable of supplying outdoor ventilation air of 15 cfm (7.08 L/s) per occupant computed on the basis of two occupants for the first bedroom and one occupant for each additional bedroom, and artificial light is provided capable of producing an average illumination of six foot-candles (6.46 lx) over the area of the room at a height of 30 inches (762 mm) above the floor level.

3603.6.4.3 Adjoining spaces: Where natural light for rooms or spaces without exterior glazing areas is provided through an adjoining room, the unobstructed opening to the adjoining room shall be at least 8% of the floor area of the interior room or space, but not less than 25 square feet (2.33 m^2). The exterior glazing area shall be based on the total floor area being served.

3603.6.4.4 Stairways: See 780 CMR 3603.6.1, Exception 2.

3603.6.4.5 Hallways: Natural light shall be capable of penetrating the full length of the hallway.

3603.6.4.6 Bathrooms and toilet rooms: See 780 CMR 3603.6.1, Exception 1.

3603.6.5 Artificial light

3603.6.5.1 General: Artificial light shall be capable of providing the minimum illumination considered safe for the specific space application (an average illumination of six foot candles over the area of a room at a height of 30 inches above the floor is typically considered acceptable except for bathrooms and toilet rooms where three foot-candles, so measured is typically considered acceptable).

3603.6.6 Natural ventilation

3603.6.6.1 General: Natural ventilation of an occupied space shall be provided by means of windows, doors, louvers or other natural openings to the outdoor air.

3603.6.6.2 Ventilation area required: The minimum openable area to the outdoors shall be 4% of the floor area being ventilated.

3603.6.6.2.1 Adjoining spaces: Where rooms and spaces without openings to the outdoors are ventilated through an adjoining room, the unobstructed opening to the adjoining room shall be at least 8% of the floor area of the interior room or space, but not less than 25 square feet (2.33 m^2). The ventilation openings to the outdoors shall be based on the total floor area being ventilated.

3603.6.6.2.2 Bathrooms and toilet rooms: See 780 CMR 3603.6.2, Exception.

3603.6.6.2.3 Openings below grade: Openings below grade shall be acceptable for natural ventilation provided that the outside horizontal clear space measured perpendicular to the opening is 1½ times the depth below the average adjoining grade.

3603.6.6.3 Openings onto yards, courts or open areas: Natural ventilation shall be provided by openings onto yards, courts or other open space on the same lot.

3603.6.7 Mechanical ventilation

3603.6.7.1 General: Mechanical ventilation shall conform to the requirements of 780 CMR 36 and otherwise to the requirements of the BOCA National Mechanical Code listed in ***Appendix A***.

3603.6.8 Ventilation of special spaces

3603.6.8.1 Roof spaces: Enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters, shall have cross ventilation for each separate space by ventilation openings that are protected against the entrance of rain and snow. The openings shall be covered with corrosion-resistant mesh not less than ¼ inch (6 mm) nor more than ½ inch (13 mm) in any direction, or other approved screening which allows for ventilation.

3603.6.8.1.1 Ventilating area: The minimum required net free ventilating area for such roof spaces shall be $^1/_{150}$ of the area of the space ventilated, except that the minimum required area shall be reduced to $^1/_{300}$, provided that: a vapor retarder having a permeance not exceeding one perm is installed on the warm side of the ceiling; or at least 50% and not more than 80%, of the required ventilating area is provided by ventilators located in the upper portion of the space to be ventilated at least three feet (914 mm) above eave or cornice vents, with the balance of the required ventilation provided by eave or cornice vents.

3603.6.8.2 Basements, cellars and crawl spaces: All basements, cellars which are not used as *habitable, occupiable* space, and crawl spaces, shall be ventilated by openings in exterior foundation walls, by openable windows or by approved mechanical means. Openings or openable windows shall be located as near as practical to provide cross ventilation. The openings shall be covered with corrosion resistant mesh not less than ¼ inch (6 mm) nor more than ½ inch (13 mm) in any direction, or other approved screening which allows for ventilation except than when openable windows are used for basement or cellar ventilation, standard window screens may be used as the corrosion resistant mesh.

Note: Crawl spaces shall not be used as an underfloor plenem.

Exception:

1. Basements or cellars used as *habitable, occupiable space* (Typically basements and cellars are not classified as habitable, occupiable space - see Definitions, 780 CMR 2 and 1202) shall satisfy the ventilation requirements of 780 CMR 3603.6.6 or 780 CMR 3603.6.7, as applicable.
2. All basements and cellars containing solid fuel fired or fossil fired appliances shall additionally satisfy combustion air requirements of 780 CMR 3611.1

3603.6.8.2.1 Opening size: Openings or openable windows shall have a net area of not less than one square foot (0.093 m^2) for each 150 square feet (13.95 m^2) of foundation floor area. Where an approved vapor retarder is installed over the ground surface, the required net area of openings shall be reduced to 0.1 square foot (0.093 m^2) for each 150 square feet (13.95 m^2) and where vents are provided, they shall have manually operable louvers.

Exception: Basements and cellars not used as habitable, occupiable space shall be provided with a minimum of four sliding type, or awning type basement windows for every 1500 square feet of floor area, or multiples thereof, and shall be located, as near as practical, to provide cross ventilation.

3603.6.8.3 Alternative mechanical ventilation: Enclosed attics, rafter, basement, cellar and crawl spaces which are not ventilated as herein required shall be equipped with a mechanical ventilation system conforming to the requirements of the BOCA National Mechanical Code listed in ***Appendix A***.

780 CMR 3603.7 ROOM DIMENSIONS

3603.7.1 Floor area: Habitable rooms, except kitchens, shall have an area of not less than 70 square feet (6.51 m^2). Every kitchen shall have not less than 50 square feet (4.64 m^2) Habitable rooms, except kitchens shall not be less than seven feet (2134 mm) in any horizontal direction.

780 CMR 3603.8 CEILING HEIGHT REQUIREMENTS

3603.8.1 Minimum ceiling height: *Habitable rooms*, except kitchens, shall have a ceiling height of not less than seven feet three inches (2210 mm) for at least 50% of their required areas. Not more than 50% of the required area may have a sloped ceiling less than seven feet three inches (2210 mm) in height with no portion of the required areas less than five feet (1524 mm) in height. If any room has a *furred ceiling*, the prescribed ceiling height is required for at least 50% of the area thereof, but in no case shall the height of the *furred ceiling* be less than seven feet (2134 mm).

Exceptions:

1. Beams and girders spaced not less than four feet (1219 mm) on center may project not more than six inches (153 mm) below the required ceiling height.
2. All other rooms including kitchens, bathrooms and hallways shall have a minimum ceiling height of seven feet (2134 mm) measured to the lowest projection from the ceiling.
3. Habitable basements shall have a minimum clear ceiling height of seven feet zero inches, except that beams, girders and other obstructions spaced not less than four feet on center may project not more than six inches below the required ceiling height.
4. Basements not used for *habitable* spaces shall have a minimum clear ceiling height of six feet eight inches (2032 mm) except for under beams, girders, ducts or other obstructions where the clear height shall be a minimum of six feet four inches (1931 mm).

3603.8.2 Height effect on room area: Portions of a room with a sloping ceiling measuring less than five feet zero inches (1524 mm) or a *furred ceiling* measuring less than seven feet zero inches (2134 mm) from the finished floor to the finished ceiling shall not be considered as contributing to the minimum required habitable area for that room.

3603.8.3 Stairway ceiling height: Stairway headroom clearances shall be in accordance with the provisions of 780 CMR 3603.13.3.

780 CMR 3603.9 ACCESS TO CRAWL SPACES AND ATTICS

3603.9.1 Access to crawl spaces: Access shall be provided to crawl spaces by an opening not less than 18 inches (457 mm) by 24 inches (610 mm).

3603.9.2 Access to attics: An opening not less than 22 inches by 30 inches (559 mm by 762 mm) with ready access thereto shall be provided to any attic area having a clear height of over 36 inches (914 mm). Where doors or other openings are installed in the draftstopping, such doors shall be self-closing and be of approved materials as specified in this section, and the construction shall be tightly fitted around all pipes, ducts or other assemblies piercing the draftstopping.

780 CMR 3603.10 MEANS OF EGRESS

3603.10.1 Means of egress: Egress from all dwelling units shall be by means of two exit doors, remote as possible from each other and leading directly to grade. Such doors shall be provided at the normal level of entry/exit. In addition, all other floors within a dwelling unit shall have at least one means by which a continuous and unobstructed path to the exit doors, by means of stairways, corridors, hallways or combinations thereof, is provided.

Exception: In split level and raised ranch style layouts, the two separate exit doors required by 780 CMR 3603.10.1 are permitted to be located on different levels.

3603.10.2 Exit doors: One of the required exit doors required by 780 CMR 3603.10.1 shall be a side-hinged swinging door. The second exit door may be provided by a side-hinged swinging door or sliding type doors. Side hinged swinging doors provided to meet this requirement may swing inward.

3603.10.3 Door hardware: Double cylinder dead bolts requiring a key operation on both sides are prohibited on required means of egress doors serving more than one dwelling unit.

3603.10.4 Emergency egress from sleeping rooms: Sleeping rooms shall have at least one openable window or exterior door approved for emergency egress or rescue in each such room. The units shall be operable from the inside to a full clear opening without the use of a key or tool. Emergency escape windows, under 780 CMR 3603.10.4, shall have a sill height of not more than 44 inches (1118 mm) above the floor.

3603.10.4.1 Minimum size. All emergency escape windows from sleeping rooms shall have a net clear opening of 3.3 square feet (0.307 m^2). The minimum net clear opening shall be 20 inches by 24 inches in either direction.

Exception: Windows in sleeping rooms of existing dwellings which do not conform to the requirements of 780 CMR 3603.10.4.1 may be replaced without conforming to 780 CMR 3603.10.4.1, provided that the replacement windows do not significantly reduce the existing opening size.

3603.10.4.2 Bars, grills and screens: Bars, grills, screens or other obstructions placed over emergency escape windows shall be releasable or removable from the inside without the use of a key or tool.

3603.10.5 Exitway under stair protection: Enclosed accessible space under stairs shall have walls and soffits protected on the enclosed side with ½-inch (12.7 mm) gypsum board.

780 CMR 3603.11 DOORS AND HALLWAYS

3603.11.1 Exit doors: The minimum nominal width of at least one of the exit doors required by 780 CMR 3603.10.1 shall be 36 inches and the minimum nominal height shall be six feet eight inches. All other exit doors and doors leading to or from enclosed stairways, shall not be less than 32 inches in nominal width nor six feet eight inches in nominal height.

Exceptions:

1. Existing Buildings: New and replacement doors are permitted to be six feet six inches in nominal height.
2. Sliding type doors utilized as a second means of egress shall not be less than six feet six inches in nominal height.

3603.11.2 Interior Doors: All doors providing access to habitable rooms shall have a minimum nominal width of 30 inches and a minimum nominal height of six feet six inches.

Exception:

1. Doors providing access to bathrooms are permitted to be 28 inches in nominal width.
2. Existing Buildings: Doors providing access to bathrooms are permitted to be 24 inches in nominal width.

780 CMR 3603.12 LANDINGS

3603.12.1 General: A minimum of three foot by three foot (914 mm by 914 mm) landing or open floor area shall be provided at the interior side of all exit doors. A minimum 48 inches wide by 42 inches deep landing shall be provided on the exterior side of all exit doors. The floor area or landing shall not be more than 1½ inches (38 mm) lower than the top of the threshold on the interior side, nor more than 8¼ inches lower than the threshold on the exterior side.

Exceptions:

1. At the top of a flight of interior stairs, on the stairway side, provided the door does not swing over the stairs.
2. For sliding type doors, or other doors where the threshold is located eight inches or less above the adjacent exterior finished grade.

780 CMR 3603.13 STAIRWAYS

3603.13.1 Width: Stairways shall not be less than 36 inches (914 mm) in clear width at all points above the permitted handrail height and below the required headroom height. The minimum width at and below the handrail height shall not be less than 32 inches (813 mm) where a handrail is installed on one side and 28 inches (711 mm) where handrails are provided on both sides.

3603.13.2 Treads and risers: The maximum riser height shall be 8¼ inches (210 mm) and the minimum tread depth shall be nine inches (229 mm). The riser height shall be measured vertically between leading edges of the adjacent treads. The tread depth shall be measured horizontally between the vertical planes of the foremost projection of adjacent treads and at a right angle to the tread's leading edge. The walking surface of treads and landings of a stairway shall be sloped no steeper than one unit vertical in 48 units horizontal (2% slope). The greatest riser height within any flight of stairs shall not exceed the smallest by more than ⅜ inch (9.5 mm) and any two successive risers shall not deviate by more than $^3/_{16}$-inch in height. The greatest tread depth within any flight of stairs shall not exceed the smallest by more than ⅜ inch (9.5 mm) and any two successive treads shall not deviate in depth by more than $^3/_{16}$-inch.

3603.13.2.1 Nosings: Nosings shall not project more than 1½ inches beyond the face of the riser below.

3603.13.3 Headroom: The minimum headroom in all parts of the stairway shall not be less than six feet six inches (1981 mm) measured vertically from the sloped plane adjoining the tread nosing or from the floor surface of the landing or platform.

3603.13.4 Winders: Winders are permitted, provided that the width of the tread at a point not more than 12 inches (305 mm) from the side where the treads are narrower is equal to the tread depth of the straight run portion of the stairs and the minimum width of any tread is not less than six inches (153 mm). The continuous handrail required by 780 CMR 3603.14.1 shall be located on the side where the tread is narrower.

3603.13.5 Spiral stairs: Spiral stairways are permitted, provided the minimum width shall be 26 inches (660 mm) with each tread having a 7½-inch

(190 mm) minimum tread width at 12 inches (305 mm) from the narrow edge. All treads shall be identical, and the rise shall be no more than 9½ inches (241 mm). A minimum headroom of six feet six inches (1982 mm) shall be provided.

3603.13.6 Circular stairways: Circular stairways shall have a minimum tread depth and a maximum riser height in accordance with 780 CMR 3603.13.2 and the smaller radius shall not be less than twice the width of the stairway. The minimum tread depth of ten inches (254 mm) shall be measured from the narrower end.

3603.13.7 Illumination: All stairways shall be provided with artificial illumination in accordance with 780 CMR 3603.6.1 (exception 2).

780 CMR 3603.14 HANDRAILS AND GUARDRAILS

3603.14.1 Handrails:

3603.14.1.1 Handrails: Handrails having minimum and maximum heights of 30 inches and 38 inches (762 mm and 965 mm), respectively, measured vertically from the nosing of the treads, shall be provided on at least one side of stairways of three or more risers. Spiral stairways shall have the required handrail located on the outside radius. All required handrails shall be continuous the full length of the stairs. Ends shall be returned or shall terminate in newel posts or safety terminals. Handrails adjacent to a wall shall have a space of not less than 1½ inches (38 mm) between the wall and the handrail.

Exceptions:

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

3603.14.1.2 Handrail grip size: Stairway handrails shall have a circular cross section with an outside diameter of at least 1¼ inches and not greater than two inches.

Exceptions:

1. Any other shape with a perimeter dimension of at least four inches but not greater than 6¼ inches (159 mm) with the largest cross-sectional dimension not exceeding 2⅝ inches.
2. Approved handrails of equivalent graspability.

3603.14.2 Guardrails:

3603.14.2.1 Guardrail details: Porches, balconies, decks or raised floor surfaces located more than 30 inches (762 mm) above the floor or grade below shall have guardrails not less than 36 inches (914 mm) in height. Open sides of stairs with a total rise of more than 30 inches (762 mm) above the floor or grade below shall have guardrails, which may also serve as handrails, not less than 34 inches (864 mm) in height measured vertically from the nosing of the treads.

3603.14.2.2 Guardrail opening limitations: Required guardrails on open sides of stairways, balconies, porches, decks and raised floor areas, shall have intermediate rails, balusters or ornamental closures which prevent the passage of an object five inches (127 mm) or more in diameter.

Exception: Triangular spaces formed by the riser, tread and bottom rail of a guard at the open side of a stairway may be of sized to prevent the passage of a sphere six inches (153 mm)in diameter.

780 CMR 3603.15 RAMPS

3603.15.1 Maximum slope: All egress ramps shall have a maximum slope of one unit vertical in eight units horizontal (12.5% slope).

Exception 1: The maximum slope of ramps for persons with disabilities shall be one unit vertical in 12 units horizontal.

Exception 2: Where access for persons with disabilities is legally mandated, ramps shall be constructed in accordance with the requirements of 521 CMR as listed in ***Appendix A***.

3603.15.2 Guardrails and handrails: Guardrails shall be provided on both sides of all ramps and shall be constructed in accordance with 780 CMR 3603.14.2. Handrails conforming to 780 CMR 3603.14.1 shall be provided on at least one side of all ramps exceeding a slope of one unit vertical in 12 units horizontal (8% slope).

Exception 1: For persons with disabilities, handrails shall be provided on both sides of the ramp when the vertical rise between landings exceeds six inches.

Exception 2: Where access for persons with disabilities is required by statute, ordinance or bylaw, guardrails and handrails shall be provided in accordance with the requirements of 521 CMR as listed in *Appendix A*.

3603.15.3 Landing required: A minimum three-foot-by-three-foot (914 mm by 914 mm) level landing shall be provided at the top and bottom of ramps where doors open onto the ramp and where the ramp changes direction.

Exception 1: Ramps required for persons with disabilities shall not have a vertical rise greater than 30 inches between landings.

Exception 2: Where access for persons with disabilities is legally mandated, landing requirements shall conform to the requirements of 521 CMR as listed in ***Appendix A***.

780 CMR 3603.16 FIRE PROTECTION SYSTEMS

3603.16.1 General: All one and two family dwellings hereafter constructed shall be equipped with a *household fire warning system*, in accordance with the provisions of 780 CMR 3603.16. All devices shall be installed and maintained in accordance with the requirements of 780 CMR 3603.16, manufacturers instructions and listing criteria and otherwise shall be installed and maintained in accordance with Chapter 2 of NFPA 72 and 527 CMR 12.00 as listed in ***Appendix A***.

Exception: In addition to the requirements of 780 CMR 3603.16.1, two family dwellings that contain common areas such as basements, hallways and/or interior stairways that serve both dwelling units, but are not within the dwelling units shall be provided with multiple station smoke detectors or a listed control unit with automatic smoke detectors and occupant notification appliances in the following locations.

1. In all common basements.
2. In all common hallways.
3. In all common stairways on each level outside the dwelling unit doorways.

Each detection device shall cause the operation of an alarm that is clearly audible in all bedrooms over background noise levels with all intervening doors closed. Such devices shall be installed in accordance with NFPA 72 and 527 CMR 12.00 as listed in ***Appendix A***.

3603.16.2 Compatibility: All devices and/or combination of devices and equipment shall be approved and listed for the purposes for which such devices are to be utilized.

3603.16.3 Smoke detectors: All detached one- and two family buildings, including *manufactured homes* in accordance with 780 CMR 35, shall contain listed single and multiple station smoke detectors or other *household fire warning systems* in compliance with ANSI/UL 217 and/or ANSI/UL 268 (listed in Appendix A) and conforming to 780 CMR 3603.16; *such household fire warning systems* shall be installed and maintained in accordance with the requirements of 780 CMR 3603.16, manufacturers instructions and listing criteria and otherwise shall be installed and maintained in accordance with Chapter 2 of NFPA 72 and 527 CMR 12.00 as listed in ***Appendix A***.

3603.16.4 Heat detectors: (Reserved).

3603.16.5 Primary electrical power for single station and multiple station smoke detectors: Power for single and multiple station smoke detectors shall be supplied from a permanently wired connection directly to an AC primary source of power. All power for AC powered smoke detectors shall be taken from a single branch circuit which also provides other electrical service to *habitable, occupiable spaces*. The power source shall be on the supply side, ahead of any switches.

3603.16.6 Primary electrical power for other *household fire warning systems*: Low voltage *household fire warning systems* that include a listed control unit with automatic detectors and occupant notification appliances shall be powered from a permanently wired AC primary power source. Such AC primary power shall be supplied either from a dedicated branch circuit or the unswitched portion of a branch circuit also used for power and lighting of *habitable, occupiable spaces*, in accordance with the requirements of NFPA 72 and 527 CMR 12.00 as listed in ***Appendix A***.

3603.16.7 Secondary electrical power: In addition to required primary power as discussed in 780 CMR 3603.16.5 and 780 CMR 3603.16.6, all household fire warning systems shall have secondary (standby) power supplied from monitored batteries in accordance with the household fire warning equipment requirements of NFPA-72 as listed in ***Appendix A***.

3603.16.8 Required alarm notification appliances: Where more than one smoke or heat detector is required by 780 CMR 3603.16.10, all required detectors shall be installed so that the activation of any detector shall cause the alarm in all required smoke detectors in the dwelling unit to sound.

Detector activation in a dwelling unit shall not activate signals in any other dwelling unit or common areas.

3603.16.9 Alarm signaling intensity: All required alarm-sounding appliances shall have a minimum rating of 85 dBA at ten feet in accordance with the requirements of NFPA 72.

Exception: Sounding appliances directly located in bedrooms shall have a sound pressure level as low as 75 dBA at ten feet in accordance with the requirements of NFPA 72.

3603.16.10 Required smoke detector/heat detector locations: Smoke detectors shall be installed in the following locations:

1. In the immediate vicinity of bedrooms;
2. In all bedrooms;

3. In each story of a dwelling unit, including basements and cellars, but not including crawl spaces and uninhabitable attics;
4. In residential units of 1200 square feet or more, automatic fire detectors, in the form of smoke detectors shall be provided for each 1200 square feet of area or part thereof;
5. Fixed temperature heat detectors shall be installed in accordance with the requirements of 780 CMR 3603.16.4.

Exceptions:
1. In dwelling units with one or more split levels, (i.e., adjacent levels with less than one full story separation between levels) a smoke detector installed on the upper level shall suffice for the adjacent lower level unless there is an intervening door between one level and the adjacent lower level in which case smoke detectors shall be installed on both levels.
2. In buildings equipped throughout with an automatic sprinkler system, smoke detectors are not required in bedrooms.

3603.16.11 Photo electric smoke detector requirements: Any smoke detector located within 20 feet of a kitchen or within 20 feet of a bathroom containing a tub or shower shall be a photo electric type smoke detector but shall satisfy the compatibility requirements of 780 CMR 3603.16.2.

3603.16.12 Maintenance and testing: It shall be the responsibility of the *owner* to properly maintain the household fire warning system in accordance with the requirements of NFPA 72 as listed in ***Appendix A***.

3603.16.13 Additions, alterations and repairs: When one or more sleeping rooms are added or created in existing dwellings, the entire building shall be provided with smoke detectors designed and located as required for new dwellings.

For other alterations or repairs that would require a fire protection system in an existing building be upgraded, refer to 780 CMR 3404 and/or 780 CMR 3405, as applicable.

780 CMR 3603.17 FOAM PLASTIC

3603.17.1 General: The provisions of this section shall govern the requirements and uses of foam plastic insulation.

3603.17.1.1 Surface burning characteristics: Except where otherwise noted in 780 CMR 3603.17.2, all foam plastic or foam plastic cores in manufactured assemblies used in building construction shall have a flame-spread rating of not more than 75 and shall have a smoke-developed rating of not more than 450 when tested in the maximum thickness intended for use in accordance with ASTM E 84.

3603.17.1.2 Thermal barrier: Foam plastic, except where otherwise noted, shall be separated from the interior of a building by minimum ½-inch (12.7 mm) gypsum wallboard. The gypsum board shall be installed using a mechanical fastening system in accordance with 780 CMR 3607.2.3.5. Reliance on adhesives to ensure the gypsum wallboard will remain in place when exposed to fire shall be prohibited.

3603.17.2 Specific requirements: The following requirements shall apply to all uses of foam plastic unless specifically approved in accordance with 780 CMR 3603.17.3 or by other sections of 780 CMR.

3603.17.2.1 Masonry or concrete construction: Foam plastics may be used without the thermal barrier described in 780 CMR 3603.17.1.2 when the foam plastic is protected by a minimum one-inch (25 mm) thickness of masonry or concrete.

3603.17.2.2 Roofing: Foam plastic may be used in a roof-covering assembly without the thermal barrier when the foam is separated from the interior of the building by plywood or wood structural panel sheathing in accordance with 780 CMR 3608.3, not less than $^{15}/_{32}$ inch (12 mm) in thickness bonded with exterior glue and identified as Exposure 1, with edge supported by blocking or tongue-and-groove joints. The smoke-developed rating shall not be limited.

3603.17.2.3 Attics: Within an attic accessible by means of a fixed stairway, foam plastics shall be protected against ignition by 1½-inch-thick (38 mm) mineral fiber insulation, ¼-inch-thick (6.4 mm) wood structural panels, ⅜-inch (9.5 mm) particleboard, ¼-inch (6.4 mm) hardboard, or ⅜-inch (9.5 mm) gypsum wallboard, corrosion-resistant steel having a base metal thickness of 0.016 inch (0.406 mm).

3603.17.2.4 Foam-filled doors: Foam-filled doors are exempt from the requirements of 780 CMR 3603.17.

3603.17.2.5 Siding backer board: Foam plastic board of not more than ½-inch (12.7 mm) thickness may be used as siding backer board when separated from interior spaces by not less than two inches (51 mm) of mineral fiber insulation or ½-inch (12.7 mm) gypsum wallboard or installed over existing exterior wall finish in conjunction with re-siding, providing the plastic board does not have a potential heat of more than 2,000 Btu per square foot (22 720 kJ/m^2) when tested in accordance with NFiPA 259.

3603.17.2.6 Interior trim: Foam plastic trim defined as picture molds, chair rails, baseboards,

handrails, ceiling beams, door trim and window trim may be installed, provided:

1. The minimum density is 20 pounds per cubic foot (3.14 kN/m^3);
2. The maximum thickness of the trim is ½ inch (12.7 mm) and the maximum width is four inches (102 mm);
3. The trim constitutes no more than 10% of the area of any wall or ceiling, and
4. The flame-spread rating does not exceed 75 when tested per ASTM E 84. The smoke-developed rating is not limited.

3603.17.3 Specific approval: Plastic foam not meeting the requirements of 780 CMR 3603.17.1 and 3603.17.2 may be specifically approved on the basis of approved tests such as, but not limited to, a tunnel test in accordance with ASTM E 84, FM 4880, UL 1040, ASTM E 152, or UL 1715, or fire tests related to actual end-use configurations. The specific approval may be based on the end use, quantity, location and similar considerations where such tests would not be applicable or practical.

3603.17.4 Interior finish: Foam plastics which are used as interior finish shall also meet the flame-spread requirements for interior finish.

780 CMR 3603.18 INTERIOR FINISH REQUIREMENTS/FLAME SPREAD AND SMOKE DEVELOPED

3603.18.1 Wall and ceiling: Wall and ceiling finishes shall have a flame-spread classification of not greater than 200.

Exception: Flame-spread requirements for finishes shall not apply to trim defined as picture molds, chair rails, baseboards and handrails; to doors and windows or their frames; or to materials which are less than $^1/_{28}$ inch (0.907 mm) in thickness cemented to the surface of walls or ceilings if these materials have a flame-spread characteristic no greater than paper of this thickness cemented to a noncombustible backing.

3603.18.2 Smoke density: The smoke density shall not be greater than 450.

3603.18.3 Testing. Tests shall be made in accordance with ASTM E 84.

780 CMR 3603.19 INSULATION/FLAME SPREAD, SMOKE DEVELOPED/CRITICAL RADIANT FLUX

3603.19.1 Insulation: All exposed insulation materials, including facings, such as vapor barriers or breather papers installed within floor-ceiling assemblies, roof-ceiling assemblies, wall assemblies, crawl spaces and attics shall have a flame-spread rating not to exceed 25 with an accompanying smoke developed factor not to exceed 450 when tested in accordance with ASTM E 84.

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

3603.19.2 Loose-fill insulation: Loose-fill insulation-materials which cannot be mounted in the ASTM E 84 apparatus without a screen or artificial supports shall have a flame-spread rating not to exceed 25 with an accompanying smoke-developed factor not to exceed 450 when tested in accordance with CAN4-S102.2-M83.

3603.19.3 Exposed attic insulation: All exposed insulation materials installed on attic floors shall have a critical radiant flux not less than 0.12 watt per square centimeter.

3603.19.4 Testing: Tests for critical radiant flux shall be made in accordance with ASTM E 970.

780 CMR 3603.20 GLAZING

3603.20.1 Scope: The provisions of 780 CMR 3603.20 and 780 CMR 24 shall govern the materials, design, construction and quality of glass and glazing in vertical and sloped applications. For the definition of approved light-transmitting plastic, see 780 CMR 2604.1. ***Safety glazing materials shall conform to the requirements of M.G.L. c. 143, §§ 3T, 3U, and 3V, and CPSC 16 CFR; 1201, as applicable.***

3603.20.2 Marking: Each light shall bear the manufacturer's **mark** designating the type and thickness of glass. Labels may be omitted from other than safety glazing materials unless specifically required by the building official. Safety glazing shall be marked in accordance with 780 CMR 3603.20.1 ***and shall conform to the requirements of M.G.L. c. 143, §§ 3T, 3U, and 3V.*** The mark shall not be omitted from tempered glass. Each unit of tempered glass shall be permanently identified by the manufacturer's mark. The identifying mark shall be etched or ceramic fired on the glass and shall be visible when the unit is glazed.

3603.20.2.1 Identification: To qualify as glass with special performance characteristics, each unit of laminated, heat-strengthened, tempered glass shall be permanently identified by the manufacturer. The identification of tempered glass shall be etched or ceramic fired on the glass and be visible when the unit is glazed. Heat-strengthened and tempered spandrel glasses are exempted from permanent labeling. This type of glass shall be labeled with a removable paper label by the manufacturer.

3603.20.3 Louvered windows or jalousies: Regular, float, wired or patterned glass in jalousies and louvered windows shall be no thinner than nominal 3/16 inch (4.76 mm) and no longer than 48 inches (1219 mm). Exposed glass edges shall be smooth. Wired glass with wire exposed on longitudinal edges shall not be used in jalousies or louvered windows.

3603.20.4 Safety glazing:

3603.20.4.1 Human impact loads: Individual glazed areas, including glass mirrors, in hazardous locations such as those indicated in 780 CMR 2405.2 shall pass the test requirements of CPSC 16 CFR; 1201 ***and shall conform to the requirements of M.G.L. c. 143, §§ 3T, 3U and 3V, as applicable***, listed in ***Appendix A***. The requirements of this section and 780 CMR 2405.2 and 2407.0 shall apply equally to replacement glass and new glass installation. Additional requirements as specified in 780 CMR 2407.2 are to be satisfied for glass used in locations where the hazard is of a continuous nature, such as glass enclosures for sporting activities as identified in 780 CMR.

Exceptions:

1. Polished wired glass used in required fire resistance rated assemblies ***or polished wire glass used in hazardous locations such as those indicated in 780 CMR 3603.20.4.2, items 6,7,8 and 9*** shall comply with ANSI Z97.1, listed in ***Appendix A.***
2. Plastic glazing shall meet the weathering requirements of ANSI Z97.1 listed in ***Appendix A.***
3. Glass-block walls shall comply with 780 CMR 2115.0.

3603.20.4.1.1 Identification: Each light of safety glazing material installed in hazardous locations as defined in 780 CMR 3603.20.4.2 shall bear a permanent identifying mark issued by an approved agency which specifies the marking agency, whether manufacturer or installer, and the test standard.

Exceptions:

1. Polished wire glass is exempt from a permanent identifying mark provided that the distributor or the installer provides an affidavit certifying that the polished wire glass complies with ANSI Z97.1 listed in Appendix A.

2. Laminated glass is exempt from a permanent identifying mark provided that the distributor or installer provides an affidavit certifying that the laminated glass complies with CPSC 16 CFR 1201, listed in Appendix A.

3603.20.4.2 Specific hazardous locations: The following shall be considered specific hazardous locations for the purposes of glazing:

1. Glazing in ingress and means of egress doors except jalousies (see 780 CMR 2402.5).
2. Glazing in fixed and sliding panels of sliding (patio) door assemblies and panels in swinging doors.
3. Glazing in storm doors.
4. Glazing in all unframed swinging doors.
5. Glazing in doors and enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers. Glazing in any portion of a building wall enclosing these compartments where the bottom exposed edge of the glazing is less than 60 inches (1525 mm) above a standing surface.
6. Glazing in an individual fixed or operable panel adjacent to a door where the nearest exposed edge of the glazing is within a 24-inch (610 mm) arc of either vertical edge of the door in a closed position and where the bottom exposed edge of the glazing is less than 60 inches (1525 mm) above the walking surface.
7. Glazing in an individual fixed or operable panel, other than in those locations described in 780 CMR 3603.20.4.2 items 5. and 6., which meets all of the following conditions:
   a. Exposed area of an individual pane greater than nine square feet (0.84 m^2);
   b. Exposed bottom edge less than 18 inches (460 mm) above the floor:
   c. Exposed top edge greater than 36 inches (915 mm) above the floor; and
   d. One or more walking surface(s) within 36 inches (915 mm) horizontally of the plane of the glazing.
8. All glazing in guards and railings regardless of area or height above a walking surface. Included are structural baluster panels and nonstructural in-fill panels.
9. Glazing in walls and fences enclosing indoor and outdoor swimming pools where the bottom edge of the glazing on the pool side is less than 60 inches (1525 mm) above a walking surface and within 36 inches (914 mm) horizontally of a walking surface. This shall apply to single glazing and all panes in multiple glazing.

Exception: The following products, materials and uses shall not be considered specific hazardous locations:

1. Glazed openings in doors through which a three-inch (76 mm) sphere is unable to pass.
2. Assemblies of leaded glass or faceted glass and items of carved glass used for decorative purposes in locations described in 780 CMR 3603.20.4.2, items 1., 6. or 7.

3. Glazing as described in 780 CMR 3603.20.4.2, item 6., where there is an intervening wall or some other permanent barrier that will prevent a person approaching the door from accidentally striking the glazing.

4. Glazing as described in 780 CMR 3603.20.4.2, item 7., where a protective bar is installed 34 inches to 38 inches (864 mm to 965 mm) above the floor on the side of the glazing having access thereto. The bar shall be capable of withstanding a horizontal load of 50 pounds per linear foot (730 N/m) without contacting the glass and be a minimum of 1½ inches (38 mm) in height. ***The protective bar may be an applied bar or an integral part of the glazed framing dividing an upper lite from a lower lite.***

5. Outboard panes in insulating glass units and other multiple-glazed panels as described in 780 CMR 3603.20.4.2, item 7., where the bottom exposed edge of the glass is 25 feet (7620 mm) or more above any grade, roof, walking surface or other horizontal or sloped (within 45 degrees of horizontal) surface adjacent to the glass exterior.

6. Louvered windows and jalousies complying with the requirements of 780 CMR 3603.20.3.

7. Glazing, including mirrors, mounted or hung on a surface that provides a continuous backing support.

3603.20.5 Sloped glazing and skylights

3603.20.5.1 Sloped glazing: Any installation of glass or other transparent, translucent or opaque glazing material which is installed at a slope of 15 degrees (0.26 rad) or more from the vertical plane —including skylights, roofs and sloped walls—shall comply with 780 CMR 3603.20.5.

3603.20.5.2 Allowable glazing materials: Sloped glazing shall be any of the following materials, subject to the limitations specified in 780 CMR 3603.20.5.3 and the exceptions specified in 780 CMR 3603.20.5.4:

1. For monolithic glazing systems, the glazing material of the single light or layer shall be laminated glass with a minimum 30-mil (762 µm) polyvinyl butyral interlayer, wired glass, approved plastic materials, heat-strengthened glass or fully tempered glass.

2. For multiple-layer glazing systems, each light or layer shall consist of any of the glazing materials specified in 780 CMR 3603.20.5.2, item 1.

For additional requirements for plastic skylights, see 780 CMR 2608.0.

3603.20.5.3 Limitations: Where used in monolithic glazing systems, heat-strengthened glass and fully tempered glass shall have screens installed below the glazing material, subject to the exceptions in 780 CMR 3603.20.5.4, 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 four inches (102 mm) of the glass. The screens shall be constructed of a noncombustible material not thinner than No. 12 B & S Gage (0.0808 inch) with a mesh not larger than one inch (25 mm by 25 mm). In a corrosive atmosphere, structurally equivalent non-corrosive materials shall be used. Where used in multiple-layer glazing systems as the bottom glass layer over the walking surface, heat-strengthened glass, fully tempered glass and wired glass shall be equipped with screening that conforms to the requirements specified for monolithic glazing systems.

3603.20.5.4 Exceptions: In monolithic and multiple-layer sloped glazing systems, the following exceptions apply:

1. Fully tempered glass installed without protective screens where glazed between intervening floors at a slope of 30 degrees (0.52 rad) or less from the vertical plane shall have the highest point of the glass one feet (3048 mm) or less above the walking surface.

2. Screens are not required below any glazing material, including annealed glass, where the walking surface below the glazing material is permanently protected from the risk of falling glass or the area below the glazing material is not a walking surface.

3. Any glazing material, including annealed glass, is permitted to be installed without screens in the sloped glazing systems of detached greenhouses, provided that the height of the greenhouse at the ridge does not exceed 20 feet (6096 mm) above grade. Greenhouse frames shall be noncombustible if the height of the sloped glazing exceeds 20 feet (6096 mm) above grade.

4. Screens shall not be required where fully tempered glass ***or laminated glass with a 15 mil polyvinyl butyral interlayer*** is used as single glazing or as both panes in an insulating glass unit, and all of the following conditions are met:

a. Each pane of glass is 16 square feet (1.5 m^2) or less in area;

b. The highest point of the glass is 12 feet (3658 mm) or less above any walking surface or other area having access thereto; and

c. The glass thickness is $^3/_{16}$ inch (5 mm) or less.

3603.20.5.5 Curbs for skylights. All unit skylights installed in a roof with a pitch flatter than three units vertical in 12 units horizontal (25% slope) shall be mounted on a curb extending at least four inches (102 mm) above the plane of the roof.

780 CMR 3603.21 ENERGY CONSERVATION REQUIREMENTS

3603.21.1 General: All one and two family detatched buildings shall comply with the comprehensive energy requirements set forth in 780 CMR *Appendix J.*

780 CMR 3603.22 PROTECTION AGAINST DECAY AND TERMITES

3603.22.1 Required Protection: Where protection of wood members is required by 780 CMR 3603.22, protection shall be provided against decay or termite damage by the use of naturally durable or preservative-treated wood as required by 780 CMR 3603.22.0.

3603.22.2 Naturally durable wood: The term "naturally durable wood" refers to the heartwood of the following species with the exception that an occasional piece with corner sapwood is permitted if 90% or more of the width of each side on which it occurs is heartwood

Decay resistant: Redwood, cedar, black locust and black walnut.
Termite resistant: Redwood and Eastern red cedar

3603.22.3 Preservative-treated wood:

3603.22.3.1 Preservative-treated wood: The term "preservative-treated wood" refers to wood (including plywood) pressure treated with preservatives, that conforms to retention, penetration and other requirements applicable to the species, product, treatment and conditions of use in AWPA C 1, C2 and C9 listed in ***Appendix A***. Preservatives shall conform to AWPA P1/P13, P2, P5, P8 and P9 listed in ***Appendix A***. Lumber and plywood in wood foundation systems shall conform to 780 CMR 1808.3.

3603.22.3.2 Identification: All piles, poles, lumber and plywood which are required to be preservative-treated shall bear the quality mark of an approved agency that maintains continuing supervision, testing and inspection over the quality of the product. Quality-control inspection agencies for preservative-treated wood shall be certified as to competency and performance by an approved organization. Said mark shall include the following information in a legible format: identification of the inspection agency; the standard to which the product is treated; the identification of the treating plant; and the purpose for which the product has been treated. The mark shall be permanently affixed to each piece unless specifically waived by the building official.

3603.22.3.3 Moisture content: Where wood that is pressure treated with a water-borne preservative is used in enclosed locations where drying in service cannot readily occur, such wood shall be at a moisture content of 19% or less before being covered with insulation, interior wall finish, floor covering or other material.

3603.22.3.4 Fasteners: Fasteners for preservative-treated wood shall be of hot-dipped, zinc-coated, galvanized stainless steel, silicon bronze, copper or other corrosion-resistant materials. Fasteners for wood foundations shall be as required in AFPA TR7 listed in ***Appendix A***.

3603.22.4 Wood used above ground: Wood installed above ground in the locations specified in 780 CMR 3603.22.4. 1 through 3603.22.4.6 shall be naturally durable wood or preservative-treated wood treated by water-borne preservatives, and shall be treated in accordance with AWPA C2 or C9 listed in ***Appendix A*** for above-ground use.

3603.22.4.1 Joists and girders: Where wood joists or the bottom of a wood structural floor without joists are closer than 18 inches (457 mm), or wood girders are closer than 12 inches (305 mm), to the exposed ground in crawl spaces or unexcavated areas located within the perimeter of the building foundation, the floor assembly (including posts, girders, joists and subfloor) shall be of approved naturally durable or preservative-treated wood.

3603.22.4.2 Framing: All wood framing members, including wood sheathing, which rest on exterior foundation walls and are less than eight inches (203 mm) from exposed earth shall be of approved naturally durable or preservative-treated wood.

3603.22.4.3 Sleepers and sills: Sleepers and sills on a concrete or masonry slab which is in direct contact with earth shall be of approved naturally durable or preservative-treated wood.

3603.22.4.4 Girder ends: The ends of wood girders entering exterior masonry or concrete walls shall be provided with a ½-inch (13 mm) air space on top, sides and end, unless approved naturally durable or preservative-treated wood is used.

3603.22.4.5 Clearance: Clearance between wood siding and earth on the exterior of a building shall not be less than six inches (152 mm) except where

siding, sheathing and wall framing are of approved preservative-treated wood.

3603.22.4.6 Posts or columns: Posts or columns supporting permanent structures and supported by a concrete or masonry slab or footing which is in direct contact with the earth shall be of approved naturally durable or preservative-treated wood

Exceptions:

1. Posts or columns which are either exposed to the weather or located in basements or cellars, supported by concrete piers or metal pedestals projecting at least one inch (25 mm) above the slab or deck and six inches (152 mm) above exposed earth, and are separated therefrom by an impervious moisture barrier.
2. Posts or columns in enclosed crawl spaces or unexcavated areas located within the periphery of the building, supported by a concrete pier or metal pedestal at a height greater than eight inches (203 mm) from exposed ground, and are separated therefrom by an impervious moisture barrier.

3603.22.5 Wood in contact with the ground: All wood in contact with the ground (exposed earth) which supports permanent structures that are intended for human occupancy, shall be of approved naturally durable or preservative-treated wood using water-borne preservatives and shall be treated in accordance with AWPA C2 or C9 listed in *Appendix A* for ground contact, where used in the locations specified in 780 CMR 3603.22.5.1 and 3603.22.5.2.

Exception: Untreated wood is permitted where such wood is entirely below the ground water level or where continuously submerged in fresh water.

3603.22.5.1 Posts or columns: Sawn posts and columns support ing permanent structures that are intended for human occupancy and which are embedded in concrete in direct contact with the earth or embedded in concrete exposed to the weather, or in direct contact with the earth, shall be of approved preservative-treated wood.

3603.22.5.2 Wood structural members: Wood structural members that support moisture-permeable floors or roofs which are exposed to the weather-such as concrete or masonry slabs-shall be of approved naturally durable or preserva tive-treated wood unless separated from such floors or roofs by an impervious moisture barrier.

3603.22.6 Exposed Structural Members: Wood members which form the structural supports of buildings, balconies, porches, decks or similar permanent building appurtenances where 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 include, but are not limited to, the following:

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

3603.22.7 Wood used in retaining walls: Wood installed in retaining or crib walls shall be of approved preservative-treated wood treated in accordance with AWPA C2 or C9 listed in *Appendix A* for ground contact, except as indicated in 780 CMR 3603.22.7.1 through 2311.7.3.

3603.22.7.1 Untreated wood: Where the wall is not more than two feet (610 mm) in height and is separated from the lot line or a permanent building by a minimum distance equal to the height of the wall, the wall is permitted to be of untreated wood.

3603.22.7.2 Naturally durable wood on the lot line: Where a retaining wall or a crib wall is not more than two feet (610 mm) in height and is located on the lot line, approved naturally durable wood is permitted.

3603.22.7.3 Naturally durable wood separated: Where retaining wall or a crib wall is not more than four feet (1219 mm) in height and is separated from the lot line or a permanent building by a minimum distance equal to the height of the wall, approved naturally durable wood is permitted.

780 CMR 3603.23 MANUFACTURED BUILDINGS AND MANUFACTURED HOUSING

3603.23.1 Scope: ***The design, manufacture, handling, storage, transportation, assembly, construction and/or installation of manufactured buildings and manufactured building components intended for installation in the Commonwealth of Massachusetts shall be in accordance with the provisions of 780 CMR 35. Manufactured buildings or manufactured building components shall not be installed in any jurisdiction of the Commonwealth of Massachusetts unless such manufactured buildings or manufactured building components have been approved and certified in accordance with 780 CMR 35, and the Rules and Regulations for Manufactured Buildings, Manufactured Building Components and Manufactured Housing, 780 CMR R3, as listed in Appendix A.***

3603.23.2 Manufactured housing: ***When constructed in accordance with the Code of Federal Regulations (CFR) Title 24, Chapter XX -***

Office of Assistant Secretary for Housing - Federal Housing Commissioner, Department of Housing and Urban Development, Parts 3280, Manufactured home construction and safety standards, and 3282, Manufactured home procedural and enforcement regulations; manufactured housing shall be exempt from the provisions of 780 CMR 3603.23.

Exceptions:

1. Foundations for manufactured housing shall conform to 780 CMR 1806.0;

2. Additions, (when not a manufactured housing unit as defined herein) and site built modifications shall conform to applicable provisions of 780 CMR.

780 CMR 3603.24 SANITATION

3603.24.1 Plumbing and Sanitary Facilities: Every dwelling unit shall be provided with plumbing and sanitary facilities as required by 248 CMR, the Massachusetts State Plumbing and Fuel Gas Code, 105 CMR 410.000, the State Sanitary Code, listed in *Appendix A*. Water closets, baths, showers and bidets shall be located in rooms which provide privacy to the occupant.

3603.24.2 Water supply to fixtures: All plumbing fixtures shall be connected to an approved water supply, in accordance with 248 CMR as listed in *Appendix A*.

3603.24.3 Wastewater: Provision shall be made for disposal of wastewater in accordance with 248 CMR, as listed in *Appendix A*. Wastewater shall be discharged to a sanitary sewer or to an approved private sewage disposal system.

780 CMR 3603.25 ELECTRICAL REQUIREMENTS

3603.25.1 General: Every dwelling unit shall be provided with electrical facilities in accordance with the requirements of 527 CMR 12.00, the Massachusetts State Electrical Code as listed in *Appendix A*.

NON-TEXT PAGE

FOUNDATIONS

780 CMR 3604.1 GENERAL

3604.1.1 General: The provisions of 780 CMR 3604.0 shall control the design and construction of the foundation and foundation spaces for all buildings.

3604.1.2 Requirements: The foundation and its structural elements shall be capable of accommodating all superimposed live, dead and other loads according to ***780 CMR 3603.0*** and all lateral loads in accordance with the provisions of 780 CMR 36. Fills which support footings and foundations shall be designed, installed and tested in accordance with accepted engineering practice. Gravel fill used as footings for wood foundations shall comply with ***780 CMR 3604.3***.

3604.1.3 Drainage: Surface drainage shall be diverted to a storm sewer conveyance or other point of collection ***away from the foundation system*** to ***avoid*** creating a hazard. ***Finished grades shall be arranged to direct*** surface water away from ***all*** foundation walls. The ***finished*** grade shall ***slope a minimum of ½" per foot for a distance of at least six feet from the face of all foundation walls.***

Exception: Where lot lines, walls, slopes or other physical barriers ***interfere with the drainage requirements of 780 CMR 3604.1.3,*** drains or swales shall be provided to ensure ***that surface drainage is appropriately diverted*** away from the structure.

3604.1.4 Geotechnical evaluation: The ***presumptive*** load-bearing values ***defined*** in Table 3604.4.1 shall be ***used to determine soil bearing capacity for all foundation systems defined herein.***

Exception: ***Where there is evidence that*** expansive, compressible, shifting or other ***unstable*** soil characteristics ***exist,*** the building official shall require soil tests as ***necessary*** to determine the ***bearing capacity of the soil. For the purposes of this section, soils test shall be conducted in accordance with 780 CMR 1802.0.***

3604.1.5 Expansive, compressible or shifting soil: When top or subsoils are expansive, compressible or shifting, such soils shall be removed to a depth and width sufficient to assure stable moisture content in each active zone and shall not be used as fill; or stabilized within each active zone by chemical, dewatering or presaturation.

TABLE 3604.1.4
PRESUMPTIVE LOAD-BEARING VALUES OF FOUNDATION MATERIALS

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

780 CMR 3604.2 MATERIALS

3604.2.1 Wood foundations: Wood foundation systems shall be designed and installed in accordance with the provisions ***780 CMR 36***.

Exception: The provisions of 780 CMR 3604.2 for wood foundations apply only in the following situations:

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

3604.2.1.1 Fasteners: Fasteners used below grade to attach plywood to the exterior side of exterior basement or crawlspace wall studs, or fasteners used in knee wall construction, shall be of Type 304 or 316 stainless steel. Fasteners used above grade to attach plywood, and all lumber-to-lumber fasteners except those used in knee wall construction shall be of Type 304 or 316 stainless steel, silicon bronze, copper, hot-dipped galvanized (zinc coated) steel nails, or hot-tumbled galvanized (zinc coated) steel nails. Electrogalvanized steel nails and galvanized (zinc coated) steel staples shall not be permitted.

3604.2.1.2 Wood treatment: All lumber and plywood shall be treated in accordance with AWPA C22 ***as listed in Appendix A*** and shall be identified as in conformance with such standard by an approved inspection agency. Where lumber and plywood is cut or drilled after treatment, the cut surface shall be field treated with Ammoniacal Copper Arsenate (ACA), Chromated Copper Arsenate (CCA), or Copper Napthenate by repeated brushing, dipping or soaking until the wood absorbs no more preservative. Water-borne preservatives ACA and CCA Types A, B and C

shall have a minimum concentration of 3% in solution. Water-borne preservatives FCAP and ACC shall be permitted for field treatment of material originally treated with CCA and ACA water-borne preservatives, and the concentration of FCAP or ACC shall be a minimum of 5% in solution. Copper Napthenate shall be prepared with a solvent conforming to AWPA P5. The preservative concentration shall contain a minimum of 2% copper metal.

3604.2.2 Concrete: Concrete shall have a minimum specified compressive strength as shown in Table ***3604.2.2 and shall be air entrained when subject to freezing and thawing during construction. Total air content (percent by volume of concrete) shall not be less than 5% or more than 7%.***

Exception: Concrete mixtures ***used*** for exterior porches, carport slabs, and steps that will be exposed to freezing and thawing in the presence of deicing chemicals shall ***consist of*** 520 pounds (236 kg) of cement per cubic yard of concrete ***which*** meets ASTM C 150 or C 595 ***as listed in Appendix A***.

TABLE 3604.2.2
MINIMUM SPECIFIED COMPRESSIVE STRENGTH OF CONCRETE

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

For SI: 1 psi = 6.895 kPa.
1. At 28 days psi.
2. Concrete in these locations which may be subject to freezing and thawing during construction shall be air-entrained concrete in accordance with Footnote 3.
3. Concrete shall be air-entrained. Total air content (percent by volume of concrete) shall not be less than 5% or more than 7%.
4. See 780 CMR 3604.2.2. for minimum cement content.

780 CMR 3604.3 FOOTINGS

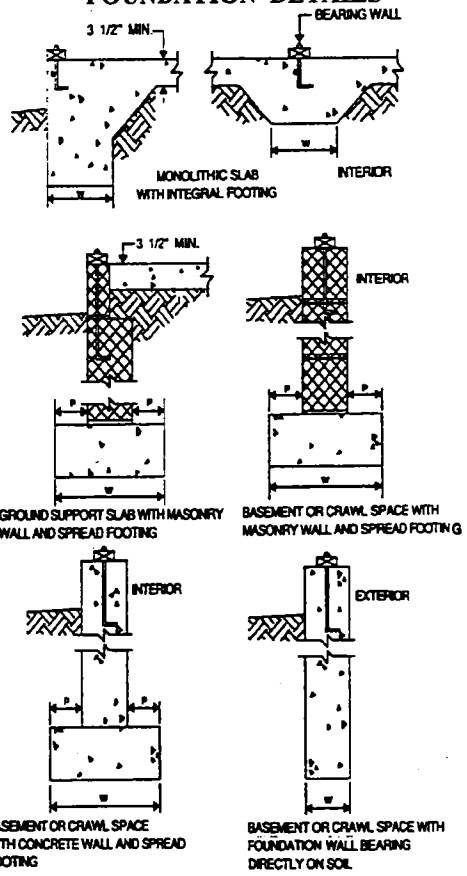
3604.3.1 General: All ***permanent supports of buildings and structures larger than 120 square feet in area or ten feet in height shall extend to minimum of four feet (1.2 m) below finished grade*** except when erected on solid rock or otherwise protected from frost, ***or when the foundation grade is established by a registered design professional and is approved by the building code official.*** Minimum sizes for concrete or masonry footings shall be as set forth in Table ***3604.3.1*** and Figure ***3604.3.1a***.

3604.3.1.1 Slope: The top surface of ***all*** footings shall be level. The bottom surface of footings may have a slope not exceeding one unit vertical in ten units horizontal (10% slope). Footings shall be stepped where it is necessary to change the elevation of the top surface of the footing, or where the slope of the bottom surface of the footing will exceed one unit vertical in ten units horizontal (10% slope).

3604.3.2 Footings for wood foundations: Footings for wood foundations shall ***comply*** with the ***applicable provisions of 780 CMR 3604.4, and*** Figures ***3604.3.1b*** and ***3604.3.1c***. ***The gravel base depicted in Figures 3604.3.1b and 3604.3.1c*** shall be washed and well graded. The maximum size stone shall not exceed ¾ inch (19 mm). Gravel shall be free from organic, clayey or silty soils. Sand shall be coarse, not smaller than 1/16-inch (1.6 mm) grains and shall be free from organic, clayey or silty soils. Crushed stone shall have a maximum size of ½ inch (12.7 mm).

3604.3.3 Insulated footings: Footings for heated buildings with slab-on-ground foundations are not required to extend below the frost line when protected from frost by insulating ***methods prescribed by*** Figure ***3604.3.3a*** and Table ***3604.3.3***. Materials used below grade for the purpose of insulating foundations against frost shall be labeled as complying with ASTM C 578.

FIGURE 3604.3.1a
CONCRETE AND MASONRY FOUNDATION DETAILS

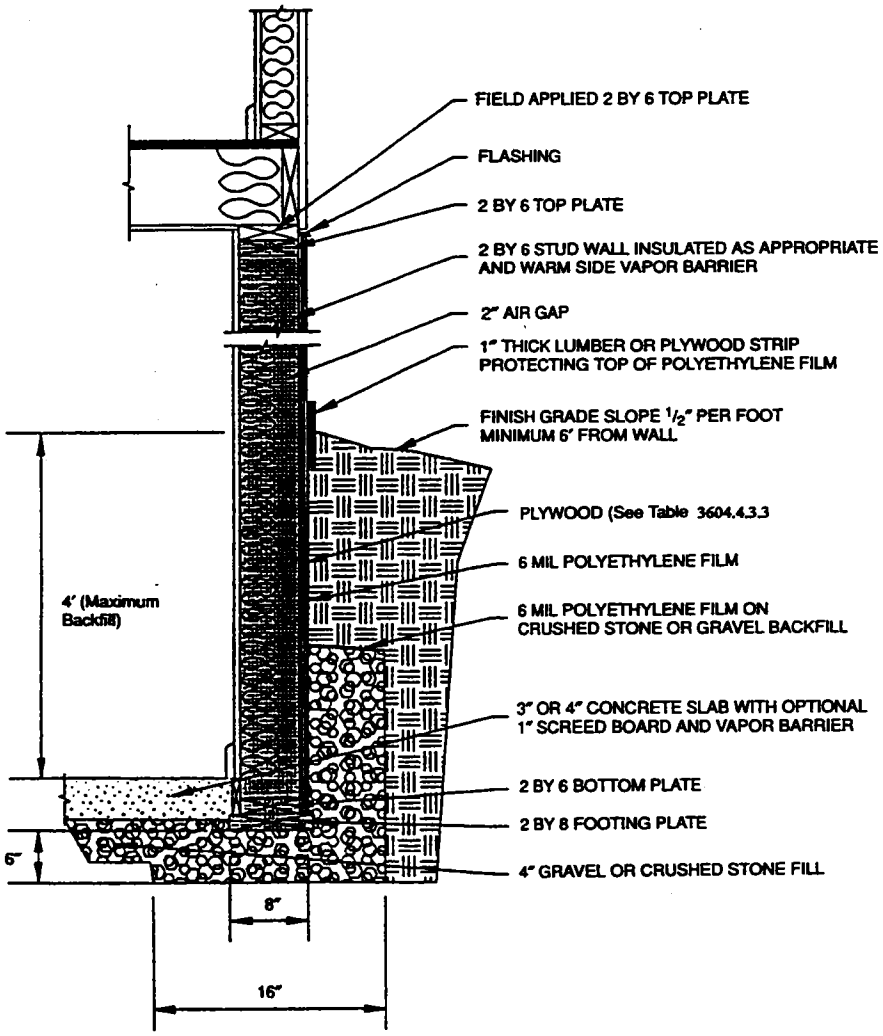


For SI 1 inch = 25.4 mm, 1 foot = 304.8 mm.

NOTES:

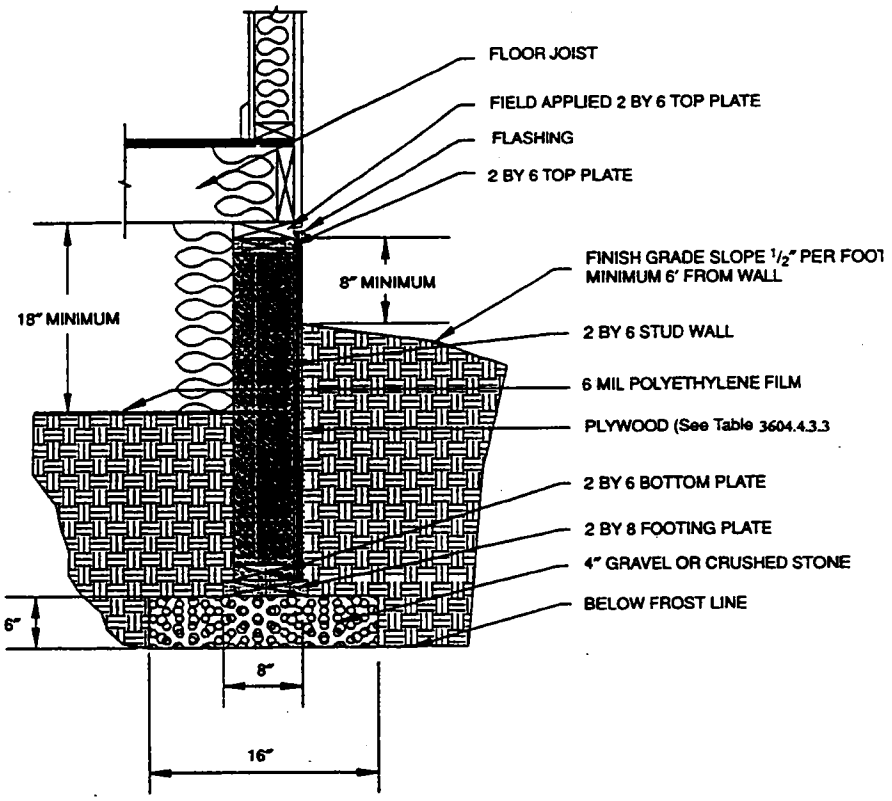
1. Exterior footings shall extend to below the frost line unless otherwise protected against frost heave. In no case shall exterior footings be less than 12 inches below grade.
2. Footing widths (*W*) shall be based on the load-bearing value of the soil in accordance with Table 3604.1.4 or shall be designed in accordance with accepted engineering practice.
3. Spread footings shall be a minimum of six inches thick, and footing projections (*P*) shall be a minimum two inches and shall not exceed the footing thickness.
4. Footings shall be supported on undisturbed natural soil or engineered fill.
5. The sill plate or floor system shall be anchored to the foundation with ½-inch-diameter bolts placed six feet on center and not more than 12 inches from corners. Bolts shall extend a minimum of 15 inches into masonry or seven inches into concrete. Sill plates shall be protected against decay where required by 780 CMR 3603.22.
6. Pier and column footing sizes shall be based on the tributary load and allowable soil pressure in accordance with Table 3605.2.3.3b.

FIGURE 3604.3.1b
TYPICAL DETAILS FOR WOOD FOUNDATION BASEMENT WALL



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

FIGURE 3604.3.1c
TYPICAL DETAILS FOR WOOD FOUNDATION CRAWL SPACE WALLS



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

TABLE 3604.3.1
MINIMUM WIDTH OF CONCRETE OR MASONRY FOOTINGS (inches)

	LOAD-BEARING VALUE OF SOIL (psf)					
	1,500	2,000	2,500	3,000	3,500	4,000
Conventional Wood Frame Construction						
1-story	16	12	10	8	7	6
2-story	19	15	12	10	8	7
3-story	22	17	14	11	10	9
4-inch Brick Veneer over Wood Frame or 8-inch Hollow Concrete Masonry						
1-story	19	15	12	10	8	7
2-story	25	19	15	13	11	10
3-story	31	23	19	16	13	12
8-inch Solid or Fully Grouted Masonry						
1-story	22	17	13	11	10	9
2-story	32	23	19	16	13	12
3-story	40	30	24	20	17	15

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

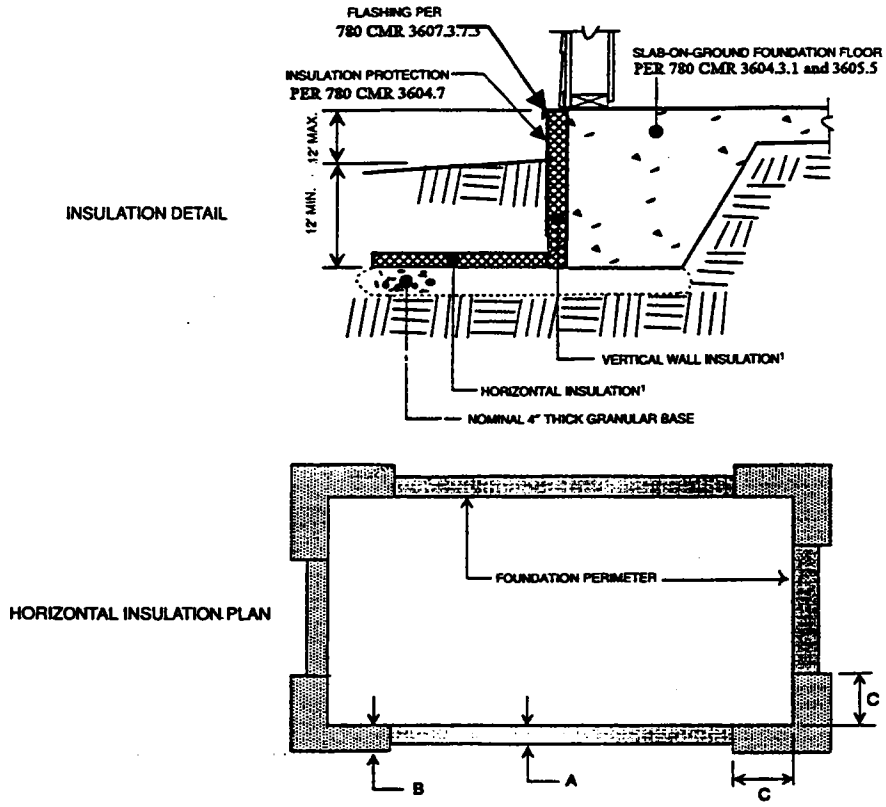
TABLE 3604.3.3
MINIMUM INSULATION REQUIREMENTS FOR FROST-PROTECTED FOOTINGS IN HEATED BUILDINGS

VERTICAL INSULATION *R*-VALUE[2,4]	HORIZONTAL INSULATION *R*-VALUE[3,5]		HORIZONTAL INSULATION DIMENSIONS PER FIGURE 3604.3.3 (inches)		
	along walls	at corners	A	B	C
4.5	NR	NR	NR	NR	NR

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

1. Insulation requirements are for protection against frost damage in heated buildings. Greater values may be required to meet energy conservation standards. Interpolation between values is permissable.
2. Air Freezing Index values based on 1,500 °F days.
3. Insulation materials shall provide the stated minimum R-values under the long term exposure to moist, below-ground conditions in freezing climates. The following R-values shall be used to determine insulation thickness required for this application: Type II expanded polystyrene - 2.4R per inch; Type IV extruded polystyrene - 4.5R per inch; Type VI extruded polystyrene - 4.5R per inch; Type IX expanded polystyrene - 3.2R per inch; Type X extruded polystyrene - 4.5R per inch. NR indicates that insulation is not required.
4. Vertical insulation shall be expanded polystyrene insulation or extruded insulation.
5. Horizontal insulation shall be extruded polystyrene insulation.

FIGURE 3604.3.3a
INSULATION PLACEMENT FOR FROST-PROTECTED FOOTINGS IN HEATED BUILDINGS



For SI: 1 inch = 25.4 mm.
1. See table 3604.3.3 for required dimensions and *R*-values for vertical and horizontal insulation.

780 CMR 3604.4 FOUNDATION WALLS

3604.4.1 Concrete and masonry foundation walls: Foundation walls shall be constructed in accordance with the provisions of 780 CMR 3604.4 or in accordance with ACI 318, ACI 318.1, NCMA TR68-A or ACI 530/ASCE 5/TMS 402 ***as listed in Appendix A,*** or other approved structural systems.

3604.4.1.1 Masonry and concrete wall construction: Masonry and concrete foundation walls shall be constructed as ***in accordance with*** Table ***3604.4.1.1a***.

Exception: Where unstable soil conditions exist or where the foundation extends to or below the seasonal high groundwater table, foundation walls shall be constructed in accordance with Table ***3604.4.1.1b***.

3604.4.1.2 Design: Foundation walls subject to more pressure than would be exerted by backfill having an equivalent fluid weight of 30 pounds per cubic foot (141 kN/m^3) shall be designed in accordance with accepted engineering practice by a registered professional engineer or registered architect.

3604.4.1.3 Grade Clearance: Foundation walls shall extend at least ***eight inches*** above the finished grade adjacent to the foundation at all points.

Exception: Where masonry veneer is used, foundation walls shall extend a minimum of four inches (102 mm) above the finished grade.

TABLE 3604.4.1.1a
MINIMUM THICKNESS AND ALLOWABLE DEPTH OF UNBALANCED FILL FOR UNREINFORCED MASONRY AND CONCRETE FOUNDATION WALLS[1,2] WHERE UNSTABLE SOIL OR GROUNDWATER CONDITIONS DO NOT EXIST

FOUNDATION WALL CONSTRUCTION	NOMINAL THICKNESS[3] (inches)	MAXIMUM DEPTH OF UNBALANCED FILL[1] (feet)
Masonry of Hollow Units, Ungrouted	8	4
	10	5
	12	6
Masonry of Solid Units	6	3
	8	5
	10	6
	12	7
Masonry of Hollow or Solid Units, Fully Grouted	8	7
	10	8
	12	8
Plain Concrete	6[4]	6
	8	7
	10	8
	12	8
Rubble Stone Masonry	16	8
Masonry of hollow units reinforced vertically, with No. 4 bars and grout at 24 inches on center. Bars located not less than 4½ inches from pressure side of wall.	8	7

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm.
1. Unbalanced fill is the difference in height of the exterior and interior finish ground levels. Where an interior concrete slab is provided, the unbalanced fill shall be measured from the exterior finish ground level to the top of the interior concrete slab.
2. The height between lateral supports shall not exceed eight feet.
3. The actual thickness shall not be more than ½ inch less than the required nominal thickness specified in the table.
4. Six-inch plain concrete walls shall be formed on both sides.

TABLE 3604.4.1.1 b
REQUIREMENTS FOR MASONRY OR CONCRETE FOUNDATION WALLS SUBJECTED TO NO MORE PRESSURE THAN WOULD BE EXERTED BY BACKFILL HAVING AN EQUIVALENT FLUID WEIGHT OF 30 POUNDS PER CUBIC FOOT OR SUBJECTED TO UNSTABLE SOIL CONDITIONS

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

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per cubic foot (pcf) = 0.1572 kN/m^3.
1 Backfilling shall not be commenced until after the wall is anchored to the floor or adequate bracing is in place.
2. Thickness of concrete walls may be six inches, provided reinforcing is placed not less than one inch or more than two inches from the face of the wall not against the earth.
3. The actual thickness shall not be more than ½ inch less than the required thickness specified in the table.
4. Solid masonry shall include solid brick or concrete units and hollow masonry units with all cells grouted.

3604.4.1.3.1 Backfill placement: Backfill adjacent to the wall shall not be placed until the wall has sufficient strength ***in accordance with 780 CMR 3604.2.2*** and has been anchored to the floor, or has been sufficiently braced to prevent damage by the backfill.

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

3604.4.2 Design required: Foundation walls subject to more lateral pressure than would be exerted by backfill consisting of freely draining sands and gravel classified as Group I according to the United States Soil Classification System or soils having an equivalent fluid weight of greater than 30 pounds per cubic foot (4.72 kN/m^3) shall be designed in accordance with accepted engineering practices by a registered professional engineer or registered architect.

3604.4.3 Wood foundation walls: Wood foundation walls shall be constructed in accordance with the provisions of *780 CMR 3604.4.3.1* through *3604.4.3.5* and with the details shown in Figures *3604.3.1b* and *3604.3.1c*.

3604.4.3.1 Wood grade: All load-bearing lumber and plywood shall conform to applicable standards or grading rules and be identified by a grade mark or certificate of inspection issued by an approved lumber or plywood grading or inspection bureau or agency. Lumber shall conform to DOC PS 20-70.

TABLE 3604.4.3.3
PLYWOOD GRADE AND THICKNESS FOR WOOD FOUNDATION CONSTRUCTION
(30 pcf equivalent-fluid weight soil pressure)

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

For SI: 1 inch = 25.4 mm, 1 pound per cubic foot = 0.1572 kN/m^3.

1. Plywood shall be of the following minimum grades in accordance with DOC PS1 or DOC PS2:
   (i) DOC PS 1 Plywood grades marked:
      a. Structural I C-D (Exposure I)
      b. C-D (Exposure I)
   (ii) DOC PS 2 Plywood grades marked:
      a. Structural I Sheathing (Exposure I)
      b. Sheathing (Exposure I)
   (iii) Where a major portion of the wall is exposed above ground and a better appearance is desired, the following plywood grades marked Exterior are suitable:
      a. Structural I A-C, Structural I B-C or Structural I C-C (Plugged) in accordance with DOC PS 1
      b. A-C Group 1, B-C Group 1, C-C (Plugged) Group 1 or MDO Group 1 in accordance with DOC PS 1
      c. Single Floor in accordance with DOC PS 2
2. Minimum thickness 15/32 inch, except crawl space sheathing may be ⅜ inch for face grain across studs 16 inches on center and maximum two foot depth of unequal fill.
3. For this fill height, thickness and grade combination, panels which are continuous over less stud spacings require blocking 16 inches above the bottom plate. Offset adjacent blocks and fasten through corrosion-resistant nails at each end.

3604.4.3.2 Stud size: The studs used in foundation walls shall be two by six (51 by 153) members. When spaced 16 inches on center, a wood species with an F_b value of not less than 1,250 psi (8612 kPa) as listed in Table *3605.2.3.1d* shall be used. When spaced 12 inches (305 mm) on center, an F_b of not less than 875 (6029 kPa) shall be required.

3604.4.3.3 Height of backfill: The height of backfill against a foundation wall shall not exceed

more than 12 inches (305 mm) above the interior grade of a crawl space or floor of a basement, the thickness of the plywood sheathing shall meet the requirements of Table *3604.4.3.3*.

3604.4.3.4 Backfilling: Wood foundation walls shall not be backfilled until the basement floor and first floor have been constructed or the walls have been braced. For crawl space construction, backfill or bracing shall be installed on the interior of the walls prior to placing backfill on the exterior.

3604.4.3.5 Drainage and dampproofing: Wood foundation basements shall be drained and dampproofed in accordance with 780 CMR 3604.5 and 780 CMR 3604.6, respectively.

780 CMR 3604.5 FOUNDATION DRAINAGE

3604.5.1 Concrete or masonry foundations: Drains shall be provided around all concrete or masonry foundations enclosing habitable or usable spaces located below grade. Drainage tiles, gravel or crushed stone drains, perforated pipe or other approved systems or materials shall be installed at or below the area to be protected and shall discharge by gravity or mechanical means into an approved drainage system. Gravel or crushed stone drains shall extend at least one foot (305 mm) beyond the outside edge of the footing and six inches (153 mm) above the top of the footing and be covered with an approved filter membrane material. The top of open joints of drain tiles shall be protected with strips of building paper, and the drainage tiles or perforated pipe shall be placed on a minimum of two inches (51 mm) of washed gravel or crushed rock at least one sieve size larger than the tile joint opening or perforation and covered with not less than six inches (153 mm) of the same material.

Exception: A drainage system is not required when the foundation is installed on well-drained ground or sand-gravel mixture soils according to the Unified Soil Classification System, Group I Soils, as detailed Table *3604.5.1*.

TABLE 3604.5.1
PROPERTIES OF SOILS CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM

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

For SI: 1 inch = 25.4 mm.
1 The percolation rate for good drainage is over four inches per hour, medium drainage is two to four inches per hour, and poor is less than two inches per hour.
2. Dangerous expansion might occur if these two soil types are dry but subject to future wetting.

3604.5.2 Wood foundations: Wood foundations enclosing habitable or usable spaces located below grade shall be adequately drained in accordance with *780 CMR 3604.5.2.1* through *3604.5.2.3*.

3604.5.2.1 Base: A porous layer of gravel, crushed stone or coarse sand shall be placed to a minimum thickness of four inches (102 mm) under the basement floor. Provision shall be made for automatic draining of this layer and the gravel or crushed stone wall footings.

3604.5.2.2 Moisture barrier: A six-mil-thick (0.15 mm) polyethylene moisture barrier shall be applied over the porous layer with the basement floor constructed over the polyethylene.

3604.5.2.3 Drainage system: In other than Group I soils, a sump shall be provided to drain the porous layer and footings. The sump shall be at least 24 inches (610 mm) in diameter or 20 inches square (0.0129 m^2), shall extend at least 24 inches (610 mm) below the bottom of the basement floor and shall be capable of positive gravity or mechanical drainage to remove any accumulated water. The drainage system shall discharge into an approved sewer system or to daylight.

780 CMR 3604.6 FOUNDATION WATERPROOFING AND DAMPPROOFING

3604.6.1 Concrete and masonry foundation dampproofing: Except where required to be waterproofed by *780 CMR 3604.6.2*, foundation walls enclosing habitable or storage space shall be dampproofed from the top of the footing to the finished grade. Masonry walls shall be dampproofed by applying not less than ⅜ inch (9.5 mm) portland cement parging to the exterior of the wall. The parging shall be covered with a bituminous coating, three pounds per square yard (1.63 kg/m^2) of acrylic modified cement, ⅛-inch (3.2 mm) coat of surface-bonding mortar complying with ASTM C 887 or any material permitted for waterproofing in *780 CMR 3604.6.2*. Concrete walls shall be dampproofed by applying any one of the above listed dampproofing materials or any one of the waterproofing materials listed in *780 CMR 3604.6.2* to the exterior of the wall.

3604.6.2 Concrete and masonry foundation waterproofing: In areas where a high water table or other severe soil-water conditions are known to exist, exterior foundation walls enclosing habitable or storage space shall be waterproofed with a membrane extending from the top of the footing to the finished grade. The membrane shall consist of two-ply hot-mopped felts, 55 pound (25 kg) roll roofing, 6-mil (0. 15 mm) polyvinyl chloride, six-mil (0.15 mm) polyethylene or 40-mil (1 mm) polymer-modified asphalt. The joints in the membrane shall be lapped and sealed with an adhesive compatible with the waterproofing membrane.

3604.6.3 Dampproofing for wood foundations: Wood foundations enclosing habitable or usable spaces located below grade shall be dampproofed in accordance with *780 CMR 3604.6.3.1* through *3604.6.3.5*.

3604.6.3.1 Panel joint sealed: Plywood panel joints in the foundation walls shall be sealed full length with a caulking compound capable of producing a moistureproof seal under the conditions of temperature and moisture content at which it will be applied and used.

3604.6.3.2 Below grade moisture barrier: A six-mil-thick (0.15 mm) polyethylene film shall be applied over the below-grade portion of exterior foundation walls prior to backfilling. Joints in the polyethylene film shall be lapped six inches (153 mm) and sealed with adhesive. The top edge of the polyethylene film shall be bonded to the sheathing to form a seal. Film areas at grade level shall be protected from mechanical damage and exposure by a pressure preservatively treated lumber or plywood strip attached to the wall several inches above finish grade level and extending approximately nine inches (229 mm) below grade. The joint between the strip and the wall shall be caulked full length prior to fastening the strip to the wall. Other coverings appropriate to the architectural treatment may also be used. The polyethylene film shall extend down to the bottom of the wood footing plate but shall not overlap or extend into the gravel or crushed stone footing.

3604.6.3.3 Porous fill: The space between the excavation and the foundation wall shall be backfilled with the same material used for footings, up to a height of one foot (305 mm) above the footing for well-drained sites, or ½ the total backfill height for poorly drained sites. The porous fill shall be covered with strips of 30-pound (13.6 kg) asphalt paper or six-mil (0.15 mm) polyethylene to permit water seepage while avoiding infiltration of fine soils.

3604.6.3.4 Backfill: The remainder of the excavated area shall be backfilled with the same type of soil as was removed during the excavation. The backfill ***shall*** be placed in six- to

eight-inch (153 mm to 203 mm) layers and compacted to consolidate the fill.

3604.6.3.5 Final grading: ***Finished grades shall conform to 780 CMR 3604.1.3.***

780 CMR 3604.7 FOUNDATION INSULATION

3604.7.1 Protection of exposed foundation insulation: Foundation walls and the edges of slab-on-ground floors with exterior applied insulation shall have a rigid, opaque and weather-resistant protective covering to prevent the degradation of thermal performance. The protective covering shall cover the exposed insulation and extend to a minimum of six inches (153 mm) below grade.

780 CMR 3604.8 COLUMNS

3604.8.1 Wood column protection: Wood columns shall be protected against decay as set forth in ***780 CMR 3603.22.***

3604.8.2 Steel column protection: All surfaces (inside and outside) of steel columns shall be given a shop coat of rust-inhibitive paint, except for corrosion-resistant steel and steel treated with coatings to provide corrosion resistance.

3604.8.3

3608.3 Structural requirements: ***All*** columns shall be restrained to prevent lateral displacement. Wood columns shall not be less in nominal size than four inches by four inches (102 mm by 102 mm) and steel columns shall not be less than three-inch-diameter (76 mm) standard pipe or approved equivalent.

780 CMR 3604.9 CRAWL SPACE

3604.9.1 Ventilation: The space between the bottom of the floor joists and the earth under any building (except such space as is occupied by a basement or cellar) shall be provided with ***a sufficient number of*** ventilation openings through foundation walls or exterior walls. ***Such*** ventilation openings shall be covered with corrosion-resistant wire mesh, the least dimension ***shall not exceed*** 1/8 inch (3.2 mm). The minimum net area of ventilation openings shall not be less than one square foot for each 150 square feet (0.67 m^2 for each 100 m^2) of crawl space area. One such ventilating opening shall be within three feet (914 mm) of each corner of the building, ***and the ventilation openings shall be positioned to provide cross ventilation.***

Exceptions:

1. The total area of ventilation openings may be reduced to 1/1,500 of the under-floor area where the ground surface is treated with an approved vapor barrier material and one such ventilation opening is within three feet (914 mm) of each corner of said buildings. The vents may have operable louvers.
2. ***If design conditions warrants,*** ventilation openings may be omitted on one side.
3. Under-floor spaces used as supply plenums for distribution of heated and cooled air shall comply with the requirements of ***780 CMR 3621 as applicable.***
4. Ventilation openings may be omitted when continuously operated mechanical ventilation is provided at a rate of 1.0 cfm for each 50 square feet (1.02 L/s for each 10 m^2) of crawl space floor area and ground surface is covered with an approved vapor barrier material.

3604.9.2 Access: An access crawl hole 18 inches by 24 inches (457 mm by 610 mm) shall be provided to the under-floor space.

3604.3 Removal of debris: The under-floor grade shall be cleaned of all vegetation and organic material. All wood forms used for placing concrete shall be removed before a building is occupied or used for any purpose.

3604.9.4 Finished grade: The finished grade of under-floor surface may be located at the bottom of the footings; however. where there is evidence that the groundwater table can rise to within six inches (153 mm) of the finished floor at the building perimeter or where there is evidence that the surface water does not readily drain from the building site, the grade in the under-floor space shall be as high as the outside finished grade. unless an approved drainage system is provided.

3604.10

Needs more Info for Columns Incl. Deck Columns

Found Anchorage

NON-TEXT PAGE

FLOORS

780 CMR 3605.1 GENERAL

3605.1.1 Application: The provisions of 780 CMR 3605.0 shall control the design and construction of the floors for all buildings. The use of materials or methods of construction not specified in 780 CMR 3605.0 accomplishing the purposes intended by 780 CMR 36 and approved by the building official in accordance with 780 CMR 109 shall be accepted as complying with 780 CMR 36.

3605.1.2 Requirements: Floor construction shall be capable of ***supporting*** all loads imposed according to ***780 CMR 3603.1*** and transmitting the resulting loads to other supporting elements.

780 CMR 3605.2 FLOOR FRAMING

3605.2.1 General: Load-bearing dimension lumber for joists, beams and girders shall conform to DOC PS 20, ***as listed in Appendix A,*** and to other applicable standards or grading rules and shall be so identified by a grade mark or certificate of inspection issued by an approved agency. The grade mark or certificate shall provide adequate information to determine *Fb*, the allowable stress in bending, and *E*, the modulus of elasticity.

Exception: Use of Native Lumber shall be allowed in accordance with 780 CMR 2303.0.

3605.2.1.1 Preservative-treated lumber: Preservative-treated dimension lumber shall also be identified by the quality mark of an approved agency.

3605.2.1.2 Blocking and subflooring: Blocking shall be a minimum of Utility grade lumber. Subflooring may be a minimum of Utility Grade lumber or No. 4 Common grade boards.

3605.2.1.3 End jointed lumber: Approved end-jointed lumber may be used interchangeably with solid-sawn members of the same species and grade.

3605.2.2 Design and construction: Floors of wood construction shall be designed and constructed in accordance with the provisions of 780 CMR 3605.2 and Figure ***3605.2.2***.

3605.2.3 Allowable spans: Joists, girders and floor sheathing shall comply with ***780 CMR 3605.2.3.1*** through ***3605.2.3.3*** and ***780 CMR 3605.3***.

3605.2.3.1 Allowable joist spans: The clear span of floor joists shall not exceed the values set forth in Tables ***3605.2.3.1a***, ***3605.2.3.1b*** and ***3605.2.3.1c***. The modulus of elasticity, E, and the actual stress in bending, F_b, shown in the tables shall not exceed the values specified in Tables ***3605.2.3.1d*** and ***3605.2.3.1e*** listed at the end of 780 CMR 3605.2. The values for F_b, specified as "repetitive member use" may be used when floor joists are spaced not more than 24 inches (610 mm) on center.

3605.2.3.2 Joists under bearing partitions: Joists under parallel bearing partitions shall be doubled or a beam of adequate size to support the load shall be provided. Double joists which are separated to permit the installation of piping or vents shall be ***provided with*** solid blocking spaced not more than four feet (1219 mm) on center.

3605.2.3.3 Allowable girder spans: The allowable spans of girders shall not exceed the values set forth in Tables ***3605.2.3.3a*** and ***3605.2.3.3b***.

3605.2.4 Bearing: The ends of ***all*** joists, beams or girders shall have not less than 1½ inches (38 mm) of bearing on wood or metal and not less than three inches (76 mm) on masonry except where supported on a one-inch-by-four-inch (25 mm by 102 mm) ribbon strip and nailed to the adjacent stud or by ***shall be supported by*** the use of approved joist hangers.

3605.2.4.1 Floor systems: Joists ***that are framed from opposite sides and extend over are a*** bearing support shall be tied together by lapping ***the ends of each*** joist a minimum of three inches (76 mm), or with a wood or metal splice ***plate***, or ***shall be secured by overlapping the floor sheathing at least three inches (76 mm) beyond the end of each floor joist***, or by other approved methods.

3605.2.4.2 Joist framing: Joists framing into the side of a wood girder shall be supported by approved framing anchors or on ledger strips ***measuring*** not less than nominal two inches by two inches (51 mm by 51 mm).

3605.2.5 Lateral restraint at supports: Joists shall be supported laterally at the ends by full-depth solid blocking not less than two inch (51 mm) ***nominal*** thickness; or by attachment to a header, band or rim joist, or to an adjoining stud; or shall be otherwise provided with lateral support to prevent rotation. Such lateral support is not required over intermediate supports such as center girders or bearing walls.

3605.2.5.1 Bridging: Joists having a depth-to-thickness ratio exceeding 6:1 based on nominal

dimensions shall be supported laterally by solid blocking, diagonal bridging (wood or metal), or a continuous one-inch-by-three-inch (25 mm by 76 mm) strip ***set perpendicularly*** across the bottom of joists ***and appropriately nailed. Bridging shall be installed*** at intervals not exceeding ***eight*** feet (2438 mm).

Exception: Cantilevered joists shall be laterally braced at points of support.

3605.2.6 Cutting and notching: It shall be unlawful to notch, cut or pierce wood beams, joists, rafters or studs in excess of the limitations specified in 780 CMR 3605.2.6, unless proven safe by structural analysis or suitably reinforced to transmit all calculated *loads*.

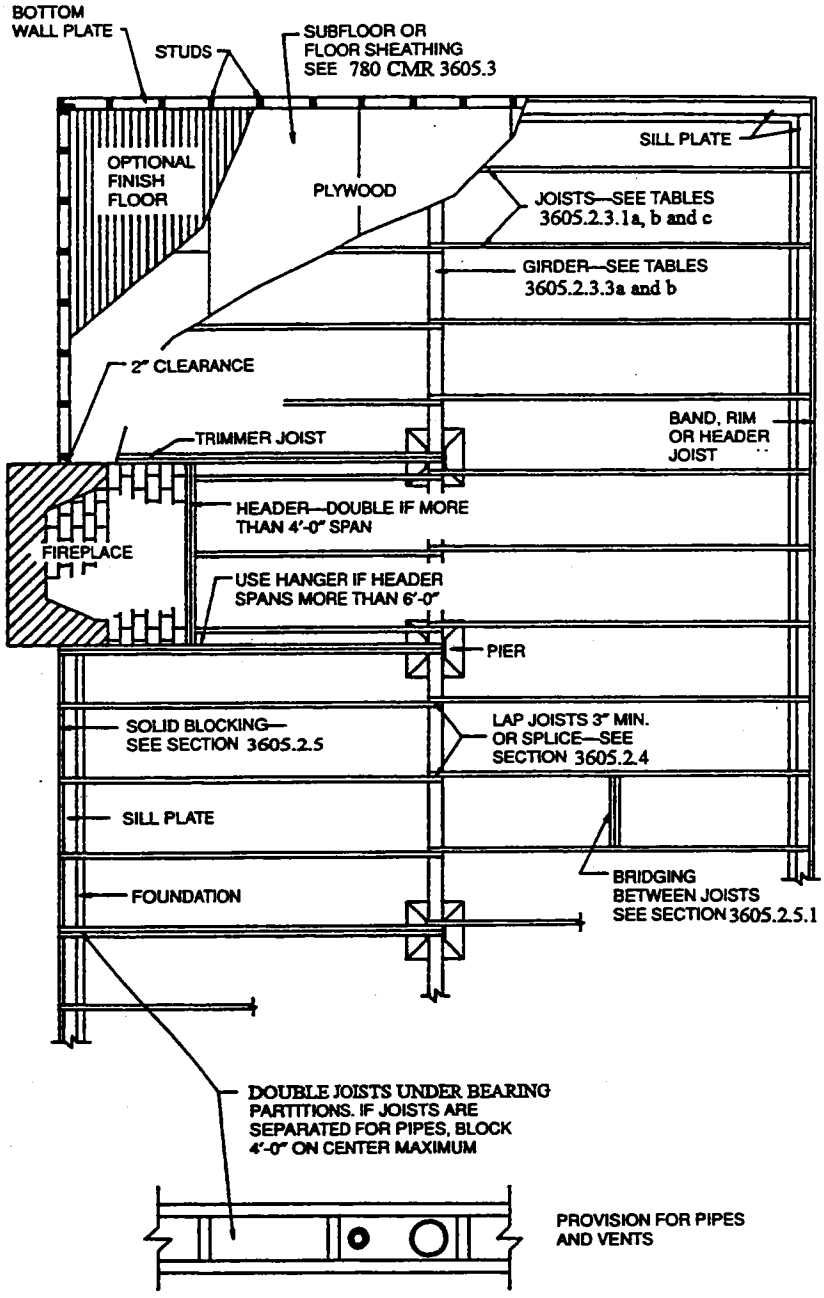
3605.2.6.1 Drilling and notches: Notches in the top or bottom of joists shall not exceed one-sixth of the depth of the joist, ***shall not be longer than one-third the depth of the member*** and shall not be located in the middle third of the span. ***Notch depth at the ends of the member*** shall not exceed one-fourth the joist depth.

Exceptions:
1. A notch over the support is permitted to extend the full width of the support.
2. Notches on cantilevered portions of the member are permitted to extend the full length of the cantilever if the strength and deflection of the cantilever is calculated based on the reduced member section.
3. The tension side of beams, joists and rafters which are four inches or greater in nominal thickness, shall not be notched, except at ends of members.

3605.2.6.2 Holes: Holes drilled, bored ***or cut*** into joists shall ***not be closer than*** two inches (51 mm) to the top or bottom of the joists, ***or to any other hole located in the joist. Where the joist is notched, the hole shall not be closer than two inches to the notch. The*** diameter ***of the hole*** shall not exceed one-third the depth of the joist.

3605.2.8 Fastening: Floor framing shall be nailed in accordance with Table ***3606.2.3a***. Where posts and beam or girder construction is used to support floor framing, positive connections shall be provided to ensure against uplift and lateral displacement.

FIGURE 3605.2.2
FLOOR CONSTRUCTION



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

TABLE 3605.2.3.1a
ALLOWABLE SPANS FOR FLOOR JOISTS
40 Lbs. per Sq. Ft. Live Load
(All rooms except those used for sleeping areas and attic floors.)

DESIGN CRITERIA:
Strength- Live load of 40 lbs. per sq. ft. plus dead load of 10 lbs. per sq. ft. determines the fiber stress value shown.
Deflection-For 40 lbs. per sq. ft. live load. Limited to span in inches divided by 360.

HOW TO USE TABLES: Enter table with span of joists (upper figure in each square). Determine size and spacing (first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

Joist Size and Spacing		MODULUS OF ELASTICITY, "E," IN 1,000,000 PSI																		
inches	inches	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2 X 6	12.0	6-9	7-3	7-9	8-2	8-6	8-10	9-2	9-6	9-9	10-0	10-3	10-6	10-9	10-11	11-2	11-4	11-7	11-11	12-3
		450	520	590	660	720	780	830	890	940	990	1,040	1,090	1,140	1,190	1,230	1,280	1,320	1,410	1,490
	16.0	6-2	6-7	7-0	7-5	7-9	8-0	8-4	8-7	8-10	9-1	9-4	9-6	9-9	9-11	10-2	10-4	10-6	10-10	11-2
		500	580	650	720	790	860	920	980	1,040	1,090	1,150	1,200	1,250	1,310	1,360	1,410	1,460	1,550	1,640
	24.0	5-4	5-9	6-2	6-6	6-9	7-0	7-3	7-6	7-9	7-11	8-2	8-4	8-6	8-8	8-10	9-0	9-2	9-6	9-9
		570	660	750	830	900	980	1,050	1,120	1,190	1,250	1,310	1,380	1,440	1,500	1,550	1,610	1,670	1,780	1,880
2 X 8	12.0	8-11	9-7	10-2	10-9	11-3	11-8	12-1	12-6	12-10	13-2	13-6	13-10	14-2	14-5	14-8	15-0	15-3	15-9	16-2
		450	520	590	660	720	780	830	890	940	990	1,040	1,090	1,140	1,190	1,230	1,280	1,320	1,410	1,490
	16.0	8-1	8-9	9-3	9-9	10-2	10-7	11-0	11-4	11-8	12-0	12-3	12-7	12-10	13-1	13-4	13-7	13-10	14-3	14-8
		500	580	650	720	790	850	920	980	1,040	1,090	1,150	1,200	1,250	1,310	1,360	1,410	1,460	1,550	1,640
	24.0	7-1	7-7	8-1	8-6	8-11	9-3	9-7	9-11	10-2	10-6	10-9	11-0	11-3	11-5	11-8	11-11	12-1	12-6	12-10
		570	660	750	830	900	980	1,050	1,120	1,190	1,250	1,310	1,380	1,440	1,500	1,550	1,610	1,670	1,780	1,880
2 X 10	12.0	11-4	12-3	13-0	13-8	14-4	14-11	15-5	15-11	16-5	16-10	17-3	17-8	18-0	18-5	18-9	19-1	19-5	20-1	20-8
		450	520	590	660	720	780	830	890	940	990	1,040	1,090	1,140	1,190	1,230	1,280	1,320	1,410	1,490
	16.0	10-4	11-1	11-10	12-5	13-0	13-6	14-0	14-6	14-11	15-3	15-8	16-0	16-5	16-9	17-0	17-4	17-8	18-3	18-9
		500	580	650	720	790	850	920	980	1,040	1,090	1,150	1,200	1,250	1,310	1,360	1,410	1,460	1,550	1,640
	24.0	9-0	9-9	10-4	10-10	11-4	11-10	12-3	12-8	13-0	13-4	13-8	14-0	14-4	14-7	14-11	15-2	15-5	15-11	16-5
		570	660	750	830	900	980	1,050	1,120	1,190	1,250	1,310	1,380	1,440	1,500	1,550	1,610	1,670	1,780	1,880
2 X 12	12.0	13-10	14-11	15-10	16-8	17-5	18-1	18-9	19-4	19-11	20-6	21-0	21-6	21-11	22-5	22-10	23-3	23-7	24-5	25-1
		450	520	590	660	720	780	830	890	940	990	1,040	1,090	1,140	1,190	1,230	1,280	1,320	1,410	1,490
	16.0	12-7	13-6	14-4	15-2	15-10	16-5	17-0	17-7	18-1	18-7	17-11	18-4	18-9	19-2	19-6	19-10	20-2	20-10	21-6
		500	580	650	720	790	860	920	980	1,040	1,090	1,220	1,280	1,330	1,390	1,440	1,500	1,550	1,650	1,750
	24.0	11-10	11-10	12-7	13-3	13-10	14-4	14-11	15-4	15-10	16-3	16-8	17-0	17-5	17-9	18-1	18-5	18-9	19-4	19-11
		570	660	750	830	900	980	1,050	1,120	1,190	1,250	1,310	1,380	1,440	1,500	1,550	1,610	1,670	1,780	1,880

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.
NOTE: The extreme fiber stress in bending, "F_b," in pounds per square inch is shown below each span.

TABLE 3605.2.3.1b
ALLOWABLE SPANS FOR FLOOR JOISTS
30 Lbs per Sq. Ft. Live Load
(All rooms used for sleeping areas and attic floors.)

DESIGN CRITERIA:
Strength- 10 lbs. per sq. ft. dead load plus 30 lbs. per sq. live load determines fiber stress value shown.
Deflection-For 30 lbs. per sq. ft. live load. Limited to span in inches divided by 360.

HOW TO USE TABLES: Enter table with span of joists (Upper figure in each square). Determine size and spacing(first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

Joist Size and Spacing		MODULUS OF ELASTICITY, "E," IN 1,000,000 PSI																		
inches	inches	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2 X 6	12.0	7-5	8-0	8-6	8-11	9-4	9-9	10-1	10-5	10-9	11-0	11-3	11-7	11-10	12-0	12-3	12-6	12-9	13-1	13-6
		440	510	570	640	700	750	810	860	910	960	1,010	1,060	1,100	1,150	1,200	1,240	1,280	1,370	1,450
	16.0	6-9	7-3	7-9	8-2	8-6	8-10	9-2	9-6	9-9	10-0	10-3	10-6	10-9	10-11	11-2	11-4	11-7	11-11	12-3
		480	560	630	700	770	830	890	950	1,000	1,060	1,110	1,160	1,220	1,270	1,320	1,360	1,410	1,500	1,590
	24.0	5-11	6-4	6-9	7-1	7-5	7-9	8-0	8-3	8-6	8-9	8-11	9-2	9-4	9-7	9-9	9-11	10-1	10-5	10-9
		550	640	720	800	880	950	1,020	1,080	1,150	1,210	1,270	1,330	1,390	1,450	1,510	1,560	1,620	1,720	1,820
2 X 8	12.0	9-10	10-7	11-3	11-10	12-4	12-10	13-4	13-9	14-2	14-6	14-11	15-3	15-7	15-10	16-2	16-6	16-9	17-4	17-10
		440	510	570	640	700	750	810	860	910	960	1,010	1,060	1,100	1,150	1,200	1,240	1,280	1,370	1,450
	16.0	8-11	9-7	10-2	10-9	11-3	11-8	12-1	12-6	12-10	13-2	13-6	13-10	14-2	14-5	14-8	15-0	15-3	15-9	16-2
		480	560	630	700	770	830	890	950	1,000	1,060	1,110	1,160	1,220	1,270	1,320	1,360	1,410	1,500	1,590
	24.0	7-9	8-5	8-11	9-4	9-10	10-2	10-7	10-11	11-3	11-6	11-10	12-1	12-4	12-7	12-10	13-1	13-4	13-9	14-2
		550	640	720	800	880	950	1,020	1,080	1,150	1,210	1,270	1,330	1,390	1,450	1,510	1,560	1,620	1,720	1,820
2 X 10	12.0	12-6	13-6	14-4	15-1	15-9	16-5	17-0	17-6	18-0	18-6	19-0	19-5	19-10	20-3	20-8	21-0	21-5	22-1	22-9
		440	510	570	640	700	750	810	860	910	960	1,010	1,060	1,100	1,150	1,200	1,240	1,280	1,370	1,450
	16.0	11-4	12-3	13-0	13-8	14-4	14-11	15-5	15-11	16-5	16-10	17-3	17-8	18-0	18-5	18-9	19-1	19-5	20-1	20-8
		480	560	630	700	770	830	890	950	1,000	1,060	1,110	1,160	1,220	1,270	1,320	1,360	1,410	1,500	1,590
	24.0	9-11	10-8	11-4	11-11	12-6	13-0	13-6	13-11	14-4	14-8	15-1	15-5	15-9	16-1	16-5	16-8	17-0	17-6	18-0
		550	640	720	800	880	950	1,020	1,080	1,150	1,210	1,270	1,330	1,390	1,450	1,510	1,560	1,620	1,720	1,820
2 X 12	12.0	15-2	16-5	17-5	18-4	19-2	19-11	20-8	21-4	21-11	22-6	23-1	23-7	24-2	24-8	25-1	25-7	26-0	26-10	27-8
		440	510	570	640	700	750	810	860	910	960	1,010	1,060	1,100	1,150	1,200	1,240	1,280	1,370	1,450
	16.0	13-10	14-11	15-10	16-8	17-5	18-1	18-9	19-4	19-11	20-6	21-0	21-6	21-11	22-5	22-10	23-3	23-7	24-5	25-1
		480	560	630	700	770	830	890	950	1,000	1,060	1,110	1,160	1,220	1,270	1,320	1,360	1,410	1,500	1,590
	24.0	12-1	13-0	13-10	14-7	15-2	15-10	16-5	16-11	17-5	17-11	18-4	18-9	19-2	19-7	19-11	20-3	20-8	21-4	21-11
		550	640	720	800	880	950	1,020	1,080	1,150	1,210	1,270	1,330	1,390	1,450	1,510	1,560	1,620	1,720	1,820

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.
NOTE: The extreme fiber stress in bending, "F_b," in pounds per square inch is shown below each span.

TABLE 3605.2.3.1c
ALLOWABLE SPANS FOR FLOOR JOISTS IN DECKS AND BALCONIES
60 Lbs per square foot Live Load

DESIGN CRITERIA:
Strength - Live load of 60 psf plus dead load of 10 psf determines the fiber stress value shown.
Deflection - Live load of 60 psf. Limited to span (in inches) divided by 360.

HOW TO USE TABLES:
Enter table with span of joists (upper figure in each square). Determine size and spacing (first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

Joist Size and Spacing inches		MODULUS OF ELASTICITY, "E", IN 1,000,000 PSI																
		0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4
2x6	12	7-5	7-9	8-0	8-3	8-6	8-9	8-11	9-2	9-4	9-7	9-9	9-11	10-1	10-3	10-5	10-7	10-9
		767	830	890	949	1005	1061	1114	1167	1218	1268	1317	1366	1413	1460	1506	1551	1596
	16	6-9	7-0	7-3	7-6	7-9	7-11	8-2	8-4	8-6	8-8	8-10	9-0	9-2	9-4	9-6	9-7	9-9
		844	913	980	1044	1107	1167	1226	1284	1341	1396	1450	1503	1556	1607	1658	1707	1757
	24	5-11	6-2	6-4	6-7	6-9	6-11	7-1	7-3	7-5	7-7	7-9	7-10	8-0	8-2	8-3	8-5	8-6
		967	1046	1122	1195	1267	1336	1404	1470	1535	1598	1660	1721	1781	1848	1897	1995	2011
2x8	12	9-10	10-2	10-7	10-11	11-3	11-6	11-10	12-1	12-4	12-7	12-10	13-1	13-4	13-6	13-9	13-11	14-2
		767	830	890	949	1005	1061	1114	1167	1218	1268	1317	1366	1413	1460	1506	1551	1596
	16	8-11	9-3	9-7	9-11	10-2	10-6	10-9	11-0	11-3	11-5	11-8	11-11	12-1	12-3	12-6	12-8	12-10
		844	913	980	1044	1107	1167	1226	1284	1341	1396	1450	1503	1556	1607	1658	1707	1757
	24	7-9	8-1	8-5	8-8	8-11	9-2	9-4	9-7	9-10	10-0	10-2	10-5	10-7	10-9	10-11	11-1	11-3
		967	1046	1122	1195	1267	1336	1404	1470	1535	1598	1660	1721	1781	1848	1897	1995	2011
2x10	12	12-6	13-0	13-6	13-11	14-4	14-8	15-1	15-5	15-9	16-1	16-5	16-8	17-0	17-3	17-6	17-9	18-0
		767	830	890	949	1005	1061	1114	1167	1218	1268	1317	1366	1413	1460	1506	1551	1596
	16	11-4	11-10	12-3	12-8	13-0	13-4	13-8	14-0	14-4	14-7	14-11	15-2	15-5	15-8	15-11	16-2	16-5
		844	913	980	1044	1107	1167	1226	1284	1341	1396	1450	1503	1556	1607	1658	1707	1757
	24	9-11	10-4	10-8	11-0	11-4	11-8	11-11	12-3	12-6	12-9	13-0	13-3	13-6	13-8	13-11	14-1	14-4
		967	1046	1122	1195	1267	1336	1404	1470	1535	1598	1660	1721	1781	1848	1897	1995	2011
2x12	12	15-2	15-10	16-5	16-11	17-5	17-11	18-4	18-9	19-2	19-7	19-11	20-3	20-8	21-0	21-4	21-7	21-11
		767	830	890	949	1005	1061	1114	1167	1218	1268	1317	1366	1413	1460	1506	1551	1596
	16	13-10	14-4	14-11	15-4	15-10	16-3	16-8	17-0	17-5	17-9	18-1	18-5	18-9	19-1	19-4	19-8	19-11
		844	913	980	1044	1107	1167	1226	1284	1341	1396	1450	1503	1556	1607	1658	1707	1757
	24	12-1	12-7	13-0	13-5	13-10	14-2	14-7	14-11	15-2	15-6	15-10	16-1	16-5	16-8	16-11	17-2	17-5
		967	1046	1122	1195	1267	1336	1404	1470	1535	1598	1660	1721	1781	1848	1897	1995	2011

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.
NOTE: The extreme fiber stress in bending, "F_b," in pounds per square inch is shown below each span.

Need more info on Deck construction ie Band Joist size Column spacing

TABLE 3605.2.3.1d
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

These "F_b" values are for use where three or more repetitive members are spaced not more than 24 inches apart. For wider spacing or for single or double member headers or beams, the "F_b" values should be reduced 13%. Values for surfaced dry or surfaced green lumber apply at 19% maximum moisture content in use.

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "Fb"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
ASPEN						
Select Structural	2" x 4"	1,510	1,735	1,885	1,100,000	Northeastern Lumber Manufacturers Association Northern Softwood Lumber Bureau Western Wood Products Association (See Footnotes 1 and 2)
No. 1		1,080	1,240	1,350	1,100,000	
No. 2		1,035	1,190	1,295	1,000,000	
No. 3		605	695	755	900,000	
Stud		600	690	750	900,000	
Construction		805	925	1,005	900,000	
Standard		430	495	540	900,000	
Utility		200	230	250	800,000	
Select Structural	2"x 6"	1,310	1,505	1,635	1,100,000	
No. 1		935	1,075	1,170	1,100,000	
No. 2		895	1,030	1,120	1,000,000	
No. 3		525	600	655	900,000	
Stud		545	630	685	900,000	
Select Structural	2" x 8"	1,210	1,390	1,510	1,100,000	
No. 1		865	990	1,080	1,100,000	
No. 2		830	950	1,035	1,000,000	
No. 3		485	555	605	900,000	
Select Structural	2"x 10"	1,105	1,275	1,385	1,100,000	
No. 1		790	910	990	1,100,000	
No. 2		760	875	950	1,000,000	
No. 3		445	510	555	900,000	
Select Structural	2" x 12"	1,005	1,155	1,260	1,100,000	
No. 1		720	825	900	1,100,000	
No. 2		690	795	865	1,000,000	
No. 3		405	465	505	900,000	
BEECH - BIRCH - HICKORY						
Select Structural	2" x 4"	2,500	2,875	3,125	1,700,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2)
No. 1		1,810	2,085	2,265	1,600,000	
No. 2		1,725	1,985	2,155	1,500,000	
No. 3		990	1,140	1,240	1,300,000	
Stud		980	1,125	1,225	1,300,000	
Construction		1,325	1,520	1,655	1,400,000	
Standard		750	860	935	1,300,000	
Utility		345	395	430	1,200,000	
Select Structural	2"x 6"	2,170	2,495	2,710	1,700,000	
No. 1		1,570	1,805	1,960	1,600,000	
No. 2		1,495	1,720	1,870	1,500,000	
No. 3		860	990	1,075	1,300,000	
Stud		890	1,025	1,115	1,300,000	
Select Structural	2" x 8"	2,000	2,300	2,500	1,700,000	
No. 1		1,450	1,665	1,810	1,600,000	
No. 2		1,380	1,585	1,725	1,500,000	
No. 3		795	915	990	1,300,000	
Select Structural	2"x 10"	1,835	2,110	2,295	1,700,000	
No. 1		1,330	1,525	1,660	1,600,000	
No. 2		1,265	1,455	1,580	1,500,000	
No. 3		725	835	910	1,300,000	
Select Structural	2" x 12"	1,670	1,920	2,085	1,700,000	
No. 1		1,210	1,390	1,510	1,600,000	
No. 2		1,150	1,325	1,440	1,500,000	
No. 3		660	760	825	1,300,000	

TABLE 3605.2.3.1d - continued
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "*Fb*"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
COTTONWOOD						
Select Structural	2" x 4"	1,510	1,735	1,885	1,200,000	Northeastern Lumber Manufacturers Association Northern Softwood Lumber Bureau Western Wood Products Association (See Footnotes 1 and 2)
No. 1		1,080	1,240	1,350	1,200,000	
No. 2		1,080	1,240	1,350	1,100,000	
No. 3		605	695	755	1,100,000	
Stud		600	690	750	1,000,000	
Construction		805	925	1,005	1,000,000	
Standard		460	530	575	900,000	
Utility		200	230	250	900,000	
Select Structural	2"x 6"	1,310	1,505	1,635	1,200,000	
No. 1		935	1,075	1,170	1,200,000	
No. 2		935	1,075	1,170	1,100,000	
No. 3		525	600	655	1,000,000	
Stud		545	630	685	1,000,000	
Select Structural	2" x 8"	1,210	1,390	1,510	1,200,000	
No. 1		865	990	1,080	1,200,000	
No. 2		865	990	1,080	1,100,000	
No. 3		485	555	605	1,000,000	
Select Structural	2"x 10"	1,105	1,275	1,385	1,200,000	
No. 1		790	910	910	1,200,000	
No. 2		790	910	990	1,100,000	
No. 3		445	510	555	1,000,000	
Select Structural	2" x 12"	1,005	1,155	1,260	1,200,000	
No. 1		720	825	900	1,200,000	
No. 2		720	825	900	1,100,000	
No. 3		405	465	505	1,000,000	
DOUGLAS FIR - LARCH						
Select Structural	2" x 4"	2,500	2,875	3,125	1,900,000	West Coast Lumber Inspection Bureau Western Wood Products Association (See Footnotes 1 and 2)
No. 1 & Btr		1,985	2,280	2,480	1,800,000	
No. 1		1,725	1,985	2,155	1,700,000	
No. 2		1,510	1,735	1,885	1,600,000	
No. 3		865	990	1,080	1,400,000	
Stud		855	980	1,065	1,400,000	
Construction		1,150	1,325	1,440	1,500,000	
Standard		635	725	790	1,400,000	
Utility		315	365	395	1,300,000	
Select Structural	2"x 6"	2,170	2,495	2,710	1,900,000	
No. 1 & Btr		1,720	1,975	2,150	1,800,000	
No. 1		1,495	1,720	1,870	1,700,000	
No. 2		1,310	1,505	1,635	1,600,000	
No. 3		750	860	935	1,400,000	
Stud		775	895	970	1,400,000	
Select Structural	2" x 8"	2,000	2,300	2,500	1,900,000	
No. & Btr		1,585	1,825	1,985	1,800,000	
No. 1		1,380	1,585	1,725	1,700,000	
No. 2		1,210	1,390	1,510	1,600,000	
No. 3		690	795	865	1,400,000	
Select Structural	2" x 10"	1,835	2,110	2,295	1,900,000	
No. 1 & Btr		1,455	1,675	1,820	1,800,000	
No. 1		1,265	1,455	1,580	1,700,000	

TABLE 3605.2.3.1d - continued
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "*Fb*"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
No. 2	2" x 10"	1,105	1,275	1,385	1,600,000	
No. 3		635	725	790	1,400,000	
DOUGLAS FIR - LARCH (NORTH)						
Select Structural	2" x 4"	2,245	2,580	2,805	1,900,000	National Lumber Grades Authority (See Footnotes 1 and 2)
No. 1/ No. 2		1,425	1,635	1,780	1,600,000	
No. 3		820	940	1,025	1,400,000	
Stud		820	945	1,030	1,400,000	
Construction		1,095	1,255	1,365	1,500,000	
Standard		605	695	755	1,400,000	
Utility		290	330	360	1,300,000	
Select Structural	2"x 6"	1,945	2,235	2,430	1,900,000	
No. 1/ No. 2		1,235	1,420	1,540	1,600,000	
No. 3		710	815	890	1,400,000	
Stud		750	860	935	1,400,000	
Select Structural	2" x 8"	1,795	2,065	2,245	1,900,000	
No. 1/ No. 2		1,140	1,310	1,425	1,600,000	
No. 3		655	755	820	1,400,000	
Select Structural	2"x 10"	1,645	1,890	2,055	1,900,000	
No. 1/ No. 2		1,045	1,200	1,305	1,600,000	
No. 3		600	690	750	1,400,000	
Select Structural	2" x 12"	1,495	1,720	1,870	1,900,000	
No. 1/ No. 2		950	1,090	1,185	1,600,000	
No. 3		545	630	685	1,400,000	
DOUGLAS FIR - SOUTH						
Select Structural	2" x 4"	2,245	2,580	2,805	1,400,000	Western Wood Products Association (See footnotes 1 and 2)
No. 1		1,555	1,785	1,940	1,300,000	
No. 2		1,425	1,635	1,780	1,200,000	
No. 3		820	940	1,025	1,100,000	
Stud		820	945	1,030	1,100,000	
Construction		1,065	1,225	1,330	1,200,000	
Standard		605	695	755	1,100,000	
Utility		290	330	360	1,000,000	
Select Structural	2" x 6"	1,945	2,235	2,430	1,400,000	
No. 1		1,345	1,545	1,680	1,300,000	
No. 2		1,235	1,420	1,540	1,200,000	
No. 3		710	815	890	1,100,000	
Stud		750	860	935	1,100,000	
Select Structural	2" x 8"	1,795	2,065	2,245	1,400,000	
No. 1		1,240	1,430	1,555	1,300,000	
No. 2		1,140	1,310	1,425	1,200,000	
No. 3		655	755	820	1,100,000	
EASTERN SOFTWOODS						
Select Structural	2" x 4"	2,155	2,480	2,695	1,200,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2
No. 1		1,335	1,535	1,670	1,100,000	
No. 2		990	1,140	1,240	1,100,000	
No. 3		605	695	755	900,000	
Stud		570	655	710	900,000	
Construction		775	895	970	1,000,000	
Standard		430	495	540	900,000	

TABLE 3605.2.3.1d - continued
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "*Fb*"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
Utility	2" x 4"	200	230	250	800,000	
Select Structural	2"x 6"	1,870	2,150	2,335	1,200,000	Northeastern Lumber Manufacturers Association Northern Softwood Lumber Bureau (See Footnotes 1 and 2)
No. 1		1,160	1,330	1,450	1,100,000	
No. 2		860	990	1,075	1,100,000	
No. 3		525	600	655	900,000	
Stud		520	595	645	900,000	
Select Structural	2" x 8"	1,725	1,985	2,155	1,200,000	
No. 1		1,070	1,230	1,335	1,100,000	
No. 2		795	915	990	1,100,000	
No. 3		485	555	605	900,000	
Select Structural	2"x 10"	1,580	1,820	1,975	1,200,000	
No. 1		980	1,125	1,225	1,100,000	
No. 2		725	835	910	1,100,000	
No. 3		445	510	555	900,000	
Select Structural	2" x 12"	1,440	1,655	1,795	1,200,000	
No. 1		890	1,025	1,115	1,100,000	
No. 2		660	760	825	1,100,000	
No. 3		405	465	505	900,000	
EASTERN WHITE PINE						
Select Structural	2" x 4"	2,155	2,480	2,695	1,200,000	Northeastern Lumber Manufacturers Association Northern Softwood Lumber Bureau (See Footnotes 1 and 2)
No. 1		1,335	1,535	1,670	1,100,000	
No. 2		990	1,140	1,240	1,100,000	
No. 3		605	695	755	900,000	
Stud		570	655	710	900,000	
Construction		775	895	970	1,000,000	
Standard		430	495	540	900,000	
Utility		200	230	250	800,000	
Select Structural	2" x 6"	1,870	2,150	2,335	1,200,000	
No. 1		1,160	1,330	1,450	1,100,000	
No. 2		860	990	1,075	1,100,000	
No. 3		525	600	655	900,000	
Stud		520	595	645	900,000	
Select Structural	2" x 8"	1,725	1,985	2,155	1,200,000	
No. 1		1,070	1,230	1,335	1,100,000	
No. 2		795	915	990	1,100,000	
No. 3		485	555	605	900,000	
Select Structural	2" x 10"	1,580	1,820	1,975	1,200,000	
No. 1		980	1,125	1,225	1,100,000	
No. 2		725	835	910	1,100,000	
No. 3		445	510	555	900,000	
Select Structural	2" x 12"	1,440	1,655	1,795	1,200,000	
No. 1		890	1,025	1,115	1,100,000	
No. 2		660	760	825	1,100,000	
No. 3		405	465	505	900,000	
HEM - FIR						
Select Structural	2" x 4"	2,415	2,775	3,020	1,600,000	
No. 1 & Btr		1,810	2,085	2,265	1,500,000	
No. 1		1,640	1,885	2,050	1,500,000	
No. 2		1,465	1,685	1,835	1,300,000	

TABLE 3605.2.3.1d - continued
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "*Fb*"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
No. 3		865	990	1,080	1,200,000	
Stud		855	980	1,065	1,200,000	
Construction		1,120	1,290	1,400	1,300,000	
Standard		635	725	790	1,200,000	
Utility		290	330	360	1,100,000	
Select Structural		2,095	2,405	2,615	1,600,000	
No. 1 & Btr		1,570	1,805	1,960	1,500,000	
No. 1	2"x 6"	1,420	1,635	1,775	1,500,000	West Coast Lumber Inspection Bureau
No. 2		1,270	1,460	1,590	1,300,000	
No. 3		750	860	935	1,200,000	
Stud		775	895	970	1,200,000	
Select Structural		1,930	2,220	2,415	1,600,000	
No. & Btr		1,450	1,665	1,810	1,500,000	Western Wood Products Association
No. 1	2" x 8"	1,310	1,510	1,640	1,500,000	
No. 2		1,175	1,350	1,465	1,300,000	
No. 3		690	795	865	1,200,000	
Select Structural		1,770	2,035	2,215	1,600,000	(See Footnotes 1 and 2)
No. 1 & Btr		1,330	1,525	1,660	1,500,000	
No. 1	2" x 10"	1,200	1,380	1,500	1,500,000	
No. 2		1,075	1,235	1,345	1,300,000	
No. 3		635	725	790	1,200,000	
Select Structural		1,610	1,850	2,015	1,600,000	
No. 1 & Btr		1,210	1,390	1,510	1,500,000	
No. 1	2" x 12"	1,095	1,255	1,365	1,500,000	
No. 2		980	1,125	1,220	1,300,000	
No. 3		575	660	720	1,200,000	
HEM - FIR (NORTH)						
Select Structural		2,245	2,580	2,805	1,700,000	
No. 1/ No. 2		1,725	1,985	2,155	1,600,000	
No. 3		990	1,140	1,240	1,400,000	
Stud	2" x 4"	980	1,125	1,225	1,400,000	
Construction		1,325	1,520	1,655	1,500,000	
Standard		720	825	900	1,400,000	National Lumber Grades Authority
Utility		345	395	430	1,300,000	
Select Structural		1,945	2,235	2,430	1,700,000	
No. 1/ No. 2	2"x 6"	1,495	1,720	1,870	1,600,000	
No. 3		860	990	1,075	1,400,000	(See Footnotes 1 and 2)
Stud		890	1,025	1,115	1,400,000	
Select Structural		1,795	2,065	2,245	1,700,000	
No. 1/ No. 2	2" x 8"	1,380	1,585	1,725	1,600,000	
No. 3		795	915	990	1,400,000	
Select Structural		1,645	1,890	2,055	1,700,000	
No. 1/ No. 2	2"x 10"	1,265	1,455	1,580	1,600,000	
No. 3		725	835	910	1,400,000	

TABLE 3605.2.3.1d - continued
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "*Fb*"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
Select Structural	2" x 12"	1,495	1,720	1,870	1,700,000	
No. 1/ No. 2		1,150	1,325	1,440	1,600,000	
No. 3		660	760	825	1,400,000	
MIXED MAPLE						
Select Structural	2" x 4"	1,725	1,985	2,155	1,300,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2)
No. 1		1,250	1,440	1,565	1,200,000	
No. 2		1,210	1,390	1,510	1,100,000	
No. 3		690	795	865	1,000,000	
Stud		695	800	870	1,000,000	
Construction		920	1,060	1,150	1,100,000	
Standard		520	595	645	1,000,000	
Utility		260	300	325	900,000	
Select Structural	2"x 6"	1,495	1,720	1,870	1,300,000	
No. 1		1,085	1,245	1,355	1,200,000	
No. 2		1,045	1,205	1,310	1,100,000	
No. 3		600	690	750	1,000,000	
Stud		635	725	790	1,000,000	
Select Structural	2" x 8"	1,380	1,585	1,725	1,300,000	
No. 1		1,000	1,150	1,250	1,200,000	
No. 2		965	1,110	1,210	1,100,000	
No. 3		550	635	690	1,000,000	
Select Structural	2"x 10"	1,265	1,455	1,580	1,300,000	
No. 1		915	1,055	1,145	1,200,000	
No. 2		885	1,020	1,105	1,100,000	
No. 3		505	580	635	1,000,000	
Select Structural	2" x 12"	1,150	1,325	1,440	1,300,000	
No. 1		835	960	1,040	1,200,000	
No. 2		805	925	1,005	1,100,000	
No. 3		460	530	575	1,000,000	
MIXED OAK						
Select Structural	2" x 4"	1,985	2,280	2,480	1,100,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2)
No. 1		1,425	1,635	1,780	1,000,000	
No. 2		1,380	1,585	1,725	900,000	
No. 3		820	940	1,025	800,000	
Stud		790	910	990	800,000	
Construction		1,065	1,225	1,330	900,000	
Standard		605	695	755	800,000	
Utility		290	330	360	800,000	
Select Structural	2"x 6"	1,720	1,975	2,150	1,100,000	
No. 1		1,235	1,420	1,540	1,000,000	
No. 2		1,195	1,375	1,495	900,000	
No. 3		710	815	890	800,000	
Stud		720	825	900	800,000	
Select Structural	2" x 8"	1,585	1,825	1,985	1,100,000	
No. 1		1,140	1,310	1,425	1,000,000	
No. 2		1,105	1,270	1,380	900,000	
No. 3		655	755	820	800,000	

TABLE 3605.2.3.1d - continued
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "*Fb*"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
Select Structural	2"x 10"	1,455	1,675	1,820	1,100,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2)
No. 1		1,045	1,200	1,305	1,000,000	
No. 2		1,010	1,165	1,265	900,000	
No. 3		600	690	750	800,000	
Select Structural	2" x 12"	1,325	1,520	1,655	1,100,000	
No. 1		950	1,090	1,185	1,000,000	
No. 2		920	1,060	1,150	900,000	
No. 3		545	630	685	800,000	
MIXED SOUTHERN PINE						
Select Structural	2" x 4"	2,360	2,710	2,945	1,600,000	Southern Pine Manufacturers Association (See Footnotes 1 and 2)
No. 1		1,670	1,920	2,085	1,500,000	
No. 2		1,495	1,720	1,870	1,400,000	
No. 3		865	990	1,080	1,200,000	
Stud		890	1,025	1,115	1,200,000	
Construction		1,150	1,325	1,440	1,300,000	
Standard		635	725	790	1,200,000	
Utility		315	365	395	1,100,000	
Select Structural	2"x 6"	2,130	2,445	2,660	1,600,000	
No. 1		1,495	1,720	1,870	1,500,000	
No. 2		1,325	1,520	1,655	1,400,000	
No. 3		775	895	970	1,200,000	
Stud		775	895	970	1,200,000	
Select Structural	2" x 8"	2,015	2,315	2,515	1,600,000	
No. 1		1,380	1,585	1,725	1,500,000	
No. 2		1,210	1,390	1,510	1,400,000	
No. 3		720	825	900	1,200,000	
Select Structural	2"x 10"	1,725	1,985	2,155	1,600,000	
No. 1		1,210	1,390	1,510	1,500,000	
No. 2		1,065	1,225	1,330	1,400,000	
No. 3		605	695	755	1,200,000	
Select Structural	2" x 12"	1,610	1,850	2,015	1,600,000	
No. 1		1,120	1,290	1,400	1,500,000	
No. 2		1,005	1,155	1,260	1,400,000	
No. 3		575	660	720	1,200,000	
NORTHERN RED OAK						
Select Structural	2" x 4"	2,415	2,775	3,020	1,400,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2)
No. 1		1,725	1,985	2,155	1,400,000	
No. 2		1,680	1,935	2,100	1,300,000	
No. 3		950	1,090	1,185	1,200,000	
Stud		950	1,090	1,185	1,200,000	
Construction		1,265	1,455	1,580	1,200,000	
Standard		720	825	900	1,100,000	
Utility		345	395	430	1,000,000	
Select Structural	2"x 6"	2,095	2,405	2,615	1,400,000	
No. 1		1,495	1,720	1,870	1,400,000	
No. 2		1,460	1,675	1,820	1,300,000	
No. 3		820	945	1,030	1,200,000	
Stud		865	990	1,080	1,200,000	

TABLE 3605.2.3.1d - continued
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "*Fb*"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
Select Structural	2" x 8"	1,930	2,220	2,415	1,400,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2)
No. 1		1,380	1,585	1,725	1,400,000	
No. 2		1,345	1,545	1,680	1,300,000	
No. 3		760	875	950	1,200,000	
Select Structural	2"x 10"	1,770	2,035	2,215	1,400,000	
No. 1		1,265	1,455	1,580	1,400,000	
No. 2		1,235	1,420	1,540	1,300,000	
No. 3		695	800	870	1,200,000	
Select Structural	2" x 12"	1,610	1,850	2,015	1,400,000	
No. 1		1,150	1,325	1,440	1,400,000	
No. 2		1,120	1,290	1,400	1,300,000	
No. 3		635	725	790	1,200,000	
NORTHERN SPECIES						
Select Structural	2" x 4"	1,640	1,885	2,050	1,100,000	National Lumber Grades Authority (See Footnotes 1 and 2)
No. 1/ No. 2		990	1,140	1,240	1,100,000	
No. 3		605	695	755	1,000,000	
Stud		570	655	710	1,000,000	
Construction		775	895	970	1,000,000	
Standard		430	495	540	900,000	
Utility		200	230	250	900,000	
Select Structural	2"x 6"	1,420	1,635	1,775	1,100,000	
No. 1/ No. 2		860	990	1,075	1,100,000	
No. 3		525	600	655	1,000,000	
Stud		520	595	645	1,000,000	
Select Structural	2" x 8"	1,310	1,510	1,640	1,100,000	
No. 1/ No. 2		795	915	990	1,100,000	
No. 3		485	555	605	1,000,000	
Select Structural	2"x 10"	1,200	1,380	1,500	1,100,000	
No. 1/ No. 2		725	835	910	1,100,000	
No. 3		445	510	555	1,000,000	
Select Structural	2" x 12"	1,095	1,255	1,365	1,100,000	
No. 1/ No. 2		660	760	825	1,100,000	
No. 3		405	465	505	1,000,000	
NORTHERN WHITE CEDAR						
Select Structural	2" x 4"	1,335	1,535	1,670	800,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2)
No. 1		990	1,140	1,240	700,000	
No. 2		950	1,090	1,185	700,000	
No. 3		560	645	700	600,000	
Stud		540	620	670	600,000	
Construction		720	825	900	700,000	
Standard		405	465	505	600,000	
Utility		200	230	250	600,000	
Select Structural	2"x 6"	1,160	1,330	1,450	800,000	
No. 1		860	990	1,075	700,000	
No. 2		820	945	1,030	700,000	
No. 3		485	560	605	600,000	
Stud		490	560	610	600,000	

TABLE 3605.2.3.1d - continued
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "*Fb*"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
Select Structural	2" x 8"	1,070	1,230	1,335	800,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2)
No. 1		795	915	990	700,000	
No. 2		760	875	950	700,000	
No. 3		450	515	560	600,000	
Select Structural	2"x 10"	980	1,125	1,225	800,000	
No. 1		725	835	910	700,000	
No. 2		695	800	870	700,000	
No. 3		410	475	515	600,000	
Select Structural	2" x 12"	890	1,025	1,115	800,000	
No. 1		660	760	825	700,000	
No. 2		635	725	790	700,000	
No. 3		375	430	465	800,000	
RED MAPLE						
Select Structural	2" x 4"	2,245	2,580	2,805	1,700,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2)
No. 1		1,595	1,835	1,995	1,600,000	
No. 2		1,555	1,785	1,940	1,500,000	
No. 3		905	1,040	1,130	1,300,000	
Stud		885	1,020	1,105	1,300,000	
Construction		1,210	1,390	1,510	1,400,000	
Standard		660	760	825	1,300,000	
Utility		315	365	395	1,200,000	
Select Structural	2"x 6"	1,945	2,235	2,430	1,700,000	
No. 1		1,385	1,590	1,730	1,600,000	
No. 2		1,345	1,545	1,680	1,500,000	
No. 3		785	905	980	1,300,000	
Stud		805	925	1,005	1,300,000	
Select Structural	2" x 8"	1,795	2,065	2,245	1,700,000	
No. 1		1,275	1,470	1,595	1,600,000	
No. 2		1,240	1,430	1,555	1,500,000	
No. 3		725	835	905	1,300,000	
Select Structural	2"x 10"	1,645	1,890	2,055	1,700,000	
No. 1		1,170	1,345	1,465	1,600,000	
No. 2		1,140	1,310	1,425	1,500,000	
No. 3		665	765	830	1,300,000	
Select Structural	2" x 12"	1,495	1,720	1,870	1,700,000	
No. 1		1,065	1,225	1,330	1,600,000	
No. 2		1,035	1,150	1,295	1,500,000	
No. 3		605	695	755	1,300,000	
RED OAK						
Select Structural	2" x 4"	1,985	2,280	2,480	1,400,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2)
No. 1		1,425	1,635	1,780	1,300,000	
No. 2		1,380	1,585	1,725	1,200,000	
No. 3		820	940	1,025	1,100,000	
Stud		790	910	990	1,100,000	
Construction		1,065	1,225	1,330	1,200,000	
Standard		605	695	755	1,100,000	
Utility		290	330	360	1,000,000	

TABLE 3605.2.3.1d - continued
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "*Fb*"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
Select Structural	2"x 6"	1,720	1,975	2,150	1,400,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2)
No. 1		1,235	1,420	1,540	1,300,000	
No. 2		1,195	1,375	1,495	1,200,000	
No. 3		710	815	890	1,100,000	
Stud		720	825	900	1,100,000	
Select Structural	2" x 8"	1,585	1,825	1,985	1,400,000	
No. 1		1,140	1,310	1,425	1,300,000	
No. 2		1,105	1,270	1,380	1,200,000	
No. 3		655	755	820	1,100,000	
Select Structural	2"x 10"	1,455	1,675	1,820	1,400,000	
No. 1		1,045	1,200	1,305	1,300,000	
No. 2		1,010	1,165	1,265	1,200,000	
No. 3		600	690	750	1,100,000	
Select Structural	2" x 12"	1,325	1,520	1,655	1,400,000	
No. 1		950	1,090	1,185	1,300,000	
No. 2		920	1,060	1,150	1,200,000	
No. 3		545	630	685	1,100,000	
REDWOOD						
Clear Structural	2" x 4"	3,020	3,470	3,775	1,400,000	Redwood Inspection Service (See Footnotes 1 and 2)
Select Structural		2,330	2,680	2,910	1,400,000	
Select Structural, open grain		1,900	2,180	2,370	1,100,000	
No. 1		1,680	1,935	2,100	1,300,000	
No. 1, open grain		1,335	1,535	1,670	1,100,000	
No. 2		1,595	1,835	1,995	1,200,000	
No. 2, open grain		1,250	1,440	1,565	1,000,000	
No. 3		905	1,040	1,130	1,100,000	
No. 3, open grain		735	845	915	900,000	
Stud		725	835	910	900,000	
Construction		950	1,090	1,185	900,000	
Standard		520	595	645	900,000	
Utility		260	300	325	800,000	
Clear Structural	2"x 6"	2,615	3,010	3,270	1,400,000	
Select Structural		2,020	2,320	2,525	1,400,000	
Select Structural, open grain		1,645	1,890	2,055	1,100,000	
No. 1		1,460	1,675	1,820	1,300,000	
No. 1, open grain		1,160	1,330	1,450	1,100,000	
No. 2		1,385	1,590	1,730	1,200,000	
No. 2, open grain		1,085	1,245	1,355	1,000,000	
No. 3		785	905	980	1,100,000	
No. 3, open grain		635	730	795	900,000	
Stud		660	760	825	900,000	
Clear Structural	2" x 8"	2,415	2,775	3,020	1,400,000	
Select Structural		1,865	2,140	2,330	1,400,000	
Select Structural, open grain		1,520	1,745	1,900	1,100,000	
No. 1		1,345	1,545	1,680	1,300,000	
No. 1, open grain		1,070	1,230	1,335	1,100,000	
No. 2		1,275	1,470	1,595	1,203,000	

TABLE 3605.2.3.1d - continued
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "*Fb*"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
No. 2, open grain	2"x 8"	1,000	1,150	1,250	1,000,000	Redwood Inspection Service (See Footnotes 1 and 2)
No. 3		725	835	905	1,100,000	
No. 3, open grain		585	675	735	900,000	
Clear Structural	2"x 10"	2,215	2,545	2,765	1,400,000	
Select Structural		1,710	1,965	2,135	1,400,000	
Select Structural, open grain		1,390	1,600	1,740	1,100,000	
No. 1		1,235	1,420	1,540	1,300,000	
No. 1, open grain		980	1,125	1,225	1,100,000	
No. 2		1,170	1,345	1,465	1,200,000	
No. 2, open grain		915	1,055	1,145	1,000,000	
No. 3		665	765	830	1,100,000	
No. 3, open grain		540	620	670	900,000	
Clear Structural	2" x 12"	2,015	2,315	2,515	1,400,000	
Select Structural		1,555	1,785	1,940	1,400,000	
Select Structural, open grain		1,265	1,455	1,580	1,100,000	
No. 1		1,120	1,290	1,400	1,300,000	
No. 1, open grain		890	1,025	1,115	1,100,000	
No. 2		1,065	1,225	1,330	1,200,000	
No. 2, open grain		835	960	1,040	1,000,000	
No. 3		605	695	755	1,100,000	
No. 3, open grain		490	560	610	900,000	
SOUTHERN PINE						
Dense Select Structural	2" x 4"	3,510	4,035	4,385	1,900,000	Southern Pine Inspection Bureau (See Footnotes 1 and 2)
Select Strctural		3,280	3,770	4,095	1,800,000	
Non - Dense Select Structural		3,050	3,505	3,810	1,700,000	
No. 1 Dense		2,300	2,645	2,875	1,800,000	
No. 1		2,130	2,445	2,660	1,700,000	
No. 1 Non - Dense		1,955	2,250	2,445	1,600,000	
No. 2 Dense		1,955	2,250	2,445	1,700,000	
No. 2		1,725	1,985	2,155	1,600,000	
No. 2 Non - Dense		1,555	1,785	1,940	1,400,000	
No. 3		980	1,125	1,220	1,400,000	
Stud		1,005	1,155	1,260	1,400,000	
Constrction		1,265	1,455	1,580	1,500,000	
Standard		720	825	900	1,300,000	
Utility		345	395	430	1,300,000	
Dense Select Structural	2"x 6"	3,105	3,570	3,880	1,900,000	
Select Structural		2,935	3,370	3,665	1,800,000	
Non - Dense Select Structural		2,705	3,110	3,380	1,700,000	
No. 1 Dense		2,015	2,315	2,515	1,800,000	
No. 1		1,900	2,180	2,370	1,700,000	
No. 1 Non - Dense		1,725	1,985	2,155	1,600,000	
No. 2 Dense		1,670	1,920	2,085	1,700,000	
No. 2		1,440	1,655	1,795	1,600,000	
No. 2 Non - Dense		1,325	1,520	1,655	1,400,000	

TABLE 3605.2.3.1d - continued
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "*Fb*"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
No. 3	2" x 6"	865	990	1,080	1,400,000	Southern Pine Inspection Bureau (See Footnotes 1 and 2)
Stud		890	1,025	1,115	1,400,000	
Dense Select Structural	2" x 8"	2,820	3,240	3,520	1,900,000	
Select Structural		2,645	3,040	3,305	1,800,000	
Non - Dense Select Structural		2,415	2,775	3,020	1,700,000	
No. 1 Dense		1,900	2,180	2,370	1,800,000	
No. 1		1,725	1,985	2,155	1,700,000	
No. 1 Non - Dense		1,555	1,785	1,940	1,600,000	
No. 2 Dense		1,610	1,850	2,015	1,700,000	
No. 2		1,380	1,585	1,725	1,600,000	
No. 2 Non - Dense		1,265	1,455	1,580	1,400,000	
No. 3		805	925	1,005	1,400,000	
Dense Select Structural	2"x 10"	2,475	2,845	3,090	1,900,000	
Select Structural		2,360	2,710	2,945	1,800,000	
Non - Dense Select Structural		2,130	2,445	2,660	1,700,000	
No. 1 Dense		1,670	1,920	2,085	1,800,000	
No. 1		1,495	1,720	1,870	1,700,000	
No. 1 Non - Dense		1,380	1,585	1,725	1,600,000	
No. 2 Dense		1,380	1,585	1,725	1,700,000	
No. 2		1,210	1,390	1,510	1,600,000	
No. 2 Non - Dense		1,095	1,255	1,365	1,400,000	
No. 3		690	795	865	1,400,000	
Dense Select Structural	2" x 12"	2,360	2,710	2,945	1,900,000	
Select Structural		2,185	2,515	2,730	1,800,000	
Non - Dense Select Structural		2,015	2,315	2,515	1,700,000	
No. 1 Dense		1,555	1,785	1,940	1,800,000	
No. 1		1,440	1,655	1,795	1,700,000	
No. 1 Non - Dense		1,325	1,520	1,655	1,600,000	
No. 2 Dense		1,325	1,520	1,655	1,700,000	
No. 2		1,120	1,290	1,400	1,600,000	
No. 2 Non - Dense		1,035	1,190	1,295	1,400,000	
No. 3		660	760	825	1,400,000	
SPRUCE - PINE - FIR						
Select Structural	2" x 4"	2,155	2,480	2,695	1,500,000	National Lumber Grades Authority (See Footnotes 1 and 2)
No. 1/ No. 2		1,510	1,735	1,885	1,400,000	
No. 3		865	990	1,080	1,200,000	
Stud		855	980	1,065	1,200,000	
Construction		1,120	1,290	1,400	1,300,000	
Standard		635	725	790	1,200,000	
Utility		290	330	360	1,100,000	
Select Structural	2"x 6"	1,870	2,150	2,335	1,500,000	
No. 1/ No. 2		1,310	1,505	1,635	1,400,000	
No. 3		750	860	935	1,200,000	
Stud		775	895	970	1,200,000	

TABLE 3605.2.3.1d - continued
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "*Fb*"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
Select Structural	2" x 8"	1,725	1,985	2,155	1,500,000	National Lumber Grades Authority (See Footnotes 1 and 2)
No. 1/ No. 2		1,210	1,390	1,510	1,400,000	
No. 3		690	795	865	1,200,000	
Select Structural	2"x 10"	1,580	1,820	1,975	1,500,000	
No. 1/ No. 2		1,105	1,275	1,385	1,400,000	
No. 3		635	725	790	1,200,000	
Select Structural	2" x 12"	1,440	1,655	1,795	1,500,000	
No. 1/ No. 2		1,005	1,155	1,260	1,400,000	
No. 3		575	660	720	1,200,000	
No 3. open grain		540	620	670	900,000	
SPRUCE - PINE - FIR (SOUTH)						
Select Structural	2" x 4"	2,245	2,580	2,805	1,300,000	Northeastern Lumber Manufacturers Association Northern Softwood Lumber Bureau West Coast Lumber Inspection Bureau Western Woods Products Association (See Footnotes 1 and 2)
No. 1		1,465	1,685	1,835	1,200,000	
No. 2		1,295	1,490	1,615	1,100,000	
No. 3		735	845	915	1,000,000	
Stud		725	835	910	1,000,000	
Construction		980	1,125	1,220	1,000,000	
Standard		545	630	685	900,000	
Utility		260	300	335	900,000	
Select Structural	2"x 6"	1,945	2,235	2,430	1,300,000	
No. 1		1,270	1,460	1,590	1,200,000	
No. 2		1,120	1,290	1,400	1,100,000	
No. 3		635	730	795	1,000,000	
Stud		660	760	825	1,000,000	
Select Structural	2" x 8"	1,795	2,065	2,245	1,300,000	
No. 1		1,175	1,350	1,465	1,200,000	
No. 2		1,035	1,190	1,295	1,100,000	
No. 3		585	675	735	1,000,000	
Select Structural	2"x 10"	1,645	1,890	2,055	1,300,000	
No. 1		1,075	1,235	1,345	1,200,000	
No. 2		950	1,090	1,185	1,100,000	
No. 3		540	620	670	1,000,000	
Select Structural	2" x 12"	1,495	1,720	1,870	1,300,000	
No. 1		980	1,125	1,220	1,200,000	
No. 2		865	990	1,080	1,100,000	
No. 3		490	560	610	1,000,000	
WESTERN CEDARS						
Select Structural	2" x 4"	1,725	1,985	2,155	1,100,000	West Coast Lumber Inspection Bureau Western Woods Products Association (See Footnotes 1 and 2)
No. 1		1,250	1,440	1,565	1,000,000	
No. 2		1,210	1,390	1,510	1,000,000	
No. 3		690	795	865	900,000	
Stud		695	800	870	900,000	
Construction		920	1,060	1,150	900,000	
Standard		520	595	645	800,000	
Utility		260	300	325	800,000	
Select Structural	2"x 6"	1,495	1,720	1,870	1,100,000	
No. 1		1,085	1,245	1,355	1,000,000	

TABLE 3605.2.3.1d - continued
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "*Fb*"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
No. 2	2" x 6"	1,045	1,205	1,310	1,000,000	West Coast Lumber Inspection Bureau Western Woods Products Association (See Footnotes 1 and 2)
No. 3		600	690	750	900,000	
Stud		635	725	790	900,000	
Select Structural	2" x 8"	1,380	1,585	1,725	1,100,000	
No. 1		1,000	1,150	1,250	1,000,000	
No. 2		965	1,110	1,210	1,000,000	
No. 3		550	635	690	900,000	
Select Structural	2"x 10"	1,265	1,455	1,580	1,100,000	
No. 1		915	1,055	1,145	1,000,000	
No. 2		885	1,020	1,105	1,000,000	
No. 3		505	580	635	900,000	
Select Structural	2" x 12"	1,150	1,325	1,440	1,100,000	
No. 1		835	960	1,040	1,000,000	
No. 2		805	925	1,005	1,000,000	
No. 3		460	530	575	900,000	
WESTERN WOODS						
Select Structural	2" x 4"	1,150	1,735	1,885	1,200,000	West Coast Lumber Inspection Bureau Western Woods Products Association (See Footnotes 1 and 2)
No. 1		1,120	1,290	1,400	1,100,000	
No. 2		1,120	1,290	1,400	1,000,000	
No. 3		645	745	810	900,000	
Stud		635	725	790	900,000	
Construction		835	960	1,040	1,000,000	
Standard		460	530	575	900,000	
Utility		230	265	290	800,000	
Select Structural	2"x 6"	1,310	1,505	1,635	1,200,000	
No. 1		970	1,120	1,215	1,100,000	
No. 2		970	1,120	1,215	1,000,000	
No. 3		560	645	700	900,000	
Stud		575	660	720	900,000	
Select Structural	2" x 8"	1,210	1,390	1,510	1,200,000	
No. 1		895	1,030	1,120	1,100,000	
No. 2		895	1,030	1,120	1,000,000	
No. 3		520	595	645	900,000	
Select Structural	2"x 10"	1,105	1,275	1,385	1,200,000	
No. 1		820	945	1,030	1,100,000	
No. 2		820	945	1,030	1,000,000	
No. 3		475	545	595	900,000	
Select Structural	2" x 12"	1,005	1,155	1,260	1,200,000	
No. 1		750	860	935	1,100,000	
No. 2		750	860	935	1,000,000	
No. 3		430	495	540	900,000	
WHITE OAK						
Select Structural	2" x 4"	2,070	2,380	2,590	1,100,000	West Coast Lumber Inspection Bureau Western Woods Products Association
No. 1		1,510	1,735	1,885	1,000,000	
No. 2		1,465	1,685	1,835	900,000	
No. 3		820	940	1,025	800,000	
Stud		820	945	1,030	800,000	
Construction		1,095	1,255	1,365	900,000	

TABLE 3605.2.3.1d - continued
DESIGN VALUES FOR DIMENSION LUMBER - VISUAL GRADING

SPECIES AND GRADE	SIZE	NORMAL DURATION	DESIGN VALUE IN BENDING "*Fb*"		MODULUS OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
Standard	2" x 4"	605	695	755	800,000	West Coast Lumber Inspection Bureau; Western Woods Products Association (See Footnotes 1 and 2)
Utility		290	330	360	800,000	
Select Structural	2"x 6"	1,795	2,065	2,245	1,100,000	
No. 1		1,310	1,505	1,635	1,000,000	
No. 2		1,270	1,460	1,590	900,000	
No. 3		710	815	890	800,000	
Stud		750	860	935	800,000	
Select Structural	2" x 8"	1,655	1,905	2,070	1,100,000	
No. 1		1,210	1,390	1,510	1,000,000	
No. 2		1,175	1,350	1,465	900,000	
No. 3		655	755	820	800,000	
Select Structural	2"x 10"	1,520	1,745	1,900	1,100,000	
No. 1		1,105	1,275	1,385	1,000,000	
No. 2		1,075	1,235	1,345	900,000	
No. 3		600	690	750	800,000	
Select Structural	2" x 12"	1,380	1,585	1,725	1,100,000	
No. 1		1,005	1,155	1,260	1,000,000	
No. 2		980	1,125	1,220	900,000	
No. 3		545	630	685	800,000	
YELLOW POPLAR						
Select Structural	2" x 4"	1,725	1,985	2,155	1,500,000	Northern Softwood Lumber Bureau (See Footnotes 1 and 2)
No. 1		1,250	1,440	1,565	1,400,000	
No. 2		1,210	1,390	1,510	1,300,000	
No. 3		690	795	865	1,200,000	
Stud		695	800	870	1,200,000	
Construction		920	1,060	1,150	1,300,000	
Standard		520	595	645	1,100,000	
Utility		230	265	290	1,100,000	
Select Structural	2"x 6"	1,495	1,720	1,870	1,500,000	
No. 1		1,085	1,245	1,355	1,400,000	
No. 2		1,045	1,205	1,310	1,300,000	
No. 3		600	690	750	1,200,000	
Stud		635	725	790	1,200,000	
Select Structural	2" x 8"	1,380	1,585	1,725	1,500,000	
No. 1		1,000	1,150	1,250	1,400,000	
No. 2		965	1,110	1,210	1,300,000	
No. 3		550	635	690	1,200,000	
Select Structural	2"x 10"	1,265	1,455	1,580	1,500,000	
No. 1		915	1,055	1,145	1,400,000	
No. 2		885	1,020	1,105	1,300,000	
No. 3		505	580	635	1,200,000	
Select Structural	2" x 12"	1,150	1,325	1,440	1,500,000	
No. 1		835	960	1,040	1,400,000	
No. 2		805	925	1,005	1,300,000	
No. 3		460	530	575	1,200,000	

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

1. When dimension lumber is used where moisture content will exceed 19% for an extended time period, F_b shall be multiplied by 0.85 if F_b exceeds 1,150 psi, and E shall be multiplied by 0.9.
2. Following is a list of agencies certified by the American Lumber Standards Committee Board of Review (as of 1991) for inspection and grading of untreated lumber under the rules indicated.

Rules in Writing Agencies	**Rules for which grading is authorized**
National Lumber Grades Authority (NLGA) 260-1055 W. Hastings Street Vancouver, BC V6E9 Canada	NLGA
Northeastern Lumber Manufacturers Association (NELMA) 272 Tuttle Road, P.O. Box 87A Cumberland Center, Maine 04021	NELMA, NLGA, WCLIB, WWPA, NLGA
Northern Softwood Lumber Bureau (NSLB) 272 Tuttle Road, P.O. Box 87A Cumberland Center, Maine 04021	WSLB, WCLIB, WWPA, NLGA
Redwood Inspection Service (RIS) 405 Enfrente Drive, Suite 200, Novato, California 94949	RIS,WCLIB, WWPA
Southern Pine Inspection Bureau (SPIB) 4709 Scenic Highway, Pensacola, Florida 32504	SPIB, NELMA, WCLIB, WWPA, NLGA
West Coast Lumber Inspection Bureau (WCLIB) 6980 SW Varnes Road, P.O. Box 23145 Portland, Oregon 97223	WCLIB, RIS, WWPA, NLGA, SPIB
Western Wood Products Association (WWPA) 522 S.W. 5th Avenue Yeon Building, Portland, OR 97204	WWPA, WCLIB, NLGA, RIS, SPIB
Non-Rules Writing Agencies	
California Lumber Inspection Services	RIS, WCLIB, WWPA, NLGA, SPIB
Pacific Lumber Inspection Bureau, Inc.	RIS,WCLIB,WWPA, NLGA
Timber Products Inspection	RIS, SPIB, WCLIS, WWPA
Alberta Forest Products Association	NLGA
Canadian Lumbermen's Association	NLGA, NELMA
Cariboo Lumber Manufacturers Association	NLGA
Central Forest Products Association	NLGA
Council of Forest Industries of British Columbia	NLGA
Interior Lumber Manufacturers Association	NLGA
Macdonald Inspection	NLGAS
Maritime Lumber Bureau	NLGA, NELMA
Ontario Lumber Manufacturers Association	NLGA, NELMA
Pacific Lumber Inspection Bureau	NLGA
Quebec Lumber Manufacturers Association	NLGA, NELMA

TABLE 3605.2.3.1e
DESIGN VALUES FOR DIMENSION LUMBER - MACHINE STRESS RATED

These "F_b" values are for use where repetitive members are spaced not more than 24 inches. For wider spacing, the "F_b" values should be reduced 13%. Values apply at 19% maximum moisture content in use.

GRADE DESIGNATION	GRADING RULES AGENCY (See Footnotes 1,2,3,4)	SIZE CLASSIFICATION	DESIGN VALUE IN BENDING "Fb"			MODULUS OF ELASTICITY "E"
			Normal Duration	Snow Loading	7-Day Loading	
900f.1.0*E*	3,4	Machine rated lumber 2 X 4 and wider	1,050	1,210	1,310	1,000,000
1200f.1.2 *E*	1,2,3,4		1,400	1,610	1,750	1,200,000
1350f.1.3 *E*	2,4		1,550	1,780	1,940	1,300,000
1450f.1.3 *E*	1,3,4		1,650	1,900	2,060	1,300,000
1500f.1.3 *E*	2		1,750	2,010	2,190	1,300,000
1500f.1.4 *E*	1,2,3,4		1,750	2,010	2,190	1,400,000
1650f.1.4 *E*	2		1,900	2,190	2,370	1,400,000
1650f.1.6 *E*	1,2,3,4		1,900	2,180	2,380	1,500,000
1800f.1.6 *E*	1,2,3,4		2,050	2,360	2,560	1,600,000
1950f.1.5 *E*	2		2,250	2,950	2,810	1,500,000
1950f.1.7 *E*	1,2,4		2,250	2,950	2,810	1,700,000
2100f.1.8 *E*	1,2,3,4		2,400	2,760	3,000	1,800,000
2250f.1.6 *E*	2		2,600	2,990	3,250	1,600,000
2250f.1.9 *E*	1,2,4		2,600	2,990	3,250	1,900,000
2400f.1.7 *E*	2		2,750	3,160	3,440	1,700,000
2400f.2.0 *E*	1,2,3,4		2,750	3,160	3,440	2,000,000
2550f.2.1 *E*	1,2,4		2,950	3,390	3,690	2,100,000
2700f.2.2 *E*	1,2,3,4		3,100	3,570	3,880	2,200,000
2850f.2.3 *E*	2		3,300	3,800	4,130	2,300,000
3000f.2.4 *E*	1,2		3,450	3,970	4,310	2,400,000
3150f.2.5 *E*	2		3,600	4,140	4,500	2,500,000
3300f.2.6 *E*	2		3,800	4,370	4,750	2,600,000
900f.1.0 *E*	1,2,3	See Footnotes	1,050	1,210	1,310	1,000,000
900f.1.2 *E*	1,2,3		1,050	1,210	1,310	1,200,000
1200f.1.5 *E*	1,2,3		1,400	1,610	1,750	1,500,000
1350f.1.8 *E*	1,2		1,550	1,780	1,940	1,800,000
1500f.1.8 *E*	3		1,750	2,010	2,190	1,800,000
1800f.2.1 *E*	1,2,3		2,050	2,360	2,560	2,100,000

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

Table 3605.2.3.1d footnotes applicable to machine stress rated joists and rafters.

1. National Lumber Grades Authority (see Footnote 2, Table 3605.2.3.1c); Machine Rated Lumber, 2 X 4 and wider.
2. Southern Pine Inspection Bureau; Machine Rated Lumber, 2 X 4 and wider.
3. West Coast Lumber Inspection Bureau; Machine Rated Lumber, 2 X 4 and wider; Machine Rated Joists, 2 X 6 and wider.
4. Western Wood Products Association; Machine Rated Lumber, 2 X 4 and wider.

TABLE 3605.2.3.3a
ALLOWABLE SPAN FOR GIRDERS SUPPORTING ONE FLOOR ONLY

SIZE OF WOOD GIRDER[2]		FLOOR LIVE LOAD (psf)	SPACING BETWEEN GIRDERS OR BETWEEN GIRDERS AND LOAD BEARING WALLS[3]				
			4 feet	6 feet	8 feet	10 feet	16 feet
4 x 4	-	30	5'6"	4'6"	3'6"	3'0"	2'6"
		40	5'0"	4'0"	3'6"	3'0"	2'6"
4 x 6	-	30	8'0"	6'6"	5'6"	5'0"	4'6"
		40	7'6"	6'0"	5'6"	4'6"	4'0"
4 x 8	6 x 6	30	11'0"	9'0"	8'0"	7'0"	5'6"
		40	10'0"	8'6"	7'6"	6'6"	5'0"
4 x 10	6 x 8	30	14'0"	11'6"	10'0"	8'6"	6'0"
		40	13'0"	10'6"	9'6"	8'6"	5'6"
4 x 12	6 x 10	30	16'6"	14'0"	12'0"	11'0"	9'0"
		40	16'0"	12'6"	11'0"	10'0"	8'0"

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kN/m^2.

1. Allowable spans may be interpolated between tributary loads shown in table. Spans and girder sizes may be computed independently of the above table in accordance with accepted engineering practice.
2. Spans are based on No. 2 lumber.
3. The spacing is the tributary load to the girder. It is found by adding the spans of the floor structure on each side which are supported by the girder and dividing by 2.

TABLE 3605.2.3.3b
ALLOWABLE SPANS FOR BUILT-UP WOOD CENTER GIRDERS AND FOOTING SIZES FOR GIRDER SUPPORT COLUMNS

WIDTH OF STRUCTURE (feet)	GIRDER SIZE (inches)	ONE STORY		TWO STORY		THREE STORY	
		Maximum Span (feet-inches)	Footing Size[3] (inches)	Maximum Span (feet-inches)	Footing Size[3] (inches)	Maximum Span (feet-inches)	Footing Size[3] (inches)
24	3-2x8	6-7	17x17*	4-11	20x20	4-1	22x22
	4-2x8	7-8	19x19*	5-8	21x21	4-8	24x24
	3-2x10	8-5	20x20*	6-3	23x23	5-3	25x25
	4-2x10	9-9	21x21	7-3	24x24	6-1	27x27
	3-2x12	10-3	22x22	7-8	25x25	6-4	27x27
	4-2x12	11-10	23x23	8-10	27x27	7-4	29x29
26	3-2x8	6-4	17x17*	4-9	20x20	3-11	22x22
	4-2x8	7-4	18x18*	5-6	22x22	4-7	24x24
	3-2x10	8-1	19x19	6-1	23x23	5-0	25x25
	4-2x10	9-4	21x21	7-0	24x24	5-10	27x27
	3-2x12	9-10	21x21	7-4	25x25	6-1	28x28
	4-2x12	11-5	23x23	8-6	27x27	7-1	30x30
28	3-2x8	6-2	17x17*	4-7	21x21	3-10	23x23
	4-2x8	7-1	18x18*	5-3	22x22	4-5	24x24
	3-2x10	7-10	19x19	5-10	23x23	4-10	26x26
	4-2x10	9-0	20x20	6-9	25x25	5-7	28x28
	3-2x12	9-6	21x21	7-1	26x26	5-11	28x28
	4-2x12	11-0	22x22	8-2	28x28	6-10	30x30
32	3-2x8	5-9	16x16*	4-3	21x21	3-7	24x24
	4-2x8	6-7	17x17	4-11	23x23	4-1	25x25
	3-2x10	7-4	18x18	5-5	24x24	4-6	27x27
	4-2x10	8-5	20x20	6-3	26x26	5-3	28x28
	3-2x12	8-11	20x20	6-8	27x27	5-6	29x29
	4-2x12	10-3	22x22	7-8	29x29	6-4	31x31

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psf = 0.0479 kN/m^2, 1 psi = 6.895 kPa.

1. Values shown are for a clear-span trussed roof, a load bearing center wall on the first floor in a two-story construction, and a load-bearing center wall on the first and second floors in three-story construction.
2. Spans based on allowable stress in bending F_b - 1,000 pounds per square inch (psi) for repetitive members. See Table 3605.2.3.1d
3. Footing size based on 2.000 psf soil-bearing capacity; footing thickness shall be one-half (minimim) the width of the footing, or ten inches, whichever is greater.
4. 4x4 posts may be used at these (*) locations, 6x6 posts, or 4x4 posts or three-inch diameter steel columns with bearing plates or equivalent area, are acceptable in all locations.

3605.2.9 Framing of openings: Openings in floor framing shall be framed with header and trimmer joists. When the header joist span does not exceed four feet (1219 mm), the header joist may be a single member the same size as the floor joist. Single trimmer joists may be used to carry a single header joist that is located within three feet (914 mm) of the trimmer joist bearing. When the header joist span exceeds four feet (1219 mm), the trimmer joists and the header joist shall be doubled and of sufficient cross section to support the floor joists framing into the header. Approved hangers shall be used for the header-joist to trimmer joist connections when the header joist span exceeds six feet (1829 mm).

3605.2.10 Floor trusses: Wood floor trusses shall be designed in accordance with approved engineering practice. The design of metal plate connected wood trusses shall comply with TPI QST, TPI PCT and TPI "Design Specification for Metal Plate Connected Wood Trusses, ***as listed in Appendix A.***" Trusses shall be braced and installed in accordance with their appropriate engineered design. In the absence of specific bracing requirements, trusses shall be braced in accordance with TPI BWT, ***as listed in Appendix A.*** Truss members shall not be drilled, cut, notched or altered in any manner unless so designed.

3605.2.11 Draftstopping required: When there is usable space above and below the concealed space of a floor/ceiling assembly, draftstops shall be installed so that the area of the concealed space does not exceed 1,000 square feet (93 m^2). Draftstopping shall divide the concealed space into approximately equal areas. Draftstopping shall be provided in floor/ceiling assemblies under the following certain circumstances:

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

3605.2.11.1 Materials: Draftstopping materials shall not be less than ½-inch (12.7 mm) gypsum board, ⅜-inch (9.5 mm) wood structural panels, ⅜-inch (9.5 mm) Type 2-M-W particleboard or other approved materials adequately supported. Draftstopping shall be installed parallel to the floor framing members unless otherwise approved by the building official. The integrity of all draftstops shall be maintained.

780 CMR 3605.3 FLOOR SHEATHING

3605.3.1 Lumber sheathing: Maximum allowable spans for lumber used as floor sheathing shall conform to Tables ***3605.3.1***, ***3605.3.2.1.1a*** and ***3605.3.2.1.1b***.

3605.3.1.1 End joints. Lumber used as subflooring ***shall be installed with end joints*** over supports unless end-matched lumber is used, in which case each piece shall bear on at least two joists. Subflooring may be omitted when joist spacing does not exceed 16 inches (406 mm) and a one-inch (25 mm) nominal tongue-and-groove wood strip flooring is applied perpendicular to the joists.

TABLE 3605.3.1 MINIMUM THICKNESS OF LUMBER FLOOR SHEATHING

JOIST OR BEAM SPACING (inches)	MINIMUM NET THICKNESS	
	Perpendicular to Joist	Diagonal to Joist
24	11/16	¾
26	⅞	⅞
48[1]	1½ T&G	N/A
54[2]		
60[3]		

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

1. Minimum 840 F_b 1,000,000 E.
2. Minimum 9500 F_b 1,300,000 E.
3. Minimum 1,060 F_b 1,600,000 E.

3605.3.2 Plywood sheathing:

3605.3.2.1 Identification and grade: Plywood used for structural purposes shall conform to DOC PS 1, DOC PS 2 and HPMA (ANSI) HP, ***as listed in Appendix A***, and wood structural panels shall conform to DOC PS 2, ***as listed in Appendix A***. All panels shall be identified by a grade mark of certificate of inspection issued by an approved agency.

3605.3.2.1.1 Subfloor and combined subfloor underlayment: Where used as subflooring or combination subfloor underlayment, wood structural panels shall be of one of the grades specified in Table ***3605.3.2.1.1a***. When sanded is plywood used as a combination subfloor underlayment, the grade shall be as specified in Table ***3605.3.2.1.1b***.

3605.3.2.1.2 Wood structural panels: Wood structural-use panels conforming to DOC PS 2 includes performance-rated plywood, oriented strand-board and composite panels. Oriented strand-board structural-use panels manufactured in Canada shall conform to CSA 0437, ***as listed in Appendix A***.

3605.3.2.2 Allowable spans: The maximum allowable span for wood structural panels used as subfloor or combination subfloor underlayment shall be as set forth in Table ***3605.3.2.1.1a***. The maximum span for sanded plywood combination subfloor underlayment shall be set forth in Table ***3605.3.2.1.1b***.

3605.3.2.3 Installation: Plywood and wood structural panels used as subfloor or combination

subfloor underlayment shall be attached to framing in accordance with Table *3606.2.3a*.

3605.3.3 Particleboard:

3605.3.3.1 Identification and grade: Particleboard shall conform to ANSI A208.1, *as listed in Appendix A*, and shall be so identified by a grade mark or certificate of inspection issued by an approved agency.

3605.3.3.2 Floor underlayment: Particleboard floor underlayment shall conform to Type PBU, *as listed in Appendix A*, and shall not be less than ¼-inch (6.4 mm) in thickness.

3605.3.3.3 Installation: Particleboard underlayment shall be installed in accordance with the recommendations of the manufacturer and attached to framing in accordance with Table *3606.2.3a*.

TABLE 3605.3.2.1.1a
ALLOWABLE SPANS AND LOADS FOR PLYWOOD AND WOOD STRUCTURAL PANELS FOR ROOF AND SUBFLOOR SHEATHING AND COMBINATION SUBFLOOR UNDERLAYMENTS[1,2,3]

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

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479kNm^2

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. Panels continuous over two or more spans with long dimension perpendicular to supports. Spans shall be limited to values shown because of possible effect of concentrated loads.
3. Applies to panels 24 inches or wider.
4. Lumber blocking, panel edge clips (one midway between each support, except two equally spaced between supports when span is 48 inches), tongue-and-groove panel edges, or other approved type of edge support.
5. Includes Structural 1 panels in these grades.
6. Uniform load deflection limitation; $^1/_{180}$ of span under live load plus dead load,[1] $^1/_{2400}$ of span under live load only.
7 Maximum span 24 inches for ½-inch panels.
8. Maximum span 24 inches where ¾-inch wood finish flooring is installed at right angles to joists.
9. Maximum span 24 inches where 1½ inches of lightweight concrete or approved cellular concrete is placed over the subfloor.
10 Unsupported edges shall have tongue-and-groove joints or shall be supported with blocking unless nominal ¼-inch thick underlayment or 1½ inches of light-weight concrete or approved cellular concrete is placed over the subfloor, or ¾-inch wood finish is used. Allowable uniform live load at maximum span, based on deflection of $^1/_{360}$ of span, is 100 psf.
11. Unsupported edges shall have tongue-and-groove joints or shall be supported with blocking unless nominal ¼-inch thick underlayment or ¾-inch wood finish flooring is used. Allowable uniform live load at maximum span, based on deflection of $^1/_{360}$ of span, is 100 psf, except panels with a Span Rating of 48 o.c. are limited to 65 psf total uniform load at maximum span.

TABLE 3605.3.2.1.1b
ALLOWABLE SPANS FOR PLYWOOD COMBINATION SUBFLOOR UNDERLAYMENT[1]

IDENTIFICATION	SPACING OF JOISTS		
	16	20	24
Species Group[2]			
1	½	5/8	¾
2,3	5/8	¾	7/8
4	¾	7/8	1

For SI: 1 inch = 25.4 mm, 1psf = 0.0479 kNm^2

1. Plywood continuous over two or more spans and face grain perpendicular to supports. Unsupported edges shall be tongue-and-groove or blocked except where nominal ¼-inch-thick underlayment or ¾-inch wood finish floor is used. Allowable uniform live load at maximum span based on deflection of $^1/_{360}$ of span is 100 psf.
2. Applicable to all grades of sanded Exterior-type plywood.

780 CMR 3605.4 TREATED-WOOD FLOORS (ON GROUND)

3605.4.1 General: Treated-wood basement floors and floors on ground shall be designed to withstand axial forces and bending moments resulting from lateral soil pressures at the base of the exterior walls and floor live and dead loads. Floor framing shall be designed to meet joist deflection requirements in accordance with *780 CMR 3603.1*.

3605.4.1.1 Unbalanced soil loads: Unless special provision is made to resist sliding caused by unbalanced lateral soil loads, wood basement floors shall be limited to applications where the differential depth of fill on opposite exterior foundation walls is two feet (610 mm) or less.

3605.4.1.2 Construction: Joists in wood basement floors shall bear tightly against the narrow face of studs in the foundation wall or directly against a band joist which bears on the studs. Plywood subfloor shall be continuous over lapped joists or over butt joints between in-line joists. Sufficient blocking shall be provided between joists to transfer lateral forces at the base of the end walls into the floor system.

3605.4.1.3 Uplift and buckling: Where required, resistance to uplift or restraint against buckling shall be provided by interior bearing walls or properly designed stub walls anchored in the supporting soil below.

3605.4.2 Site preparation: The area within the foundation walls shall have all vegetation, topsoil and foreign material removed, and any fill material which is added shall be free of vegetation and foreign material. The fill shall be compacted to assure uniform support of the treated-wood floor sleepers.

3605.4.2.1 Base: A minimum four-inch-thick (102 mm) granular base of gravel having a maximum size of ¾ inch (19 mm) or crushed stone having a maximum size of ½ inch (12.7 mm) shall be placed over the compacted sub-grade.

3605.4.2.2 Moisture barrier: Polyethylene sheeting of minimum six-mil (0.15 mm) thickness shall be placed over the granular base. Joints shall be lapped six inches (153 mm) and left unsealed. The polyethylene membrane shall be placed over the treated-wood sleepers and shall not extend beneath the footing plates of the exterior walls.

3605.4.3 Materials: All framing materials, including sleepers, joists, blocking and plywood subflooring, shall be pressure preservatively treated and dried after treatment in accordance with AWPA C22, *as listed in Appendix A*.

780 CMR 3605.5 CONCRETE FLOORS (ON GRADE)

3605.5.1 General: Concrete slab-on-grade floors shall be constructed in accordance with Figure *3604.3.1a*. The specified compressive strength of concrete at 28 days shall not be less than 2,500 pounds per square inch (17,225 kPa), except where weather exposure requires greater strength and air-entrained concrete, as set forth in Table *3604.2.2 and 780 CMR 3604.2.2*.

Slabs shall be constructed with control joints having a depth of at least ¼ the slab thickness but not less than one inch, and joints shall be spaced at intervals not more than 30 feet in each direction and slabs not rectangular in shape shall have control joints across the slab at points of offset, if offset exceeds ten feet.

Exception: Control joints are not required or may exceed 30 foot intervals where welded wire fabric or equivalent is provided in accordance with Table 3605.5.1. The welded wire fabric or equivalent material shall be placed at mid-depth of the slab or two inches from the top surface for slabs more than four inches in thickness.

Table 3605.5.1
CRACK CONTROL REINFORCEMENT FOR SLABS

MAXIMUM DIMENSION OF SLAB OR DISTANCE BETWEEN CONTROL JOINTS (Feet)[1]						WWF[2] WIRE SPACING (inches)	WWF[2] WIRE SIZE DESIGNATION
SLAB THICKNESS (inches)							
3.5	4.0	4.5	5.0	5.5	6.0		
42	36	32	29	26	24	6x6	W1.4xW1.4
59	52	46	42	38	35	6x6	W2.0xW2.0
86	75	67	60	55	50	6x6	W2.9xW2.9

1. Values in table are based on reinforcement with a yield strength of 65,000 psi. If reinforcement with a different yield strength is used, the slab dimension shown

in the table shall be adjusted by multiplying by the yield strength of the steel to be used and dividing by 65,000.
2. Welded wire fabric.

3605.5.2 Site preparation: The area within the foundation walls shall ***be cleaned of all*** vegetation ***and organic and foreign material and*** top soil.

3605.5.2.1 Fill: Fill material shall be free of vegetation and foreign material. The fill shall be compacted to assure uniform support of the slab, and except where approved, the fill depths shall not exceed 24 inches (610 mm) for clean sand or gravel.

3605.5.2.2 Base: A four-inch-thick (102 mm) base course consisting of clean graded sand, gravel, crushed stone or crushed blast-furnace slag passing a two-inch (51 mm) sieve shall be placed on the prepared subgrade when the slab is below grade.

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

3605.5.2.3 Vapor barrier: An approved vapor barrier with joints lapped not less than six inches (153 mm) shall be placed between the concrete floor slab and the base course or the prepared subgrade where no base course exists.

Exception: The vapor barrier may be omitted:

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

780 CMR 3605.6 METAL

3605.6.1 General: ***Steel and aluminum elements shall be constructed of materials and designed in accordance with the AISC "Specification for the Design, Fabrication and Erection of Structural Steel Buildings" and AA SAS30, respectively, as listed in Appendix A. Steel elements may be hot-rolled or cold-formed structural steel.*** Members shall be straight and free of any defects which would significantly affect their structural performance.

WALL CONSTRUCTION

780 CMR 3606.1 GENERAL

3606.1.1 Application: The provisions of 780 CMR 3606.1 shall control the design and construction of all walls and partitions for all buildings. The use of materials or methods of construction not specified in this chapter accomplishing the purposes intended by 780 CMR 36 and approved by the building official in accordance with ***780 CMR 109.0*** shall be accepted as complying with 780 CMR 36.

3606.1.2 Requirements: The wall construction shall be capable of accommodating all loads imposed according to ***780 CMR 3603.1*** and transmitting the resulting loads to supporting structural elements.

3606.1.2.1 Floor-covering materials: ***Interior and exterior bearing and non-loadbearing walls shall be placed directly on floor sheathing, underlayment or a structural framing member, fastened in accordance with Table 3606.2.3a.*** Compressible floor-covering materials that compress more than $^{1}/_{32}$ inch (0.794 mm) when subjected to 50 pounds (23 kg) applied over one square inch (645 mm) of material and are greater than ⅛ inch (3.2 mm) in thickness in the uncompressed state shall not extend beneath walls, partitions or columns which are fastened to the floor.

780 CMR 3606.2 WALL FRAMING

3606.2.1 Identification: Load-bearing dimension lumber used for studs, plates and headers shall conform to DOC PS 20, ***as listed in Appendix A***, and to other applicable standards and grading rules and shall be identified by a grade mark, or certificate of inspection issued by an approved agency. The grade mark or certificate shall provide adequate information to determine the "F_b" the allowable stress in bending, and "E," the modulus of elasticity. Approved end-jointed lumber may be used interchangeably with solid-sawn members of the same species and grade.

Exception: Native Lumber as identified in 780 CMR 2303.2 and 780 CMR R4.

3606.2.2 Grade: Studs shall be a minimum No. 3, Standard or Stud grade lumber.

Exception: Bearing studs not supporting floors and nonbearing studs may be Utility grade lumber, provided the studs are spaced in accordance with Table 602.3d.

3606.2.3 Exterior Walls: Exterior walls of wood-frame construction shall be designed and constructed in accordance with the provisions of 780 CMR 3606.2 and ***Figures 3606.2.3a*** and ***3606.2.3b***. Components of exterior walls shall be fastened in accordance with ***Tables 3606.2.3a*** through ***3606.2.3d***.

3606.2.3.1 Special provisions for high wind loads: Exterior walls subject to wind pressures of 30 pounds per square foot (1.44 kN/m^2) or greater, as established ***by wind load maps, 780 CMR 1611.1a, b and c,*** shall be designed in accordance with accepted engineering practice.

3606.2.3.2 Stud spacing: In bearing walls, studs which are not more than ten feet (3048 mm) in length shall be spaced not more than is specified in ***Table 3606.2.3d*** for the corresponding stud size.

3606.2.3.3 Top plate: Exterior wall studs shall be capped with a double top plate installed to provide overlapping at corners and intersections with bearing partitions. End joints in top plates shall be offset at least 48 inches (1219 mm).

Exception: A single top plate may be installed in bearing and exterior walls, provided the plate is adequately tied at joints, corners and intersecting walls with three-inch-by-six-inch by a 0.036-inch-thick (76 mm by 153 mm by 0.914 mm) galvanized steel plate that is nailed to each wall or segment of wall by three 8d nails, provided the rafters or joists are centered over the studs with a tolerance of no more than one inch (25 mm). The top plate may be omitted over lintels which are adequately tied to adjacent wall sections with steel plates or equivalent as previously described.

3606.2.3.4 Bearing studs: Where floor or roof framing members are spaced more than 16 inches (406 mm) on center and the bearing studs are spaced 24 inches (610 mm) on center, such members shall bear within five inches (127 mm) of the ***bearing studs***.

Exceptions:

1. The top plates are two two-inch-by-six-inch (51 mm by 153 mm) or two three-inch-by-four-inch (76 mm by 102 mm) 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.

3606.2.4 Interior load-bearing partitions: Interior load-bearing partitions shall be constructed, framed and firestopped as specified for exterior walls.

3606.2.4.1 Interior nonbearing partitions: Interior nonbearing partitions may be constructed with two-inch-by-three-inch (51 mm by 76 mm) studs spaced 24 inches (610 mm) on center or two-inch-by-four-inch (51 mm by 102 mm) flat studs spaced 16 inches (406 mm) on center. Interior nonbearing partitions may be capped with a single top plate.

3606.2.5 Drilling and notching-studs: Any stud in an exterior wall or bearing partition may be cut or notched to a depth not exceeding 25% of its width. Studs in nonbearing partitions may be notched to a depth not to exceed 40% of a single stud width. Any stud may be bored or drilled, provided that the diameter of the resulting hole is no greater than 40% of the stud width, the edge of the hole is no closer than 5/8 inch (15.9 mm) to the edge of the stud, and the hole is not located in the same section as a cut or notch.

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

TABLE 3606.2.3a
FASTENER SCHEDULE FOR STRUCTURAL MEMBERS

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENERS[1,2,3,4]	SPACING OF FASTENERS
Joist to sill or girder, toe nail	3-8d	-
1" x 6" subfloor or less to each joist, face nail	2-8d 2 staples, 1¾"	- -
2" subfloor to joist to girder, blind and face nail	2-16d	-
Sole plate to joist or blocking, face nail	16d	16d" o.c.
Top or sole plate to stud, end nail	2-16d	-
Stud to sole plate, toe nail	3-8d or 2-16d	-
Double studs, face nail	10d	24" o.c.
Double top plates, face nail	10d	24" o.c.
Double top plates, minimum 48-inch offset of end to joints, face to mail in lapped area	4-10d	-
Top plates, laps at corners and intersections, face nail	2-10d	-
Built-up header, two pieces with ½" spacer	16d	16" o.c. along each edge
Continued header, two pieces	16d	16" o.c. along each edge
Ceiling joists to plate, toe plate	3-8d	-
Continuous header to stud, toe nail	4-8d	-
Ceiling joist, laps over partitions, face nail	3-10d	-
Ceiling joist to parallel rafters, face nail	3-10d	-
Rafter to plate, toe nail	2-16d	-
1" brace to each stud and plate, face nail	2-8d 3 staples,1¾"	- -
1" x 6" sheathing to each bearing, face nail	2-8d 2 staples, 1¾"	- -
1" x 8" sheathing to each hearing, face nail	3-8d 3 staples, 1¾"	- -
Wider than 1" x 8" sheathing to each bearing, face nail	3-8d 4 staples, 1¾"	- -
Built up corner studs	10d	24" o.c.
Built-up girders and beams, 2-inch lumber layers	10d	Nail each layer as follows: 32: o.c. at top and bottom and staggered. Two nails at ends and at each splice.
2" planks	2-16d	At each bearing
Roof Rafters to ridge, valley or hip rafters: toe nail face nail	4-16d 3-16d	- -
Rafter ties to rafters, face	3/8d	-

DESCRIPTION OF BUILDING MATERIALS	DESCRIPTION OF FASTENER[2,3,4,5]	SPACING OF FASTENERS	
		Edges (inches)	Intermediate Supports[3,5] (inches)
Plywood and wood structural panels, subfloor, roof and wall sheathing to framing, and particleboard wall sheathing to framing			
5/16" - ½"	6d common nail (subfloor, wall) 8d common nail (roof)[6]	6	12[7]
19/32" - 1"	8d common nail	6	12[7]
1⅛" - 1¼	10d common nail or 8d deformed nail	6	12

DESCRIPTION OF BUILDING MATERIALS	DESCRIPTION OF FASTENER[2,3,4,5]	SPACING OF FASTENERS	
		Edges (inches)	Intermediate Supports[3,5] (inches)
Other wall sheathing[8]			
½" gypsum sheathing	1½" galvanized roofing nail; 6d common nail; staple galvanized, 1½" long; 1¼" screws, Type W or S	4	8
⅝" gypsum sheathing	1¾" galvanized roofing nail; 8d common nail; Staple galvanized, 1⅝" long, 1⅝" screws, Type W or S	4	8
Plywood and wood structural panels, conbination subfloor underlayment to framing			
¾" and less	6d deformed nail, or 8d common nail	6	12
⅞" - 1"	8d common nail or 8d deformed nail	6	12
1⅛" - 1¼"	10d common nail or 8d deformed nail	6	12

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

1. All nails are smooth-common, box or deformed shanks except where otherwise stated.
2. Staples are 16 gauge wire and have a minimum $^{7}/_{16}$-inch O.D. crown width.
3. Nails shall be spaced not more than six inches o.c. at all supports where spans are 48 inches or greater.
4. Four-foot by eight-foot or four-foot-by-nine-foot panels shall be applied vertically.
5. Spacing of fasteners not included in this table shall be based on Table 3606.2.3a(1).
6. For regions having basic wind speed of 90 mph or greater, 8d deformed nails shall be used for attaching plywood and wood structural panel roof sheathing to framing within minimum 48-inch distance from gable end walls, if mean roof height is more than 24 feet, up to 35 feet maximum.
7. For regions having basic wind speed of 80 mph or less, nails for attaching plywood and wood structural panel roof sheathing to gable end wall framing shall be spaced six inches o.c. When basic wind speed is greater than 80 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced six inches o.c. for minimum 48-inch distance from ridges, eaves and gable end walls; and four inches o.c. to gable end wall framing.
8. Gypsum sheathing shall conform to ASTM C 79 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to either AHA 194.1 or ASTM C 208.

TABLE 3606.2.3a(1)
ALTERNATE ATTACHMENTS

NOMINAL MATERIAL THICKNESS	DESCRIPTION[1,2] OF FASTENER AND LENGTH	SPACING[3] OF FASTENERS	
		Edges (inches)	Intermediate Supports (inches)
Plywood and wood structural panels subfloor, roof and wall sheathing to framing and particleboard wall sheathing to framing			
$^{5}/_{16}$"	0.097 -0.099 Nail 1½" Staple 15 ga 1⅜"	6	12
⅜"	Staple 15 ga 1⅜"	6	12
	0.097 -0.099 Nail 1½"	4	10
$^{15}/_{32}$" and ½"	Staple 15 ga 1½"	6	12
	0.097 -0.099 Nail 1⅝"	3	6
$^{19}/_{32}$" and ⅝"	0.113 Nail 1⅞" Staple 15 and 16 ga. 1⅝"	6	12
	0.097 -0.099 Nail 1¾"	3	6
$^{23}/_{32}$" and ¾"	Staple 14 ga. 1¾"	6	12
	Staple 15 ga. 1¾"	5	10
	0.097 -0.099 Nail 1⅞"	3	6
1"	Staple 14 ga. 2"	5	10
	0113 Nail 2¼" Staple 15 ga. 2"	4	8
	0.097 -0.099 Nail 2⅛"	3	6
Floor underlayment; plywood-hardboard-particleboard			
Plywood		6	8
¼" and $^{5}/_{16}$"	1¼" ring or screw shank nail - minimum 12½ ga. (0.099") shank diameter	6	8[5]
$^{11}/_{32}$", and ⅜", $^{15}/_{32}$" and ½"	1¼" ring or screw shank nail - minimum 12½ ga. (0.099") shank diameter	6	12
$^{19}/_{32}$", and ⅝", $^{23}/_{32}$" and ¾"	1½" ring or screw shank nail - minimum 12½ ga. (0.099") shank diameter		

NOMINAL MATERIAL THICKNESS	DESCRIPTION[1,2] OF FASTENER AND LENGTH	SPACING[3] OF FASTENERS	
		Edges (inches)	Intermediate Supports (inches)
Hardboard 0.200"	1½" long ring-grooved underlayment nail	6	6
	4d cement-coated sinker nail	6	6
	Staple 18 ga. 7/8" long (plastic coated)	3	6
Particleboard ¼"	4d ring-grooved underlayment nail	3	6
	Staple 18 ga. 7/8" long 3/16" crown	3	6
3/8"	6d ring-grooved underlayment nail	6	10
	Staple 16 ga. 1⅛" long 3/8" crown	3	6
½" - 5/8"	6d ring-grooved underlayment nail	6	10
	Staple 16 ga. 1⅝" long 3/8" crown	3	6

For SI: 1 inch = 25.4 mm.

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

TABLE 3606.2.3b
ALLOWABLE STUD SPACING FOR WOOD STRUCTURAL PANEL WALL SHEATHING

PANEL SPAN RATING	PANEL NOMINAL THICKNESS (inch)	MAXIMUM STUD SPACING (inches)	
		Siding Nailed to:[1]	
		Stud	Sheathing
12/0m 16/0, 20/0, or Wall - 16 o.c.	5/16, 3/8	16	16[2]
24/0, 24/16, 32/16 or Wall - 24 o.c.	3/8, 7/16, 15/32, ½	24	24[3]

For SI: 1 inch = 25.4 mm.

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

TABLE 3606.2.3c
ALLOWABLE SPANS FOR PARTICLEBOARD WALL SHEATHING[1]

THICKNESS (inches)	GRADE	STUD SPACING (inches)	
		When Siding is nailed to Studs	When Siding is Nailed to Sheathing
3/8	M-1 Exterior Glue	16	-
½	M-2 Exterior Glue	16	16

For SI: 1 inch = 25.4 mm.

1. Wall sheathing not exposed to the weather. If the panels are applied horizontally, the end joints of the panels shall be offset so that four panels corners will not meet. All panel edges must be supported. Leave a 1/16-inch gap between panels and nail to no closer than 3/8 inch from panel edges.

TABLE 3606.2.3d
MAXIMUM STUD SPACING (inches)

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

For SI: 1 inch = 25.4 mm.

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

3606.2.5.1 Drilling and notching-top plate: When piping or ductwork is placed in or partly in an exterior wall or interior load-bearing wall, necessitating a cutting of the top plate by more than 50% of its width, the plate shall be reinforced *to provide equivalent strength.*

3606.2.6 Headers: The allowable spans for nominal four-inch thick (102 mm) single headers and two-

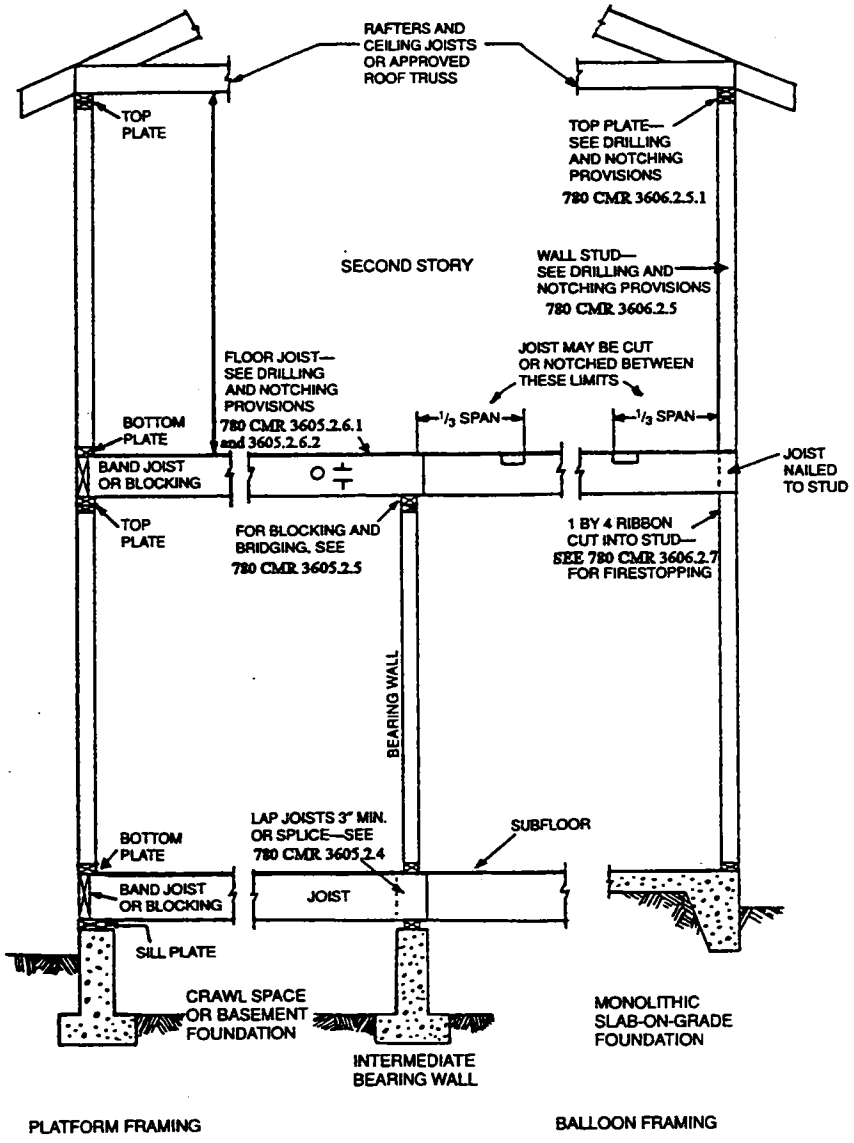
inch thick (51 mm) double headers in bearing walls shall not exceed the spans set forth in Table *3606.2.6*. The table shall not be used where concentrated loads are supported by the headers.

3606.2.6.1 Single headers: Nominal two-inch thick (51 mm) single headers ***shall not be used in*** load-bearing walls.

3606.2.6.2 Plywood box headers: Plywood box headers shall be constructed in accordance with Figure *3606.2.6.2* and Table *3606.2.6.2*.

3606.2.6.3 Non-bearing walls: Load-bearing headers are not required in interior or exterior nonbearing walls. A single flat two-inch-by-four-inch (51 mm by 102 mm) member may be used as a header in interior or exterior nonbearing walls for openings up to eight feet (2438 mm) in width if the vertical distance to the parallel nailing surface above is not more than 24 inches (610 mm). *Cripple spacing shall be the same as spacing of studs.*

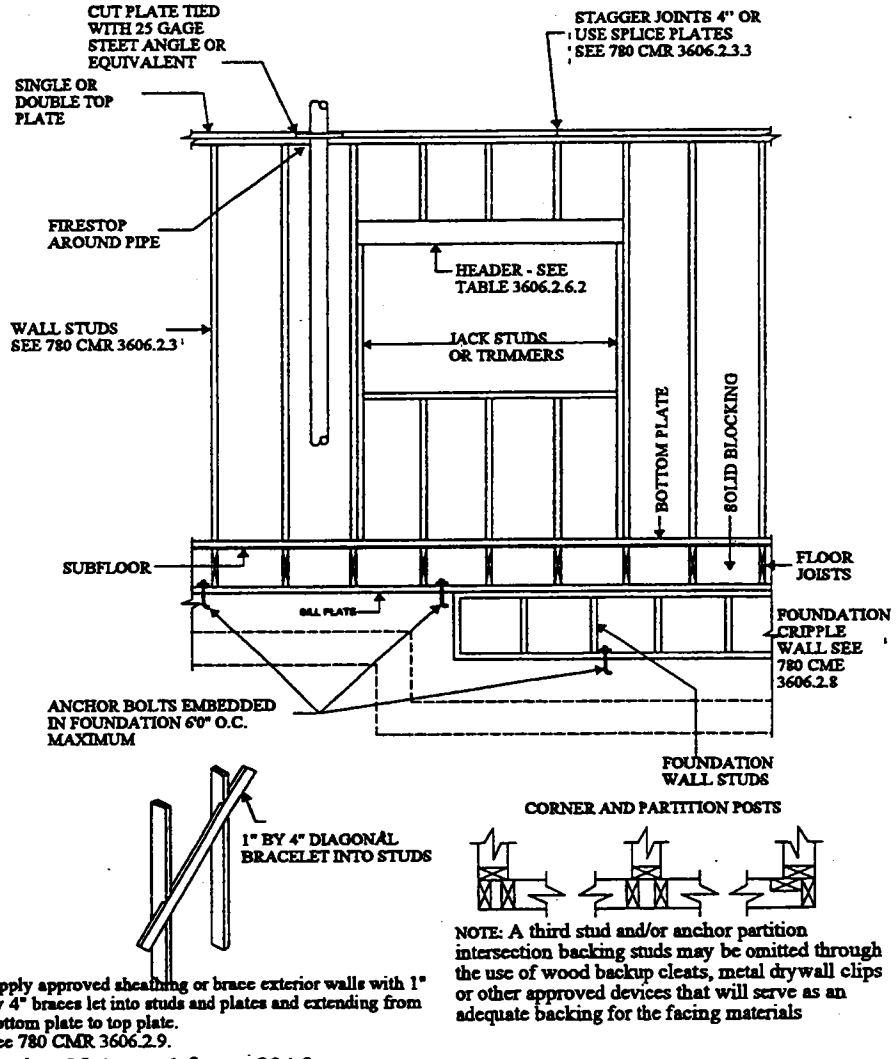
FIGURE 3606.2.3a
TYPICAL WALL, FLOOR AND ROOF FRAMING



NOTE: See Figure 3604.3.1a for other foundation types

For SI: 1 inch = 25.4 mm.

FIGURE 3606.2.3b
FRAMING DETAILS



For SI: 1 inch = 25.4 mm, 1 foot = 204.8 mm.

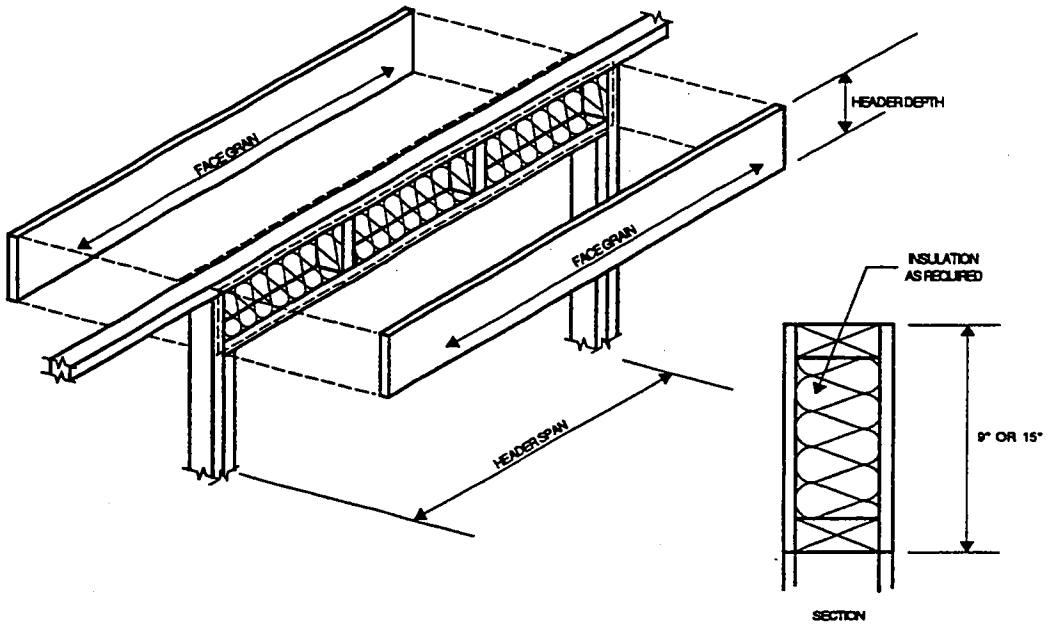
TABLE 3606.2.6
MINIMUM SPANS FOR HEADERS LOCATED OVER OPENINGS IN WALLS

SIZE OF HEADER[1,2]	HEADERS IN BEARING WALLS[2]			HEADERS IN WALLS NOT SUPPORTING FLOORS OR ROOFS
	Supporting Roof Only	One Story Above	Two Stories Above	
2 x 4	4	-	-	-
2 x 6	6	4	-	-
2 x 8	8	6	-	10
2 x 10	10	8	6	12
2 x 12	12	10	8	16

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

1. Nominal four-inch thick single headers may be substituted for double members.
2. Spans are based on No. 2 Grade Lumber with ten-foot tributary floor and roof loads.

FIGURE 3606.2.6.2
TYPICAL PLYWOOD BOX HEADER CONSTRUCTION



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.
1 The top plate shall be continuous over header.
2. Jack studs shall be used for soans over four feet.
3. Cripple spacing shall be the same as for studs.
4. Plywood faces shall be single pieces of $^{15}/_{32}$-inch-thick C-D (exterior glue) or better, installed on the interior or exterior or both sides of the header.
5. Plywood faces shall be nailed to framing and cripples with 8d common nails spaced three inched o.c. staggering alternate nails ½ inch.

TABLE 3606.2.6.2
MAXIMUM SPANS FOR PLYWOOD BOX HEADERS (feet)[1]

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

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.
1. Spans are based on single story with clear-span trussed roof or two story with floor and roof supported by interior-bearing walls.
2. See Figure 3606.2.6.2 for construction details.

3606.2.7 Firestopping: Firestopping shall be provided to cut off all concealed draft openings (both vertical and horizontal) and to form an effective fire barrier between stories, and between a top story and the roof space. Firestopping shall be provided in wood-frame construction in the following locations.

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

3606.2.7.1 Materials: Except as provided in 780 CMR 3606.2.7 item 4, fire-stopping shall consist of two-inch (51 mm) nominal lumber, or two thicknesses of one-inch (25 mm) nominal lumber with broken lap joints, or one thickness of $^{23}/_{32}$-inch (18 mm) wood structural panels with joints backed by $^{23}/_{32}$-inch (18 mm) wood structural panels or one thickness of ¾-inch (19 mm) particleboard with joints backed by ¾-inch (19 mm) particleboard, ½-inch (12.7 mm) gypsum board, or ¼-inch (6.4 mm) cement-based mill-board

3606.2.7.1.1 Unfaced fiberglass: Unfaced fiberglass bat insulation used as firestopping shall fill the entire cross section of the wall cavity to a minimum height of 16 inches (406 mm) measured vertically. When piping, conduit or similar obstructions are encountered, the insulation shall be packed tightly around the obstruction.

3606.2.7.1.2 Firestopping integrity: The integrity of all firestops shall be maintained.

3606.2.8 Cripple walls: Foundation cripple walls shall be framed of studs not less in size than the studs supported. When exceeding four feet (1219 mm) in height, such walls shall be framed of studs having the size required for an additional story.

3606.2.8.1 Bracing: Such walls having a stud height exceeding 14 inches (356 mm) shall be considered to be first story walls for the purpose of determining the bracing required by 780 CMR 3606.2.9. Stud walls less than 14 inches (356 mm) in height shall be sheathed with plywood or wood structural panels attached to both the top and bottom plates in accordance with Table 3606.2.3a, or the walls shall be constructed of solid blocking.

3606.2.9 Wall bracing: Exterior and foundation wall panels of frame construction shall be braced with one-inch-by-four-inch (25 mm by 102 mm) let-in braces, or approved metal strap devices installed in accordance with the manufacturer's specifications; wood structural panels in accordance with Table ***3606.2.3b***; particleboard in accordance with Table ***3606.2.3c***, gypsum sheathing, wallboard or veneer base applied vertically or horizontally to studs spaced not more than 24 inches (610 mm) on center and fastened in accordance with Table ***3606.2.3a***; fiberboard sheathing applied vertically to studs spaced not more than 16 inches (406 mm) on center and fastened in accordance with Table ***3606.2.3a***; portland cement plaster applied over metal lath attached to studs spaced not more than 16 inches (406 mm) on center in accordance with ***780 CMR 3607.3.6***, or other approved material. If let-in bracing is used, it shall be let into the top and bottom plates and the intervening studs, placed at not more than 60 degrees or less than 45 degrees from the horizontal and attached to the framing in conformance with Table ***3606.2.3a***. Structural sheathing and one-inch-by-four-inch (25 mm by 102 mm) let-in braces shall be installed in accordance with Table ***3606.2.9*** and fastened in accordance with Table ***3606.2.3a***.

Exception: The minimum 48-inch (1219 mm) braced wall panel width required by Table ***3606.2.9*** may be replaced by an alternate braced wall panel constructed in accordance with the following:

1. In one-story buildings, each panel shall have a width of not less than 32 inches (813 mm) and a height of not more than ten feet (3048 mm). Each panel shall be sheathed on one face with 3/8-inch (9.5 mm) minimum thickness wood structural panel sheathing nailed with 8d common or galvanized box nails in accordance with Table ***3606.2.3a*** and blocked at all edges. Two anchor bolts installed in accordance with Figure ***3604.3.1a*** or approved equivalent shear connectors shall be provided in each panel. Each panel end stud shall have a tie-down device fastened to the foundation, capable of providing an approved uplift capacity of not less than 1,800 pounds (816 kg). The tie-down device shall be installed in accordance with the manufacturer's recommendations. The panels shall be supported directly on a foundation or on floor framing supported directly on a foundation. This foundation or footing shall be continuous across the entire length of the braced wall line and shall be reinforced with not less than two No. 4 bars.
2. In the first story of two-story buildings, each braced wall panel shall be constructed in accordance with 780 CMR 2606.2.9 Exception item 1, except that the wood structural panel sheathing shall be applied to both faces, three anchor bolts or approved equivalent shear connectors shall be provided, and tie-down device uplift capacity shall not be less than 3,000 pounds (1361 kg).

780 CMR 3606.3 METAL

3606.3.1 General: ***Metal structural elements in walls and partitions may be either hot-rolled structural shapes or bar sections or members cold formed to shape from sheet, strip or plate, or a fabricated combination thereof. Members shall be straight and free of any defects which would significantly affect their structural performance.***

Structural elements in walls and partitions shall be constructed of materials and designed in accordance with AA SAA30, the AISI "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings", as listed in Appendix A.

780 CMR 3606.4 GENERAL MASONRY CONSTRUCTION

3606.4.1 General: Masonry construction shall be designed and constructed in accordance with the provisions of 780 CMR 3606.4 or in accordance with the provisions of ACI 530/ASCE 5/TMS 402, ***as listed in Appendix A.***

TABLE 3606.2.9
WALL BRACING

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

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

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

3606.4.2 Thickness of masonry: The nominal thickness of masonry walls shall conform to the requirements of ***780 CMR 3606.4.2.1*** through ***3606.4.2.4***.

3606.4.2.1 Minimum thickness: The minimum thickness of masonry bearing walls more than one story in height shall be eight inches (203 mm). Solid masonry walls of one story dwellings and garages shall not be less than six inches (153 mm) in thickness when not greater than nine feet (2743 mm) in height, provided that when gable construction is used, an additional six feet (1829 mm) is permitted to the peak of the gable. Masonry walls shall be laterally supported in either the horizontal or vertical direction at intervals as required by ***780 CMR 3606.4.8***.

3606.4.2.2 Rubble stone masonry wall: The minimum thickness of rough, random or coursed rubble stone masonry walls shall be 16 inches (406 mm).

3606.4.2.3 Change in thickness: ***Masonry walls comprised of hollow units or of masonry bonded hollow units that decrease in thickness shall be constructed with a course of solid masonry between the wall below and the thinner wall above, or shall be constructed with special units or construction that shall transmit the loads from face shells or wythes above to those below.***

3606.4.2.4 Parapet walls: Unreinforced solid masonry parapet walls shall not be less than eight inches (203 mm) in thickness and the height of the parapet shall not exceed four times its thickness. Unreinforced hollow unit masonry parapet walls shall not be less than eight inches (203 mm) in thickness, and the height of the parapet shall not exceed three times its thickness.

3606.4.3 Corbeled masonry: Solid masonry units shall be used for corbeling. The maximum corbeled projection beyond the face of the wall shall not be more than ½ of the wall thickness or ½ the wythe thickness for hollow walls; the maximum projection of one unit shall not exceed ½the height of the unit or ⅓ the thickness at right angles to the wall. The top course of corbels shall be a header course when the corbeled masonry is used to support floor or roof-framing members.

3606.4.3.1 Support conditions: Cavity wall or masonry veneer construction may be supported on an eight-inch (203 mm) foundation wall, provided the eight-inch (203 mm) wall is corbeled with solid masonry to the width of the wall system above. The total horizontal projection of the corbel shall not exceed two inches (51 mm) with individual corbels projecting not more than ⅓ the thickness of the unit or ½ the height of the unit. The top course of all corbels shall be a header course.

3606.4.4 Allowable stresses: Allowable compressive stresses in masonry shall not exceed the values prescribed in Table ***3606.4.4***. In determining the stresses in masonry, the effects of all loads and conditions of loading and the influence of all forces affecting the design and strength of the several parts shall be taken into account.

3606.4.4.1 Combined units: In walls or other structural members composed of different kinds or grades of units, materials or mortars, the maximum stress shall not exceed the allowable stress for the weakest of the combination of units, materials and mortars of which the member is composed. The net thickness of any facing unit which is used to resist stress shall not be less than 1½ inches (38 mm).

3606.4.5 Piers: The unsupported height of masonry piers shall not exceed ten times the least dimension of the pier. 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. When hollow masonry units are solidly filled with concrete or Type M, S or N mortar, the allowable compressive stress may be increased as provided in Table 604.4.

Exception: Unfilled hollow piers may be used if the unsupported height of the pier is not more than four times its least

3606.4.5.1 Pier cap: Hollow piers shall be capped with four inches (102 mm) of solid masonry or concrete or the cavities of the top course shall be filled with concrete or grout or other methods approved by the building official.

TABLE 3606.4.4
ALLOWABLE COMPRESSIVE STRESSES FOR EMPIRICAL DESIGN OF MASONRY

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

For SI: 1 psi = 6.895 kPa.

1. Linear interpolation shall be used for determining allowable stresses for masonry units having comprehensive strengths which are intermediate between those given in this table.
2. Gross cross-sectional area shall be calculated on the actual rather than nominal dimensions.
3. See 780 CMR 3606.7 Grouted Masonry.
4. Where floor and roof loads are carried upon one wythe, the gross cross-sectional area is that of the wythe under load; if both wythes are loaded, the gross cross-sectional area is that of the wall minus the area of cavity between the wythes. Walls bonded with metal ties shall be considered as cavity walls unless the collar joints are filled with mortar or grout.

3606.4.6 Chases: Chases and recesses in masonry walls shall not be deeper than ⅓ the wall thickness, and the maximum length of a horizontal chase or horizontal projection shall not exceed four feet (1219 mm), and shall have at least eight inches (203 mm) of masonry in back of the chases and recesses and between adjacent chases or recesses and the jambs of openings. Chases and recesses in masonry walls shall be designed and constructed so as not to reduce the required strength or required fire resistance of the wall and in no case shall a chase or recess be permitted within the required area of a pier. Masonry directly above chases or recesses wider than 12 inches (305 mm) shall be supported on noncombustible lintels.

3606.4.7 Stack bond: In unreinforced masonry construction where units are laid in stack bond, longitudinal reinforcement consisting of not less than two continuous wires each with a minimum aggregate cross-sectional area of 0.017 square inches (11 mm^2) shall be provided in horizontal bed joints spaced not more than 16 inches (406 mm) on center vertically.

3606.4.8 Lateral support: Masonry walls shall be laterally supported in either the horizontal or the vertical direction. The maximum spacing between lateral supports shall not exceed the distances allowed in Table ***3606.4.8***. Lateral support shall be provided by cross walls, pilasters, buttresses, or structural frame members when the limiting distance is taken horizontally, or by floors or roofs when the limiting distance is taken vertically.

3606.4.8.1 Horizontal lateral support: Lateral support in the horizontal direction provided by intersecting masonry walls shall be provided by one of the methods defined in ***780 CMR 3606.4.8.1.1*** or ***3606.4.8.1.2***.

3606.4.8.1.1 Bonding pattern: 50% of the units at the intersection shall be laid in an overlapping masonry bonding pattern, with alternate units having a bearing of not less than three inches (76 mm) on the unit below.

TABLE 3606.4.8
SPACING OF LATERAL SUPPORT FOR MASONRY WALLS

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

For SI: 1 foot = 304.8 mm.

1. Except for cavity walls and cantilevered walls, the thickness of a wall shall be its nominal thickness measured perpendicular to the face of the wall. For cavity walls, the thickness shall be determined as the sum of the nominal thicknesses of the of the individual wythes. For cantilever walls, except for parapets, the ratio of the height to nominal thickness shall not exceed six for solid masonry, or four for hollow masonry. For parapets, see 780 CMR 3606.4.2.4.
2. An additional unsupported height of six feet is permitted for gable end walls.

3606.4.8.1.2 Metal reinforcement: Interior nonload-bearing walls shall be anchored at their intersections, at vertical intervals of not more than 16 inches (406 mm) with joint reinforcement of at least 9 gage, or ¼ inch (6.4 mm) galvanized mesh hardware cloth. Intersecting masonry walls, other than interior nonloadbearing walls, shall be anchored at vertical intervals of not more than eight inches (203 mm) with joint reinforcement of at least 9 gage and shall extend at least 30 inches (762 mm) in each direction at the intersection. Other metal ties, joint reinforcement or anchors, if used, shall be spaced to provide equivalent area of anchorage to that required by 780 CMR 3606.4.8.

3606.4.8.2 Vertical lateral support: Vertical lateral support of masonry walls shall be provided in accordance with one of the methods in 780 CMR 3606.4.8.2.1 or 3606.4.8.2.2.

3606.4.8.2.1 Roof structures: Masonry walls shall be anchored to roof structures with metal strap anchors, ½-inch (12.7 mm) bolts, or other approved anchors spaced not more than six feet (1829 mm) on center. Anchors shall be embedded at least 16 inches (406 mm) into the masonry, or be hooked or welded to bond beam reinforcement placed not less than six inches (153 mm) from the top of the wall.

3606.4.8.2.2 Floor diaphragms: Masonry walls shall be anchored to floor diaphragms at intervals not to exceed six feet (1829 mm). Support shall be provided by metal strap anchors or ½-inch-diameter (12.7 mm) bolts installed as shown in Figure ***3606.4.10a***, or by other approved methods.

3606.4.9 Lintels: Masonry over openings shall be supported by steel lintels, reinforced concrete or masonry lintels or masonry arches, designed to support load imposed.

3606.4.10 Anchorage. Masonry walls shall be anchored to floor and roof systems in accordance with the details shown in Figure ***3606.4.10a***, ***3606.4.10b*** or ***3606.4.10c***. Footings may be considered as points of lateral support.

3606.4.11 Reinforcement: Masonry walls subject to wind loads of 30 pounds per square foot (1.44 kN/m^2) or greater, shall be constructed in accordance with the requirements of 780 CMR 3606.4.11 and Figures ***3606.4.10b*** and ***3606.4.10c***. In addition, the minimum area of reinforcement shall not be less than 0.002 times the gross cross-sectional area of the wall, not more than ⅔ of which may be used in either direction. No required vertical reinforcement shall be less than ⅜ inch (9.5 mm) in diameter. Principal wall reinforcement shall have a maximum spacing of four feet (1219 mm) on center.

3606.4.12 Protection for reinforcement: All bars shall be completely embedded in mortar or grout. Joint reinforcement embedded in horizontal mortar joints shall not have less than ⅝-inch (15.9 mm) mortar coverage from the exposed face. All other reinforcement shall have a minimum coverage of one bar diameter over all bars, but not less than ¾ inch (19 mm). Where exposed to weather or soil, the minimum coverage shall be two inches (51 mm).

3606.4.13 Beam supports: Beams, girders or other concentrated loads supported by a wall or column shall have a bearing of at least three inches (76 mm) in length measured parallel to the beam upon solid masonry not less than four inches (102 mm) in thickness, or upon a metal bearing plate of adequate design and dimensions to distribute the load safely, or upon a continuous reinforced masonry member projecting not less than four inches (102 mm) from the face of the wall.

3606.4.13.1 Joist bearing: Joists shall have a bearing of not less than 1½ inches (38 mm), except as provided in ***780 CMR 3606.4.13***, and shall be supported in accordance with Figures ***3606.4.10b*** and ***3606.4.10c***.

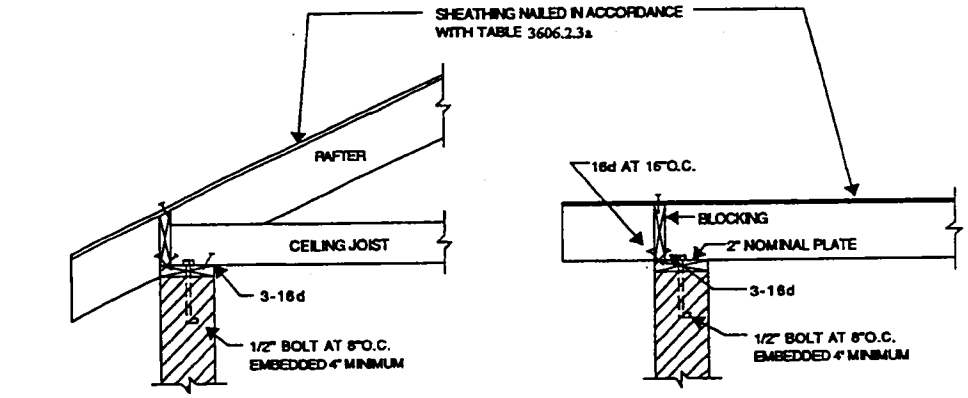
3606.4.14 Metal accessories: Joint reinforcement, anchors, ties and wire fabric shall conform to the following ***reference standards as listed in Appendix A***: ASTM A 82 for joint reinforcement, wire anchors and ties; ASTM A 36 for plate, headed and bent-bar anchors; ASTM A 510 for corrugated sheet metal anchors and ties; ASTM B 227 for copper-clad steel wire ties or ASTM A 167 for stainless steel hardware.

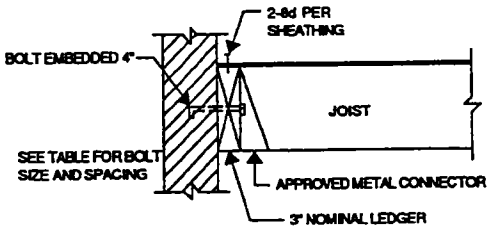
3606.4.14.1 Corrosion protection: Minimum corrosion protection of joint reinforcement, anchor ties and wire fabric for use in masonry wall construction shall conform to Table *3606.4.14.1*.

TABLE 3606.4.14.1 – MINIMUM CORROSION PROTECTION

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

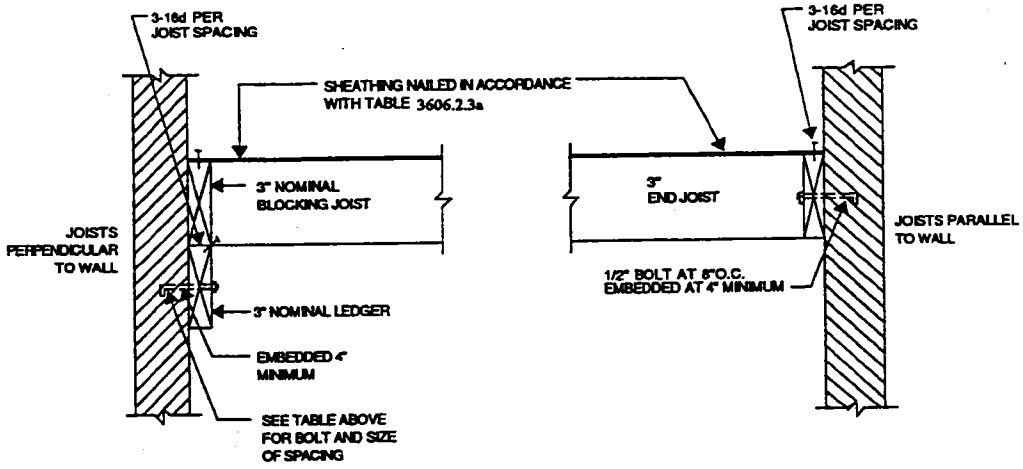
FIGURE 3606.4.10a
ANCHORAGE REQUIREMENTS FOR MASONRY WALLS





LEDGER BOLT SIZE AND SPACING

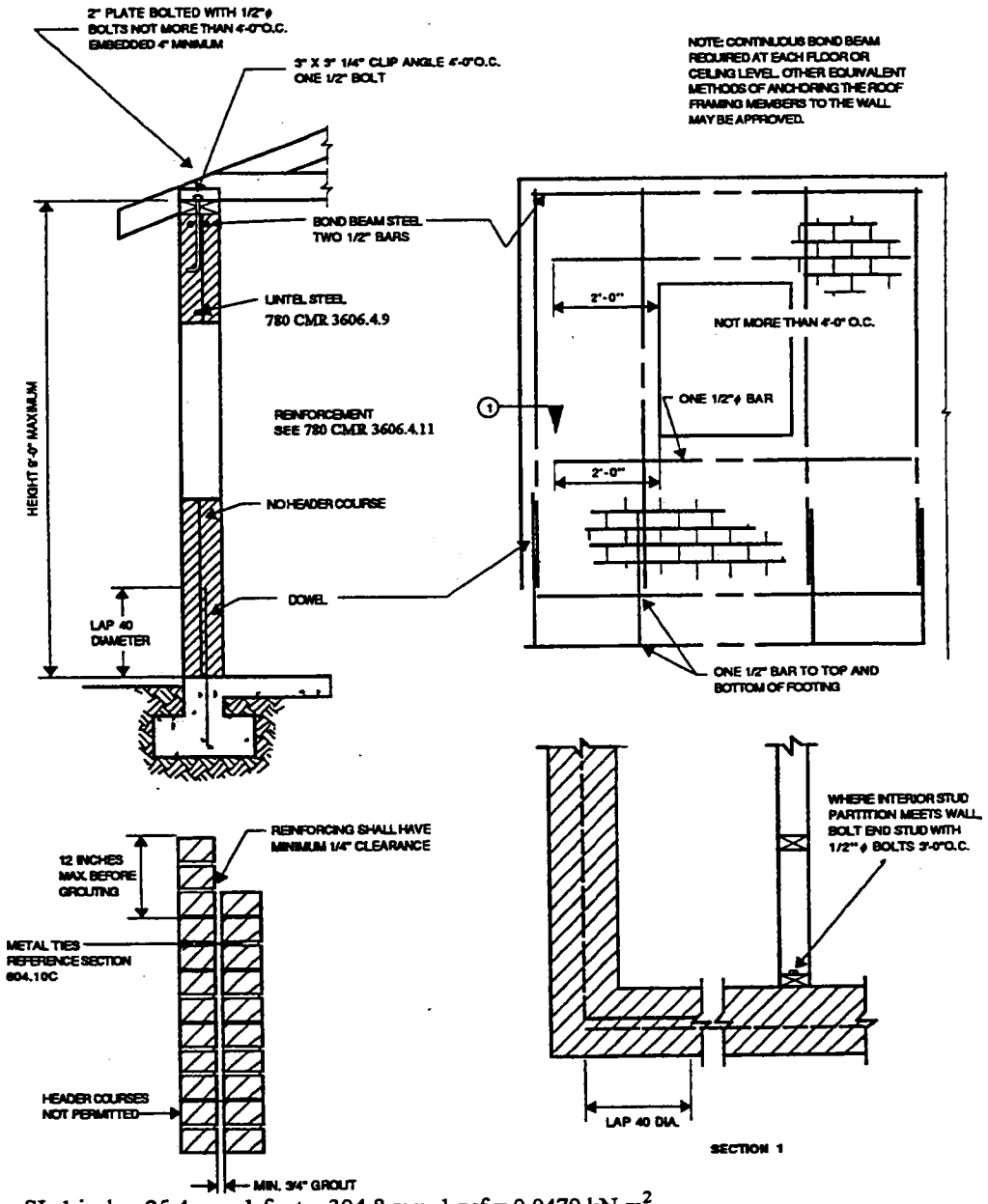
JOIST SPAN	BOLT SIZE AND SPACING	
	Roof	Floor
10'	1/2 @ 2'-6" 7/8 @ 3'-6"	1/2 @ 2'-0" 7/8 @ 2'-9"
10'-15'	1/2 @ 1'-9" 7/8 @ 2'-6"	1/2 @ 1'-4" 7/8 @ 2'-0"
15'-20'	1/2 @ 1'-3" 7/8 @ 2'-0"	1/2 @ 1'-0" 7/8 @ 1'-6"



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

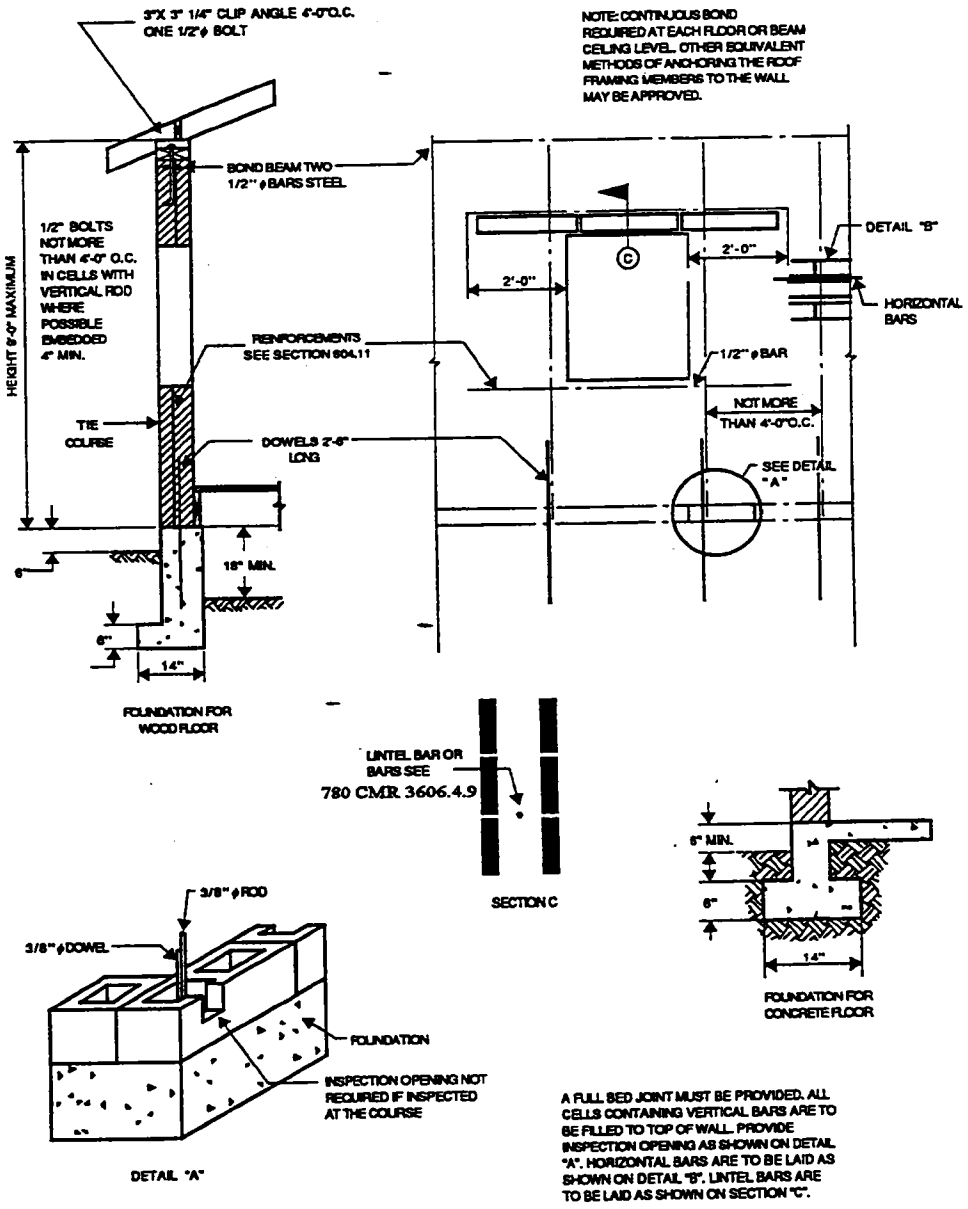
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psf = 0.0479 kN/m^2

FIGURE 3606.4.10b
REQUIREMENTS FOR REINFORCED GROUTED MASONRY CONSTRUCTION WHERE WIND LOADS ARE 30 PSF OR GREATER



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

FIGURE 3606.4.10c
REQUIREMENTS FOR REINFORCED HOLLOW-UNIT MASONRY CONSTRUCTION WHERE WIND LOADS ARE 30 PSF OR GREATER



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

780 CMR 3606.5 UNIT MASONRY

3606.5.1 Placing mortar and masonry units:

3606.5.1.1 Bed and head joints: Unless otherwise required or indicated on the project drawings, head and bed joints shall be ⅜ inch (9.5 mm) thick, except that the thickness of the bed joint of the starting course placed over foundations shall not be less than ¼ inch (6.4 mm) and not more than ¾ inch (19 mm).

3606.5.1.1.1 Mortar joint thickness tolerance: Mortar joint thickness shall be within the following tolerances from the specified dimensions:

bed joint ..... ±⅛ inch (3.2 mm)
head joint ..... -¼ inch (6.4 mm), +⅜ inch (9.5 mm)
collar joints ... -¼ inch (6.4 mm), +⅜ inch (9.5 mm)

Exception: Nonload-bearing masonry elements and masonry veneers designed and constructed in accordance with ***780 CMR 3607.3.7*** are not required to meet these tolerances.

3606.5.1.2 Masonry unit placement: The mortar shall be sufficiently plastic and units shall be placed with sufficient pressure to extrude mortar from the joint and produce a tight joint. Deep furrowing of bed joints which produces voids shall not be permitted. Any units disturbed to the extent that the initial bond is broken after initial placement shall be removed and relaid in fresh mortar. Surfaces to be in contact with mortar shall be clean and free of deleterious materials.

3606.5.1.2.1 Solid masonry: All solid masonry units shall be laid with full head and bed joints and all interior vertical joints that are designed to receive mortar shall be filled solid.

3606.5.1.2.2 Hollow masonry: ***All head and bed joints of hollow masonry units*** shall be filled solidly with mortar. ***The mortar shall extend a distance from the face of the masonry unit that shall measure less than the thickness of the face shell.***

3606.5.2 Installation of wall ties: The installation of wall ties shall be as follows:

1. The ends of wall ties shall be embedded in mortar joints. Wall tie ends shall engage outer face shells of hollow units by at least ½ inch (12.7 mm). Wire wall ties shall be embedded at least 1½ inches (38 mm) into the mortar bed of solid masonry units or solid grouted hollow units.
2. Wall ties shall not be bent after being embedded in grout or mortar.

780 CMR 3606.6 MULTIPLE WYTHE MASONRY

3606.6.1 General: The facing and backing of multiple wythe masonry walls shall be bonded in accordance with ***780 CMR 3606.6.1.1, 3606.6.1.2 or 3606.6.1.3***. In cavity walls, neither the facing nor the backing shall be less than three inches (76 mm) nominal in thickness and the cavity shall not be more than four inches (102 mm) nominal in width. The backing shall be at least as thick as the facing.

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

3606.6.1.1 Bonding with masonry headers: Bonding with solid or hollow masonry headers shall comply with ***780 CMR 3606.6.1.1.1*** and ***3606.6.1.1.2***.

3606.6.1.1.1 Solid units: Where the facing and backing (adjacent wythes) of solid masonry construction are bonded by means of masonry headers, no less than 4% of the wall surface of each face shall be composed of headers extending not less than three inches (76 mm) into the backing. The distance between adjacent full-length headers shall not exceed 24 inches (610 mm) either vertically or horizontally. In walls in which a single header does not extend through the wall, headers from the opposite sides shall overlap at least three inches (76 mm), or headers from opposite sides shall be covered with another header course overlapping the header below at least three inches (76 mm).

3606.6.1.1.2 Hollow units: Where two or more hollow units are used to make up the thickness of a wall, the stretcher courses shall be bonded at vertical intervals not exceeding 34 inches (864 mm) by lapping at least three inches (76 mm) over the unit below, or by lapping at vertical intervals not exceeding 17 inches (432 mm) with units which are at least 50% greater in thickness than the units below.

3606.6.1.2 Bonding with wall ties or joint reinforcement: Bonding with wall ties or joist reinforcement shall comply with ***780 CMR 3606.6.1.2.1*** through ***3606.6.1.2.3***.

3606.6.1.2.1 Bonding with wall ties: Bonding with wall ties, except as required by ***780 CMR 3606.6.1.2.2***, where the facing and backing (adjacent wythes) of masonry walls are bonded with $^{3}/_{16}$-inch-diameter (4.8 mm) wall ties embedded in the horizontal mortar joints, there shall be at least one metal tie for each 4½ square feet (0.418 m^2) of wall area. Ties in alternate courses shall be staggered. The maximum vertical distance between ties shall not exceed 24 inches (610 mm), and the maximum horizontal distance shall not exceed 36 inches (914 mm). Rods or ties bent to rectangular shape shall be used with hollow masonry units laid with the cells vertically. In other walls, the ends of ties shall be bent to 90-

degree angles to provide hooks no less than two inches (51 mm) long. Additional bonding ties shall be provided at all openings, spaced not more than three feet (914 mm) apart around the perimeter and within 12 inches (305 mm) of the opening.

3606.6.1.2.2 Bonding with adjustable wall ties: Where the facing and backing (adjacent wythes) of masonry are bonded with adjustable wall ties, there shall be at least one tie for each 2⅔ square feet (0.248 m^2) of wall area. Neither the vertical nor horizontal spacing of the adjustable wall ties shall exceed 24 inches (610 mm). The maximum vertical offset of bed joints from one wythe to the other shall be 1¼ inches (32 mm). The maximum clearance between connecting parts of the ties shall be $^1/_{16}$ inch (1.6 mm). When pintle legs are used, ties shall have at least two $^3/_{16}$-inch-diameter (4.8 mm) legs.

3606.6.1.2.3 Bonding with prefabricated joint reinforcement: Where the facing and backing (adjacent wythes) of masonry are bonded with prefabricated joint reinforcement, there shall be at least one cross wire serving as a tie for each 2⅔ square feet (0.248 m^2) of wall area. The vertical spacing of the joint reinforcement shall not exceed 16 inches (406 mm). Cross wires on prefabricated joint reinforcement shall not be smaller than No. 9 gage. The longitudinal wires shall be embedded in the mortar.

3606.6.1.3 Bonding with natural or cast stone: Bonding with natural and cast stone shall conform to ***780 CMR 3606.6.1.3.1*** and ***3606.6.1 3.2***.

3606.6.1.3.1 Ashlar masonry: Bonder units in ashlar masonry that are uniformly distributed, shall be provided to the extent of not less than 10% of the wall area. Such bonder units shall extend not less than four inches (102 mm) into the backing wall.

3606.6.1.3.2 Rubble stone masonry: Rubble stone masonry 24 inches (610 mm) or less in thickness shall have bonder units with a maximum spacing of three feet (914 mm) vertically and three feet (914 mm) horizontally, and if the masonry is of greater thickness than 24 inches (610 mm), shall have one bonder unit for each six square feet (0.557 m^2) of wall surface on both sides.

3606.6.2 Masonry bonding pattern: Masonry laid in running and stack bond shall conform to ***780 CMR 3606.6.2.1*** and ***3606.6.2.2***.

3606.6.2.1 Masonry laid in running bond: In each wythe of masonry laid in running bond, head joints in successive courses shall be offset by not less than one-fourth the unit length, or the masonry walls shall be reinforced longitudinally as required in ***780 CMR 3606.6.2.2***.

3606.6.2.2 Masonry laid in stack bond: Where unit masonry is laid with less head joint offset than in 780 CMR ***3606.6.2.1***, the minimum area of horizontal reinforcement placed in mortar bed joints or in bond beams spaced not more than 48 inches (1219 mm) apart, shall be 0.0007 times the vertical cross-sectional area of the wall.

780 CMR 3606.7 GROUTED MASONRY

3606.7.1 General: Grouted multiple-wythe masonry is a form of construction in which the space between the wythes is solidly filled with grout. It is not necessary for the cores of masonry units to be filled with grout. Grouted hollow unit masonry is a form of construction in which certain cells of hollow units are continuously filled with grout.

3606.7.1.1 Mortar and grout: Only Type M or Type S mortar mix consisting of portland cement, hydrated lime and sand in accordance with ASTM C 270, ***listed in Appendix A***, and the proportion specifications of Table ***3606.7.1.1a*** shall be used to construct masonry wythes. Grout shall consist of cementitious material and aggregate in accordance with ASTM C 476, ***listed in Appendix A***, and the proportion specifications of Table ***3606.7.1.1b***. Type M or Type S mortar to which sufficient water has been added to produce pouring consistency can be used as grout.

TABLE 3606.7.1.1a
MORTAR PROPORTIONS[1,2]

PROPORTIONS BY VOLUME (Cementitious Materials)							
Mortar	**Type**	**Portland Cement or Blended Cement**	**Masonry Cement**			**Hydrated Lime or Lime Putty**	**Aggregate Ratio (Measured in Damp, Loose Conditions)**
			M	**S**	**N**		
Cement-lime	M	1	-	-	-	¼	Not less than 2¼ and not more than three times the sum of separate volumes of lime, if used, and cement
	S	1	-	-	-	over ¼ to ½	
	N	1	-	-	-	over ½ to 1¼	
	O	1	-	-	-	over 1¼ to 2½	
Masonry cement	M	1	-	-	1		
	M	-	1	-	-		
	S	½	-	-	1		
	S	-	-	1	-		
	N	-	-	-	1		
	O	-	-	-	1		

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

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

Portland Cement	94 lb.
Masonry cement	Weight printed on bag
Hydrated lime	40 lb.
Lime putty(quicklime)	80 lb.
Sand, damp and loose	80 lb. of dry sand

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

TABLE 3606.7.1.1b
GROUT PROPORTIONS BY VOLUME FOR MASONRY CONSTRUCTION

TYPE	**PORTLAND CEMENT OR BLENDED CEMENT SLAG CEMENT**	**HYDRATED LIME OR LIME PUTTY**	**AGGREGATE MEASURED IN A DAMP, LOOSE CONDITION**	
			Fine	**Coarse**
Fine	1	0 to $^1/_{10}$	2¼ to three times the sum of the volume of the cementitious materials	-
Coarse	1	0 to $^1/_{10}$	2¼ to three times the sum of the volume of the cementitious materials	One to two times the sum of the volumes of the cementitious materials

3606.7.1.2 Grouting requirements: Maximum pour heights and the minimum dimensions of spaces provided for grout placement shall conform to Table *3606.7.1.2*. If the work is stopped for one hour or longer, the horizontal construction joints shall be formed by stopping all tiers at the same elevation and with the grout one inch (25 mm) below the top.

TABLE 3606.7.1.2
GROUT SPACE DIMENSIONS AND POUR HEIGHTS

GROUT TYPE	**GROUT POUR MAXIMUM HEIGHT (feet)**	**MINIMUM WIDTH OF GROUT SPACES[1,2] (inches)**	**MINIMUM GROUT[2,3] SPACE DIMENSIONS FOR GROUTING CELLS OF HOLLOW UNITS (inches = 43 inches)**
Fine	1	¾	1½ x 2
	5	2	2 x 3
	12	2½	2½ x 3
	24	3	3 x 3
Coarse	1	1½	1½ x 3
	5	2	2½ x 3
	12	2½	3 x 3
	24	3	3 x 4

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

1 For grouting between masonry wythes.

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

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

3606.7.1.3 Grout space (cleaning): Provision shall be made for cleaning grout space. Mortar projections which project more than ½ inch (12.7 mm) into grout space and any other foreign matter shall be removed from grout space prior to inspection and grouting.

3606.7.1.4 Grout placement: Grout shall be a plastic mix suitable for pumping without segregation of the constituents and shall be mixed thoroughly. Grout shall be placed by pumping or by an approved alternate method and shall be

placed before any initial set occurs and in no case more than 1½ hours after water has been added. Grouting shall be done in a continuous pour, in lifts not exceeding four feet (1219 mm). It shall be consolidated by puddling or mechanical vibrating during placing and reconsolidated after excess moisture has been absorbed but before plasticity is lost.

3606.7.1.4.1 Grout pumped through aluminum pipes: Grout shall not be pumped through aluminum pipes.

3606.7.1.5 Cleanouts: Where required by the building official, cleanouts shall be provided as specified in 780 CMR 3606.7.1.5. The cleanouts shall be sealed before grouting and after inspection.

3606.7.1.5.1 Grouted multiple-wythe masonry: Cleanouts shall be provided at the bottom course of the exterior wythe at each pour of grout where such pour exceeds five feet (1524 mm) in height.

3606.7.1.5.2 Grouted hollow unit masonry: Cleanouts shall be provided at the bottom course of each cell to be grouted at each pour of grout, where such pour exceeds four feet (1219 mm) in height.

3606.7.1.6 Inspection: Special inspection during grouting shall be provided where required by the building official.

3606.7.2 Grouted multiple-wythe masonry: Grouted multiple-wythe masonry shall conform to all the requirements specified in ***780 CMR 3606.7.1*** and the requirements of 780 CMR 2606.7.2.

3606.7.2.1 Bonding of backup wythe: Where all interior vertical spaces are filled with grout in multiple-wythe construction, masonry headers shall not be permitted. Metal wall ties shall be used in accordance with ***780 CMR 3606.6.1.2*** to prevent spreading of the wythes and to maintain the vertical alignment of the wall. Wall ties shall be installed in accordance with ***780 CMR 3606.6.1.2***, when the backup wythe in multiple-wythe construction is fully grouted.

3606.7.2.2 Grout spaces: Fine grout shall be used when interior vertical space to receive grout does not exceed two inches (51 mm) in thickness. Interior vertical spaces exceeding two inches (51 mm) in thickness shall use course or fine grout.

3606.7.2.3 Grout barriers: Vertical grout barriers or dams shall be built of solid masonry across the grout space the entire height of the wall to control the flow of the grout horizontally. Grout barriers shall not be more than 25 feet (7620 mm) apart. The grouting of any section of a wall between control barriers shall be completed in one day with no interruptions greater than one hour.

3606.7.3 Reinforced grouted multiple-wythe masonry: Reinforced grouted multiple-wythe masonry shall conform to all the requirements specified in ***780 CMR 3606.7.1*** and ***3606.7.2*** and the requirements of 780 CMR 3606.7.3

3606.7.3.1 Construction: The thickness of grout or mortar between masonry units and reinforcement shall not be less than ¼ inch (6.4 mm), except that ¼-inch (6.4 mm) bars may be laid in horizontal mortar joints at least ½ inch (12.7 mm) thick, and steel wire reinforcement may be laid in horizontal mortar joints at least twice the thickness of the wire diameter.

3606.7.4 Reinforced hollow unit masonry: Reinforced hollow unit masonry shall conform to all the requirements of ***780 CMR 3606.7.1*** and the requirements of 780 CMR 2606.7.4.

3606.7.4.1 Construction: Requirements for construction shall be as follows:

1. All reinforced hollow-unit masonry shall be built to preserve the unobstructed vertical continuity of the cells to be filled. Walls and cross webs forming such cells to be filled shall be full-bedded in mortar to prevent leakage of grout. All head and end joints shall be solidly filled with mortar for a distance in from the face of the wall or unit not less than the thickness of the longitudinal face shells. Bond shall be provided by lapping units in successive vertical courses.
2. Cells to be filled shall have vertical alignment sufficient to maintain a clear, unobstructed continuous vertical cell of dimensions prescribed in Table ***3606.7.1.2***.
3. Vertical reinforcement shall be held in position at top and bottom and at intervals not exceeding 200 diameters of the reinforcement.
4. All cells containing reinforcement shall be filled solidly with grout. Grout shall be poured in lifts of eight-foot (2438 mm) maximum height. When total grout pour exceeds eight feet (2438 mm) in height, the grout shall be placed in lifts not exceeding four feet (1219 mm) and special inspection during grouting shall be required.
5. Horizontal steel shall be fully embedded by grout in an uninterrupted pour.

780 CMR 3606.8 WINDOWS

3606.8.1 Testing and certification: Windows shall be tested and certified to indicate compliance with the requirements of the following specifications:

Aluminum: AAMA (ANSI) 101
Wood: ANSI/NWWDA I.S. 2
Polyvinyl Chloride: ASTM D 4099, ***each as listed in Appendix A.***

3606.8.2 Air infiltration: Regardless of the type or requirements of the windows set forth in the aforementioned specifications, no window may be selected whose air infiltration exceeds 0.50 cubic feet per minute per linear foot (0.236 L/s per mm) of crack when tested in accordance with ASTM E 283, ***as listed in Appendix A***, at a pressure differential of 1.56 psf (0.075 kN/m^2).

780 CMR 3606.9 SLIDING GLASS DOORS

3606.9.1 Testing and certification: Sliding glass doors shall be tested and certified to indicate compliance with the requirements of the following specifications:

Aluminum: AAMA (ANSI) 101
Wood: ANST/NWWDA I.S.3, ***each as listed in Appendix A***.

3606.9.2 Air infiltration: Regardless of the type or requirements of the sliding glass doors set forth in the aforementioned specifications, no sliding glass door may be selected whose air infiltration exceeds 0.50 cubic feet per minute per square foot (0.236 L/s per mm^2) of door area when tested in accordance with ASTM E 283, ***as listed in Appendix A,*** at a pressure differential of 1.56 pounds per square foot (0.075kN/m^2).

780 CMR 3606.10 PLYWOOD AND WOOD STRUCTURAL PANELS

3606.10.1 Identification and grade: Plywood shall conform to DOC PS 1, DOC PS 2 or HPMA (ANSI) HP, ***as listed in Appendix A***. Wood structural panels shall conform to DOC PS 2, ***as listed in Appendix A***. All panels shall be identified by a grade mark or certificate of inspection issued by an approved agency. Wood structural panels shall comply with the grades specified in Table ***3606.2.3b***.

3606.10.2 Allowable spans: The maximum allowable spans for wood structural panel wall sheathing shall not exceed the values set forth in Table ***3606.2.3b***.

3606.10.3 Installation: Wood structural panel wall sheathing shall be attached to framing in accordance with Table ***3606.2.3a***. Wood structural panels marked Exposure 1 or Exterior are considered water-repellent sheathing under 780 CMR.

780 CMR 3606.11 PARTICLEBOARD

3606.11.1 Identification and grade: Particleboard shall conform to ANSI A208.1, ***as listed in Appendix A,*** and shall be so identified by a grade mark or certificate of inspection issued by an approved agency. Particleboard shall comply with the grades specified in Table ***3606.2.3c***.

WALL COVERING

780 CMR 3607.1 - GENERAL

3607.1.1 Application: The provisions of 780 CMR 3607.1 shall control the design and construction of the interior and exterior wall covering for all buildings. The use of materials or methods of construction not specified in 780 CMR 3607.1 accomplishing the purposes intended by 780 CMR 36 and approved by the building of in accordance with ***780 CMR 109*** shall be accepted as complying with 780 CMR 36.

3607.1.2 Installation: Products sensitive to adverse weather shall not be installed until adequate weather protection for the installation is provided. Exterior sheathing shall be dry before applying exterior cover.

780 CMR 3607.2 INTERIOR COVERING

3607.2.1 General: Interior coverings shall be installed in accordance with this ***section*** and Tables ***3607.2.1a, 3607.2.1b, 3607.2.1c and 3607.2.3.4.*** Interior finishes and materials shall conform to the flame spread and smoke-density requirements of ***780 CMR 3603***.

3607.2.2 Interior plaster: Gypsum plaster or portland cement plastering materials shall conform to ASTM C 5, C 28, C 35, C 37, C 59, C 61, C 587, C 588, C 631, C847, C 897, C 933, C 1032 and C 1047, and shall be installed or applied in conformance with ASTM C 843, C 844 and C 1063, ***each as listed in Appendix A***. Plaster shall not be less than three coats when applied over metal lath and not less than two coats when applied over other bases permitted by 780 CMR 3607.2, except that veneer plaster may be applied in one coat not to exceed $^{3}/_{16}$ inch (4.76 mm) thickness, provided the total thickness is as set forth in Table ***3607.2.1a***.

3607.2.2.1 Support: Support spacing, ***spacing of fasteners and size of fasteners*** for gypsum and metal lath shall conform with Table ***3607.2.3.4***. Gypsum lath shall be installed at right angles to support framing with end joints staggered.

3607.2.3 Gypsum wallboard:

3607.2.3.1 Materials: All gypsum wallboard materials and accessories shall conform to ASTM C 36, C 475, C 514, C 960, C 1002 and C 1047 ***as listed in Appendix A***, and shall be installed in accordance with the provisions of 780 CMR 3607.2. Adhesives for the installation of gypsum wallboard shall conform to ASTM C 557 ***as listed in Appendix A***.

3607.2.3.2 Wood framing: Wood framing supporting gypsum wallboard shall not be less than two inches (51 mm) nominal thickness in the least dimension except that wood furring strips not less than one-inch-by-two inch (25 mm by 51 mm) nominal dimension may be used over solid backing or framing spaced not more than 24 inches (610 mm) on center.

3607.2.3.3 Steel framing: Steel framing shall not be less than ¼ inches (32 mm) wide in the least dimension. Light-gage nonload-bearing steel framing shall comply with ASTM C 645 ***as listed in Appendix A***. Load-bearing steel framing and steel framing from 0.033 inch to 0.112 inch (0.838 mm to 2.84 mm) thick shall comply with ASTM C 955 ***as listed in Appendix A***.

3607.2.3.4 Application: Support spacing and size and spacing of fasteners shall comply with Table ***3607.2.3.4***. Gypsum wallboard may be applied at right angles or parallel to framing members. All edges and ends of gypsum wallboard shall occur on the framing members, except those edges and ends which are perpendicular to the framing members. Interior gypsum wallboard shall not be installed where it is exposed to the weather construction.

3607.2.3.5 Fastening: Screws for attaching gypsum wallboard to wood shall be Type W in accordance with ASTM C 1002 ***as listed in Appendix A*** and shall penetrate the wood not less than ⅝ inch (15.9 mm). Screws for attaching gypsum wallboard to light-gage steel shall be Type S in accordance with ASTM C 1002 ***as listed in Appendix A*** and shall penetrate the steel not less than ¼ inch (6.4 mm). Screws for attaching gypsum wallboard to steel 0.033 inch to 0.112 inch (0.838 mm to 2.84 mm) thick shall comply with ASTM C 954 ***as listed in Appendix A***.

3607.2.4 Bathtub and shower spaces: Bathtub and shower floors and walls shall be finished with a smooth, hard and nonabsorbent surface. Ceramic tile surfaces shall be installed in accordance with ANSI A 108.1, A108.4, A108.5, A108.6, A108.11, A118.1, A 118.3, A 136.1 and A 137.1 ***as listed in Appendix A***. Such wall surfaces shall extend to a height of not less than six feet (1829 mm) above the floor.

3607.2.4.1 Ceramic tile: Gypsum board utilized as the base or backer board for adhesive application of ceramic tile or other nonabsorbent

finish material shall conform with ASTM C 630 ***as listed in Appendix A***. Water-resistant gypsum backing board shall be permitted to be used on ceilings where framing spacing does not exceed 12 inches (305 mm) on center. All cut or exposed edges, including those at wall intersections, shall be sealed as recommended by the manufacturer.

3607.2.5 Other finishes: Wood veneer or hardboard paneling not less than ¼-inch (6.4 mm) nominal thickness [$^{13}/_{64}$-inch (5.2 mm) actual] shall conform to HPMA (ANSI) HP and stud spacing may not exceed 16 inches on center.

3607.2.6 Wood shakes and shingles: Wood shakes and shingles shall conform to CSSB "Grading Rules for Wood Shakes and Shingles" ***as listed in Appendix A*** and shall be permitted to be installed directly to the studs with maximum 24 inches (610 mm) on center spacing; wood veneer harboard paneling less than ¼-inch (6.4 mm) nominal thickness must not have less than ⅜-inch (9.5 mm) gypsum board backer.

TABLE 3607.2.1a
THICKNESS OF PLASTER

PLASTER BASE	FINISHED THICKNESS OF PLASTER FROM FACE TO LATH, MASONRY, CONCRETE	
	Gypsum Plaster	Portland Cement Mortar
Expanded metal lath	⅝" minimum[1]	⅝" minimum[1]
Wire lath	⅝" minimum[1]	¾" minimum (interior)[2] ⅞" minimum (exterior)[2]
Gypsum lath	½" minimum	
Masonry walls[3]	½" minimum	½" minimum
Monolithic concrete walls[3,4]	⅝" maximum	⅞" maximum
Monolithic concrete ceilings[3,4]	⅜" maximum[5]	½" maximum
Gypsum veneer base[6]	$^{1}/_{16}$" minimum[1]	

For SI: 1 inch = 25.4 mm

1. When measured from back plane of expanded metal lath, exclusive of ribs, or self -furring lath, plaster thickness shall be ¾ inch minimum.
2. When measured from face of support or backing.
3. Because masonry and concrete surfaces may vary in plane, thickness of plaster need not be uniform.
4. When applied over a liquid bonding agent, finish coat may be applied directly to concrete surface.
5. Approved acoustical plaster may be applied directly to concrete or over base coat plaster, beyond the maximum plaster thickness shown.
6. Attachment shall be in accordance with Table 3607.2.3.4.

TABLE 3607.2.1b
GYPSUM PLASTER PROPORTIONS

NUMBER	COAT	PLASTER BASE OR LATH	MAXIMUM VOLUME AGGREGATE PER 100 POUNDS NEAT PLASTER[2] (cubic feet)	
			Damp Loose Sand[1]	Perlite or Vermiculite[3]
Two-coat work	Base coat	Gypsum lath	2½	2
	Base coat	Masonry	3	3
Three-coat work	First coat	Lath	2[4]	2
	Second coat	Lath	3[4]	2[5]
	First and second coats	Masonry	3	3

For SI: 1 inch = 25.4 mm, 1 cubic foot = 0.0283 m^3, 1 pound = 0.454 kg.

1. Wood-fibered gypsum plaster may be mixed in the proportions of 100 pounds of gypsum to not more than one cubic foot of sand where applied on masonry or concrete.
2. When determining the amount of aggregate in set plaster, a tolerance of 10% shall be allowed.
3. Combinations of sand and lightweight aggregate may be used, provided the volume and weight relationship of the combined aggregate to gypsum plaster is maintained.
4. If used for both first and second coats, the volume of aggregate may be 2½ cubic feet.
5. Where plaster is one inch or more in total thickness, the proportions for the second coat may be increased to three cubic feet.

TABLE 3607.2.1c
PORTLAND CEMENT PLASTER

COAT	MAXIMUM VOLUME AGGREGATE PER VOLUME CEMENTITIOUS MATERIAL[1]				MINIMUM PERIOD MOIST COATS	MINIMUM INTERVAL BETWEEN
	Portland Cement Plaster[2] Maximum Volume Aggregate per Volume Cement	Portland Cement-lime Plaster[3] Maximum Volume Lime per Volume Cement	Portland Cement-lime Plaster[3] Maximum Volume Sand per Volume Cement and Lime	Approximate Minimum Thickness[4] Curing		
First	4	¾	4	⅜[5]	48[6] Hours	48[7] Hours
Second	5	¾	5	First and Second coats	48 Hours	7 Days[8]
Finished	3[9]	-	3[9]	⅛	-	-[8]

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

1. When determining the amount of aggregate in set plaster, a tolerance of 10% may be allowed.
2. From ten to 20 pounds of dry hydrated lime (or an equivalent amount of lime putty) may be added as a plasticizing agent to each sack of Type I and Type II standard portland cement in base coat plaster.
3. No additions of plasticizing agents shall be made.
4. See Table 3607.2.1a
5. Measured from face of support or backing to crest of scored plaster.
6. 24 hour minimum period for moist curing of interior portland cement plaster.
7. 24 hour minimum interval between coats of interior portland cement plaster.
8. Finish coat plaster may be applied to interior portland cement base coat after a 48-hour period.
9. For finish coat, plaster up to an equal part of dry hydrated lime by weight (or an equivalent volume of lime putty) may be added to Type I, Type II and Type III standard portland cement.

TABLE 3607.2.3.4
APPLICATION AND MINIMUM THICKNESS OF GYPSUM WALLBOARD

THICKNESS OF GYPSUM WALLBOARD (inch)	PLANE OF FRAMING SURFACE[4]	LONG DIMENSION OF GYPSUM WALLBOARD SHEETS IN RELATION TO DIRECTION OF FRAMING MEMBERS	MAXIMUM SPACING OF FRAMING MEMBERS (center-to-center in inches)	MAXIMUM SPACING OF FASTENERS (center-to-center, in inches)		NAILS[1] TO WOOD
				Nails[1,2]	Screws	
Fastening required without adhesive application.						
3/8	Horizontal[4]	Perpendicular	16	7	12	No. 13 gage 1¼" long 19/64" head 0.098" diameter, 1¼" long, annular-ringed; 4d cooler nail
	Vertical	Either direction	16	8	12	
½	Horizontal[3]	Either direction	16	7	12	No. 13 gage 1⅜" long 19/64" head 0.098"diameter, 1¼" long, annular-ringed; 5d cooler nail
	Horizontal[3]	Perpendicular	24	7	12	
	Vertical	Either direction	24	8	12	
5/8	Horizontal	Either direction	16	7	12	No. 13 gage 1⅝" long 19/64" head 0.098" diameter, 1⅜" long, annular-ringed; 6d cooler nail
	Horizontal	Perpendicular	24	7	12	
	Vertical	Either direction	24	8	12	
With adhesive application.						
3/8	Horizontal[4]	Perpendicular	16	16	16	Same as above for 3/8"
	Vertical	Either direction	16	16	24	
½ or 5/8	Horizontal	Either direction[3]	16	16	16	As required for ½" and 5/8" gypsum wallboard, see above
		Perpendicular	24	12	16	
	Vertical	Either direction	24	24	24	
2 3/8 layers	Horizontal	Perpendicular	24	16	16	Base ply nailed ad required for ½" gypsum wallboard and face ply placed with adhesive
	Vertical	Either direction	24	24	24	

For SI: 1 inch = 25.4 mm

1. Where the metal framing has a clinching design formed to receive the nails by two edges of metal, the nails shall not be less than 5/8 inch longer than the wallboard thickness and shall have ringed shanks. Where the metal framing has a nailing groove formed to receive the nails, the nails shall have barbed shanks or be 5d, 13½ gage, 1⅝ inches long, 15/64-inch head for ½-inch gypsum wallboard; 6d, 13 gage, 1⅞ inches long, 15/64 -inch head for 5/8-inch gypsum wallboard.
2. Two nails spaced not less than two inches apart, or more than 2½ inches apart may be used where the pairs are spaced 12 inches on center except around the perimeter of the boards.
3. 3/8-inch single-ply gypsum board shall not be installed in water-based textured finish is applied or to support insulation above a ceiling. On horizontal applications to receive a water-based texture material, either hand or spray applied, gypsum board shall be applied perpendicular to framing and board thickness increased from 3/8 inch to ½ inch for 16-inch o.c. framing, and from ½ inch to 5/8 inch for 24-inch o.c. framing.
4. Horizontal refers to applications such as ceilings. Vertical refers to applications such as walls.

3607.2.6.1 Attachment: Nails, staples or glue are permitted for use in attaching shakes or shingles to the wall, and the shakes or shingles shall be permitted to be attached directly to the surface provided the fasteners are appropriate for the type of wall surface material. When nails or staples are used, two fasteners shall be provided and shall be placed so that they are covered by the course above.

3607.2.6.2 Furring strips: Where furring strips are used, they shall be one inch by two inches or one inch by three inches (25 mm by 51 mm or 25

mm by 76 mm), spaced a distance on center equal to the shake or shingle exposure, and shall be attached to the wall by nailing through the base wall material into the studs of the interior spaces.

3607.2.6.3 Bottom course: The bottom course shall be doubled.

780 CMR 3607.3 EXTERIOR COVERING

3607.3.1 General: All exterior walls shall be covered with approved materials designed and installed to provide a barrier against the weather and insects to enable environmental control of the interior spaces. The exterior coverings in 780 CMR 3607.0 shall be installed in the specified manner unless otherwise approved.

3607.3.2 Weather-resistant sheathing paper: Asphalt-saturated felt, free from holes and breaks and weighing not less than 14 pounds per 100 square feet (0.683 kg/m^2) or other approved weather-resistant material shall be applied over studs or sheathing of all exterior walls as required by Table *3607.3.4*. Such felt or material shall be applied horizontally, with the upper layer lapped over the lower layer not less than two inches (51 mm). Where joints occur, felt shall be lapped not less than six inches (153 mm).

3607.3.2.1 Felt or material: Such felt or material may be omitted.

1. In detached accessory buildings.
2. Under panel siding with shiplap joints or battens.
3. Under exterior wall finish materials as permitted in Table *3607.3.4*.
4. Under paperbacked stucco lath.
5. Over water-repellent sheathing materials.

3607.3.3 Wood, plywood and wood structural panel siding: Joints in wood, plywood or wood structural panel siding shall be made as follows unless otherwise approved. Vertical joints in panel siding shall occur over framing members, unless wood or wood structural panel sheathing is used, and shall be shiplapped or covered with a batten. Horizontal joints in panel siding shall be lapped a minimum of one inch (25 mm) or shall be flashed with Z-flashing.

3607.3.3.1 Horizontal siding: Horizontal siding shall be lapped a minimum of one inch (25 mm), or ½ inch (12.7 mm) if rabbeted, and shall have the ends caulked, covered with a batten, or sealed and installed over a strip of flashing.

3607.3.4 Attachments: Unless specified otherwise, all wall coverings shall be securely fastened in accordance with Table *3607.3.4* or with other approved aluminum, stainless steel, zinc-coated, or other approved corrosion-resistive fasteners.

3607.3.5 Wood shakes and shingles: Wood shakes and shingles shall conform to CSSB "Grading Rules for Wood Shakes and Shingles."

3607.3.5.1 Application: Wood shakes or shingles shall be applied either single-course or double-course over nominal ½-inch (12.7 mm) wood-based sheathing or to furring strips over ½-inch (12.7 mm) nominal non-wood sheathing. A weather-resistant permeable membrane shall be provided over the sheathing, with horizontal overlaps in the membrane of not less than two inches (51 mm) and vertical overlaps of not less than six inches (153 mm). Where furring strips are used, they shall be one inch by three inches or one inch by four inches (25 mm by 76 mm or 25 mm by 102 mm) and shall be fastened horizontally to the studs with 7d or 8d box nails and shall be spaced a distance on center equal to the actual weather exposure of the shakes or shingles, not to exceed the maximum exposure specified in Table *3607.3.5.2*. The spacing between adjacent shingles to allow for expansion shall not exceed ¼ inch (6.4 mm), and between adjacent shakes, shall not exceed ½ inch (12.7 mm). The offset spacing between joints in adjacent courses a minimum of 1½ inches (38 mm).

3607.3.5.2 Weather exposure: The maximum weather exposure for shakes and shingles shall not exceed that specified in Table *3607.3.5.2*.

3607.3.5.3 Attachment: Each shake or shingle shall be held in place by two hot-dipped zinc-coated, stainless steel, or aluminum nails or staples. The fasteners shall be long enough to penetrate the sheathing or furring strips by a minimum of ½ inch (12.7 mm) and shall not be overdriven.

3607.3.5.3.1 Staple attachment: Staples shall not be less than 16 gage and shall have a crown width of not less than $^7/_{16}$ inch (11 mm), and the crown of the staples shall be parallel with the butt of the shake or shingle. In single-course application, the fasteners shall be concealed by the course above and shall be driven approximately one inch (25 mm) above the butt line of the succeeding course and ¾ inch (19 mm) from the edge. In double-course applications, the exposed shake or shingle shall be face-nailed with two casing nails, driven approximately two inches (51 mm) above the butt line and ¾ inch (19 mm) from each edge. Staples shall not be permitted for face-nailing. With shingles wider than eight inches (203 mm), two additional nails shall be required and shall be nailed approximately one inch (25 mm) apart near the center of the shingle.

3607.3.6 Exterior lath: All lath and lath attachments shall be of corrosion-resistant materials.

Expanded metal or woven wire lath shall be attached with 1½ inch (38 mm) long, 11 gage nails having a $^{7}/_{16}$-inch (11 mm) head, or ⅞ inch (22 mm) long, 16 gage staples, spaced at no more than six inches (153 mm), or as otherwise approved.

3607.3.7 Masonry veneer, general: All masonry veneer shall be installed in accordance with 780 CMR 3607.3.7, Table ***3607.3.4*** and Figure ***3607.3.7***. Exterior masonry veneer shall not be laterally supported by wood frame at any point more than 35 feet (7620 mm) above the adjacent ground elevation.

Exceptions:

1. Veneers used as interior wall finishes may be supported on wood floors which are designed to support the loads imposed.
2. Exterior masonry veneers ***with*** an installed weight of 40 pounds per square foot (195 kg/m^2) or less may be supported on wood construction. When the masonry veneer is supported by wood construction that adjoins the masonry veneer supported by the foundation, there shall be a movement joint between the veneer supported by the wood construction and the foundation. The wood construction supporting the masonry veneer shall be designed to limit deflection to $^{1}/_{600}$ of the span for the supporting members.

3607.3.7.1 Lintels: Masonry veneer shall not support any vertical load other than the dead load of the veneer above. Veneer above openings shall be supported on lintels of noncombustible materials and the allowable span shall not exceed the values set forth in Table ***3607.3.7.1***. The lintels shall have a length of bearing of not less than four inches (102 mm).

3607.3.7.2 Attachment: Masonry veneer shall be attached to the supporting wall with corrosion-resistant metal ties.

3607.3.7.2.1 Size and spacing: Veneer ties, if strand wire, shall not be less in thickness than No. 9 U.S. gage wire and shall have a hood embedded in the mortar joint, or if sheet metal, not less than No. 22 U.S. gage by ⅞ inch (22 mm) corrugated. Each tie shall be spaced not more than 24 inches (610 mm) on center horizontally and shall support not more than 3¼ square feet (0.302 m^2) of wall area.

Exception: In wind areas of more than 30 pounds per square foot (1.44 kN/m^2), each tie shall support not more than two square feet (0.186 m^2) of wall area.

TABLE 3607.3.4
WEATHER-RESISTANT SIDING ATTACHMENT AND MINIMUM THICKNESS

SIDING MATERIAL		NOMINAL THICNESS[1] (inches)	JOINT TREATMENT	SHEATHING PAPER REQUIRED	TYPE OF SUPPORTS FOR THE SIDING MATERIAL AND FASTENERS[2,3,4]				
					Wood, or Wood structural Panel Sheathing	Fiberboard Sheathing into Stud	Gypsum Sheathing into Stud	Direct to Studs	Number or Spacing of Fasteners
Horizontal aluminum[5]	Without insulation	0.019[6]	Lap	No	0.120 nail 1½" long	0.120 nail 2" long	0.120 nail 2" long	Not allowed	Same as stud spacing
	Without insulation	0.024	Lap	No	0.120 nail 1½" long	0.120 nail 2" long	0.120 nail 2" long	Not allowed	
	With insulation	0.019	Lap	No	0.120 nail 1½" long	0.120 nail 2" long	0.120 nail 2½" long	0120 nail 1½" long	
Brick veneer Concrete masonry veneer		2 2	780 CMR 3607.3	Yes (13)	See 780 CMR 3607.3.7[8]				
Hardboard[12] Board and batten-vertical		7/16	(7)	(7)	0.099 nail 2" long	0.099 nail 2½" long	0.099 nail 2" long	0.099 nail 1¾" long	6" panel edges 8" inter. sup.
Hardboard[12] Lap-siding-horizontal		7/16	(7)	(7)	0.099 nail 2" long	0.099 nail 2½" long	0.099 nail 2¼" long	0.099 nail 2" long	Same as stud spacing 2 per bearing
Steel[9]		29 ga.	Lap	No	0.113 nail 1¾" Staple 1¾"	0.113 nail 2¾" Staple 2½"	0.113 nail 2½" Staple 2¼"	Not allowed	Same as stud spacing
Stone veneer		2	780 CMR 3607.3	Yes	See 780 CMR 3607.3 and Figure 3607.3.7				
Particalboard panels		⅜ - ½	(7)	(7)	6d box nail	6d box nail	6d box nail	6d box nail, ⅜ not allowed	6" panel edges 12" inter. sup.
		⅝	(7)	(7)	6d box nail	8d box nail	8d box nail	6d box nail	
Plywood panel[10] (exterior grade)		⅜	(7)	(7)	0.099 nail 2" Staple 1⅜"	0.113 nail 2½" Staple 2¼"	0.099 nail 2" Staple 2"	0.099 nail 2" Staple 1⅜"	6" on edges 12" inter. sup.
Vinyl Siding[14]		0.035	Lap	No	0.120 nail 1½" Staple 1¾"	0.120 nal 2" Staple 2½"	0.120 nail 2" Staple 2½"	Not allowed	Same as stud spacing
Wood[11] Rustic drop Shiplap		⅜ Minimum 19/32 Average	Lap	No	Fastener penetration into stud - 1"			0.113 nail 2½" Staple 2"	Face nailig up to 6" widths, 1 nail per bearing: 8" widrhs and over, 2 nails per bearing
Bevel		7/16	Lap	No					
Butt tip		3/16	Lap	No					

For SI: 1 inch = 25.4 mm.

1. Based on stud spacing of 16 inches o.c. Where studs are spaces 24 inches, siding may be applied to sheathing approved for that spacing.
2. Nail is a general description and may be T-head, modified round head, or round head with smooth or deformed shanks.
3. Staples shall have a minimum crown width of 7/16-inch O.D. and be manufactured of minimum No. 16 gage wire.
4. Nails or staples must be aluminum, galvanized, or rust-preventive coated and shall be driven into the studs for fiberboard or gypsum backing.
5. Aluminum nails shall be used to attach aluminum siding.
6 Aluminum (0.019 inch) may be unbacked only when the maximum panel width is ten inches and the maximum flat area is eight inches. The tolerance for aluminum siding shall be ±0.002 inch of the nominal dimension.
7. If boards are applied over sheathing or weather resistant membrane, joints need not be treated. Otherwise, vertical joints must occur at studs and be covered with battens or be lapped.
8. All attachments shall be coated with a corrosion-resistive coating.
9. Shall be of approved type.
10. ⅜-inch plywood may be applied directly to studs spaced 16 inches on center. ½-inch plywood may be applied directly to studs spaced at 24 inches on center.
11. Woodboard sidings applied vertically shall be nailed to horizontal nailing strips or blocking set 24 inches o.c. Nails shall penetrate 1½ inches into studs, studs and wood sheathing combined, or blocking. A weather-resistant membrane shall be installed weatherboard fashion under the vertical siding unless the siding boards are lapped or battens are used.
12. Hardboard siding shall comply with AHA A135.6
13. For masonry veneer, a weather-resistant membrane or building paper is not required over water-repellent sheathing materials when a one-inch air space is provided between the veneer and the sheathing. When the one-inch space is

filled with mortar, a weather-resistant membrane or building paper is required over studs or sheathing.
14. Vinyl siding shall comply with ASTM D 3679.

TABLE 3607.3.5.2
MAXIMUM WEATHER EXPOSURE FOR WOOD SHAKES AND SHINGLES ON EXTERIOR WALLS
(Dimensions are in

LENGTH	EXPOSURE FOR SINGLE COURSE	EXPOSURE FOR DOUBLE COURSE
SHINGLES[1]		
16	7½	12[2]
18	8½	14[3]
24	11½	16
SHAKES[1]		
18	8½	14
24	11½	18

For SI: 1 inch = 25.4 mm
1. Dimensions given are for No. 1 Grade.
2. A maximum ten-inch exposure is permitted for No. 2 Grade.
3. A maximum 11-inch exposure is permitted for No. 2 Grade.

3607.3.7.2.2 Paper backing required: When applied over stud construction, the studs shall be spaced a maximum of 24 inches (610 mm) on center and approved paper shall first be applied over the sheathing or wires between the studs, except as otherwise provided in *780 CMR 3607.3.2* and mortar shall be slushed into the one-inch (25 mm) space between facing and paper.

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

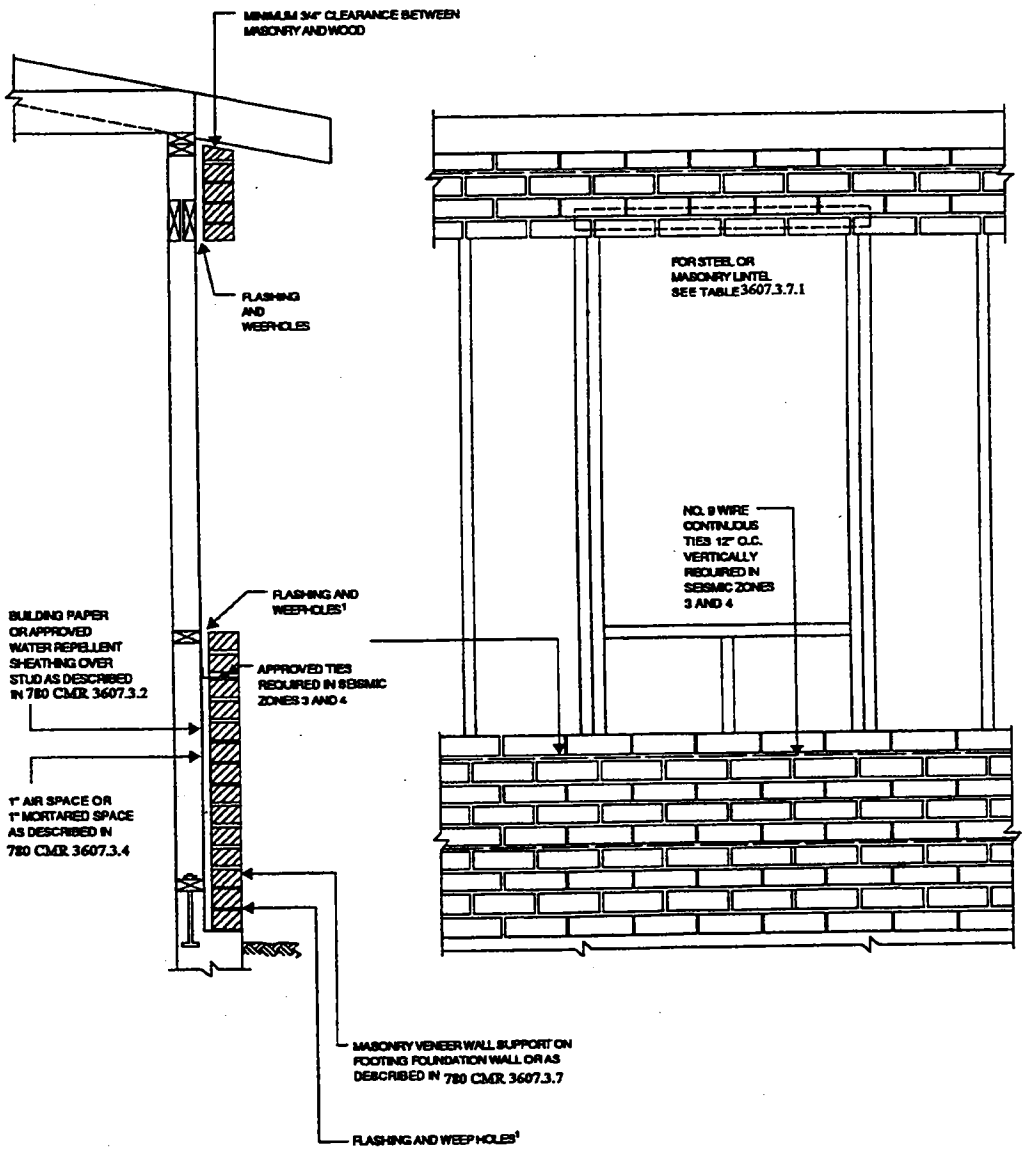
3607.3.7.2.3 Veneer grouting: In lieu of such wire ties, an approved method of grouting the veneer to a paperbacked reinforcement attached directly to the studs may be used.

3607.3.7.3 Flashing: Flashing shall be located beneath the first course of masonry above finished ground level above the foundation wall or slab, and at other points of support, including structural floors, shelf angles and lintels when masonry veneers are designed in accordance with *780 CMR 3607.3.7. See 780 CMR 3607.3.8* for additional requirements.

3607.3.7.4 Weepholes: Weepholes shall be provided in the outside the of masonry walls at a maximum spacing of 33 inches (838 mm) on center. Weepholes shall not be less than $^{3}/_{16}$ inch (4.8 mm) in diameter. Weepholes shall be located immediately above the flashing.

3607.3.8 Flashing: Approved corrosion-resistive flashing shall be provided at top and sides of all exterior window and door openings in such a manner as to be leak-proof, except that self-flashing windows having a continuous lap of not less than 1⅜ inches (28 mm) over the sheathing material around the perimeter of the opening, including corners, do not require additional flashing; jamb flashing may also be omitted when specifically approved by the building official. Similar flashings shall be installed at the intersection of chimneys or other masonry construction with frame or stucco walls, with projecting lips on both sides under stucco copings; under and at the ends of masonry, wood or metal copings and sills; continuously above all projecting wood trim; where exterior porches. decks or stairs attach to a wall or floor assembly of wood-frame construction; at wall and roof intersections.

FIGURE 3607.3.7
MASONRY VENEERED WALL DETAIL



For SI: 1 inch = 25.4 mm.
1. Location of flashing and weepholes as described in 780 CMR 3607.3.7.3 and 3607.3.7.4.

TABLE 3607.3.7.1
ALLOWABLE SPANS FOR LINTELS SUPPORTING MASONRY VENEER

SIZE OF STEEL ANGLE[1,2]	NO STORY ABOVE	ONE STORY ABOVE	TWO STORIES ABOVE	NO OF ½" OR EQUIVALENT REINFORCING BARS[2]
3 x 3 x ¼	6'-0"	3'-6"	3'-0"	1
4 x 3 x ¼	8' - 0"	5'-0"	3'-0"	1
6 x 3½ x ¼	14' - 0"	8'-0"	3'-6"	2
2-6 x 3½ x ¼	20' - 0"	11'-0"	5'-0"	4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.
1. Long leg of the angle shall be placed in a vertical position.
2. Depth of reinforced lintels shall not be less than eight inches and all cells of hollow masonry lintels shall be grouted and solid. Reinforcing bars shall extend not less than eight inches into the support.
3. Steel members indicated are adequate typical examples; other steel members meeting structural design requirements may be used.

ROOF-CEILING CONSTRUCTION

3608.1 GENERAL

3608.1.1 Application: The provisions of 780 CMR 3608.1 shall control the design and construction of the roof-ceiling system for all buildings. The use of materials or methods of construction not specified in 780 CMR 3608.1 accomplishing the purposes intended with 780 CMR 36 and approved by the building official in accordance with 780 CMR 36 and approved by the building official in accordance with ***780 CMR 109*** shall be accepted as complying with 780 CMR 36.

3608.1.2 Requirements: Roof-ceiling construction shall be capable of ***supporting*** all loads imposed according to ***780 CMR 3603.1*** and shall transmit the resulting loads to supporting structural elements.

3608.1.3 Roof drainage: In areas where expansive or collapsible soils are known to exist ***or where required by city or town ordinance or by-law***, all dwellings shall have a controlled method of water disposal from roofs that will collect and discharge all roof drainage to the ground surface at least five feet (1524 mm) from foundation walls or to an approved drainage system.

780 CMR 3608.2 ROOF FRAMING

3608.2.1 Identification and grade: Load-bearing dimension lumber for rafters, trusses and ceiling joists shall conform to DOC PS 20 and to other applicable standards or grading rules, ***as listed in Appendix A***, and be identified by a grade mark or certificate of inspection issued by an approved agency. The grade mark or certificate shall provide adequate information to determine F_b, the allowable stress in bending, and E, the modulus of elasticity. Approved end jointed lumber may be used interchangeably with solid-sawn members of the same species and grade. Blocking shall be a minimum of utility grade lumber.

Exception: ***Use of Native Lumber shall be allowed in accordance with 780 CMR 2303.0.***

3608.2.1.1 Fire-retardant-treated lumber: The allowable unit stresses for fire-retardant-treated lumber, including fastener values, shall be developed from an approved method of investigation which considers the effects of anticipated temperature and humidity to which the fire-retardant lumber will be subjected, the type of treatment and redrying process. The fire-retardant treated lumber shall be graded by an approved agency.

3608.2.2 Design and construction: Roof-ceilings of wood construction shall be designed and constructed in accordance with the provisions of 780 CMR 2608.2 or with the AFPA NDS-1991 "National Design Specification for Wood Construction," the CWC-1987 "Canadian Dimension Lumber Data Book," the WWPA- 1992 "Western Lumber Span Tables for Floor and Ceiling Joists and Roof Rafters," or the "Southern Pine Maximum Spans for Joists and Rafters," ***each as listed in Appendix A***. Roof-ceilings shall be constructed in accordance with Figures ***3606.4.10a***, ***3606.4.10b***, ***3606.4.10c*** and ***3608.2.4.1*** and nailed in accordance with Table ***3606.2.3a***.

3608.2.2.1 Cathedral ceilings: When ceiling joists and rafter ties are omitted and the rafters are used to create a cathedral ceiling, rafter ends shall be supported on bearing walls, headers or ridge beams. Rafters shall be attached to supporting members in accordance with Table ***3606.2.3a***. Ridge beams shall be capable of carrying the imposed roof loads and shall be supported by structural elements which transmit the loads to the foundation.

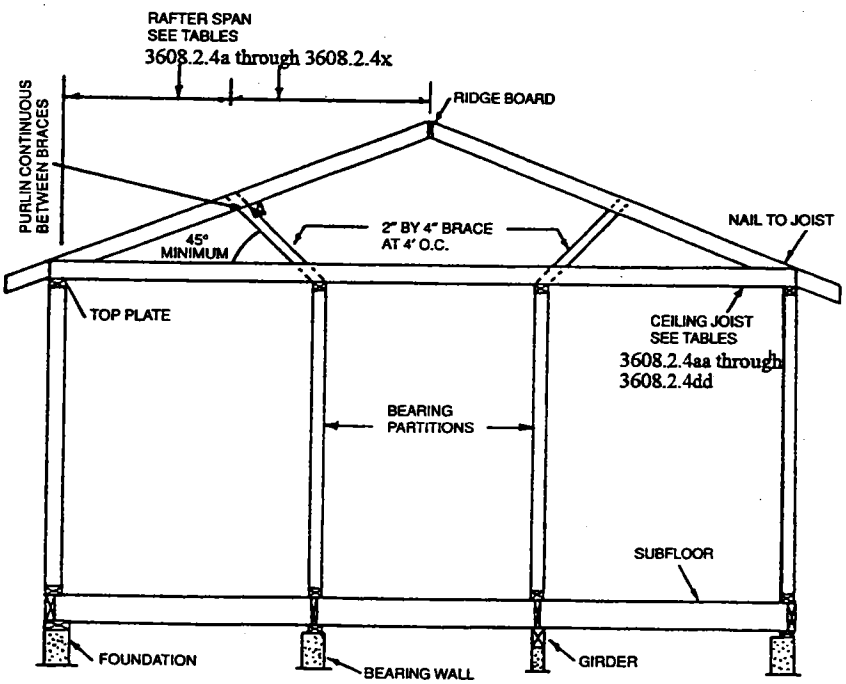
3608.2.3 Framing details: Rafters shall be nailed to ceiling joists to form a continuous tie between exterior walls where joists are parallel to the rafters. Where not parallel, rafters shall be tied with a rafter tie, located as near the plate as practical. Rafter ties shall be spaced not more than four feet (1219 mm) on center. Rafters shall be framed to ridge board or to each other with gusset plate as a tie. Ridge board shall be at least one-inch (25 mm) nominal thickness and not less in depth than the cut end of the rafter. At all valleys and hips there shall be a valley or hip rafter not less than two-inch (51 mm) nominal thickness and not less in depth than the cut end of the rafter. Hip and valley rafters shall be supported at the ridge by a brace to a bearing partition or be designed to carry and distribute the specific load at that point.

3608.2.3.1 Ceiling joists lapped: Ends of ceiling joists shall be lapped a minimum of three inches (76 mm) or butted over bearing partitions or beam and toenailed to the bearing member. When ceiling joists are used to provide resistance to rafter thrust, lapped joists shall be nailed together and butted joists shall be tied together in a manner to resist such thrust.

3608.2.4 Allowable spans: The unsupported spans for ceiling joists shall not exceed the values set forth in Tables ***3608.2.4aa*** through ***3608.2.4dd*** The unsupported spans for rafters shall not exceed the values set forth in Tables ***3608.2.4a through 3608.2.4x***. When the roof pitch is less than three units vertical in 12 units horizontal (25% slope), members supporting rafters and ceiling joists, such as ridge beams, hips and valleys, shall be designed as beams. Selection of rafters shall be based on lumber properties, snow load zone and deflection due to live load based on ceiling finish (see table 3603.1.6

3608.2.4.1 Purlins: Purlins may be installed to reduce the span of rafters as shown in Figure ***3608.2.4.1***. Purlins shall be sized no less than the required size of the rafters that they support. Purlins shall be continuous and shall be supported by two by four (51 by 102) struts installed to bearing walls at a slope not less than 45 degrees from the horizontal. The struts shall be spaced not more than four feet (1219 mm) on center, and the unbraced length of struts shall not exceed eight feet (2438 mm).

FIGURE 3608.2.4.1
BRACED RAFTER CONSTRUCTION



For SI: one inch = 25.4 mm, one foot = 304.8 mm.
NOTE: Where ceiling joists run perpendicular to the rafters, rafter ties shall be nailed to the rafters near the plate line and spaced not more than four feet on center.

3608.2.5 Bearing: The ends of each rafter or ceiling joist shall have not less than 1½ inches (38 mm) of bearing on wood or metal and not less than three inches (76 mm) on masonry.

3608.2.6 Cutting and notching: It shall be unlawful to notch, cut or pierce wood beams, joists or rafters in excess of the limitations herein specified, unless proven safe by structural analysis or suitably reinforced to transmit all calculated *loads*. Notches in the top or bottom of rafter shall not exceed $^1/_{16}$ of the depth of the rafter, ***shall not be longer than ⅓ the depth of the member*** and shall not be located in the middle third of the span. ***Notch depth at the ends of the member*** shall not exceed ¼ the rafter depth.

Exceptions:
1. A notch over the support is permitted to extend the full width of the support.
2. Notches on cantilevered portions of the member are permitted to extend the full length of the cantilever if the strength and deflection of the cantilever is calculated based on the reduced member section.
3. The tension side of rafters which are four inches or greater in nominal thickness, shall not be notched, except at ends of members.

3608.2.7 Holes: Holes drilled, bored ***or cut*** into rafters shall ***not be closer than*** two inches (51 mm) to the top or bottom of the rafters, ***or to any other hole located in the rafter. Where the rafter is notched, the hole shall not be closer than two***

inches to the notch. The diameter *of the hole* shall not exceed ⅓ the depth of the rafter.

3608.2.8 Lateral support: Rafters and ceiling joists having a depth-to-thickness ratio exceeding five to one based on nominal dimensions shall be provided with lateral support at points of bearing to prevent rotation.

3608.2.8.1 Bridging: Rafters and ceiling joists having a depth-to-thickness ratio exceeding six to one based on nominal dimensions shall be supported laterally by solid blocking, diagonal bridging (wood or metal) or a continuous one-inch-by-three-inch (25 mm by 76 mm) wood strip nailed across the rafters or ceiling joists at intervals not exceeding ten feet (3048 mm).

3608.2.9 Framing of openings: Openings in roof and ceiling framing shall be framed with headers between ceiling joists or rafters. When the header span does not exceed four feet (1219 mm), the header may be a single member the same size as the ceiling joist or rafter. When the header span exceeds four feet (1219 mm), the header and the joists or rafters that support the header shall be doubled, and approved hangers shall be used to connect the header to the joists or rafters.

3608.2.10 Headers: Roof-ceiling framing around openings shall be provided with headers. The allowable spans for headers in bearing walls shall not exceed the values set for in Table *3608.2.6.2*.

3608.2.11 Trusses: Wood trusses shall be designed in accordance with approved engineering practice. Truss components may be joined by nails, glue, timber connectors or other approved fastening devices. The design of metal plate connected wood trusses shall comply with TPI QST, TPI PCT and TPI-1985 "Design Specification for Metal Plate Connected Wood Trusses", *each as listed in Appendix A*. Trusses shall be braced according to their appropriate engineered design. In the absence of specific bracing requirements, trusses shall be braced in accordance with TPI BWT, *as listed in Appendix A*. Truss members shall not be cut or altered unless so designed.

3608.2.12 Roof tie-down: Roof assemblies subject to wind uplift pressures of 20 pounds per square foot (0.958 kN/m^2) or greater, shall have rafter or truss ties provided in accordance with Table *3608.2.12*. The resulting uplift forces from the rafter or truss ties shall be transmitted to the foundation.

780 CMR 3608.3 ROOF SHEATHING

3608.3.1 Lumber sheathing: Allowable spans for lumber used as roof sheathing shall conform to Table *3608.3.1*. Spaced lumber sheathing for wood shingle and shake roofing shall conform to the requirements of *780 CMR 3609.8 and 3609.9*.

3608.3.2 Plywood sheathing:

3608.3.2.1 Identification and grade: Plywood and wood structural panels shall conform to DOC PS 1 or DOC PS 2 *as listed in Appendix A*, and shall be identified by grade mark or certificate of inspection issued by an approved agency. Plywood and wood structural panels shall comply with the grades specified in Table *3605.3.2.1.1a*.

3608.3.2.1.1 Type: All plywood, when designed to be exposed in outdoor applications, shall be of an exterior type. Plywood or wood structural panel roof sheathing exposed to the underside may be of interior type bonded with exterior glue, identified as Exposure 1.

3608.3.2.1.2 Fire-retardant-treated plywood: The allowable unit stresses for fire-retardant-treated plywood, including fastener values, shall be developed from an approved method of investigation which considers the effects of anticipated temperature and humidity to which the fire-retardant plywood will be subjected, the type of treatment and redrying process. The fire-retardant-treated plywood shall be graded by an approved agency.

3608.3.2.1.3 Wood structural panels: Wood structural-use panels conforming to DOC PS 2, *as listed in Appendix A*, includes performance-rated plywood, oriented strandboard and composite panels. Oriented strandboard structural-use panels manufactured in Canada shall conform to CSA 0437 *as listed in Appendix A*.

3608.3.2.2 Allowable spans: The maximum allowable spans for plywood and wood structural panel roof sheathing shall not exceed the values set forth in Table *3605.3.2.1.1a*.

3608.3.2.3 Installation: Plywood and wood structural panel roof sheathing shall be installed with joints staggered or nonstaggered in accordance with Tables **3605.3.2.1.1a** and **3606.2.3a**, or APA E 30 *as listed in Appendix A.*

TABLE 3608.2.12
WIND UPLIFT FORCES ON ROOF TRUSSES AND RAFTERS[1, 2, 3, 4]
(Pounds Per Tie-Down Connection)

WIND UPLIFT PRESSURE ON ROOF (psf)[5]	TOTAL BUILDING WIDTH ROOF INCLUDING OVERHANG (feet)				
	24	28	32	36	40
20	192	224	256	288	320
30	432	504	576	648	720
40	672	784	895	1,008	1,120
50	912	1,064	1,216	1,368	1,520
60	1,152	1,344	1,536	1,728	1,920
70	1,392	1,624	1,856	2,088	2,320
80	1,632	1,904	2,176	2,448	2,720
90	1,872	2,184	2,496	2,808	3,120

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, psf = 0.0479 kNm^2

1. A continuous load path capable of resisting the tributary forces shall be provided from tie-down connections to the foundation.
2. Wind uplift forces are based on 24-inch spacing of roof trusses or rafters. For spacing other than 24 inches, forces shall be adjusted accordingly.
3. Interpolation is permitted for intermediate values of wind uplift pressures and building widths.
4. The rated capacity of approved tie-down devices is permitted to include a ⅓ increase for wind effects.
5. Tie-down connections shall be provided at bearing walls for roof trusses or rafters to resist wind uplift forces.

3608.3.3 Particleboard sheathing:

3608.3.3.1 Identification and grade: Particleboard roof sheathing shall conform to Type 2-M-W as set forth in ANSI A208.1 ***as listed in Appendix A*** and shall be so identified by a grade mark or certificate of inspection issued by an approved agency.

3608.3.3.2 Allowable spans: The allowable loads and spans for particleboard roof sheathing shall not exceed the values set forth in Table **3608.3.3.2**.

3608.3.3.3 Installation: Particleboard roof sheathing shall be installed in accordance with Tables ***3606.2.3a*** and ***3608.3.3.2***. Where walls are subject to wind pressures of 30 pounds per square foot (1.44 kN/m^2) or greater, particleboard roof sheathing shall be attached to the gable end with 8d common nails spaced at no more than four inches ***on center*** (102 mm), or equivalent fasteners.

TABLE 3608.3.1
MINIMUM THICKNESS LUMBER ROOF SHEATHING

RAFTER OR BEAM SPACING (inches)	MINIMUM NET THICKNESS (inches)
24	5/8
48[1]	1½ T & G
60[2]	
72[3]	

For SI: 1 inch = 25.4 mm, 1 psi= 6.895 kPa.
1. Minimum 270 F_b, 340,000 E.
2. Minimum 420 F_b, 660,000 E.
3. Minimum 600 F_b, 1,150,000 E.

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

GRADE	THICKNESS (inches)	MAXIMUM ON-CENTER SPACING	LIVE LOAD (pounds per square foot)	TOTAL LOAD (pounds per square foot)
2-M-W	3/8[4]	16	45	65
	7/16[4]	16	105	105
	7/16[4]	24	30	40
	½	16	110	150
	½	24	40	55

For SI: 1 inch = 25.4 mm, 1 psi = 6895 kPa.
1. Panels are continuous over two or more spans.
2. Uniform load deflection limitations: 1/180 of the span under live load plus dead load and 1/240 of the span under live load only.
3. The panels may be applied parallel or perpendicular to the span of the rafters or joists and shall be continuous over two or more spans. If the panels are applied perpendicular to roof supports, the end joints of the panels shall be offset so that four panel corners will not meet. Cutouts for items such as plumbing and electrical shall be oversized to avoid a forced fit. A ½-inch gap must be provided between the panel and concrete masonry walls. Leave a 1/16-inch gap between panels and nail no closer than ⅜ inch from panel edge.
4. Edges shall be tongue and groove or supported with the blocking or edge clips.

780 CMR 3608.4 METAL

3608.4.1 General: Elements shall be straight and free of any defects which would significantly affect their structural performance.

3608.4.2 Steel Elements: Steel structural elements in roof-ceiling construction may be either hot-rolled structural steel shapes or members cold formed to shape from steel strip or plate or a fabricated combination thereof. Steel structural members in roof-ceiling construction shall be designed in accordance with the AISC "Specification for the Design", "Fabrication and Erection of Structural Steel for Buildings" as listed in Appendix A.

3608.4.3 Aluminum Elements: Aluminum structural elements in roof-ceiling systems shall, be constructed of materials and designed in accordance with AA SAS 30 as listed in Appendix A.

780 CMR 3608.5 CEILING FINISHES

3608.5.1 Ceiling installation: Ceilings shall be installed in accordance with the requirements for interior wall finishes, as provided in *780 CMR 3607.2.*

780 CMR 3608.6 ROOF VENTILATION

3608.6.1 Ventilation required: Enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters shall have cross ventilation for each separate space by ventilating openings protected against the entrance of rain or snow. Ventilating openings shall be provided with corrosion-resistant wire mesh, with the least dimension being ⅛ inch (3.2 mm).

3608.6.2 Minimum area: The total net free ventilating area shall not be less than one to 150 of the area of the space ventilated except that the total area is permitted to be reduced to one to 300, provided at least 50% and not more than 80% of the required ventilating area is provided by ventilators located in the upper portion of the space to be ventilated at least three feet (914 mm) above eave or cornice vents with the balance of the required ventilation provided by eave or cornice vents. As an alternative, the net free cross-ventilation area may be reduced to one to 300 when a vapor barrier having a transmission rate not exceeding one perm (57.4 ng/s·m^2·Pa) is installed on the warm side of the ceiling.

3608.6.3 Vent clearance: Where eave or cornice vents are installed, insulation shall not block the free flow of air. A minimum of one-inch (25 mm) space shall be provided between the insulation and the roof sheathing at the location of the vent.

780 CMR 3608.7 ATTIC ACCESS

3608.7.1 Accessible attic access: A readily accessible attic access framed opening not less than 22 inches by 30 inches (559 mm by 762 mm) shall be provided to any attic area having a clear height of over 30 inches (762 mm).

TABLE 3608.2.4aa
ALLOWABLE SPANS FOR CEILING JOISTS
20 Lbs. per Sq. Ft. Live Load
(Limited attic storage where development of future rooms is not possible)
(Veneer Plaster Ceiling)

DESIGN CRITERIA: Deflection—For 20 lbs. per sq. ft. live load. Limited to span in inches divided by 360. Strength—Live load of 20 lbs. per sq. ft. plus dead load of 10 lbs. per sq. ft. determines fiber stress value shown.
HOW TO USE TABLES: Enter table with span of joists (upper figure in each square). Determine size and spacing (first column) based stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

JOIST SIZE AND SPACING		MODULUS OF ELASTICITY, "*E*," IN 1,000,000 PSi									
(inches)	(inches)	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2 x 4	12.0	5-5 430	5-10 500	6-2 560	6-6 630	6-10 680	7-1 740	7-4 790	7-7 850	7-10 900	8-0 950
	16.0	4-11 470	5-4 550	5-8 620	5-11 690	6-2 750	6-5 810	6-0 870	6-11 930	7-1 990	7-3 1,040
	24.0	4-4 540	4-8 630	4-11 710	5-2 790	5-5 860	5-8 930	5-10 1,000	6-0 1,070	6-2 1,130	6-4 1,190
2 x 6	12 0	8-6 430	9-2 500	9 9 560	10-3 630	10-9 680	11-2 740	11-7 790	11-11 850	12-3 900	12-7 950
	16.0	7-9 470	8-4 550	8-10 620	9-4 690	9 9 750	10-2 810	10-6 870	10-10 930	11-2 990	11-5 1,040
	24 0	6-9 540	7-3 630	7-9 710	8-2 790	8-6 860	8-10 930	9-2 1,000	9-6 1,070	9-9 1,130	10-0 1.190
2 x 8	12 0	11-3 430	12-1 500	12-10 560	13-6 630	14-2 680	14-8 740	15-3 790	15-9 850	16-2 900	16-7 950
	16.0	10-2 470	11-0 550	11-8 620	12-3 690	12-10 750	13-4 810	13-10 870	14-3 930	14-8 990	15-1 1,040
	24.0	8-11 540	9-7 630	10-2 710	10-9 790	11-3 860	11-8 930	12-1 1,000	12-6 1,070	12-10 1,130	13-2 1,190
2x 10	12.0	14-4 430	15-5 500	16-5 560	17-3 630	18-0 680	18-9 740	19-5 790	20- 1 850	20-8 900	21 -2 950
	16.0	13-0 470	14-0 550	14-11 620	15-8 690	16-5 750	17-0 810	17-8 870	18-3 930	18-9 990	19-3 1,040
	24.0	11-4 540	12-3 630	13-0 710	13-8 790	14-4 860	14-11 930	15-5 1,000	15-11 1,070	16-5 1,130	16-10 1,190
(inches)	(inches)	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4	
2 x 4	12.0	8-3 990	8-5 1,040	8-7 1,090	8-9 1,130	8-11 1,170	9-1 1,220	9-3 1,260	9-7 1,340	9-10 1,420	
	16.0	7-6 1,090	7-8 1,140	7-10 1,200	8-0 1,240	8-1 1,290	8-3 1,340	8-5 1,390	8-8 1,480	8-11 1,570	
	24.0	6-6 1,250	6-8 1,310	6-10 1,370	7-0 1,420	7-1 1,480	7-3 1,530	7-4 1,590	7-7 1 690	7-10 1,790	
2 x 6	12.0	12-11 990	13-3 1,040	13-6 1,090	13-9 1,130	14-1 1,170	14-4 1,220	14-7 1,260	15 0 1 340	15-6 1,420	
	16.0	11-9 1,090	12-0 1,140	12-3 1,200	12-6 1,240	12-9 1,290	13-0 1,340	13-3 1,390	13-8 1,480	14-1 1,570	
	24.0	10-3 1,250	10-6 1,310	10-9 1,370	10-11 1,420	11-2 1,480	11-4 1,530	11-7 1,590	11.11 1,690	12-3 1,790	
2 x 8	12.0	17-0 990	17-5 1,040	17-10 1,090	18-2 1,130	18-6 1,170	18-10 1,220	19-2 1,260	19-10 1,340	20-5 1,420	
	16.0	15-6 1,090	15-10 1,140	16-2 1,200	16-6 1,240	16-10 1,290	17-2 1,340	17-5 1,390	18-0 1,480	18-6 1,570	
	24.0	13-6 1,250	13-10 1,310	14-2 1,370	14-5 1,420	14-8 1,480	15-0 1,530	15-3 1,590	15-9 1,690	16-2 1,790	
2 x 10	12.0	21-9 990	22-3 1,040	22-9 1,090	23-2 1,130	23-8 1,170	24-1 1,220	24-6 1,260	25-3 1,340	26-0 1,420	
	16.0	19-9 1,090	20-2 1,140	20-8 1,200	21-1 1,240	21-6 1,290	21-10 1,340	22-3 1,390	22-11 1,480	23-8 1,570	
	24.0	17-3 1,250	17-8 1,310	18-0 1,370	18-5 1,420	18-9 1,480	19-1 1,530	19-5 1,590	20-1 1,690	20-8 1,790	

For SI: I inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 11 pound per square foot = 0.0479 kN/m2.
NOTE: The extreme fiber stress in bending, *"Fb,"* in pounds per square inch is shown below each span.

TABLE 3608.2.4bb
ALLOWABLE SPANS FOR CEILING JOISTS
20 Lbs. per Sq. Ft. Live Load
(Limited attic storage where development of future rooms is not possible)
(Gypsum Ceiling)

DESIGN CRITERIA: Deflection—For 20 lbs. per sq. ft. live load. Limited to span in inches divided by 240. Strength—Live load of 20 lbs. per sq. ft. plus dead load of 10 lbs. per sq. ft. determines fiber stress value.
HOW TO USE TABLES: Enter table with span of joists (upper figure in each square). Determine size and spacing (first column) based stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

JOIST SIZE AND SPACING		MODULUS OF ELASTICITY, "*E*," IN 1,000,000 PSI									
(inches)	(inches)	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2 x 4	12.0	6-2 560	6-8 660	7-1 740	7-6 820	7-10 900	8-1 970	8-5 1,040	8-8 1,110	8-11 1,170	9-2 1,240
	16.0	5-8 620	6-1 720	6-5 810	6-9 900	7-1 990	7-5 1,070	7-8 1,140	7-11 1,220	8-1 1,290	8-4 1,360
	24.0	4-11 710	5-4 830	5-8 930	5-11 1,030	6-2 1,130	6-5 1,220	6-8 1,310	6-11 1,400	7-1 1,480	7-3 1,560
2 x 6	12.0	9-9 560	10-6 660	11-2 740	11-9 820	12-3 900	12-9 970	13-3 1,040	13-8 1,110	14-1 1,170	14-5 1,240
	16.0	8-10 620	9-6 720	10-2 810	10-8 900	11-2 990	11-7 1,070	12-0 1,140	12-5 1,220	12-9 1,290	13-1 1,360
	24.0	7-9 710	8-4 830	8-10 930	9-4 1,030	9-9 1,130	10-2 1,220	10-6 1,310	10-10 1,400	11-2 1,480	11 -5 1,560
2 x 8	12.0	12-10 560	13-10 660	14-8 740	15-6 820	16-2 900	16-10 970	17-5 1,040	18-0 1,110	18-6 1,170	19-0 1,240
	16.0	11 -8 620	12-7 720	134 810	14-1 900	14-8 990	15-3 1,070	15-10 1,140	164 1,220	16-10 1,290	17-3 1,360
	24.0	10-2 710	11-0 830	11-8 930	12-3 1,030	12-10 1,130	13-4 1,220	13-10 1,310	14-3 1,400	14-8 1,480	15-1 1,560
2 x 10	12.0	16-5 560	17-8 660	18-9 740	19-9 820	20-8 900	21 -6 970	22-3 1,040	22-11 1,110	23-8 1,170	24-3 1,240
	16.0	14-11 620	16-0 720	17-0 810	17-11 900	18-9 990	19-6 1.070	20-2 1,140	20-10 1,220	21-6 1,290	22-1 1,360
	24.0	13-0 710	14-0 830	14-11 930	15-8 1,030	16-5 1,130	17-0 1,220	17-8 1,310	18-3 1,400	18 9 1,480	19-3 1,560
(inches)	(inches)	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4	
2 x 4	12.0	9-5 1,300	9-8 1,360	9-10 1,420	10-0 1,480	10-3 1,540	10-5 1,600	10-7 1,650	10-11 1,760	11-3 1,860	
	16.0	8-7 1,430	8-9 1,500	8- 11 1,570	9- 1 1,630	9-4 1,690	9-6 1,760	9-8 1,820	9- 11 1,940	10-3 2,050	
	24.0	7-6 1,640	7-8 1,720	7-10 1,790	8-0 1,870	8-1 1,940	8-3 2,010	8-5 2,080	8-8 2,220	8-11 2,350	
2 x 6	12.0	14-9 1,300	15-2 1,360	15-6 1,420	15-9 1,480	16-1 1,540	16-4 1,600	16-8 1,650	17-2 1,760	17-8 1,860	
	16.0	13-5 1,430	13-9 1,500	14-1 1,570	14-4 1,630	14-7 1,690	14-11 1,760	15-2 1,820	15-7 1,940	16-1 2,050	
	24.0	11-9 1,640	12-0 1,720	12-3 1,790	12-6 1,870	12-9 1,940	13-0 2,010	13-3 2,080	13-8 2,220	14-1 2,350	
2 x 8	12.0	19-6 1,300	19-11 1,360	20-5 1,420	20-10 1,480	21-2 1,540	21-7 1,600	21-11 1,650	22-8 1,760	23-4 1,860	
	16.0	17-9 1,430	18-2 1,500	18-6 1,570	18-11 1,630	19-3 1,690	19-7 1,760	19-11 1,820	20-7 1,940	21-2 2,050	
	24.0	15-6 1,640	15-10 1,720	16-2 1,790	16-6 1,870	16-10 1,940	17-2 2,010	17-5 2,080	18-0 2,220	18-6 2,350	
2 x 10	12.0	24-10 1,300	25-5 1,360	26-0 1,420	26-6 1,480	27-1 1,540	27-6 1,600	28-0 1,650	28-11 1,760	29-9 1,860	
	16.0	22-7 1,430	23-2 1,500	23-8 1,570	24- 1 1,630	24-7 1,690	25-0 1,760	25-5 1,820	26-3 1,940	27- 1 2,050	
	24.0	19 9 1,640	20-2 1,720	20-8 1,790	21-1 1,870	21-6 1,940	21-10 2,010	22-3 2,080	22-11 2,220	23-8 2,350	

For SI: I inch = 25.4 mm, I pound per square inch = 6.895 kPa, I pound per square foot = 0.0479 kN/m2.
NOTE: The extreme fiber stress in bending, "*Fb*," in pounds per square inch is shown below each span.

TABLE 3608.2.4cc
ALLOWABLE SPANS FOR CEILING JOISTS
10 Lbs. per Sq. Ft. Live Load
(No attic storage and roof slope not steeper than 3 in 1 2)
(Veneer Plaster Ceiling)

DESIGN CRITERIA: Deflection-For 10 lbs. per sq. Ft. live load. Limited to span in inches divided by 360. Strength-Live load of 10 lbs. per sq. Ft. plus dead load of 5 lbs. per sq. ft. determines fiber stress value.
HOW TO USE TABLES: Enter table with span of joists (upper figure in each square). Determine size and spacing (first column) based stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

JOIST SIZE AND SPACING		MODULUS OF ELASTICITY, "E" IN 1,000,000 PSI									
(inches)	(inches)	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2 x 4	12.0	6-10 340	7-4 400	7-10 450	8-3 500	8-7 540	8-11 590	9-3 630	9-7 670	9-10 710	11-1 750
	16.0	6-2 380	6-8 440	7-1 490	7-6 550	7-10 600	8-1 650	8-5 690	8-8 740	8-11 780	9-2 830
	24.0	5-5 430	5-10 500	6-2 560	6-6 630	6-10 680	7-1 740	7-4 790	7-7 850	7-10 900	8-0 950
2 x 6	12.0	10-9 340	11-7 400	11-7 450	12-11 500	13-6 540	14-1 590	14-7 630	15-0 670	15-6 710	15-11 750
	16.0	9-9 380	10-6 440	11-2 490	11-9 550	12-3 600	12-9 650	13-3 690	13-8 740	14.1 780	14-5 830
	24.0	8-6 430	9-2 500	9-9 560	10-3 630	10-9 680	11-2 740	11-7 790	11-11 850	12-3 900	12-7 950
2 x 8	12.0	14-2 340	15-3 400	16-2 450	17-0 500	17-10 540	18-6 590	19-2 630	19-10 670	20-5 710	20-11 750
	16.0	12-10 380	13-10 440	14-8 490	15-6 550	16-2 600	16-10 650	17-5 690	18-0 740	18.6 780	19-0 830
	24.0	11-3 430	12-1 500	12-10 560	13-6 630	14-2 680	14-8 740	15-3 790	15-9 850	16-2 900	16-7 950
2 x 10	12.0	18-0 340	19-5 400	20-8 450	21-9 500	22-9 540	23-8 590	24-6 630	25-3 670	26-0 710	26-9 750
	16.0	16-5 380	17-8 440	18-9 490	19-9 550	20-8 600	21 -6 650	22-3 690	22- 11 740	23-8 780	24-3 830
	24.0	14-4 430	15-5 500	16-5 560	17-3 630	18-0 680	18-9 740	19-5 790	20-1 850	20-8 900	21-2 950
(inches)	(inches)	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4	
2 x 4	12.0	10-4 790	10-7 830	10-10 860	11-1 900	11-3 930	11-6 970	11-8 1,000	12-1 1,070	12-5 1,130	
	16.0	9-5 870	9-8 910	9-10 950	10-0 990	10-3 1,030	10-5 1,060	10-7 1,100	10 11 1,170	11-3 1,240	
	24.0	8-3 990	8-5 1,040	8-7 1,090	8-9 1,130	8-11 1,170	9-1 1,220	9-3 1,260	9-7 1,340	9-10 1,420	
2 x 6	12.0	16-3 790	16-8 830	17-0 860	17-4 900	17-8 930	18-0 970	18-4 1,000	18-11 1,070	19-6 1,130	
	16.0	14-9 870	15-2 910	15-6 950	15-9 990	16-1 1,030	16-4 1,060	16-8 1,100	17-2 1,170	17-8 1,240	
	24.0	12-11 990	13-3 1,040	13-6 1,090	13-9 1,130	14-1 1,170	14-4 1,220	14-7 1,260	15-0 1,340	15-6 1,420	
2 x 8	12.0	21 -5 790	21 - 11 830	22-5 860	22- 11 900	23-4 930	23-9 970	24-2 1,000	24- 11 1,070	25-8 1,130	
	16.0	19-6 870	19-11 910	20-5 950	20-10 990	21-2 1,030	21-7 1,060	21-11 1,100	22-8 1,170	23-4 1,240	
	24.0	17-0 990	17-5 1,040	17-10 1,090	18-2 1,130	18-6 1,170	18-10 1,220	19-2 1,260	19-10 1,340	20-5 1,420	
2 x 10	12.0	27-5 790	28-0 830	28-7 860	29-2 900	29-9 930	30-4 970	30- 10 1,000	31 - 10 1,070	32-9 1,130	
	16.0	24-10 870	25-5 910	26-0 950	26-6 990	27-1 1,030	27-6 1,060	28-0 1,100	28-11 1,170	29-9 1,240	
	24.0	21 -9 990	22-3 1,040	22-9 1,090	23-2 1,130	23-8 1,170	24- 1 1,220	24-6 1,260	25-3 1,340	26-0 1,420	

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The extreme fiber stress in bending, *"Fb,"* in pounds per square inch is shown below each span.

TABLE 3608.2.4dd
ALLOWABLE SPANS FOR CEILING JOISTS
10 Lbs per Sq. Ft. Live Load
(No attic storage and roof slope not steeper than 3 in 12)
(Gypsum Ceiling)

DESIGN CRITERIA: Deflection—For 10 lbs. per sq. ft. live load. Limited to span in inches divided by 240. Strength—Live load of 10 lbs. per *sq. R.* plus dead load of 5 lbs. per sq. ft. determines fiber stress value.
HOW TO USE TABLES: Enter table with span of joists (upper figure in each square). Determine size and spacing (first column) based stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

JOIST SIZE AND SPACING		MODULUS OF ELASTICITY, "*E*," IN 1,000,000 PSI									
(inches)	(inches)	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2 x 4	12.0	7-10 450	8-5 520	8-11 590	9-5 650	9-10 710	10-3 770	10-7 830	10-11 880	11-3 930	11-7 980
	16.0	7-1 490	7-8 570	8-1 650	8-7 720	8-11 780	9-4 850	9-8 910	9-11 970	10-3 1,030	10-6 1,080
	24.0	6-2 560	6-8 660	7-1 740	7-6 820	7-10 900	8-1 970	8-5 1,040	8-8 1,110	8-11 1,170	9-2 1,240
2 x 6	12.0	12-3 450	13-3 520	14-1 590	14-9 650	15-6 710	16-1 770	16-8 830	17-2 880	17-8 930	18-2 980
	16.0	11-2 490	12-0 570	12-9 650	13-5 720	14-1 780	14-7 850	15-2 910	15-7 970	16-1 1,030	16-6 1,080
	24.0	9-9 560	10-6 660	11-2 740	11-9 820	12-3 900	12-9 970	13-3 1,040	13-8 1,110	14-1 1,170	14-5 1,240
2x8	12.0	16-2 450	17-5 520	18-6 590	19-6 650	20-5 710	21-2 770	21-11 830	22-8 880	23-4 930	24-0 980
	16.0	14-8 490	15-10 570	16-10 650	17-9 720	18-6 780	19-3 850	19-11 910	20-7 970	21-2 1,030	21-9 1,080
	24.0	12-10 560	13-10 660	14-8 740	15-6 820	16-2 900	16-10 970	17-5 1,040	18-0 1,110	18-6 1,170	19-0 1,240
2x 10	12.0	20-8 450	22-3 520	23-8 590	24- 10 650	26-0 710	27- 1 770	28-0 830	28- 11 880	29-9 930	30-7 980
	16.0	18-9 490	20-2 570	21 -6 650	22-7 720	23-8 780	24-7 850	25 -5 910	26-3 970	27- 1 1,030	27-9 1,080
	24.0	16-5 560	17-8 660	18-9 740	1 9-9 820	20-8 900	21-6 970	22-3 1,040	22-11 1,110	23-8 1,170	24-3 1,240
(inches)	(inches)	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4	
2 x 4	12.0	11-10 1,030	12-2 1,080	12-5 1,130	12-8 1,180	12-11 1,220	13-2 1,270	13-4 1,310	13-9 1,400	14-2 1,480	
	16.0	10-9 1,140	11-0 1,190	11 -3 1,240	11 -6 1,290	11-9 1,340	11-11 1,390	12-2 1,440	12-6 1,540	12- 11 1,630	
	24.0	9-5 1,300	9-8 1,360	9-10 1,420	10-0 1,480	10-3 1,540	10-5 1,600	10-7 1,650	10-11 1,760	11-3 1,860	
2 x 6	12.0	18-8 1,030	19-1 1,080	19-6 1,130	19-11 1,180	20-3 1,220	20-8 1,270	21-0 1,310	21-8 1,400	22-4 1,480	
	16.0	16-11 1,140	17-4 1,190	17-8 1,240	18-1 1,290	18-5 1,340	18-9 1,390	19-1 1,440	19-8 1,540	20-3 1,630	
	24.0	14-9 1,300	15-2 1,360	15-6 1,420	15-9 1,480	16-1 1,540	16-4 1,600	16-8 1,650	17-2 1,760	17-8 1,860	
2 x 8	12.0	24-7 1,030	25-2 1,080	25-8 1,130	26-2 1,180	26-9 1,220	27-2 1,270	27-8 1,310	28-7 1,400	29-5 1,480	
	16.0	22-4 1,140	22-10 1,190	23-4 - 1,240	23-10 1,290	24-3 1,340	24-8 1,390	25-2 1,440	25-11 1,540	26-9 1,630	
	24.0	19-6 1,300	19-11 1,360	20-5 1,420	20-10 1,480	21-2 1,540	21-7 1,600	21-11 1,650	22-8 1,760	23-4 1,860	
2 x 10	12.0	31-4 1,030	32-1 1,080	32-9 1,130	33-5 1,180	34-1 1,220	34-8 1,270	35-4 1,310	36-5 1,400	37-6 1,480	
	16.0	28-6 1,140	29-2 1,190	29-9 1,240	30-5 1,290	31 -0 1,340	31 -6 1,390	32- 1 1,440	33- 1 1,540	34- 1 1,630	
	24.0	24-10 1,300	25-5 1,360	26-0 1,420	26-6 1,480	27-1 1,540	27-6 1,600	28-0 1,650	28-11 1,760	29-9 1,860	

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The extreme fiber stress in bending, "*Fb*," in pounds per square inch is shown below each span.

TABLE 3608.2.4a
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
25 Lbs. per Sq. Ft. Live Load
For Use in Snow Load Zone 1

DESIGN CRITERIA: Strength 25 lbs. per sq. ft. dead load plus 10 lbs. per sq. ft. live load determines fiber stress. Deflection—For 25 lbs. per sq. ft. live load. Limited to span in inches divided by 180.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)									
(inches)	**(inches)**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**
2 x 6	12.0	6-7 .12	7-7 .18	8-6 .25	9-4 .33	10-0 .41	10-9 .50	11-5 .60	12-0 .70	12-7 .81	13-2 .92
	16.0	5-8 .10	6-7 .15	7-4 .21	8-1 .28	8-8 .36	9-4 .43	9-10 .52	10-5 .61	10-11 .70	11-5 .80
	24.0	4-8 .08	5-4 .13	6-0 .18	6-7 .23	7-1 .29	7-7 .35	8-1 .42	8-6 .50	8-11 .57	9-4 .65
2 x 8	12.0	8-8 .12	10-0 .18	11-2 .25	12-3 .33	13-3 .41	14-2 .50	15-0 .60	15-10 .70	16-7 .81	17-4 .92
	16.0	7-6 .10	8-8 .15	9-8 .21	10-7 .28	11-6 .36	12-3 .43	13-0 .52	13-8 .61	14-4 .70	15-0 .80
	24. 0	6-2 .08	7-1 .13	7-11 .18	8-8 .23	9-4 .29	10-0 .35	10-7 .42	11-2 .50	11-9 .57	12-3 .65
2 x 10	12.0	11-1 .12	12-9 .18	14-3 .25	15.8 .33	16-11 .41	18-1 .50	19-2 .60	20-2 .70	21-2 .81	22-1 .92
	16.0	9-7 .10	11-1 .15	12-4 .21	13-6 .28	14-8 .36	15-8 .43	16-7 .52	17-6 .61	18-4 .70	19-2 .80
	24.0	7-10 .08	9-0 .13	10-1 .18	11-1 .23	11-11 .29	12-9 .35	13-6 .42	14-3 .50	15-0 .57	15-8 .65
2x 12	12.0	13-6 0.12	15-6 0.18	17-4 0.25	19-0 0.33	20-7 0.41	22-0 0.50	23-4 0.60	24-7 0.70	25-9 0.81	26-11 0.92
	16.0	11-8 0.10	13-5 0.15	15-0 0.21	16-6 0.28	17-9 0.36	19-0 0.43	20-2 0.52	21-3 0.61	22-3 0.70	23-3 0.92
	24.0	9-6 0.08	11-0 0.13	12-3 0.18	13-5 0.23	14-6 0.29	15-6 0.35	16-6 0.42	17-4 0.50	18-3 0.57	19-0 0.65
(inches)	**(inches)**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**
2 x 6	12. 0	13-8 1.04	14-2 1.16	14-8 1.29	15-2 1.42	15-8 1.55	16-1 1.69	16-7 1.84	17-0 1.98	17-5 2.13	17-10 2.29
	16.0	11-10 .90	12-4 1.01	12-9 1.12	13-2 1.23	13-7 1.35	13-11 1.47	14-4 1.59	14-8 1.72	15-1 1.85	15-5 1.98
	24.0	9-8 .74	10-0 .82	10-5 .91	10-9 1.00	11-1 1.10	11-5 1.20	11-8 1.30	12-0 1.40	12-4 1.51	12-7 1.62
2 x 8	12.0	18-0 1.04	18-9 1.16	19-5 1.29	20-0 1.42	20-8 1.55	21-3 1.69	21-10 1.84	22-4 1.98	22-11 2.13	23-6 2.29
	16.0	15-7 .90	16-3 1.01	16-9 1.12	17-4 1.23	17-10 1.35	18-5 1.47	18-11 1.59	19-5 1.72	19-10 1.85	20-4 1.98
	24.0	12-9 .74	13-3 .82	13-8 .91	14-2 1.00	14-7 1.10	15-0 1.20	15-5 1.30	15-10 1.40	16-3 1.51	16-7 1.62
2 x 10	12.0	23-0 1.04	23-11 1.16	24-9 1.29	25-6 1.42	26-4 1.55	27-1 1.69	27-10 1.84	28-7 1.98	28-3 2.13	30-0 2.29
	16.0	19-11 .90	20-8 1.01	21-5 1.12	22-1 1.23	22-10 1.35	23-5 1.47	24-1 1.59	24-9 1.72	25-4 1.85	25-11 1.98
	24.0	16-3 .74	16-11 .82	17-6 .91	18-1 1.00	18-7 1.10	19-2 1.20	19-8 1.30	20-2 1.40	20-8 1.51	21-2 1.62
2x 12	12.0	28-0 1.04	29-1 1.16	30-1 1.29	31-1 1.42	32-0 1.56	33-0 1.70	33-10 1.84	34-9 1.98	35-8 2.13	36-5 2.29
	16.0	24-3 0.90	25.2 1.01	26-0 1.12	26-10 1.23	27-9 1.35	28-6 1.47	29-2 1.59	30-0 1.72	30-9 1.85	31-6 1.98
	24.0	19-10 0.74	20-7 0.82	21-3 0.91	22-0 1.01	22-8 1.10	23-4 1.20	23-11 1.30	24-7 1.41	25-2 1.51	25-9 1.62

For SI: 1 inch = 25,4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4b
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
25 Lbs. per Sq. Ft. Live Load (Supporting Gypsum Wallboard Ceiling)
For Use in Snow Load Zone 1

DESIGN CRITERIA: Strength—25 lbs. per sq.ft. live load plus 10 lbs. per sq. ft. dead load determines fiber stress. Deflection—For 25 lbs. per sq. ft. live load. Limited to span in inches divided by 240.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)									
(inches)	**(inches)**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**
2 x 6	12.0	6-7 .15	7-7 .24	8-6 .33	9-4 .43	10-0 .55	10-9 .67	11-5 .80	12-0 .94	12-7 1.03	13-2 1.23
	16.0	5-8 .13	6-7 .20	7-4 .29	8-1 .38	8-8 .47	9-4 .58	9-10 .69	10-5 .81	10-11 .93	11-5 1.06
	24.0	4-8 .11	5-4 .17	6-0 .23	6-7 .31	7-1 .39	7-7 .47	8-1 .56	8-6 .66	8-11 .76	9-4 .87
2 x 8	12.0	8-8 .15	10-0 .24	11-2 .33	12-3 .43	13-3 .55	14-2 .67	15-0 .80	15-10 .94	16-7 1.08	17-4 1.23
	16.0	7-6 .13	8-8 .20	9-8 .29	10-7 .38	11-6 .47	12-3 .58	13-0 .69	13-8 .81	14-4 .93	15-0 1.06
	24. 0	6-2 .11	7-1 .17	7-11 .23	8-8 .31	9-4 .39	10-0 .47	10-7 .56	11-2 .66	11-9 .76	12-3 .87
2 x 10	12.0	11-1 .15	12-9 .24	14-3 .33	15-8 .43	16-11 .55	18-1 .67	19-2 .80	20-2 .94	21-2 1.08	22-1 1.23
	16.0	9-7 .13	11-1 .20	12-4 .29	13-6 .38	14-8 .47	15-8 .58	16-7 .69	17-6 .81	18-4 .93	19-2 1.06
	24.0	7-10 .11	9-0 .17	10-1 .23	11-1 .31	11-11 .39	12-9 .47	13-6 .56	14-3 .66	15-0 .76	15-8 .87
2x 12	12.0	13-5 .15	15-6 .24	17-4 .33	19-0 .43	20-6 .55	21-11 .67	23-3 .80	24-7 .94	25-9 1.08	26-11 1.23
	16.0	11-8 .13	13-5 .20	15-0 .29	16-6 .38	17-9 .47	19-0 .58	20-2 .69	21-3 .81	22-4 .93	23-3 1.06
	24.0	9-6 .11	11-0 .17	12-3 .23	13-5 .31	14-6 .39	15-6 .47	16-6 .56	17-4 .66	18-2 .76	19-0 .87
(inches)	**(inches)**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**
2 x 6	12. 0	13-8 1.39	14-2 1.55	14-8 1.72	15-2 1.89	15-8 2.07	16-1 2.26	16-7 2.45	17-0 2.65	17-5 2.85	17-10 3.06
	16.0	11-10 1.20	12-4 1.34	12-9 1.49	13-2 1.64	13-7 1.80	13-11 1.96	14-4 2.12	14-8 2.29	15-1 2.46	15-5 2.64
	24.0	9-8 .98	10-0 1.10	10-5 1.21	10-9 1.34	11-1 1.47	11-5 1.60	11-8 1.73	12-0 1.87	12-4 2.01	12-7 2.16
2 x 8	12.0	18-0 1.39	18-9 1.55	19-5 1.72	20-0 1.89	20-8 2.07	21-3 2.26	21-10 2.45	22-5 2.65	22-11 2.85	23-6 3.06
	16.0	15-7 1.20	16-3 1.34	16-9 1.49	17-4 1.64	17-10 1.80	18-5 1.96	18-11 2.12	19-5 2.29	19-10 2.46	20-4 2.64
	24.0	12-9 .98	13-3 1.10	13-8 1.21	14-2 1.34	14-7 1.47	15-0 1.60	15-5 1.73	15-10 1.87	16-3 2.01	16-7 2.16
2 x 10	12.0	23-0 1.39	23-11 1.55	24-9 1.72	25-6 1.89	26-4 2.07	27-2 2.26	27-10 2.45	28-7 2.65	29-3 2.85	29-11 3.06
	16.0	19-11 1.20	20-8 1.34	21-5 1.49	22-1 1.64	22-10 1.80	23-5 1.96	24-1 2.12	24-9 2.29	25-4 2.46	25-11 2.64
	24.0	16-3 .98	16-11 1.10	17-6 1.21	18-1 1.34	18-7 1.47	19-2 1.60	19-8 1.73	20-2 1.87	20-8 2.01	21-2 2.16
2x 12	12.0	28-0 1.39	29-1 1.55	30-1 1.72	31-1 1.89	32-0 2.07	32-11 2.26	33-9 2.45	34-9 2.65	35-7 2.85	36-6 3.06
	16.0	24-3 1.20	25-2 1.34	26-0 1.49	26-10 1.64	27-9 1.80	28-6 1.96	29-4 2.12	30-1 2.29	30-9 2.46	31-6 2.64
	24.0	19-10 .98	20-6 1.10	21-3 1.21	21-11 1.34	22-8 1.47	23-3 1.60	23-11 1.73	24-7 1.87	25-2 2.01	25-9 2.16

For SI: 1 inch = 25,4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4c
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
25 Lbs. per Sq. Ft. Live Load (Supporting Veneer Plaster Ceiling)
For Use in Snow Load Zone 1

DESIGN CRITERIA: Strength-25 lbs. per sq.ft. live load plus 10 lbs. per sq. ft. dead load determines fiber stress. Deflection—For 25 lbs. per sq. ft. live load. Limited to span in inches divided by 360.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)									
(inches)	**(inches)**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**
2 x 6	12.0	6-7 .23	7-7 .35	8-6 .50	9-4 .65	10-0 .82	10-9 1.00	11-5 1.20	12-0 1.40	12-7 1.62	13-2 1.84
	16.0	5-8 .20	6-7 .31	7-4 .43	8-1 .56	8-8 .71	9-4 .87	9-10 1.04	10-5 1.21	10-11 1.40	11-5 1.60
	24.0	4-8 .16	5-4 .25	6-0 .35	6-7 .46	7-1 .58	7-7 .71	8-1 .85	8-6 .99	8-11 1.14	9-4 1.30
2 x 8	12.0	8-8 .23	10-0 .35	11-2 .50	12-3 .65	13-3 .82	14-2 1.00	15-0 1.20	15-10 1.40	16-7 1.62	17-4 1.84
	16.0	7-6 .20	8-8 .31	9-8 .43	10-7 .56	11-6 .71	12-3 .87	13-0 1.04	13-8 1.21	14-4 1.40	15-0 1.60
	24. 0	6-2 .16	7-1 .25	7-11 .35	8-8 .46	9-4 .58	10-0 .71	10-7 .85	11-2 .99	11-9 1.14	12-3 1.30
2 x 10	12.0	11-1 .23	12-9 .35	14-3 .50	15.8 .65	16-11 .82	18-1 1.00	19-2 1.20	20-2 1.40	21-2 1.62	22-1 1.84
	16.0	9-7 .20	11-1 .31	12-4 .43	13-6 .56	14-8 .71	15-8 .87	16-7 1.04	17-6 1.21	18-4 1.40	19-2 1.60
	24.0	7-10 .16	9-0 .25	10-1 .35	11-1 .46	11-11 .58	12-9 .71	13-6 .85	14-3 .99	15-0 1.14	15-8 1.30
2x 12	12.0	13-5 .23	15-6 .35	17-4 .50	19-0 .65	20-6 .82	21-11 1.00	23-3 1.20	24-7 1.40	25-9 1.62	26-11 1.84
	16.0	11-8 .20	13-5 .31	15-0 .43	16-6 .56	17-9 .71	19-0 .87	20-2 1.04	21-3 1.21	22-4 1.40	23-3 1.60
	24.0	9-6 .16	11-0 .25	12-3 .35	13-5 .46	14-6 .58	15-6 .71	16-6 .85	17-4 .99	18-2 1.14	19-0 1.30
(inches)	**(inches)**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**
2 x 6	12. 0	13-8 2.08	14-2 2.32	14-8 2.58	15-2 2.84	15-8 3.11	16-1 3.39	16-6 3.68	17-0 3.97	17-5 4.28	17-10 4.58
	16.0	11-10 1.80	12-4 2.01	12-9 2.23	13-2 2.46	13-7 2.69	13-11 2.93	14-4 3.18	14-8 3.44	15-1 3.70	15-5 3.96
	24.0	9-8 1.47	10-0 1.64	10-5 1.82	10-9 2.01	11-1 2.20	11-5 2.40	11-8 2.60	12-0 2.81	12-4 3.02	12-7 3.24
2 x 8	12.0	18-0 2.08	18-9 2.32	19-5 2.58	20-0 2.84	20-8 3.11	21-3 3.39	21-10 3.68	22-5 3.97	22-11 4.28	23-6 4.59
	16.0	15-7 1.80	16-3 2.01	16-9 2.23	17-4 2.46	17-10 2.69	18-4 2.93	18-10 3.18	19-4 3.44	19-10 3.70	20-4 3.97
	24.0	12-9 1.47	13-3 1.64	13-8 1.82	14-2 2.01	14-7 2.20	15-0 2.40	15-5 2.60	15-10 2.81	16-3 3.02	16-7 3.24
2 x 10	12.0	23-0 2.08	23-11 2.32	24-9 2.58	25-7 2.84	26-4 3.11	27-2 3.39	27-10 3.68	28-7 4.28	29-3 4.59	29-11 4.90
	16.0	19-11 1.80	20-8 2.01	21-5 2.23	22-1 2.46	22-9 2.69	23-5 2.93	24-1 3.18	24-9 3.44	25-4 3.70	25-11 3.97
	24.0	16-3 1.47	16-11 1.64	17-6 1.82	18-1 2.01	18-7 2.10	19-2 2.40	19-8 2.60	20-2 2.81	20-8 3.02	21-2 3.24
2x 12	12.0	28-0 2.08	29-1 2.33	30-2 2.58	31-1 2.84	32-0 3.11	32-11 3.39	33-11 3.68	34-9 3.97	35-7 4.28	36-5 4.59
	16.0	24-3 1.80	25-2 2.01	26-0 2.23	26-11 2.46	27-9 2.69	28-6 2.93	29-4 3.18	30-1 3.44	30-10 3.70	31-6 3.97
	24.0	19-10 1.47	20-6 1.64	21-3 1.82	21-11 2.01	22-8 2.20	23-3 2.40	23-11 2.60	24-7 2.81	25-2 3.02	25-9 3.24

For SI: 1 inch = 25,4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4d
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
25 Lbs. per Sq. Ft. Live Load
For Use in Snow Load Zone 1

DESIGN CRITERIA: Strength—25 lbs. per sq. ft.live load plus 15 lbs. per sq.ft. dead load determines fiber stress. Deflection—For 25 lbs. per sq. ft. live load. Limited to span in inches divided by 180.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)									
(inches)	**(inches)**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**
2 x 6	12.0	6-2 0.09	7-1 0.15	7-11 0.20	8-8 0.27	9-5 0.34	10-0 0.41	10-8 0.49	11-3 0.57	11-9 0.66	12-4 0 .75
	16.0	5-4 .08	6-2 .13	6-10 .18	7-6 .23	8-2 .29	8-8 .36	9-3 .42	9-9 .50	10-2 .57	10-8 .65
	24.0	4-4 .07	5-0 .10	5-7 .14	6-2 .19	6-8 .24	7-1 .29	7-6 .35	7-11 .41	8-4 .47	8-8 .53
2 x 8	12.0	8-1 .09	9-4 .15	10-6 .20	11-6 .27	12-5 .34	13-3 .41	14-0 .49	14-10 .57	15-6 .66	16-3 .75
	16.0	7-0 .08	8-1 .13	9-1 .18	9-11 .23	10-9 .29	11-6 .36	12-2 .42	12-10 .50	13-5 .57	14-0 .65
	24. 0	5-9 .07	6-7 .10	7-5 .14	8-1 .19	8-9 .24	9-4 .29	9-11 .35	10-6 .41	11-0 .47	11-6 .53
2 x 10	12.0	10-4 .09	11-11 .15	13-4 .20	14-8 .27	15-10 .34	16-11 .41	17-11 .49	18-11 .57	19-10 .66	20-8 .75
	16.0	8-11 .08	10-4 .13	11-7 .18	12-8 .23	13-8 .29	14-8 .36	15-6 .42	16-4 .50	17-2 .57	17-11 .65
	24.0	7-4 .07	8-5 .10	9-5 .14	10-4 .19	11-2 .24	11-11 .29	12-8 .35	13-4 .41	14-0 .47	14-8 .53
2x 12	12.0	12-7 .09	14-6 .15	16-3 .20	17-9 .27	19-3 .34	20-6 .41	21-9 .49	23-0 .57	24-1 .66	25-2 .75
	16.0	10-11 .08	12-7 .13	14-1 .18	15-5 .23	16-8 .29	17-9 .36	18-10 .42	19-11 .50	20-10 .57	21-9 .65
	24.0	8-11 .07	10-3 .10	11-6 .14	12-7 .19	13-7 .24	14-6 .29	15-5 .35	16-3 .41	17-0 .47	17-9 .53
(inches)	**(inches)**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**
2 x 6	12. 0	12-10 .85	13-3 .95	13-9 1.05	14-2 1.16	14-8 1.27	15-1 1.39	15-6 1.50	15-11 1.62	16-3 1.75	16-8 1.87
	16.0	11-1 .74	11-6 .82	11-11 .91	12-4 1.01	12-8 1.10	13-1 1.20	13-5 1.30	13-9 1.41	14-1 1.51	14-5 1.63
	24.0	9-1 .60	9-5 .67	9-9 .75	10-0 .82	10-4 .90	10-8 .98	10-11 1.06	11-3 1.15	11-6 1.24	11-9 1.32
2 x 8	12.0	16-10 .85	17-6 .95	18-1 1.05	18-9 1.16	19-4 1.27	19-10 1.39	20-5 1.50	20-11 1.62	21-11 1.75	21-11 1.87
	16.0	14-7 .74	15-2 .82	15-8 .91	16-3 1.01	16-9 1.10	17-2 1.20	17-8 1.30	18-1 1.41	18-7 1.51	19-0 1.63
	24.0	11-11 .60	12-5 .67	12-10 .75	13-3 .82	13-8 .90	14-0 .98	14-5 1.06	14-10 1.15	15-2 1.24	15-6 1.32
2 x 10	12.0	21-6 .85	22-4 .95	23-1 1.05	23-11 1.16	24-7 1.27	25-4 1.39	26-0 1.50	26-8 1.62	27-4 1.75	28-0 1.87
	16.0	18-8 .74	19-4 .82	20-0 .91	20-8 1.01	21-4 1.10	21-11 1.20	22-6 1.30	23-1 1.41	23-8 1.75	24-3 1.63
	24.0	15-3 .60	15-10 .67	16-4 .75	16-11 .82	17-5 .90	17-11 .98	18-5 1.06	18-11 1.15	19-4 1.24	19-9 1.32
2x 12	12.0	26-2 0.85	27-2 0.95	28-2 1.05	29-1 1.16	29-11 1.27	30-10 1.39	31-8 1.50	32-6 1.62	33-3 1.75	34-1 1.87
	16.0	22-8 0.74	23-6 0.83	24-4 0.92	25-2 1.01	25-11 1.10	26-8 1.20	27-5 1.30	28-2 1.41	28-10 1.51	29-6 1.63
	24.0	18-6 0.60	19-2 0.67	19-10 0.75	20-6 0.82	21-2 0.90	21-9 0.98	22-4 1.06	22-11 1.15	23-6 1.24	24-1 1.32

For SI: 1 inch = 25,4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4e
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
25 Lbs. per Sq. Ft. Live Load (Supporting Gypsum Wallboard Ceiling)
For Use in Snow Load Zone 1

DESIGN CRITERIA: Strength-25 lbs. per sq. ft. live load plus 15 lbs. per sq.ft. dead load determines fiber stress. Deflection—For 25 lbs. per sq. ft. live load. Limited to span in inches divided by 240.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)									
(inches)	**(inches)**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**
2 x 6	12.0	6-2 .13	7-1 .19	7-11 .27	8-8 .36	9-5 .45	10-0 .55	10-8 .65	11-3 .77	11-9 .88	12-4 1.01
	16.0	5-4 .11	6-2 .17	6-10 .23	7-6 .31	8-2 .39	8-8 .47	9-3 .57	9-9 .66	10-2 .76	10-8 .87
	24.0	4-4 .09	5-0 .14	5-7 .19	6-2 .25	6-8 .32	7-1 .39	7-6 .46	7-11 .54	8-4 .62	8-8 .71
2 x 8	12.0	8-1 .13	9-4 .19	10-6 .27	11-6 .36	12-5 .45	13-3 .55	14-0 .65	14-10 .77	15-6 .88	16-3 1.01
	16.0	7-0 .11	8-1 .17	9-1 .23	9-11 .31	10-9 .39	11-6 .47	12-2 .57	12-10 .66	13-5 .76	14-0 .87
	24. 0	5-9 .09	6-7 .14	7-5 .19	8-1 .25	8-9 .32	9-4 .39	9-11 .46	10-6 .54	11-0 .62	11-6 .71
2 x 10	12.0	10-4 .13	11-11 .19	13-4 .27	14-8 .36	15-10 .45	16-11 .55	17-11 .65	18-11 .77	19-10 .88	20-8 1.01
	16.0	8-11 .11	10-4 .17	11-7 .23	12-8 .31	13-8 .39	14-8 .47	15-6 .57	16-4 .66	17-2 .76	17-11 .87
	24.0	7-4 .09	8-5 .14	9-5 .19	10-4 .25	11-2 .32	11-11 .39	12-8 .46	13-4 .54	14-0 .62	14-8 .71
2x 12	12.0	12-7 .13	14-6 .19	16-3 .23	17-9 .36	19-3 .45	20-6 .55	21-9 .65	23-0 .77	24-1 .88	25-2 1.01
	16.0	10-11 .11	12-7 .17	14-1 .23	15-5 .31	16-8 .39	17-9 .47	18-10 .57	19-11 .66	20-10 .76	21-9 .87
	24.0	8-11 .09	10-3 .14	11-6 .19	12-7 .25	13-7 .32	14-6 .39	15-5 .46	16-3 .54	17-0 .62	17-9 .71
(inches)	**(inches)**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**
2 x 6	12. 0	12-10 1.13	13-3 1.27	13-9 1.41	14-2 1.55	14-8 1.70	15-1 1.85	15-6 2.00	15-11 2.17	16-3 2.33	16-8 2.5
	16.0	11-1 0.98	11-6 1.10	11-11 1.22	12-4 1.34	12-8 1.47	13-1 1.60	13-5 1.74	13-9 1.88	14-1 2.02	14-5 2.17
	24.0	9-1 0.80	9-5 0.90	9-9 0.99	10-0 1.10	10-4 1.20	10-8 1.31	10-11 1.42	11-3 1.53	11-6 1.65	11-9 1.77
2 x 8	12.0	16-10 1.13	17-6 1.27	18-1 1.41	18-9 1.55	19-4 1.70	19-10 1.85	20-5 2.00	20-11 2.17	21-6 2.33	21-11 2.50
	16.0	14-7 0.98	15-2 1.10	15-8 1.22	16-3 1.34	16-9 1.47	17-2 1.60	17-8 1.74	18-1 1.88	18-7 2.02	19-0 2.17
	24.0	11-11 0.80	12-5 0.90	12-10 0.99	13-3 1.10	13-8 1.20	14-0 1.31	14-5 1.42	14-10 1.53	15-2 1.65	15-5 1.77
2 x 10	12.0	21-6 1.13	22-4 1.27	23-1 1.41	23-11 1.55	24-7 1.70	25-4 1.85	26-0 2.00	26-9 2.17	27-4 2.33	28-0 2.50
	16.0	18-8 0.98	19-4 1.10	20-0 1.22	20-8 1.34	21-4 1.47	21-11 1.60	22-6 1.74	23-1 1.88	23-8 2.02	24-3 2.17
	24.0	15-3 0.80	15-10 0.90	16-4 0.99	16-11 1.10	17-5 1.20	17-11 1.31	18-5 1.42	18-11 1.53	19-4 1.65	19-10 1.77
2x 12	12.0	26-2 1.13	27-2 1.27	28-2 1.41	29-1 1.55	29-11 1.70	30-10 1.85	31-8 2.00	32-6 2.17	33-3 2.33	34-1 2.50
	16.0	22-8 0.98	23-6 1.10	24-4 1.22	25-2 1.34	25-11 1.47	26-8 1.60	27-5 1.74	28-1 1.88	28-10 2.02	29-6 2.17
	24.0	18-6 0.80	19-3 .90	19-11 .99	20-6 1.10	21-2 1.20	21-9 1.31	22-5 1.42	23-0 1.53	23-6 1.65	24-1 1.77

For SI: 1 inch = 25,4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4f
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
25 Lbs. per Sq. Ft. Live Load (Supporting Veneer Plaster Ceiling)
For Use in Snow Load Zone 1

DESIGN CRITERIA: Strength-25 lbs. per sq. ft. live load plus 15 lbs. per sq.ft. dead load determines fiber stress. Deflection—For 25 lbs. per sq. ft. live load. Limited to span in inches divided by 360.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)									
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200
2 x 6	12.0	6-2 .19	7-1 .29	7-11 .41	8-8 .53	9-5 .67	10-0 .82	10-8 .98	11-3 1.15	11-9 1.32	12-4 1.51
	16.0	5-4 .16	6-2 .25	6-10 .35	7-6 .46	8-2 .58	8-8 .71	9-3 .85	9-9 .99	10-2 1.15	10-8 1.31
	24.0	4-4 .13	5-0 .21	5-7 .29	6-2 .38	6-8 .48	7-1 .58	7-6 .69	7-11 .81	8-4 .94	8-8 1.07
2 x 8	12.0	8-1 .19	9-4 .29	10-6 .41	11-6 .53	12-5 .67	13-3 .82	14-0 .98	14-10 1.15	15-6 1.32	16-3 1.51
	16.0	7-0 .16	8-1 .25	9-1 .35	9-11 .46	10-9 .58	11-6 .71	12-2 .85	12-10 .99	13-5 1.15	14-0 1.31
	24. 0	5-9 .13	6-7 .21	7-5 .29	8-1 .38	8-9 .48	9-4 .58	9-11 .69	10-6 .81	11-0 .94	11-6 1.07
2 x 10	12.0	10-4 .19	11-11 .29	13-4 .41	14-8 .53	15-10 .67	16-11 .82	17-11 .98	18-11 1.15	19-10 1.32	20-8 1.51
	16.0	8-11 .16	10-4 .25	11-7 .35	12-8 .46	13-8 .58	14-8 .71	15-6 .85	16-4 .99	17-2 1.15	17-11 1.31
	24.0	7-4 .13	8-5 .21	9-5 .29	10-4 .38	11-2 .48	11-11 .58	12-8 .69	13-4 .81	14-0 .94	14-8 1.07
2x 12	12.0	12-7 .19	14-6 .29	16-3 .41	17-9 .53	19-3 .67	20-6 .82	21-9 .98	23-0 1.15	24-1 1.32	25-2 1.51
	16.0	10-11 .16	12-7 .25	14-1 .35	15-5 .46	16-8 .58	17-9 .71	18-10 .85	19-11 .99	20-10 1.15	21-9 1.31
	24.0	8-11 .13	10-3 .21	11-6 .29	12-7 .38	13-7 .48	14-6 .58	15-5 .69	16-3 .81	17-0 .94	17-9 1.07
(inches)	**(inches)**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**
2 x 6	12. 0	12-10 1.70	13-3 1.90	13-9 2.11	14-2 2.32	14-8 2.55	15-1 2.77	15-6 3.01	15-10 3.25	16-3 3.49	16-8 3.75
	16.0	11-1 1.47	.46 1.65	11-11 1.83	12-4 2.01	12-8 2.20	13-1 2.40	13-5 2.61	13-9 2.82	14-1 3.03	14-5 3.25
	24.0	9-1 1.20	9-5 1.34	9-9 1.49	10-0 1.64	10-4 1.80	10-8 1.96	10-11 2.13	11-3 2.30	11-6 2.47	11-9 2.65
2 x 8	12.0	16-10 1.70	17-6 1.90	18-1 2.11	18-9 2.32	19-4 2.55	19-10 2.77	20-5 3.01	20-11 3.25	21-5 3.49	21-11 3.75
	16.0	14-7 1.47	15-2 1.65	15-8 183	16-3 2.01	16-9 2.20	17-2 2.40	17-8 2.61	18-2 2.82	18-7 3.03	19-0 3.25
	24.0	11-11 1.20	12-5 1.34	12-10 1.49	13-3 1.64	13-8 1.80	14-0 1.96	14-5 2.13	14-10 2.30	15-2 2.47	15-6 2.65
2 x 10	12.0	21-6 1.70	22-4 1.90	23-1 2.11	23-11 2.32	24-7 2.55	25-4 2.77	26-0 3.01	26-9 3.25	27-4 3.49	28-0 3.75
	16.0	18-8 1.47	19-4 1.65	20-0 1.83	20-8 2.01	21-4 2.20	21-11 2.40	22-6 2.61	23-2 2.82	23-9 3.03	24-3 3.25
	24.0	15-3 1.20	15-10 1.34	16-4 1.49	16-11 1.64	17-5 1.80	17-11 1.96	18-5 2.13	18-11 2.30	19-4 2.47	19-10 2.65
2x 12	12.0	26-2 1.70	27-2 1.90	28-2 2.11	29-1 2.32	29-11 2.55	30-10 2.77	31-8 3.01	32-6 3.25	33-3 3.49	34-1 3.75
	16.0	22-8 1.47	23-6 1.65	24-4 1.83	25-2 2.01	25-11 2.20	26-8 2.40	27-5 2.61	28-2 2.82	28-10 3.03	29-6 3.25
	24.0	18-6 1.20	19-3 1.34	19-11 1.49	20-6 1.64	21-2 1.80	21-9 1.96	22-5 2.13	23-0 2.30	23-6 2.47	24-1 2.65

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4g
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
30 Lbs. per Sq. Ft. Live Load
For Use in Snow Load Zone 2

DESIGN CRITERIA: Strength—10 lbs. per sq. fl. dead load plus 30 lbs. per sq. ft. live load determines fiber stress. Deflection—For 30 lbs. per sq. ft. live load. Limited to span in inches divided by 180.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)										
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 6	12.0	6-2 0.11	7-1 0.17	7-11 0.24	8-8 0.32	9-4 0.40	10-0 0.49	10-8 0.59	11-3 0.69	11-9 0.80	12-4 0.91	12-9 1.02
	16.0	5-4 0.10	6-2 0.15	6-10 0.21	7-6 0.28	8-2 0.35	8-8 0.43	9-3 0.51	9-9 0.60	10-2 0.69	10-8 0.78	11-1 0.88
	24. 0	4-4 0.08	5-0 0.12	5-8 0.17	6-2 0.23	6-8 0.29	7-1 0.35	7-6 0.42	7-11 0.49	8-4 0.56	8.8 0.64	9-1 0.72
2 x 8	12.0	8-1 0.11	9-4 0.17	10-6 0.24	11-6 0.32	12-4 0.40	13-3 0.49	14-1 0.59	14-10 0.69	15-6 0.80	16-3 0.91	16-10 1.02
	16.0	7-0 0.10	8-1 0.15	9-1 0.21	9-11 0.28	10-9 0.35	11-6 0.43	12-2 0.51	12-10 0.60	13-6 0.69	14-1 0.78	14-8 0.88
	24.0	5-9 0.08	6-8 0.12	7-5 0.17	8-1 0.23	8-9 0.29	9-4 0.35	9-11 0.42	10-6 0.49	11-0 0.56	11-6 0.64	11-11 0.72
2x 10	12.0	10-4 0.11	11-11 0.17	13-4 0.24	14-8 0.32	15-10 0.40	16-11 0.49	17-11 0.59	18-11 0.69	19-11 0.80	20-8 0.91	21-6 1.02
	16.0	8-11 0.10	10-4 0.15	11-7 0.21	12-8 0.28	13-8 0.35	14-8 0.43	15-6 0.51	16-4 0.60	17-2 0.69	17-11 0.78	18-8 0.88
	24.0	7-4 0.08	8.5 0.12	9-5 0.17	10-4 0.23	11-2 0.29	11-11 0.35	12-8 0.42	13-4 0.49	14-0 0.56	14-8 0.64	15-3 0.72
2 x 12	12. 0	12-7 0.11	14-6 0.17	16-3 0.24	17-9 0.32	19-3 0.40	20-6 0.49	21-10 0.59	22-11 0.69	24-1 0.80	25-2 0.91	26-2 1.02
	16. 0	10-11 0.10	12-7 0.15	14-1 0.21	15-5 0.28	16-8 0.35	17-10 0.43	18-10 0.51	19-11 0.60	20-10 0.69	21-10 0.78	22-8 0.88
	24. 0	8-10 0.08	10-3 0.12	11-6 0.17	12-7 0.23	13-7 0.29	14-6 0.35	15-5 0.42	16-3 0.49	17-0 0.56	17-9 0.64	18-6 0.72
(inches)	(inches)	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
2 x 6	12.0	13-3 1.14	13-9 1.27	14-3 1.40	14-8 1.53	15-1 1.67	15-6 1.81	15-10 1.95	16-3 2.10	16-8 2.25	17-0 2.41	17-5 2.57
	16.0	11-6 0.99	11-11 1.10	12-4 1.21	12-8 1.32	13-1 1.44	13-5 1.56	13-9 1.69	14-1 1.82	14-6 1.95	14-9 2.08	15-1 2.22
	24.0	9-5 0.81	9-9 0.89	10-0 0.99	10-4 1.08	10-8 1.18	10-11 1.27	11-3 1.38	11-6 1.48	11.9 1.59	12-0 1.70	12-3 1.81
2 x 8	12.0	17-6 1.14	18-2 1.27	18-9 1.40	19-4 1.53	19-10 1.67	20-5 1.81	20-11 1.95	21-6 2.10	21-11 2.25	22-6 2.41	22-11 2.57
	16.0	15-2 0.99	15-7 1.10	16-3 1.21	16-9 1.32	17-2 1.44	17-8 1.56	18-2 1.69	18-7 1.82	19-0 1.95	19-5 2.08	19-10 2.22
	24.0	12-4 0.81	12-10 0.89	13-3 0.99	13-8 1.08	14-0 1.18	14-5 1.27	14-9 1.38	15-2 1.48	15-6 1.59	15-10 1.70	16-3 1.81
2 x 10	12.0	22-4 1.14	23-2 1.27	23-11 1.40	24-8 1.53	25-4 1.67	26-0 1.81	26-9 1.95	27-5 2.10	28-0 2.25	28-8 2.41	29-3 2.57
	16.0	19-4 0.99	20-0 1.10	20-8 1.21	21-4 1.32	21-11 1.44	22-7 1.56	32-2 1.69	23-9 1.82	24-3 1.95	24-10 2.08	25-4 2.22
	24.0	15-9 0.81	16-4 0.89	16-10 0.99	17-5 1.08	19-11 1.18	18-5 1.27	18-10 1.38	19-4 1.48	19-9 1.59	20-3 1.70	20-8 1.81
2x 12	12.0	27-2 1.14	28-1 1.27	29-1 1.40	29-11 1.53	30-10 1.67	31-8 1.81	32-6 1.95	33-3 2.10	34-1 2.25	34-10 2.41	35-7 2.57
	16.0	23-6 0.99	24-4 1.10	25-2 1.21	25-11 1.32	26-8 1.44	27-5 1.56	28-2 1.69	28-10 1.82	29-6 1.95	30-2 2.08	30-10 2.22
	24.0	19-3 0.81	19-10 0.89	20-6 0.99	21-2 1.08	21-9 1.18	22-4 1.27	22-11 1.38	23-6 1.48	24-1 1.59	24-9 1.70	25-2 1.81

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/mZ.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4h
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
30 Lbs. per Sq. Ft. Live Load (Supporting Gypsum Ceiling)
For Use in Snow Load Zone 2

DESIGN CRITERIA: Strength—10 lbs. per sq. fl. dead load plus 30 lbs. per sq. ft. live load determines fiber stress. Deflection—For 30 lbs. per sq. ft. live load. Limited to span in inches divided by 240.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)										
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 6	12.0	6-2 0.15	7-1 0.23	7-11 0 32	8-8 0.43	9-5 0.54	10-0 0.66	10-8 0.78	11-3 0.92	11-9 1.06	124 1.21	12-10 1.36
	16.0	54 0.13	6-2 0.20	6-11 0.28	7-6 0.37	8-2 0.47	8-8 0.57	9-3 0.68	9 9 0.80	10-2 0.92	10-8 1.05	11-1 1.18
	24. 0	4 4 0.11	5 0 0.16	5 7 0.23	6 2 0.30	6 8 0.38	7 1 0.46	7 6 0.55	7 11 0.65	84 0.75	8 8 0.85	9 1 0.96
2 x 8	12.0	8-1 0.15	9-4 0.23	10-6 0.32	11-6 0.43	12-5 0.54	13-3 0.66	14-0 0.78	14-10 0.92	15-6 1.06	16-3 1.21	16-10 1.36
	16.0	7-0 0.13	8-1 0.20	9-1 0.28	9-11 0.37	10-9 0.47	11-6 0.57	12-2 0.68	12-10 0.80	13-5 0.92	14-0 1.05	14-7 1.18
	24.0	5-9 0.11	6-7 0.16	7-5 0.23	8-1 0.30	8-9 0.38	9-4 0.46	9-11 0.55	10-6 0.65	11-0 0.75	11-6 0.85	11-11 0.96
2x 10	12.0	10-4 0.15	11-11 0.23	13-4 0.32	14-8 0.43	15-10 0.54	16-11 0.66	17-11 0.78	18-11 0.92	19-10 1.06	20-8 1.21	21-6 1.36
	16.0	8-11 0.13	10-4 0.20	11-7 0.28	12-8 0.37	13-8 047	14-8 057	15-6 0.68	164 0.80	17-2 0.92	17-11 1.05	18-8 1.18
	24.0	74 0.11	8-5 0.16	9-5 0.23	10-4 0.30	11-2 0.38	11-11 0.46	12-8 0.55	134 0.65	14-0 0.75	14-8 0.85	15-3 0.96
2 x 12	12. 0	12-7 0.15	14-6 0.23	16-3 0.32	17-9 0.43	19-3 0.54	20-6 0.66	21-9 0.78	23-0 0.92	24-1 1.06	25-2 1.21	26-2 1.36
	16. 0	10-11 0.13	12-7 0.20	14-1 0.28	15-5 0.37	16-8 0.47	17-9 0.57	18-10 0.68	19-11 0.80	20-10 0.92	21-9 1.05	22-8 1.18
	24. 0	8-11 0.11	10-3 0.16	11-6 0.23	12-7 0.30	13-7 0.38	14 6 0.46	15-5 0.55	16-3 0.65	17-0 0.75	17-9 0.85	18-6 0.96
(inches)	(inches)	1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	
2 x 6	12.0	13-3 1 52	13-9 1.69	14-2 1.86	14-8 2.04	15-1 2.22	15-6 2.41	15-11 2.60	16-3 2.80	16-8 3.00	17-5 3.42	
	16.0	11-6 1.32	11-11 1.46	12-4 1.61	12-8 1.76	13-1 1.92	13-5 2.08	13-9 2.25	14-1 2.42	14-5 2.60	15-1 2.96	
	24.0	9-5 1.08	9 9 1.19	10-0 1.31	10-4 1.44	10-8 1.57	10-11 1.70	11-3 1.84	11-6 1.98	11-9 2.12	12-4 2.41	
2 x 8	12.0	17-6 1.52	18 2 1.69	18-9 1.86	19-4 2.04	19-10 2.22	20-5 2.41	20-11 2.60	21-5 2.80	21-11 3.00	22-11 3.42	
	16.0	15-2 1.32	15-8 1.46	16-3 1.61	16-9 1.76	17-2 1.92	17-8 2.08	18-2 2.25	18-7 2.42	19-0 2.60	19-10 2.96	
	24.0	12-5 1.08	12-10 1.19	13-3 1.31	13-8 1.44	14-0 1.57	14-5 1.70	14-10 1.84	15-2 1.98	15-6 2.12	16-3 2.41	
2 x 10	12.0	22-4 1.52	23-2 1.69	23-11 1.86	24-7 2.04	25-4 2.22	26-0 2.41	26-8 2.60	27-4 2.80	28-0 3.00	29-3 3.42	
	16.0	19-4 1.32	20-0 1.46	20-8 1.61	21-4 1.76	21-11 1.92	22-6 2.08	23-2 2.25	23-8 2.42	24-3 2.60	25-4 2.96	
	24.0	15-10 1.08	16-4 1.19	16-11 1.31	17-5 1.44	17-11 1.57	18-5 1.70	18-11 1.84	19-4 1.98	19-10 2.12	20-8 2.41	
2x 12	12.0	27-2 1.52	28-2 1.69	29- 1 1.86	29- 11 2.04	30- 10 2.22	31 -8 2.41	32-6 2.60	33-3 2.80	34-1 3.00	35-7 3.42	
	16.0	23-6 1.32	24-4 1.46	25-2 1.61	25-11 1.76	26-8 1.92	27-5 2.08	28-2 2.25	28-10 2.42	29-6 2.60	30-10 2.96	
	24.0	19-3 1.08	19-11 1.19	20-6 1.31	21.2 1.44	21-9 1.57	22-5 1.70	23-0 1.84	23-6 1.98	24-1 2.12	25-2 2.41	

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/mZ.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4i
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
30 Lbs. per Sq. Ft. Live Load (Supporting Veneer Plaster Ceiling)
For Use in Snow Load Zone 2

DESIGN CRITERIA: Strength—10 lbs. per sq. fl. dead load plus 30 lbs. per sq. ft. live load determines fiber stress. Deflection—For 30 lbs. per sq. ft. live load. Limited to span in inches divided by 360.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)										
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 6	12.0	6-2 0.23	7-1 0.35	7-11 0.49	8-8 0.64	9-5 0.81	10-0 0.99	10-8 1.18	11-3 1.38	11-9 1.59	12-3 1.81	12-10 2.04
	16.0	5-4 0.20	6-2 0.30	6-10 0.42	7-6 0.55	8-2 0.70	8-8 0.85	9-3 1.02	9-9 1.19	10-2 1.38	10-8 1.57	11-1 1.77
	24. 0	4-4 0.16	5-0 0.25	5-7 0.34	6-2 0.45	6-8 0.57	7-1 0.70	7-6 0.83	7-11 0.97	8-4 1.12	8-8 1.28	9-1 1.44
2 x 8	12.0	8-1 0.23	9-4 0.35	10-6 0.49	11-5 0.64	12-4 0.81	13-3 0.99	14-1 1.18	14-10 1.38	15-6 1.59	16-3 1.81	16-10 2.04
	16.0	7-0 0.20	8-1 0.30	9-1 0.42	9-11 0.55	10-9 0.70	11-6 0.85	12-2 1.02	12-10 1.19	13-5 1.38	14-0 1.57	14-8 1.77
	24.0	5-9 0.16	6-7 0.25	7-5 0.34	8-1 0.45	8-9 0.57	9-4 0.70	9-11 0.83	10-6 0.97	11-0 1.12	11-6 1.28	11-11 1.44
2x 10	12.0	10-4 0.23	11-11 0.35	13-4 0.49	14-8 0.64	15-10 0.81	16-11 0.99	17-11 1.18	18-11 1.38	19-11 1.59	20-8 1.81	21-6 2.04
	16.0	8-11 0.20	10-4 0.30	11-7 0.42	12-8 0.55	13-8 0.70	14-7 0.85	15-6 1.02	16-4 1.19	17-2 1.38	17-11 1.57	18-8 1.77
	24.0	7-4 0.16	8-5 0.25	9-5 0.34	10-4 0.45	11-2 0.57	11-11 0.70	12-8 0.83	13-4 0.97	14-0 1.12	14-8 1.28	15-3 1.44
2 x 12	12. 0	12-7 0.23	14-6 0.35	16-3 0.49	17-10 0.64	19-3 0.81	20-6 0.99	21-9 1.18	23-0 1.38	24-1 1.59	25-2 1.81	26-2 2.04
	16. 0	10-11 0.20	12-7 0.30	14-1 0.42	15-5 0.55	16-8 0.70	17-9 0.85	18-10 1.02	19-11 1.19	20-10 1.38	21-9 1.57	22-8 1.77
	24. 0	8-11 0.16	10-3 0.25	11-6 0.34	12-7 0.45	13-7 0.57	14-6 0.70	15-5 0.83	16-3 0.97	17-0 1.12	17-9 1.28	18-6 1.44
(inches)	(inches)	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
2 x 6	12.0	13-3 2.29	13-9 2.53	14-3 2.79	14-8 3.06	15-1 3.33	15-6 3.61	15-10 3.90	16-3 4.20	16-8 4.50	17-0 4.81	17-5 5.13
	16.0	11-6 1.98	11-11 2.19	12-4 2.42	12-8 2.65	13-0 2.88	13-5 3.13	13-9 3.38	14-1 3.63	14-5 3.89	14-9 4.16	15-1 4.44
	24.0	9-4 1.61	9-9 1.79	10-0 1.97	10-4 2.16	10-8 2.35	10-11 2.55	11-3 2.75	11-6 2.96	11-9 3.18	12-0 3.39	12-3 3.62
2 x 8	12.0	17-6 2.29	18-1 2.53	18-9 2.79	19-3 3.06	19-10 3.33	20-5 3.61	20-11 3.90	21-5 4.20	21-11 4.50	22-5 4.81	22-11 5.13
	16.0	15-2 1.98	15-8 2.19	16-3 2.42	16-9 2.65	17-3 2.88	17-8 3.13	18-1 3.38	18-7 3.63	19-0 3.89	19-5 4.16	19-10 4.44
	24.0	12-4 1.61	12-10 1.79	13-3 1.97	13-8 2.16	14-0 2.35	14-5 2.55	14-9 2.75	15-2 2.96	15-6 3.18	15-10 3.39	16-3 3.62
2 x 10	12.0	22-4 2.29	23-1 2.53	23-10 2.79	24-7 3.06	25-4 3.33	26-0 3.61	26-9 3.90	27-4 4.20	28-0 4.50	28-8 4.81	29-3 5.13
	16.0	19-4 1.98	20-0 2.19	20-8 2.42	21-4 2.65	21-11 2.88	22-7 3.13	23-2 3.38	23-9 3.63	24-3 3.89	24-10 4.16	25-4 4.44
	24.0	15-9 1.61	16-4 1.79	16-10 1.97	17-5 2.16	19-11 2.35	18-5 2.55	18-10 2.75	19-4 2.96	19-10 3.18	20-3 3.39	20-8 3.62
2x 12	12.0	27-2 2.29	28-1 2.53	29-1 2.79	29-11 3.06	30-10 3.33	31-8 3.61	32-6 3.90	33-3 4.20	34-1 4.50	34-10 4.81	35-7 5.13
	16.0	23-6 1.98	24-4 2.19	25-2 2.42	25-11 2.65	26-8 2.88	27-5 3.13	28-2 3.38	28-10 3.63	29-6 3.89	30-2 4.16	30-10 4.44
	24.0	19-2 1.61	19-10 1.79	20-6 1.97	21-2 2.16	21-9 2.35	22-4 2.55	22-11 2.75	23-6 2.96	24-1 3.18	24-7 3.39	25-2 3.62

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/mZ.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4j
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
30 Lbs. per Sq. Ft. Live Load
For Use in Snow Load Zone 2

DESIGN CRITERIA: Strength—15 lbs. per sq. fl. dead load plus 30 lbs. per sq. ft. live load determines fiber stress. Deflection—For 30 lbs. per sq. ft. live load. Limited to span in inches divided by 180.

RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SPACING AND SIZE		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)											
(inches)	(inches)	200	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 4	12.0	3-0 0.05	3-8 0.09	4-3 0.15	4-9 0.20	5-3 0.27	5-8 0.34	6-0 0.41	6-5 0.49	6-9 0.58	7-1 0.67	7-5 0.76	7-8 0.86
	16.0	2-7 0.04	3-2 0.08	3-8 0.13	4-1 0.18	4-6 0.23	4-11 0.29	5-3 0.36	5-6 0.43	5-10 0.50	6-1 0.58	6-5 0.66	6-8 0.74
	24.0	2-2 0.04	2-7 0.07	3-0 0.10	3-4 0.14	3-8 0.19	4-0 0.24	4-3 0.29	4-6 0.35	4-9 0.41	5-0 0.47	5-3 0.54	5-5 0.61
2x6	12.0	4-9 0.05	5-10 0.09	6-8 0.15	7-6 0.20	8-2 0.27	8-10 0.34	9-6 0.41	10-0 0.49	10-7 0.58	11-1 0.67	11-7 0.76	12-1 0.86
	16.0	4-1 0.04	5-0 0.08	5-10 0.13	6-6 0.18	7-1 0.23	7-8 0.29	8-2 0.36	8-8 0.43	9-2 0.50	9-7 0.58	10-0 0.66	10-5 0.74
	24.0	3-4 0.04	4-1 0.07	4-9 0.10	5-4 0.14	5-10 0.19	6-3 0.24	6-8 0.29	7-1 0.35	7-6 0.41	7-10 0.47	8-2 0.54	8-6 0.61
2 x 8	12.0	6-3 0.05	7-8 0.09	8-10 0.15	9-10 0.20	10-10 0.27	11-8 0.34	12-6 0.41	13-3 0.49	13-11 0.58	14-8 0.67	15-3 0.76	15-11 0.86
	16.0	5-5 0.04	6-7 0.08	7-8 0.13	8-7 0.18	9-4 0.23	10-1 0.29	10-10 0.36	11-6 0.43	12-1 0.50	12-8 0.58	13-3 0.66	13-9 0.74
	24.0	4-5 0.04	5-5 0.07	6-3 0.10	7-0 0.14	7-8 0.19	8-3 0.24	8-10 0.29	9-4 0.35	9-10 0.41	10-4 0.47	10-10 0.54	11-3 0.61
2x 10	12.0	8-0 0.05	9-9 0.09	11-3 0.15	12-7 0.20	13-9 0.27	14-11 0.]4	15-11 0.41	16-11 0.49	17-10 0.58	18-8 0.67	19-6 0.76	20-4 0.86
	16.0	6-11 0.04	8-5 0.08	9-9 0.13	10-11 0.18	11-11 0.23	12-11 0.29	13-9 0.36	14-8 0.43	15-5 0.50	16-2 0.58	16-11 0.66	17-7 0.74
	24.0	5-8 0.04	6-11 0.07	8-0 0.10	8-11 0.14	9-9 0.19	10-6 0.24	11-3 0.29	11-11 0.35	12-7 0.41	13-2 0.47	13-9 0.54	14-4 0 61
(inches)	(inches)	1400	1500	1600	1700	1800	1900	2000	2 1 00	2200	2400	2700	3000
2 x4	12.0	8-0 0.96	8-3 1.06	8-6 1.17	8-9 1.28	9-0 1.39	9-3 1.51	9-6 1.63	9 9 1.76	10-0 1.88	10-5 2.15	2.56	
	16.0	6- 11 0.83	7-2 0.92	7-5 1.01	7-7 1.11	7- 10 1.21	8-0 1.31	8-3 1.41	8-5 1.52	8-8 1.63	9-0 1.86	9-7 2.22	10- 1 2.60
	24.0	5-8 0.68	5-10 0.75	6-0 0.83	6-3 0.90	6-5 0.99	6-7 1.07	6-9 1.15	6-11 1.24	7-1 1.33	7-5 1.52	7-10 1.81	8-3 2.12
2 x 6	12.0	12-6 0.96	13-0 1.06	13-5 1.17	13-10 1.28	14-2 1.39	14-7 1.51	15-0 1.63	15-4 1.76	15-8 1.88	16-5 2.15	17-5 2.56	
	16.0	10-10 0.83	11-3 0.92	11-7 1.01	11-11 1.11	12-4 1.21	12-8 1.31	13-0 1.41	13-3 1.52	13-7 1.63	14-2 1.86	15-1 2.22	15-11 2.60
	24.0	8-10 0.68	9-2 0.75	9-6 0.83	9-9 0.90	10-0 0.99	10-4 1.07	10-7 1.15	10-10 1.24	11-1 1.33	11-7 1.52	12-4 1.81	13-0 2.12
2x8	12.0	16-6 0.96	17-1 1.06	17-8 1.17	18-2 1.28	18-9 1.39	19-3 1.51	19-9 1.63	20-3 1.76	20-8 1.88	21-7 2.15	22-11 2.56	
	16.0	14-4 0.83	14-10 0.92	15-3 1.01	15-9 1.11	16-3 1.21	16-8 1.31	17-1 1.41	17-6 1.52	17-11 1.63	18-9 1.86	19-10 2.22	20-11 2.60
	24.0	11-8 0.68	12-1 0.75	12-6 0.83	12-10 0.90	13-3 0.99	13-7 1.07	13-11 1.15	14-4 1.24	14-8 1.33	15-3 1.52	16-3 1.81	17-1 2.12
2x 10	12.0	21-1 0.96	21-10 1.06	22-6 1.17	23-3 1.28	23-11 1.39	24-6 1.51	25-2 1.63	25-10 1.76	26-5 1.88	27-7 2.15	29-3 2.56	
	16.0	18-3 0.83	18-11 0.92	19-6 1.01	20-1 1.11	20-8 1.21	21-3 1.31	21-10 1.41	22-4 1.52	22-10 1.63	23-11 1.86	25-4 2.22	26-8 2.60
	24.0	14-11 0.68	15-5 0.75	15-11 0.83	16-5 0.90	16-11 0.99	17-4 1.07	17-10 1.15	18-3 1.24	18-8 1.33	19-6 1.52	20-8 1.81	21-10 2.12

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.

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

TABLE 3608.2.4k
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
30 Lbs. per Sq. Ft. Live Load (Supporting Gypsum Ceiling)
For Use in Snow Load Zone 2

DESIGN CRITERIA: Strength—15 lbs. per sq. fl. dead load plus 30 lbs. per sq. ft. live load determines fiber stress. Deflection—For 30 lbs. per sq. ft. live load. Limited to span in inches divided by 240.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)										
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 6	12.0	5-10 0.13	6-8 0.19	7-6 0.27	8-2 0.36	8-10 0.45	9-6 0.55	10-0 0.66	10-7 0.77	11-1 0.89	11-7 1.01	12-1 1.14
	16.0	5-0 0.11	5-10 0.17	6-6 0.24	7-1 0.31	7-8 0.39	8-2 0.48	8-8 0.57	9-2 0.67	9-7 0.77	10-0 0.88	10-5 0.99
	24.0	4-1 0.09	4-9 0.14	5-4 0.19	5-10 0.25	6-3 0.32	6-8 0.39	7-1 0.46	7-6 0.54	7-10 0.63	8-2 0.72	8-6 0.81
2 x 8	12.0	7-8 0.13	8-10 0.19	9-10 0.27	10-10 0.36	11-8 0.45	12-6 0.55	13-3 0.66	13-11 0.77	14-8 0.89	15-3 1.01	15-11 1.14
	16.0	6-7 0.11	7-8 0.17	8-7 0.24	9-4 0.31	10-1 0.39	10-10 0.48	11-6 0.57	12-1 0.67	12-8 0.77	13-3 0.88	13-9 0.99
	24.0	5-5 0.09	6-3 0.14	7-0 0.19	7-8 0.25	8-3 0.32	8-10 0.39	9-4 0.46	9-10 0.54	10-4 0.63	10-10 0.72	11-3 0.81
2x 10	12.0	9 9 0.13	11-3 0.19	12-7 0.27	13-9 0.36	14-11 0.45	15-11 0.55	16-11 0.66	17-10 0.77	18-8 0.89	19-6 1.01	20-4 1.14
	16.0	8-5 0.11	9 9 0.17	10-11 0.24	11-11 0.31	12-11 0.39	13-9 0.48	14-8 0.57	15-5 0.67	16-2 0.77	16-11 0.88	17-7 0.99
	24.0	6-11 0.09	8-0 0.14	8-11 0.19	9 9 0.25	10-6 0.32	11-3 0.39	11-11 0.46	12-7 0.54	13-2 0.63	13-9 0.72	14-4 0.81
2 x 12	12.0	11-10 0.13	13-8 0.19	154 0.27	16-9 0.36	18-1 0.45	194 0.55	20-6 0.66	21-8 0.77	22-8 0.89	23-9 1.01	24-8 1.14
	16.0	10-3 0.11	11-10 0.17	13-3 0.24	14-6 0.31	15-8 0.39	16-9 0.48	17-9 0.57	18-9 0.67	19-8 0.77	20-6 0.88	21-5 0.99
	24.0	8-5 0.09	9-8 0.14	10-10 0.19	11-10 0.25	12-10 0.32	13-8 0.39	14-6 0.46	15-4 0.54	16-1 0.63	16-9 0.72	17-5 0.81
(inches)	(inches)	1 400	1500	1600	1700	1800	1900	2000	2100	2200	2400	
2 x 6	12.0	12-6 1.28	13-0 1.41	13-5 1.56	13-10 1.71	14-2 1.86	14-7 2.02	15-0 2.18	15-4 2.34	15-8 2.51	16-5 2.86	
	16.0	10-10 1.10	11-3 1.22	11-7 1.35	11-11 1.48	12-4 1.61	12-8 1.75	13-0 1.89	13-3 2.03	13-7 2.18	14-2 2.48	
	24.0	8-10 0.90	9-2 1.00	9-6 1.10	9 9 1.21	10-0 1.31	10-4 1.43	10-7 1.54	10-10 1.66	11-1 1.78	11-7 2.02	
2 x 8	12 0	16-6 1.28	17-1 1.41	17-8 1.56	18-2 1.71	18-9 1.86	19-3 2.02	19-9 2.18	20-3 2.34	20-8 2.51	21-7 2.86	
	16.0	14-4 1.10	14-10 1.22	15-3 1.35	15-9 1.48	16-3 1.61	16-8 1.75	17-1 1.89	17-6 2.03	17-11 2.18	18-9 2.48	
	24.0	11-8 0.90	12-1 1.00	12-6 1.10	12-10 1.21	13-3 1.31	13-7 1.43	13-11 1.54	14-4 1.66	14-8 1.78	15-3 2.02	
2x 10	12 0	21-1 1.28	21-10 1.41	22-6 1.56	23-3 1.71	23-11 1.86	24-6 2.02	25-2 2.18	25-10 2.34	26-5 2.51	27-7 2.86	
	16.0	18-3 1.10	18-11 1.22	19-6 1.35	20-1 1.48	20-8 1.61	21-3 1.75	21-10 1.89	22-4 2.03	22-10 2.18	23-11 2.48	
	24.0	14-11 0.90	15-5 1.00	15-11 1.10	16-5 1.21	16-11 1.31	17-4 1.43	17-10 1.54	18-3 1.66	18-8 1.78	19-6 2.02	
2 x 12	12 0	25-7 1.28	26-6 1.41	27-5 1.56	28-3 1.71	29-1 1.86	29-10 2.02	30-7 2.18	31-4 2.34	32-1 2.51	33-6 2.86	
	16.0	22-2 1.10	23-0 1.22	23-9 1.35	24-5 1.48	25-2 1.61	25-10 1.75	26-6 1.89	27-2 2.03	27-10 2.18	29-1 2.48	
	24.0	18-1 0.90	18-9 1.00	19-4 1.10	20-0 1.21	20-6 1.31	~21-1 1.43	21-8 1.54	22-2 1.66	22-8 1.78	23-9 2.02	

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown oelow each span.

TABLE 3608.2.4l
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
30 Lbs. per Sq. Ft. Live Load (Supporting Plaster Ceiling)
For Use in Snow Load Zone 2

DESIGN CRITERIA: Strength—15 lbs. per sq ft. dead load plus 30 lbs. per sq.ft. live load determines fiber stress. Deflection—For 30 lbs. per sq. ft. live load. Limited to span in inches divided by 360.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)									
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200
2 x 6	12.0	5-10 0.19	6-8 0.29	7-6 0.41	8-2 0.54	8-10 0.68	9-6 0.83	10-0 0.99	10-7 1.15	11-1 1.33	11-7 1.52
	16.0	5-0 0.16	5-10 0.25	6-6 0.35	7-1 0.46	7-8 0.59	8-2 0.72	8-8 0.85	9-2 1.00	9-7 1.15	10-0 1.31
	24.0	4-1 0.13	4-9 0.21	5-4 0.29	5-10 0.38	6-3 0.48	6-8 0.58	7-1 0.70	7-6 0.82	7-10 0.94	8-2 1.07
2 x 8	12.0	7-8 0.19	8-10 0.29	9-10 0.41	10-10 0.54	11-8 0.68	12-6 0.83	13-3 0.99	13-11 1.15	14-8 1.33	15-3 1.52
	16.0	6-7 0.16	7-8 0.25	8-7 0.35	9-4 0.46	10-1 0.59	10-10 0.72	11-6 0.85	12-1 1.00	12-8 1.15	13-3 1.31
	24. 0	5-5 0.13	6-3 0.21	7-0 0.29	7-8 0.38	8-3 0.48	8-10 0.58	9-4 0.70	9-10 0.82	10-4 0.94	10-10 1.07
2 x 10	12.0	9-9 0.19	11-3 0.29	12-7 0.41	13-9 0.54	14-11 0.68	15-11 0.83	16-11 0.99	17-10 1.15	18-8 1.33	19-6 1.52
	16.0	8-5 0.16	9-9 0.25	10-11 0.35	11-11 0.46	12-11 0.59	13-9 0.72	14-8 0.85	15-5 1.00	16-2 1.15	16-11 1.31
	24.0	6-11 0.13	8-0 0.21	8-11 0.29	9 9 0.38	10-6 0.48	11-3 0.58	11-11 0.70	12-7 0.82	13-2 0.94	13-9 1.07
2x 12	12.0	11-10 0.19	13-8 0.29	15-4 0.41	16-9 0.54	18-1 0.68	19-4 0.83	20-6 0.99	21-8 1.15	22-8 1.33	23-9 1.52
	16.0	10-3 0.16	11-10 0.25	13-3 0.35	14-6 0.46	15-8 0.59	16-9 0.72	17-9 0.85	18-9 1.00	19-8 1.15	20-6 1.31
	24.0	8-5 0.13	9-8 0.21	10-10 0.29	11-10 0.38	12-10 0.48	13-8 0.58	14-6 0.70	15-4 0.82	16-1 0.94	16-9 1.07
(inches)	(inches)	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200
2 x 6	12. 0	12-1 1.71	12-6 1.91	13-0 2.12	13-5 2.34	13-10 2.56	14-1 2.79	14-6 3.02	15-0 3.27	15-4 3.51	15-8 3.77
	16.0	10-5 1.48	10-10 1.66	11-3 1.84	11-7 2.02	11-11 2.22	12-4 2.41	12-8 2.62	12-11 2.82	13-3 3.04	13-11 3.26
	24.0	8-6 1.21	8-10 1.35	9-2 1.50	9-6 1.65	9-9 1.81	10-0 1.97	10-4 2.14	10-7 2.31	10-10 2.48	11-1 2.66
2 x 8	12.0	15-11 1.71	16-6 1.91	17-1 2.12	17 8 2 34	18-2 2.56	18-8 2.79	19-3 3.02	19-9 3.27	20-3 3.51	20-8 3.77
	16.0	13-9 1.48	144 1.66	14-10 1.84	15-3 2.02	15-9 2.22	16-3 2.41	16-8 2.62	17-1 2.83	17-6 3.04	17-11 3.26
	24.0	11-3 1.21	11-8 1.35	12-1 1.50	12-6 1.65	12-10 1.81	13-3 1.97	13-7 2.14	13-11 2.31	14-4 2.48	14-7 2.66
2 x 10	12.0	20-4 1.71	21-1 1.91	21-10 2.12	22-6 2.34	23-3 2.56	23-10 2.79	24-6 3.02	25-2 3.27	25-10 3.51	26-5 3.77
	16.0	17-7 1.48	18-3 1.66	18-11 1.84	19-6 2.02	20-1 2.22	20-8 2.41	21-3 2.62	21-9 2.83	22-4 3.04	22-10 3.26
	24.0	14-4 1.21	14-11 1.35	15-5 1.50	15-11 1.65	16-5 1.81	16-11 1.97	17-4 2.14	17-10 2.31	18-3 2.48	18-8 2.66
2x 12	12.0	24-8 1.71	25-7 1.91	26-6 2.12	27-5 2.34	28-3 2.56	29-1 2.79	29-10 3.02	30-7 3.27	21-4 3.51	32-1 3.77
	16.0	21-5 1.48	22-2 1.66	23-0 1.84	23-9 2.02	24-5 2.22	25-2 2.41	25-10 2.62	26-6 2.83	27-2 3.04	27-10 3.26
	24.0	17-5 1.21	18-1 1.35	18-9 1.50	19-4 1.65	20-0 1.81	20-6 1.97	21-1 2.14	21-8 2.31	22-2 2.48	22-8 2.66

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4m
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
35 Lbs. per Sq. Ft. Live Load
For Use in Snow Load Zone 3

DESIGN CRITERIA: Strength-35 lbs. per sq. ft. live load plus 10 lbs. per sq. ft. dead load determines fiber stress. Deflection—For 35 lbs. per sq. ft. live load. Limited to span in inches divided by 180.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)									
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200
2 x 6	12.0	5-10 .11	6-8 .17	7-6 .24	8-2 .31	8-10 .39	9-6 .48	10-0 .58	10-7 .67	11-1 .78	11-7 .89
	16.0	5-0 .10	5-10 .15	6-6 .21	7-1 .27	7-8 .34	8-2 .42	8-8 .50	9-2 .58	9-7 .67	10-0 .77
	24.0	4-1 .08	4-9 .12	5-4 .17	5-10 .22	6-3 .28	6-8 .34	7-1 .41	7-6 .48	7-10 .55	8-2 .63
2 x 8	12.0	7-8 .11	8-10 .17	9-10 .24	10-10 .31	11-8 .39	12-6 .48	13-3 .58	13-11 .67	14-8 .78	15-3 .89
	16.0	6-7 .10	7-8 .15	8-7 .21	9-4 .27	10-1 .34	10-10 .42	11-6 .50	12-1 .58	12-8 .67	13-3 .77
	24. 0	5-5 .08	6-3 .12	7-0 .17	7-8 .22	8-3 .28	8-10 .34	9-4 .41	9-10 .48	10-4 .55	10-10 .63
2 x 10	12.0	9-9 .11	11-3 .17	12-7 .24	13-9 .31	14-11 .39	15-11 .48	16-11 .58	17-10 .67	18-8 .78	19-6 .89
	16.0	8-5 .10	9-9 .15	10-11 .21	11-11 .27	12-11 .34	13-9 .42	14-8 .50	15-5 .58	16-2 .67	16-11 .77
	24.0	6-11 .08	8-0 .12	8-11 .17	9-9 .22	10-6 .28	11-3 .34	11-11 .41	12-7 .48	13-2 .55	13-9 .63
2x 12	12.0	11-10 0.11	13-8 0.17	15-4 0.24	16-9 0.31	18-1 0.39	19-4 0.48	20-6 0.58	21-8 0.67	22-9 0.78	23-9 0.89
	16.0	10-3 0.10	11-10 0.15	13-3 0.21	14-6 0.27	15-8 0.34	16-9 0.42	17-8 0.58	18-9 0.58	19-8 0.67	20-6 0.77
	24.0	8-4 0.08	9-8 0.12	10-10 0.17	11.10 0.22	12-10 0.28	13-8 0.34	14-6 0.41	15-4 0.48	16-1 0.55	16-9 0.63
(inches)	**(inches)**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**
2 x 6	12. 0	12-1 1.00	12-6 1.12	13-0 1.24	13-5 1.36	13-10 1.49	14-2 1.63	14-7 1.76	15-0 1.91	15-4 2.05	15-9 2.2
	16.0	10-5 .86	10-10 .97	11-3 1.07	11-7 1.18	11-11 1.29	12-4 1.41	12-8 1.53	13-0 1.65	13-3 1.78	13-7 1.90′
	24.0	8-6 .71	8-10 .79	9-2 .88	9-6 .96	9-9 1.06	10-0 1.15	10-4 1.25	10-7 1.35	10-10 1.45	11-1 1.55
2 x 8	12.0	15-11 1.00	16-6 1.12	17-1 1.24	17-8 1.36	18-2 1.49	18-9 1.63	19-3 1.76	19-9 1.91	20-3 2.05	20-8 2.20
	16.0	13-9 .86	14-4 .97	14-10 1.07	15-3 1.18	15-9 1.29	16-3 1.41	16-8 1.53	17-1 1.65	17-6 1.78	17-11 1.90
	24.0	11-3 .71	11-8 .79	12-1 .88	12-6 .96	12-10 1.06	13-3 1.15	13-7 1.25	13-11 1.35	14-4 1.45	14-8 1.55
2 x 10	12.0	20-4 1.00	21-1 1.12	21-10 1.24	22-6 1.36	23-3 1.49	23-11 1.63	24-6 1.76	25-2 1.91	25-10 2.05	26-5 2.20
	16.0	17-7 .86	18-3 .97	18-11 1.07	19-6 1.18	20-1 1.29	20-8 1.41	21-3 1.53	21-10 1.65	22-4 1.78	22-10 1.90
	24.0	14-4 .71	14-11 .79	15-5 .88	15-11 .96	16-5 1.06	16-11 1.15	17-4 1.25	17-10 1.35	18-3 1.45	18-8 1.55
2x 12	12.0	24-8 1.00	25-7 22-2	26-6 1.24	27-4 1.36	28-3 1.49	29-1 1.63	29-10 1.76	30-7 1.91	31-4 2.05	21-1 2.20
	16.0	21-4 0.86	0.97 18-1	22-11 1.07	23-9 1.18	24-5 1.29	25-2 1.41	25-10 1.53	26-6 1.65	27-2 1.78	27-10 1.90
	24.0	17-5 0.71	0.79 0.79	18-9 0.87	19-4 0.96	19-11 1.06	20-6 1.15	21-2 1.25	21-8 1.35	22.2 1.45	22-9 1.55

For SI: 1 inch = 25,4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 36082.4n
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
35 Lbs. per Sq. Ft. Live Load (Supporting Gypsum Wallboard Ceiling)
For Use in Snow Load Zone 3

DESIGN CRITERIA: Strength-35 lbs. per sq. ft. live load plus 10 lbs. per sq. ft. dead load determines fiber stress. Deflection—For 35 lbs. per sq. ft. live load. Limited to span in inches divided by 240.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)									
(inches)	**(inches)**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**
2 x 6	12.0	5-10 0.15	6-8 0.23	7-6 .32	8-2 .42	8-10 .53	9-6 .64	10-0 .77	10-7 .90	11-1 1.04	11-7 1.18
	16.0	5-0 .13	5-10 .20	6-6 .27	7-1 .36	7-8 .46	8-2 .56	8-8 .66	9-2 .78	9-7 .90	10-0 1.02
	24.0	4-1 .10	4-9 .16	5-4 .22	5-10 .30	6-3 .37	6-8 .45	7-1 .54	7-6 .64	7-10 .73	8-2 .83
2 x 8	12.0	7-8 .15	8-10 .23	9-10 .32	10-10 .42	11-8 .53	12-6 .64	13-3 .77	13-11 .90	14-8 1.04	15-3 1.18
	16.0	6-7 .13	7-8 .20	8-7 .27	9-4 .36	10-1 .46	10-10 .56	11-6 .66	12-1 .78	12-8 .90	13-3 1.02
	24. 0	5-5 .10	6-3 .16	7-0 .22	7-8 .30	8-3 .37	8-10 .45	9-4 .54	9-10 .64	10-4 .73	10-10 .83
2 x 10	12.0	9-9 .15	11-3 .23	12-7 .32	13-9 .42	14-11 .53	15-11 .64	16-11 .77	17-10 .90	18-8 1.04	19-6 1.18
	16.0	8-5 .13	9-9 .20	10-11 .27	11-11 .36	12-11 .46	13-9 .56	14-8 .66	15-5 .78	16-2 .90	16-11 1.02
	24.0	6-11 .10	8-0 .16	8-11 .22	9-9 .20	10-6 .37	11-3 .45	11-11 .54	12-7 .64	13-2 .73	13-9 .83
2x 12	12.0	11-10 .15	13-8 .23	15-4 .32	16-9 .42	18-1 .53	19-4 .64	20-6 .77	21-8 .90	22-8 1.04	23-9 1.18
	16.0	10-3 .13	11-10 .20	13-3 .27	14-6 .36	15-8 .46	16-9 .56	17-9 .66	18-9 .78	19-8 .90	20-6 1.02
	24.0	8-5 .10	9-8 .16	10-10 .22	11-10 .30	12-10 .37	13-8 .45	14-6 .54	15-4 .64	16-1 .73	16-9 .83
(inches)	**(inches)**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**
2 x 6	12. 0	12-1 1.33	12-6 1.49	13-0 1.65	13-5 1.82	13-10 1.99	14-2 2.17	14-7 2.35	15-0 2.54	15-4 2.74	15-8 2.93
	16.0	10-5 1.15	10-10 1.29	11-3 1.43	11-7 1.57	11-11 1.72	12-4 1.88	12-8 2.04	13-0 2.20	13-3 2.37	13-7 2.54
	24.0	8-6 .94	8-10 1.05	9-2 1.17	9-6 1.29	9-9 1.41	10-0 1.53	10-4 1.66	10-7 1.80	10-10 1.93	11-1 2.07
2 x 8	12.0	15-11 1.33	16-6 1.49	17-1 1.65	17-8 1.82	18-2 1.99	18-9 2.17	19-3 2.35	19-9 2.54	20-3 2.74	20-8 2.93
	16.0	13-9 1.15	14-4 1.29	14-10 1.43	15-3 1.57	15-9 1.72	16-3 1.88	16-8 2.04	17-1 2.20	17-6 2.37	17-11 2.54
	24.0	11-3 .94	11-8 1.05	12-1 1.17	12-6 1.29	12-10 1.41	13-3 1.53	13-7 1.66	13-11 1.80	14-4 1.93	14-7 2.07
2 x 10	12.0	20-4 1.33	21-1 1.49	21-10 1.65	22-6 1.82	23-3 1.99	23-11 2.17	24-6 2.35	25-2 2.54	25-10 2.74	26-5 2.93
	16.0	17-7 1.15	18-3 1.29	18-11 1.43	19-6 1.57	20-1 1.72	20-8 1.88	21-3 2.04	21-10 2.20	22-4 2.37	22-10 2.54
	24.0	14-4 .94	14-11 1.05	15-5 1.17	15-11 1.29	16-5 1.41	16-11 1.53	17-4 1.66	17-10 1.80	18-3 1.93	18-8 2.07
2x 12	12.0	24-8 1.33	25-7 1.49	26-6 1.65	27-4 1.82	28-3 1.99	29-0 2.17	29-10 2.35	30-7 2.54	31-4 2.74	32-1 2.93
	16.0	21-5 1.15	22-2 1.29	23-0 1.43	23-9 1.57	24-5 1.72	25-2 1.88	25-10 2.04	26-5 2.20	27-2 2.37	27-10 2.54
	24.0	17-5 .94	18-1 1.05	18-9 1.17	19-4 1.29	20-0 1.41	20-6 1.53	21-1 1.66	21-8 1.80	22-2 1.93	22-8 2.07

For SI: 1 inch = 25,4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4o
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
35 Lbs. per Sq. Ft. Live Load (Supporting Veneer Plaster Ceiling)
For Use in Snow Load Zone 3

DESIGN CRITERIA: Strength-35 lbs. per sq. ft. live load plus 10 lbs. per sq. ft. dead load determines fiber stress. Deflection—For 35 lbs. per sq. ft. live load. Limited to span in inches divided by 360.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)									
(inches)	**(inches)**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**
2 x 6	12.0	5-10 .22	6-8 .34	7-6 .48	8-2 .63	8-10 .79	9-6 .96	10-0 1.15	10-7 1.35	11-1 1.55	11-7 1.77
	16.0	5-0 .19	5-10 .30	6-6 .41	7-1 .54	7-8 .68	8-2 .83	8-8 1.00	9-2 1.17	9-7 1.35	10-0 1.53
	24.0	4-1 .16	4-9 .24	5-4 .34	5-10 .44	6-3 .56	6-8 .68	7-1 .81	7-6 .95	7-10 1.10	8-2 1.25
2 x 8	12.0	7-8 .22	8-10 .34	9-10 .48	10-10 .63	11-8 .79	12-6 .96	13-3 1.15	13-11 1.35	14-8 1.55	15-3 1.77
	16.0	6-7 .19	7-8 .30	8-7 .41	9-4 .54	10-1 .68	10-10 .83	11-6 1.00	12-1 1.17	12-8 1.35	13-3 1.53
	24. 0	5-5 .16	6-3 .24	7-0 .34	7-8 .44	8-3 .56	8-10 .68	9-4 .81	9-10 .95	10-4 1.10	10-10 1.25
2 x 10	12.0	9-9 .22	11-3 .34	12-7 .48	13-9 .63	14-11 .79	15-11 .96	16-11 1.15	17-10 1.35	18-8 1.55	19-6 1.77
	16.0	8-5 .19	9-9 .30	10-11 .41	11-11 .54	12-11 .68	13-9 .83	14-8 1.00	15-5 1.17	16-2 1.35	16-11 1.53
	24.0	6-11 .16	8-0 .24	8-11 .34	9-9 .44	10-6 .56	11-3 .68	11-11 .81	12-7 .95	13-2 1.10	13-9 1.25
2x 12	12.0	11-10 .22	13-8 .34	15-4 .48	16-9 .63	18-1 .79	19-4 .96	20-6 1.15	21-8 1.35	22-8 1.55	23-9 1.77
	16.0	10-3 .19	11-10 .30	13-3 .41	14-6 .54	15-8 .68	16-9 .83	17-9 1.00	18-9 1.17	19-8 1.35	20-6 1.53
	24.0	8-5 .16	9-8 .24	10-10 .34	11-10 .44	12-10 .56	13-8 .68	14-6 .81	15-4 .95	16-1 1.10	16-9 1.25
(inches)	**(inches)**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**
2 x 6	12. 0	12-1 2.00	12-6 2.23	13-0 2.47	13-4 2.73	13-10 2.99	14-2 3.26	14-7 3.53	14-11 3.81	15-4 4.10	15-8 4.40
	16.0	10-5 1.73	10-10 1.93	11-3 2.14	11-7 2.36	11-11 2.59	12-4 2.82	12-7 3.06	12-11 3.30	13-3 3.55	13-7 3.81
	24.0	8-6 1.41	8-10 1.58	9-2 1.75	9-6 1.93	9-9 2.11	10-0 2.30	10-4 2.49	10-7 2.69	10-10 2.90	11-1 3.11
2 x 8	12.0	15-11 2.00	16-6 2.23	17-1 2.47	17-8 2.73	18-2 2.99	18-9 3.26	19-3 3.53	19-9 3.81	20-3 4.10	20-8 4.40
	16.0	13-9 1.73	14-4 1.93	14-10 2.14	15-3 2.36	15-9 2.59	16-3 2.82	16-8 3.06	17-1 3.30	17-6 3.55	17-11 3.81
	24.0	11-3 1.41	11-8 1.58	12-1 1.75	12-6 1.93	12-10 2.11	13-3 2.30	13-7 2.49	13-11 2.69	14-4 2.90	14-8 3.11
2 x 10	12.0	20-4 2.00	21-1 2.23	21-10 2.47	22-6 2.73	23-3 2.99	23-10 3.26	24-6 3.53	25-2 3.81	25-9 4.10	26-5 4.40
	16.0	17-7 1.73	18-3 1.93	18-11 2.14	19-6 2.36	20-1 2.59	20-8 2.82	21-3 3.06	21-9 3.30	22-4 3.55	22-10 3.81
	24.0	14-4 1.41	14-11 1.58	15-5 1.75	15-11 1.93	16-5 2.11	16-11 2.30	17-4 2.49	17-9 2.69	18-3 2.90	18-8 3.11
2x 12	12.0	24-8 2.00	25-7 2.23	26-6 2.47	27-4 2.73	28-3 2.99	29-0 3.26	29-10 3.53	30-7 3.81	31-4 4.10	21-1 4.40
	16.0	21-5 1.73	22-2 1.93	23-0 2.14	23-9 2.36	24-5 2.59	25-2 2.82	25-10 3.06	26-6 3.30	27-2 3.55	27-10 3.81
	24.0	17-5 1.41	18-1 1.58	18-9 1.75	19-4 193	20-0 2.11	20-6 2.30	21-1 2.49	21-8 2.69	22-2 2.90	22-9 3.11

For SI: 1 inch = 25,4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 36082.4p
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
35 Lbs. per Sq. Ft. Live Load
For Use in Snow Load Zone 3

DESIGN CRITERIA: Strength-35 lbs. per sq. ft. live load plus 15 lbs. per sq. ft. dead load determines fiber stress. Deflection—For 35 lbs. per sq. ft. live load. Limited to span in inches divided by 180.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)									
(inches)	**(inches)**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**
2 x 6	12.0	5-6 .09	6-4 .15	7-1 .20	7-9 .27	8-5 .34	9-0 .41	9-6 .49	10-0 .58	10-6 .66	11-0 .76
	16.0	4-9 .08	5-6 .13	6-2 .18	6-9 .23	7-3 .29	7-9 .36	8-3 .43	8-8 .50	9-1 .57	9-6 .65
	24.0	3-11 .07	4-6 .10	5-0 .14	5-6 .19	5-11 .24	6-4 .29	6-9 .35	7-1 .41	7-5 .47	7-9 .53
2 x 8	12.0	7-3 .09	8-4 .15	9-4 .20	10-3 .27	11-1 .34	11-10 .41	12-7 .49	13-3 .58	13-11 .66	14-6 .76
	16.0	6-3 .08	7-3 .13	8-1 .18	8-11 .23	9-7 .29	10-3 .36	10-10 .43	11-6 .50	12-0 .57	12-7 .65
	24. 0	5-2 .07	5-11 .10	6-7 .14	7-3 .19	7-10 .24	8-4 .29	8-1 .35	9-4 .41	9-10 .47	10-3 .53
2 x 10	12.0	9-3 .09	10-8 .15	11-11 .20	13-1 .27	14-2 .34	15-1 .41	16-0 .49	16-11 .58	17-9 .66	18-6 .76
	16.0	8-0 .08	9-3 .13	10-4 .18	11-4 .23	12-3 .29	13-1 .36	13-10 .43	14-8 .50	15-4 .57	16-0 .65
	24.0	6-6 .07	7-7 .10	8-5 .14	9-3 .19	10-0 .24	10-8 .29	11-4 .35	11-11 .41	12-6 .47	13-1 .53
2x 12	12.0	11-3 0.09	13-0 0.15	14-6 0.20	15-11 0.27	17-2 0.34	18-4 0.41	19-6 0.49	20.6 0.58	21-6 0.66	22-6 0.76
	16.0	9-9 0.08	11-3 0.13	12-7 0.18	13-9 0.23	14-10 0.29	15-11 0.36	16-10 0.43	17-9 0.50	18-8 0.57	19-6 0.65
	24.0	8-0 0.07	9-2 0.10	10-3 0.14	11-3 0.19	12-2 0.24	13-0 0.29	13-8 0.35	14-6 0.41	15-3 0.47	15-11 0.53
(inches)	**(inches)**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**
2 x 6	12. 0	11-5 .85	11-11 .95	12-4 1.06	12-8 1.16	13-1 1.27	13-6 1.39	13-10 1.51	14-2 1.63	14-7 1.75	14-10 1.88
	16.0	9-11 .74	10-3 .83	10-8 .91	11-0 1.01	11-4 1.10	11-8 1.20	12-0 1.30	12-4 1.41	12-7 1.52	12-10 1.62
	24.0	8-1 .60	8-5 .67	8-8 .75	9-0 .82	9-3 .90	9-6 .98	9-9 1.07	10-0 1.15	10-3 1.24	10-6 1.33
2 x 8	12.0	15-1 .85	15-8 .95	16-3 1.06	16-9 1.16	17-3 1.27	17-9 1.39	18-3 1.51	18-9 1.63	19-2 1.75	19-7 1.88
	16.0	13-1 .74	13-7 .83	14-0 .91	14-6 1.01	14-11 1.10	15-5 1.20	15-10 1.30	16-3 1.41	16-7 1.52	17-0 1.62
	24.0	10-8 .60	11-1 .67	11-6 .75	11-10 .82	12-2 .90	12-7 .98	12-11 1.07	13-3 1.15	13-7 1.24	13-10 1.33
2 x 10	12.0	19-3 .85	20-0 .95	20-8 1.06	21-4 1.16	22-0 1.27	22-8 1.39	23-3 1.51	23-11 1.63	24-6 1.75	25-0 1.88
	16.0	16-8 .74	17-4 .83	17-11 .91	18-6 1.01	19-1 1.10	19-7 1.20	20-2 1.30	20-8 1.41	21-2 1.52	21-8 1.62
	24.0	13-7 .60	14-2 .67	14-8 .75	15-1 .82	15-7 .90	16-0 .98	16-6 1.07	16-11 1.15	17-4 1.24	17-9 1.33
2x 12	12.0	23-5 0.85	24-3 0.95	25-2 1.06	21-4 1.16	26-9 1.27	27-6 1.39	28-4 1.51	29-0 1.63	29-9 1.75	30-5 1.88
	16.0	20-3 0.74	21-0 0.82	21-9 0.91	22-6 1.01	23-2 1.10	23-10 1.20	24-6 1.30	25-2 1.41	25-9 1.51	26-4 1.62
	24.0	16-6 0.60	17-2 0.67	17-9 0.75	18-4 0.82	18-11 0.90	19-6 0.98	20-0 1.07	20-6 1.15	21-0 1.24	21-7 1.33

For SI: 1 inch = 25,4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4q
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
35 Lbs. per Sq. Ft. Live Load (Supporting Gypsum Wallboard Ceiling)
For Use in Snow Load Zone 3

DESIGN CRITERIA: Strength-35 lbs. per sq.ft. live load plus 15 lbs. per sq.ft. dead load determines fiber stress. Deflection—For 35 lbs. per sq. ft. live load. Limited to span in inches divided by 240.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)									
(inches)	**(inches)**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**
2 x 6	12.0	5-6 .13	6-4 .19	7-1 .27	7-9 .36	8-5 .45	9-0 .55	9-6 .65	10-0 .77	10-6 .88	11-0 1.01
	16.0	4-9 .11	5-6 .17	6-2 .23	6-9 .31	7-3 .39	7-9 .48	8-3 .57	8-8 .66	9-1 .77	9-6 .87
	24.0	3-11 .09	4-6 .14	5-0 .19	5-6 .25	5-11 .32	6-4 .39	6-9 .46	7-1 .54	7-5 .63	7-9 .71
2 x 8	12.0	7-3 .13	8-4 .19	9-4 .27	10-3 .36	11-1 .45	11-10 .55	12-7 .65	13-3 .77	13-11 .88	14-6 1.01
	16.0	6-3 .11	7-3 .17	8-1 .23	8-11 .31	9-7 .39	10-3 .48	10-10 .57	11-6 .66	12-0 .77	12-7 .87
	24. 0	5-2 .09	5-11 .14	6-7 .19	7-3 .25	7-10 .32	8-4 .39	8-11 .46	9-4 .54	9-10 .63	10-3 .71
2 x 10	12.0	9-3 .13	10-8 .19	11-11 .27	13-1 .36	14-2 .45	15-1 .55	16-0 .65	16-11 .77	17-9 .88	18-6 1.01
	16.0	8-0 .11	9-3 .17	10-4 .23	11-4 .31	12-3 .39	13-1 .48	13-10 .57	14-8 .66	15-4 .77	16-0 .87
	24.0	6-6 .09	7-7 .14	8-5 .19	9-3 .25	10-0 .32	10-8 .39	11-4 .46	11-11 .54	12-6 .63	13-1 .71
2x 12	12.0	11-3 .13	13-0 .19	14-6 .23	15-11 .36	17-2 .45	18-4 .55	19-6 .65	20-6 .77	21-7 .88	22-6 1.01
	16.0	9-9 .11	11-3 .17	12-7 .23	13-9 .31	14-11 .39	15-11 .48	16-10 .57	17-9 .66	18-8 .77	19-6 .87
	24.0	7-11 .09	9-2 .14	10-3 .19	11-3 .25	12-2 .32	13-0 .39	13-9 .46	14-6 .54	15-3 .63	15-11 .71
(inches)	**(inches)**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**
2 x 6	12. 0	11-5 1.14	11-11 1.27	12-4 1.41	12-8 1.55	13-1 1.70	13-6 1.85	13-10 2.01	14-2 2.17	14-7 2.33	14-10 2.50
	16.0	9-11 .98	10-3 1.10	10-8 1.22	11-0 1.34	11-4 1.47	11-8 1.60	12-0 1.74	12-4 1.88	12-7 2.02	12-10 2.16
	24.0	8-1 .80	8-5 .90	8-8 1.00	9-0 1.10	9-3 1.20	9-6 1.31	9-9 1.42	10-0 1.53	10-3 1.65	10-6 1.77
2 x 8	12.0	15-1 1.14	15-8 1.27	16-3 1.41	16-9 1.55	17-3 1.70	17-9 1.85	18-3 2.01	18-9 2.17	19-2 2.33	19-7 2.50
	16.0	13-1 .98	13-7 1.10	14-0 1.22	14-6 1.34	14-11 1.47	15-5 1.60	15-10 1.74	16-3 1.88	16-7 2.02	17-0 2.17
	24.0	10-8 .80	11-1 .90	11-6 1.00	11-10 1.10	12-2 1.20	12-7 1.31	12-11 1.42	13-3 1.53	13-7 1.65	13-10 1.77
2 x 10	12.0	19-3 1.14	20-0 1.27	20-8 1.41	21-4 1.55	22-8 1.70	22-8 1.85	23-3 2.01	23-11 2.17	24-6 2.33	25-0 2.50
	16.0	16-8 .98	17-4 1.10	17-11 1.22	18-6 1.34	19-1 1.47	19-7 1.60	20-2 1.74	20-8 1.88	21-2 2.02	21-8 2.16
	24.0	13-7 .80	14-2 .90	14-8 1.00	15-1 1.10	15-7 1.20	16-0 1.31	16-6 1.42	16-11 1.53	17-4 1.65	17-9 1.77
2x 12	12.0	23-5 1.14	24-4 1.27	25-2 1.41	26-0 1.55	26-9 1.70	27-6 1.85	28-4 2.01	29-0 2.17	29-9 2.33	30-5 2.50
	16.0	20-3 .98	21-1 1.10	21-9 1.22	22-6 1.34	23-2 1.47	23-10 1.60	24-6 1.74	25-2 1.88	25-9 2.02	26-4 2.16
	24.0	16-7 .80	17-2 .90	17-9 1.00	18-4 1.10	18-11 1.20	19-6 1.31	20-0 1.42	20-6 1.53	21-1 1.65	21-6 1.77

For SI: 1 inch = 25,4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4r
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
35 Lbs. per Sq. Ft. Live Load (Supporting Veneer Plaster Ceiling)
For Use in Snow Load Zone 3

DESIGN CRITERIA: Strength-35 lbs. per sq. ft. live load plus 15 lbs. per sq. ft.dead load determines fiber stress. Deflection—For 35 lbs. per sq. ft. live load. Limited to span in inches divided by 360.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)									
(inches)	**(inches)**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**
2 x 6	12.0	5-6 .19	6-4 .29	7-1 .41	7-9 .53	8-5 .67	9-0 .82	9-6 .98	10-0 1.15	10-6 1.33	11-0 1.51
	16.0	4-9 .16	5-6 .25	6-2 .35	6-9 .46	7-3 .58	7-9 .71	8-3 .85	8-8 1.00	9-1 1.15	9-6 1.31
	24.0	3-11 .13	4-6 .21	5-0 .29	5-6 .38	5-11 .48	6-4 .58	6-9 .69	7-1 .81	7-5 .94	7-9 1.07
2 x 8	12.0	7-3 .19	8-4 .29	9-4 .41	10-3 .53	11-1 .67	11-10 .82	12-7 .98	13-3 1.15	13-11 1.33	14-6 1.51
	16.0	6-3 .16	7-3 .25	8-1 .35	8-11 .46	9-7 .58	10-3 .71	10-10 .85	11-6 1.00	12-0 1.15	12-7 1.31
	24. 0	5-2 .13	5-11 .21	6-7 .29	7-3 .38	7-10 .48	8-4 .58	8-11 .69	9-4 .81	9-10 .94	10-3 1.07
2 x 10	12.0	9-3 .19	10-8 .29	11-11 .41	13-1 .53	14-2 .67	15-1 .82	16-0 .98	16-11 1.15	17-9 1.33	18-6 1.51
	16.0	8-0 .16	9-3 .25	10-4 .35	11-4 .46	12-3 .58	13-1 .71	13-10 .85	14-8 1.00	15-4 1.15	16-0 1.31
	24.0	6-6 .13	7-7 .21	8-5 .29	9-3 .38	10-0 .48	10-8 .58	11-4 .69	11-11 .81	12-6 .94	13-1 1.07
2x 12	12.0	11-3 .19	13-0 .29	14-6 .41	15-11 .53	17-2 .67	18-4 .82	19-6 .98	20-6 1.15	21-7 1.33	22-6 1.51
	16.0	9-9 .16	11-3 .25	12-7 .35	13-9 .46	14-11 .58	15-11 .71	16-10 .85	17-9 1.00	18-8 1.15	19-6 1.31
	24.0	7-11 .13	9-2 .21	10-3 .29	11-3 .38	12-2 .48	13-0 .58	13-9 .69	14-6 .81	15-3 .94	15-11 1.07
(inches)	**(inches)**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**
2 x 6	12. 0	11-5 1.70	11-11 1.91	12-4 2.11	12-8 2.33	13-1 2.55	13-6 2.78	13-10 3.01	14-2 3.25	14-6 3.50	14-10 3.75
	16.0	9-11 1.48	10-3 1.65	10-8 1.83	11-0 2.02	11-4 2.21	11-8 2.41	12-0 2.61	12-3 2.81	12-7 3.03	12-10 3.25
	24.0	8-1 1.21	8-5 1.35	8-8 1.49	9-0 1.65	9-3 1.80	9-6 1.96	9-9 2.13	10-0 2.30	10-3 2.48	10-6 2.65
2 x 8	12.0	15-1 1.70	15-8 1.91	16-3 2.11	16-9 2.33	17-3 2.55	17-9 2.78	18-3 3.01	18-9 3.25	19-2 3.50	19-7 3.75
	16.0	13-1 1.48	13-7 1.65	14-0 1.83	14-6 2.02	14-11 2.21	15-5 2.41	15-9 2.61	16-2 2.81	16-7 3.03	17-0 3.25
	24.0	10-8 1.21	11-1 1.35	11-6 1.49	11-10 1.65	12-2 1.80	12-7 1.96	12-11 2.13	13-3 2.30	13-7 2.48	13-10 2.65
2 x 10	12.0	19-3 1.70	20-0 1.91	20-8 2.11	21-4 2.33	22-0 2 .55	22.8 2.78	23-3 3.01	23-10 3.25	24-6 3.50	25-0 3.50
	16.0	16-8 1.48	17-4 1.65	17-11 1.83	18-6 2.02	19-1 2.21	19-7 2.41	20-2 2.61	20-8 2.81	21-2 3.03	21-8 3.25
	24.0	13-7 1.21	14-2 1.35	14-8 1.49	15-1 1.65	15-7 1.80	16-0 1.96	16-6 2.13	16-11 2.30	17-4 2.48	17-9 2.65
2x 12	12.0	23-5 1.70	24-4 1.91	25-2 2.11	26-0 2.33	26-9 2.55	27-6 2.78	28-3 3.01	29-0 3.25	20-9 3.50	30-5 3.75
	16.0	20-3 1.48	21-1 1.65	21-9 1.83	22-6 2.02	23-2 2.21	23-10 2.41	24-6 2.61	25-2 2.81	25-9 3.03	26-4 3.25
	24.0	16-7 1.21	17-2 135	17-9 1.49	18-4 1.65	18-11 1.80	19-6 1.96	20-0 2.13	20-6 2.30	21-1 2.48	21-6 2.65

For SI: 1 inch = 25,4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4s
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
40 Lbs. per Sq. Ft. Live Load
For Use in Snow Load Zone 4

DESIGN CRITERIA: Strength-40 lbs. per sq. ft. live load plus 10 lbs. per sq. ft. dead load determines fiber stress. Deflection—For 40 lbs. per sq. ft. live load. Limited to span in inches divided by 180.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)										
(inches)	**(inches)**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**
2x6	12.0	5-6 0.11	6-4 0.17	7-1 0.23	7-9 0.30	8-5 0.38	9-0 0.47	9-6 0.56	10-0 0.66	10-6 0.76	11-0 0.86	11-5 0.97
	16.0	4-9 0.09	5-6 0.14	6-2 0.20	6-9 0.26	7-3 0.33	7-9 0.41	8-3 0.48	8-8 0.57	9-1 0.66	9-6 0.75	9-11 0.84
	24.0	3-10 0.08	4-6 0.12	5-0 0.16	5-6 0.22	5-11 0.27	6-4 0.33	6-9 0.40	7-1 0.47	7-5 0.54	7-9 0.61	8-1 0.69
2 x 8	12.0	7-3 0.11	8-4 0.17	9-4 0.23	10-3 0.30	11-1 0.38	11-10 0.47	12-6 0.56	13-3 0.66	13-10 0.76	14-6 0.86	15-1 0.97
	16.0	6-3 0.09	7-3 0.14	8-1 0.20	8-10 0.26	9-7 0.33	10-3 0.41	10-10 0.48	11-5 0.57	12-0 0.66	12-7 0.75	13-1 0.84
	24.0	5-1 0.08	5-11 0.12	6-7 0.16	7-3 0.22	7-10 0.27	8-4 0.33	8-10 0.40	9-4 0.47	9-9 0.54	10-3 0.61	10-8 0.69
2 x 10	12.0	9-3 0.11	10-8 0.17	11-11 0.23	13-1 0.30	14-1 0.38	15-1 0.47	16-0 0.56	16-10 0.66	17-8 0.76	18-6 0.86	19-3 0.97
	16.0	8-0 0.09	9-3 0.14	10-4 0.20	11-4 0.26	12-3 0.33	13-1 0.41	13-10 0.48	14-7 0.57	15-4 0.66	16-0 0.75	16-8 0.84
	24.0	6-6 0.08	7-6 0.12	8-5 0.16	9-3 0.22	10-0 0.27	10-8 0.33	11-4 0.40	11-11 0.47	12-6 0.54	13-1 0.61	13-7 0.69
2 x 12	12.0	11-3 0.11	13-0 0.17	14-6 0.23	15-11 0.30	17-2 0.38	18-4 0.47	19-6 0.56	20-6 0.66	21-6 0.76	22-6 0.86	23-5 0.97
	16.0	9-9 0.09	11-3 0.14	12-7 0.20	13-9 0.26	14-10 0.33	15-11 0.41	16-10 0.48	17-9 0.57	18-8 0.66	19-6 0.75	20-3 0.84
	24.0	8-0 0.08	9-2 0.12	10-3 0.16	11-3 0.22	12-1 0.27	13-0 0.33	13-9 0.40	14-6 0.47	15-3 0.54	15-11 0.61	16-6 0.69
(inches)	**(i nches)**	**1400**	**1500**	**1600**	**1700**	**1 800**	**1900**	**2000**	**2100**	**2200**	**2300**	**2400**
2 x 6	12 0	11-10 1.09	12-3 1.20	12-8 1.33	13-1 1.45	13-6 1.58	13-10 1.72	14-2 1.85	14-6 2.00	14-10 2.14	15-3 2.29	15-7 2.44
	16.0	10-3 0.94	10-8 1.04	11-0 1.15	11-4 1.26	11-8 1.37	12-0 1.49	12-3 1.61	12-7 1.73	12-11 1.85	13-2 1.98	13-5 2.11
	24.0	8-5 0.77	8-8 0.85	9-0 0.94	9-3 1.03	9-6 1.12	9-9 1.22	10-0 1.32	10-3 1.42	10-6 1.52	10-9 1.62	11-0 1.73
2x 8	12.0	15-8 1.09	16-2 1.20	16-9 1.33	17-3 1.45	17-9 1.58	18-3 1.72	18-9 1.85	19-2 2.00	19-8 2.14	20-1 2.29	20-6 2.44
	16.0	13-7 0.94	14-0 1.04	14-6 1.15	14-11 1.26	15-4 1.37	15-9 1.49	16-2 1.61	16-7 1.73	17-0 1.85	17-4 1.98	17-9 2.11
	24.0	11-1 0.77	11-5 0.85	11-10 0.94	12-3 1.03	12-6 1.12	12-11 1.22	13-3 1.32	13-7 1.42	13-10 1.52	14-2 1.62	14-6 1.73
2 x10	12.0	20-0 1.09	20-8 1.20	21-4 1.33	22-0 1.45	22-8 1.58	23-3 1.72	23-10 1.85	24-6 2.00	25-0 2.14	25-7 2.29	26-2 2.44
	16.0	17-3 0.94	17-11 1.04	18-6 1.15	19-1 1.26	19-8 1.37	20-2 1.49	20-8 1.61	21-2 1.73	21-8 1.85	22-2 1.98	22-8 2.11
	24.0	14-1 0.77	14-8 0.85	15-1 0.94	15-7 1.03	16-0 1.12	16-6 1.22	16-10 1.32	17-4 1.42	17-9 1.52	18-1 1.62	18-6 1.73
2x 12	12 0	24-3 1.09	25-2 1.20	26-0 1.33	26-9 1.45	27-7 1.58	28-3 1.72	29-0 1.85	29-9 2.00	30-5 2.14	31-1 2.29	31-10 2.44
	16.0	21-0 0.94	21-9 1.04	22-6 1.15	23-2 1.26	23-10 1.37	24-6 1.49	25-2 1.61	25-9 1.73	26-4 1.85	27-0 1.98	27-7 2.11
	24.0	17-2 0.77	17-9 0.85	18-4 0.94	18-11 1.03	19-6 1.12	20-0 1.22	20-6 1.32	21-1 1.42	21-7 1.52	22-0 1.62	22-6 1.73

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "*E*," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4t
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
40 Lbs. per Sq. Ft. Live Load (Supporting Gypsum Ceiling)
For Use in Snow Load Zone 4

DESIGN CRITERIA: Strength-40 lbs. per sq. ft. live load plus 10 lbs. per sq. ft. dead load determines fiber stress. Deflection—For 40 lbs. per sq. ft. live load. Limited to span in inches divided by 240.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)										
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 6	12.0	5-6 0.14	6-4 0.22	7-1 0.31	7-9 0.41	8-5 0.51	9-0 0.63	9-6 0.75	10-0 0.88	10-6 1.01	11-0 1.15	11-5 1.30
	16.0	4-9 0.12	5-6 0.19	6-2 0.27	6-9 0.35	7-3 0.44	7-9 0.54	8-3 0.65	8-8 0.76	9- 1 0.88	9-6 1.00	9- 11 1.12
	24.0	3-11 0.10	4-6 0.16	5-0 0.22	5-6 0.29	5-11 0.36	6-4 0.44	6-9 0.53	7-1 0.62	7-5 0.71	7-9 0.81	8-1 0.92
2 x 8	12.0	7-3 0.14	8-4 0.22	9-4 0.31	10-3 0.41	11-1 0.51	11-10 0.63	12-7 0.75	13-3 0.88	13-11 1.01	14-6 1.15	15-1 1.30
	16.0	6-3 0.12	7-3 0.19	8-1 0.27	8-11 0.35	9-7 0.44	10-3 0.54	10-11 0.65	11-6 0.76	12-0 0.88	12-7 1.00	13-1 1.12
	24.0	5-2 0.10	5-11 0.16	6-7 0.22	7-3 0.29	7-10 0.36	84 0.44	8-11 0.53	9-4 0.62	9-10 0.71	10-3 0.81	10-8 0.92
2 x 10	12.0	9-3 0.14	10-8 0.22	11-1 0.31	12-1 0.41	14-2 0.51	15-1 0.63	16-0 0.75	16-11 0.88	17-9 1.01	18-6 1.15	19-3 1.30
	16.0	8-0 0.12	9-3 0.19	104 0.27	11-4 0.35	12-3 0.44	13-1 0.54	13-11 0.65	14-8 0.76	154 0.88	16-0 1.00	16-8 1.12
	24.0	6-6 0.10	7-7 0.16	8-5 0.22	9-3 0.29	10-0 0.36	10-8 0.44	11-4 0.53	11- 11 0.62	12-6 0.71	13-1 0.81	13-7 0.92
2 x 12	12.0	11-3 0.14	13-0 0.22	14-6 0.31	15-11 0.41	17-2 0.51	18-4 0.63	19-6 0 75	20-6 0.88	21-7 1.01	22-6 1.15	23-5 1.30
	16.0	9-9 0.12	11-3 0.19	12-7 0.27	13-9 0.35	14-11 0.44	15-11 0.54	16-11 0.65	17-9 0.76	18-8 0.88	19-6 1.00	20-3 1.12
	24. 0	7-11 0.10	9-2 0.16	10-3 0.22	11-3 0.29	12-2 0.36	13-0 0.44	13-9 0.53	14-6 0.62	15-3 0.71	15-11 0.81	16-7 0.92
(Inches)	(Inches)	1400	1500	1600	1700	1 600	1900	2000	2100	2200	2300	2400
2 x 6	120	11-11 1.45	12-4 1.61	12-8 1.77	13-1 1.94	13-6 2.12	13-10 2.30	14-2 2.48	14-6 2.66	14-10 2.85	15-3 3.05	15-7 3.25
	16.0	10-3 1.26	10-8 1.39	11-0 1.54	11-4 1.68	11-8 1.83	12-0 1.99	12-4 2.15	12-7 2.31	12-11 2.48	13-2 2.64	13-5 2.82
	24.0	8-5 1.03	8-8 1.14	9-0 1.25	9-3 1.37	9-6 1.50	9-9 1.62	10-0 1.75	10-3 1.89	10-6 2.02	10-9 2.16	11-0 2.30
2 x 8	12.0	15-8 1.45	16-3 1.61	16-9 1.77	17-3 1.94	17-9 2.12	18-3 2.30	18-9 2.48	19-2 2.66	19-7 2.85	20-1 3.05	20-6 3.25
	16.0	13-7 1.26	14-0 1.39	14-6 1.54	14-11 1.68	15-5 1.83	15-10 1.99	16-3 2.15	16-7 2.31	17-0 2.48	17-4 2.64	17-9 2.82
	24.0	11-1 1.03	11-6 1.14	1 [-10 1.25	12-2 1.37	12-7 1.50	12-11 1.62	13-3 1.75	13-7 1.89	13-11 2.02	14-2 2.16	14-6 2.30
2 x 10	12.0	20-0 1.45	20-8 1.61	21-4 1.77	22-0 1.94	22-8 2.12	23-3 2.30	23-11 2 48	24-6 2.66	25-0 2.85	25-7 3.05	26-2 3.25
	16.0	17-4 1.26	17-11 1.39	18-6 1.54	19-1 1.68	19-7 1.83	20-2 1.99	20-8 2.15	21-2 2.31	21-8 2.48	22-2 2.64	22-8 2.82
	24.0	14-2 1.03	14-8 1.14	15-1 1.25	15-7 1.37	16-0 1.50	16-6 1.62	16-11 1.75	17-4 1.89	17-9 2.02	18-1 2.16	18-6 2.30
2 x 12	12.0	24-4 1.45	25-2 1.61	26-0 1.77	26-9 1.94	27-7 2.12	28-4 2.30	29-1 2.48	29-9 2.66	30-5 2.85	31-2 3.05	31-9 3.25
	16.0	21-1 1.26	21-9 1.39	22-6 1.54	23-2 1.68	23-10 1.83	24-6 1.99	25-2 2.15	25-9 2.31	26-5 2.48	27-0 2.64	27-7 2.82
	24.0	i7-2 1.03	17-9 1.14	18-4 1.25	18-11 1.37	19-6 1.50	20-0 1.62	20-6 1.75	21-1 1.89	21-7 2.02	22-0 2.16	22-6 2.30

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m'.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4u
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
40 Lbs. per Sq. Ft. Live Load (Supporting Veneer Plaster Ceiling)
For Use in Snow Load Zone 4

DESIGN CRITERIA: Strength-40 lbs. per sq. ft. live load plus 10 lbs. per sq. ft. dead load determines fiber stress. Deflection—For 40 lbs. per sq. ft. live load. Limited to span in inches divided by 360.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)										
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12.0	5-6 0.22	6-4 0.33	7-1 0.46	7-9 0.61	8-5 0.77	9-0 0.94	9-6 1.12	10-0 1.31	10-6 1.51	11-0 1.72	11-5 1.94
	16.0	4-9 0.19	5-6 0.29	6-2 0.40	6-9 0.53	7-3 0.67	7-9 0.81	8-3 0.97	8-8 1.14	9-1 1.31	9-6 1.49	9-11 1.68
	24.0	3-11 0.15	4-6 0.24	5-0 0.33	5-6 0.43	5-11 0.54	6-4 0.67	6-9 0.79	7-1 0.93	7-5 1.07	7-9 1.22	8-1 1.38
2 x 8	12.0	7-3 0.22	8-4 0.33	9-4 0.46	10-3 0.61	11-1 0.77	11-10 0.94	12-6 1.12	13-3 1.31	13-10 1.51	14-6 1.72	15-1 1.94
	16.0	6-3 0.19	7-3 0.29	8-1 0.40	8-10 0.53	9-7 0.67	10-3 0.81	10-10 0.97	11-5 1.14	12-0 1.31	12-6 1.49	13-1 1.68
	24.0	5-1 0.15	5-11 0.24	6-7 0.33	7-3 0.43	7-10 0.54	8-4 0.67	8-10 0.79	9-4 0.93	9-9 1.07	10-3 1.22	10-8 1.38
2 x 10	12.0	9-3 0.22	10-8 0.33	11-11 0.46	13-1 0.61	14-1 0.77	15-1 0.94	16-0 1.12	16-10 1.31	17-9 1.51	18-6 1.72	19-3 1.94
	16.0	8-0 0.19	9-3 0.29	10-4 0.40	11-4 0.53	12-3 0.67	13-1 0.81	13-10 0.97	14-7 1.14	15-4 1.31	16-0 1.49	16-8 1.68
	24.0	6-6 0.15	7-6 0.24	8-6 0.33	9-3 0.43	10-0 0.54	10-8 0.67	11-4 0.79	11-11 0.93	12-6 1.07	13-1 1.22	13-7 1.38
2 x 12	12.0	11-3 0.22	13-0 0.33	14-6 0.46	15-11 0.61	17-2 0.77	18-4 0.94	19-6 1.12	20-6 1.31	21-6 1.51	22-6 1.72	23-5 1.94
	16.0	9-9 0.19	11-3 0.29	12-7 0.40	13-9 0.53	14-10 0.67	15-11 0.81	16-10 0.97	17-9 1.14	18-8 1.31	19-6 1.49	20-3 1.68
	24.0	8-0 0.15	9-2 0.24	10-3 0.33	11-3 0.43	12-2 0.54	13-0 0.67	13-9 0.79	14-6 0.93	15-3 1.07	15-11 1.22	16-7 1.38
(inches)	(inches)	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
2 x 6	12 0	11-10 2.17	12-3 2.41	12-8 2.65	13-1 2.91	13-6 3.17	13-10 3.43	14-2 3.71	14-6 3.99	14-10 4.28	15-3 4.57	15-7 4.88
	16.0	10-3 1.88	10-8 2.09	11-0 2.30	11-4 2.52	11-8 2.74	12-0 2.97	12-3 3.21	12-7 3.46	12-11 3.71	13-2 3.96	13-6 4.22
	24.0	8-5 1.54	8-9 1.71	9-0 1.88	9-3 2.06	9-6 2.25	9-9 2.44	10-0 2.63	10-3 2.83	10-6 3.04	10-9 3.24	11-0 3.46
2 x 8	12.0	15-8 2.17	16-2 2.41	16-9 2.65	17-3 2.91	17-9 3.17	18-3 3.43	18-9 3.71	19-2 3.99	19-7 4.28	20-1 4.57	20-6 4.88
	16.0	13-7 1.88	14-0 2.09	14-6 2.30	14-11 2.52	15-4 2.74	15-9 2.97	16-2 3.21	16-7 3.46	17-0 3.71	17-4 3.96	17-9 4.22
	24.0	11-1 1.54	11-6 1.71	11-10 1.88	12-3 2.06	12-6 2.25	12-11 2.44	13-3 2.63	13-7 2.83	13-11 3.04	14-2 3.24	14-6 3.46
2 x10	12.0	20-0 2.17	20-8 2.41	21-4 2.65	22-0 2.91	22-8 3.17	23-3 3.43	23-10 3.71	24-6 3.99	25-0 4.28	25-7 4.57	26-2 4.88
	16.0	17-3 1.88	17-11 2.09	18-6 2.30	19-1 2.52	19-7 2.74	20-2 2.97	20-8 3.21	21-2 3.46	21-8 3.71	22-2 3.96	22-8 4.22
	24.0	14-1 1.54	14-7 1.71	15-1 1.88	15-7 2.06	16-0 2.25	16-6 2.44	16-10 2.63	17-4 2.83	17-9 3.04	18-1 3.24	18-6 3.46
2x 12	12 0	24-3 2.17	25-2 2.41	26-0 2.65	26-9 2.91	27-7 3.17	28-3 3.43	29-0 3.71	29-9 3.99	30-5 4.28	31-2 4.57	31-10 4.88
	16.0	21-0 1.88	21-9 2.09	22-6 2.30	23-2 2.52	23-10 2.74	24-6 2.97	25-2 3.21	25-9 3.46	26-4 3.71	27-0 3.96	27-7 4.22
	24.0	17-2 1.54	17-9 1.71	18-4 1.88	18-11 2.06	19-6 2.25	20-0 2.44	20-6 2.63	21-1 2.83	21-7 3.04	22-0 3.24	22-6 3.46

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "*E*," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3608.2.4v
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
40 Lbs. per Sq. Ft. Live Load
For Use in Snow Load Zone 4

DESIGN CRITERIA: Strength-40 lbs. per sq. ft. live load plus 15 lbs. per sq. ft. dead load determines fiber stress. Deflection—For 35 lbs. per sq. ft. live load. Limited to span in inches divided by 180.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)										
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12.0	5-3 0.09	6-1 0.14	6-9 0.20	7-5 0.26	8-0 0.33	8-7 0.41	9-1 0.49	9-7 0.57	10-0 0.66	10-6 0.75	10-11 0.84
	16.0	4-6 0.08	5-3 0.12	5- 10 0.17	6-5 0.23	6- 11 0.29	7-5 0.35	7- 10 0.42	8-3 0.49	8-8 0.57	9- 1 0.65	9-5 0.73
	24.0	3-8 0.07	4-3 0.10	4-9 0.14	5-3 0.19	5-8 0.24	6-1 0.29	6-5 0.34	6-9 0.40	7-1 0.46	7-5 0.53	7-9 0.60
2 x 8	12.0	6-11 0.09	8-0 0.14	8-11 0.20	9-9 0.26	10-7 0.33	11-3 0.41	12-0 0.49	12-7 0.57	13-3 0.66	13-10 0.75	14-5 0.84
	16.0	6-0 0.08	6-11 0.12	7-9 0.17	8-6 0.23	9-2 0.29	9-9 0.35	10-4 0.42	10-11 0.49	11-6 0.57	12-0 0.65	12-6 0.73
	24.0	4-11 0.07	5-8 0.10	6-4 0.14	6-11 0.19	7-6 0.24	8-0 0.29	8-6 0.34	8-11 0.40	9-4 0.46	9-9 0.53	10-2 0.60
2 x 10	12.0	8-10 0.09	10-2 0.14	11-5 0.20	12-6 0.26	13-6 0.33	14-5 0.41	15-3 0.49	16-1 0.57	16-11 0.66	17-8 0.75	18-4 0.84
	16.0	7-8 0.08	8-10 0.12	9-10 0.17	10-10 0.23	11-8 0.29	12-6 0.35	13-3 0.42	13-1 1 0.49	14-8 0.57	15-3 0.65	15-11 0.73
	24.0	6-3 0.07	7-2 0.10	8-1 0.14	8-10 0.19	9-6 0.24	10-2 0.29	10-10 0.34	11-5 0.40	11-1 0.46	12-6 0.53	13-0 0.60
2 x 12	12.0	10-9 0.09	12-4 0.14	13-10 0.20	15-2 0.26	16-4 0.33	17-6 0.41	18-7 0.49	19-7 0.57	20-7 0.66	21-6 0.75	22-4 0.84
	16.0	9-3 0.08	10-9 0.12	12-0 0.17	13-1 0.23	14-2 0.29	15-2 0.35	16-1 0.42	17-0 0.49	17-9 0.57	18-7 0.65	19-4 0.73
	24.0	7-7 0.07	8-9 0.10	9-9 0.14	10-9 0.19	11-7 0.24	12-4 0.29	13-1 0.34	13-10 0.40	14-6 0.46	15-2 0.53	15-9 0.60
(inches)	**(inches)**	**1400**	**1500**	**1600**	**1700**	**1 800**	**1900**	**2000**	**2100**	**2200**	**2300**	**2400**
2 x 6	12 0	11-4 0.94	11-9 1.05	12-1 1.15	12-6 1.26	12-10 1.38	13-2 1.49	13-6 1.61	13-10 1.73	14-2 1.86	14-6 1.99	14-10 2.12
	16.0	9-10 0.82	10-2 0.91	10-6 1.00	10-10 1.09	11-1 1.19	11-5 1.29	11-9 1.40	12-0 1.50	12-4 1.61	12-7 1.72	12-10 1.83
	24.0	8-0 0.67	8-3 0.74	8-7 0.82	8-10 0.89	9-1 0.97	9-4 1.06	9-7 1.14	9-10 1.23	10-0 1.31	10-3 1.41	10-6 1.50
2 x8	12.0	14-11 0.94	15-5 1.05	16-0 1.15	16-5 1.26	16-11 1.38	17-5 1.49	17-10 1.61	18-3 1.73	18-9 1.86	19-2 1.99	19-7 2.12
	16.0	12-11 0.82	13-5 0.91	13-10 1.00	14-3 1.09	14-8 1.19	15-1 1.29	15-5 1.40	15-10 1.50	16-3 1.61	16-7 1.72	16-11 1.83
	24.0	10-7 0.67	10-11 0.74	11-3 0.82	11-8 0.89	12-0 0.97	12-4 1.06	12-7 1.14	12-11 1.23	13-3 1.31	13-6 1.41	13-10 1.50
2 x10	12.0	19- 1 0.94	19-9 1.05	20-4 1.15	21-0 1.26	21-7 1.38	22-2 1.49	22-9 1.61	23-4 1.73	23- 11 1.86	24-5 1.99	24-11 2.12
	16.0	16-6 0.82	17-1 0.91	17-8 1.00	18-2 1.09	18-9 1.19	19-3 1.29	19-9 1.40	20-2 1.50	20-8 1.61	21-2 1.72	21-7 1.83
	24.0	13-6 0.67	13-11 0.74	14-5 0.82	14-10 0.89	15-3 0.97	15-8 1.06	16-1 1.14	16-6 1.23	16-11 1.31	17-3 1.41	17-8 1.50
2x 12	12 0	23-2 0.94	24-0 1.05	24-9 1.15	25-6 1.26	26-3 1.38	27-0 1.49	27-8 1.61	28-4 1.73	29-1 1.86	29-9 1.99	30-4 2.12
	16.0	20-1 0.82	20-9 0.91	21-5 1.00	22-1 1.09	22-9 1.19	23-4 1.29	24-0 1.40	24-7 1.50	25-2 1.61	25-9 1.72	26-3 1.83
	24.0	16-4 0.67	17-0 0.74	17-6 0.82	18-1 0.89	18-7 0.97	19-1 1.06	19-7 1.14	20-1 1.23	20-6 1.31	21-0 1.41	21-5 1.50

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "*E*," in 1,000,000 pounds per square inch is shown below each span.

TABLE 802.4w
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
40 Lbs. per Sq. Ft. Live Load (Supporting Gypsum Ceiling)
For Use in Snow Load Zone 4

DESIGN CRITERIA: Strength—15 lbs. per sq. ft. dead load plus 40 lbs. per sq. ft. live load determines fiber stress. Deflection—For 40 lbs. per sq. ft. live load. Limited to span in inches divided by 240.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, *'Fb,"* (psi)										
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 6	12.0	5-3 0.12	6-1 0.19	6-9 0.27	7-5 0.35	8-0 0.44	8-7 0.54	9-1 0.65	9-7 0.76	10-0 0.88	10-6 1.00	10-11 1.13
	16.0	4-6 0.11	5-3 0.17	5-10 0.23	6-5 0.31	6-11 0.39	7-5 0.47	7-10 0.56	8-3 0.66	8-8 0.76	9-1 0.86	9-5 0.98
	24.0	3-8 0.09	4-3 0.14	4-9 0.19	5-3 0.25	5-8 0.31	6-1 0.38	6-5 0.46	6-9 0.54	7-1 0.62	7-5 0.71	7-9 0.80
2 x 8	12.0	6-11 0.12	8-0 0.19	8-11 0.27	9-9 0.35	10-7 0.44	11-3 0.54	12-0 0.65	12-7 0.76	13-3 0.88	13-10 1.00	14-5 1.13
	16.0	6-0 0.11	6- 11 0.17	7-9 0.23	8-6 0.31	9-2 0.39	9-9 0.47	10-4 0.56	10- 11 0.66	11 -6 0.76	12-0 0.86	12-6 0.98
	24.0	4-11 0.09	5-8 0.14	6-4 0.19	6-11 0.25	7-6 0.31	8-0 0.38	8-6 0.46	8-11 0.54	9-4 0.62	9-9 0.71	10-2 0.80
2x 10	12.0	8-10 0.12	10-2 0.19	11-5 0.27	12-6 0.35	13-6 0.44	14-5 0.54	15-3 0.65	16-1 0.76	16-11 0.88	17-8 1.00	18-4 1.13
	16.0	7-8 0.11	8-10 0.17	9-10 0.23	10-10 0.31	11-8 0.39	12-6 0.47	13-3 0.56	13-11 0.66	14-8 0.76	15-3 0.86	15-11 0.98
	24.0	6-3 0.09	7-2 0.14	8-1 0.19	8-10 0.25	9-6 0.31	10-2 0.38	10-10 0.46	11-5 0.54	11-11 0.62	12-6 0.71	13-0 0.80
2 x 12	12.0	10-9 0.12	12-5 0.19	13- 10 0.27	15-2 0.35	16-5 0.44	17-6 0.54	18-7 0.65	19-7 0.76	20-6 0.88	21 -5 1.00	22-4 1.13
	16.0	9-3 0.11	10-9 0.17	12-0 0.23	13-2 0.31	14-2 0.39	15-2 0.47	16-1 0.56	17-0 0.66	17-9 0.76	18-7 0.86	19-4 0.98
	24.0	7-7 0.09	8-9 0.14	9-10 0.19	10-9 0.25	11-7 0.31	12-5 0.38	13-2 0.46	13-10 0.54	14-6 0.62	15-2 0.71	15-9 0.80
(inches)	(inches)	1400	1500	1600	1700	1 800	1900	2000	2100	2200	2300	2400
2 x 6	120	11-4 1.26	11-9 1.40	12-1 1.54	12-6 1.68	12-10 1.83	13-2 1.99	13-6 2.15	13-10 2.31	14-2 2.48	14-6 2.65	14-10 2.82
	16.0	9-10 1.09	10-2 1.21	10-6 1.33	10-10 1.46	11-1 1.59	11-5 1.72	11-9 1.86	12-0 2.00	12-4 2.15	12-7 2.29	12-10 2.45
	24.0	8-0 0.89	8-3 0.99	8-7 1.09	8- 10 1.19	9- 1 1.30	9-4 1.41	9-7 1.52	9- 10 1.63	10-0 1.75	10-3 1.87	10-6 2.00
2 x 8	12.0	14-11 1.26	15-5 1.40	16-0 1.54	16-5 1.68	16-11 1.83	17-5 1.99	17-10 2.15	18-3 2.31	18-9 2.48	19-2 2.65	19-7 2.82
	16. 0	12-11 1.09	13-5 1.21	13-10 1.33	14-3 1.46	14-8 1.59	15-1 1.72	15-5 1.86	15-10 2.00	16-3 2.15	16-7 2.29	16-11 2.45
	24.0	10-7 0.89	10-11 0.99	11-3 1.09	11-8 1.19	12-0 1.30	12-4 1.41	12-7 1.52	12-11 1.63	13-3 1.75	13-6 1.87	13-10 2.00
2x 10	12.0	19- 1 1.26	19-9 1.40	20-4 1.54	21 -0 1.68	21 -7 1.83	22-2 1.99	22-9 2.15	23-4 2.31	23-11 2.48	24-5 2.65	25-0 2.82
	16.0	16-6 1.09	17-1 1.21	17-8 1.33	18-2 1.46	18-9 1.59	19-3 1.72	19-9 1.86	20-2 2.00	20-8 2.15	21-2 2.29	21-7 2.45
	24.0	13-6 0.89	13-11 0.99	14-5 1.09	14-10 1.19	15-3 1.30	15-8 1.41	16-1 1.52	16-6 1.63	16-11 1.75	17-3 1.87	17-8 2.00
2x 12	12.0	23-2 1.26	24-0 1.40	24-9 1.54	25-6 1.68	26-3 1.83	27-0 1.99	27-8 2.15	28-5 2.31	29- 1 2.48	29-9 2.65	30-4 2.00
	16.0	20- 1 1.09	20-9 1.21	21 -5 1.33	22- 1 1.46	22-9 1.59	23-5 1.72	24-0 1.86	24-7 2.00	25-2 2.15	25-9 2.29	26-3 2.45
	24.0	16-5 0.89	17-0 0.99	17-6 1.09	18- 1 1.19	18-7 1.30	19- 1 1.41	19-7 1.52	20- 1 1.63	20-6 1.75	21-0 1.87	21 -5 2.00

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0 0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

TABLE 3408.2.4x
ALLOWABLE SPANS FOR LOW OR HIGH SLOPE RAFTERS
40 Lbs. per Sq. Ft. Live Load (Supporting Veneer Plaster Ceiling)
For Use in Snow Load Zone 4

DESIGN CRITERIA: Strength—15 lbs. per sq. fl. dead load plus 40 lbs. per sq. fl. live load determines fiber stress. Deflection—For 40 lbs. per sq. fl. live load. Limited to span in inches divided by 360.
RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.
HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SPACING AND SIZE		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "*Fb*," (psi)									
(inches)	**(inches)**	**300**	**400**	**500**	**600**	**700**	**300**	**900**	**1000**	**1100**	**1200**
2x6	12.0	5-3 0.19	6-1 0.29	6-9 0.40	7-5 0.53	8-0 0.67	8-7 0.82	9-1 0.97	9-7 1 14	10-0 1 31	10-6 1 50
	16 0	4-6 0.16	5-3 025	5-10 035	6-5 046	6-1 1 058	7-5 071	7-10 084	8-3 099	8-8 1 14	9-1 1 30
	24.0	3-8 0.13	4-3 0.20	4-9 0.28	5-3 0.37	5-8 0.47	6-1 0.58	6-5 0.69	6-9 0.81	7-1 0.93	7-5 1.06
2x8	12.0	6-11 0.19	8-0 0.29	8-11 0.40	9-9 0.53	10-7 0.67	11-3 0.82	12-0 0.97	12-7 1.14	13-3 1.31	13-10 1.50
	16.0	6-0 0.16	6-11 0.25	7-9 0.35	8-6 0.46	9-2 0.58	9 9 0.71	104 0.84	10-11 0.99	11-6 1.14	12-0 1.30
	24.0	4-11 0.13	5-8 0.20	6-4 0.28	6-11 0.37	7-6 0.47	8-0 0.58	8-6 0.69	8-11 0.81	9-4 .093	9-9 1.06
2x 10	12.0	8-10 0.19	10-2 0.29	115 040	12-6 053	13-6 067	14-5 082	15-3 097	16-1 1 14	16-11 1 31	17-8 1 50
	16.0	7-8 0.16	8-10 0.25	9-10 0.35	10-10 0.46	11-8 0.58	12-6 0.71	13-3 0.84	13-1 1 0.99	14-8 1 14	15-3 1.30
	24.0	6-3 0.1 3	7-2 0.20	8-1 0.28	8-10 0.37	9-6 0.47	10-2 0.58	10-10 0.69	11-5 0.8 1	11-11 0.93	12-6 1.06
2x 12	12.0	10-9 0.19	12-5 0.29	13-10 0.40	15-2 0.53	16-5 0.67	17-6 0.82	18-7 0.97	19-7 1.14	20-6 1.31	21-5 1.50
	16.0	9-3 0.16	10-9 0.25	12-0 0.35	13-2 0.46	14-2 0.58	15-2 0.71	16-1 0.84	17-0 0.99	17-9 1.14	18-7 1 30
	24 0	7-7 0.13	8-9 0.20	9-10 0.28	10-9 0..37	1 1-7 0.47	12-5 0.58	13-2 0.69	13-10 0.81	14-6 0.93	15-2 1.06
(inches)	**(inches)**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**
2 x 6	12.0	10-11 1.69	11-4 1.89	11-9 2.09	12-1 2.31	12-6 2.53	12-10 2.75	13-2 2.98	13-6 3.22	13-10 3.47	14-2 3.72
	16.0	9-5 1.46	9-10 1.63	10-2 1.81	10-6 2.00	10-10 2.19	11-1 2.38	11-5 2.58	11-9 2.79	12-0 3.00	12-3 3.22
	24.0	7-9 1.19	8-0 1.33	8-3 1.48	8-7 1.63	8-10 1.79	9-1 1.95	9-4 2.11	9-7 2.28	9-10 2.45	10-0 2.63
2 x 8	12.0	14-5 1.69	14-11 1.89	15-5 2.09	16-0 2.31	16-5 2.53	16-11 2.75	17-5 2.98	17-10 3.22	18-4 3.47	18-9 3.72
	16.0	12-6 1.46	12-11 1.63	13-5 1.81	13-10 2.00	14-3 2.19	14-8 2.38	15-1 2.58	15-6 2.79	15-10 3.00	16-2 3.22
	24.0	10-2 1.19	10-7 1.33	10-11 1.48	11-3 1.63	11-8 1.79	12-0 1.95	12-4 2.11	12-7 2.28	12-11 2.45	13-3 2.63
2x 10	12.0	18-4 1.69	19-1 1.89	19-9 2.09	20-4 2.31	21-0 2.53	21-7 2.75	22-2 2.98	22-9 3.22	23-4 3.47	23-10 3.72
	16.0	15-11 1.46	16-6 1.63	17-1 1.81	17-8 2.00	18-2 2.19	18-9 2.38	19-3 2.58	19-9 2.79	20-2 3.00	20-8 3.22
	24.0	13-0 1.19	13-6 1.33	13-11 1.48	14-5 1.63	14-10 1.79	15-3 1.95	15-8 2.11	16-1 2.28	16-6 2.45	16-10 2.63
2 x 12	12 0	22-4 1.69	23-2 1.89	24-0 2.09	24-9 2.31	25-6 2.53	26-3 2.75	27-0 2.98	27-9 3.22	28-4 3.47	29-1 3.72
	16.0	19-4 1.46	20- 1 1.63	20-9 1.81	21-5 2.00	22- 1 2.19	22-9 2.38	23-5 2.58	24-0 2.79	24-7 3.00	25-2 3.22
	24.0	15-9 1.19	16-5 1.33	17-0 1.48	17-6 1.63	18-1 1.79	18-7 1.95	19-1 2.11	19-7 2.28	20-1 2.45	20-6 2.63

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m2.
NOTE: The modulus of elasticity, "E," in 1,000,000 pounds per square inch is shown below each span.

NON-TEXT PAGE

ROOF COVERINGS

3609.1 GENERAL

3609.1.1 Application: The provisions of 780 CMR 3609.1 shall control the design and construction of roof coverings for all buildings. Roof coverings shall be listed for their intended use. Materials for which listing is not available shall be required to be approved by the ***State Board of Building Regulations and Standards in accordance with 780 CMR 109.3.4.***

3609.1.2 Requirements: The roof covering shall be capable of accommodating the loads indicated in ***780 CMR 3603.1*** and provide a barrier against the weather to protect supporting elements and the structure beneath.

3609.1.3 Roofing covering materials: Roofs shall be covered with materials as set forth in ***780 CMR 3609.3 through 3609.9.*** Classified roofing shall conform to UL 790, ***as listed in Appendix A,*** shall be installed when the edge of the roof is less than three feet (914 mm) from a property line ***or as required by city or town ordinance or bylaw.*** The roofing materials set forth in ***780 CMR 3609.4 through 3609.6*** and concrete slabs may be accepted as Class A roofing.

780 CMR 3609.2 DECK PREPARATION

3609.2.1 Supporting construction: Roofing shall be applied only when the supporting roof construction is clean and dry.

3609.2.2 Single layer underlayment: When a single ply of underlayment is required, it shall be laid parallel to the eaves with a two-inch (51 mm) top lap and four-inch (102 mm) end lap nailed sufficiently to hold in place.

3609.2.3 Multiple layer underlayment: When two layers of underlayment are required, they shall be laid shingle fashion parallel to the eaves with 19-inch (483 mm) top lap and 12-inch (305 mm) end lap, with end laps located at least six feet (1829 mm) from end laps in the preceding course, and blind nailed sufficiently to hold in place.

780 CMR 3609.3 ASPHALT SHINGLES

3609.3.1 General: Asphalt shingles shall be applied only to solidly sheathed roofs Asphalt shingles shall be applied according to the manufacturer's printed instructions and 780 CMR 36.

3609.3.2 Slopes of four units vertical in 12 units horizontal (33% slope) or greater: Asphalt shingle roofs shall have an underlayment of not less than one ply of No. 15 felt, applied as required in ***780 CMR 3609.2*** and Table ***3609.3.4.***

3609.3.3 Slopes less than four units vertical in 12 units horizontal (33% slope) but not less than two units vertical in 12 units horizontal (17% slope): Nominally double-coverage asphalt shingles may be installed on slopes as low as two units vertical in 12 units horizontal (17% slope), provided the shingles are approved self-sealing shingles or are hand sealed and are installed with an underlayment consisting of two layers of No. 15 felt, applied as required in ***780 CMR 3609.2*** and Table ***3609.3.4.*** The two layers of felt shall be cemented together, in addition to the required nailing, from the eaves up the roof to overlie a point 24 inches (610 mm) inside the interior wall line of the building. Asphalt shingles shall not be used on roofs with slopes less than two units vertical in 12 units horizontal (17% slope).

3609.3.4 Fasteners: Asphalt shingles shall be fastened according to the manufacturer's printed instructions and Table ***3609.3.4.***

3609.3.5 Valley flashing: Roof valleys shall be flashed by one of the methods listed in ***780 CMR 3609.3.5.1 through 3609.3.5.3.*** Asphalt shingles shall be applied according to the manufacturer's printed instructions.

3609.3.5.1 Sheet metal: Open roof valleys may be provided of not less than No. 28 gage galvanized corrosion-resistant sheet metal and shall extend at least eight inches (203 mm) from the center line each way. Sections of flashing shall be jointed to provide an adequate water lock.

TABLE 3609.3.4
ASPHALT SHINGLE APPLICATION

ROOF OF SLOPE	NOT PERMITTED BELOW 2:12	
	2:12 to less than 4:12	4:12 and over
DECK REQUIREMENT	Asphalt shingles shall be fastened to solidly sheathed roofs. Sheathing shall conform to Tables 3605.3.2.1.1a and 3608.3.3.2	
UNDERLAYMENT Temperate climate	Asphalt strip shingles may be installed on slopes as low as two inches in twelve inches, provided the shingles are approved self-sealing or are hand sealed and are installed with an underlayment consisting of two layers of nonperforated Type 15 felt applied shingle fashion. Starting with an 18-inch-wide sheet and a 36-inch-wide sheet over the eaves, each subsequent sheet shall be lapped 19 inches horizontally.	One layer nonperforated Type 15 felt lapped two inches horizontally and four inches vertically to shed water.
Severe climate: In areas subject to wind-driven snow or roof ice buildup.	Same as for temperate climate, and additionally the two layers shall be solid cemented together with approved cementing material between the plies extending from the eave up the roof to a line 24 inches inside the exterior wall line of the building.	One layer nonperforated Type 15 felt lapped two inches horizontally and four inches vertically to shed water.
ATTACHMENT Type of fasteners	Corrosion-resistant nails, minimum 12-gage 3/8-inch head, or approved corrosion-resistant staples, minimum 16-gage $^{15}/_{16}$-inch-crown width.	
	Fasteners shall be long enough to penetrate into the sheathing ¾ inch or through the thickness of the sheathing, whichever is less.	
No. of fasteners[1]	four per 36-40 inch strip two per nine-18-inch strip	
Exposure Field of roof	Per manufacturer's instructions included with packages of shingles.	
Hips and ridges	Hip and ridge weather exposures shall not exceed those permitted for the field of the roof	
Method	Per manufacturer's instructions included with packages of shingles.	
FLASHINGS Valleys Other buildings	 Per 780 CMR 3609.3.5 Per 780 CMR 3609.3.6 and 3609.3.7	

For SI: 1 inch = 25.4 mm.
1. Figures shown are for normal application. For special conditions such as mansard application and where roofs are in special wind regions, shingles shall be attached per manufacturer's instructions.

3609.3.5.2 Roll roofing: Woven or closed valleys may be constructed by centering 36-inch-wide (914 mm) roll roofing material not less than Type 50 in the valley over the underlayment.

3609.3.5.3 Multiple layer flashing: Roof valley flashing may be of laced composition shingles, applied in an approved manner, with an underlay not less than 30-pound (14 kg) felt extending ten inches (254 mm) from the center line each way, or shall be of two layers of 90-pound (41 kg) mineral-surfaced cap sheet cemented together with the bottom layer not less than 12 inches (305 mm) wide laid face down and the top layer not less than 24 inches (610 mm) wide laid face up.

3609.3.6 Side wall flashing: Flashing against a vertical sidewall shall be by the step-flashing method.

Exception: Other methods shall be permitted when installed in accordance with the shingle manufacturer's printed instructions.

3609.3.7 Other flashing: Flashings against vertical front wall, as well as soil stack, vent pipe and chimney flashing, shall be applied according to asphalt shingle manufacturer's printed instructions.

3609.3.8 Hips and ridges: Hip and ridge shingles shall be fastened according to the manufacturer's printed instructions and Table *3609.3.4.*

780 CMR 3609.4 SLATE SHINGLES

3609.4.1 General: Slate shingles shall be applied in an approved manner and securely fastened with corrosion-resistant nails or corrosion-resistant nails and wire.

3609.4.2 Slate shingles: Slate shingles shall conform to ASTM C406 as listed in Appendix A. Slate shingles shall not be installed on roof slopes below two units vertical in 12 units horizontal (2:12). Double-layer No. 15 felt underlayment shall be required on roof slopes below four units vertical in 12 units horizontal (4:12). Single-layer No. 15 felt underlayment shall be required on all other roof slopes. Slate shingles shall be secured to the roof with two fasteners per slate. The minimum slate headlap shall be three inches (76 mm).

3609.4.3 Valleys: Roof valley flashing shall be provided of not less than No. 28 gage galvanized corrosion-resistant sheet metal and shall extend at least 11 inches (279 mm) from the center line each

way and shall have a splash diverter rib not less than one inch (25 mm) high at the flow line formed as part of the flashing. Sections of flashing shall have an end lap of not less than six inches (153 mm) and shall be provided with an adequate water lock.

780 CMR 3609.5 METAL

3609.5.1 General: Flat sheets or shingles shall be applied only to solid sheathed roofs. Metal roofing shall be applied in an approved manner ***consistent with the manufacturer's recommendations***.

3609.5.2 Materials: Metal roofing shall conform to AA ASM 35, or ARTM A 361 or PS 209, ***as listed in Appendix A***.

3609.5.3 Metal shingles: Metal shingles shall not be installed on roof slopes below four units vertical in 12 units horizontal (4:12). Single-layer underlayment of No. 15 felt is required for all metal shingles other than flat metal shingles on all roof slopes.

780 CMR 3609.6 TILE, CLAY OR CONCRETE SHINGLES

3609.6.1 Attachment: All roof tile shall be securely fastened with corrosion-resistant nails or corrosion-resistant nails and wire, or other approved means.

3609.6.2 Interlocking clay or cement tile: Interlocking clay or cement tile shall be installed only over solid sheathing or spaced structural sheathing boards. Interlocking clay or cement tile shall not be installed on roof slopes below four units vertical in 12 units horizontal (4:12). Horizontal battens shall be required on roof slopes over seven units vertical in 12 units horizontal (7:12). Single-layer underlayment is required over solid sheathing on all roof slopes. Reinforced underlayment shall be required where spaced sheathing is installed. Regardless of roof slope, the first three tile courses and all tile within three feet (914 mm) of roof edges, changes in roof slope or changes in slope direction, shall be fastened to the roof. For the field of the roof, fastening is not required on roof slopes below five units vertical in 12 units horizontal (5:12); every tile course shall be fastened on roof slopes five units vertical in 12 units horizontal (5:12) to less than 12 units vertical in 12 units horizontal (12:12); and every tile shall be fastened on roof slopes 12 units vertical in 12 units horizontal (12:12) and over. Tile overlap shall be in accordance with approved manufacturer's installation instructions.

3609.6.3 Noninterlocking clay or cement tile: Noninterlocking clay or cement tile shall not be installed on roof slopes below 2½ units vertical in 12 units horizontal (2½:12). Double-layer underlayment is required on roof slopes below three units vertical in 12 units horizontal (3:12). Single-layer underlayment is required on all other roof slopes. Noninterlocking clay or cement tile shall be secured to the roof with two fasteners per tile. The minimum tile overlap shall be three inches (76 mm).

3609.6.4 Tile lugs: Tile with projection anchor lugs at the bottom of the tile shall be held in position by means of one-inch-by-two-inch wood (25 mm by 51 mm) stripping, treated to resist moisture deterioration, nailed to the roof sheathing over the underlayment or other approved means.

3609.6.5 Nailing and flashing: Nailing and valley flashing shall be the same as required for slate shingles.

780 CMR 3609.7 BUILT-UP ROOFING

3609.7.1 Decking: Built-Up roofing shall be applied only to solid surface roof decks.

3609.7.2 Materials: Built-Up roofing shall conform to UL 55A ***as listed in Appendix A***.

3609.7.3 Underlayment: An underlayment of one layer sheathing paper is required under built-up roofing assemblies when the roof deck is constructed of sheathing boards Underlayment is to be applied as specified in ***780 CMR 3609.2***.

3609.7.4 Base ply: On nailable decks, a base ply is to be fastened to the deck in accordance with the manufacturer's published specifications and Table **3609.3.4**.

3609.7.4.1 Nonnailable decks: On nonnailable decks, cast-in-place concrete or precast concrete, a base ply required by manufacturer's specification shall be cemented or spot mopped to a primed deck as required by the type of deck material, using not less than 20 pounds (9.1 kg) per square of hot asphalt for solid mopping, or not less than ten pounds (4.5 kg) per square for spot mopping, or not less than 1½ gallons (5.7 L) per square of cold bituminous compound, or 25 pounds (11 kg) per square of coal-tar pitch, in accordance with the manufacturer's published specifications. If a base ply is not used, a minimum of three roofing plies applied shingle fashion shall be solidly cemented to the primed deck and cemented together, using no less cementing material than that specified for a solidly cemented base ply.

3609.7.4.2 Insulated decks: On insulated decks, a vapor retarder shall be installed between the deck and the insulation. Insulation shall be of a rigid type suitable for application of a roof covering. The insulation must be properly attached using mechanical fasteners Type II or Type III asphalt in accordance with ASTM D 312, ***as listed in Appendix A***, and installed in

accordance with the manufacturer 's published ply specifications. The insulation may be taped if required. A base ply required by the manufacturer's specification shall be solidly cemented to the insulation, using no less cementing material than that specified for a solidly cemented base ply to a primed nonnailable deck. If a base ply is not used, a minimum of three roofing plies applied shingle fashion shall be solidly cemented to the insulation and cemented together, using no less cementing material than that specified for a solidly cemented base ply.

3609.7.5 Membrane over base ply: A minimum of two successive layers of roofing plies shall be solidly cemented shingle fashion to the base ply, using no less cementing material than that specified for a solidly cemented base ply.

3609.7.6 Surfacing: The built-up roofing assembly shall be surfaced by one of the methods described in ***780 CMR 3609.7.6.1 and 3609.7.6.2.***

3609.7.6.1 Mineral aggregate roofs: Mineral aggregate surfaced roofs shall be surfaced with not less than 60 pounds (27 kg) of hot asphalt or 75 pounds (34 kg) of coal-tar pitch in which is embedded not less than 400 pounds (181 kg) of gravel or 300 pounds (136 kg) of crushed slag per roofing square.

3609.7.6.2 Mineral-surfaced cap roofs: Mineral-surfaced cap sheets shall be cemented to the roofing plies using no less cementing material than specified for between the plies.

780 CMR 3609.8 WOOD SHINGLES

3609.8.1 Sheathing requirements: Wood shingles shall be applied to roofs with solid or spaced sheathing. Spaced sheathing boards shall not be less than one inch by four inch (25 mm by 102 mm) nominal dimensions and shall be spaced on centers a distance equal to the actual weather exposure of the shingles, not to exceed the dimensions set forth in Table ***3609.8 3.3.***

3609.8.2 Materials: Wood shingle roofing shall conform to CSSB "Grading and Packing Rules for Centigrade Red Cedar Shingles," ***as listed in Appendix A.***

3609.8.3 Installation: Wood shingles shall be laid with a side lap of not less than 1½ inches (38 mm). Joints in adjacent courses shall be offset a minimum of 1½ inches (38 mm) and no two joints in alternate courses shall be in direct alignment. Spacing between shingles shall not be less than ¼ inch (6.4 mm) or more than ⅜ inch (9.5 mm). Wood shingles shall be fastened to the sheathing in accordance with Table ***3609.8.3.***

3609.8.3.1 Roof slope: Shingles shall not be installed on a roof having a slope less than three units vertical in 12 units horizontal (25% slope) On roofs having slopes of three units vertical in 12 units horizontal (25% slope) and seven inches (178 mm) from the center line each way for slopes of 12 inches (305 mm) to less than four units vertical in 12 units horizontal (33% slope), shingles shall be installed with reduced exposures or they shall be installed over an underlayment of not less than one ply of No. 15 felt, applied as required in ***780 CMR 3609.2.***

3609.8.3.2 Valley flashing: Roof valley flashing shall not be less than No. 28 gage corrosion-resistant sheet metal and shall extend ten inches (254 mm) from the center line each way for roofs having slopes less than 12 units vertical in 12 units horizontal (100% slope) and greater. Sections of flashing shall have an end lap of not less than four inches (102 mm).

3609.8.3.3 Weather exposure: Weather exposures shall not exceed those set forth in Table ***3609.8.3.3.*** Hip and ridge weather exposures shall not exceed those permitted for the field of the roof. Wood shingle hip and ridge units shall conform to CSSB "Grading Rules for Shake Hip and Ridge based on the Standards of the Cedar Shake and Shingle Bureau," ***as listed in Appendix A.*** Nails used to fasten hip and ridge units shall be longer than those used in the field of the roof in order to penetrate the sheathing ¾-inch (19 mm) minimum.

3609.8.3.4 Label required: Each bundle of shingles shall be identified by a label of an approved grading or inspection bureau or agency.

780 CMR 3609.9 WOOD SHAKES

3609.9.1 Sheathing requirements: Wood shakes shall be applied to roofs with solid or spaced sheathing. Spaced sheathing boards shall not be less than one-inch-by-by-inch (25 mm by 102 mm) nominal dimensions for shakes installed at maximum 7½-inch (190 mm) exposures and shall be spaced on centers a distance equal to the actual weather exposure of the shakes, not to exceed the dimensions set forth in Table ***3609.8.3.3.*** For 24-inch (610 mm) shakes used in ten-inch (254 mm) exposure, the spaced sheathing shall be either one-inch-by-four-inch (25 mm by 102 mm) nominal dimension board spaced on centers a distance equal to the weather exposure with an additional one-inch-by-four-inch (25 mm by 102 mm) board placed between these boards, or one-inch-by-six-inch (25 mm by 153 mm) nominal dimension boards spaced on centers a distance equal to the weather exposure. The shakes shall be applied over an underlayment as required in Table ***3609.8.3.***

TABLE 3609.8.3
WOOD SHINGLE OR SHAKE APPLICATION

ROOF SLOPE	WOOD SHINGLES Not permitted below 3:12 See Table 3609.8.3.3	WOOD SHAKES Not permitted below 4:12[1] See Table 3609.8.3.3
DECK REQUIREMENT	Wood shingles shall be applied to roofs having solid or spaced sheathing in accordance with 780 CMR 3609.8.1	Wood shakes shall be applied to roofs having solid or spaced sheathing in accordance with 780 CMR 3609.9.1
UNDERLAYMENT Temperate climate	No Requirements	One 18-inch-wide interlayment of Type 30 felt shingled between each course in such a manner that no felt is exposed to the weather below the shake butts.
Severe climate: In areas subject to roof ice buildup.	Two layers of nonperforated Type 15 felt applied shingle fashion shall be installed and solid cemented together with approved cementing material between the plies extending from the eaves to a line 36 inches inside the exterior wall line of the building.	Sheathing shall be solid and the shakes shall be applied over a layer of nonperforated Type 15 felt applied shingle fashion. Two layers of nonperforated Type 15 felt applied shingle fashion shall be installed and solid cemented together with approved cementing material between the plies extending from the eaves up the roof to a line 36 inches inside the exterior wall line of the building.
ATTACHMENT Type of fasteners	Corrosion-resistant nails, minimum No. 14 ½-gage, $^{7}/_{32}$-inch head, or corrosion-resistant staples when approved by the building official.	Corrosion-resistant nails, minimum No. 13-gage, $^{7}/_{32}$-inch head, or corrosion-resistant staples when approved by the building official.
	Fasteners shall be long enough to penetrate into the sheathing ¾ inch or through the thickness of the sheathing, whichever is less.	
No. of fasteners	two per shingle	two per shake
Exposure Field of roof Hips and ridges	Weather exposures shall not exceed those set forth in Table 3609.8.3.3. Hip and ridge weather exposures shall not exceed those permitted for the field of the roof.	
Method	Shingles shall be laid with a side lap of not less than 1½ inches between joints in adjacent courses, and not in direct alignment in alternate courses. Spacing between shingles shall be approximately ¼ inch. Each shingle shall be fastened with two nails only, positioned approximately ¾ inch from each edge and approximately one inch above the exposure line. Starter course at the eaves shall be doubled.	Shakes shall be laid with a side lap of not less than 1½ inches between joints in adjacent courses. Spacing between shakes shall not be less than ⅛ inch or more than ⅝ inch except for preservative-treated wood shakes which shall have a spacing not less than ¼ inch or more than ⅜ inch. Shakes shall be fastened to the sheathing with two nails only, positioned approximately one inch from each edge and approximately two inches above the exposure line. The starter course at the eaves shall be doubled. The bottom or first layer may be either shakes or shingles. 15-inch or 18-inch shakes may be used for the starter course at the eaves and final course at the ridge.
FLASHINGS Valleys Other flashings	Per 780 CMR 3609.8.3.2 and 3609.9.3.3 Per accepted practice.	

For SI: 1 inch = 25.4 mm.

1. When approved by the building official, wood shakes may be installed on a slope of not less than three units vertical in 12 units horizontal (25% slope) when underlayment of not less than nonperforated Type 15 felt is installed.

TABLE 3609.8.3.3
WOOD SHINGLE AND SHAKE MAXIMUM WEATHER EXPOSURES

GRADE	LENGTH (inches)	LESS THAN 4' in 12" (inches) (Minimum 3" in 12" Permitted)	4" IN 12" AND STEEPER (inches)
WOOD SHINGLES			
No. 1	16	3¾	5
No. 2[1]	16	3½	4
No. 3[1]	16	3	3½
No. 1	18	4¼	5½
No. 2[1]	18	4	4½
No. 3[1]	18	3½	4
No. 1	24	5¾	7½
No. 2[1]	24	5½	6½
No. 3[1]	24	5	5½
WOOD SHAKES[2]			
No. 1	18	7½	7½
No. 2	18[3]	Not Permitted	5½
No. 1	24	10	10
No. 2	24[3]	Not Permitted	7½

For SI: 1 inch = 25.4 mm.
1. To be used only when specifically permitted by the building official.
2. Exposure of 24-inch resawn handsplit shakes shall not exceed 7½ inches regardless of the roof slope.
3. No. 2 grade wood shakes pertain to Taper-sawn shakes only.

3609.9.2 Materials: Wood shake shall conform to CSSB "Grading and Packing Rules for Certi-Split Red Cedar Shakes" or "Grading Rules for Certi-Sawn Taper-Sawn Cedar Shakes," ***each as listed in Appendix A.***

3609.9.3 Installation: Preservative treated wood shakes shall conform to CSSB "Wood Shakes (Preservative Treated) based on Grading and Packing Rules for Treated Southern Pine Taper Sawn Shakes of the Cedar Shake and Shingle Bureau," ***as listed in Appendix A***. Wood shakes shall be fastened to the sheathing in accordance with Table ***3609.8.3***.

3609.9.3.1 Shake and shingle placement: The starter course at the eaves shall be doubled and the bottom layer shall be either 15-, 18- or 24-inch (381, 457 or 610 mm) wood shakes or wood shingles. Fifteen-inch (381 mm) or 18-inch (457 mm) wood shakes may be used for the final course at the ridge. Shakes shall be interlaid with 18-inch-wide (451 mm) strips of not less than No. 30 felt shingled between each course in such a manner that no felt is exposed to the weather by positioning the lower edge of each felt strip above the butt end of the shake it covers a distance equal to twice the weather exposure.

3609.9.3.2 Roof slope: Shakes shall not be installed on a roof having a slope less than four units vertical in 12 units horizontal (33% slope) unless they are installed over an underlayment of not less than No. 15 felt, applied as required in ***780 CMR 3609.2***.

3609.9.3.3 Valley flashing: Roof valley flashing shall not be less than No. 28 gage corrosion-resistant sheet metal and shall extend at least 11 inches (279 mm) from the center line each way. Sections of flashing shall have an end lap of not less than four inches (102 mm).

3609.9.3.4 Weather exposure: Weather exposures shall not exceed those set forth in Table ***3609.8.3.3***. Hip and ridge weather exposures shall not exceed those permitted for the field of the roof. Wood shake hip and ridge units shall conform to CSSB "Grading Rules for Shake Hip and Ridge based on the Standards of the Cedar Shake and Shingle Bureau," ***as listed in Appendix A***. Nails used to fasten hip and ridge units shall be longer than those used in the field of the roof in order to penetrate the sheathing ¾ inch (19 mm) minimum.

3609.9.3.5 Label Required: Each bundle of shakes shall be identified by a label of an approved grading or inspection bureau or agency.

780 CMR 3609.10 REROOFING

3609.10.1 General: Materials and methods used for repair, replacement or recovering an existing roof shall comply with ***780 CMR 3601.17 and 3609.1.1***. When the repair replacement or recovering within any 12-month period exceeds 25% of the roof covering of the building, the entire roof covering shall comply with the requirements for new roofing.

3609.10.2 Structural and construction loads: The existing roof system shall be capable of supporting all equipment loads encountered during installation as well as the loads resulting from the new roofing materials.

3609.10.3 Recovering vs. replacement: New roof covering shall not be installed without first removing existing roof coverings when any of the following conditions occur:

1. When the existing roof or roof covering is water soaked or deteriorated to the point of being unacceptable as a base for additional roofing.
2. When the existing roof covering is wood shake, slate, clay or cement tile; except when the new roof covering is installed in accordance with approved industry standards.
3. When the existing roof has three or more layers of any type of roofing.

Exception: The removal of existing roof coverings shall not be required where complete

and separate roofing systems are provided which transmit all roof loads directly to the structural system of the building and which do not bear upon the existing roof.

3609.10.4 Reinstallation of materials: The reinstallation of existing roof covering materials which have been removed is not permitted.

3609.10.5 Flashings: Flashings shall be reconstructed in accordance with approved manufacturer's instruction.

NON-TEXT PAGE

CHIMNEYS, FIREPLACES AND SOLID FUEL-FIRED APPLIANCES

3610.1 GENERAL

3610.1.1 Scope: The provisions of 780 CMR 3610 shall control the design, construction, listing and/or installation of chimneys, fireplaces and solid fuel-fired appliances in one- and two-family buildings.

3610.2 Masonry chimneys, general: Masonry chimneys shall be constructed, anchored, supported and reinforced as required in 780 CMR 3610 and the applicable provisions of 780 CMR 3603, 3604 and 3606. Chimneys shall be structurally sound, durable, smoke tight and capable of conveying flue gases to the exterior safely.

Chimneys in wood-frame buildings, shall, at a minimum, be anchored laterally at the ceiling lines and at each floor line which is more than six feet above grade except when entirely within the framework of the building. Anchors, bolts, and straps so utilized shall be listed for such use and utilized in accordance with their listing.

3610.2.1 Support: Masonry chimneys shall be supported on foundations of solid masonry or concrete at least 12 inches (305 mm) thick and at least six inches (153 mm) beyond each side of the exterior dimensions of the chimney. Footings shall be founded on natural undisturbed earth below frostline. In areas not subject to freezing, footings shall be located a minimum of 12 inches (305 mm) below finished grade.

3610.2.2 Corbeling: Masonry chimneys shall not be corbeled more than six inches (153 mm) from a wall or foundation, or a chimney be corbeled from a wall or foundation which is less than 12 inches (305 mm) in thickness unless it projects equally on each side of the wall, except that on the second story of a two-story dwelling, corbeling of chimneys on the exterior of the enclosing walls may equal the wall thickness. The projection of a single course shall not exceed one-half the unit height or one third of the unit bed depth, whichever is less.

3610.2.3 Changes in dimension: The chimney wall or chimney flue lining shall not change in size or shape within six inches (153 mm) above or below where the chimney passes through floor components, ceiling components or roof components.

3610.2.4 Additional load: Chimneys shall not support loads other than their own weight unless they are designed and constructed to support the additional load.

3610.2.5 Termination: Chimneys shall extend at least two feet (610 mm) higher than any portion of the building within ten feet (3048 mm), but shall not be less than three feet (914 mm) above the point where the chimney passes through the roof.

3610.2.6 Wall thickness: Masonry chimney walls shall be constructed of solid masonry units with not less than four inches (102 mm) nominal thickness.

3610.2.7 Flue lining (material): All masonry chimneys shall be lined with fireclay flue liners not less than ⅝ inch (15.9 mm) in thickness or with other approved liner of material that will resist, without cracking or softening, a temperature of 1,800°F (982°C).

Note: Lined masonry chimneys may require additional metal liners when such chimneys convey the exhaust products of gas-fired or oil-fired appliances - refer also to 248 CMR or 527 CMR as applicable.

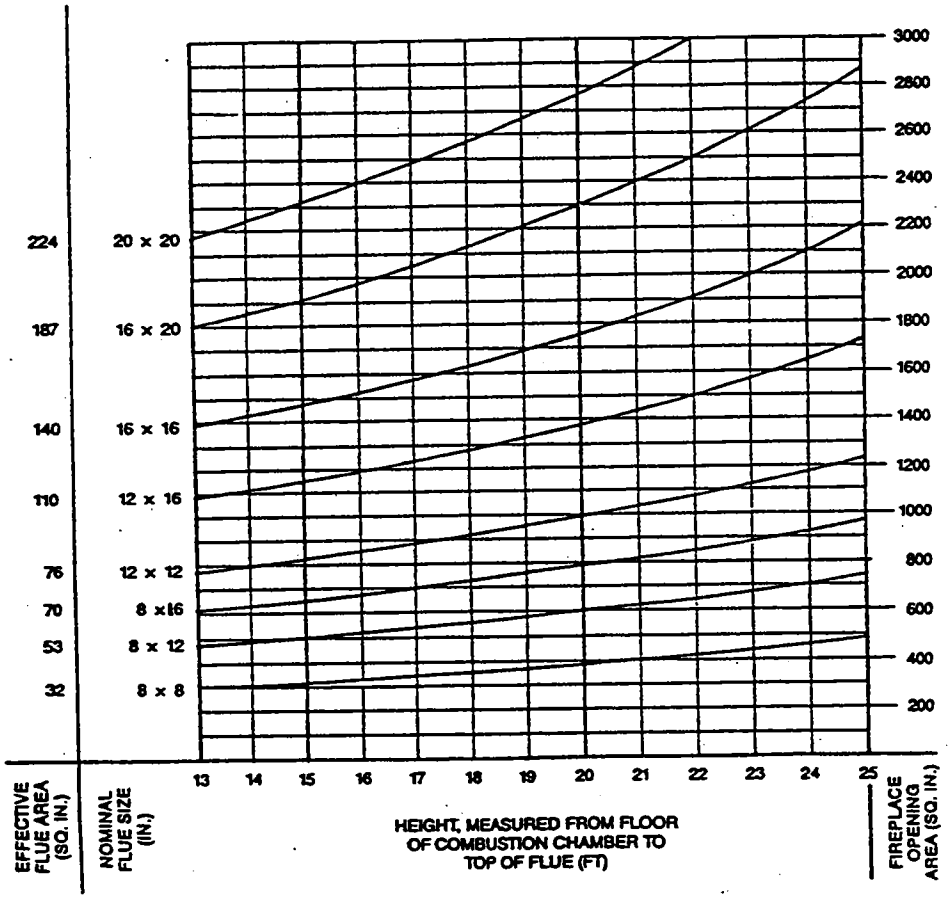
3610.2.8 Flue lining (installation): Flue liners shall extend from a point not less than eight inches (203 mm) below the lowest inlet or as otherwise required by 248 CMR or 527 CMR if applicable, or, in the case of fireplaces, from the top of the smoke chamber, to a point above the enclosing walls. Fireclay flue liners shall be laid with tight mortar joints left smooth on the inside and installed to maintain a ½-inch-wide (12.7 mm) air space separating the flue liners from the interior face of the chimney masonry walls. Flue lining shall be supported on all sides.

3610.2.9 Multiple flues: When two or more flues are located in the same chimney, masonry wythes shall be built between adjacent flue linings. The masonry wythes shall be at least four inches (102 mm) thick and bonded into the walls of the chimney.

Exception: When venting only one appliance, two flues may adjoin each other in the same chimney with only the flue lining separation between them. The joints of the adjacent flue linings shall be staggered at least seven inches (178 mm).

3610.2.10 Flue area (appliance): Chimney flues shall not be smaller in area than that of the area of the connector from the appliance. The sizing and installation of a chimney flue to which multiple-appliance venting systems are connected shall be in accordance with 780 CMR 3621.

Figure 3610.2.11
FLUE SIZES FOR MASONRY CHIMNEYS[1]



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square inch = 645.16 mm^2.

1. When using figure 3610.2.11, select the smaller flue size when the opening and height selected for the fireplace and chimney, respectively, intersect between standard flue sizes.

3610.2.11 Flue area (masonry fireplace): The cross-sectional area of the chimney flue shall be determined in accordance with Figure 3610.2.11. For square or rectangular flues, the nominal flue size shown or a size providing equivalent cross-sectional area shall be used. For round flues, the size selected shall be least equal to the effective flue area determined in accordance with Figure 3610.2.11. The height of the chimney shall be measured from the firebox floor to the top of the last chimney flue tile. Individual flue tiles shall not have a cross-sectional area less than 50 square inches (0.032 m^2) for round flues or 64 square inches (0.041 m^2) for square or rectangular flues. Unlined chimneys shall have a minimum cross-sectional area of 100 square inches (0.064 m^2).

3610.2.12 Inlet: Inlets to masonry chimneys shall enter from the side. Inlets shall have a thimble of fireclay, rigid refractory material or metal that will prevent the connector from pulling out of the inlet or from extending beyond the wall of the liner.

3610.2.13 Masonry chimney cleanout openings: Cleanout openings shall be provided within six inches (153 mm) of the base of every masonry chimney.

Exception: Chimneys serving masonry fireplaces.

3610.2.14 Chimney clearances: A portion of a masonry chimney located in the interior of the building or within the exterior wall of the building shall have a minimum air space clearance to combustibles of two inches (51 mm). Chimneys located entirely outside the exterior walls of the building, are permitted to have combustible material in contact with the chimney exterior surfaces. Masonry chimneys equipped with a chimney lining system listed and labeled for use in chimneys in contact with combustibles in accordance with UL 1777, and installed in accordance with the manufacturer's installation instructions, are permitted to have combustible material in contact with their exterior surfaces.

The requirements of 780 CMR 3610.2.14 shall not eliminate the requirement for noncombustible firestopping in accordance with 780 CMR 3610.2.15.

3610.2.15 Chimney firestopping: See 780 CMR 3606.2.7.

3610.2.16 Chimney crickets Chimney shall be provided with crickets when the dimension parallel to the ridgeline is greater than 30 inches (762 mm) and does not intersect the ridgeline. The intersection of the cricket and the chimney shall be flashed and counterflashed in the same manner as normal roof-chimney intersections. Crickets shall be constructed in conformity with Figure 3610.2.16 and Table 3610.2.16.

3610.4 Masonry fireplaces, general: Masonry fireplaces shall conform to the requirements of 780 CMR 3610.4.1 through 3610.4.7.

Note: Masonry fireplaces may be prescriptively constructed or may be of the "Rumford" type or may be of contemporary design; refer, additionally to the BOCA National Mechanical Code; Brick Institute of America, Technical Notes and NFPA 211 as listed in ***Appendix A*** - also see Figures 3610.4.1a, 1b, 1c, 1d,. 1e, 1f and 1g.

3610.4.1 Fireplace support: Fireplace foundations and supporting walls shall be anchored, supported and reinforced as required in 780 CMR 3610.4.1 through 3610.4.7, Table 3610.4.1, Figure 3610.4.1a and the applicable provisions of 780 CMR 3610 and 3604.

Figure 3610.2.16
CHIMNEY CRICKET

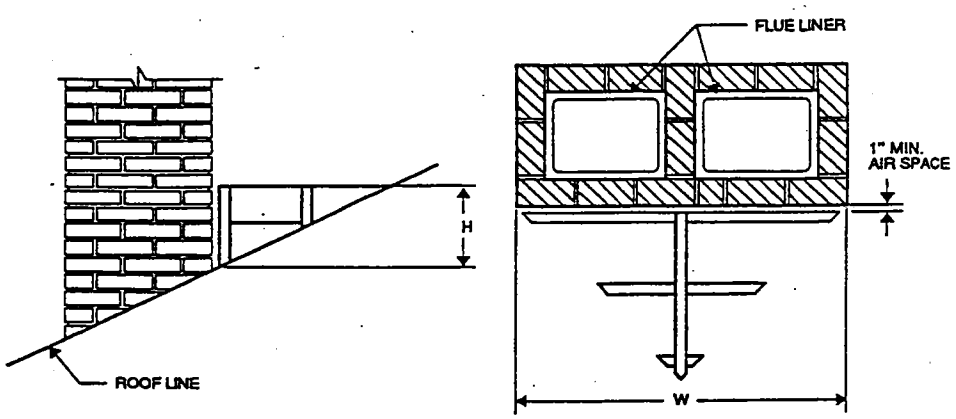


Table 3610.2.16
CRICKET DIMENSIONS

ROOF SLOPE	H
12 - 12	1/2 of W
8 - 12	1/3 of W
6 - 12	1/4 of W
4 - 12	1/6 of W
3 - 12	1/8 of W

3610.3 Factory-built chimneys, general: Factory-built chimneys shall be tested and listed to UL-103 or CAN/ULC-S629-M87 as found in **Appendix A** and shall be installed, operated and maintained in accordance with the conditions of their listing and the manufacturer's requirements. Factory-built chimneys that are listed as part of an assembly with factory-built fireplaces shall conform to 780 CMR 3610.5.1.

Exception: Masonry fireplaces other than those that are prescriptively constructed shall comply with the requirements of 780 CMR 3610.4.1 through 3610.4.7 but may be of a design other than shown in Figure 3610.4.1a - also see Figures 3610.4.1b, 1c, 1d,. 1e, 1f and 1g.

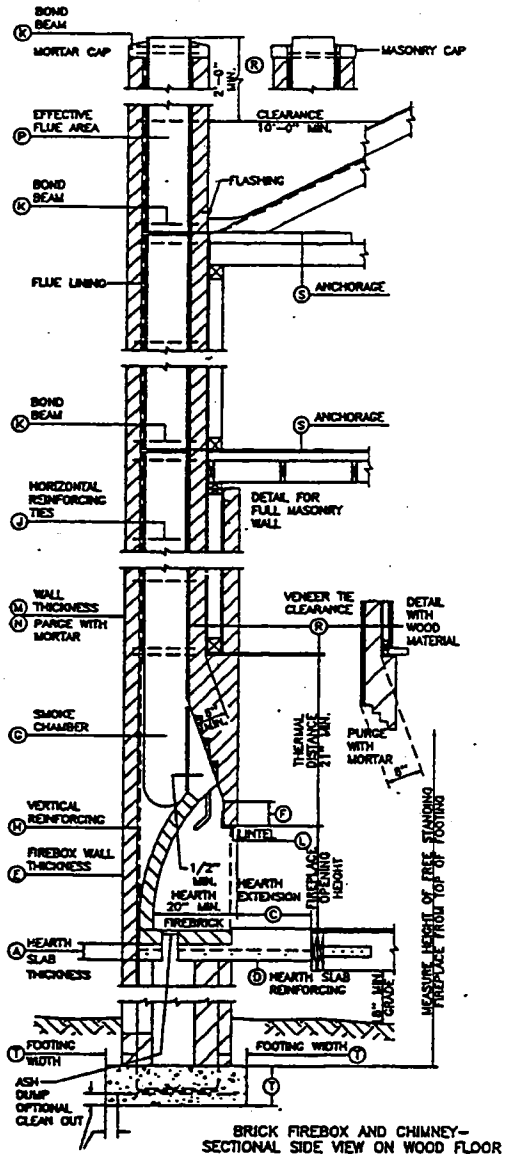
Foundations for masonry fireplaces and their chimneys shall be constructed of concrete or solid masonry at least 12 inches (305 mm) thick and extend at least six inches (153 mm) beyond the face of the fireplace or supporting wall on all sides. Footings shall be founded on natural undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be at least 12 inches (305 mm) below finished grade.

Table 3610.6.4.1
REQUIREMENTS FOR MASONRY FIREPLACES AND CHIMNEYS

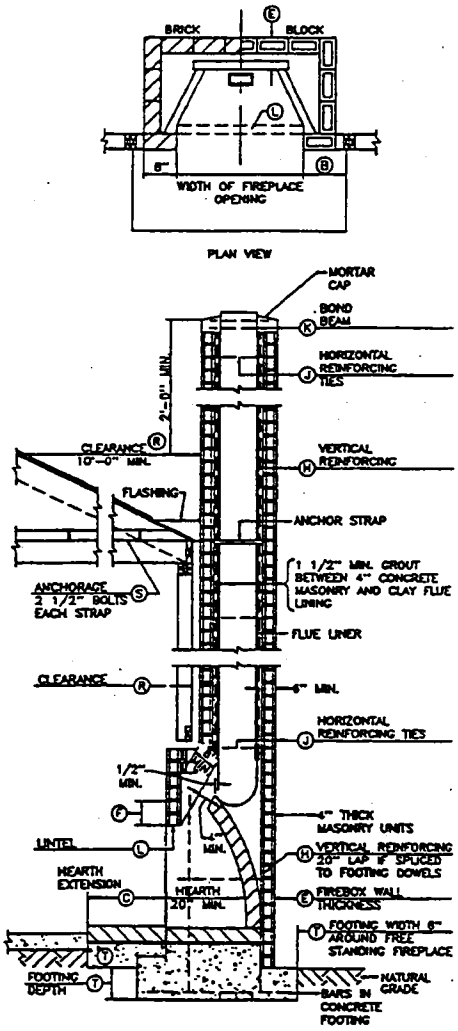
ITEM	LETTER[1]	REQUIREMENTS
Hearth slab thickness	A	4"
Hearth extension (each side of opening)	B	8" fireplace opening < 6 sq. ft. 12" fireplace opening > 6 sq. ft.
Hearth extension (front of opening)	C	16" fireplace opening < 6 sq. ft. 20" fireplace opening > 6 sq. ft
Hearth slab reinforcing	D	Reinforced as necessary to carry its own weight and all imposed loads
Thickness of wall of firebox	E	10" solid brick or 8" where a firebrick lining is used. Joints in firebrick 1/4" max.
Distance from top of opening to throat	F	8"
Smoke chamber edge of shelf Rear wall - thickness Front wall - thickness	G	 6" 8"
Chimney Vertical reinforcing	-	Seismic load reinforcement not required in Massachusetts
Horizontal reinforcing	-	Seismic load reinforcement not required in Massachusetts
Bond beams	K	No specified requirements
Fireplace lintel	L	Noncombustible material
Walls with flue lining	M	Refer to 780 CMR 3610.2.8
Walls with unlined flue	N	Unlined chimneys are not allowed to be constructed in Massachusetts
Distances between adjacent flues	-	Refer to 780 CMR 3610.2..9
Effective flue area (based on area of fireplace opening)	P	Refer to 780 CMR 3610.2.10 and 3610.2.11
Clearances Wood frame and combustible material Above roof	R	 Refer to 780 CMR 3610.2.14 and 3610.4.7 2' at 10' (780 CMR 3610.2.5)
Anchorage	-	Seismic load reinforcement not required in Massachusetts but also refer to 780 CMR 3610.2
Footing Thickness Width	T	 12" min. 6" each side of fireplace wall

For SI: 1 inch = 304.8 mm.
1. The letters in this column refer to Figure 3610.4.1a

Figure 3610.4.1a
FIREPLACE AND CHIMNEY DETAILS



BRICK FIREBOX AND CHIMNEY–
SECTIONAL SIDE VIEW ON WOOD FLOOR



BRICK FIREBOX AND BLOCK CHIMNEY–
SECTIONAL SIDE VIEW ON CONCRETE SLAB

Figures 3610.4.1b through 3610.4.1g
TYPICAL FIREPLACE DETAILS

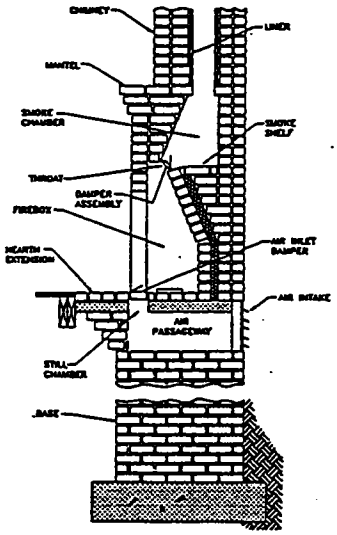


Figure 3610.4.1b
SINGLE-FACE FIREPLACE SECTION

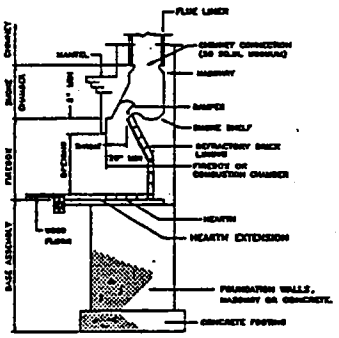


Figure 3610.4.1c
SECTION THROUGH FIREPLACE

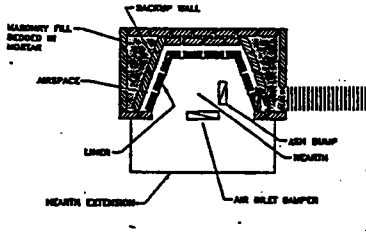


Figure 3610.4.1c
SINGLE-FACES FIREPLACE PLAN

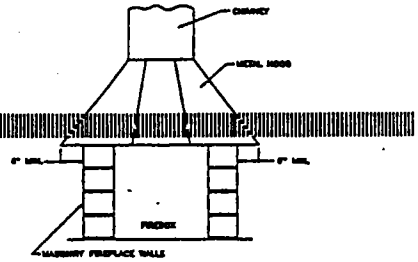


Figure 3610.4.1f
FRONT VIEW OF METAL HOOD OVERHANG

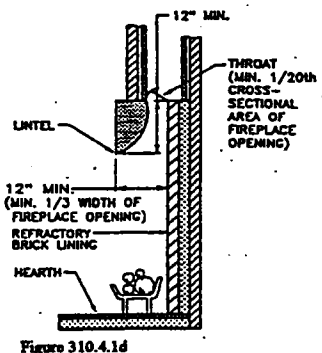


Figure 310.4.1d
RUMFORD REQUIREMENTS

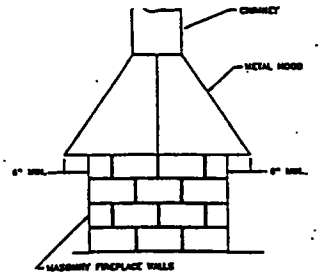


Figure 3610.4.1g
SIDE VIEW OF METAL HOOD OVERHANG

3610.4.2 Seismic reinforcing: Not applicable in Massachusetts.

3610.4.2.1 Seismic anchorage: Not applicable in Massachusetts.

3610.4.3 Fireplace walls: Masonry fireplaces shall be constructed of solid masonry units, stone or reinforced concrete in accordance with Figure 3610.4.1a. When a lining of firebrick at least two inches (51 mm) in thickness is provided, the total thickness of back and sides, including the lining, shall not be less than eight inches (203 mm). When no lining is provided, the thickness of back and sides shall not be less than ten inches (254 mm).

3610.4.3.1 Walls, steel fireplace units: Steel fireplace units shall be listed in accordance with UL 127 as found in ***Appendix A*** and shall be installed, operated and maintained according to their listing, the manufacturer's requirements and any applicable requirements of 780 CMR. Such fireplaces incorporating a fire box liner of not less than ¼ inch (6.4 mm) in thickness and an air chamber, may be installed with masonry to provide a total thickness at the back and sides of not less than eight inches (203 mm), of which not less than four inches (102 mm) shall be of solid masonry. Warm-air ducts employed with steel fireplace units of the circulating air type shall be constructed of metal or masonry.

3610.4.4 Lintel: Masonry over a fireplace opening shall be supported by a lintel of noncombustible material. The minimum required bearing length on each end of the fireplace opening shall be four inches (102 mm).

3610.4.5 Hearth extension material: Hearth extensions shall be of masonry or concrete at least two inches (51 mm) thick and supported by noncombustible materials and reinforced to carry its own weight and all imposed loads. The hearth extension shall be readily distinguishable from the surrounding floor. Combustible forms and centers used during the construction of the hearth extension shall be removed after the construction is complete.

Exception: When the bottom of the firebox opening is raised at least eight inches (203 mm) above the top of the hearth extension, a hearth extension of not less than ⅜ inch-thick (9.5I mm) brick, concrete, stone, tile or other approved noncombustible material may be used.

3610.4.6 Hearth extension: The hearth and the hearth extension shall extend a minimum of 36 inches (914 mm) from the back of the firebox to the end of the hearth extension. Hearth extensions shall extend at least 16 inches (406 mm) in front of, and at least eight inches (203 mm) beyond, each side of the fireplace opening. Where the fireplace opening is six square feet (0.557 m2) or larger, the hearth extension shall extend at least 20 inches (508 mm) in front of, and at least 12 inches (305 mm) beyond, each side of the fireplace opening.

3610.4.7 Fireplace clearance: Wood or combustible framing shall not be placed within two inches (51 mm) of the outside face of a masonry fireplace and not less than six inches (153 mm) from the inside surface of the nearest flue lining. Wood framing and other combustible material shall not be placed within two inches (51 mm) of the back surface of a masonry fireplace. See Figures 3610.4.7a and 7b.

Figure 3610.4.7a
CONSTRUCTION REQUIREMENTS FOR A TYPICAL MASONRY FIREPLACE IN A WOOD FRAME WALL

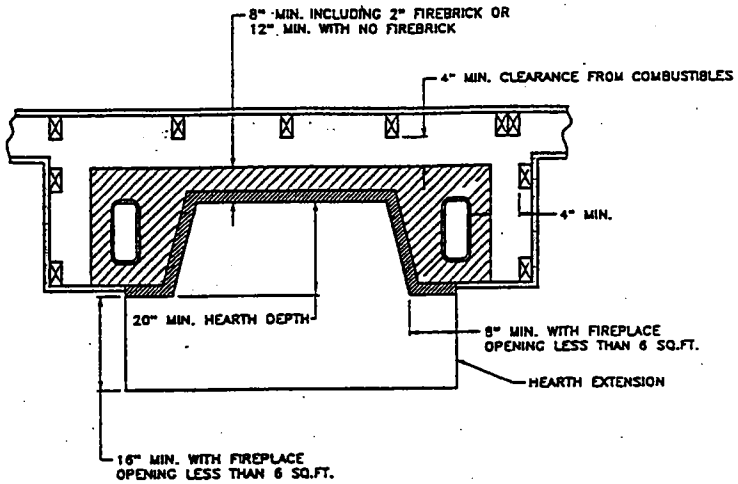
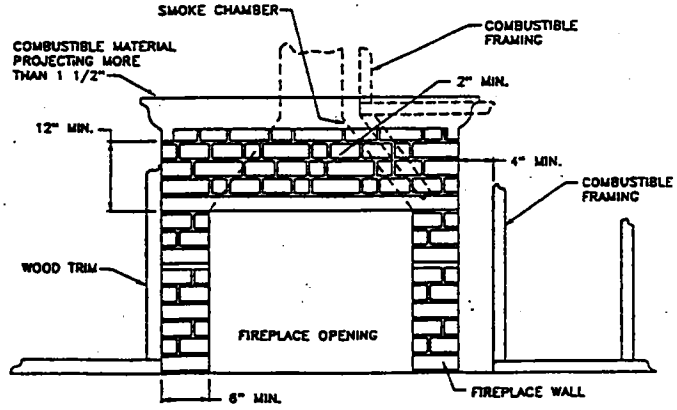


Figure 3610.4.7b
REQUIRED CLEARANCES FROM AMSONRY FIREPLACE TO COMBUSTIBLES



3610.5 Factory-built fireplaces, general: Factory-built fireplaces shall conform to the requirements of 780 CMR 3610.5.1 through 3610.5.4.

3610.5.1 Installation: Factory-built fireplaces that consist of a fire chamber assembly, one or more chimney sections, a roof assembly and other parts shall be tested and listed to UL-127 as found in ***Appendix A***. Such fireplaces may be installed when complying with all the following provisions:

1. The fire chamber assembly is installed to provide clear clearance to combustible materials not less than set forth in the listing.
2. The chimney sections are installed to provide clearance to combustible material not less than specified in the listing and if the fireplace chimney extends through floors and ceilings, factory-furnished firestops or firestop spacers shall be installed. Portions of chimneys which extend through rooms or closets are to be enclosed to avoid personal contact, contact of combustible material, and damage to the chimney.
3. Hearth extensions shall not be less than 3/8-inch-thick (9.5 mm) millboard, hollow metal, stone, tile or other approved noncombustible material. Such hearth extensions may be placed on combustible subflooring or finish flooring. The hearth extension shall be readily distinguished from the surrounding floor.

Note: Where *floor protection* underneath, to the sides, back or in front of factory-built fireplaces is required via testing/listing and/or manufacturer's requirments, refer to

floor protector requirements of 780 CMR 3610.6.7.1 and 3610.6,7,1,1.

4. Hearth extensions shall extend not less than 16 inches (406 mm) in front of and at least eight inches (203 mm) beyond both sides of the fireplace opening.

Exception: Where tested/listed extensions are identified, such hearth extension shall be allowed and required.

5. Factory-built fireplaces shall be installed in accordance with their listing and the manufacturer's installation instructions.

6. The supporting structure for a hearth extension shall be at the same level as the supporting structure for the fire place unit unless otherwise authorized by the listing.

3610.6

3610.6.1 Solid fuel-fired appliances, general: Solid fuel-fired appliances employed for comfort heating include, but are not limited to, room heaters and stoves, fireplace inserts, furnaces and boilers; additionally, the fuel for such appliances includes, but is not limited to: wood and wood pellets, coal and various other solid fuels such as nut shells and corn, etc. Solid fuel-burning appliances shall be tested and listed by *approved agencies* and installed, operated and maintained in accordance with such listing, the manufacturers' requirements and otherwise conform to the requirements of 780 CMR 3610.6.

Note 1: No solid fuel-burning appliance shall be installed in Massachusetts unless such appliance conforms to all applicable requirements of 780 CMR 3610.6, including the testing and listing of all clearances to combustibles and identification of required floor protection.

Note 2: In the absence of explicit requirements of 780 CMR 3610.6, the applicable requirements of NFPA 211 and/or the BOCA National Mechanical Code, as listed in ***Appendix A***, shall apply.

3610.6.1.1 Listing standards, Room heaters, stoves and fireplace inserts: Room heaters, stoves and fireplace stoves (inserts), employed for comfort heating shall be listed and tested to UL 1482 and/or ANSI/UL 737 as found in ***Appendix A*** and as applicable; all such appliances shall bear labeling as required in 780 CMR 3610.6.2 or 3610.6.3 as applicable.

3610.6.1.2 Listing standards, all pellet fueled solid fuel-burning appliances: All pellet solid fuel-burning appliances sold for use in Massachusetts shall conform to 780 CMR 3610.6.1.1 and additionally comply with the certification program set forth by the State Board of Building Regulations and Standards (for pellet appliance certification information, contact the State Board of Building Regulations and Standards).

Note: Commencing January 1, 1998, all pellet solid fuel-burning appliances shall be tested and listed to ASTM E 1509 as found in Appendix A and shall bear such labeling as required in 780 CMR 3610.6.2

3610.6.2 Solid fuel-burning appliance labeling (not central heating appliances): Every solid fuel-burning appliance utilized for comfort heating shall bear a permanent and legible factory-applied label supplied to the manufacturer and controlled by *an approved testing agency;* such label shall contain the following information:

1. Manufacturer's name and trademark;
2. Model and/or identification number of the appliance;
3. Type(s) of fuel(s) approved;
4. Testing laboratory's name or trademark and location;
5. Date tested;
6. Clearances to combustibles
   (a) Above top
   (b) From front
   (c) From back
   (d) From sides
7. Floor protection
8. National test standard(s)
9. Label serial number

3610.6.3 Solid fuel-burning central heating appliance labeling: Every solid fuel-burning boiler or warm air furnace shall bear a permanent and legible factory-applied label supplied to the manufacturer and controlled by an approved testing agency; such label shall contain the following information:

1. Manufacturer's name and trademark;
2. Model and/or identification number of the appliance;
3. Type(s) of fuel(s) approved;
4. Testing laboratory's name or trademark and location;
5. Date tested;
6. Clearances to combustibles
   (a) Above top
   (b) From front
   (c) From back
   (d) From sides
7. Floor protection if applicable
8. National test standard(s)
9. Label serial number
10. Type of appliance (boiler or warm air furnace)
11. Every boiler, pressure vessel, or pressure relief device must be stamped in accordance with the requirements of the ASME Boiler and Pressure Vessel Code. ASME stamping shall also be required for boilers, pressure vessels

and pressure relief devices produced outside the United State of America. Where required by the ASME Boiler and Pressure Vessel Code, ASME stamping may be affixed directly to the appliance in lieu of on the data plate.

3610.6.3 Hazardous locations: Solid fuel-burning appliances shall not be installed in hazardous locations (any location considered to be a fire hazard for flammable vapors, dust, combustible fibers or other highly combustible substances).

Exception: solid fuel-fired appliances listed for such locations.

3610.6.4 Air for combustion and ventilation: Solid fuel-burning appliances shall be installed in a location and manner to assure satisfactory combustion of fuel, proper chimney draft and maintenance of safe operating temperatures. Combustion air may be obtained from interior spaces when the interior space containing the appliance has a volume, in cubic feet equal to one-twentieth (1/20) of the output Btu rating of all fuel-burning appliances in the space. When buildings are so tight as to preclude adequate infiltration, provisions shall be made to introduce outside air for combustion and ventilation.

3610.6..5 Chimney connection: All solid fuel-burning appliances shall be connected to chimneys in accordance with their listing, the manufacturer's requirements and the requirements of 780 CMR 36.

Exception: Solid fuel-burning appliances listed for exhaust vent termination other than through a chimney.

3610.6.5.1 Chimney connector clearance to combustibles: See 780 CMR Table 3610.6.5.1.

3610.6.5.2 Chimney flue size: For solid fuel-burning comfort heating appliances for one- and two family use, the cross-sectional area of the flue shall not be less than the cross-sectional area of the appliance flue collar. The cross-sectional area of the flue shall not be more than three times the cross-sectional area of the flue collar of the appliance.

Table 3610..6.5.1[1,2]
CHIMNEY AND/OR VENT CONNECTOR CLEARANCES TO COMBUSTIBLE MATERIALS/SOLID FUEL-BURNING APPLIANCES ONLY

Description of Appliance	Connector Type	Minimum Clearance (in)	Minimum Clearance (mm)
Residential-Type Appliances	Single-wall Metal Pipe Connector	18	457
Residential-Type Appliances	Type L Vent Piping Connector	9	229
Low-heat Appliances Boilers, Furnaces, Water Heaters	Single-wall Metal Pipe Connector	18	457
Medium-Heat Appliances	Single-wall Metal Pipe Connector	36	914
High-Heat Appliances	Masonry or Metal Connector	Note 3	Note 3

1. For greater detail and guidance, refer to NFPA 211, Section 6-5.
2. For Chimney Connectors tested and listed for other clearances to combustibles, such tested, listed clearances shall apply.
3. Clearances shall be based on engineering calculations and, good engineering practice - Refer to NFPA 211, Section 6-5

3610.6.6 Connection to masonry fireplaces: A solid fuel-burning appliance such as a stove or fireplace insert shall be permitted to use a masonry fireplace flue where the following conditions are met:

1. There is a connector that extends from the appliance to the flue liner;
2. The cross-sectional area of the flue is no more than three times the cross-sectional area of the flue collar of the appliance but never less than the appliance exhaust collar cross-sectional area;
3. If the appliance vents directly through the chimney wall above the smoke chamber of the fireplace, there shall be a noncombustible seal below the entry point of the connector, sealing the fireplace from the appliance;
4. The installation shall be such that the chimney system can be inspected and cleaned;
5. Means shall be provided to prevent dilution of combustion products in the chimney flue with air from the habitable space.

3610.6.7 Mounting (placing) of residential solid fuel-burning appliances: Residential type solid fuel-burning appliances shall be tested and listed by *approved agencies* and such appliances, when mounted (placed) on combustible or noncombustible materials, shall be installed in accordance with their listing and the manufacturer's requirements.

Exceptions: See NFPA 211, Section 9-5.1.1.1 (all such exceptions pertain to placing of such appliances on well supported concrete bases, concrete slabs, properly stabilized, noncombustible soils or on approved, noncombustible assemblies of two hour fire resistance with floors constructed of noncombustible materials).

3610.6.7.1 Floor protection: Floor protection shall satisfy all listing requirements.

3610.6.7.1.1 Floor protectors - definition: *Floor protectors* are noncombustible surfacing applied to the combustible or noncombustible floor area underneath and extending in front, to the sides and to the rear of a heat producing appliance. For purposes of 780 CMR 3610.6.7, *floor protectors* must be noncombustible and have the necessary thermal conductivity to satisfy the appliance tested/listing floor protection requirements.

Note 1: Refer to Appendix K for information on floor protector thermal conductivity calculations

Note 2: Various "hearth rugs", "mats", "tile board", "hearth board" and similar products, sold as floor protectors may be noncombustible but may not satisfy thermal conductivity requirements to comply with 780 CMR 3610.6.7.1.

3610.6.8 Appliance clearances: Solid fuel-burning appliances shall be installed in accordance with the manufacturer's tested, listed clearances (also see 780 CMR 3610.6.11.1 for *used* solid fuel-burning appliance clearance requirements).

3610.6.8.1 Clearance reductions: Tested, listed clearances to combustibles shall only be permitted to be reduced in accordance with the requirements of NFPA 211, Section 9-6.1 and 9-6.2.

Note that an engineered protection system is required to achieve a reduced clearance installation except when appliances are installed in rooms that are large in comparison to the size of the appliance - see NFPA 211, Section 9-6.1.

3610.6.9 Supply ducts: When a solid fuel-burning appliance utilizes supply ducts such ducts conveying heated air shall be fabricated of noncombustible materials.

Exception: Combustible ducts specifically tested and listed for such purpose.

3610.6.9.1 Supply duct clearance to combustibles: Supply ducts conveying heated air shall have a clearance to combustibles of not less than 12 inches for the first ten feet of distance from the appliance plenum/bonnet.

Exception: ducts specifically tested and listed for such purpose.

3610.6.10 Multiple flue connections: A solid fuel-burning appliance and a fossil fuel-burning appliance shall not be vented into a common flue of a masonry chimney unless such common connection is allowed by 248 CMR or 527 CMR as applicable. If allowed, the common flue shall be of such size to serve all appliances connected if such appliances were operated simultaneously.

Note that 248 CMR and 527 CMR are enforced by Gas Inspectors and the Heads of Fire Departments, respectively.

3610.6.10.1 Multiple flue connections not allowed: A solid fuel-burning appliance shall not share a common flue with a working fireplace nor with another solid fuel-burning appliance (also see 780 CMR 3610.6.10 above).

Exception: 780 CMR 3610.6.6.

3610.6.11 Used solid fuel-burning appliances - installation inspection: Used solid fuel-burning appliances that predate the listing requirements set forth in 780 CMR 3610 may be utilized but the installation of such appliances shall otherwise conform to the requirements of 780 CMR 3610

and such installations shall be inspected by the Building Official (or Fire Official in such towns that utilize the Fire Official for such inspection purposes).

3610.6.11.1 Used solid fuel-burning appliance clearances to combustibles: In the absence of tested, listed clearances and floor protection requirements, used solid fuel-burning appliances shall be required to be installed in accordance with the clearances of Table 3610.6.11. Floor protection requirements shall be evaluated by engineering methods or otherwise four inches of 3/8 inch millboard having a thermal conductivity of:

$k = 0.84$ (Btu) (inch) / (foot^2) (hour) (°F)

or an equivalent noncombustible *floor protector* of the same overall thermal conductivity shall be required (also see 780 CMR 3610.6.7.1.1).

Exception 1: If tested, listed clearances and/or floor protection requirements are documentable for the specific used appliance being installed, then such clearances and/or floor protection may be utilized.

Exception 2: If known tested, listed clearances are greater than those of Table 3610.6.11, then such clearances must be maintained.

Exception 3: If existing floor protection can be demonstrated to have been adequate for previous installations of said used solid fuel-burning appliances then such previously utilized floor protection shall be allowed. If calculations demonstrate that the existing floor protection has a thermal conductivity lower than that set by 780 CMR 3610.6.11.1 and adequacy has otherwise been demonstrated, then the existing floor protection must be maintained.

Table 3610.6.11[1,2,3]
STANDARD CLEARANCES TO COMBUSTIBLES FOR SOLID FUEL-BURNING APPLIANCES

Appliance Type	Clearance Above Top of Appliance (inches)	Clearance from Front of Appliance (inches)	Clearance from Back of Appliance (inches)	Clearance from Sides of Appliance (inches)
Room Heaters; Fireplace Stoves; Combination	36	36	36	36

1. For reduced clearance requirements, see 780 CMR 3610. 6.8.1
2. Adequate clearance for maintenance and cleaning shall be provided.
3. Provisions for solid fuel storage - solid fuel shall not be stored any closer than 36 inches from the sides, front or back of the solid fuel-burning appliance.

MECHANICAL ADMINISTRATION

(This Section is Entirely Unique to Massachusetts)

3611.1 GENERAL

3611.1.1 Scope. The provisions of 780 CMR 3611 shall establish the general scope of the mechanical system and equipment requirements of 780 CMR.

3611.1.2 Definitions: General definitions are provided in 780 CMR 3612.1

3611.1.3 Application: In addition to the general administration requirements of 780 CMR 1, the provisions of 780 CMR 3611 - 780 CMR 3622 shall apply; additionally, in the absence of specific criteria set forth in such sections, the International Mechanical Code, as listed in ***Appendix A*** shall apply.

Note: This supplementing of the administrative provisions is necessary, in part, as the regulatory requirements of other State Agencies legally impact the design, installation and maintenance of fossil fuel-fired appliances; i.e., 527 CMR for oil-fired appliances and 248 CMR for gas-fired appliances and specifically 527 CMR 12 as the Massachusetts Electrical Code.

3611.1.4 Conformity: Conformity with the applicable Code of Massachusetts Regulations (527 CMR and 248 CMR) or otherwise with the applicable provisions of 780 CMR 3611 - 780 CMR 3622 is required.

780 CMR 3611.2 - EXISTING MECHANICAL SYSTEMS

3611.2.1 Additions, alterations, repairs or replacement: Additions, alterations, repairs or replacement shall be made to existing mechanical systems in accordance with the requirements of the applicable CMR (527 CMR or 248 CMR) except that in the absence of other CMR regulatory control, in an existing one- or two-family detached home, any new mechanical system shall conform to 780 CMR for new construction to the fullest extent practical. However, individual components of an existing mechanical system may be repaired or replaced without requiring that system to comply with 780 CMR for new construction, provided such component repair or replacement shall not cause an existing system to become unsafe, unsanitary or overloaded.

NON-TEXT PAGE

MECHANICAL DEFINITIONS

3612.1 GENERAL

3612.1.1 Scope: Unless otherwise expressly stated, the following terms shall, for the purpose of *780 CMR*, have the meanings indicated in 780 CMR 3612.1. Words used in the present tense include the future; the singular number includes the plural and the plural the singular. ***Where terms are not defined in 780 CMR 3612.1 and are defined in 780 CMR 2 they shall have the meanings ascribed to them in 780 CMR 2. Where terms are not defined in 780 CMR 2 or 780 CMR 3612.1, they shall have their ordinarily accepted meanings.***

Note: Such definitional terms are provided to establish a uniform technical language consistent with definitional terms of 527 CMR, 248 CMR, NFPA-31, NFPA-54 and the International Mechanical Code, as applicable.

780 CMR 3612.2.1 - GENERAL MECHANICAL DEFINITIONS

ACCESSIBLE: Signifies access that requires the removal of an access panel or similar removable obstruction.

ACCESSIBLE, READILY: Signifies access without the necessity for removing a panel or similar obstruction.

AIR CIRCULATION, FORCED: A means of providing space conditioning utilizing movement of air through ducts or plenums by mechanical means.

AIR-CONDITIONING SYSTEM: An air-conditioning system consists of heat exchangers, blowers, filters, supply, exhaust and return-air systems and shall include any apparatus installed in connection therewith

ALTERATION: A change in an air-conditioning, heating, ventilating or refrigeration system that involves an extension, addition or change to the arrangement, type or purpose of the original installation.

APPLIANCE: A device which utilizes fuel or other forms of energy to produce light, heat, power, refrigeration or air-conditioning. This definition shall also include a vented decorative gas appliance and decorative gas appliances for installation in vented solid-fuel-burning fireplaces. Unlisted gas-fired log lighters shall not be considered appliances.

BOILER, HOT WATER HEATING: A self-contained appliance from which hot water is circulated for heating purposes and then returned to the boiler, and which operates at water pressures not exceeding 160 pounds per square inch gage (psig) (1102 kPa gage) and at water temperatures not exceeding 250°F (121°C) near the boiler outlet.

BRAZED JOINTS: A joint obtained by the joining of metal parts with metals or alloys that melt at a temperature above 1,000°F (538°C) but lower than the melting temperature of the parts to be joined.

Btu/h: The listed maximum capacity of any appliance, absorption unit or burner expressed in British thermal units input per hour.

CHIMNEY: (See also "Vent") One or more passageways, vertical or nearly so, for conveying flue gases to the outside atmosphere.

CHIMNEY CONNECTOR: A pipe that connects a fuel-burning appliance to a chimney.

CLOSET: A small room or chamber used for storage.

COMBUSTIBLE MATERIAL: Any material not defined as noncombustible.

COMBUSTION AIR: The air provided to fuel-burning equipment including air for fuel combustion, draft hood dilution and ventilation of the equipment enclosure.

CONCEALED GAS PIPING: Piping that is enclosed in the building construction without means of access.

CONDENSATE: The liquid which separates from a gas due to a reduction in temperature, e.g., water that condenses from flue gases and water that condenses from air circulating through the cooling coil in air-conditioning equipment.

CONDENSING APPLIANCE: An appliance that condenses water generated by the burning of fuels.

CONDITIONED AIR: Air treated to control its temperature, relative humidity or quality.

CONDITIONED SPACE: The space contained within a building which is conditioned directly or

indirectly by heating the operation of a cooling appliance.

CONFINED SPACE: A room or space having a volume less than 50 cubic feet per 1,000 Btu/h (4X3 L/W) of the aggregate input rating of all fuel-burning appliances installed in that space.

CONTROL, LIMIT: An automatic control responsive to changes in liquid flow or level, pressure, or temperature for limiting the operation of an appliance.

CONTROL, PRIMARY SAFETY: A safety control responsive directly to flame properties that senses the presence or absence of flame and, in event of ignition failure or unintentional flame extinguishment, automatically causes shutdown of mechanical equipment.

CONVECTOR: A system incorporating heating element in an enclosure in which air enters an opening below the heating element, is heated and leaves the enclosure through an opening located above the heating element.

CONVENIENCE OUTLET,GAS: A permanently mounted hand-operated device for connecting and disconnecting an appliance to the gas supply piping conforming to AGA Requirement 7-90. The device includes an integral, manually operated gas valve so that the appliances can be disconnected only when the valve is in the closed position.

DAMPER, VOLUME: A device that will restrict, retard or direct the flow of air in any duct, or the products of combustion of heat-producing equipment, vent connector, vent or chimney.

DECORATIVE GAS APPLIANCE, VENTED: A vented appliance installed for the aesthetic effect of the flames rather than functional effects.

DECORATIVE GAS APPLIANCES FOR INSTALLATION IN VENTED SOLID-FUEL-BURNING FIREPLACES: A self-contained, freestanding, fuel-gas-burning appliance designed for installation only in a vented solid-fuel-burning fireplace and whose primary function lies in the aesthetic effect of the flame.

DILUTION AIR: Air that enters a draft hood or draft regulator and mixes with flue gases.

DIRECT-VENT APPLIANCE: A fuel-burning appliance with a sealed combustion system that draws all air for combustion from the outside atmosphere and discharges all flue gases to the outside atmosphere.

DRAFT: The flow of gases or air through chimney, flue or equipment caused by pressure differences. **Mechanical or induced**: The draft developed by fan, air, steam jet or other mechanical means. **Natural**: The draft developed by the difference in temperature of hot gases and outside atmosphere.

DRAFT HOOD: A device built into an appliance, or a part of the vent connector from an appliance, which is designed to (1) provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft or stoppage beyond the draft hood, (2) prevent a backdraft from entering the appliance, and (3) neutralize the effect of stack action of the chimney or gas vent on the operation of the appliance.

DRAFT REGULATOR: A device which functions to maintain a desired draft in the appliance by automatically reducing the draft to the desired value.

DUCT SYSTEM: A duct system is a continuous passageway for the transmission of air which, in addition to ducts, may include duct fittings, dampers, plenums, fans and accessory airhandling equipment.

EQUIPMENT: A general term including materials, fittings, devices, appliances and apparatus used as part of or in connection with installations regulated by 780 CMR 36.

EVAPORATIVE COOLER: A device used for reducing air temperature by the process of evaporating water into an airstream.

EXCESS AIR: Air which passes through the combustion chamber and the appliance flue in excess of that which is theoretically required for complete combustion.

EXHAUST HOOD, FULL OPENING: An exhaust hood with an opening at least equal to the diameter of the connecting vent.

FACTORY-BUILT CHIMNEY: A chimney composed of listed and labeled factory-built components assembled in accordance with the manufacturer's installation instructions to form the completed chimney.

FIREPLACE: A listed and labeled factory-built or site-built hearth and fire chamber constructed of noncombustible material for use with solid fuels and provided with a chimney.

FIREPLACE STOVE: A freestanding, chimney-connected solid-fuel-burning heater with or without doors connected to the chimney.

FLAME-SPREAD INDEX: A numerical index indicating the relative surface-burning behavior of a material tested in accordance with ASTM E 84.

FLOOR FURNACE: A self-contained furnace suspended from the floor of the space being heated, taking air for combustion from outside such space, and with means for lighting the appliance from such space.

FLUE: See "Vent."

FLUE, APPLIANCE: The passages within an appliance through which combustion products pass from the combustion chamber to the flue collar.

FLUE COLLAR: The portion of a fuel-burning appliance designed for the attachment of a draft hood, vent connector or venting system.

FLUE GASES: Products of combustion plus excess air in appliance flues or heat exchangers.

FUEL-PIPING SYSTEM: All piping, tubing, valves and. fittings used to connect fuel utilization equipment to the point of fuel delivery.

FURNACE, WARM-AIR: A vented heating appliance designed or arranged to discharge heated air into a conditioned space.

GAS: Fuel gas, such as natural gas, manufactured gas, undiluted liquefied petroleum gas (vapor phase only), liquefied petroleum gas-air mixture or mixtures of these gases.

GAS PRESSURE REGULATOR: See "Regulator."

HEAT PUMP: An appliance having heating or heating/cooling capability and which uses refrigerants to extract heat from air, liquid or other sources.

HIGH-TEMPERATURE (H.T.) CHIMNEY: A high temperature chimney complying with the requirements of UL 103. A Type H.T. chimney is identifiable by the markings "Type H.T." on each chimney pipe section.

LABELED: Devices, equipment or materials to which have been affixed a label, seal, symbol or other identifying mark of a testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the above labeled items which attests to compliance with a specific standard.

LISTED and LISTING: Terms referring to equipment which is shown in a list published by an approved testing agency qualified and equipped for experimental testing and maintaining an adequate periodic inspection of current productions and whose listing states that the equipment complies with nationally recognized standards when installed in accordance with the manufacturer's installation instructions.

LOG LIGHTER, GAS-FIRED: An unlisted manually operated gas-fired solid-fuel ignition device for installation in a vented solid-fuel-burning fireplace.

LOW-PRESSURE GAS SUPPLY SYSTEM: A gas supply system with gas pressure at or below 0.5 psig (3.44 kPa gage).

LP GAS: Liquefied petroleum gas composed predominately of propane, propylene, butanes or butylenes, or mixtures thereof which are gaseous under normal atmospheric conditions, but can be liquefied under moderate pressure at normal temperatures.

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

MASONRY CHIMNEY: A field-constructed chimney of masonry units, bricks, stones, labeled masonry chimney units, or reinforced portland cement concrete, lined with suitable chimney flue liners.

MECHANICAL EXHAUST SYSTEM: Equipment installed in a venting system to provide an induced draft.

MEDIUM-PRESSURE GAS SUPPLY SYSTEMS: A gas supply system with gas pressure exceeding 0.5 psig (3.44 kPa gage) but not exceeding 5 psig (34 kPa gage).

NONCOMBUSTIBLE MATERIAL: Materials that pass the test procedure for defining noncombustibility of elementary materials set forth in ASTM E 136.

NONCONDITIONED SPACE: A space that is isolated from conditioned space by insulated walls, floors or ceilings.

PLENUM: A chamber which forms part of an air-circulation system other than the occupied space being conditioned.

PURGE: To clear of air, gas or other foreign substances.

QUICK-DISCONNECT DEVICE: A hand-operated device that provides a means for connecting and disconnecting an applianceto a gas supply and that is equipped with an automatic means to shut off the gas supply when the device is disconnected.

REFRIGERANT: A substance used to produce refrigeration by its expansion or evaporation.

REFRIGERANT COMPRESSOR: A specific machine, with or without accessories, for compressing a given refrigerant vapor.

REFRIGERATING SYSTEM: A combination of interconnected refrigerant-containing parts constituting one closed refrigerant circuit in which a refrigerant is circulated for the purpose of extracting heat. In a direct cooling system, the refrigeration is circulated through a heat exchanger located in an air passage. In an indirect cooling system. a secondary working fluid is cooled by the refrigerating system and circulated through a heat exchanger located in an air passage.

REGULATOR: A device for reducing, controlling and maintaining the pressure in a portion of a piping system downstream of the device.

REGULATOR VENT: The opening in the atmospheric side of the regulator housing permitting the movement of air to compensate for the movement of the regulator diaphragm.

RETURN AIR: Air removed from a conditioned space through openings, ducts, plenums or concealed spaces to the heat exchanger of a heating, cooling or ventilating system.

ROOM HEATER: A freestanding heating appliance installed in the space being heated and not connected to ducts.

SERVICE PIPING: The piping and equipment between the street gas main and the gas-piping system inlet, which is installed by and is under the control and maintenance of the serving gas supplier.

SMOKE-DEVELOPED RATING: A numerical index indicating the relative density of smoke produced by burning assigned to a material tested in accordance with ASTM E 84.

SUPPLY AIR: Air delivered to a conditioned space through ducts or plenums from the heat exchanger of a heating, cooling or ventilating system.

TYPE B VENT: A listed and labeled vent conforming to UL 441 for venting gas appliances with draft hoods and other gas appliances listed for use with Type B vents.

TYPE BW VENT: A listed and labeled vent conforming to UL 1 441 for venting gas-fired vented wall furnaces listed for use with Type BW vents.

TYPE L VENT: A listed and labeled vent conforming to UL 641 for venting oil-burning appliances listed for use with Type L vents or with listed gas appliances.

UNUSUALLY TIGHT CONSTRUCTION: Construction in which:

1. Walls and ceilings exposed to the outside atmosphere have a continuous water vapor retarder with a rating of one perm [57.4 ng/(s-m2 Pa)] or less with openings gasketed or sealed, and
2. Weatherstripping has been added on openable windows and doors, and
3. Caulking or sealants are applied to areas such as joints around window and door frames between sole plates and floors, between wall-ceiling joints, between wall panels, at penetrations for plumbing, electrical and gas lines, and at other openings.

VENT: A passageway for conveying flue gases from fuel-fired appliances, or their vent connectors, to the outside atmosphere.

VENT COLLAR: see "flue collar."

VENT CONNECTOR: That portion of a venting system which connects the flue collar or draft hood of an appliance to a vent.

VENT DAMPER DEVICE, AUTOMATIC: A device intended for installation in the venting system, in the outlet of or downstream of the appliance draft hood, of an individual, automatically operated fuel-burning appliance and which is designed to automatically open the venting system when the appliance is in operation and to automatically close off the venting system when the appliance is in a standby or shutdown condition.

VENT GASES: Products of combustion from fuel-burning appliances, plus excess air and dilution air, in the venting system above the draft hood or draft regulator.

VENTED GAS APPLIANCE CATEGORIES: The following categories are used to differentiate gas utilization equipment according to vent pressure and flue gas temperature.

Category I. An appliance that operates with a nonpositive vent connector pressure and with

a flue gas temperature at least 140°F (60°C) above its dewpoint.

Category II. An appliance that operates with a nonpositive vent connector pressure and with a flue gas temperature less than 140°F (60°C) above its dewpoint.

Category III. An appliance that operates with a positive vent pressure and with a flue gas temperature at least 140°F (60°C) above its dewpoint.

Category IV. An appliance that operates with a positive vent pressure and with a flue gas temperature less than 140°F (60°C) above its dewpoint.

VENTILATION: The process of supplying or removing conditioned or unconditioned air by natural or mechanical means to or from any space.

VENTING: Removal of combustion products to the outdoors.

WATER HEATER: A closed vessel in which water is heated by the combustion of fuels, electricity or other energy source and withdrawn for use external to the vessel at pressures not exceeding 160 psig (1102 kPa gage), including the apparatus by which heat is generated and all controls and devices necessary to prevent water temperatures from exceeding 210°F (99°C).

NON-TEXT PAGE

GENERAL MECHANICAL SYSTEM REQUIREMENTS

(This Section is Entirely Unique to Massachusetts)

3613.1 GENERAL

3613.1.1 Scope: The provisions of 780 CMR 3613.0 shall govern the installation of mechanical systems not specifically addressed elsewhere in 780 CMR 36.

780 CMR 3613.2 APPROVAL

3613.2.1 Heating and cooling appliances: Fossil-fueled heating and cooling appliances shall be listed and bear the label of an approved agency in accordance with the requirements of 527 CMR or 248 CMR as applicable; other heating and cooling appliances not under the jurisdictional control of 527 CMR or 248 CMR shall be provided with listing labeling information as set forth in 780 CMR 3613.3.1, 3613.3.2, or 3613.3.3 as applicable or otherwise be approved by the BBRS when such approval is necessary.

Note: for solid fuel-burning appliances, see 780 CMR 3610.

780 CMR 3613.3 LABELING OF EQUIPMENT NOT UNDER THE CONTROL OF 527 CMR OR 248 CMR

3613.3.1 General: All appliances shall bear a permanent and legible factory-applied label which shall include the following information:

1. Name or trademark of the manufacturer.
2. The model and serial number.
3. Identity of the agency certifying compliance of equipment with approved standards.
4. Clearances from combustible construction for heat-producing appliances.

3613.3.2 Fuel-burning appliances: The listing and label for fuel-burning appliances, except wood stoves and fireplaces (for solid fuel-burning appliances and fireplaces see 780 CMR 3610.1), shall also indicate:

1. The type of fuel approved for use with the appliance.
2. The input or output ratings.
3. Instructions for the lighting operation and shut off of the appliance.

3613.3.3 Other than fuel-burning appliances: When the design, installation and maintanence of other than fuel-burning appliances falls under the jurisdiction of 780 CMR, the listing and label for such appliances shall also indicate:

1. The output rating in Btu/h or kw.
2. The electrical rating in volts, amperes (or watts) and, for other than single phase, the number of phases.
3. The electrical rating in volts, amperes or watts of each field-replaceable electrical component.
4. Amount and type of refrigerant, and factory test pressures or pressures applied for heat pumps and refrigeration cooling equipment.

780 CMR 3613.4 TYPE OF FUEL

3613.4.1 Appliances: Each appliance shall be designed for use with the type of fuel to which it is to be connected. Appliances shall not be converted from fuel specified on the rating plate for use with a different fuel without conforming to the applicable requirements of 527 CMR or 248 CMR for oil or gaseous fuels respectivley or otherwise securing approval from the BBRS for other types of appliances.

780 CMR 3613.5 APPLIANCE ACCESS

1305.1 Appliance access for inspection service, repair and replacement: Fossil fueled appliances shall conform to the access requirements set fort in 527 CMR or 248 CMR as applicable; additionally, all appliances shall be accessible for inspection, service, repair and replacement without removing permanent construction. In the absence of manufacturer's listing/installation requirements, thirty inches (762 mm) of working space and platform shall be provided in front of the control side to service an appliance not otherwise under the jurisdictional control of 527 CMR or 248 CMR .

Note: solid-fuel burning appliances shall comply with the applicable requirements of 780 CMR 3610.

780 CMR 3613.6 CLEARANCES FROM COMBUSTIBLE CONSTRUCTION

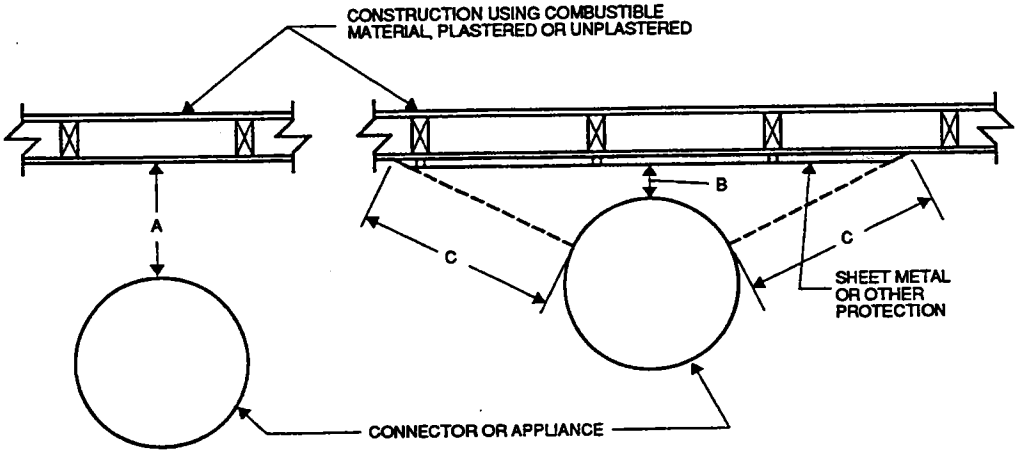
3613.6.1 Appliance clearance: Appliances shall comply with the clearance requirements of 527 CMR or 248 CMR as applicable or: if not under the jurisdictional control of 527 CMR or 248 CMR shall have clearances from combustible materials in accordance the manufacturer's listing requirements or in the absence of such information, in accordance with Figure 3613.6.1 and Tables 3613.6.1a and 3613.6.1b as applicable. Forms of protection with ventilated air space shall conform to the following requirements:

1. Not less than one-inch (25 mm) air space shall be provided between the protection and combustible wall surface.
2. Air circulation shall be provided by having edges of the wall protection open at least one inch (25 mm).
3. If the wall protection is mounted on a single flat wall away from corners, air circulation shall be provided by having the bottom and top edges, or the side and top edges open at least one inch (25 mm).
4. Wall protection covering two walls in a corner shall be open at the bottom and top edges at least one inch (25 mm).

780 CMR 3613.7 APPLIANCE INSTALLATION

3613.7.1 General: Fossil fuel-fired appliances shall be installed in accordance with the applicable requirements of 527 CMR or 248 CMR. The installation of appliances not under the jurisdictional control of 527 CMR or 248 CMR shall conform to the conditions of the manufacturer's listing/ installaion requirements. The manufacturer's operating instructions shall remain attached to the appliance or otherwise be provided to the installer and end-user of such appliances.

FIGURE 3613.6.1 - REDUCED CLEARANCE DIAGRAM



Note:
"A" equals the required clearance with no protection, specified in Table 3613.6.1a. "B" equals the reduced clearance permitted with Table 3613.6.1b. The protection applied to the construction using combustible material shall extend far enough in each direction to make "C" equal to "A".

TABLE 3613.6.1a
STANDARD INSTALLATION CLEARANCES FOR HEATING APPLIANCE[1]

RESEDENTIAL-TYPE APPLIANCES	CLEARANCE (inches)			
	Above Top[2]	From Front	From Back	From Sides
Boilers and Water Heaters:				
Automatic oil or combination gas and oil-	6	24	6	6
Automatic gas-	6	18	6	6
Solid-	6	48	6	6
Electric-	6	18	6	6
Central Furnaces:				
Automatic oil or combination gas and oil-	6	24	6	6
Automatic gas-	6	18	6	6
Solid-	18	48	18	18
Electric-	6	18	6	6
Floor Furnaces:				
Automatic oil or combination gas and oil-	36	12	12	12
Automatic gas-	36	12	12	12
Room Heaters:[3]				
Circulating type:				
Oil or solid fuel-	36	24	12	12
Gas-	36	24	12	12
Radiant or other type:				
Oil or solid fuel-	36	36	36	36
Gas-	36	36	18	18
Gas with double metal or ceramic back-	36	36	12	18
Fireplace stove:				
Solid fuel-	48	54	48	48

For SI: 1 inch = 25.4 mm.

1. Reductions in the required clearance shall be permitted in accordance with Table 3613.6.1b.
2. Same clearances required from top and sides of warm air bonnet or plenum of central furnaces.
3. Room heaters shall be installed on noncombustible floors.

TABLE 1306.1b
REDUCED CLEARANCES WITH SPECIFIED FORMS OF PROTECTION (inches)

TYPE OF PROTECTION	WHERE REQUIRED CLEARANCE WITH NO PROTECTION IS							
	36		19		12		6	
	CLEARANCE MAY BE REDUCED TO							
½-inch noncombustible insulation board over one-inch glass fiber or mineral wood butts with no air space	Wall	Ceiling	Wall	Ceiling	Wall	Ceiling	Wall	Ceiling
	18	24	9	12	6	8	3	4
½-inch-thick noncomnustible insulation board with ventilated air space	12	18	6	9	4	6	2	3
24-gage sheet metal with ventilated air space	12	18	6	9	4	6	2	3
3½-inch thick masonry wall with air space	12	-	6	-	4	-	2	-

For SI: = 1 inch = 25.4 mm, 1 pound per cubic foot = 0.1572 kN/m^3, °F = 1.8 °C + 32, 1 (Btu-inch)/(square foot hour-°F) = 1.721 W/(m-K).

Notes:

1. Required clearances shall be measured as shown in Figure 3613.6.1.
2. The clearance between the appliance and the face of the protection shall not be reduced below that shown in the table. Required clearances between those shown in the table may be interpolated.
3. With all clearance reduction systems using ventilated are space, air circulation shall be provided as described in 780 CMR 3613.6.1.
4. Spacers and ties shall be noncombustible and shall not be used directly behind an appliance or a connector.
5. Mineral wood butts shall have a minimum density of eight pounds per cubic foot and a minimum melting point of 1,500°F.
6. Insulation material shall have a thermal conductivity of 1.0 (Btu-in.)/(sq. ft.-hr°F) or less.
7. A single wall connector passing through the masonry wall shall have at least ½ inch of open ventilated air space between the connector and the masonry.

3613.7.1.1 Additional installation requirements/appliances located in garages: The requirements of 527 CMR or 248 CMR shall be met when fossil fueled heating and/or cooling appliances are to be located in a garage; additionally, all appliances shall be protected from impact by automobiles. Appliances that generate a glow, spark or flame capable of igniting gasoline vapors and located in a garage shall be installed with burners, burner ignition

devices, or heating elements and switches at least 18 inches (457 mm) above the floor level or as further required by 527 CMR or 248 CMR when applicable. When such appliances are enclosed in a separate compartment having access only from outside of the garage, such appliances may be installed at floor level, provided that the required combustion air is taken from and discharged to the exterior of the garage.

3613.7.2 Electrical appliances: Electrical appliances shall be installed in accordance with 527 CMR 12.

780 CMR 3613.8 CONTROL DEVICES

3618.8.1 Oil-fired and gas-fired appliances: See 527 CMR or 248 CMR as applicable.

3613.8.2 Electric duct heaters: Electric duct heaters shall be equipped with an automatic reset air outlet temperature-limit control that will limit the outlet air temperature to no more than 200°F (93°C). The electric elements of the heater shall be equipped with fusible links or a manual reset temperature-limit control that will prevent air temperature in the immediate vicinity of the heating elements from exceeding 25°F (121°C).

HEATING AND COOLING EQUIPMENT

(This Section is Entirely Unique to Massachusetts)

3614.1 GENERAL

3614.1.1 General: All heating and cooling appliances that are fossil-fuel fired shall conform to the requirements of 780 CMR 3614.0.

Note 1: Solid fuel burning appliances shall conform to the requirements of 780 CMR 3610.

Note 2: Boilers and water heaters shall additionally comply with the requirements of 248 CMR and 527 CMR, as applicable.

3614.1.2 Installation: Heating and cooling equipment installation shall be in accordance with the specific requirements of 527 CMR for oil fired equipment and 248 CMR for gas-fired equipment or otherwise in accordance with the general requirements of 780 CMR 36 when such equipment is not under the jurisdictional control of 527 CMR or 248 CMR.

Note 1: When explicit requirements of 527 CMR and/or 248 CMR apply, enforcement of such explicit requirements lies with the Head of the Fire Department of the jurisdiction (or his designee) for matters controlled under 527 CMR and with the Gas Inspector of the jurisdiction for matters controlled under 248 CMR.

Note 2: 248 CMR explicitly regulates the size, type, listing and installation criteria for gas-fired appliances, associated connector, equipment venting, including chimney flue size and liner criteria and combustion air and appliance venting criteria.

Note 3: 527 CMR explicitly regulates the size, type, listing and installation criteria for oil-fired appliances, associated connector piping, combustion air and appliance ventilation criteria and certain aspects of equipment venting criteria but otherwise defaults to 780 CMR for chimney flue size and liner criteria.

Note 4: Where flue liner size and/or material is otherwise not controlled by 527 CMR or 248 CMR, flue size and material type shall conform to the requirements of 780 CMR and the appliance manufacturer's listing/installation requirements.

3614.1.3 Ventilation requirements: See 780 CMR 3617.1

3614.1.4 Exhaust system requirements: See 780 CMR 3618.1.

3614.1.5 Duct construction requirements: See 780 CMR 3619.1.

3614.1.6 Combustion air requirements: See 780 CMR 3620.1.

3614.1.7 Chimney and vent requirements: See 780 CMR 3621.1 and 780 CMR 3610, generally.

3614.1.8 Access: Heating and cooling equipment shall be located relative to building construction and other equipment in such manner as to permit maintenance, servicing and replacement. Refer to the specific requirements of 527 CMR or 248 CMR as applicable; otherwise such equipment access shall comply to applicable requirements of 780 CMR 36 and the manufacturer's specific listing/installation requirements.

3614.1.9 Sizing: Comfort heating and cooling equipment shall be sized according 780 CMR 3603.21.

3614.1.10 Heating and cooling equipment room installations: Refer to the specific requirements of 527 CMR or 248 CMR as applicable or otherwise such installations shall comply to applicable requirements of 780 CMR 36 and the manufacturer's specific listing/installation requirements.

3614.1.10.1 Additional installation requirements/attic installations: Refer to the specific requirements of 527 CMR or 248 CMR as applicable; otherwise such installations shall comply to applicable requirements of 780 CMR 36 and the manufacturer's specific listing/ installation requirements.

Note that attic installation of heating equipment and associated duct/piping requires care that heating system heat loss to the attic space does not lead to roof winter ice damming. Materials acceptable to the building official shall be presented to demonstrate that heating system heat loss to the attic space will not result in heat loss to the space sufficient to promote roof ice damming. To reduce heat loss to the attic space, if the attic heating system is insulated or placed in an isolated, insulated space, such approach shall in no way violate manufacturer's listing requirements of the heating equipment nor preclude proper combustion air, ventilation or exhaust of such equipment and/or space.

3614.1.10.1.1 Electricity required: For attic installations, a permanent electric outlet and lighting fixture shall be provided near the equipment which shall be controlled by a switch and installed in accordance with 527 CMR 12.00.

3614.1.10.2 Additional installation requirements/crawl space installations: Refer to 527 CMR or 248 CMR as applicable or in the absence of such jurisdictional guidance, equipment supported from the ground shall be level and firmly supported on frost-protected construction extending not less than three inches (76 mm) above the adjoining ground. Equipment suspended from the floor shall have a clearance of not less than six inches (153 mm) from the ground.

3614.1.10.2.1 Electricity required: A permanent electric outlet and lighting fixture shall be provided near the equipment controlled by a switch and installed in accordance with 527 CMR 12.

3614.1.10.3 Additional installation requirements/exterior installations: Refer to the specific requirements of 527 CMR or 248 CMR as applicable, or in the absence of such jurisdictional guidance such supports and foundations shall prevent excessive vibration, settlement, or movement of the equipment. Supports and foundations shall be level and conform to the manufacturer's installation instructions and be frost-protected.

780 CMR 3614.1.11 - Fossil fired furnaces and boilers:

3614.1.11.1 General: All fossil-fired furnaces and boilers shall conform to the requirements of 527 CMR or 248 CMR as applicable. Such furnaces and boilers shall not be installed in a room designed to be used as a storage closet unless allowed by both the manufacturer and by either 527 CMR or 248 CMR as applicable. Furnaces and boilers located in a bedroom or bathroom shall be installed in a sealed enclosure such that combustion air will not be taken from the living space unless such furnaces or boilers are of a direct vent type.

Exception: Unless required by 527 CMR or 248 CMR, direct vent furnaces are not required to be installed within an enclosure.

3614.1.11.1.1 Clearances: Refer to the specific requirements of 527 CMR or 248 CMR as applicable, or otherwise clearances to combustibles shall comply with applicable requirements of 780 CMR 36 and the manufacturer's specific listing/installation requirements.

3614.1.12 Electric furnaces: Electric furnaces shall be constructed in accordance with UL 1096. Electric furnaces shall be installed in compliance with 780 CMR 36, their listing, the manufacturer's installation instructions and 527 CMR 12.00.

780 CMR 3614.2 HEAT PUMP EQUIPMENT

3614.2.1 Heating elements: Heat pump equipment utilizing supplemental electric heating elements shall have such elements constructed in accordance with UL 559 and installed in accordance with 527 CMR 12.00.

3614.2.1 Foundations and supports: Supports and foundations for the outdoor unit of a heat pump shall be raised at least three inches (76 mm) above the ground to permit free drainage of defrost water, shall conform to the manufacturer's installation instructions and be frost-protected.

780 CMR 3614.3 REFRIGERATION COOLING EQUIPMENT

3614.3.1 Compliance: When applicable, refrigeration cooling equipment and its installation shall comply with M.G.L. c. 146, §§ 42 through 45A, 81 and 528 CMR 11.

ELECTRIC RESISTANCE HEATING

780 CMR 3615.1 GENERAL

3615.1.1 General: Electric baseboard convectors shall be listed and labeled and shall be installed in accordance with the manufacturer's installation instructions and 527 CMR 12.00.

780 CMR 3615.2 RADIANT HEATING SYSTEMS

3615.2.1 General: Radiant heating systems shall be listed and labeled and shall be installed in accordance with the manufacturer's installation instructions and 527 CMR 12.00.

3615.2.2 Clearances: Clearances for radiant heating panels or elements to any wiring, outlet boxes, and junction boxes used for installing electrical devices or mounting lighting fixtures shall comply with manufacturer's listing requirements and 527 CMR 12.00.

3615.2.3 Installation of radiant panels on wood framing: Radiant panels installed on wood framing shall only be so installed if so listed by the manufacturer and additionally shall conform to the following requirements:

1. Heating panels shall be installed parallel to framing members and secured to the surface of framing members or mounted between framing members.
2. Panels shall be nailed or stapled only though the unheated portions provided for this purpose and shall not be fastened at any point closer than ¼ inch (6.4 mm) from an element.
3. Unless listed and labeled for field cutting, heating panels shall be installed as complete units.

3615.2.4 Installation of radiant panels in concrete or masonry: Radiant heating systems installed in concrete or masonry shall only installed if so listed by the manufacturer and additionally conform to the following requirements:

1. Radiant heating systems shall be identified as being suitable for the installation and shall be secured in place as specified in the manufacturer's installation instructions.
2. Radiant heating panels or radiant heating panel sets shall not be installed where they bridge expansion joints unless protected from expansion and contraction.

3615.2.5 Installation of radiant panels in gypsum assemblies: Radiant heating systems shall only be used in gypsum assemblies when so listed by the manufacturer and such panel operating temperatures shall not exceed 125°F (52°C).

3615.2.6 Finish surfaces: Finish materials installed over radiant heating panels or systems shall be installed in accordance with the manufacturer's installation instructions. Surfaces shall be secured so that nails or other fastenings do not pierce the radiant heating elements.

780 CMR 3615.3 DUCT HEATERS

3615.3.1 General: Electric duct heaters shall be listed and labeled and shall be installed in accordance with the manufacturer's installation instructions and 527 CMR 12.

3615.3.2 Installation: Electric duct heaters shall be installed so that they will not create a fire hazard. Class I ducts, duct coverings and linings shall be interrupted at each heater to provide the clearances specified in the manufacturer's installation instructions. Such interruptions are not required for duct heaters listed and labeled for zero clearance from combustible materials. Insulation installed in the immediate area of each heater shall be classified for the maximum temperature produced on the duct surface.

3615.3.3 Installation with heat pumps and air conditioners: Duct heaters located within four feet (1219 mm) of a heat pump or air conditioner shall be listed and labeled for such installations. The heat pump or air conditioner shall additionally be listed and labeled for such duct heater installations.

3615.3.4 Access: Duct heaters shall be accessible for servicing, and clearance shall be maintained to permit adjustment, servicing, and replacement of controls and heating elements in accordance with the manufacturer's listing/installation requirements and otherwise in accordance with any applicable requirements of 780 CMR 36.

NON-TEXT PAGE

VENTED FLOOR, WALL AND ROOM HEATERS

780 CMR 3616.1 GENERAL

3616.1.1 General: Vented floor furnaces, vented wall furnaces and room heaters shall conform to the listing, design, installation and maintenance requirements of 527 CMR or 248 CMR and otherwise shall be installed in accordance with applicable requirements of 780 CMR 36 and the manufacturer's listing/installation instructions.

Exception: Solid fuel burning appliances shall conform to the requirements of 780 CMR 3610.

3616.1.2 Clearances: Vented floor furnaces, vented wall furnaces and room heaters shall be installed in accordance with clearance installation requirements of 527 CMR or 248 CMR and otherwise installed in accordance with the applicable requirements of 780 CMR 36 and the manufacturer's listing /installation requirements.

3616.1.3 Location: Location of vented floor furnaces, vented wall furnaces and room heaters shall conform to the requirements of 527 CMR or 248 CMR and otherwise be installed in accordance with the applicable requirements of 780 CMR 36 and the manufacturer's listing/installation requirements.

3616.1.4 Access: Access to vented floor furnaces, vented wall furnaces and room heaters shall be in accordance with the requirements of 527 CMR or 248 CMR and otherwise shall be provided in accordance with the applicable requirements of 780 CMR 36 and the manufacturer's listing /installation requirements.

3616.1.5 Installation: Vented floor furnace, vented wall furnace and room heater installations shall conform to the requirements of 527 CMR or 248 CMR and otherwise conform with the applicable requirements of 780 CMR 36 and the manufacturer's listing/installation requirements.

780 CMR 3616.2 VENTED WALL FURNACES/ADDITIONAL REQUIREMENTS

3616.2.1 Location: The location of vented wall furnaces falling under the jurisdiction of 780 CMR 3616.1.6 shall conform to the following requirements:

1. Vented wall furnaces shall be located not less than six inches (153 mm) from adjoining walls at inside corners.
2. Vented wall furnaces shall not be located where a door can swing within 12 inches (305 mm) of the furnace air inlet or outlet and shall not be installed less than 18 inches (457 mm) below overhead projections.

3616.2.2 Installation: Vented wall furnace installations shall conform to the following requirements:

1. Required wall thicknesses shall be in accordance with the manufacturer's installation instructions.
2. Ducts shall not be attached to a wall furnace. Casing extensions or boots shall only be installed when listed as part of a listed and labeled appliance.

780 CMR 3616.3 VENTED ROOM HEATERS/ADDITIONAL REQUIREMENTS

3616.3.1 Location: A room heater shall be placed so as not to cause a hazard to walls, floors, curtains and drapes, or to the free movement of persons.

3616.3.2 Installation: Room heaters shall be installed on noncombustible floors or on approved *floor protectors* for combustible floors (see 780 CMR 3610). Such *floor protectors* shall be constructed of noncombustible materials. The noncombustible floor or *floor protector* shall extend at least 16" beyond the appliance on all sides unless the room heater manufacturer has listing/installation requirements that allow for less than an 18" extension.

3616.3.3 Solid-fuel-burning heaters. See 780 CMR 3616.10.

NON-TEXT PAGE

VENTILATION AIR SUPPLY

3617.1.1 Ventilation required: General building ventilation shall be in accordance with 780 CMR 3603.6 unless specific appliance ventilation requirements impose greater ventilation criteria on a building space, in which case the ventilation criteria, as dictated by appliance requirements shall apply.

NON-TEXT PAGE

EXHAUST SYSTEMS

780 CMR3618.1 CLOTHES DRYER EXHAUST

3618.1.1 General: Dryer vent systems shall be independent of all other systems and shall convey the moisture to the outdoors - no dryer vent shall terminate in the interior space of a building unless such dryer system is listed for such application and has been approved by the BBRS if necessary; additionally, the following criteria shall be satisfied:

1. Gas fired clothes dryers shall be installed in accordance with the requirements of 248 CMR, and such exhaust vent systems shall also have a backdraft damper located on the building interior side of the vent termination unless otherwise prohibited by listing or by 248 CMR;
2. For clothes dryers generally, vents shall not be connected with sheet-metal screws or fastening means which extend into the vent. Exhaust vents shall be equipped with a backdraft damper. Vents shall be constructed of minimum 0.016-inch-thick (0.406 mm) rigid metal ducts, having smooth interior surfaces with joints running in the direction of air flow, except that;
3. Approved flexible duct connectors may be used in connection with domestic dryer exhausts unless otherwise prohibited by equipment listing or 248 CMR. Flexible duct connectors shall not be concealed within construction.

3618.1.2 Exhaust vent size: The minimum diameter of the exhaust vent shall be in accordance with 780 CMR 3618.1.3, but shall be at least the diameter of the appliance outlet.

3618.1.3 Length limitation: The maximum length of a four-inch (102 mm) diameter exhaust vent shall not exceed 25 feet (7620 mm) from the dryer location to wall or roof termination, and shall terminate with a full opening exhaust hood. A reduction in maximum length of 2.5 feet (762 mm) for each 45-degree bend and five feet (1524 mm) for each 90-degree bend shall apply. Installations when this length is exceeded shall be installed in accordance with the manufacturer's installation instructions.

780 CMR 3618.2 RANGE HOODS

3618.2.1 General: Gas-fired appliances shall conform to the requirements of 248 CMR and otherwise all range hoods shall be vented to the outdoors by a single-wall duct constructed of galvanized steel, stainless steel or copper. The duct serving the hood shall have a smooth interior surface, be substantially air tight and shall be equipped with a backdraft damper. Vents serving range hoods shall not terminate in an attic or crawl space or areas inside the building but shall vent directly to the building exterior.

Exception: Listed labeled unvented range hoods shall be allowed and shall be installed in accordance with the terms of their listing.

780 CMR 3618.3 INSTALLATION OF MICROWAVE OVENS

3618.3.1 Installation of microwave oven over a cooking appliance: The installation of a listed and labeled cooking appliance or microwave oven over a listed and labeled cooking appliance shall conform to the terms of the upper appliance's listing and label and the manufacturer's installation instructions.

780 CMR 3618.4 OVERHEAD VENTILATING HOODS

3618.4.1 General: Gas-fired appliances shall conform to the requirements of 248 CMR and otherwise domestic open-top broiler units shall be provided with a metal ventilating hood, not less than 28 gage, with a clearance of not less than ¼ inch (6.4 mm) between the hood and the underside of combustible material or cabinets. A clearance of at least 24 inches (610 mm) shall be maintained between the cooking surface and the combustible material or cabinet. The hood shall be at least as wide as the broiler unit and shall extend over the entire unit.

Exception: Broiler units incorporating an integral exhaust system, and listed and labeled for use without a ventilating hood, need not be provided with a ventilating hood.

NON-TEXT PAGE

DUCT SYSTEMS

780 CMR 3619.1 DUCT CONSTRUCTION

3619.1.1 Materials - duct construction: Ducts and duct materials used for a duct serving heating and cooling equipment shall be fabricated in accordance with the provisions of 780 CMR 3619.1.

3619.1.1.1 Above ground duct systems: Above ground duct systems shall conform to the following:

1. Equipment connected to duct systems shall have a 250°F (121°C) temperature limit control.
2. Factory-made air ducts shall be constructed of Class 1 or Class 2 materials as designated in Table 3619.1.1a. Class 2 materials shall not be used for ducts located within the first three feet (914 mm) of the bonnet, plenum or casing of the heating unit.
3. Minimum thicknesses of metal duct material shall be listed in Table 3619.1.1b. Galvanized steel shall conform to ASTM A 525.
4. Gypsum products may be used as ducts or plenums, provided that the air temperature does not exceed 125°F (52°C) and exposed surfaces are not subject to condensation.
5. Return ducts, except those portions directly above the heating surface or closer than two feet (610 mm) to the heating unit casing, shall be constructed of materials having a flame-spread rating not greater than 200.
6. Structural areas between studs or partitions to be used as return ducts shall be isolated from unused spaces with tight-fitting stops of sheet metal, or with wood not less than 2-inch (51 mm) nominal thickness.

3619.1.1.2 Underground duct systems. Underground duct systems shall be constructed of approved concrete, clay, metal or plastic. The maximum duct temperature for plastic ducts shall not be greater than 150°F (66°C). Plastic pipe and fittings shall conform to cell classification 12454-B of ASTM D 1248 or ASTM D 1784, and external loading properties of ASTM D 2412.

3619.1.2 Factory-made ducts: Factory-made air ducts or duct material shall be approved for the use intended, and shall be installed in accordance with the manufacturer's installation instructions. Each portion of a factory-made air duct system shall bear a listing and label indicating compliance with UL 181 and UL 181A.

3619.1.2.1 Duct insulation materials: Duct insulation materials shall conform to the following requirements:

1. Duct insulation shall comply with the energy conservation requirements of 780 CMR 3603.21.;
2. Duct coverings and linings shall have a flame-spread rating not greater than 25, and a smoke-developed rating not greater than 50.
3. Duct coverings and duct linings shall withstand a test temperature of 250°F (121°C) minimum.
4. Blanket insulation and factory-insulated flexible duct shall be labeled with the R-value, flame-spread rating, and smoke-developed rating.

3619.1.2.2 Vibration isolators: Vibration isolators installed between mechanical equipment and metal ducts shall be fabricated from approved materials and shall not exceed ten inches (254 mm) in length.

3619.1.3 Installation: Duct installation shall comply with 780 CMR 3619.1.3.1 through 3619.1.3.8.

3619.1.3.1 Duct sizing: Supply and return ducts shall be sized according to ACCA Manual D or SMACNA Installation Standards for Residential Heating and Air Conditioning Systems or other approved methods.

3619.1.3.2 Joints and seams. Joints of duct systems shall be made substantially air tight by means of tapes, mastics or gasketing. Crimp joints for round ducts shall have a contact lap of at least 1½ inches (38 mm) and shall be mechanically fastened by means of at least three sheet metal screws equally spaced around the joint.

TABLE 3619.1.1a
CLASSIFICATION OF FACTORY-MADE AIR DUCTS

DUCT CLASS	MAXIMUM FLAME SPREAD RATING
0	0
1	25
2	50

TABLE 3619 1.1b
GAGES OF METAL DUCTS AND PLENUMS USED FOR HEATING OR COOLING

TYPE OF DUCT	SIZE (INCHES)	NOMINAL THICKNESS (inches)	EQUIVALENT GALVANIZED SHEET GAGE	APPROXIMATE ALUMINUM B. & S. GAGE
Round ducts and enclosed rectangular ducts	14 or less	0.016	30	26
	over 14	0.019	28	24
Exposed rectangular ducts	14 or less	0.019	28	24
	over 14	0.022	26	22

For SI: 1 inch = 25.4 mm.

3619.1.3.3 Support: Metal ducts shall be supported by one-inch (2mm) by 18-gage metal straps, 12-gage galvanized wire at intervals not exceeding ten feet (3048 mm). Nonmetallic ducts shall be supported in accordance with the manufacturer's installation instructions.

3619.1.3.4 Firestopping: Duct installations shall be firestopped in accordance with 780 CMR 3606.2.7.

3619.1.3.5 Duct insulation: Duct insulation shall be installed in accordance with the following requirements:

1. All ductwork shall be insulated in accordance with 780 CMR 3603.21.
2. Vapor retarders with a maximum permeance of 0.05 perm [(2.87 ng/(s m2 Pa)], or aluminum foil with a minimum thickness of two mils (0.051 mm), shall be installed on cooling supply ducts that pass through nonconditioned spaces conducive to condensation.
3. Exterior ducts shall be protected with weatherproof covering capable of ultraviolet (UV) protection.
4. Duct coverings shall not penetrate a firestopped wall or floor.

3619.1.3.6 Ducts in slabs: Ducts shall be listed and labeled for underground installation. Metallic ducts not having an approved protective coating shall be completely encased in a minimum of two inches (51 mm) of concrete. Metallic ducts having an approved protective coating and nonmetallic ducts shall be installed in accordance with the manufacturer's installation instructions.

3619.1.3.7 Factory-made air ducts: Factory-made air ducts shall not be installed in or on the ground, in tile or metal pipe, or within masonry or concrete.

3619.1.3.8 Metal duct separation: Metal ducts shall be installed with at least four inches (102 mm) separation from earth.

3619.1.4 Under-floor plenums: An under-floor space used as a supply plenum shall conform to the requirements of 780 CMR 3619.1.4. Fuel gas lines and plumbing waste cleanouts shall not be located within the space.

3619.1.4.1 General: The space shall be cleaned of loose combustible materials and scrap, and shall be tightly enclosed. The ground surface of the space shall be covered with a moisture barrier having a minimum thickness of four mils (0.102 mm).

3619.1.4.2 Materials: The under-floor space, including the sidewall insulation, shall be formed by materials having flamespread ratings not greater than 200.

3619.1.4.3 Furnace connections: A duct shall extend from the furnace supply outlet to not less than sixinches (153 mm) below the combustible framing. This duct shall comply with the provisions of 780 CMR 3616.2.1. A noncombustible receptacle shall be installed below the floor opening into the plenum in accordance with the following requirements:

1. The receptacle shall be securely suspended from the floor members and shall not be more than 18 inches (457 mm) below the floor opening.
2. The area of the receptacle shall extend three inches (76 mm) beyond the opening on all sides.
3. The perimeter of the receptacle shall have a vertical lip at least one inch (25 mm) high at the open sides.

3619.1.4.4 Access: Access to an under-floor plenum shall be provided through an opening in the floor with minimum dimensions of 18 inches by 24 inches (457 mm by 610 mm).

3619.1.4.5 Furnace controls: Furnace controls shall conform to the applicable requirements of 527 CMR or 248 CMR

Exception: For solid fuel burning appliances see 780 CMR 3610.

780 CMR 3619.2 RETURN AIR

3619.2.1 Return air: Return air shall be taken from inside the dwelling, but may be diluted with outdoor air.

3619.2.2 Required area: The total unobstructed area of return ducts or openings to a warm-air furnace shall be in accordance with the manufacturer's installation instructions, but not less than two square inches (1290 mm^2) for each 1,000

Btu/h (293 W) input rating of the furnace. The minimum unobstructed total area of the return air ducts or openings to a central air-conditioning unit and/or heat pump shall be in accordance with the manufacturer's installation instructions, but shall not be less than six square inches (3870 mm^2) for each 1,000 Btu/h (293 W) nominal cooling output rating.

3619.2.3 Prohibited sources: Return air for a warm-air furnace shall not be taken from bathrooms, kitchens, garages or other dwelling units. Outdoor air shall not be taken from within ten feet (3048 mm) of an appliance or plumbing vent outlet that is located less than three feet (914 mm) above the air inlet.

3619.2.4 Inlet opening protection: Outdoor air inlets shall be covered with screen having no less than ¼-inch (6.4 mm) openings and no greater than ½-inch (12.7 mm) openings.

780 CMR 3619.3 - SUPPLY AIR

3619.3.1 General: The minimum unobstructed total area of supply ducts from a warm-air furnace shall be in accordance with the manufacturer's installation instructions, but shall not be less than two square inches (1290 mm^2) for each 1,000 Btu/h (293 W) input rating of the furnace. The minimum unobstructed total area of the supply air ducts from a central air-conditioning unit and/or heat pump shall be in accordance with the manufacturer's installation instructions, but shall not be less than six square inches (3870 mm^2) for each 1,000 Btu/h (293 W) nominal cooling output rating. Dampers, grilles or registers installed for the purpose of controlling the supply airflow shall not be considered as obstructions.

NON-TEXT PAGE

COMBUSTION AIR

3620.1 General: Combustion air requirements of 780 CMR 3620 are intended to apply only when the requirements of 248 CMR or 527 CMR, as applicable, do not apply.

3620.1.1 Air supply: Fuel-burning equipment shall be provided with a supply of air for fuel combustion, draft hood dilution and ventilation of the space in which the equipment is installed. The methods of providing combustion air in this chapter do not apply to direct vent appliances, listed cooking appliances, refrigerators and domestic clothes dryers.

3620.1.1.1 Buildings of unusually tight construction: In buildings of unusually tight construction, combustion air shall be obtained from outside the sealed thermal envelope. In buildings of ordinary tightness insofar as infiltration is concerned, all or a portion of the combustion air for fuel-burning appliances may be obtained from infiltration when the room or space has a volume of 50 cubic feet per 1,000 Btu/h (4.83 L/W) input.

3620.1.2 Exhaust and ventilation system: Air requirements for operation of exhaust fans, kitchen ventilation systems, clothes dryers, and fireplaces shall be considered in determining the adequacy of a space to provide combustion air.

3620.1.3 Volume dampers prohibited: Volume dampers shall not be installed in combustion air openings.

3620.1.4 Prohibited sources: Combustion air ducts and openings shall not connect appliance enclosures with space in which the operation of a fan may adversely affect the flow of combustion air. Combustion air shall not be obtained from an area in which flammable vapors present a hazard.

3620.1.5 Opening area: The free area of each opening shall be used for determining combustion air. Unless otherwise specified by the manufacturer or determined by actual measurement, the free area shall be considered 75% of the gross area for metal louvers and 25% of the gross area for wood louvers.

3620.2 All air from inside the building, general: The requirements of 780 CMR 3620.2.1 through 3620.2.3 shall apply when all combustion air is taken from inside the building.

Note: also see 780 CMR 3610, generally, for fireplaces and solid fuel-burning appliances.

3620.2.1 Required volume: If the volume of the space in which fuel-burning appliances are installed is greater than 50 cubic feet per 1 ,000 Btu/h (4.83 L/W) of aggregate input rating in buildings of ordinary tightness insofar as infiltration is concerned, normal infiltration shall be regarded as adequate to provide combustion air. Rooms communicating directly with the space in which the appliances are installed through openings not furnished with doors shall be considered part of the required volume.

3620.2.2 Confined space: Where the space in which the appliance is located does not meet the criterion specified in 780 CMR 3620.2.1, two permanent openings to adjacent spaces shall be provided so that the combined volume of all spaces meets the criterion. One opening shall be within 12 inches (305 mm) of the top and one within 12 inches (305 mm) of the bottom of the space, as illustrated in Figure 3620.2.2. Each opening shall have free area equal to a minimum of one square inch per 1,000 Btu/h (2.20 mm2/W) input rating of all appliances installed within the space, but not less than 100 square inches (0.064 m^2).

3620.2.3 Unusually tight construction: If the space is of adequate volume in accordance with 780 CMR 3620.2.1 or 3620.2.2, but is within a building sealed so tightly that infiltration air is not adequate for combustion, combustion air shall be obtained from outdoors or from spaces freely communicating with the outdoors in accordance with 780 CMR 3620.3 or 3620.4.

3620.3 All combustion air from outside the building, general: The requirements of 780 CMR 3620.3.1 through 3620.3.5 shall apply when all combustion air is taken from outside the building.

3620.3.1 Outdoor air: When the space in which fuel-burning appliances are located does not meet the criterion for indoor air specified in 780 CMR 3620.2, outside combustion air shall be supplied through openings or ducts, as illustrated in Figures 3620.3.1, 3620.3.3a, 3620.3.3b and 3620.4. One opening shall be within 12 inches (305 mm) of the top of the enclosure, and one within 12 inches (305 mm) of the bottom of the enclosure. Openings are permitted to connect to spaces directly communicating with the outdoors, such as ventilated crawl spaces or ventilated attic spaces. The same duct or opening shall not serve both combustion air openings. The duct serving the upper opening shall be level or extend upward from the appliance space.

3620.3.2 Size of opening: When communicating with the outdoors by means of vertical ducts, each opening shall have a free area of at least one square inch per 4,000 Btu/h (0.550 mm^2/W) of total input rating of all appliances in the space. If horizontal ducts are used, each opening shall have a free area of at least one square inch per 2,000 Btu/h (1.10 mm^2/W) of total input of all appliances in the space. Ducts shall be of the same minimum cross-sectional area as the required free area of the openings to which they connect. The minimum cross-sectional dimension of rectangular air ducts shall be three inches (76 mm).

3620.3.3 Attic combustion air: Combustion air obtained from an attic area, as illustrated in Figure 3620.3.3a, shall be in accordance with the following:

1. The attic ventilation shall be sufficient to provide the required volume of combustion air.
2. The combustion air opening shall be provided with a metal sleeve extending from the appliance enclosure to at least six inches (153 mm) above the top of the ceiling joists and ceiling insulation.
3. An inlet air duct within an outlet air duct shall be an acceptable means of supplying attic combustion air to an appliance room provided that the inlet duct extends at least 12 inches (305 mm) above the top of the outlet duct in the attic space, as illustrated in Figure 3620.3.3b.
4. The end of ducts that terminate in an attic shall not be screened.

3620.3.4 Under-floor combustion air: Combustion air obtained from under-floor areas, as illustrated in Figure 3620.3.4, shall have a free opening area to the outside equivalent to not less than twice the required combustion air opening.

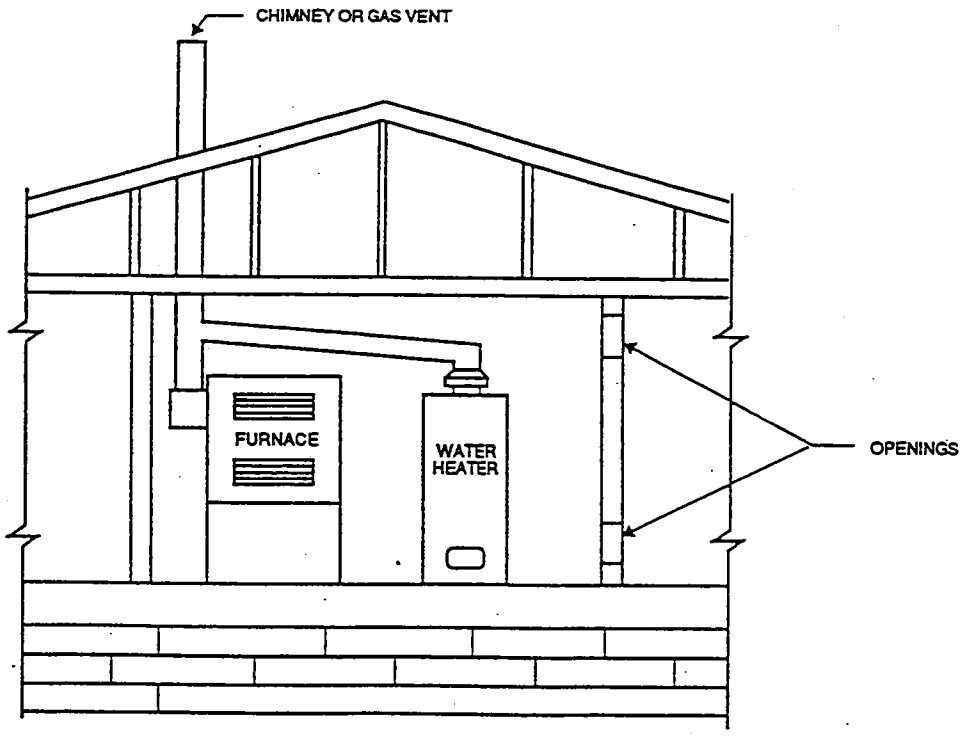
3620.3.5 Opening requirements: Outside combustion air openings shall be covered with corrosion-resistant screen or equivalent protection having no less than ¼-inch (6.4 mm) openings, and not greater than ½-inch (12.7 mm) openings.

3620.4 Combined use of indoor and outdoor air for combustion, general: The requirements of 780 CMR 3620.4.1 through 3620.4.2 shall apply when required combustion air consists of both indoor and outdoor air.

3620.4.1 Supply method: When the space in which fuel-burning appliances are located does not meet the criterion for indoor air specified in 780 CMR 3620.2, combustion air supplied by a combined use of indoor and outdoor air shall be supplied through openings and ducts extending to the appliance room or to the vicinity of the appliance.

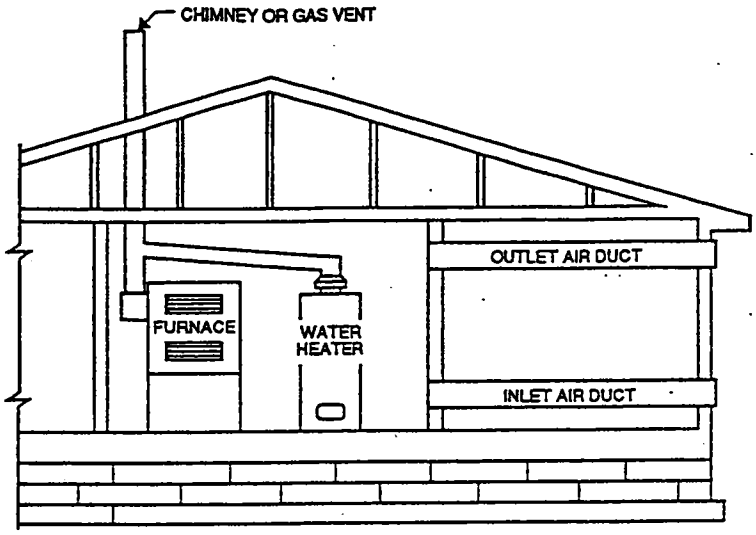
3620.4.2 Openings and supply ducts: Two openings for ventilation shall be located and sized in accordance with 780 CMR 3620.2.2. In addition, there shall be one opening directly communicating with the outdoors or to such spaces (crawl space or attic) that freely communicates with the outdoors. This opening shall have free area of at least one square inch per 5,000 Btu/h (0.440 mm^2/W) of total input of all appliances in the space. Ducts shall be of the same minimum cross-sectional area as the required free area of the opening. Ducts admitting outdoor air may be connected to the return air side of the heating system.

Figure 3620.2.2
EQUIPMENT LOCATED IN CONFINED SPACES -
ALL AIR FROM ADJACENT SPACES WITHIN THE BUILDING



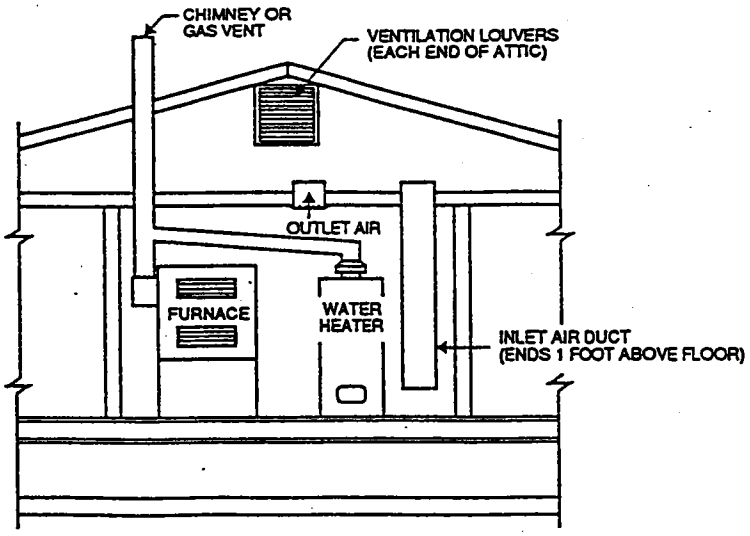
For SI: 1 square inch = 645.16 mm^2, 1 Btu/h = 0.2931 W.
NOTE: Each opening shall have a free area of not less than one square inch per 1,000 Btu/h of the total input rating of all equipment in the enclosure, but not less than 100 square inches.

Figure 3620.3.1
EQUIPMENT LOCATED IN CONFINED SPACES -
ALL AIR TAKEN FROM OUTDOORS



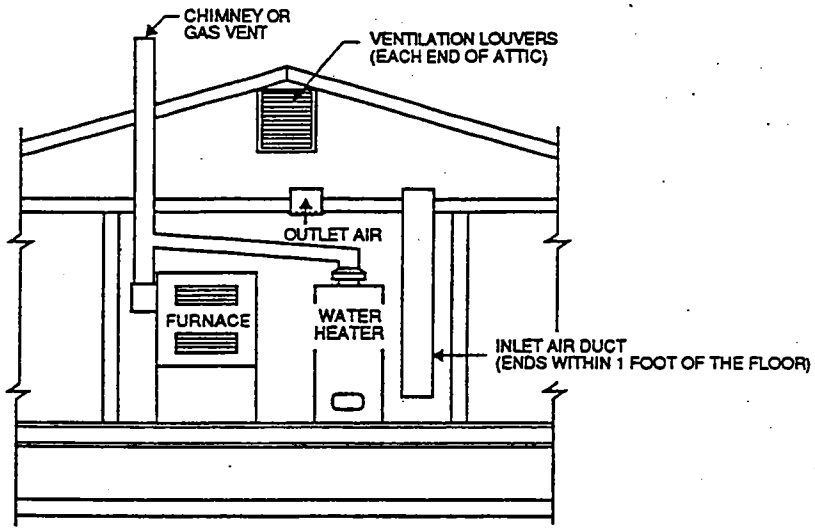
For SI: 1 Btu/h = 0.2931 W.
NOTES: Each air duct opening shall have a free area of not less than one square inch per 2,000 Btu/h of the total input rating of all equipment in the enclosure.

FIGURE 3620.3.3a
EQUIPMENT LOCATED IN CONFINED SPACES -
ALL AIR FROM OUTDOORS THROUGH VENTILATED ATTIC



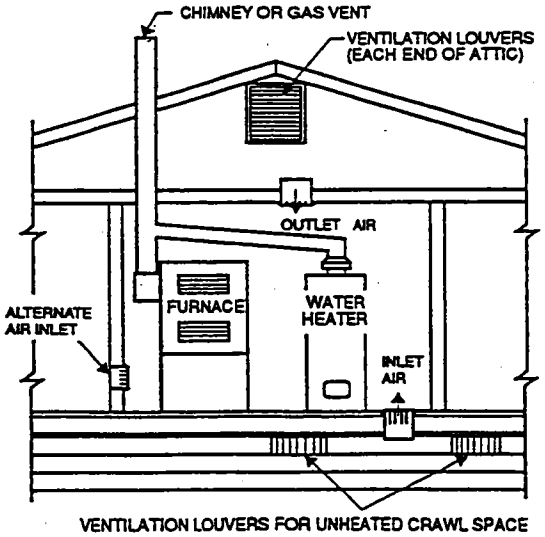
For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm^2, 1 Btu/h = 0.2931 W.
NOTE: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 Btu/h of the total input rating of all equipment in the enclosure.

Figure 3620.3.3b
EQUIPMENT LOCATED IN CONFINES SPACES -
ALL AIR FROM OUTDOORS THROUGH VENTILATED ATTIC
(Alternative Method)



For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm^2, 1 Btu/h = 0.2931 W.
NOTE: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 Btu/h of the total input of all equipment in the enclosure.

Figure 3620.4
EQUIPMENT LOCATED IN CONFINED SPACES -
INLET AIR FROM VENTILATED CRAWL SPACE AND OUTLET AIR
TO VENTILATED ATTIC



For SI: 1 square inch = 645.16 mm^2, 1 Btu/h = 0.2931 W.
NOTE: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 Btu/h of the total input of all equipment in the enclosure.

NON-TEXT PAGE

CHIMNEYS AND VENTS

3621.1 GENERAL

NOTE: The requirements of 780 CMR 3621 are to be recognized in conjunction with applicable requirements of 248 CMR and/or 527 CMR for gas-fired and oil-fired appliances respectively; also note that 248 CMR is enforced by Gas Inspectors and 527 CMR is enforced by the Heads of Fire Departments.

3621.1.1 Vent required: Fuel-burning appliances shall be vented to the outside in accordance with their listing and label and manufacturer's installation instructions. Venting systems shall consist of approved chimneys or vents, or venting assemblies which are integral parts of labeled appliances.

3621.1.2 Draft requirements: A venting system shall satisfy the draft requirement of the equipment in accordance with the manufacturer's installation instructions and shall be constructed and installed to develop a positive flow to convey combustion products to the outside atmosphere.

3621.1.3 Inspection of chimneys: Before connecting a vent connector to a chimney, the chimney passageway shall be cleaned and free of obstructions. When inspection reveals that an existing chimney is not safe for the intended application, it shall be rebuilt to conform to 780 CMR 3610.2 if the chimney is a masonry chimney (or applicable requirements of 248 CMR or 527 CMR), lined or relined with an approved liner, or replaced with an approved vent or chimney.

3621.1.4 Mechanical draft systems: A mechanical draft system shall be used only with equipment listed and labeled for such use. Provision shall be made to prevent the flow of fuel to the equipment when the draft system is not operating. Forced draft systems and all portions of induced draft systems under positive pressure during operation shall be designed and installed so as to prevent leakage of flue gases into a building.

3621.1.5 Direct vent appliances: *Direct vent* appliances shall be listed and labeled and shall be installed in accordance with the manufacturer's installation instructions

3621.1.6 Support: Venting systems shall be adequately supported for the weight of the material used.

3621.1.7 Duct penetrations: Vents or vent connectors shall not extend into or through supply and return air ducts or plenums.

3621.1.8 Firestopping: Vent and chimney installations shall be firestopped in accordance with 780 CMR 3606.2.7.

3621.1.9 Unused openings: Unused openings in any venting system shall be closed or capped.

780 CMR 3621.2 - VENT COMPONENTS

3621.2.1 Draft hoods: Unless otherwise allowed by 248 CMR or 527 CMR as applicable, draft hoods shall be located in the same room or space as the combustion air openings for the appliances.

3621.2.2 Vent dampers: Vent dampers shall comply with 780 CMR 3621.2.2.1 and 3621.2.2.2.

3621.2.2.1 Manually operated: Unless otherwise allowed by 248 CMR or 527 CMR as applicable, manually operated dampers shall not be installed except in connectors or chimneys of solid fuel-burning appliances.

3621.2.2.2 Automatically operated: Automatically operated dampers shall be installed in accordance with the requirements of 248 CMR or 527 CMR if applicable and otherwise in accordance with the terms of their listing and label and the manufacturer's requirements and shall be installed to prevent firing of the burner unless the damper is opened to a safe position. Automatic dampers shall conform to ANSI Z21.66.

3621.2.3 Draft regulators: For oil-fired appliances required to be connected to a chimney, draft regulators shall be provided as required by 527 CMR. Draft regulators provided for solid-fuel-burning appliances to reduce draft intensity shall be installed and set in accordance with the manufacturer's installation and operation requirements.

3621.2.3.1 Location: When required by 248 CMR or 527 CMR or the manufacturer's installation/operation requirements, draft regulators shall be installed in the same room or enclosure as the appliance such that no difference in pressure between the air at the regulator and the combustion air supply will exist.

780 CMR 3621.3 CHIMNEY AND VENT CONNECTORS

3621.3.1 Chimney and vent connectors: Connectors shall be used to connect fuel-burning appliances to a vertical chimney or vent unless the chimney or vent is attached directly to the appliance.

3621.3.2 Connectors for gas appliances: See 248 CMR

3621.3.3 Connectors for oil and solid fuel appliances: For connector requirements for oil-fired appliances, see 527 CMR. For solid fuel-burning appliances, connectors compatible with the listed appliance shall be utilized and may include, but not be limited to factory-built chimney material, Type L vent material, Type PL vent material or single-wall metal pipe having resistance to corrosion and heat, and thickness not less than that of galvanized steel as specified in Table 3621.3.3.

Table 3621.3.3
THICKNESS FOR SINGLE-WALL METAL PIPE CONNECTORS

Diameter of Connector (in)	Sheet Metal Gage Number
Less than 6	26
6 to 10	24

For SI: 1 inch = =25.4 mm

3621.3.4 Installation: Unless otherwise permitted by 248 CMR or 527 CMR, if applicable, the following requirements shall be met: vent and chimney connectors shall be installed in accordance with the appliance manufacturer's installation instructions and within the space that the appliance is located. Appliances shall be located as close as practical to the vent or chimney. Connectors shall be as short and straight as possible and installed with a rise of not less than ¼ inch (6.4 mm) to the foot run. Connectors shall be securely supported and joints shall be fastened with sheet metal screws and rivets. Devices that obstruct the flow of flue gases shall not be installed in a connector unless listed and labeled or approved for such installations.

3621.3.4.1 Location: When the connector serving a gas appliance with a draft hood is located in nonconditioned space, that portion of the connector shall conform to the requirements of 248 CMR.

3621.3.4.2 Floors ceiling and wall penetrations: A chimney connector or vent connector shall not pass through any floor, ceiling, wall, or partition unless the connector is listed and labeled for wall pass-through, or is routed through a device listed and labeled for wall pass-through and is installed in accordance with the conditions of its listing and label. Connectors for listed and labeled gas appliances with draft hoods, and oil-fired appliances listed and labeled for Type L vents, passing through walls or partitions shall be in accordance with the following:

1. Type B or Type L vent material for gas appliances and Type L vent material for oil appliances shall be installed with not less than listed and labeled clearances to combustible material.
2. Single-wall metal pipe shall be guarded by a ventilated metal thimble not less than four inches (102 mm) larger in diameter than the vent connector.

3621.3.4.3 Length: Unless otherwise permitted by 248 CMR or 527 CMR, if applicable, the horizontal run of an uninsulated connector to a natural draft chimney shall not exceed 75% of the height of the vertical portion of the chimney above the connector. The horizontal run of a listed connector to a natural draft chimney shall not exceed 100% of the height of the vertical portion of the chimney above the connector.

3621.3.4.4 Size: A connector shall not be smaller than the flue collar of the appliance.

Exception: When the appliance is otherwise listed for such connector application and the respective requirements of 248 CMR or 527 CMR, if applicable, so allow.

3621.3.4.5 Clearance: Connectors shall be installed with clearance to combustibles as set forth in NFPA 211, Section 6-5.1. Reduced clearances to combustible material shall be in accordance with NFPA 211, Section 6-5.1.2.

3621.3.4.6 Access: The entire length of a connector shall be accessible for inspection, cleaning and replacement.

3621.3.4.7 Fireplace connection: An appliance shall not be connected to a chimney flue serving a fireplace unless the fireplace opening is sealed or the chimney flue which vents the fireplace is permanently sealed below the connection. (Also see 780 CMR 3610.6.5.2).

780 3621.4 VENTS

3621.4.1 Type of vent required: Gas-fired and oil-fired appliances shall be vented in accordance with 248 CMR or 527 CMR as applicable. Solid fuel-burning appliances shall be vented in accordance with the requirements of 780 CMR 3610.6.5.2 and 3610.6.6 and additionally in accordance with their listing and manufacturer's requirements, as applicable.

3621.4.2 Termination: Vent termination shall comply with 780 CMR 3621.4.2.1 and 3621.4.2.6.

3621.4.2.1 Through the roof: Vents passing through a roof shall extend through flashing and terminate in accordance with the manufacturer's installation requirements.

3621.4.2.2 Natural draft appliances: Vents for natural draft fossil fuel-fired appliances shall terminate at heights above the highest connected appliance in accordance with the requirements of 248 CMR or 527 CMR as applicable, otherwise such vents shall terminate at least five feet (1524 mm) above the highest connected appliance outlet, and natural draft gas vents serving wall furnaces shall terminate at an elevation at least 12 feet (3658 mm) above the bottom of the furnace. Also see 780 CMR 3610 generally.

3621.4.2.3 Type B or BW vent: See 248 CMR.

3621.4.2.4 Type L vent: For oil-fired appliances, see 527 CMR (in the absence of guidance from 527 CMR, such vents shall terminate not less than 2 feet (610 mm) above any portion of the building within ten feet (3048 mm)).

3621.4.2.5 Direct vent appliances: See 248 CMR or 527 CMR if applicable, otherwise, the vent terminal of a direct vent appliance with an input of 50,000 Btu/h (14 655 W) or less shall be located not less than nine inches (229 mm) from any opening through which vent gases could enter a building. The vent terminal of a direct vent appliance having an input exceeding 50,000 Btu/h (14 655 W) shall be located not less than 12 inches (305 mm) from the opening. The bottom of a vent terminal and an air intake shall be located at least 12 inches (305 mm) above grade and in all cases shall comply to manufacturer's installation requirements when such requirements exceed the criteria of 780 CMR 3621.4.2.5.

3621.4.2.6 Mechanical draft systems: Mechanical draft systems other than direct vent systems shall be installed in accordance with 248 CMR or 527 CMR if applicable, otherwise such systems shall be installed in accordance with their listing and the manufacturer's installation requirements.

3621.4.3 Installation: Type B, Type BW and Type L vents shall be installed in accordance with the applicable requirements of 248 CMR or 527 CMR and otherwise in accordance with the terms of their listing and label and the manufacturer's installation instructions. For venting systems for listed and labeled Category II, 111 and IV gas appliances, see 248 CMR and the manufacturer's installation instructions.

3621.4.3.1 Size of single appliance venting systems: Except as otherwise allowed by 248 CMR or 527 CMR as applicable, an individual vent for a single appliance shall have a cross-sectional area equal to or greater than the area of the connector to the appliance, but not less than seven square inches (45 I5 mm^2) except where the vent is an integral part of a listed and labeled appliance. Also see 780 CMR 3610 generally.

3621.4.3.2 Size of multiple-appliance venting systems. For gas-fired and oil-fired appliances, see 248 CMR or 527 CMR as applicable. For other appliances see 780 CMR 3610 generally.

Note 1: Connectors serving appliances operating under natural draft shall not be connected into any portion of a mechanical draft system operating under positive pressure.

Note 2: Solid fuel-burning appliances shall not be connected to a vent serving another appliance burning other fuels except as noted in 780 CMR 3610.6.10.

3621.4.3.3 Size of solid fuel vents: See 780 CMR 3610.6.5.2.

3621.5 MASONRY AND FACTORY-BUILT CHIMNEYS

3621.5.1 Masonry and factory-built chimneys - general: Masonry and factory-built chimneys shall be built and installed in accordance with 780 CMR 3610.

3621.5.2 Installation of factory-built chimneys: Factory-built chimneys and chimney units shall be installed in accordance with the manufacturer's installation instructions such that flue gas temperatures in the chimney shall not exceed the limits specified in their listing and label. Factory-built chimneys for use with wood-burning appliances shall be Type HT - Also see 780 CMR 3610.3.

3621.5.3 Masonry chimney connection: Unless otherwise allowed by 248 CMR or 527 CMR, if applicable: a chimney connector shall enter a masonry chimney not less than six inches (153 mm) above the bottom of the chimney, except that if six inches (153 mm) are not available, a cleanout shall be provided by installing a capped tee in the connector next to the chimney. A connector entering a masonry chimney shall extend through, but not beyond the wall and shall be flush with the inner face of the liner. Connectors, or thimbles, when used, shall be firmly cemented into the masonry.

3621.5.4 Size of masonry chimneys: The effective area of a natural draft chimney flue for one appliance shall not be less than the area of the connector to the appliance. Chimneys connected to more than one appliance shall not be less than the area of the largest connector plus 50% of the areas of additional vent connectors - also see 780 CMR 3610.2.10 and 3610.2.11.

3621.5.4.1 Size of chimney for single gas appliance: See 248 CMR.

3621.5.4.2 Size of chimney for multiple gas appliance: See 248 CMR.

SOLAR SYSTEMS

3622.1 Solar systems, general: 780 CMR 3622 provides for construction, installation, alteration, and repair of equipment and systems utilizing solar energy to provide space heating or cooling, hot water heating, and swimming pool heating.

NOTE 1: Also see energy conservation provisions, 780 CMR 3603.

NOTE 2: Solar systems shall conform to all applicable requirements of 248 CMR.

3622.2 Installation: Installation of solar energy systems shall comply with 780 CMR 3622.2.1 through 3622.2.7.

3622.2.1 Access: Solar energy collectors, controls, dampers, fans, blowers, and pumps shall be accessible for inspection, maintenance, repair, and replacement.

3622.2.2 Roof-mounted collectors: The roof shall be constructed to support the loads imposed by roof-mounted solar collectors . Roof-mounted solar collectors that serve as a roof covering shall conform to the requirements for roof coverings in 780 CMR 3609. When mounted on or above the roof coverings, the collectors and supporting structure shall be constructed of noncombustible materials or fire-retardant-treated wood equivalent to that required for the roof construction and such mounting shall be engineered to ensure proper structural support, unless the collector and mounting design satisfies the criteria set forth in Table 3622.2, including all Table notes.

3622.2.3 Pressure and temperature relief: System components containing fluids shall be protected with pressure- and temperature-relief valves. Relief devices shall be installed in sections of the system such that a section cannot be valved offor isolated from a relief device. Such pressure and.or pressure-temperature relief devices shall conform to all pertinent requirements of 248 CMR or ASME Boiler and Pressure Vessel Rules as applicable.

3622.2.4 Vacuum relief: System components that may be subjected to pressure drops below atmospheric pressure during operation or shutdown shall be protected by a vacuum-relief valve.

3622.2.5 Protection from freezing: System components shall be protected from damage by freezing of heat-transfer liquids at the lowest ambient temperatures during operation.

3622.2.6 Expansion tanks: Expansion tanks in solar energy systems shall be installed in accordance with 248 CMR and possess ASME Boiler and Pressure Vessel stamps if applicable.

3622.2.7 Roof penetrations: Roof penetrations shall be flashed and waterproofed in accordance with 780 CMR 3609.

3622.3 Labeling: Labeling shall comply with 780 CMR 3622.3.1 and 3622.3.2.

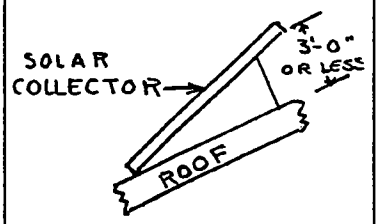
Exception: Collectors and/or thermal storage units that are site-built except such labeling that would otherwise be required by state and/or federal agencies having jurisdiction.

3622.3.1 Collectors: Collectors shall be listed and labeled to show the manufacturer's name, model, serial number, collector weight, maximum allowable temperatures and pressures, and the type of heat transfer fluids allowed

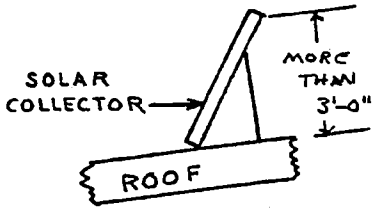
3622.3.2 Thermal storage units: Pressurized thermal storage units shall be listed and labeled to show the manufacturer's name, model, serial number, maximum and minimum allowable operating temperatures and pressures, and the type of heat transfer fluids allowed

3622.4 Prohibited heat transfer fluids: Flammable gases and liquids shall not be used as heat transfer fluids.

Table 3622.2
ALLOWABLE SPANS FOR ROOF RAFTERS
SUPPORTING CERTAIN SOLAR COLLECTORS



CONDITION A



CONDITION B

Member	800 psi (spruce or better MAX SPAN		1200 psi (hemfir or better) MAX SPAN		800psi (spruce or better MAX SPAN		1299 psi (hemfir or better) MAX SPAN	
	LRC	HRC	LRC	HRC	LRC	HRC	LRC	HRC
2 x 6								
12" o.c.	9-1	8-8	11-3	10-8	7-0	6-9	8-10	8-6
16" o.c.	7-11	7-5	9-9	9-3	6-0	5-10	7-6	7-3
24" o.c.	6-8	6-0	7-11	7-5	4-10	4-9	6-0	5-10
2 x 8								
12" o.c.	12-2	11-7	15-1	14-4	9-7	9-3	12-0	11-7
16" o.c.	10-6	10-0	13-0	12-4	8-2	7-11	10-3	9-11
24" o.c.	8-6	8-1	10-6	10-0	6-5	6-3	8-2	7-11
2 x 10								
12" o.c.	15-9	14-11	19-6	18-5	12-7	12-1	15-9	15-2
16" o.c.	13-6	12-10	16-9	15-10	10-9	10-4	13-5	12-11
24" o.c.	10-11	10-5	13-6	12-10	8-6	8-3	10-8	10-4
2 x 12								
12" o.c.	19-4	18-4	23-11	22-7	15-8	15-0	19-7	18-10
16" o.c.	16-8	15-9	20-6	19-5	13-4	12-10	16-9	16-1
24" o.c.	13-5	12-9	16-7	15-9	10-8	10-3	13-4	12-10

CRITICAL NOTES TO TABLE 3622.2 ALLOWABLE SPANS FOR ROOF RAFTERS SUPPORTING SOLAR COLLECTORS

HOW TO USE TABLE 3622.2:

1. Check to determine that none of the maximum conditions listed below are exceeded (see all Notes)
   a. maximum pitch of collectors - 20:12 (60°)
   b. maximum collector weight - seven lbs. per sq. ft.
   c. maximum length of collector - nine ft.
2. Determine whether Condition A or Condition B applies.
3. Inspect roof rafters and determine their size, spacing & type of wood. (Most are hemfir or better).
4. Determine whether light roof construction (LRC-asphalt, wood shingles, etc.) or heavy roof construction (HRC-slate, tile shingles, etc.) applies.
5. Read allowable span from tables. Rafter spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.

ADDITIONAL CONSTRUCTION CRITERIA:

Provide solid blocking between each panel connection to roof. Lag bolt or through bolt panel connection to rafters or blocking.

For situations exceeding any maximum condition listed above or not shown in Condition A or B, the structure shall be approved by a licensed professional engineer or registered architect

DESIGN CRITERIA (Table 3622.2):

Strength: ten lbs per sq. ft. (Light roof construction-LRC) or 15 lbs. per sq. ft. (heavy roof construction-HRC) as noted plus 30 lbs. per sq. ft. live load plus load of drifting snow plus loads of solar collectors determine fiber stress.

Deflection: For 30 lbs. per sq. ft. live load, deflection shall be limited to span in inches divided by 180.

APPENDIX A

REFERENCED STANDARDS

Part I

The following is a listing of the standards referenced in 780 CMR, the effective date of the standard, the promulgating agency of the standard and the section(s) of 780 CMR that refer to the standard.

AA

Aluminum Association
900 19th Street, N.W.
Suite 300
Washington, D.C. 20006

Standard reference number	Title	Referenced in 780 CMR Section number
ASM 35-80	Specification for Aluminum Sheet Metal Work in Building Construction	2002.1, 3609.5.2
SAS 30-94	Specification for Aluminum Structures	2002.1, 3608.4.3

AAMA

American Architectural Manufactures Association
Suite 310
1540 Dundee Road
Palatine, IL 60067

Standard reference number	Title	Referenced in 780 CMR Section number
1402-86	Standard Specifications for Aluminum Siding, Soffit and Fascia	1405.3.4
101-88	Volentary Specification for Aluminum Prime Windows and Glass Doors	3606.8.1, 3606.9.1

AASHTO

American Association of State Highway and Transportation Officials
444 North Capitol Street, N.W.
Suite 225
Washington, D.C. 20001

Standard reference number	Title	Referenced in 780 CMR Section number
HB-15-92	Standard Specifications for Highway Bridges	1606.1.1

ACI

American Concrete Institute
P.O. Box 19150
Detroit, Michigan 48219

Standard reference number	Title	Referenced in 780 CMR Section number
318-95	Building Code Requirements for Structural Concrete	1705.4.1, 1705.4.2, 1705.4.3, Table 1705.4.4, 1705.4.5, 1810.2, 1821.3.6, 1901.1, 1901.2, 1903.1, 1903.4, 1903.5.2, 1903.6.2, 1903.6.3, 1906.1, 1906.2, 1906.4.2, 1906.5.1, 1906.6.1, 1906.7, 1907.1.3, 1907.1.4, 1908.1, 1908.2, 1908.2.1, 1908.3.1, 1908.3.4, 1908.5.2, 1908.8.2, 1910.1, 1910.3.1, 1910.5, 1910.6.2, 1910.6.5, 3604.4.1
336	Concrete Code	1815.4, 1815.7

Standard reference number	Title	Referenced in 780 CMR Section number
318.1-89	Building Code Requirements for Structural Plain Concrete-with 1992 Revisions.	1810.2, 1812.3.2, 1901.2, 1904.1, 1904.2, 1904.3.3, *3604.4.1*
506.2-90	Specification for Materials, Proportioning, and Application of Shortcrete	1911.9
ACI 530/ASCE 5/ TMS402-95	Building Code Requirements for Masonry Structures	707.3 1705.5, Table 1705.5, 1812.3.2, Table 1812.3.2, 2101.1.1, 2101.1.2, 2104.2, 2104.2.1, 2104.3, 2104.4, 2106.3.1, 3604.4.1, 3606.4.1
ACI 530.1/ ASCE6/TMS 602-95	Specifications for Masonry Structures	Table 1705.5, 2112.1.1

AFPA

American Forest and Paper Association
1111 19TH Street, NW, Suite 800
Washington, D.C. 20036

Standard reference number	Title	Referenced in 780 CMR Section number
NDS-91	(National Design) Specification for Wood Construction Design Values for Wood Construction	3608.2.2

AHA

American Hardboard Association
520 N. Hicks Road
Palatine, Illinois 60067

Standard reference number	Title	Referenced in 780 CMR Section number
A135.4-95	Basic Hardboard	1405.3.1
A135.6-90	Hardboard Siding	1405.3.2, 2309.7, Table 3607.3.4
A194.1-85	Cellulosic Fiber Board	2309.1, Table 3606.2.3(a)

AISC

American Institute of Steel Construction, Inc.
Suite 3100
One East Wacker Drive
Chicago, Illinois 60601-2001

Standard reference number	Title	Referenced in 780 CMR Section number
ASD-89	Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design	Table 1705.3.2, 2203.1, 2203.5, 2208.1
LFRD-93	Load and Resistance Factor Design Specifications for Structural Steel Buildings	Table 1705.3.2, 2203.1, 2203.5, 2208.1
AISC-92	Seismic Provisions for Structural Steel Buildings	2203.2, 2203.2.1

APPENDIX A

AISI **American Iron and Steel Institute**
Suite 1300
1010 17th Street, N.W.
Washington, D.C. 20036-4700

Standard reference number	Title	Referenced in 780 CMR Section number
AISI-73	Criteria for Structural Applications of Steel Cables for Buildings	2207.2
CFSD-ASD-86	Specification for Design of Cold- Formed Steel Structural Members - with 1989 Addendum	2206.1, 2206.3 2206.3.1
CFSD-LRFD-91	Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members	2206.1, 2206.3, 2206.3.1

AITC **American Institute of Timber Construction**
Suite 407
1818 S. E. Mill Plain Blvd.
Vancouver, Washington 98684

Standard reference number	Title	Referenced in 780 CMR Section number
108-93	Standard for Heavy Timber Construction	2304.1
109-90	Standard for Preservative treatment of Structural Glued Laminated Timber	2313.1.1
112-93	Standard for Tongue and Groove Heavy Timber Roof Decking	2304.1
117-93	Standard Specifications for Structural Glued Laminated Timber of Softwood Species (Design)	2304.1
119-96	Standard Specifications for Hardwood Glued Laminated Timber	2304.1
A190.1-92	Structural Glued Laminated Timber	2304.1

ANSI **American National Standards Institute**
11 West 42nd Street
New York, New York 10036

Standard reference number	Title	Referenced in 780 CMR Section number
A108.1-92	Specifications for the installation of Ceramic Tile with Portland Cement Mortar	2105.10, 3607.2.4
A108.4-92	Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile Setting Epoxy Adhesive	2105.10.7, 3607.2.4
A108.5-92	Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar	2105.10.1, 2105.10.3, 3607.2.4
A108.6-92	Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile Setting and Grouting Epoxy	2105.10.4 3607.2.4
A108.7-92	Specifications for Electrically Conductive Ceramic Tile Installed with Conductive Dry-Set Portland Cement Mortar	2105.10.2,
A108.8-92	Installation of Ceramic Tile with Chemical Resistant Furan Mortar and Grout	2105.10.5
A108.9-92	Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout	2105.10.6
A108.10-92	Installation of Grout in Tilework	2105.10.8
A108.11-90	Installation of Interior Cementitious Backer Units	3607.2.4
A118.1-92	Specifications for Dry-Set Portland Cement Mortar	2105.10.1
A118.2-92	Specifications for Conductive Dry-Set Portland Cement Mortar	2105.10.2, 3607.2.4
A118.3-92	Specifications for Chemical Resistant Water Cleanable Tile Setting and Grouting Epoxy and Water Cleanable Tile Setting Epoxy Adhesive	2105.10.4, 3607.2.4
A118.4-92	Specifications for Latex-Portland Cement Mortar	2105.10.3
A118.5-92	Specifications for Chemical Resistant Furan	2105.10.5
A118.6-92	Specifications for Ceramic Tile Grouts	2105.10.8
A118.8-92	Specifications for Modified Epoxy Emulsion Mortar/Grout	2105.10.6
A136.1-92	Specification for Organic Adhesives for Installation of Ceramic Tile, Types I and II	2105.10.7, 3607.2.4
A137.1-88	Specifications for Ceramic Tile	2105.4, 3607.2.4

Standard reference number	Title	Referenced in 780 CMR Section number
A208.1-93	Wood Particleboard	2308.1, 2308.2, 3605.3.3.1, 3606.11.1, 3608.3.3.1
Z97.1-84	Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings	2405.1, 3603.8.3
Z21.66-85	Electrically Operated Automatic Vent Damper Devices for Use with Gas-fired Appliances	3621.2.2.2
NWWDA I.S.2-87	Industry Standard for Wood Window Units	3606.8.1
NWWDA I.S.3-88	Industry Standard for Wood Sliding Doors	3606.9.1

APA

American Plywood Association
P.O. Box 11700
Tacoma, WA 98411

Standard reference number	Title	Referenced in 780 CMR Section number
E30-90	Design and Construction Guide: Residential and Commercial	3608.3.2.3

ASCE

American Society of Civil Engineers
345 East 47th Street
New York, NY 10017

Standard reference number	Title	Referenced in 780 CMR Section number
ASCE 3-84	Specifications for the Design and Construction of Composite Slabs	2206.1.1
ASCE 5/ACI 530/TMS 402-95	Building Code Requirements for Masonry Structures	707.3, 1705.5, Table 1705.5, 1812.3.2 Table 1812.3.2, 2101.1.1, 2101.1.2, 2104.2, 2104.3, 2104.4, 2106.3.1
ASCE 6/ACI 530.1/TMS 602-95	Specifications for Masonry Structures	2112.1.1
ASCE 7-95	Minimum Design Loads for Buildings and Other Structures	1604.2, 1605.1 1611.1.1, 1611.12, 1611.12.2, 3603.1.2(b)
ASCE 8-SSD-LRFD/ASD-90	Specifications for Design of Cold-Formed Stainless Steel Structural Members	2206.1, 2206.3, 2206.3.1

ASHRAE

American Society of Heating,
Refrigerating and Air Conditioning Engineers
1791 Tullie Circle, N.E.
Atlanta, Georgia 30329-2305

Standard reference number	Title	Referenced in 780 CMR Section number
90.1-1989	Energy Code for Commercial and High Rise Residential Buildings	1314.5.2

ASME **American Society of Mechanical Engineers**
345 East 47th Street
New York, New York 10017

Standard reference number	Title	Referenced in 780 CMR Section number
A13.1-81(85)	Scheme for Identification of Piping Systems	416.15.3
B31.3-93	Chemical Plant and Petroleum Refinery Piping	416.15

ASTM **American Society for Testing Materials**
1916 Race Street
Philadelphia, Pennsylvania 19103

Standard reference number	Title	Referenced in 780 CMR Section number
A6-95c	Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use	Table 1705.3.2
A36-94	Specification for Structural Steel	1818.1, 2105.9.5, 3606.4.14
A82-95	Specification for Steel Wire, Plain, for Concrete Reinforcement	2105.9.2 2105.9.5, 3606.4.14
A153-95	Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware	2105.9.6, Table 3606.14.1
A167-94a	Specification for Stainless and Heat-Resisting Chromium-Nickel steel Plate, Sheet, and Strip	2105.9.2, 2105.9.5, 2105.9.6, 3604..14, Table 3606.14.1
A185-94	Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement	2105.9.4, 2105.9.5
	(Note: ASTM A256 - 82 has been discontinued and not replaced by ASTM)	
A252-93	Specification for Welded and Seamless Steel Pipe Piles	1818.1, 1819.1
A283-93a	Specification for Low and Intermediate Tensile Strength Carbon Steel Plates	1818.1, 1819.1
A361-94	Specification for Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process for Roofing and Siding	1507.3.7, 3609.5.2
A366-91	Specification for Steel, Sheet, Carbon, Cold-Rolled Commercial Quality	2105.9.5
A416-94a	Specification for Steel Strand, Uncoated Seven Wire for Prestressed Concrete	1821.3.2
A496-95	Specification for Steel Wire, Deformed, for Concrete Reinforcement	2105.9.3
A 497-95	Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement	2105.9.4
A510-82	Specification for Wire Rods and Course Round Wire, Carbon Steel	3606.4.14
A 525-91b	Specification for General Requirements for Steel Sheet, Zinc - Coated (Galvanized) by the Hot - Dip Process	2105.9.6, Table 3606.14.1, 3619.1.1.1.3
A 568-95	Specification for Steel Sheet, Carbon and High - Strength, Low - Alloy, Hot - Rolled and Cold - Rolled, General Requirements for	Table 1705.3.2
A 572 -94c	Specification for High - Strength Low Alloy Columbium - Vanadium Steels of Structural Quality	1818.1
A 588 -94	Specification for High - Strength Low Alloy Structural Steel with 50 ksi (345 Mpa) Minimum Yield Point to 4 in. (100 mm) Thick	1818.1
A 615 -95c	Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement	2105.9.1
A 616 -95b	Specification for Rail - Steel Deformed and Plain Bars for Concrete Reinforcement	2105.9.1
A 617 -95b	Specification for Axle - Steel Deformed and Plain Bars for Concrete Reinforcement	2105.9.1
A 641 -92	Specification for Zinc-Coated (Galvanized) Carbon Steel Wire	2105.9.6, Table 3606.4.14.1
A 706 -95b	Specification for Low - Alloy Steel Deformed Bars for Concrete Reinforcement.	1906.5.2, 2105.9.1
A 755 -95	Specification for Steel Sheet, Metallic - Coated by the Hot - Dip Process and Prepainted by the Coil - Coating Process for Exterior Exposed Building Products	1507.3.7
B101-92	Specification for Lead - Coated Copper Sheets	1507.3.7

Standard reference number	Title	Referenced in 780 CMR Section number
B 209-89	Specification for Aluminum and Aluminum-Alloy Seet and Plate	3609.5.2
B 227-80	Specifiation for Hard-Drawn Copper-Clad Steel Wire	3606.4.14
C 5 -79	Specification for Quicklime for Structural Purposes (Re-approved 1992)	Table 2505.2, 3607.2.2
C 28-92	Specifications for Gypsum Plasters	Table 2505.2, 3607.2.2
C 31-95	Practice for Making and Curing Concrete Test Specimens in the Field	1908.3.2
C 33-93	Specifications for Concrete Aggregates	1906.3, Table 1907.1.1
C 34-93	Specifications for Structural Clay Load-Bearing Wall Tile	2105.2, Table 3603.1.2(a)
C 35-95	Specifications for Inorganic Aggregates for Use in Gypsum Plaster	Table 2505.2, 3607.2.2
C 36-92	Specifications for Gypsum Wallboard	Table 2503.2, 3607.2.3.1
C 37-92	Specifications for Gypsum Lath	Table 2505.2, 3607.2.2
C 39-94	Test Method for Compressive Strength of Cylindrical Concrete Specimens	1908.3.2
C 55-95	Specification for Concrete Building Brick	2105.1, 3602.2
C 56-93	Specification for Structural Clay Non-Load-Bearing Tile	2104.7.3, 2105.2
C 59-91	Specifications for Gypsum Casting and Molding Plaster	Table 2505.2, 3607.2.2
C 61-95	Specifications for Gypsum Keene's Cement	Table 2505.2, 3607.2.2
C 62-95a	Specifications for Building Brick (Solid Masonry Units made from from Clay or Shale)	2105.2, 3602.2
C 67-94	Test Methods of Sampling and Testing Brick and Structural Clay Tile	2112.5
C 73-95	Specifications for Calcium Silicate Face Brick (Sand Lime Brick)	2105.1, 3602.2
C 79-95	Specifications for Gypsum Sheathing Board	Table 2503.2, Table 3606.2.3(a)
C 90-85	Hollow Load-Bearing Concrete Masonry Units	3602.2
C 94-95	Specifications for Ready-Mix Concrete	1908.5.1
C 126-95	Specifications for Ceramic Glazed Structural Clay Facing Tile, Facing Brick and Solid Masonry Units	2105.2
C129-85	Nonload-Bearing Concrete Masonry Units	3602.2
C145-85	Solid Load-Bearing Concrete Masonry Unit	3602.2
C150-95	Specification for Portland Cement	1906.2, 1907.1.2.1, 1907.1.2.2.3, 1908.2.1, 1908.2.2, Table 2505.2, 3604.2.2
C 172-90	Practice for Sampling Freshly Mixed Concrete	1908.3.2
C 206-84	Specification for Finishing Hydrated Lime	Table 2505.2
C 208-95	Specification for Cellulosic Fiber Insulating Board	2309.1, Table 3606.2.3(a)
C 212-93	Specification for Structural Clay Facing Tile	2105.2
C 216-95a	Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)	2105.2, 3602.2
C 231-91b	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method	1907.1.1
C 260-95	Specification for Air-Entraining Admixtures for Concrete	1906.6.2
C 270-95	Specification for Mortar for Unit	2105.7, 3606.7.1.1
C 330-89	Specification for Lightweight Aggregates for Structural Concrete	1906.3
C 406-89	Specification for Roofing Slate	1507.2.7, 3609.4.2
C 474-94	Test Methods for Joint Treatment Materials for Gypsum Board Construction	Table 2503.2
C 475-94	Specification for Joint Compound and Joint Tape for Finishing Gypsum Board	Table 2503.2, 3607.2.3.1
C476-95	Specification for Grout for Masonry	2105.11, 3606.7.1.1
C494-92	Specification for Chemical Admixtures for Concrete	1906.6.2
C503-89	Specification for Marble Dimension Stone (Exterior)	2105.3
C514-94	Specification for Nails for the Application of Gypsum Wallboard	Table 2503.2, 3607.2.3.1
C532-88	Specification for Structural Insulating Formboard (Cellulosic Fiber)	2309.1
C 557-93	Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing	3607.2.3.1
C 568-89	Specification for Limestone Dimension Stone	2105.3
C 578-87	Specification for Preformed Cellular Polytyrene Thermal Insulation	3604.3.3
C 587-91	Specification for Gypsum Veneer Plaster	Table 2505.2, 3607.2.2
C 588-95	Specification for Gypsum Base for Veneer Plasters	Table 2505.2, 3607.2.2
C 595-95a	Specification for Blended Hydraulic Cements	1907.1.2.1, 1907.1.2.2.1, 1907.1.2.2.2, 1908.2.2, 3604.2.2

Standard reference number	Title	Referenced in 780 CMR Section number
C 615-92	Specification for Granite Dimension Stone	2105.3
C 616-95	Specification Quartz- Based Dimension Stone	2105.3
C 618-95	Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete	1502.6.3, 1906.6.3, 1907.1.2.1
C 629-89	Specification for Slate Dimension Stone	2105.3
C 630-95	Specification for Water - Resistant Gypsum Backing Board	Table 2503.2, Table 2505.2, 3607.2.4.1
C 631-95a	Specification for Bonding Compounds for Interior Plastering	Table 2505.2, 3607.2.2
C 645-95a	Specification for Non-Load (Axis) Bearing Steel Studs, Runners (Track), and Rigid Furring Channels for Screw Application of Gypsum Board	Table 2503.2, Table 2505.2, 3607.2.3.3
C 652-95c	Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale)	2105.2, 3602.2
C 685-95	Specification for Concrete Made by Volumetric Batching and Continuous Mixing	1908.5.1
C 744-95a	Specification for Prefaced Concrete and Calcium Silicate Masonry Units	2105.1
C 754-95a	Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Board	Table 2504.1
C 836-89a	Specification for High- Solids Content, Cold Liquid- Applied Elastometric Waterproofing Membrane for Use With Separate Wearing Course	1507.3.6
C 841-90	Specification for Installation of Interior Lathing and Furring	Table 2504.1
C 842-85	Specification for Application of Interior Gypsum Plaster	Table 2504.1
C 843-94	Specification for Application of Gypsum Veneer Plaster	Table 2504.1, 3607.2.2
C844-85	Specification for Application of Gypsum Base to Receive Gypsum Veneer Plaster	Table 2504.1, 3607.2.2
C847-93	Specification for Metal Lath (Re-approved 1992)	Table 2505.2, 3607.2.2
C887-95	Specification for Packaged, Dry, Combined Materials for Surface Bonding Mortar	1813.3.2.2, 2105.8, 3604.6.1
C897-95a	Specification for Aggregate for Job-Mixed Portland Cement-Based Plasters	Table 2505.2, 3607.2.2
C926-95	Specification for Application of Portland Cement Based-Plaster	2506.3
C932-85	Specification for Surface-Applied Bonding Agents for Exterior Plastering	Table 2505.2
C933-85	Specification for Welded Wire Lath (Re-approved 1990)	Table 2505.2, 3607.2.2
C946-91	Practice for Construction of Dry-stacked, Surface-Bonded Walls	2105.8, 2106.4
C954-93	Specification for Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness	Table 2503.2, 2505.2, 3607.2.3.5
C955-95b	Specification for Load Bearing (Transverse and Axial) Steel Studs, Runners (Track), and Bracing or Bridging for Screw Application of Gypsum and Metal Plaster Bases	Table 2505.2, 3607.2.3.3
C957-93	Specification for High- Solids Content, Cold Liquid- Applied Elastometric Waterproofing Membrane with Integral Wearing Surface	1507.3.6
C 989-95	Specification for Ground Granulated Blast - Furnace Slag for Use in Concrete and Mortars	1906.6.4, 1907.1.2.1, 1907.1.2.2.2, 3607.2.3.1
C960-91	Specifications for Predecorated Gypsum Board	
C1002-93	Specification for Drill Screws for the Application of Gypsum Board or Metal Plaster Bases	Table 2503.2, Table 2505.2, 3607.2.3.1, 3607.2.3.5
C1007-83	Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs Accessories and Related Accessories	Table 2504.1
C1029-90	Specification for Spray - Applied Rigid Cellular Polyurethane Thermal Insulation	1507.3.5
C1032-86	Specification for Woven Wire Plaster Base (Re-approved 1990)	3607.2.2
C1047-85	Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base (Re-approved 1990)	3607.2.2, 3607.2.3.1
C1063- 95a	Specification for Installation of Lathing and Furring for Portland Cement - Based Plaster	2506.3, 3607.2.2

Standard reference number	Title	Referenced in 780 CMR Section number
C1088-94	Specification for Thin Veneer Brick Units Made from Clay or Shale	2105.2
D1586		
D25-91	Specification for Round Timber Piles	1822.1
D56-93	Test Method for Flash Point by Tag Closed Tester	307.2
D93-94	Test Methods for Flash Point by Pensky-Martens Closed Tester	Table 307.2
D224-89	Specification for Smooth- Surfaced Asphalt Roll Roofing (Organic Felt)	1507.2.2
D225-95	Specification for Asphalt Shingles (Organic Felt) Surfaced With Mineral Granules	1507.2.3
D226-95	Specification for Asphalt- Saturated Organic Felt Used in Roofing and Waterproofing	Table 1507.3.1
D227-95	Specification for Coal-Tar Saturated Organic Felt Used in Roofing and Waterproofing	Table 1507.3.1
D2487		
D2488		
D249-89	Specification for Asphalt Roll Roofing (Organic Felt) Surfaced with Mineral Granules	1507.2.2
D2938		
D312-95	Specification for Asphalt Used in Roofing	Table 1507.3.1, 3609.7.4.2
D323-94	Test Method for Vapor Pressure of Petroleum Products (Reid Method)	307.2
D368	Tension Load Test	1801
D371-89	Specification for Asphalt Roll Roofing (Organic Felt) Surfaced with Mineral Granules; Wide- Selvage	1507.2.2
D450-91	Specification for Coal-Tar Pitch Used in Roofing, Dampproofing, and Waterproofing	Table 1507.3.1
	(Note 568-77 has been discontinued and not replaced by ASTM)	
D635-91	Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position	2601.2, 2604.1
D1143-81	Test Method for Piles under Static Axial Compressive Load	1817.4.2
D1227-87	Specification for Emulsified Asphalt Used as a Protective Coating for Roofing	1507.3.6
D1248-84 (1989)	Specification for Polystyrene Plastics Molding and Extrusion Materials	3619.1.1.2
D1557	Test methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb. (4.54-kg) Rammer and 18-in. (457-mm) Drop	1804.3.2, 1805.3
D 1586-84	Method for Penetration Test and Split Barrel Sampling of Soils	1805.3
D1761-88	Test Methods for Mechanical Fasteners in Wood	2312.1, 2312.2, 2312.3
D1784-90	Specification for Rigid Poly (Vinyl Chloride) (PFC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds	3619.1.1.2
D1863- 86	Specification for Mineral Aggregate Used on Built-Up Roofs	Table 1507.3.1
D 1929-93	Test Method for Ignition Properties of Plastics	2601.2, 2604.2
D2178-89	Specification for Asphalt Glass Felt Used in Roofing and Waterproofing	Table 1507.3.1
D2412-87	Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading	3619.1.1.2
D2487	Classification of Soils for Engineering Purposes (Unified Soil Classification System)	
D2488	Practice for description and Identification of Soils (Visual-Manual Procedure)	
D2626-95	Specification for Asphalt-Saturated and Coated Organic Felt Base Sheet Used in Roofing	Table 1507.3.1
	(Note: D2277-87 has been discontinued and not replaced by ASTM)	
D2843-93	Test Method for Density of Smoke from the Burning or Decomposition of Plastics	2601.2, 2604.1
D2898-94	Methods for Accelerated Weathering of Fire-Retardant Tested Wood for Fire Testing	1506.2, 2310.3
D2938		
D3161-81	Test Method for Wind Resistance of Asphalt Shingles	1505.2.3
D3462-93a	Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules	1507.2.3
D3468-90	Specification for Liquid- Applied Neoprene and Chlorosulfonated Polyethylene Used in Roofing and Waterproofing	1507.3.6
D3672-86	Specification for Venting Asphalt - Saturated and Coated Inorganic Felt Base Sheet Used in Roofing	Table 1507.3.1
D3679-88	Rigid Poly (Vinyl Chloride) (PVC) Siding	Table 3607.3.4
D3689-90	Test Method Individual Piles under Static Axial Tensile Load	1817.7
D3746-85	Test Method for Impact Resistance of Bituminous Roofing Systems	1505.3.2

APPENDIX A

Standard reference number	Title	Referenced in 780 CMR Section number
D3909-95a	Specification for Asphalt Roll Roofing (Glass Felt) Surfaced with Mineral Granules	1507.2.2, Table 1507.3.1
D3966-90	Test Method for Piles Under Lateral Loads	1817.6.2
D4099-89	Specification for Poly (Vinyl Chloride) (PVC) Prime Wndows	3606.8.1
D4272-90a	Test Method for Total Energy Impact of Plastic Films by Dart Drop	1505.3.2
D4434-87	Specification for Poly (Vinyl Chloride) Sheet Roofing	1507.3.3
D4601-95	Specification for Asphalt Coated Glass Fiber Base Sheet Used in Roofing	Table 1507.3.1
D4637-87	Specification for Vulcanized Rubber Sheet Used in Single-Ply Roof Membrane.	1507.3.2
D5055-95a	Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-Joists	2313.5
E72-95	Methods of Conducting Strength Tests of Panels for Building Construction	2305.7
E84-95b	Test Method for Surface Burning Characteristics of Building Materials	412.3.6.3, 428.11, 704.4.1.2, 722.2, 722.3, 803.2, 803.3.2, 2310.2, 2601.2, 2603.3, 2603.6.3, 2603.7.4, 2604.1, 2805.2.2, 3105.3, 3603.17.1.1, 3603.17.2.6, 3603.17.3, 3603.18.3, 3603.19.1, 3603.19.2, 3612.2
E90-90	Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions	1214.2, 3603.4.3.1
E96-90	Standard Test for Water Vapor Transmission of Materials	
E108-95	Test Methods for Fire Tests of Roof Coverings	1506.1, 1506.2, 2608.2, 2608.3
E119-95a	Test Methods for Fire Tests of Building Construction and Materials	412.3.6.2, 704.1.1, 705.2.4 705.4, 707.7.2, 707.7.3, 707.8.1.2, 709.6.1, 709.6.2, 709.6.4, 709.7.1.2, 713.4.2, 2105.2, 2603.4, 3603.4.1
E136-95	Test Method for Behavior of Materials in Vertical Tube Furnace at 750°C	704.4.1.1, 3612.2
E152-81a	Methods of Fire Tests of Door Assemblies	716.1, 716.1.1, 3603.17.3
E163-84	Methods of Fire Tests of Window Assemblies	718.1, 719.1
E283-91	Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified PressureDifferences Across the Specimen	3606.8.2, 3606.9.2
E492-90	Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine	1214.3, 3603.4.3.3
E648-95	Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source	805.2
E814-94b	Test Method for Fire Tests of Through-Penetration Fire Stops	707.7.2, 707.7.3, 709.6.1, 709.6.2, 713.4.1
E838-81	Practice for Performing Accelerated Outdoor Weathering Using Concentrated Natural Sunlight	1505.3.1
E970-89	Test Method for Critical Rdiant Flux of Exposed Attic Floor Insulation Using a Radiant Heat Energy Sources	3603.19.4
E1509-	Specification for Room Heaters, Pellet Fuel-Burning Type	
G23-95	Practice for Operating Light- Exposure Apparatus (Carbon- Arc Type) With and Without Water for Exposure of Nonmetallic Materials	1505.3.1
G26-95	Practice for Operating Light- Exposure Apparatus (Xenon- Arc Type) With and Without Water for Exposure of Nonmetallic Materials	1505.3.1
G53-95	Practice for Operating Light- and Water- Exposure Apparatus (Fluorescent UV - Condensation Type) for Exposure of Nonmetallic Materials	1505.3.1

AWPA

American Wood Preservers Association
P.O. Box 5690
Granbury, TX 76049
(1-817-326-6300)

Standard reference number	Title	Referenced in 780 CMR Section number
C1-95	All Timber Products -Preservative Treatment by Pressure Processes	1506.3, 2311.3, 3603.22.3.1
C2-95	Lumber, Timber, Bridge Ties and Mine Ties -Preservative Treatment by Pressure Processes	1808.1, 1808.2, 2311.3, 2311.4, 2311.5, 2311.7, 3603.22.3.1, 3603.22.4
C3-97	Piles - Preservative Treatment by Pressure Processes	1808.1, 1822.2, 3603.22.3.1
C4-95	Poles - Preservative Treatment by Pressure Processes	3603.22.3.1
C9-95	Plywood- Preservative Treatment by Pressure Processes	2311.3, 2311.4, 2311.5, 2311.7, 3603.22.3.1, 3603.22.4
C15-90	Wood for Commercial-Residential Constrruction Preservative Treatment by Pressure Process	3603.22.3.1
C18-90	Standard for Pressure-treated Material in Marine Construction	3603.22.3.1
C20-93	Structural Lumber - Fire- Retardant Treatment Pressure Processes	2310.2, 3603.22.3.1
C22-93	Lumber and Plywood for Permanent Wood Foundations - Preservative Treatment by Pressure Processes	1808.3, 3603.22.3.1, 3604.2.1.2, 3605.4.3
C23-84	Round Poles and Posts Used in Building Construction, Preservative Treatment by Pressure Process	3603.22.3.1
C24-86	Sawn Timber Piles Used for Residential Commerce Building	3603.22.3.1
C27-93	Plywood- Fire-Retardant Treatment by Pressure Process	2310.2, 3603.22.3.1
C28-90	Standard for Preservative Treatment of Structural Glues-Laminated Members and Laminations Before Cluing of Southern Pine, Pacific Coast Douglas Fir, Hem-fir and Western Hemlock by Pressure Process.	
M4-95	Standard for the Care of Preservative- Treated Wood Products	1822.2
P1/P13-95	Standard for Coal Tar Creosote for Land and Fresh Water and Marine (Coastal Water) Use	2311.3, 3603.22.3.1
P2-95	Standard for Creosote Solutions	2311.3, 3603.22.3.1
P3-89	Standard for Creosote - Petroleum Oill Solution	3603.22.3.1
P5-95	Standards for Waterborne Preservatives	2311.3, 3603.22.3.1, 3604.2.1.2
P8-95	Standards for Oil- Borne Preservatives	2311.3, 3603.22.3.1
P9-92	Standards for Solvents and Formulations for Organic Preservative Systems	2311.3, 3603.22.3.1

AWS

American Welding Society
550 N.W. Lejeune Road
P.O. Box 351040
Miami, Florida 33135

Standard reference number	Title	Referenced in 780 CMR Section number
D1.1-92	Structural Welding Code- Steel	1705.5.3.2.1
D1.4-92	Structural Welding Code- Reinforced Steel	1906.5.2

BOCA

Building Officials and Code Administrators International
4051 West Flossmoor Road
Country Club Hills, Illinois 60477-5795

Standard reference number	Title	Referenced in 780 CMR Section number
BNFOC-93	BOCA National Fire Prevention Code	307.5, 307.8, Table 307.8(1), Table 307.8(2), 408.6, 415.1, 417.1, 417.2.1, 417.3, 417.5, 417.5.1, 417.5.2, 417.5.3, 417.5.5, 417.6, 417.6.1, 417.6.3, 418.1, 418.2, 418.2.1, 418.3, 418.3.1, 418.3.2, 418.3.3, 418.4, 418.5, 419.2.3, 705.2.1, 707.1.1, 901.2, 3103.1
BNMC-93	BOCA National Mechanical Code	201.3, 307.8, 408.4.1, 408.5, 411.3, 416.9, 417.1, 417.3, 418.3.1.4, 418.3.2, 418.3.2.3, 418.3.3, 418.3.4, 419.2, 419.2.1, 602.4.2, 602.4.3, 717.2, 722.2, 913.1, 1203.1, 1208.3, 1209.1, 1210.3, 2114.2, 2114.9, 2305.12, 2801.2, 2802.1, 2802.3, 2804.1, 2805.2.3, 2805.2.4, 2808.3, 2811.1, 3107.6, 3309.2, 3603.6.7.1
BNPC-93	BOCA National Plumbing Code	201.3, 408.4, 418.3.4, 602.4.3, 1212.7, 1813.5.3

CGSB

Canadian General Standards Board
Technical Information Unit
PC1, Phase III, Place Du Portage
Hull, Ottawa, Canada K1A 1G6

Standard reference number	Title	Referenced in 780 CMR Section number
37-GP-52M-84	Roofing and Waterproofing Membrane, Sheet Applied, Elastometric	1505.3.2, 1507.3.2
37-GP-54M-79	Roofing and Waterproofing Membrane, Sheet Applied, Flexible, Polyvinyl Chloride	1507.3.3
37GP-56M-80	Membrane, Modified, Bituminous, Prefabricated, and Reinforced for Roofing - with Dec. 1985 revision	1507.3.4

CPSC

Consumer Product Safety Commission
Office of the Secretary
Washington, D.C. 20207

Standard reference number	Title	Referenced in 780 CMR Section number
16CFR Part 1201-77	Safety Standard for Architectural Glazing	2405.1, 2406.1, 2407.2, 3603.20.4.1
16CFR Part 1209-86	Interim Safety Standard for Cellulose Insulation	722.4
16CFR Part 1404-86	Cellulose Insulation	722.4
16CFR Part 1500-84	Hazardous Substances and Articles; Administration and Enforcement Regulations	307.2
16CFR, Part 1630 (DOC FF-1)-70	Standard for the Surface Flammability of Carpets and Rugs	805.3, 805.5

CSA

Canadian Standards Association
178 Rex Dale Boulevard
Rex Dale, Ontario, Canada M9W1R3

Standard reference number	Title	Referenced in 780 CMR Section number
CSA 0437-M92	OSB and Waferboard	3605.2.1.2, 3608.2.1.3

CSSB

Cedar Shake and Shingle Bureau
515 116TH Avenue, NE, Suite 275
Bellevue, WA 98004

Standard reference number	Title	Referenced in 780 CMR Section number
CSSB-84	Grading and Packing Rules for Certigrade Red Cedar Shingles (Revised February 1, 1984)	3609.8.2
CSSB-85	Grading and Packing Rules for Cert-Split Red Cedar Shakes (Revised October 1, 1985)	3609.9.2
CSSB-90	Grading Rules for Shake Hip and Ridge based on the Standards of the Cedar Shake and Shingle Bureau	3609.8.3.3, 3609.9.3.4
CSSB-90	Grading Rules for Certi-Sawn Taper-Sawn Cedar Shakes (Revised May 30, 1990)	3609.9.2
CSSB-90	Wood Shakes (Preservative Treated) based on Grading and Packing Rules for Treated Southern Pine Taper-Sawn Shakes of the Cedar Shake and Shingle Bureau	3609.9.3
CSSB-93	Grading Rules for Wood Shakes and Shingles	3607.2.6, 3607.3.5
	Exterior and Interior Walls - Design and Application Manual for, 1989	
	New Roof Coverings - Red Cedar Shingle and Shake Design and Application Manual for, 1989	
	Red Cedar Shingles - Grading Rules for Certi-Grade, 1984	
	Wood Shakes -	
	Grading Rules for Certi-Sawn Taper Sawn Red Cedar Shakes, 1981	
	Grading Rules for Certi-Split Red Cedar Shakes, 1985	
	Wood Shingles -	
	Grading Rules for Certi-Grade Shingles, 1984	

CWC

Canadian Wood Council
1730 St. Laurent Boulevard - Suite 350
Ottawa, Ontario, Canada K1G 5L1

Standard reference number	Title	Referenced in 780 CMR Section number
CWC-87	Canadian Dimension Lumber Data Book	3608.2.2

DOC

United States Department of Commerce
National Institute of Standards and Technology
Gaithersburg, MD 20899

Standard reference number	Title	Referenced in 780 CMR Section number
PS 1-95	Construction and Industrial Plywood	2306.4.6, 2307.1, 3606.10.1, 3608.3.2.1, Table 3604.4.3.3
PS 2-95	Performance Standard for Wood- Based Structural- Use Panels	2307.1, 3604.4.3.3, 3605.3.2.1, 3605.3.2.1.2, 3606.10.1 3608.3.2.1
PS 20-94	American Softwood Lumber Standard -with 1991 Amendments	2302.1, 3604.4.3.1, 3605.2.1, 3606.2, 3608.2.1
FF-1(CPSC 16 CFR, Part 1630) -70	Standard for the Surface Flammability of Carpet and Rugs	805.3, 805.5

DOTn

U.S. Department of Transportation
c/o Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402-9325

Standard reference number	Title	Referenced in 780 CMR Section number
49 CFR, Part 100-178 & 179-199 -88	Specification for Transportation of Explosive and Other Dangerous Articles, Shipping Containers	307.2

EIA **Electronics Industries Association**
2001 Pennsylvania Avenue, NW
Washington, D.C. 20006

Standard reference number	Title	Referenced in 780 CMR Section number
222-E - 91	Structural Standards for Steel Antenna Towers and Antenna Supporting Structures	3108.4

FM **Factory Mutual Engineering Corporation**
Standards Laboratories Department
1151 Boston Providence Turnpike
Norwood, Massachusetts 02062

Standard reference number	Title	Referenced in 780 CMR Section number
4450-90	Approval Standard for Class I Insulated Steel Deck Roofs -with Supplement (July 1992)	1505.2.2, 2603.4.1.5
4470-86	Approval Standard for Class 1 Roof Coverings -with Supplement 3 (August 1992)	1505.2.2, 1505.3.2
4880-94	Test Procedure for Building Corner Fire Test	2603.8, 3605.17.3

GA **Gypsum Association**
103 Orrington Avenue, Suite 1210
Evanston, IL 60201

Standard reference number	Title	Referenced in 780 CMR Section number
GA 253-93	Recommended Specification for the Application of Gypsum Seathing	Table 3606.2.3(a)

HPMA **Hardwood Plywood Manufactures Association**
1825 Michael Faraday Drive, P.O. Box 2789
Reston, Virginia 22090-2789

Standard reference number	Title	Referenced in 780 CMR Section number
HP-83	Hardwood and Decorative Plywood	2307.1, 3607.2.5
HP-SG-86	Structural Design Guide for Hardwood Plywood Wall Panels	2307.1, 3605.3.2.1, 3606.10.1

THE MASSACHUSETTS STATE BUILDING CODE

MASSACHUSETTS, COMMONWEALTH OF
CODE OF MASSACHUSETTS REGULATIONS (CMR)

Specific numbers have been established by the Massachusetts Office of the Secretary of State to identify for reference purposes all rules and regulations promulgated by agencies of the Commonwealth of Massachusetts. These numbers are designated as "Code of Massachusetts Regulations" (CMR's).

Board of State Examiners of Plumbers and Gas Fitters
100 Cambridge Street
Boston, MA 02202

248 CMR 2.00	Massachusetts State Plumbing Code
248 CMR 4.00 - 7.00	Massachusetts Fuel Gas Code

Outdoor AdvertisingBoard
100 Cambridge Street, Floor 20
Boston, MA 02002

711 CMR 3.00	Control and Restriction of Billboards, Signs and Other Advertising Devices

Department of Public Health
150 Tremont
Boston, MA 02111

105 CMR 130.000	Hospital Licensure
105 CMR 140.000	Licensure of Clinics
	Designer's Guide (Bureau of Planning and Construction) Dispensaries and Clinics, December 21, 1966-
105 CMR 151.000	General Standards of Construction for Long Term Care Facilities in Massachusetts
105 CMR	Intensive Care Unit Amendment, October 1, 1972
105 CMR 400.000	State Sanitary Code Chapter I: General Administrative Procedures
105 CMR 410.000	Minimum Standards of Fitness for Human Habitation (State Sanitary Code: Chapter II:
105 CMR 420.000	Housing and Sanitation Standards for Farm Labor Camps (State Sanitary Code: Chapter III)
105 CMR 430.000	Minimum Sanitation and Safety Standards for Recreational Camps for Children (State Sanitary Code: Chapter IV)
105 CMR 435.000	Minimum Standards for Swimming Pools (State Sanitary Code: Chapter V)
105 CMR 440.000	Minimum Standards for Developed Family Type Campgrounds (State Sanitary Code: Chapter VI)
105 CMR 590:000	State Sanitary Code Chapter X - Minimum Sanitation Standards for Food Establishments

Division of Industrial Safety
100 Cambridge Street, 11th Floor
Boston, MA 02202

454 CMR 2.00	Toilets in Industrial Establishments *Industrial Bulletin No. 4*
454 CMR 10.00	Construction Industry Rules and Regulations *Industrial Bulletin No. 12*
454 CMR 11.00	Structural Painting Safety Code *Industrial Bulletin No. 13*
454 CMR 12.00	Requirements for the Care of Employees Injured or Taken Ill in Industrial Establishments *Industrial Bulletin No. 14*
454 CMR 16.00	Lighting Code for Factories, Workshops, Manufacturing, Mechanical and Mercantile Establishments *Industrial Bulletin No. 18*
454 CMR 19.00:	Window Cleaning *Industrial Bulletin No. 21*

Architectural Access Board
Department of Public Safety
One Ashburton Place, 13 th Floor
Boston, MA 02108

521 CMR 1.00 - 47.00	Architectural Access Board Regulations

Board of Boiler Rules
Department of Public Safety
One Ashburton Place, Roon 1301
Boston, MA 02108

522 CMR 2.00	Construction of Power Boilers
522 CMR 3.00	Power Boilers, Power Reactor Vessels and Piping and Unfired Pressure Vessels as Used in Atomic Energy Installations
522 CMR 4.00	Steam and Hot Water Boilers and Heat Storage Sources
522 CMR 5.00	Heating Boilers
522 CMR 6.00	Low Pressure Heating Boilers
522 CMR 7.00	Air Tanks
522 CMR 8.00	Air Tanks
522 CMR 9.00	Refrigeration and Air Conditioning Systems
522 CMR 10.00	Material Specifications
522 CMR 11.00	Welding Specifications
522 CMR 12.00	Fiberglass-reinforced Plastic Pressure Vessels

Board of Elevator Regulations
One Ashburton Place, Roon 1301
Boston, MA 02108

524 CMR 2.00 - 11.00	Elevator and Escalator Regulations
524 CMR 15.00-34.00	Elevator, Dumbwaiter, Escalator, and Moving Walk Regulations

Board of Fire Prevention and Regulation
1010 Commonwealth Avenue
Boston, MA 02215

527 CMR 3.00	Dry Cleaning and Dry Dyeing and the Keeping, Storage and Use of Cleaning and Dyeing Fluids
527 CMR 4.00	Oil Burning Equipment
527 CMR 5.00	Operation and Maintenance of Buildings or Other Structures Used as Garages, Service Stations and the Related Storage, Keeping and Use of Gasoline or Other Motor Fuel
527 CMR 6.00	Liquefied Petroleum Gas Containers and Systems
527 CMR 7.00	Manufacture and Handling of Plastics
527 CMR 9.00	Tanks and Containers
527 CMR 10.00	Prevention of Fire in Buildings and in or on Ships
527 CMR 12.00	1993 National Electrical Code (Amendments)
527 CMR 14.00	Flammable and Combustible Liquids, Flammible Solids or Flammable Gases
527 CMR 21.00	Decorations, Curtains, Draperies, Blinds and Other Window Treatments

NCMA

National Concrete Masonry Association
2302 Horse Pen Road, P.O. Box 781
Herndon, VA 22070

Standard reference number	Title	Referenced in 780 CMR Section number
NCMA TR68-A-75	Design and Construction of Plain and Reinforced Concrete Masonry Basement and Foundation Walls	3604.4.1

NFPA

National Fire Protection Association
Batterymarch Park
Quincy, Massachusetts 02269

Standard reference number	Title	Referenced in 780 CMR Section number
10-94	Portable Fire Extinguishers	920.2
11-94	Low Expansion Foam And Combined Agent Systems	911.1, 911.5
11A-94	Medium and High Expansion Foam Systems	911.1, 911.5
12-93	Carbon Dioxide Extinguishing Systems	909.1, 909.5
12A-92	Halon 1301 Fire Extinguishing Systems	912.1, 912.5
12B-90	Halon 1211 Fire Extinguishing Systems	912.1, 912.5
13-96	Installation of Sprinkler Systems	412.7, 416.4, 706.2, 906.2.1, 906.9.1, 907.2.1, 917.7.3
13D-96	Installation of Sprinkler Systems in One- and Two- Family Dwellings and Mobile Homes	906.2.3
13 R-94	Installation of Sprinkler Systems in Residential Occupancies Up to Four Stories in Height	906.2.2, 923.1
14-95	Standpipe and Hose Systems	914.1, 914.5, 914.12.1
15-96	Water Spray Fixed Systems for Fire Protection	908.1, 908.4
16-95	Deluge Foam- Water Sprinkler and Spray Systems	911.1, 911.5
17-94	Dry Chemical Extinguishing System	910.1, 910.5
17A-94	Wet Chemical Extinguishing Systems	913.1, 913.5
20-96	Installation of Centrifugal Fire Pumps	924.1
22-96	Standard for Water Tanks for Private Fire Protection	
24-95	Installation of Private Fire Service Mains	417.6.3, 906.9.1, 914.6.1
25-95	Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems	901.4
30-96	Flammable and Combustible Liquids Code	307.8, 416.14, 418.3.2, 419.2.3
30A-96	Automotive and Marine Service Station Code	408.6, 417.6.6
32-96	Dry Cleaning Plants	418.3.4
33-95	Spray Application Using Flammable and Combustible Materials	307.8, 419.1
34-95	Dipping and Coating Processes Using Flammable or Combustible Liquids	307.8, 419.1
40-94	Cellulose Nitrate Motion Picture Film	411.1
50-96	Bulk Oxygen Systems at Consumer Sites	2810.1
51-92	Oxygen-Fuel Gas Systems for Welding, Cutting and Allied Processes	2810.1
61-95	Prevention of Fire and Dust Explosions in Agricultural Food Products Facilities	418.3.1
65-93	Processing and Finishing of Aluminum	418.3.1
69-92	Explosion Prevention Systems	417.5.1.2
70-96	National Electrical Code	416.11, 416.14.6, 416.15.2, 602.4.4, 1405.4.3, 3102.6.3, 3102.13.1, 3107.6
72-96	National Fire Alarm Code	403.6, 417.5.3, 917.1, 917.6, 917.7, 917.8.1, 917.9, 917.10, 918.1, 918.8, 919.1, 919.6, 921.4, 923.1
80-95	Fire Doors and Windows	716.2, 716.5, 1017.4.4
80A-96	Protection of Buildings from Exterior Fire Exposures	
82-94	Incinerators, Waste and Linen Handling Systems and Equipment	2807.1
90A-96	Installation of Air Conditioning and Ventilation Systems	
90B-96	Installation of Warm Air Heating and Air Conditioning Systems	

APPENDIX A

Standard reference number	Title	Referenced in 780 CMR Section number
82-94	Incinerators, Waste and Linen Handling Systems and Equipment	2807.1
90A-96	Installation of Air Conditioning and Ventilation Systems	
90B-96	Installation of Warm Air Heating and Air Conditioning Systems	
92A-96	Smoke Control Systems	
92B-95	Smoke Management System in Malls, Atria and Alrge Areas	
96-98	Ventilation Control and Fire Protection of Commercial Cooking Operations	
99-96	Health Care Facilities	2809.1, 2809.2
101-94	Life Safety Code	
102-95	Assembly Seating, Tents and Membrane Structures	3104.4
120-94	Coal Preparation Plants	418.3.1
130-95	Standard for Fixed Guideway Systems	
211	Chimney, Fireplace and Vents	3610.4
231-95	General Storage	426.3, 426.6
231C-95	Rack Storage of Materials	507.1, 426.3, Table 922.2
231D-94	Storage of Rubber Tires	426.3, 426.6
241-96	Safeguarding Construction, Alteration and Demolition Operations	903.1.5, 915.1, 914.7.2
259-87	Standard Test Method for Potential Heat of Building Materials	3603.17.2.5
409-95	Aircraft Hangers	426.3, 426.5, 426.6
416-93	Construction and Protection of Airport Terminal Buildings	
418-95	Roof-top Heliport Construction and Protection	1511.3
430-95	Storage of Liquid and Solid Oxidizers	426.3, 426.5, 426.6
495-96	Explosive Material Code	417.5.1 *See also 527 CMR*
502-96	Access Highways, Tunnels, Bridges, Air Right Structures	
651-93	Manufacture of Aluminum or Magnesium Powder	418.3.1
654-94	Prevention of Fire, and Dust Explosions in the Chemical, Dye, Pharmaceutical, and Plastics Industries	418.3.1
655-93	Prevention of Sulfur Fires and Explosions	418.3.1
664-93	Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities	418.3.1
701-96	Standard Methods of Fire Tests for Flame Resistant Textiles and Films	807.2, 807.2.2, 3102.6.4.2, 3103.3.2, 3104.5, 3105.3
704-96	Identification of the Fire Hazards of Materials	416.2, 416.15.1
750-96	Installation of Water Mist Fire Protection Systems	
8503-96	Pulverized Fuel Systems	418.3.1

NFoPA
(AFPA)

American Forest and Paper Association*
1250 Connecticut Avenue, N.W./ Suite 200
Washington, D.C. 20036

Standard reference number	Title	Referenced in 780 CMR Section number
NDS-97	National Design Specification for Wood Construction -with 1997 Supplement; Design Values for Wood Construction	1801.1, 2303.1, 2304.1, 2305.14.1, 2305.15, 2306.4, 2306.4.5.1, 2306.4.5.2, 2306.4.6, 2306.4.6.1.1, 2306.4.6.2.1, 2306.4.7.1.1, 2306.4.7.2.1, 2312.1, 2312.4, 2313.3.1, 2313.3.2
TR7-87	Basic Requirements for Permanent Wood Foundation System	1808.3, 1813.3, 2311.3.3

**The National Forest Products Association (NFoPA) has changed their name to the American Forest and Paper Association (AFPA). The referenced standard in this code may be identified with the designation AFPA.*

RCSC

Research Council On Structural Connections
c/o American Institute of Steel Construction, Inc.
Suite 3100
One East Wacker Drive
Chicago, IL 60601-2001

Standard reference number	Title	Referenced in 780 CMR Section number
RCSC-85	Specifications for Structural Joints Using A325 or A490 Bolts	1705.5.3.2.1
RCSC-88	Specification for Load and Resistance Design	

RMA

Rubber Manufacturers Association
1200 K Street, N.W.
Washington, D.C. 20005

Standard reference number	Title	Referenced in 780 CMR Section number
RP-1-90	Minimum Requirements for Non- Reinforced Black EPDM Rubber Sheets	1507.3.2
RP-2-90	Minimum Requirements for Fabric- Reinforced Black EPDM Rubber Sheets	1507.3.2
RP-3-85	Minimum Requirements for Fabric- Reinforced Black Polychlorprene Rubber Sheets	1507.3.2

SJI

Steel Joist Institute
1205 48th Avenue North
Suite A
Myrtle Beach, South Carolina 29577

Standard reference number	Title	Referenced in 780 CMR Section number
SJI-94	Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders	2205.1

SMACNA

Sheet Metal and Air Conditioning Contractors
National Association, Inc.
4201 Lafayette Center Drive
Chantilly, VA 22021

Standard reference number	Title	Referenced in 780 CMR Section number
SMACNA-88	Installation Standards for Residential Heating and Air Conditioning Systems	3619.1.3.1

TFS

Texas Forest Service
Forest Products Laboratory
P.O. Box 310
Lufkin, Texas 75902-0310

Standard reference number	Title	Referenced in 780 CMR Section number
TFS-90	Grading Rules for Preservative Treated Southern Yellow Pine Tapersawn Shakes	1507.2.9

TMS

The Masonry Council
Suite B
2619 Spruce Street
Boulder, CO 80302-3808

Standard reference number	Title	Referenced in 780 CMR Section number
TMS 402/ACI 530/ ASCE 5-95	Building Code Requirements for Masonry Structures	707.3, 1705.5, Table 1705.5, 1812.3.2, Table 1812.3.2, 2101.1.1, 2101.1.2, 2104.2, 2104.3, 2104.4, 2106.3.1
TMS 602/ACI 530.1/ASCE 6-95	Specifications for Masonry Structures	Table 1705.5, 2104.2, 2112.1.1

TPI

Truss Plate Institute Inc.
Suite 200
583 D'Onofrio Drive
Madison, Wisconsin 53719

Standard reference number	Title	Referenced in 780 CMR Section number
PCT-80	Design Specification for Metal Plate Connected Parallel Chord Wood Trusses	2305.14.1, 2313.3.2, 3605.2.10, 3608.2.11
TPI 1-95	National Design Standard for Metal Plate Connected Wood Truss Construction	2305.15, 2313.3.1, 3605.2.10, 3608.2.11
TPI BWT-76	Bracing Wood Trusses: Commentary and Recommendations	3605.2.10, 3608.2.11
TPI QST-89	Quality Standard for Metal Plate Connected Wood Trusses	3605.2.10, 3608.2.11

UL

Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, Illinois 60062

Standard reference number	Title	Referenced in 780 CMR Section number
10A-93	Standard for Safety Tin- Clad Fire -with Revisions through May 1985	716.2
14B-93	Standard for Safety Sliding Hardware for Standard, Horizontally Mounted Tin-Clad Fire Doors -with Revisions through October 1984	716.2
14C-93	Standard for Safety Swinging Hardware for Standard Tin-Clad Fire Doors Mounted Singly and in Pairs -with Revisions through October 1984	716.2
55A-83	Material for Built-up Roof Coverings (Revised 1989)	3609.7.2
103-94	Standard for Safety Chimneys, Factory Built, Residential Type and Building Heating Appliance -with Revisions through February 1989	720.6.4, 3612.2
127-88	Standard for Safety Factory-Built Fireplaces -with Revisions through June, 1992	720.6.4
181-90	Factory-Made Air Ducts and Air Connectors (Revised November, 1990)	3619.1.2
181A-90	Closure System for Use with Rigid Air Ducts and Connectors	3619.1.2
217-93	Standard for Safety Single and Multiple Station Smoke Detectors -with Revisions through February 1989	409.5.1
268-89	Standard for Safety Smoke Detectors for Fire Protective Signaling Systems -with Revisions through May 1989	409.5.1
441-86	Gas Vents	3612.2
555-95	*Fire Dampers*	
559-85	Heat Pumps (Revised December, 1987)	3614.3.1
580-94	Standard for Safety Tests for Uplift Resistance of Roof Assemblies -with Revisions through December 1989	1505.2.2
641-86	Low-Temperature Venting Systems, Type L	3612.2
790-83	Tests for Fire Resistance of Roof Covering Material (Revised, 1989)	3609.1.3
910-95	Standard for Safety Test for Flame Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables used in Spaces Transporting Environmental Air	2805.2.5
997-81	Standard for Safety Wind Resistance of Prepared Roof Covering Materials -with Revisions through July, 1981	1505.2.3

Standard reference number	Title	Referenced in 780 CMR Section number
1040-71	Outline of Investigation for Insulated Wall Construction	3603.17.3
1096-86	Electric Central Air Heating Equipment (Revised January, 1988)	3614.1.12
1256-85	Standard for Safety Fire Test of Roof Deck Constructions	2603.4.1.5
1715-94	Fire Test of Interior Finish Material -with Revisions through March 1991	2603.8, 3603.17.3
1777-88	Chimney Liners (Revised November, 1989)	3610.1.14
1820-94	Standard for Safety Fire Test Pneumatic Tubing for Flame and Smoke Characteristics -with Revisions through April 1991	2805.2.6
1887-95	Fire Tests of Plastic Sprinkler Pipe for Flame and Smoke Characteristics	2805.2.1
1040-89	Outline of Proposed Investigation for Insulated Wall Construction	2603.8

USC

United States Code
c/o Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402-9325

Standard reference number	Title	Referenced in 780 CMR Section number
Title 18; Chapter 40-70	Importation, Manufacture, Distribution and Storage of Explosive Materials	307.2

WWPA

Western Lumber

Standard reference number	Title	Referenced in 780 CMR Section number
WWPA-92	Western Lumber Span Tables for Floor and Ceiling Joists and Roof Rafters	3608.2.2

780 CMR Appendix B

Appendix B contains the following information and documentation;

Appendix B-1

A) Sample Uniform Building Permit Application Form for One and Two Family Dwellings and Accessory Buildings. This application form is not mandated by 780 CMR, however, the information requested on the form is the minimum information required to satisfy 780 CMR 110.4.

B) Sample Uniform Building Permit Application Form for Any Building Other than One and Two Family Dwellings and Accessory Buildings. This application form is not mandated by 780 CMR, however, the information requested on the form is the minimum information required to satisfy the requirements of 780 CMR 110.4.

Appendix B-2

Application Forms required to file an appeal with the State Building Code Appeals Board in accordance with 780 CMR 122.0.

Appendix B-3

Official Interpretations of the Building Code issued by the BBRS under authority of M.G.L. c 143, § 94(e). These interpretations have been made over the period since the promulgation of the first Edition of 780 CMR on January 1, 1975. Interpretations are identified by number, in order of interpretation, followed by the year of the interpretation. The edition of 780 under which the interpretation was made is indicated for each *Official Interpretation*.

APPENDIX B-1

SAMPLE BUILDING PERMIT APPLICATION FORMS

The following sample building permit application forms have been developed to simplify the building permit application process for the applicant and providing a building department with sufficient detail, in a standardized and concise form. Wherever possible the forms utilize a check off process for ease of the user(s).

The sample application forms also reference certain Massachusetts General Laws which impact the issuance of the building permit.

The primary objective in the development of these application forms is to promote standardization throughout the Commonwealth. Standardization will benefit both the building permit applicant and the building department.

The sample application forms are not mandatory, but their use is strongly suggested. The information contained on the sample application forms, however, is the minimum required to be contained on a building permit application consistent with 780 CMR 110.4.

Application forms have been developed for;

- One and two family dwellings and accessory buildings thereto and;
- All other buildings and structures.

The Commonwealth of Massachusetts
State Board of Building Regulations and Standards
Massachusetts State Building Code
780 CMR

FOR MUNICIPALITY USE

APPLICATION TO CONSTRUCT, REPAIR, RENOVATE OR DEMOLISH A ONE OR TWO FAMILY DWELLING

This Section For Official Use Only

Building Permit Number: _____ Date Issued: _____

Signature: _____ Date
Building Commissioner/Inspector of Buildings

SECTION 1 - SITE INFORMATION

1.1 Property Address:

_____

_____

1.2 Assessors Map & Parcel Number:

_____ _____
Map Number Parcel Number

1.3 Zoning Information:

_____ _____
Zoning District Proposed Use

1.4 Property Dimensions:

_____ _____
Lot Area (sf) Frontage (ft)

1.6 Building Setbacks (ft)

Front Yard		Side Yards		Rear Yard	
Required	Provided	Required	Provided	Required	Provided
		/	/		

1.7 Water Supply (M.G.L. c. 40, § 54)
Public ☐ Private ☐

1.5 Flood Zone Information:
Zone:_____ Outside Flood Zone ☐

1.8 Sewage Disposal System:
Municipal ☐ On site disposal system ☐

SECTION 2 - PROPERTY OWNERSHIP/AUTHORIZED AGENT

2.1 Owner of Record:

_____ _____
Name (Print) Address for Service:

_____ _____
Signature Telephone

2.2 Authorized Agent:

_____ _____
Name (Print) Address for Service:

_____ _____
Signature Telephone

SECTION 3 - CONSTRUCTION SERVICES

3.1 Licensed Construction Supervisor:

Not Applicable ☐

_____
Licensed Construction Supervisor:

_____
License Number

_____
Address

_____
Expiration Date

_____ _____
Signature Telephone

3.2 Registered Home Improvement Contractor:

Not Applicable ☐

_____
Company Name

_____
Registration Number

_____
Address

_____
Expiration Date

_____ _____
Signature Telephone

SECTION 4 - WORKERS' COMPENSATION INSURANCE AFFIDAVIT (M.G.L. c. 152, § 25C(6))

Workers Compensation Insurance affidavit must be completed and submitted with this application. Failure to provide this affidavit will result in the denial of the issuance of the building permit.

Signed Affidavit Attached Yes..... ☐ No..... ☐

SECTION 5 - DESCRIPTION OF PROPOSED WORK (check all applicable)

New Construction ☐	Existing Building ☐	Repair(s) ☐	Alteration(s) ☐	Addition ☐
Accessory Bldg. ☐	Demolition ☐	Other ☐ Specify:		

Brief Description of Proposed Work:

_____

_____

_____

_____

SECTION 6 - ESTIMATED CONSTRUCTION COSTS

Item	Estimated Cost (Dollars) to be completed by permit applicant	Official Use Only	
1. Building		(a) Building Permit Fee Multiplier	
2. Electrical		(b) Estimated Total Cost of Construction from (6)	
3. Plumbing		**Building Permit Fee (a) x (b)**	
4. Mechanical (HVAC)			
5. Fire Protection			
6. Total = (1 + 2 + 3 + 4 + 5)		Check Number	

SECTION 7a - OWNER AUTHORIZATION - TO BE COMPLETED WHEN OWNERS AGENT OR CONTRACTOR APPLIES FOR BUILDING PERMIT

I, _____, as Owner of the subject property

hereby authorize _____ to act on my behalf, in all matters relative to work authorized by this building permit application.

_____ _____

Signature of Owner Date

SECTION 7b - OWNER/AUTHORIZED AGENT DECLARATION

I, _____, as Owner/Authorized Agent hereby declare that the statements and information on the foregoing application are true and accurate, to the best of my knowledge and belief.

Signed under the pains and penalties of perjury.

_____

Print Name

_____ _____

Signature of Owner/Agent Date

The Commonwealth of Massachusetts
State Board of Building Regulations and Standards
Massachusetts State Building Code
780 CMR

FOR MUNICIPALITY USE

APPLICATION TO CONSTRUCT, REPAIR, RENOVATE, CHANGE THE USE OR OCCUPANCY OF, OR DEMOLISH ANY BUILDING OTHER THAN A ONE OR TWO FAMILY DWELLING

This Section For Official Use Only

Building Permit Number: _____ Date Issued: _____

Signature: _____ _____
Building Commissioner/Inspector of Buildings Date

SECTION 1 - SITE INFORMATION

1.1 Property Address:

_____

_____

1.2 Assessors Map & Parcel Number:

_____ _____
Map Number Parcel Number

1.3 Zoning Information:

_____ _____
Zoning District Proposed Use

1.4 Property Dimensions:

_____ _____
Lot Area (sf) Frontage (ft)

1.6 Building Setbacks (ft)

Front Yard		Side Yards		Rear Yard	
Required	Provided	Required	Provided	Required	Provided
		/	/		

1.7 Water Supply (M.G.L. c. 40, § 54)
Public ☐ Private ☐

1.5 Flood Zone Information:
Zone:_____ Outside Flood Zone ☐

1.8 Sewage Disposal System:
Municipal ☐ On site disposal system ☐

SECTION 2 - PROPERTY OWNERSHIP/AUTHORIZED AGENT

2.1 Owner of Record:

_____ _____
Name (Print) Address:

_____ _____
Signature Telephone

2.2 Authorized Agent:

_____ _____
Name (Print) Address:

_____ _____
Signature Telephone

SECTION 3 - CONSTRUCTION SERVICES FOR PROJECTS LESS THAN 35,000 CUBIC FEET OF ENCLOSED SPACE

3.1 Licensed Construction Supervisor:

_____
Licensed Construction Supervisor:

_____
Address

_____ _____
Signature Telephone

Not Applicable ☐

_____
License Number

_____
Expiration Date

3.2 Registered Home Improvement Contractor:

_____
Company Name

_____
Address

_____ _____
Signature Telephone

Not Applicable ☐

_____
Registration Number

_____
Expiration Date

SECTION 4 - WORKERS' COMPENSATION INSURANCE AFFIDAVIT (M.G.L. c. 152 § 25C(6))

Workers Compensation Insurance affidavit must be completed and submitted with this application. Failure to provide this affidavit will result in the denial of the issuance of the building permit.

Signed Affidavit Attached Yes.....□ No.....□

SECTION 5- PROFESSIONAL DESIGN AND CONSTRUCTION SERVICES - FOR BUILDINGS AND STRUCTURES SUBJECT TO CONSTRUCTION CONTROL PURSUANT TO 780 CMR 116 (CONTAINING MORE THAN 35,000 C.F. OF ENCLOSED SPACE)

5.1 Registered Architect:

Name (Registrant):

Address

Signature Telephone

Not Applicable □

Registration Number

Expiration Date

5.2 Registered Professional Engineer(s):

Name

Address

Signature Telephone

Area of Responsibility

Registration Number

Expiration Date

Name

Address

Signature Telephone

Area of Responsibility

Registration Number

Expiration Date

Name

Address

Signature Telephone

Area of Responsibility

Registration Number

Expiration Date

Name

Address

Signature Telephone

Area of Responsibility

Registration Number

Expiration Date

5.3 General Contractor

Company Name:

Responsible In Charge of Construction

Address

Signature Telephone

Not Applicable □

SECTION 6 - DESCRIPTION OF PROPOSED WORK (check all applicable)

New Construction ☐	Existing Building ☐	Repair(s) ☐ Alteration(s) ☐	Addition ☐
Accessory Bldg. ☐	Demolition ☐	Other ☐ Specify:	

Brief Description of Proposed Work:

SECTION 7 - USE GROUP AND CONSTRUCTION TYPE

USE GROUP (Check as applicable)								CONSTRUCTION TYPE	
A Assembly	☐	A-1	☐	A-2	☐	A-3	☐	1A	☐
		A-4	☐	A-5	☐			1B	☐
B Business	☐							2A	☐
E Educational	☐							2B	☐
F Factory	☐	F-1	☐	F-2	☐			2C	☐
H High Hazard	☐							3A	☐
I Institutional	☐	I-1	☐	I-2	☐	I-3	☐	3B	☐
M Mercantile	☐							4	☐
R Residential	☐	R-1	☐	R-2	☐	R-3	☐	5A	☐
S Storage	☐	S-1	☐	S-2	☐			5B	☐
U Utility	☐	Specify:							
M Mixed Use	☐	Specify:							
S Special Use	☐	Specify:							

COMPLETE THIS SECTION IF EXISTING BUILDING UNDERGOING RENOVATIONS, ADDITIONS AND/OR CHANGE IN USE

Existing Use Group:	Proposed Use Group:
Existing Hazard Index 780 CMR 34):	Proposed Hazard Index 780 CMR 34):

SECTION 8 BUILDING HEIGHT AND AREA

BUILDING AREA	Existing (if applicable)	Proposed
Number of Floors or stories include basement levels		
Floor Area per Floor (sf)		
Total Area (sf)		
Total Height (ft)		

SECTION 9- STRUCTURAL PEER REVIEW (780 CMR 110.11)

Independent Structural Engineering Structural Peer Review Required Yes.....☐ No.....☐

SECTION 10a - OWNER AUTHORIZATION - TO BE COMPLETED WHEN OWNERS AGENT OR CONTRACTOR APPLIES FOR BUILDING PERMIT

I, _____, as Owner of the subject property

hereby authorize _____ to act on my behalf, in all matters relative to work authorized by this building permit application.

_____ _____

Signature of Owner Date

SECTION 10b - OWNER/AUTHORIZED AGENT DECLARATION

I, _____, as Owner/Authorized Agent hereby declare that the statements and information on the foregoing application are true and accurate, to the best of my knowledge and belief.
Signed under the pains and penalties of perjury.

_____
Print Name

_____ _____
Signature of Owner/Agent Date

SECTION 11 - ESTIMATED CONSTRUCTION COSTS

Item	Estimated Cost (Dollars) to be completed by permit applicant	Official Use Only	
1. Building		(a) Building Permit Fee Multiplier	
2. Electrical		(b) Estimated Total Cost of Construction from (6)	
3. Plumbing		**Building Permit Fee (a) x (b)**	
4. Mechanical (HVAC)			
5. Fire Protection			
6. Total = (1 + 2 + 3 + 4+ 5)		Check Number	

Appendix B-2

State Building Code Appeals Board Filing Instructions and Application Forms

The Commonwealth of Massachusetts
Executive Office of Public Safety
State Board of Building Regulations and Standards
McCormack State Office Building
One Ashburton Place - Room 1301
Boston, Massachusetts 02108

WILLIAM F. WELD
Governor

KATHLEEN M. O'TOOLE
Secretary

TEL: (617) 727-3200 FAX: (617) 227-1754

KENTARO TSUTSUMI
Chairman

THOMAS L. ROGERS
Administrator

STATE BUILDING CODE APPEALS BOARD - FILING INSTRUCTIONS

Note: Appeals are held pursuant to 801 CMR 1.02 Informal/Fair Hearing Rules

The procedure outlined below must be followed when filing a Building Code Appeal:

1. The appellant must be in receipt of a letter of denial from the local Building Official as required under 780 CMR 111.1 of the State Building Code. An appeal must be filed within 45 days of the date of the letter of denial. An appeal may be filed either with the local **Building Code Appeals Board**, if one has been established, or directly with the State Building Code Appeals Board.

2. Two documents are required to be completed by the appellant or his/her representative - the **Appeal Application Form** (2 pages) and the **Service Notice** (1 page).

The **Service Notice**, which gives notice to the building official that an appeal is being filed, should include the date appearing on the appeal form and the name and address of the Building Official under the section "PERSON/AGENCY SERVED". The **Method of Service** should list one of the following procedures as set forth in Section 121.2.1 of the State Building Code.

A. Personally; or
B. Registered or Certified Mail, return receipt requested; or
C. By any person authorized to serve civil process.

The **Date of Service** is the date when a copy of the appeal is delivered or mailed to the Building Official or other party entitled.

The **Service Notice** must be signed by the appellant or his/her representative and the signature must be notarized.

The **Appeal Application Form** (2 pages) must be completed in total. The application will be reviewed for completeness prior to a hearing being scheduled. Applications determined to be incomplete will be returned to the applicant for correction. Questions relating to completing the application should be directed to your local building department or this office.

3. One complete copy of the appeal filing, including the original of the **Service Notice**, must be delivered to the Building Official or the official entitled. Four complete copies of the appeal filing, including the original plus three copies of the **Appeal Application** form, four copies of the **Service Notice** and four copies of the letter of denial, together with a check for **$150.00** (filing fee)payable to the Commonwealth of Massachusetts must be filed with this office, if the appeal is made directly to the State Building Code Appeals Board. (Filing fee requirements for filings before a local Building Code Appeals Board may differ from the fees prescribed for submission to the State Building Code Appeals Board).

ALL CASES WILL BE HEARD ON THE SCHEDULED DATE.
POSTPONEMENTS WILL NOT BE GRANTED.

The Commonwealth of Massachusetts

Executive Office of Public Safety

State Board of Building Regulations and Standards

McCormack State Office Building

One Ashburton Place - Room 1301

Boston, Massachusetts 02108

WILLIAM F. WELD
Governor

KATHLEEN M. O'TOOLE
Secretary

TEL: (617) 727-3200 FAX: (617) 227-1754

KENTARO TSUTSUMI
Chairman

THOMAS L. ROGERS
Administrator

STATE USE ONLY
Fee Received:_____
Check No.: _____
Received By: _____

STATE BUILDING CODE APPEALS BOARD APPEAL APPLICATION FORM

DOCKET NUMBER:_____ DATE: _____

(State Use Only)

The undersigned hereby appeals to the State Board of Building Regulations and Standards from the decision of the:

Building Official from the City/Town of: _____

Board of Appeals from the City/Town of: _____

Other Municipal Agency/Official entitled: _____

State Agency/Official entitled: _____

OTHER: _____

Dated: _____ 19 ____, having been aggrieved by such (check as appropriate)

Interpretation o Order o Requirement o Direction o
Failure to Act o Other o Explain_____

All appropriate code sections must be identified. **All written supporting documentation must be submitted with this application. Parties may present written material at the hearing. However, the Board reserves the right to continue the proceeding if such material warrants extensive review.**

State Briefly desired relief:

_____

_____

APPELLANT: _____

ADDRESS FOR SERVICE:_____

_____ Telephone No. _____

ADDRESS OF SUBJECT PROPERTY:_____

_____

APPELLANT'S CONNECTION TO SUBJECT PROPERTY:_____

_____ _____

SIGNATURE OF APPELLANT/REPRESENTATIVE **(NAME - PLEASE PRINT)**

DESCRIPTION OF BUILDING OR STRUCTURE RELATIVE TO THE MASSACHUSETTS STATE BUILDING CODE (780 CMR 6th EDITION): (Check as appropriate)

Check Here if Building is a One or Two Family Dwelling ☐ Proceed to section entitled "*Brief Description of the Proposed Work*" - Do not complete the tables below

DESCRIPTION OF PROPOSED WORK (check all applicable)

New Construction ☐	Existing Building ☐	Repair(s) ☐	Alteration(s) ☐	Addition ☐
Accessory Bldg. ☐	Demolition ☐	Other ☐ Specify:		

Brief Description of Proposed Work:

USE GROUP AND CONSTRUCTION TYPE

USE GROUP (Check as applicable)							CONSTRUCTION TYPE	
A Assembly	☐	A-1 ☐	A-2 ☐	A-3 ☐			1A	☐
		A-4 ☐	A-5 ☐				1B	☐
B Business	☐						2A	☐
E Educational	☐						2B	☐
F Factory	☐	F-1 ☐	F-2 ☐				2C	☐
H High Hazard	☐						3A	☐
I Institutional	☐	I-1 ☐	I-2 ☐	I-3 ☐			3B	☐
M Mercantile	☐						4	☐
R Residential	☐	R-1 ☐	R-2 ☐	R-3 ☐			5A	☐
S Storage	☐	S-1 ☐	S-2 ☐				5B	☐
U Utility	☐	Specify:						
M Mixed Use	☐	Specify:						
S Special Use	☐	Specify:						

COMPLETE THIS SECTION IF EXISTING BUILDING UNDERGOING RENOVATIONS, ADDITIONS AND/OR CHANGE IN USE

Existing Use Group:	Proposed Use Group:
Existing Hazard Index (780 CMR 34):	Proposed Hazard Index (780 CMR 34):

BUILDING HEIGHT AND AREA

BUILDING AREA	Existing (if applicable)	Proposed
Number of Floors or stories include basement levels		
Floor Area per Floor (sf)		
Total Area (sf)		
Total Height (ft)		

Brief Description of the Proposed Work:

APPENDIX B

The Commonwealth of Massachusetts
Executive Office of Public Safety
State Board of Building Regulations and Standards
McCormack State Office Building
One Ashburton Place - Room 1301
Boston, Massachusetts 02108

WILLIAM F. WELD
Governor

KATHLEEN M. O'TOOLE
Secretary

TEL: (617) 727-3200 FAX: (617) 227-1754

KENTARO TSUTSUMI
Chairman

THOMAS L. ROGERS
Administrator

STATE BUILDING CODE APPEALS BOARD - SERVICE NOTICE

I,_____, as _____ for the

Appellant/Petitioner _____ in an appeal filed with the

State Building Code Appeals Board on _____, 19____

HEREBY SWEAR UNDER THE PAINS AND PENALTIES OF PERJURY THAT IN ACCORDANCE WITH THE PROCEDURES ADOPTED BY THE STATE BOARD OF BUILDING REGULATIONS AND STANDARDS AND SECTION 122.3.1 OF THE STATE BUILDING CODE, I SERVED OR CAUSED TO BE SERVED, A COPY OF THIS APPEAL APPLICATION ON THE FOLLOWING PERSON(S) IN THE FOLLOWING MANNER:

NAME AND ADDRESS OF PERSON/AGENCY SERVED	METHOD OF SERVICE	DATE OF SERVICE
_____		
_____	_____	_____
_____		
_____		
_____	_____	_____
_____		

_____
Signature: APPELLANT/PETITIONER

On the _____Day of _____ 19 ____, PERSONALLY APPEARED

BEFORE ME THE ABOVE NAMED _____
(Type or Print the Name of the Appellant)

AND ACKNOWLEDGED AND SWORE THE ABOVE STATEMENTS TO BE TRUE.

_____ _____
NOTARY PUBLIC MY COMMISSION EXPIRES

ENERGY CONSERVATION MANDATORY CHECKLIST FOR NEW CONSTRUCTION (OTHER THAN LOW-RISE RESIDENTIAL) 780 CMR, 1301.8.1

Owner/Agent Name: _____ Phone: _____

Owner/Agent Address: _____

City/State/Zip: _____

Project Name: _____

Site Address: _____ City/Town _____

Applicant's Name: _____ Signature: _____

Applicant's Phone: _____ Date of Application: _____

I. Envelope Compliance Option (check ONE)

☐ **Trade-Off** (1304.5) - Attach software Compliance Report (COMcheck-EZ)

☐ **Appendix J** (1301.2 - For buildings up to 10,000 sf only) - Attach Appendix J compliance documentation

☐ **Systems Analysis** (1309) - Attach Registered Architect's or Engineer's report

☐ **Prescriptive** (1304.2) - Complete this section, and attach copy of applicable Table (1304.2.1 through 13.4.2.12)

Climate Zone (from Table 1303.1) ☐ Zone 12a ☐ Zone 13a ☐ Zone 14a

a. Gross above-grade wall area _____ sq.ft.

b. Total window & glass door area _____ sq.ft.

c. Glazing % (100 x b÷a) _____ % Table # utilized: _____

II. HVAC (check ONE)

☐ Simple Systems & Equipment (1305.2) ☐ Complex Systems & Equipment (1305.3)

☐ Systems Analysis (1309) - Attach Registered Architect's or Engineer's report

III. Lighting (check ONE)

☐ Building Area Method (1308.6.2.1)
☐ Space-by-Space Method (1308.6.2.2) } Attach Compliance Documentation (COMcheck-EZ or other)
☐ Systems Analysis (1309) - Attach Registered Architect's or Engineer's report

IV. Approval & Acceptance Construction Documents (1301.8.4.1)

Attach a narrative report describing the HVAC, Lighting, and Electric Distribution systems, including:

For Official Use ONLY Building Official: check off completed sections of report	
☐	1. Design Intent
☐	2. Basis of Design
☐	3. Sequence of operation / systems interaction
☐	4. Description of the systems (capacities, etc.)
☐	5. Testing requirements / criteria acceptance
☐	6. Requirement for submittal of operation manuals and maintenance manuals
☐	7. Requirement for submittal of record drawings and control documents

APPENDIX B

This Side For Use by Building Department Only

Official's Name: _____ Title: _____

I. Plans Review

Date Application Received: _____

☐ Complete Narrative Report Received (1301.8.4.1)

☐ Design and Specification Documents prepared by legally recognized professional (1301.8.4.3)

Application is: Approved ☐ Date: _____ Signature: _____

Denied ☐ Date: _____

Reason(s) for Denial: (provide additional details as needed on separate sheet)

II. Acceptance (1301.8.4.4)

☐ Successful system tests witnessed by Building Official, **OR** ☐ satisfactory test report received (check one)

☐ Certification by Registered Professional (per 780 CMR 116.2) that systems are installed in accordance with construction documents

☐ Confirmation by owner (or their authorized representative) that they have received record drawings, reviewed for reasonable accuracy

☐ Confirmation by owner (or their authorized representative) that they have received reports, controls documentation, operations manual(s), maintenance manual(s), and other documents specified in 1301.8.4.1

Building Official's Signature: _____

CONSUMER INFORMATION FORM - "SUNROOMS"

Massachusetts State Building Code (780 CMR, Appendix J, Section J1.1.2.3.1)

The Massachusetts State Building Code *(780 CMR)* includes provisions to ensure that houses and house additions meet energy efficiency standards. This supplemental CONSUMER INFORMATION FORM is to be filed as part of the building permit application when a builder/contractor or homeowner, constructing/installing a house addition with very large percentage of glass to opaque wall, seeks to utilize a special energy conservation exemption option for "sunroom" additions to an existing house (780 CMR, Appendix J, Section J1.1.2.3.1). This FORM is not intended to prevent a homeowner from selecting a "sunroom" of any size, configuration, orientation, form of construction or percent glazing, but rather is only intended to assist homeowners in becoming aware of some of the important energy conservation and year-round comfort considerations involved in selecting and utilizing a "sunroom" addition.

The connection of "sunroom" structures to residential buildings may create comfort and energy consumption issues due to uncontrolled solar gain or uncontrolled radiation cooling of the main house. In the selection and construction/installation of "sunrooms", included below is a non-required, open-ended list of product and design considerations that a homeowner may wish to consider before actually constructing/installing a "sunroom". It is recommended that consumers carefully review these options with their designer, builder, or contractor, in order to minimize potential energy consumption and/or house discomfort issues. In addition, the qualifications and reputation of the company or individuals to be hired are important considerations.

PRODUCT AND DESIGN CONSIDERATIONS RELATED TO "SUNROOMS"

- **Solar Orientation and Natural Shading**
- **Type of Glazing**
  - **Insulating value**
  - **Solar heat gain**
  - **Frame materials**
  - **Glazing to frame sealing and gasketing materials/ seal durability and/or weather tightness of the sunroom**
- **Adequate ventilation - Operable windows and fans**
- **Applied Shading Systems**
- **Insulation level in floors, walls, and ceilings**
- **Possible Sunroom isolation from the main house via a wall and/or door or slider**
- **Heating and Cooling Methods: Efficiency, Zoning and Controls**

Homeowner Acknowledgment

The Massachusetts State Building Code, Section J1.1.2.3.1, requires that the actual property owner (not the owner's agent or representative) acknowledge receipt of this CONSUMER INFORMATION FORM prior to issuance of a Building Permit for a project that includes "sunroom" additions to an existing residential building. In accordance with this requirement, the undersigned hereby acknowledges that she/he has read the information in this document concerning sunroom comfort and energy conservation.

Signature of Actual Building Owner	Date
Print Name	Address of Permitted Project
Owner Address (if different than project location)	Owner's telephone number

Official Interpretation No. 1-85

DATE: October 30, 1985

SUBJECT: State Building Code Section 108.5.1

Question 1: Section 108.5.1 requires the periodic inspection of certain buildings, and the issuance of Certificates of Inspection for these buildings on a regular basis. The standard form Certificate of Inspection which was developed by the Commonwealth states that "The means of egress are sufficient for the following number of persons:" and provides space for the listing of permitted occupancy load by story and by place of assembly. Is it the intent of the Code to require a complete periodic reinspection of the entire building or is such an inspection limited to the building's egress system?

Answer 1: No. Section 108.5.1 states in part "A Certificate of Inspection as herein specified shall not be issued until an inspection is made certifying that the building or structure or parts thereof complies with ALL the applicable requirements of this Code ..." (emphasis supplied). The periodic reinspection is not necessarily limited to the building's egress system but may extend throughout to the entire building, or parts thereof requiring certification. The Certificate of Inspection serves as a spot check to ensure that other Code mandated procedures have been followed (e.g. permits obtained for alterations) and that the building has been maintained in a safe condition. The building has been maintained in a safe condition. The building official is free to use his judgment in determining how extensive a periodic inspection need be.

Question 2: Do Code requirements for periodic reinspection include a requirement to reinspect by wiring, plumbing, gas fitting and elevator inspectors for compliance with the various applicable specialized codes?

Answer 2: No. The Massachusetts State Building Code does not include a requirement for periodic reinspection by plumbing, wiring, gas fitting or other various specialized code enforcement officials. However, periodic inspections conducted by the building official may reveal conditions that would require further attention by local wiring, plumbing, gas or elevator inspectors.

Question 3: May a professional consultant assume or be granted the powers and duties of the Building Official to issue permits and certificates or may he merely submit a report for the Building Official's review and acceptance?

Answer 3: Section 114.1 states in pert, "The Building Commissioner or Inspector of Buildings shall examine or cause to be examined all applications for permits and amendments thereto within 30 days after filing. ... If he is satisfied that the proposed work conforms to the requirements of this Code and all pertinent law applicable thereto, he shall issue a permit." Only a Building Official, appointed in accordance with Section 107 to enforce the building code may issue building permits and/or related certificates. A professional consultant may submit a report for the Building Official's review, but the issuance or denial of the permit or certificate is ultimately the Building Official's responsibility.

Question 4: May such a professional consultant be hired by a municipality to perform inspections in the absence of any "unusual technical issues" as described in Section 108.5, or should the consultant more properly be engaged by the building owner in the absence of unusual technical issues?

Answer 4: A professional consultant or expert retained by a municipality in the absence of any "unusual technical issues" to perform inspections would be required to meet the criteria and qualifications outlined in M.G.L. c. 143, § 3, and would be deemed a local inspector, and subject to all pertinent requirements of Code and law. However, a Building Official may review and/or accept reports from other qualified personnel, per Section 111.2.1 (see Question 3).

Question 5: What, if any, liability under the Code would a municipality assume in utilizing a professional consultant for the various functions described above?

Answer 5: Opinions relative to broad legal questions of liability are beyond the purpose and scope of the Board of Building Regulations and Standards. Therefore, we must decline to answer this question, and would direct the municipality to its legal advisor(s) for such and opinion.

Official Interpretation No. 2-85

DATE: October 30, 1985
SUBJECT: State Building Code Section 119.3

Question 1: Do All existing buildings have a legal use group classification , whether in use or not?

Answer 1: Yes. Section 202.1 states "All buildings and structures shall be classified with respect to use in one (1) of the use groups listed...". The use group classification is based on the purpose for which a building or structure is designed, used or intended to be used. A use group classification is required to be assigned to a building or structure whether in actual use or not.

Question 2: On what is the legal use based?

Answer 2: The Massachusetts State Building Code defines use as "The purpose for which the building or structure is designed, used or intended to be used." The lawful use and/or use group classification of an existing building may be based upon the Building Official's records pertaining to the particular structure. In the case of a vacant structure, the last legal use of record would apply.

Question 3: Does the legal use change or cease to exist when ownership changes?

Answer 3: No. A change in ownership of a building would not change the use group classification of the building or cause the use to cease. A change of use and/or occupancy may take place regardless of ownership when done in accordance with a permit issued by the Building Official.

Does the use have any relationship with ownership?

The use and ownership are only related in that the owner, as defined by Code, is responsible to comply with the applicable sections of the Code as regard to use, and must obtain a permit to change the use of a building.

Question 4: Is there ever any such thing as "abandonment" of a use group classification, so that an existing building has no use group?

Answer 4: No. All buildings are required to be classified with respect to their use. The discontinuance or "abandonment" of the actual using of a building or structure would not change the use group classification. For example, a vacant office building (formerly legally occupied) would remain in use group "B" (Business Buildings), the last lawful use of the building, until a permit was obtained to change that use.

Question 5: Upon request by an owner for a certificate of use and occupancy, is the Building Official obligated to cite in writing any violation of law or orders pending?

Answer 5: Yes. If there are violations of law or orders pending, the provisions of Section 121.0 would apply. Section 121.2.1 states that every notice or order authorized by this Code shall be in writing and shall be served on the person responsible.

Question 6: Can the use of a building or portion of a building, subsequent to January 1, 1975, legally change without the issuance of a building permit and a certificate of use and occupancy?

Answer 6: No. Section 113.0 and Section 113.1 state that a permit is required "...to change the use or occupancy of a building or structure...".

Section 119.0 and Section 119.2 state " A building or structure, in whole or in part, altered to change from one use group to another: to a different use within the same use group...shall not be occupied or used until the certificate shall have been issued certifying that the work has been completed in accordance with the provisions of the approved permits...".

The Massachusetts State Building Code became effective on January 1, 1975. All changes of use or occupancy subsequent to January 1, 1975 would be subject to the provisions of the Code.

Official Interpretation No. 3-85

DATE: October 30, 1985

SUBJECT: State Building Code Section 609.3

Massachusetts State Building Code Section 609.2 requires not less than two approved independent exitways serving every building except as modified in Section 609.3.

Massachusetts State Building Code Section 609.3 also allows one exitway in a building of the use group and characteristics as specified in Table 609.

Massachusetts State Building Code Section 609.3 also allows one exitway from the first story of a building when the first story is 2,000 square feet or less in area and with an occupancy load not exceeding 50 persons. Egress from other stories shall comply with Article 6.

Massachusetts State Building Code Section 609.2 also specifies not less than two approved independent exitways serving every story, except in one and two family dwellings and as modified in Section 609.3.

It is our interpretation that Section 609.3 deals with two distinct and separate building design configurations. In its first essence, Section 609.3 provides for certain buildings (those complying with Table 609)which are required to have only one exitway. The remaining sentences in Section 609.3 describe conditions (less than 50 occupants and less than 2,000 square feet in area) in which the first story only of any building is required to have only one exitway. Table 609 does not relate to the latter case.

Official Interpretation No. 4-85

DATE: October 30, 1985

SUBJECT: State Building Code Table 214 and Section 217.4

An existing three story building is proposed to be of type 3-C constriction. The exterior walls have a fire separation of 30 feet or more and the walls themselves are non-bearing. The loads are carried by a structural steel frame and there are structural beams and columns within the exterior wall which are part of the load bearing system. Therefore, the steel frame is load bearing. The walls themselves are essentially curtain walls.

Question: Are the beams and columns which are on the exterior part of the building, required as load bearing members, to have a two hour fire rating?

Answer: No. Table 214, line 8 of the State Building Code establishes the fire resistance rating required for the columns and framing(beams) and does not require a fire resistance rating for columns or beams for the proposed condition. However, it should be noted that, per Section 911.6, beams which support walls required to be fire resistance rated must be protected to afford not less than the fire resistance rating of the wall supported and, when supporting masonry walls, must carry a minimum fire resistance of one hour. Further, it should be noted that, if the framing supports a required fire separation wall such as an exitway enclosure, Section 909.4 would require this framing to be protected to afford a fire resistance rating equal to the wall supported.

Official Interpretation No. 5-86

DATE: January 28, 1986
SUBJECT: State Building Code Section 2101.10.4.2

Question: In a single family dwelling, the (nominal) width of a second means of egress doorway is required by Section 2101.10.4.2 to be a minimum of 32 inches. Does a six foot wide sliding glass door providing a net clear opening of 29 3/4 inches comply with this requirement?

Answer: Yes. Section 2101.10.2 allows the use of sliding glass doors for egress. Section 612.3 of the Code allows means of egress doorways to have a minimum clear width of 28 inches in one- and two-family dwellings. Per Sections 857.5.6.1 (Item 2) and 2101.7.2 (Item 2) of the Code, and Massachusetts General Laws (M.G.L.) Chapter 143, Section 3T, safety glass must be used in these sliding glass doors. M.G.L., Chapter 143, Section 3U requires that safety glazing be etched or otherwise permanently identified as such.

Official Interpretation No. 6-86

DATE: January 28, 1986
SUBJECT: State Building Code Section 909.1.2

Question: Is it the intent to require a fire separation wall and/or fireresistive floor-ceiling assembly between units which has a fire rating of one hour, that is, an assembly with one face in one unit and the opposite face in another unit, with an assembly between the two faces producing a fireresistance rating of one hour, or, a one hour fire rated assembly for each dwelling unit, which in effect, produces a two hour fire rated assembly between the two dwelling units?

Answer: It is the intent of Section 909.1.2 to require a one hour rated dwelling unit separation between dwelling units, rather than a one hour rated assembly per dwelling unit.

Official Interpretation No. 7-86

DATE: January 28, 1986
SUBJECT: State Building Code Table 214, Line 7 "Dwelling Unit Separations and other Non-Bearing Partitions"

Question: Does Table 214, Line 7, control the fireresistance rating of only the vertical dwelling unit separations, with Line 10 controlling the horizontal separation?

Answer: No. Table 214, Line 7, regulates the fireresistance rating required between dwelling units. A rating of not less than one hour is required to be provided between dwellings regardless of their orientation and type of construction. If a certain type of construction is required by Table 214, Line 10 to provide a greater fireresistance rating for floor-ceiling assemblies, this assembly may also serve as the dwelling unit separation required by Table 214, Line 7.

Official Interpretation No. 8-86

DATE: August 19, 1986
SUBJECT: State Building Code Section 607.3

Question: Section 607.3 requires that building exitways be "...as remote from each other as practicable." Do so-called "scissor stairways" which are constructed side-by-side, usually located in the center of a building, violate this requirement?

Answer: No. Section 607.3 also states that exit stairways must be "...arranged to provide direct access in separate directions from any point in the area served." Scissor stairways, especially when located in a center core, may well satisfy Section 607.3. The exit access passageways or corridors must provide direct access to the stairways in separate directions. Because the entrances to the scissor stairways are usually at opposite sides of the core, they may, in fact, be as remote as practicable and accessible in separate directions. Table 214, Line 4, provides fire resistance requirements for enclosure of the exitways, and Table 214, Line 6, and Section 610.4 specifies fireresistance requirements for exitway access corridors.

Official Interpretation No. 9-86

DATE: August 26, 1986

SUBJECT: State Building Code Sections 504.2 and 1009.2

Question: Does the Code allow the usage of flexible duct and duct connector in forced hot air heating systems for residential construction?

Answer: Yes. Sections 504.2 and 1009.2, which speak to the use of ductwork for heating and ventilating, make reference to the mechanical code listed in Appendix B of the State Building Code, which is the BOCA Basic Mechanical Code, 1978 edition. In Sections M-301.4.3 through M-301.4.5 flexible duct and duct connector are permitted for all occupancies except one and two family dwellings when conforming to the UL 181 standards, and subject to other limits stated therein. Section M-302.2.1 allows non-metallic supply ducts in one and two family dwellings when in conformance with the applicable standard (UL 181 or SMACNA-75) listed in the appendix of the Mechanical Code.

Official Interpretation No. 10-86

DATE: August 27, 1986

SUBJECT: State Building Code Sections 1004.0 and 1006.0

Question: Must condensing type oil-fired furnaces (central heating appliances) always be vented into masonry chimneys?

Answer: No. The purpose of the masonry chimney requirement is to provide safe venting of the high temperature exhaust gasses generated by conventional type oil-fired central heating appliances. However, certain condensing type oil-fired furnaces generate low temperature exhaust gases which also contain corrosive products that can adversely effect masonry. Consequently, condensing type oil-fired furnaces which operate to produce vent gas temperatures of no greater than 150°F are to be approved for through-wall and/or through-roof venting with polyvinylchloride or similar pipe when installed according to the manufacturer's recommendations. The appliance and its venting system must have been tested together and "listed" or the provisions of Section 1006.0 for "unlisted appliance" apply.

Official Interpretation No. 11-87

DATE: December 30, 1986

SUBJECT: State Building Code Section 2108.3.2

Question: Do chimney lining and/or re-lining systems which do not use fire-clay flue lining (ASTM C315) require specific approval by the State Board of Building Regulations and Standards?

Answer: No. Section 2108.3.2 of the Code permits the use as chimney lining of, "...other approved material that will resist corrosion, softening or cracking from flue gasses at temperatures up to seventeen hundred (1700) degrees Fahrenheit."

Materials and/or systems which satisfy the high temperature provisions of the Underwriters' Laboratory Test Standard 103 (UL-103 HT) satisfy this performance requirement for lining of masonry chimneys contained in Section 2108.3.2.

Since each system is tested in the configuration required by the manufactures' installation instructions, these instructions become the requirements for installation of the chimney lining system.

Official Interpretation No. 12-87

DATE: February 24, 1987

SUBJECT: State Building Code Sections 616 and 2101

Question: Are alternating tread stairways, such as the Lapeyre Stair, permitted by Massachusetts State Building Code as an element of required means of egress?

Answer: No. The exit stairway requirements described in Sections 616 and 2101 of the Code are intended to provide a stairway of certain minimum exit capacity, with the full width being available for occupant egress, at an incline that results in motion familiar to the occupants. Alternate tread stairways are intended for use where floor space is limited and therefore a steeper than usual incline is required. The steeper incline, when descending the stairway, requires an unfamiliar foot motion more downward and less outward than that typically required. Imposing such an unfamiliar motion on occupants exiting the building during a life threatening situation is unwarranted.

The Lapeyre Alternating Tread Stair exceeds the maximum incline permitted by Sections 616 and 2101 and will, therefore, require an unfamiliar motion by the occupants.

In addition, the overall width of these stairs does not meet the minimum width requirement of Sections 616 and 2101, nor would the exit capacity be equal to that of a full stairway if the minimum width were satisfied since these stairs do not permit parallel egress of individuals.

The Lapeyre Alternating Tread Stair is, therefore, not permitted as an element of a required means of egress.

Official Interpretation No. 13-88

DATE: October 25, 1988
SUBJECT: State Building Code Section 2108

Question: A single family dwelling is to be constructed with a fuel-fired water heater in the basement and a fireplace lined with a 2 inch thick refractory brick on the first floor. What construction is required to separate the water heater flue from the firebox and smoke chamber of the fireplace at the first floor? What separation is required within the chimney?

Answer: Section 2108.7.2 requires that the firebox of a fireplace constructed of solid masonry and lined with refractory brick have back and side walls of at least 8 inches total thickness.

Section 2108.7.4.5 requires that the walls of the smoke chamber be a minimum of eight inches thick. Thus a minimum of eight inches of solid masonry is required in these locations. Once the elevation of the fireplace flue is reached, Section 2108.3.2.4 allows two adjoining flues to be contained in the same chimney, so long as the flue liner joints are staggered at least seven inches. If this staggering of flue liner joints is not provided, or if more than two flues are present, Section 2108.3.2.5 requires that masonry flue partitions of at least four inch thickness, bonded into the chimney walls, be constructed to separate the flues.

Official Interpretation No. 14-89

DATE: March 28, 1989
SUBJECT: State Building Code Section 437 and 616.8

Question 1: Section 437.1.3.2 provides that "At least one required exitway shall be accessible without passage through an atrium." Section 437.2.2, which speaks to the enclosure of atriums, contains an exception which provides that "The adjacent spaces of any three (3) floors of the atrium shall not be required to be separated from the atrium; however, these spaces shall be included in the atrium volume according to Section 437.2." Is it the intent of Section 437.1.3.2 to require at least one required exitway to be accessible without passage through an atrium on those floors exempted by Section 437.2.2 from the requirement for separation from the atrium?

Answer 1: No. The exception in Section 437.2.2 allows the designer to eliminate atrium separations on any three floors so long as the additional spaces on these floors are added to the atrium volume for purposes of sizing the smoke control requirements of the atrium. What this allowance essentially does is to add these adjacent spaces to the atrium. It is impossible to provide an exit which is accessible without passage through an atrium for spaces within that atrium. The provisions of Section 437.1.3.2 are intended to ensure that spaces outside the atrium need not depend on the viability of the atrium in order to gain access to an exitway. Therefore, these provisions are not applicable for any spaces which are already included in the atrium space, including those spaces added when the exception in Section 437.2.2 is applied.

Question 2: Is it the intent of the Code that stairways conforming to Section 616.8 and escalators conforming to Article 16 be subject to the requirements of Section 437.3.1?

Answer 2: Not necessarily. It is intended that unenclosed supplemental stairways be prohibited from connections with (required) exit stairways and exitway access corridors, and that these unenclosed supplemental stairways be equipped with a draft stop conforming to Section 437.3.1. While there are no provisions in the Code text to require that escalators be classified and protected as floor openings, it is possible that escalators can be so classified. However, escalators may also be enclosed in fire resistance rated construction, or may be located within an atrium. A supplemental stairway may also be enclosed in fire resistance rated construction, or may be located in an atrium, and may therefore not be classified as a floor opening.

Sequential Gap - Official Interpretation Number 15

Official Interpretation No. 16-89

DATE: August 29, 1989

SUBJECT: State Building Code Ssections 616

Question: Does the installation of a handicapped stair lift in a required exit stairway constitute an obstruction to the means of egress?

Answer: Yes. Section 616 of the State Building Code makes the following provisions:

"Stairways shall not reduce in width in the direction of exit travel. Projections into a stairway a re prohibited except for handrails as indicated in Section 616.5.1 and for stairway stringers which may project not more than one and one-half inches." (616.2.3)

"The least dimension of landings and platforms shall be not less than the required width of stairway." (616.3.1)

"Stairways shall have continuous guards and handrails on both sides..." (616.5)

"An exitway enclosure shall not be used for any purpose other than means of egress." (616.9.2)

Moreover, Section 605 states that "It shall be unlawful to obstruct, or reduce in any manner, the clear widths of any doorway, hallway, passageway or any other exitway required by the provisions of this code." Section 605 also requires that "All required means of egress components shall at all times be maintained in a safe usable condition."

Handicapped stair lifts installed in required egress stairs can conceivably violate all of the above sections. When in use, such lifts render at least a portion of a stairway unusable. Even when not in use, the lift equipment projects into the required width, interferes with the use of handrails, and presents a potential tripping hazard to persons using the stair. Also, the introduction of this equipment into a stair enclosure does, in a sense utilize an exitway enclosure as an elevator shaft, and there is the possibility that the equipment, motor, and wiring can catch fire, thereby rendering the exitway unusable. There is also reason to expect that loss of primary electrical power in an emergency situation could disable the lift in a position where it would present a greater obstruction than when not in use. For these reasons, we conclude that the installation of inclined stairway chairlifts in required exitway stairways is potentially hazardous, and is therefore not permitted. However, the building official may allow the installation of such lifts in stairways which are not a component of the required means of egress, so long as the building official determines that the particular installation is not hazardous. It is the policy of the Department of Public Safety, Division of Inspection, Elevator Section to require a letter of approval from the building official before granting a permit for an inclined stairway chairlift.

Official Interpretation No. 17-89

DATE: October 24, 1989

SUBJECT: State Building Code Section 1216

Question: Under the new (ASME/ANSI A 17.1) elevator code, smoke detectors are required in the elevator lobby for elevator control. Are these same smoke detectors required to be tied into the fire alarm system?

Answer: Yes. NfiPA 72A, the applicable fire protection standard referenced in Section 1216.1, requires that these detectors be tied into the fire alarm system.

Official Interpretation No. 18-90

DATE: February 27, 1990
SUBJECT: State Building Code Section 1006.2

Question: Is the "direct venting" (through-the-sidewall combustion product exhaust venting) of "listed" comfort heating and comfort cooling appliances allowed in lieu of venting to a masonry chimney as required in Section 1004 of the State Building Code?

Answer: Yes, Section 1006 of the State Building Code (the Code) defines "listed appliances" and Section 1006.2 addressing appliances to be vented states:

- "Appliances shall be connected to a listed venting system or provided with other means for exhausting the flue gasses to the outside atmosphere in accordance with the venting system selection chart contained in the mechanical code listed in Appendix B."

In Section 1001.2, the Code recognizes that appliances required to be vented "shall be connected to a vent or chimney..." and in Section 1002 addresses the performance test and acceptance criteria to insure safe and proper performance of the venting system.

Direct venting systems that are "listed" or are part of a listed appliance conform to the requirements of the Code.

Official Interpretation No. 19-90

DATE: December 11, 1990
SUBJECTS: of Section 602.1 of the Fifth Edition of the State Building Code and. BBRS Approval of the Use of Power Venters

In order to immediately correct an inadvertent oversight in Section 602.1 of the Fifth Edition of the State Building Code, at is meeting of November 20, 1990, the Board unanimously voted that it should reflect the provisions of M.G.L. c. 148, §§ 26A and 26A½ and, therefore, should read -

602.1 Applicability: the provisions of this section shall apply to all buildings more than 70 feet above mean grade, except that the provisions of this section shall not apply to airport traffic control towers conforming to the requirements of Section 616.0.

By way of clarification, Section 602.1, as cited in the Fifth Edition, is in conflict with statutory requirements of 2 counts:

1. It ties high rise provisions to floors used for human occupancy and located more than 70 feet above the lowest level of fire department vehicle access; whereas, the governing statues identify high rise buildings as all buildings of more than 70 feet in height above the mean grade; and

2. The cited section in the Fifth Edition measures from the lowest level of fire department vehicle access; whereas, the statutes measure from mean grade.

As you know, statutory requirements govern and in this case also reference the high rise provisions of the State Building Code.

POWER VENTERS

Power Venters, as contained in Section 2513 of the Fifth Edition, are ONLY allowed for use WITH GAS OR OIL FIRED comfort heating and/or cooling appliances. Approval from the BBRS is required for use with solid fuel burning appliances.

Official Interpretation No. 21-91

DATE: July 30, 1991

SUBJECT: Section 908.1 of the Fifth Edition of the State Building Code as related to attached dwelling units (Use Group R-3), in which the units are separated by interior lot lines.

Question: a) When side by side attached single family dwelling units (Use Group R-3) are constructed such that the exterior wall of each is located at the lot line which divides them, will two one-hour rated wood stud walls comply with Section 908.1 (Fire Walls and Party Walls) of the 5th Edition of the Code?

b) Could the two walls referred to in question a) above be supported on a single foundation wall.

Answer: a) For multiple attached single family dwelling units, (Use Group R-3), which are separated by interior lot lines, the intent of section 908.1 is satisfied by the construction of a single fire separation wall having a fireresistance rating of one-hour. Such fire separation walls may be used between attached dwelling units providing that the wall construction meets the requirements of Section 910 and the sound transmission ratings of Section 714. and that the allowable area limitations between fire walls of Table 501 are not exceeded. Fire walls, constructed in accordance with Section 908, are required when the allowable area limitations of table 501 are reached. (e.g. 4800 sf per floor for multiple attached single family dwelling units, Use Group R-3).

b) The wall referenced in answer a) above may be supported one a single concrete or masonry foundation wall of equivalent or greater fire resistance rating.

Discussion: Section 908.1 of the Code requires party walls to be constructed as fire walls if an interior lot line is present. Furthermore, the fire walls "....shall be constructed of any approved noncombustible materials providing the required strength and fireresistance rating specified in Table 401 for the type of construction, but not less than the fire grading of the use group specified in Table 902. Strength.....".

The argument can be made that such party walls can be considered to be exterior walls, thus causing the requirements of section 908.1 to be in conflict with the exterior wall fireresistance requirements of Table 906.2 (for fire separations of five feet or less).

Table 906.2 requires an exterior wall fireresistance rating of one hour for a fire separation distance of zero feet. If two dwelling units were constructed on adjacent lots and each were constructed on the common lot line, such that the fire separation distance of each unit was zero, Table 906.2 would require each exterior wall to have a fireresistance rating of one hour. However, Code requirements for multiple single family attached dwelling units when interior lot lines are not present, table 401 would simply require the construction of *dwelling unit separation* walls with a fireresistance rating of one hour, between dwelling units. It would appear to be inconsistent to require the same R-3 structure to have a greater degree of fire safety due simply to the separation of the dwelling units by an imaginary lot line.

Official Interpretation No. 22-91

DATE: September 24, 1991

SUBJECT: Section 2102.4(1) of the Fifth Edition of the State Building Code as it relates to reconstruction in Coastal High Hazard Areas following Storm Damage.

At a regular meeting of the Board of Building Regulations and Standards held on Tuesday 24, September 1991, the Board approved the following interpretation of Section 2102.4(1) of the 5th Edition of the Massachusetts State Building Code, effective immediately.

Question: When a structure is located in a Coastal High Hazard Area ("V" zone) and is swept from its foundations during a storm, and the building remains intact but the foundation system is completely destroyed, does the code require that the structure be constructed on an elevated pile foundation, in accordance with Section 2102.4 ?

Answer: Yes. The structure, as described would be considered to be substantially damaged and as such would be required to be provided with a new foundation system. Section 3203.3, the foundation system would constitute a "new system", as defined in Section 3201 and therefore would be required to be constructed to meet the requirements for new construction. Since the structure is located within a "V" zone, Section 2102.4(1) would require the structure to be elevated on piles.

Question: When a structure is located in a Coastal High Hazard Area ("V" zone) and is swept from its foundations during a storm, and both the building and foundation system remain intact and if the costs associated in relocating the building onto its existing foundation system are less than 50% of the market value of the structure prior to the damage, does the code require that the structure be constructed on a raised pile foundation, in accordance with Section 2102.4 ?

Answer: No. If both the foundation system and structure are intact and the cost associated in relocating the structure to its pre-damaged condition, then the structure is permitted to be relocated on the existing foundation unless, in the opinion of the building official, under Section 101.3, the proposed reconstruction would constitute an unsafe structural condition, in which case the structure should be elevated in accordance with Section 2102.4(1).

Official Interpretation No. 23-91

DATE: September 30, 1991

SUBJECT: Section 816 of the Fifth Edition of the State Building Code as It Relates to Requirements for Stairways

Date of Interpretation:

The State Board of Building Regulations and Standards, at it's regular monthly meeting of September 24, 1991, affirmed the following requirements:

Question: To what extent are the provisions of Massachusetts State Building Code, Section 816, applicable to a stairway providing access to an attic area in a business establishment; said attic area used for the storage of stock used in conjunction with that business?

Answer: Section 816, INTERIOR STAIRWAYS, (in conjunction with Section 819, EXTERIOR STAIRWAYS), of the Fifth Edition of the Massachusetts State Building Code requires that all stairways, whether interior or exterior, required or supplemental, must be so constructed to satisfy the applicable requirements imposed for interior exit stairways.

This means that for interior or exterior, required or supplemental stairways, the width, headroom, stairway allowed width restrictions, the allowed dimensions of platforms and landings, the acceptable vertical rise between landings and platforms, riser height and tread depth and the dimensional uniformity required between adjacent risers and treads and the requirements for stairway guards and handrails are controlled by the requirements of Section 816.

Note 1: If classified as a mezzanine, then the subject attic area would fall under the requirements of Section 605 of the State Building Code; otherwise such area would be treated as an additional story of the building, with the resulting classification determining what applicable State Building Code requirements apply.

Note 2: Only fixed interior or exterior, required or supplemental stairways (dimensions and handrail/guardrail requirements) are controlled by Section 816 - ladder type stairs and "pull-down", non-fixed stair systems are not explicitly regulated by the Building Code.

Note 3: Article 34, Section 3401, still controls dimensions and handrail/guardrail requirements for fixed stairways in one and two family detached dwellings.

Official Interpretation No. 24-92

DATE: January 28, 1992

SUBJECT: Section 1205 of the Fifth Edition of the State Building Code as it relates to Frost Protection for Fence Posts

At a regular meeting of the Board of Building Regulations and Standards held on Tuesday 28, January, 1992, the Board approved the following interpretation of Section 1205 of the 5th Edition of the Massachusetts State Building Code, effective immediately.

Question: Is it the intent of the Code to require a four foot deep concrete footing to the posts of a fence up to six feet in height ?

Answer: No. The requirement of section 1205, which requires protection against frost for footings for permanent structures is not applicable to minor fences such as described in the above question.

In certain fence applications, post embedment depths of four feet or more may indeed be required for fences of unusual size, or fences which are subjected to unusual loading conditions (such as a prison security fence, for instance which, in addition to wind loads, may also be subjected to vehicle impact loads). However, it is not the intent of the Code to require frost protection for fences which are only four feet in height.

As an example consider the construction of a four foot high chain link fence, erected as a property line demarkation. The required post embedment depth is determined by a number of factors including; the height of the fence; the applied horizontal loads; the nature of the soil and; the intended function of the fence. Specific reference related to post embedment depths can be found in ASTM F 567-84 " Standard Practice for Installation of Chain Link Fence", and although not specifically referenced in the Code, is a recognized national standard of practice. Sections 4.1 and 4.8 of ASTM F 567-84 specify *minimum* post embedment depths of 24 inches and 36 inches, for concrete encased and driven posts, respectively, when used in the construction of a four foot high chain link fence. For this particular type of fence, it is unlikely that movement due to frost heave would result in a life safety hazard or cause serious damage. However, it is incumbent upon the designer to make this determination on a site specific basis (and to submit his determination to the local building official for approval) and prepare the design accordingly.

In summary, the intent of the Code relating to these issues is expressed in Section 311.0, USE GROUP U, UTILITY AND MISCELLANEOUS USES, which states ..." *Buildings and Structures of an accessory character..... shall be constructed equipped and maintained to meet the requirements of this code commensurate with the fire and life hazard incidental to their use.* [emphasis added] *Utility and miscellaneous uses shall include fences over 6 feet high, tanks, cooling towers, retaining walls and buildings such as private garages, carports, sheds and agricultural buildings".* The phrase *"commensurate with the fire and life hazard incidental to their use"* is the key phrase to consider, as it provides the necessary guidance to the designer and building code official to avoid the "blanket" literal interpretation of the requirements of Section 1205 and other inappropriate sections of the Code.

Official Interpretation No. 25-92

DATE: January 28, 1992

SUBJECT: Section 921.6.2 of the Fifth Edition of the State Building Code as it relates to Firestopping.

At a regular meeting of the Board of Building Regulations and Standards held on Tuesday 28 January, 1992, the Board approved the following interpretation of Section 921.6.2 of the 5th Edition of the Massachusetts State Building Code, effective immediately.

Question: In a building which has suspended ceilings and vertical partitions extending to the underside or suspended horizontal membrane of the ceiling, is it the intent of Section 921.6.2 to require firestopping at the top of the partitions to eliminate the open connection between the vertical wall openings and the horizontal ceiling space ?

If firestopping is required, is the requirement applicable to combustible and noncombustible construction ?

Answer: If the vertical partition does not penetrate the ceiling membrane, (i.e. if the partition terminates at the underside of the plane of the ceiling) there is effectively no connection between the horizontal space above the ceiling and the vertical space within the partition, therefore firestopping is not required. If, however, the vertical partition penetrated the plane of the ceiling, firestopping would be required at the interface of the ceiling and partition. For this situation, the firestopping would be required whether the partition and ceiling materials were combustible or noncombustible.

Official Interpretation No. 26-92

DATE: January 28, 1992

SUBJECT: Sections 706.1 and 707.1 of the Fifth Edition of the State Building Code as related to Mechanical Ventilation of Non Public Bathrooms

At a regular meeting of the Board of Building Regulations and Standards held on Tuesday 28, January, 1992, the Board approved the following interpretation of Section 706.1 and 707.1 of the 5th Edition of the Massachusetts State Building Code, effective immediately.

Question: Can a bathroom exhaust fan exhaust into an enclosed ventilated attic space which has soffit vents in conjunction with continuous ridge vents or eaves vents.

Answer: No. Section 707.1 requires that " Mechanical ventilation, when provided, shall conform to the requirements of the BOCA National Mechanical Code listed in Appendix A, unless expressly defined within this Code, and may be substituted for the requirements for natural ventilation."

Article 16 of the BOCA National Mechanical Code (1987) lists the required mechanical ventilation air in Table 1602.2.

Section M-1604.1 (Mechanical Exhaust) of the BOCA National Mechanical Code (1987) states, in part, that "**.... The exhaust shall discharge directly to an approved location on the exterior of the building".**

Warm, moist air exhausted from bathroom spaces would condense in the cooler attic space, even if the attic space were adequately ventilated. Moisture from condensation will eventually cause damage to wood framing members (or sheathing), insulation and ceiling materials and may pose a threat of fire if electrical circuitry is contacted.

Sequential Gap 27 and 28

Official Interpretation No. 29-92

DATE: January 12, 1993

SUBJECT: Articles 6, 8 and 9 - Smoke Protection in Egress Corridors of Fully Suppressed Buildings

Question 1: In a fully sprinklered building, is it the intent of Section 810.4.1 of the Fifth Edition of the Massachusetts State Building Code (the Code) that egress corridors be constructed so as to serve as an effective barrier to limit the transfer of smoke?

Answer 1: Yes, for USE GROUPS where *"sleeping uses"* are involved.

The BOCA National Building Code/1987 Commentary, for Section 810.4.1 (the Massachusetts Code, utilizes the BOCA Building Code language for this Section) states that Section 810.4.1 "...acknowledges that an automatic fire suppression system can serve to control or eliminate fire development which could threaten the exit access corridor. The nonsleeping occupancies are permitted to have nonrated corridors if the suppression system is installed throughout the area served by the corridor as well as the corridor itself". "In the sleeping uses ...the corridor fireresistance is reduced to one-half hour. The purpose of the fireresistance rated corridor is not only to provide a fire endurance capability, but mainly to provide a quality of construction that would ensure such walls would serve effectively as barriers to smoke. The dwelling unit (sleeping uses) separation walls, while reduced to one-half hour, are to be constructed tight to the ceiling above (tight to the underside of the floor/roof deck above or tight to the rated floor/ceiling assembly above), to complete the barrier to smoke function."

The interpretation provided above is not meant to imply that Section 810.4 requires satisfying Section 911 - "SMOKE BARRIERS", as "SMOKE BARRIERS" are unique to certain "defend-in-place" concepts, specifically associated with Section 610.5, I-2 USE.

Note that Section 810.4.1 does allow that when an approved fire suppression system is installed and supervised in accordance with Section 1020.1, parts 1, 2 or 3, and has its water flow alarm device connected to an approved central station system, proprietary system or remote station system of the jurisdiction, a fire resistance rating for exit access corridors, and tenant separation walls which are also corridor walls, is not required in USE GROUPS A, B, E, F, M and S.

Question 2: In a fully sprinklered building of USE GROUP I-2, is it the intent of Section 610.4 of the Fifth Edition of the Massachusetts State Building Code (the Code) that egress corridors be constructed so as to serve as an effective barrier to limit the transfer of smoke?

Answer 2: Yes - Section 610.4 clearly states that "...in buildings equipped throughout with an approved automatic fire suppression system, the corridor wall fireresistance rating is not required provided the corridor walls form a barrier to limit the transfer of smoke."

The BOCA National Building Code/1987 Commentary, for Section 610.4 (the Massachusetts Code, utilizes the BOCA Building Code language for this Section) states that "...if the building is protected throughout with an automatic fire suppression system, thereby reducing the possibility that a fire will develop which is life-threatening to persons outside the room of origin, the corridor walls need only be able to resist the passage of smoke."

"...when the building is protected with an automatic fire suppression system, the primary concern is to contain the smoke since the suppression system is expected to suppress and thereby contain the fire."

The interpretation provided above is not meant to imply that Section 610.4 requires satisfying Section 911 - "SMOKE BARRIERS", unless a wall of the exit access corridor is intended to be a "SMOKE BARRIER" wall. "SMOKE BARRIERS" are unique to certain "defend-in-place" concepts, specifically associated with Section 610.5, I-2 USE.

Question 3: In fully sprinklered buildings of USE GROUPS R-1, R-2 and I-2, is it the intent of the Code that smoke dampers be provided at duct penetrations through the unrated corridor walls?

Answer 3: No, provided in the case of the I-2 USE, the corridor wall is not a portion of a "SMOKE BARRIER" (Section 911.5 would require a smoke damper in a "SMOKE BARRIER"/I-2 USE).

Note that the Code is effectively silent on the use of "smoke dampers", but does provide guidance in Section 918, on the use of "fire dampers". Section 918.2 states that "fire dampers" shall be provided at locations where air distribution systems penetrate assemblies required to have a fireresistance rating", thus the R-1 and R-2 USES, having a one-half hour rating would require "fire dampers" but not smoke dampers" - the I-2 USE corridor walls, if not a portion of a "SMOKE BARRIER" - Section 911 - would not be rated and would not require a "fire damper".

Exceptions to Section 918.2 "fire damper" requirements include exception no. 3 to Section 918.2, where:

Exception 3 states that a fire damper is not required "...at penetrations of tenant separation and corridor walls in buildings equipped throughout with an approved automatic fire suppression system." Here, the 1987 Commentary states that "since an automatic fire suppression system reduces the potential for duct collapse, fire dampers are not required to protect penetrations of tenant separation and corridor walls in buildings protected throughout with an approved automatic suppression system."

Utilizing this same reasoning, a smoke damper would not be required as it is not expected that a fire can develop sufficiently in R-1 and R-2 or I-2 buildings that are fully suppressed, thus the level of "passive defense" required in corridor construction (where such corridor walls are not part of a "SMOKE BARRIER"/I-2 USE), is limited to the corridor walls being constructed tight to the ceiling above (tight to the underside of the floor/roof deck above or tight to the

rated floor/ceiling assembly above), to complete the barrier to smoke function and thus limit the transfer of smoke in the exit corridors of these "sleeping occupancies.

Question 4: In fully sprinklered buildings of USE GROUP I-2, is it the intent of the Code to allow the use of flexible duct (designed, listed and installed per the requirements of Section M-303 of the BOCA National Mechanical Code/1987)?

Answer 4: Yes. As is noted in answers #1, #2, and #3 above, the Code now places great emphasis on "active defense" in the form of full suppression and would allow the use of flexible duct when designed, listed and installed per the BOCA National Mechanical Code/1987 and additionally satisfies the requirements of NFiPA-90A in the case of the I-2 USE.

Official Interpretation No. 30-93

DATE: March 9, 1993

SUBJECT: of Table 401, Item 12 of the Fifth Edition of the State Building Code as it relates to the Use of Skylights in Fire resistance Rated Roof Construction

Question: Is it the intent of the Code to allow the use of unrated skylights in roof construction that is required to have a fire resistance rating under the provisions of item 12 of table 401, by virtue of the type of construction and height from the floor to the lowest structural member ?

Answer: Yes. The intent of the fire resistance rating requirements of table 401 are (in protected construction) to offer a degree of protection to the structural members of the roof system in order to prevent premature structural collapse of the roof.

For a particular type of construction, the degree of fire resistance required by table 401 to be provided for the roof construction is consistent with the protection required for the remainder of the structural elements of the building. Damage caused to a skylight during a fire event will not promote premature structural collapse of a rated roof system.

Question: Is it the intent of the code to allow a roof assembly, which is required to be rated under table 401 (item 12), to be constructed wholly of non rated skylights.

Answer: Yes. Provided that the following conditions exist:

a. the structural members of the roof system are protected in accordance with the requirements of table 401;

b. the subject building does not require the roof to be rated under the provisions of section 906.5. If the roof system is required to be rated due to vertical protection issues of section 906.5, unrated skylights are prohibited from being located within fifteen feet of the adjacent building.

Question: Are opening protectives required, in accordance with Section 906.5, for exterior wall openings which are located less than fifteen feet vertically above the roof of an adjacent lower building, if the adjacent lower building has a roof assembly fire resistance rating of one hour or greater and the roof assembly contains unrated glass skylights ?

Answer: Yes. Section 906.5 requires opening protectives for exterior wall openings in an adjacent higher building if the openings are located less than fifteen feet vertically above the lower roof and the adjacent buildings are separated horizontally by a distance less than fifteen feet, unless the roof construction of the lower roof has a fire resistance rating of one hour or greater. Fire in the lower building may be a source of exposure to openings in an adjacent higher building if the fire were to breech the roof construction. If the roof of the lower building has a fire resistance rating which affords the degree of safety against collapse of the roof, the potential for spread of fire to the adjacent (and taller) building would exist if fire penetrated the skylights and if the skylights were located within fifteen feet vertically and fifteen feet horizontally of the skylight. Section 906.5 does not require exterior wall opening protectives, even if the lower adjacent roof assembly is unrated provided that the buildings are separated horizontally by a fire separation distance of over fifteen feet.

Therefore skylights would be permitted in rated roof construction of the lower roof without the need for exterior wall opening protectives if either the buildings were separated horizontally

fifteen feet greater, if the skylights were a distance of fifteen feet or more from the adjacent exterior wall, or if the adjacent exterior wall openings were greater than fifteen feet above the lower roof level.

Official Interpretation No. 31-93

DATE: April 13,1993

SUBJECT: of Section 113.3 and Section 201.0 Definitions (owner) of the Fifth Edition of the State Building Code as it relates to the definition of owner.

Question 1: If a contractor is hired by an owner, is the contractor considered an agent under the definition of owner (Section 201.0) ?

Answer 1: Yes

Question 2: What information would be necessary to qualify that the contractor was an agent ?

Answer 2: The contractor would need to produce (1) a letter stating that he/she has been granted the authority to act as an agent or (2) a copy of a written contract signed by the owner and the contractor as specified.

Question 3: Can a city or town refuse to issue a permit to a contractor with (1) a letter stating that they may act as an agent or (2) with a signed contract between the two parties to remodel or construct a structure simply because he/she is not the owner of the structure or property ?

Answer 3: No. The definition of owner (Section 201.0 owner) states " Every person who alone or jointly or severally with others .....

(b) has care, charge or control of any building or structure in any capacity .....". The contractor is considered to have control, care or charge of the building during the time of construction as ling as the contractor has a letter stating that he/she is authorized to take out a permit (act as an agent of the owner) or the contractor has a signed contract with the owner.

Official Interpretation No. 32-93

DATE: May 14, 1993

SUBJECT: of Section 827.1 of the Fifth Edition of the Massachusetts State Building Code as it relates to when guardrails are required.

Question 1: Is the 30 inch elevation intended to be the limit above which guardrails are required to be installed in accordance with Section 827.1 ?

Answer 1: Yes. It is generally established in the BOCA National Building Code (1987) that when the height difference between the walking surface and the adjacent lower walking surface or grade is 30 inches or greater, guardrails are required to be provided.

Question 2: Is the 30 inch difference in elevation intended to be the point at which guardrails are required for ramps in addition to stairs or walking surfaces ?

Answer: No. Ramps are required to be provided with guardrails (if the ramp has an open side) irrespective of the difference in elevation between the ramp and the adjacent walking surface.

Official Interpretation No. 33-93

DATE: May 14, 1993

SUBJECT: Section 114.3 of the Fifth Edition of the Massachusetts State Building Code as it relates building permit extensions

Question: May a building official, if work has not begun as required under a building permit, within the six month period after the issuance of such permit, issue an extension of time for a period of more than six months.

Answer: No. Section 114.3 states that the building permit shall be considered abandoned unless the work authorized by it shall have commenced within six months after its issuance. Section 114.3 permits the building commissioner or inspector of buildings, for cause, to grant one or more extensions of time, for periods not exceeding six months. {emphasis added}.

Building permit extensions may be granted for periods of greater than six months by variance from a local or State Building Code Appeals Board pursuant to sections 126 of the Building Code.

Official Interpretation No. 34-93

DATE: September 28, 1993

SUBJECT: Requirements of the Fifth Edition of the Massachusetts State Building Code for "Permanent Foundations", "Frost-Protected Foundations" and the Building Inspector's Responsibilities Under "Doubtful Use Classification"

Question 1: Do Sections 1205.1 or 3402.3.4 of the Massachusetts State Building Code (the Code) mandate that all buildings and structures that are constructed, be placed on "permanent", frost-protected foundation systems?

Answer 1: No. Neither Section 1205.1, nor 3402.3.4 mandate permanent supports for all buildings and structures, but rather state that where permanent supports exist, they shall be frost-protected in a certain way (in order for supports to be considered "permanent", they must satisfy the requirements of either Section 1205.1 or 3402.3.4 of the Code).

Question 2: Does the State Building Code allow for other than frost-protected foundation systems or permanent foundation systems for new construction building and structures?

Answer 2: Yes.

(The issue of when such non-permanent foundation systems should be allowed, often arises when the Building Official is confronted with a "Doubtful Use" or "Utility Use" building - typically, storage sheds, carports, landscape type structures such as detached gazebos, etc.).

Question 3: As the Code does allow for other than frost-protected or permanent foundation systems in buildings and structures, what Code guidance is provided to assess whether or not frost-protected/permanent foundation systems are required for new construction buildings and structures?

Answer 3: Article 3 of the Code, Sections 301 through 313, address USE classification, and review of same will lead the reader to Sections 311.1 and 312.1 of the Code.

Section 311.1, in part, states: "Buildings and structures of an accessory character and miscellaneous structures not classified in any specific use group shall be constructed, equipped and maintained to meet the requirements of this code commensurate with the fire and life hazard incidental to their use. Utility and miscellaneous uses shall include... carports, sheds and agricultural buildings." (note underlining emphasis added).

Section 312.1, in part, states: "When a building or structure is proposed for a use not specifically provided for in this code, or the classification of which is doubtful, such building or structure shall be included in the use group which it most nearly resembles in respect to the existing or proposed life and fire hazard, and it shall be so classified by the building official." (note underlining emphasis added).

Review of these, Article 3 subsections, reveals that use classification, under utility or doubtful use, allows - in fact, mandates - that the Building Official make a judgement call and that the classification of use be commensurate with the fire and life hazard incidental to the use of the structure. On this basis, if, in the judgement of the Building Official (which is required to be made under Section 312.1), a utility type structure, such as a shed, would have a low fire and life hazard, the Building Official could allow a non-frost-protected, non-permanent foundation system.

Official Interpretation No. 35-94

DATE: April 12, 1994
SUBJECT: Referenced Standards adopted as listed in Appendix A.

Question: Some of the reference standards, as listed in Appendix A, give the local authority having jurisdiction the power to amend or vary the requirements of certain provisions contained within the standard. Does this mean that a building official may, (or the fire official, when reviewing plans pursuant to article 10) when requested, or on his or her own initiative, waive or vary said requirements.

Answer: No. The Board adopts the technical content of the reference standards, as written, but retains jurisdiction to adjudicate all variance requests pursuant to M.G.L. c. 143, § 100. The variance must be pursued through the appeals process pursuant to Section 126 of the Building Code and must be heard at the State level or by local or regional Building Code Appeals Board if local or regional boards exist within your jurisdiction.

Official Interpretation No. 36-94

DATE: April 12, 1994
SUBJECT: Design of Connections in Structural Steel Braced Frames - Sections 1113.5.2.2(a) and 1113.5.7.2

Question: What design force should be considered for the members of a braced frame constructed of structural steel ?

Answer: The connection of members in a structural steel braced frame shall be designed for not less than the lesser of the following forces;

a. 1.25 (one point twenty five) times the force determined in accordance with Section 1113.4.1, without the allowable ⅓ (one third) stress increase or;

b. The full axial capacity of the member, based on 0.6 (zero point six) Fy multiplied by the member gross cross sectional area.

This is a minimum requirement and may be followed in lieu of Section 1113.5.7.2.

DATE: April 12, 1994
SUBJECT: **Formal Interpretation Number 36-94**

The seismic advisory committee, at its meeting of April 7, 1994, voted to approve the attached formal interpretation number 36-94 relating to the design of connections in structural steel frames. The request for the interpretation was submitted by Weidlinger Associates, Inc. on December 6, 1993.

Advisory Ruling No. 1-94

DATE: April 14, 1994
SUBJECT: Section 119.1 of the Fifth Edition of the Massachusetts State Building Code as it relates to the Issuance of the Certificate of Occupancy

Question: If a conflict occurs between a building official and other local agencies as to whether or not a certificate of use and occupancy (c/o) is to issue for a building or structure, what action

should the building official take pursuant to Section 119.1 of the Fifth Edition of the Massachusetts State Building Code?

Answer: The building official has the authority to issue a c/o pursuant to Section 119.1. If a conflict is created with other local agencies as a result of the issuance of the c/o, the aggrieved party/parties may, in accordance with M.G.L. c.143, §100, appeal to the State Building Code Appeals Board. Any person aggrieved by a decision of the State Building Code Appeals Board may appeal to a court of law or equity in conformance with M.G.L. c.30A, §14.

Official Interpretation No. 38-94

DATE: August, 16, 1994

SUBJECT: Use of a Registered Professional Engineers Seal as Required under Section s 113.5.2 and 127

Discussion: Section 113.5.2 requires the seal of a qualified registered professional engineer or architect be contained on all plans and specifications for buildings and structures containing over 35,000 cubic feet of enclosed space. Additionally section 127.2.1 requires that all plans computations and specifications involving new construction, alterations repairs, expansions or additions shall be prepared by..... a registered professional architect or engineer and shall bear his signature and seal.....

The Board of Registration of Professional Engineers and Land Surveyors (the Board of Registration) is the Board having statutory authority to register professional engineers in the Commonwealth of Massachusetts. The Board of Registration registers engineers by discipline, perhaps the those most related to the construction of buildings and structures being civil, mechanical, HVAC, structural, sanitary, electrical and fire protection.

Question 1: Consider the situation where a set of plans and specifications are filed with the building official at the permit application stage for an automatic fire suppression (sprinkler) system. The plans and specifications bear the seal and signature of a Massachusetts Registered Professional Structural (or any other discipline) Engineer. Do the plans, as filed comply with section 1113.5.2 and 127.2.1 ? Additionally, is it required that the discipline of the engineer to be shown on the plans ?

Answer 1: The plans and specifications may be sealed by an engineer of any discipline with the following conditions;.

The Board of Registration's regulations 250 CMR are the rules and regulations relating to the practice of engineering and land surveying.

The Board of Registration initially registers an engineer in one branch of engineering only, following a determination that the engineer has been found competent by education, experience and specific examination passed by the registrant. The branch of engineering in which the engineer is registered shall either be included as part of the seal, or shall be handwritten above the registrant's signature (250 CMR 3.05(2).

The Board of Registration's regulations 250 CMR 3.05(7) requires the engineer to limit professional practice to areas of professional competence as demonstrated to and approved by (emphasis added} the Board of Registration.

The Board of Registration does not limit the engineer to the discipline in which he/she is registered but allows the registrant to practice in branches of engineering outside that indicated on his/her seal provided that he he/she has demonstrated competence to the Board of Registration. (250 CMR 3.05(6) A registrant who wishes to practice engineering in an area of competence other than that in which registered may request a determination of competence by submitting such evidence as may be required by the Board of Registration). The Board of Registrations regulations mandate that the burden of proof of competence rests with the registrant should a question be raised as to that competence. The Board of Registration is the only authority empowered to determine competency and will do so if requested by the registrant or any person or entity. The entity could be a city or town and an individual could be the building official acting in his official capacity or acting as a private citizen.

Question 2: Under the requirements of construction control (section 127), does the building official (or the fire official when reviewing plans pursuant to Article 10) have to accept the seal of any Massachusetts registered professional engineer even if the discipline noted on said seal is not the discipline associated with the reports, design, plans or specifications under the building permit review ?

Answer 2: No, the building official (or the fire official when reviewing plans pursuant to Article 10) does not have to accept the seal. In the case where the seal is a different discipline than the work contained in the report, design, plans or specifications, or where the reviewing official believes there is a question of competency, the building official, may require that the registered professional engineer demonstrate competence, in accordance with the Board of Registration's regulations (250 CMR 3.05(6) or (7)). When the registrant's competency is questioned, it is incumbent upon the registrant to apply to the Board of Registration for a determination of competency. It is not the responsibility of the building (or fire) official to make a determination relative to competency, but it is perfectly permissible for a building (or fire) official to request that the registrant prove

Official Interpretation No. 39-94

DATE: July 12, 1994

SUBJECT: The Impact on the State Building Code Due to the May 17, 1994 Emergency Updating of Reference Standards in Appendix A (NFiPA Reference Standards)

Question 1: At its May 17, 1994 Public Hearing, the Board, via emergency adoption, updated numerous NFiPA reference standards in Appendix A of the Code - did the Board, by this action, intend to cause substantive changes to the explicit regulatory requirements of the Code proper?

Answer 1: No. The Board was simply updating Appendix A reference standards to reflect currently available NFiPA reference standards; there was no intention to change explicit requirements of the Code proper.

Question 2: As NFiPA 72-1993, the "NATIONAL FIRE ALARM CODE" is one of the reference standards that was updated at the May 17, 1994 Public hearing and as Section 2-2.1.1.1 of NFiPA 72-93 requires that in new residential construction, there be smoke detectors installed in each sleeping room, would this requirement supersede smoke detector requirements historically mandated by the Code?

Answer 2: No. As indicated in the response to the first question, above, there was no intention on the part of the Board to cause substantive changes to the explicit requirements of the Code when Appendix A reference standards were updated in May of 1994.

Also, Section 101.4 of Article 1 of the Code states that: "Where differences occur between provisions of this Code and referenced standards, the provisions of this Code shall apply."

In the case of smoke detector requirements for residential occupancies, Section 1018 of the Code is explicitly prescriptive relative to the required location for smoke detectors and therefore supersedes the installation requirements of NFiPA 72-93.

Official Interpretation No. 41-94

DATE: August 15, 1994

SUBJECT: Section 109.1.1.1 - The Use of Municipal Construction Supervisor Licenses in Municipalities Where Such Licensing was Established Prior to January 1, 1975

Background/Discussion:

Section 109.1.1.1 does not prohibit a municipality from requiring a license for individuals engaged in directly supervising persons engaged in construction, reconstruction, alteration...in those categories of buildings and structures for which the BBRS is not requiring a license.

Section 109.1.1.1 goes on to say; provided that those municipalities which have established licensing requirements for construction supervisors prior to January 1, 1975 may maintain their existing licensing requirements.

As a result of a Building Code Appeal, a BBRS Appeals Board, on March 18, 1992, unanimously agreed that no municipality can implement building licensing regulations that conflict with those promulgated by the Commonwealth. The City of Boston was ordered: (1) "to immediately issue appropriate building permits to the appellants, provided such work falls within the scope of their State Construction Supervisor's Licenses"; (2) "to immediately cease the illegal activity of denying building permits to holders of valid State Construction Supervisor's Licenses, provided such work falls within the scope of such State Construction Supervisor's Licenses"; and (3) to immediately cease the illegal activity of issuing building permits to holders of Boston Builders Licenses, but who do not hold a valid State Construction Supervisor's License, where such work falls within the scope of the State Construction Supervisor's License program."

Question: Considering the current practice of many Building Departments requiring a State Construction Supervisor's License (CSL) or a Municipal Construction License (of that Municipality, only) and where such Municipal License was established prior to January 1, 1975, is the Board, via the Board of Appeal ruling of March 18, 1992, ruling that all building permits awarded to holders of such Municipal Licenses are invalid and illegal?

Also, is it the Board's intent to propose a Code Change to Section 109.1.1.1 eliminating Construction Licensing by Municipalities when such Municipal Licensing was established prior to January 1, 1975?

Answer: The Board decision of March 18, 1992 was tied to the City of Boston refusing to issue building permits to holders of State CSL's and was based on the language of St. 1972, c. 802, § 75, which states "All by-laws and ordinances of cities and towns in conflict with the state building code shall cease to be effective on January 1, 1975."

The Board is charged with promulgating a single uniform building code for the Commonwealth and Section 109.1.1.1 of the Code is an explicit portion of said Code and may be formally interpreted by the Board. To this end, it is the Board's position that Section 109.1.1.1, for Municipalities that had appropriate construction supervisor licensing programs in effect prior to January 1, 1975, such Municipalities may maintain their existing practices of accepting either their local Municipal construction supervisor license or the State CSL - Note that a building permit may not be denied to holders of valid State CSLs (provided such work falls within the scope of the State CSL) even though such holders of the State CSL do not have the Municipal construction supervisor's license; also note that the holder of a local Municipal construction supervisor license may not utilize that license in another Municipality but must possess the State CSL when performing building permittable work within the scope of the State CSL in a community without a valid, local Municipal construction supervisor license program.

Official Interpretation No. 42-94

DATE: September 13, 1994

SUBJECT: Section 1011.2 - Acceptable Discharge Testing of Wet Chemical Range Hood Extinguishing Systems

Background/Discussion:

Section 1011.2, ***"TESTS"***, in part, states that: "a completed system shall be tested by a discharge of wet chemical in sufficient amounts to verify that the system is properly installed and functional."

In reality, that portion of the sprinkler installation industry installing specialized commercial kitchen suppression tests the various pre-engineered wet chemical systems, not by discharging wet chemical, but rather by utilizing pressurized gas - this industry approach allows for determination that piping to spray nozzle integrity exists and that nozzles are not blocked, but does not create a clean-up problem nor does such testing wet up the internals of the piping /nozzle system.

NfiPA 17A, ***"STANDARD ON WET CHEMICAL EXTINGUISHING SYSTEMS"***
and which is referenced in Section 1011 defines pre-engineered wet chemical extinguishing systems as those having predetermined flow rates, nozzle pressures, and quantities of liquid

agent. Such systems may have specific pipe sizes, maximum and minimum pipe lengths. flexible hose specifications, number of fittings, and number and types of nozzles prescribed by a testing laboratory. The hazards protected by these pre-engineered systems are specifically limited as to type and size by a testing laboratory. Limitations on hazards that can be protected and piping and nozzle configurations are contained in the manufacturer's listed installation and maintenance manual which is part of the listing.

NfiPA 17A also notes that where required by the authority having jurisdiction, the approval tests shall include a discharge of wet chemical (such a test is not mandated, however, by NFiPA 17A) - the Standard further notes that the method of verification shall be acceptable to the authority having jurisdiction.

Discussions with a major manufacturer of pre-engineered wet chemical range hood extinguishing systems indicates that since the basic system is a pre-engineered listed product, acceptance testing of the entire wet chemical/piping/nozzle system need only consist of ensuring piping integrity and further ensuring that the installed nozzles are not blocked and a full, wet chemical discharge for acceptance testing of a pre-engineered system is not necessary and a simplified gas discharge test would suffice.

Question: For pre-engineered wet chemical range hood extinguishing systems as discussed in Section 1011 of the Code, is it acceptable to substitute a pressurized gas discharge test for the full wet chemical discharge test as required by Section 1011.2?

Answer: **YES**, for pre-engineered systems, since such systems are tested, listed systems, it is sufficient for acceptance testing that a simple gas discharge test that ensures down stream piping integrity and further ensures that spray nozzles are not blocked, would be an acceptable test approach since the intent of the Code is to ensure that the installed range hood extinguishing system is functioning.

Note that it would also be acceptable to test in accordance with the pre-engineered system manufacturer's recommendations.

Official Interpretation No. 43-95

DATE: May 9, 1995

SUBJECT: Section 600.3 - Impact of Section 600.3 on Egress Requirements of Sections 631, 636 and 638

Background/Discussion:

Section 600.3 is language excerpted directly from the 1987 BOCA National Building Code and directly adopted into the Fifth Edition of the Massachusetts State Building Code - it's noted that the requirements of Section 600.3 of the 1987 BOCA National Building Code were dropped in the 1990 version of the BOCA National Building Code and additionally, such requirements are also absent in the latest, 1993 BOCA National Building Code.

In the current Massachusetts State Building Code, Section 600.3 , *"MEANS OF EGRESS"* states: "The means of egress for buildings of special uses and occupancies shall conform to the requirements of Article 8, except as is modified by more restrictive provisions of this article for specific uses."

This language is sufficiently broad so that one current interpretation of this Section is to require in Section 631, 636 and 638 residences EXIT SIGNS and LIGHTS in accordance with Section 823 of Article 8 and MEANS OF EGRESS LIGHTING in accordance with Section 824 of the Code.

Section 631, "GROUP RESIDENCE"; Section 636, "LIMITED GROUP RESIDENCE"; and Section 638, "GROUP DWELLING UNITS" are sections of the Code that were developed on a consensus basis in conjunction with DMR/DMH/OFC** input and the specific requirements contained within these sections are intended to stand alone as express life-safety requirements for these special uses .

The adoption of Section 600.3 of the 1987 BOCA National Building Code was not intended to impose additional signage and lighting requirements in these dwelling units although should certain of these dwelling units be located, for example, in an R-2 USE apartment building, the common egress areas of the apartment building would be required by Code to

possess exit signage and lighting appropriate to the building but exit signage and/or lighting for the dwelling unit proper and not expressly required by Section 631 or 636 or 638 would not be required in the dwelling unit.

** Department of Mental Retardation (DMR); Department of Mental Health (DMH); Office for Children (OFC)

Question: Does Section 600.3, *"MEANS OF EGRESS"* of the Code require that the requirements of Section 823, "EXIT SIGNS AND LIGHTS" and/or Section 824, "MEANS OF EGRESS LIGHTING" automatically be imposed on dwelling units falling under Sections 631, 636 and 638 respectively?

Answer: No. Numerous dwelling units with respect to Sections 631, 636 or 638 are found in one- or two-family buildings of R-4 or R-3 USE and it is not the intention of the Code to require exit signage or means of egress lighting in such dwelling units unless expressly required by the special Section. For example, the specific requirements of Section 636.3.3.10 requires MEANS OF EGRESS LIGHTING in accordance with Section 824, but nowhere in Section 636 is there a requirement for EXIT SIGNS and EXIT LIGHTS.

Residences licensed under Sections 631, 636 and 638 are defined as RESIDENTIAL USES and are not classified as INSTITUTIONAL USE; therefore only the lighting/signage requirements of 631, 636 and 638 proper are to be imposed on the dwelling units of these residences - note the deliberate term "dwelling unit" as opposed to the term "building". A Section 638 "GROUP DWELLING UNIT", for example, could be found in an R-2 USE apartment building, and by Code, the common egress areas of the R-2 building would require exit signage, lights and means of egress lighting, but the Section 638 dwelling unit proper would not require such signage and lighting unless expressly required by Section 638 and /or other sections of Code expressly referenced in Section 638.

Official Interpretation No. 44-95

DATE: June 13, 1995

SUBJECT: Use Group Classification - *Warehouse-Mercantile* Buildings and Structures.

Discussion: Recent trends in retail marketing and sales have seen an upsurge in the numbers of the *"warehouse-mercantile"* type stores. These kinds of facilities utilize bulk storage on the actual sales floor area in racks. Commodities stored and sold range from hardware and household items through floorcoverings, cabinetry, lumber paint, adhesives and other building materials, flammables, aerosols, pool chemicals and fertilizers. The building typically functions as both a warehouse and a retail establishment, and the amounts of each type of product stored is typically orders of magnitude greater than a typical mercantile establishment. Furthermore, there is usually no dedicated storage area separate from gross sales area. Aisles are used for staging product prior to storage in the high rack storage system, in addition to merchandizing. Typically, mercantile stores which utilize separated storage and sales areas are designed as *mixed use* buildings, and conform to the separated or non separated requirements of the code. The increasingly popular trend of the *warehouse-mercantile* occupancies has raised a question as to which *use group* is most appropriate for such occupancies. Depending upon the amounts and types of product stored, it is possible that the building could consist of a variety of uses such as; *Mercantile* (*M*), *Low Hazard Storage* (*S-2*), *Moderate Hazard Storage* (*S-1*) and *High Hazard* (*H*) and/or other uses.

Question: Since the State Building Code does not specifically address warehouse retail (retail warehouse) type occupancies or use groups (occupancies consisting of open type floor plan utilizing rack storage type structures consisting of any combination of horizontal, vertical or diagonal members that support stored material or displayed material generally exceeding 12 feet in height), is it the intent of the code to classify such uses as *Mercantile*, Use Group *M*, based on the stock of goods for sale and accessibility to the public?

Answer: No. Due to the life and fire hazard as noted in Section 312, *Doubtful Use* Classification, this type of occupancy should be classified Doubtful Use Group until sufficient information is provided to the satisfaction of the Building Official in order that the Building Official can

determine the appropriate use (or uses) which it most resembles in terms of life and fire hazard in accordance with section 312.

Regardless of the *Use Group* classifications determined by the Building Official, it is the responsibility of the permit applicant in accordance with section 113 (*Application for Permit*), to provide sufficient information to show the nature and character of the work. As part of this section, the Building Official shall forward the available information to the Head of the Fire Department for review and approval of the applicable sections of Article 6, Special Use and Occupancy Requirements and Article 10, Fire Protection Systems.

As addressed in Article 10, Section 1001.2, the information presented must be "... of sufficient detail to evaluate the hazard and the effectiveness of the system. The details of the hazards shall include materials involved, the location and arrangement, and the exposure to the hazard."

To properly address the particular issues and acquire the required information for such a review as identified in Section 1001.2, any plans, documents and reports which are submitted to the Building Official in accordance with sections 113 and 127 must bear the seal of a qualified professional engineer or architect when required by the building code or statute. Since Section 1001.2 addresses special fire protection features, it shall be noted that the Building Official and the Head of the Fire Department should refer to the official interpretation No. 38-94 Relating to the Use of Registered Professional Engineers Seal as required under Section 113.5.2 and 127, to determine whether the information submitted is sufficient and properly documented and sealed by engineers qualified in fire protection concerns. (see Official Interpretation No. 38-94)

Unless the necessary information and documentation is properly submitted in sufficient detail per Section 1001.2, the Head of the Fire Department will not be capable of proper evaluation and analysis of the hazards and exposures to property and life and any associated fire and life safety systems provided and therefore can not approve the plans. In order for the Head of the Fire Department to approve plans and specifications per Section 113.5(*Plans and Specifications*).

Sufficient details and supporting documentation should be included to address, as a minimum, the following;

- Material storage/display arrangement
- Segregation/separation of incompatible/hazardous materials
- Emergency evacuation plans (number and location of exits)
- Warehousing operations (open and closed)
- Employee training and drills
- Management participation (housekeeping)
- Fire initiation and development
- Spread of smoke and toxic products
- Smoke exhaust venting
- Fire Suppression Systems
- Standpipe systems ($2^{1/2"}$ vs. $1^{1/2"}$ outlets)
- Requirements for rack sprinklers (NFiPA 231C)
- Adequacy of water supplies
- Egress relative to rack aisles (blockage/obstructions)
- Occupant evacuation time
- Fire alarm systems (automatic and manual)
- Fire Department notification (master box/central station service)
- Occupant notification
- Fire Department site and building entry access
- Seasonal changes in merchandising (introduction of additional flammable and hazardous material)
- Access to floor/merchandising plan (periodic review)
- Review of other agency requirements (CMR 527, Fire Prevention Regulations)
- Review of other nationally recognized engineering standards relative to fire hazards and life safety

If sufficient client information is not provided to the Head of the Fire Department as identified above, then the Building Official shall classify the building as Doubtful Use Group per Section 312, *Doubtful Use* Classification, and the structure shall be included in the use group it most nearly resembles, (such as a Use Group *H*, *High Hazard* Uses, Section 306 or as described in Section 308, *Mercantile* Uses, Use Group *M*, or as the Building Official so deems until adequate information is provided as per Section 1001.2, to determine otherwise.

If sufficient information is submitted in detail satisfactory to the Building Official and the Head of the Fire Department to achieve the desired level of life safety and fire hazard protection, then the building could be classified Use Group *M* or other as determined by the Building Official in cooperation with the Head of the Fire Department.

Official Interpretation No. 45-96

DATE: June 27, 1996

SUBJECT: Impacts of M.G.L. c. 148, §§ 26G, 26H and 26I

At a regular meeting of the Board of Building Regulations and Standards held on Thursday 27, June 1996, the Board approved the following interpretation of the application of M.G.L. c. 148, § 26G, 26H and 26I as they impact the building permit process.

Discussion: M.G.L. c. 148, §§ 26G, 26H and 26I are "local option statutes". These are state laws which are not applicable in a municipality until a municipality elects to adopt them, at which time they become law in that municipality. The statutes are "Fire Safety Statutes", and require the installation of automatic sprinkler systems in specific buildings identified in the statutes. Once adopted, they are enforced by the Head of the Local Fire Department (the Fire Chief).

In summary, the statutes require the following

Statute (M.G.L.)[a]	Requirements	Appeal Provision
c. 148, § 26G[b]	Automatic Sprinkler System in: 1) New buildings over 7,500 sf 2) Additions to existing buildings (addition only) over 7,500 sf 3) Major alterations to existing buildings over 7,500 sf	Automatic Sprinkler Appeals Board
c. 148, § 26H	Automatic Sprinkler System in lodging and boarding houses	Automatic Sprinkler Appeals Board
c. 148, § 26I	Sprinkler system installation in; 1) New multiple family dwellings containing four or more dwelling units. 2) Substantially rehabilitated buildings in multi family dwellings containing four or more dwelling units.	State Fire Marshal

Notes:

(a) Refer to statute for exact wording

(b) Residential uses exempted

In some municipalities, the adoption of these statutes has created an apparent regulatory conflict and has, in extreme cases resulted in omission of sprinkler systems at the outset of construction resulting in lawsuits and court judgments requiring the installation of the sprinkler systems after occupancy. Needless to say, such cases have proved to be extremely costly.

Question: How do these particular statutes affect the responsibilities of the Building Official in the enforcement of the State Building Code? In particular, what action does the Building Official take at the building permit application stage?

Answer: In accordance with the provisions of *M.G.L. c. 143, § 3*, the Building Official is empowered to enforce the provisions of the State Building Code and the Architectural Access Board Regulations (521 CMR). The Fire Chief is empowered to enforce the provisions of *M.G.L. c. 148, §§ 26G, 26H and 26I.*

The statutes link the requirement to install the automatic sprinkler to the building code by requiring the installation to be *"....in accordance with the provisions of the state building code"* . This language shall be properly interpreted as *"....in accordance with standards referenced for the installation of an automatic sprinkler system"*, e.g. NFiPA 13, 13R or 13D, etc. Such interpretation would also extend to the permitting requirements of Article 1.

The Building Official's approach in municipalities which have adopted said statutes shall be;

The Building Official should become generally aware of the requirements of *M.G.L. c. 148, §§ 26G, 26H and 26I.*

If a building permit application is made which may trigger the enforcement of the statutes, the determination is (by law) made by the Fire Chief. It is clear in the subject statutes that the Fire Chief is the sole authority to determine whether or not a particular construction activity is subject to said statutes and the municipality and its agents, including the Building Official are bound by this determination. The permit applicant is provided avenues of administrative appeal from the Fire Chief's determination, by way of the State Fire Marshal or the Automatic Sprinkler Appeals Board. Once a determination has been made by the Fire Chief that the statute is applicable, the Building Official must ensure, at the building permit application stage, that provision has been made for the design and installation of the automatic sprinkler system. If plans submitted at the building permit application stage do not include the sprinkler system, the application shall be denied based on non compliance with Section 113 of the Massachusetts State Building Code, i.e. incomplete plans and/or application materials.

If an appeal is taken, the Building Official, pending the outcome of the appeal, may issue a permit in part and shall, in writing, concurrently notify the Fire Chief and the permit applicant. Said notification must clearly identify the limits placed on the construction.

In communities which have adopted the provisions of M.G.L. c. 148, § 26H, a certificate of inspection, as required by Table 108 for a lodging or boarding house, shall not be issued if an automatic sprinkler system has not been installed within the time provided for by said statute, providing that the Building Official has been notified by the Fire Chief of the date of the adoption of said statute. If an appeal is pending a temporary certificate of inspection may be issued and renewed, each for periods not exceeding 30 days, pending the outcome of the appeal.

This interpretation is made to foster cooperation between building and fire officials in this particular area of law which has caused some confusion in the past.

Official Interpretation No. 46-96

DATE: June 27, 1996

SUBJECT: Handrails and Guardrails in One and Two Family Dwellings
Section 3401.11 of the Fifth Edition of the State Building Code

At a regular meeting of the Board of Building Regulations and Standards held on Thursday 27, June 1996, the Board approved the following interpretation of the application of Section 3401.11 of the Fifth Edition of the State Building Code.

Section 3401.11 states that *". . . Handrails having [a] minimum and maximum height of thirty (30) inches and thirty-four (34) inches, respectively, measured vertically from the nosing of the treads shall be provided on at least one (1) side of stairways of three (3) or more risers. Open sides of all stairs shall be similarly protected by guards. . . "*

Question 1: Is it the intent of Section 3401.11 to require ***both*** handrails and guardrails set at different heights on the open sides of stairs in a one or two family dwelling?

Answer 1: No. It is the opinion of the Board that the word ***similarly*** refers to the handrail description, which means that the open side of the stair must be protected with a guardrail that also acts as a handrail. It is ***not*** necessary to provide a guardrail set at 36 inches in height with a handrail set between 30 and 34 inches.

Question 2: At what height should the guardrail be set?

Answer 2: The guardrail may be set between 30 and 34 inches in height measured vertically from the nosing of the tread. If a handrail is provided on the opposite side of the stair, it shall be set at the same height..

APPENDIX B

Official Interpretation No. 50-98

DATE: January 28, 1999

SUBJECT: Height and Area Requirements for Type 5B, One and Two-Family Dwellings as Defined by the Sixth Edition of the Code

Background:

A one- or two-family dwelling designed and constructed as an R-4 Use in accordance with the provisions of Chapter 36 of the Sixth Edition of the Code is typically built of Type 5B Construction. Chapter 36 does not define a one- or two- family structure in terms of its construction type. Referencing the definition section of this chapter, we learn only the number of lodgers and/or boarders legally allowed to occupy each dwelling, but do not learn much about the structure itself. However, the materials generally employed in one- and two-family dwelling construction most closely resemble those used in a Type 5B building as defined in Chapter 6 of the base code.

Also, Chapter 36 does not provide guidance in respect to the maximum size of a one-or two-family dwelling in terms of its height above grade (number of stories, and dimensional height) or in terms of its square foot area per floor.

Question: Absent this information, how does one determine the maximum size of a one and two-family dwelling building (both in terms of stories above grade and maximum square foot area per floor) if it is designed and constructed as an R-4 Use according to the provisions of Chapter 36?

Answer: Since Chapter 36 does not provide the answers we seek, we must first turn to Chapter 3, Section 310.6 which defines an R-4 structure as a *"detached one- or two-family dwelling(s) not more than three stories in height, and (its) accessory structures."* This section states further that *"All such structures shall be designed in accordance with 780 CMR 36 (Chapter 36 of the Sixth Edition) or in accordance with the requirements of 780 CMR (this code) applicable to Use Group R-3".*

This section provides the code user with two distinct options for the design and construction of R-4 structures (detached one or two family dwellings and their accessory structures). Option 1; design in accordance with Chapter 36. Option 2; design in accordance with the requirements applicable to R-3 structures.

Question: Does this mean that such buildings may be designed and constructed with habitable floors three stories above the exterior grade plane?

Answer: Yes. However, one must assure that all applicable code requirements are satisfied for all inhabited floors including the upper-most floor (i.e.: light, ventilation, means of egress requirements, etc.).

At times, depending upon the configuration of the exterior grade, it may be difficult to determine the number of stories above which a building projects. Therefore, we have provided examples of buildings correctly configured under this definition. (See Figures 1a and 1b).

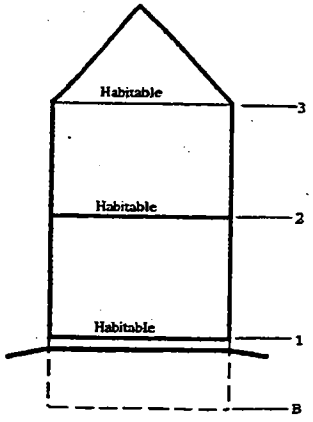


Figure 1a.

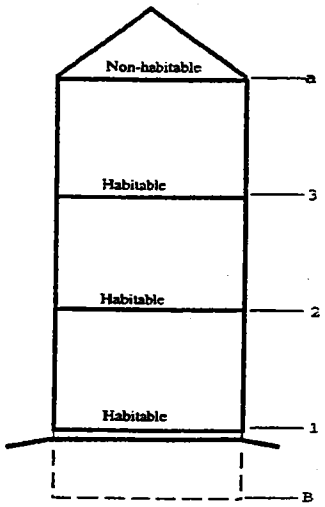


Figure 1b.

Note: Figures 1a and 1b illustrate typical gable roof, single family dwellings. Figure 1a depicts a dwelling consisting of three floors of habitable space and a basement. Figure 1b shows a dwelling consisting of three floors of habitable space, a basement and attic space above the third floor. Assuming requirements set by local zoning ordinances are met, each structure as depicted satisfies building code requirements in terms of its allowable number of stories above grade. However, be cautioned that the attic area shown in Figure 1b shall only be used as storage (**not habitable or occupiable**) space.

Question: Figure 1b illustrates a structure with attic space as the upper-most level. How does one distinguish habitable space from attic space?

Answer: *Habitable space* is defined in Chapter 2 of the code as *"space in a structure for living, sleeping, eating, or cooking. Bathrooms, toilets compartments, closets, halls, storage or utility space and similar areas are not considered habitable space"*. *Attic* is defined in Chapter 12 as *"the space between the ceiling beams of the top story and the roof rafters"*.

Attic space may only be provided if it does not constitute an additional story (i.e.: the head height and other conditions of this area do not allow for human occupancy. **Remember that by definition, the structure may only be three stories in height above the exterior grade plane.**

Question: Since bathrooms are not considered habitable space, is it permissible to locate a bathroom in this attic level?

Answer: No. The upper-most level, as illustrated in Figure 1b, is intended to be used as **storage** or **utility** space only and is limited by one or more construction features which fall short of that required for habitable or occupiable space (i.e.: ceiling height measures less than seven (7) feet, structural members will support only loads that are less than that required for habitable space, or room dimensions measure less than required, etc.).

Question: What about an existing, two story home with attic space; may it be converted into a three story structure with each floor made habitable?

Answer: Again, the key to this question is, does the attic comply with **all** applicable sections of Chapter 36 for habitable spaces (i.e.: design loads, light, ventilation, means of egress, etc.). If the answer is yes, then the structure may be converted. If portions of the third story do not satisfy code requirements (i.e.: the access stair is too narrow or rise and run dimensions are not satisfactory) the building official must reject the permit application. However, an applicant may seek relief through administrative appeal procedures (the Building Code Appeals Board) as defined in Chapter 1, Section 126, or offer compliance alternatives as defined in Chapter 34 of the code.

Question: Is a walk-out basement defined as a story above grade, and is it considered to contribute to the height of the building?

Answer: Chapter 5, Section 502.1 defines a story above grade as *"Any story having its finished floor surface entirely above grade except that a basement shall be considered as a story above grade where the finished surface of the floor above the basement is:*

1. *More than six feet (1829mm) above [the] grade plane;*
2. *More than six feet (1829 mm) above the finished ground level for more than 50% of the total building perimeter, or*
3. *More than 12 feet (3658mm) above the finished ground level at any point"*.

As demonstrated by the definition above, the answer to this question is dependent upon exterior grade conditions; which makes sense. The code limits the number of stories above grade which a building may be constructed as a direct function of an occupant's ability to exit the building in the event of an emergency. The higher up in the building one resides, the farther one must travel to exit the building. In a fire condition, the code is concerned with smoke conditions in open stairwells and other factors that may limit one's ability to escape from a building. Consequently, a walk-out basement (or any basement meeting a part of the definition identified above) may very well contribute to the height of the building above grade, if it is constructed according to one of the methods defined above.

Figures 2a through 2c illustrate conditions where a basement contributes to the number of stories above grade.

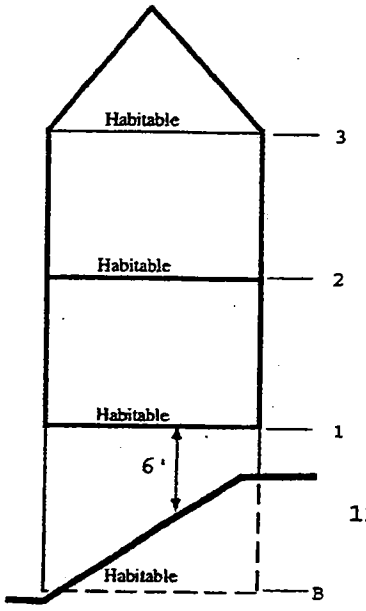


Figure 2a.

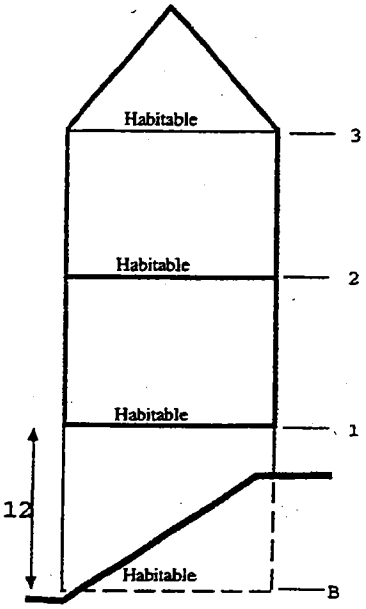


Figure2b.

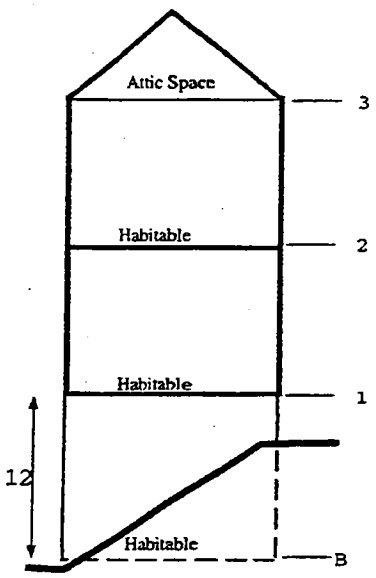


Figure2c.

Note: Both Figures 2a and 2b depict a single family dwelling which is **four stories** above grade (in reference to the definition for story above grade). Since the definition of an R-4 limits the building to **three stories** in height, these buildings (Figures 2a and 2b), erected of Type 5B construction, would be in violation of building code provisions. However, as is illustrated in Figure 2c, if the upper-most floor is designed and used as an attic (as defined in 780 CMR 202), it shall not be considered an additional story).

Question: To this point, only the height of the building has been addressed. What about the maximum area per floor for an R-4 structure?

Answer: Unlike the number of stories above grade, the code is silent on the issue of floor area for these structures. Essentially, the area is unlimited. This is not to imply that the code is not concerned with the size of the building in terms of its area, and that additional safeguards should not be considered in the design and construction of very large R-4 structures. However, these safeguards are built into the code in that very large buildings will be afforded additional smoke detection (see Chapter 36, Section 3603.16) and large structures are generally designed with egress capacity well in excess of what the code would normally require; usually with many exterior decks and balconies providing additional means of egress and/or routes of escape from the building.

Question: At the start of this interpretation, it was mentioned that Section 310.6 affords the code user two options when designing and building R-4 structures. We spoke of Chapter 36 requirements, but what about the option of designing the building as an R-3 using code provisions applicable to that use group?

Answer: It is clear that the code allows one to utilize this option. In doing so, however, one must recognize that different code requirements apply. Why? The Sixth Edition of 780 CMR is based on two separate national model codes; the 1993 BOCA National Building Code and the 1995 CABO One and Two Family Dwelling Code. As one might expect, uniting these two codes into a single document (as was done with the Sixth Edition of the Massachusetts State Code) sometimes results in conflicts between the two texts. The subject matter this interpretation illustrates one of these conflicts.

In explanation, R-3 structures are typically designed as multiple, single family, attached units (what are commonly referred to as row houses). Because these units are adjoined, the code is more concerned with conflagration and other safety issues, and therefore restricts the design of these structures more rigorously than it does for detached one and two-family dwellings.

We know that Chapter 36 is silent on height and area limitations for one and two family structures. Reviewing code provisions relative to R-3 structures, we find that 780 CMR Chapter 5, Table 503 defines height and area limitations for the R-3 Use Group Classification, but does not include reference to detached one and two-family buildings, as does the 1993 BOCA National Code. This reference was purposely deleted in the Massachusetts code to illustrate that the intended height limitations for detached one and two-family dwellings is to be three stories above grade as defined herein (and 780 CMR 310.6).

OFFICIAL INTERPRETATION No. 54-2002

DATE : June 19, 2002

SUBJECT: Use Classification of Assisted Living Residence Facilities / 780 CMR 3, Section 310.1

At a regular meeting of the Board of Building Regulations and Standards held on Tuesday, June 11, 2002, the Board approved the following interpretation of the application of 780 CMR 310.1 of the Sixth Edition of the State Building Code as such applies to Assisted Living Residence Facilities.

Background/Discussion:

780 CMR 310.1 addresses RESIDENTIAL USE Classification and contains a specific note which reads: *"Assisted Living Residences certified as such by the Executive Office of Elder Affairs and pursuant to MGL c.19D shall be classified in the residential use group, R-1, R-2, R-3 or R-4 as applicable. Portions of an Assisted Living Residence which are used for any use other than residential shall be classified in accordance with the intended use."*

The intention of this note is to ensure that the RESIDENTIAL USES of an Assisted Living Facility are classified as RESIDENTIAL USE and not, for example, an INSTITUTIONAL USE; additionally the State Building Code, via this note, requires that for life-safety purposes, the non-residential areas of an Assisted Living Facility be appropriately classified as to use.

As an example, although it is obvious that the residential areas of an Assisted Living Facility must be classified as RESIDENTIAL USE (consistent with MGL c.19D, Section 18(d)), an area such as a boiler room constructed in the Assisted Living Facility presents a unique fire hazard to the occupants of the building.

Although a boiler room is essentially ancillary to a RESIDENTIAL USE Assisted Living Facility, a boiler room clearly cannot to be designed and constructed as simply a RESIDENTIAL USE.

The State Building Code (the Code) sets forth requirements for the construction of a boiler room that are specific and different than the Code requirements for the construction of RESIDENTIAL USES - again for life-safety purposes (refer to 780 CMR Section 302.1.1).

When one views an Assisted Living Residence, it is probable that such facility might consist of numerous different USES including: residential living areas, a dining room or restaurant, offices for conducting the day-to-day business of the facility, a boiler/mechanical room, electrical room, linen storage rooms, etc.

Such a hypothetical Assisted Living Facility, by actual use function, would, in part, be classified as a MIXED USE building - consistent with the use classification philosophy of all National Model Building Codes and the Massachusetts State Building Code (780 CMR).

The reasoning behind such mixed use classification is to ensure an equivalent level of life safety performance of the various uses in the building by first identifying the particular uses and then applying the specific Building Code-required life-safety requirements for each of the uses.

As a case in point, the sizing of EGRESS ELEMENTS is dependent on the USE Classification of the Building or portion thereof.

If a large dining facility, contained within an Assisted Living Facility, is erroneously classified as a RESIDENTIAL USE, rather than as an ASSEMBLY (A-3) USE, the resulting required means of egress will be improperly sized, in part because the occupant load calculations required by the Building Code assume a much lower occupancy in a residential setting than in a true assembly setting (see 780 CMR Section 1008 and Table 1008.1.2).

Using the guidance of Table 1008.1.2, titled "Maximum Floor Area Allowances Per Occupant", one example for the calculation of the OCCUPANT LOAD for an A-3 USE, would require the designer to establish the A-3 OCCUPANT LOAD by assuming no more than 7 square feet (net) per person whereas for a RESIDENTIAL occupancy, this Table allows 200 square feet (gross) per person.

For a relatively large dining facility within an Assisted Living Facility (100' x 100') it is possible that **20 times as many people** would have to be accommodated in laying out the REQUIRED EGRESS from the subject dining facility space in the building when the dining area is treated as an A-3 USE as opposed to being treated as an R USE or to state this in another way, necessary egress for the occupants of such a dining facility could be significantly undersized if the dining room is erroneously classified as a RESIDENTIAL USE.

There are numerous other life safety issues that arise as a result of erroneously classifying all portions of an Assisted Living Residence as a RESIDENTIAL USE when in reality such a building is truly a MIXED-USE OCCUPANCY.

For such reasons, the subject note in 780 CMR 310.1 is structured to recognize the USE Classification requirements of MGL c.19D, Section 18(d), but to also recognize the reality of the fire physics and life-safety ramifications associated with the non-residential uses of a MIXED USE OCCUPANCY Assisted Living Facility.

Question 1: Does the Note relating to Assisted Living Residences in 780 CMR 310.1 require that the residential portions of an Assisted Living Residence be classified as a RESIDENTIAL USE?

Answer 1: Yes, all portions of an Assisted Living Residence that function in a residential capacity are to be classified as RESIDENTIAL USE and not, for example, INSTITUTIONAL USE.

Question 2: Does the Note relating to Assisted Living Residences in 780 CMR 310.1 require that non-residential portions of an Assisted Living Residence be classified in accordance with their actual use?

Answer 2: Yes, non-residential uses must be classified in accordance with their actual use to ensure the minimum life safety requirements of the Building Code are incorporated into the design, construction and maintenance of such non-residential uses.

Question 3: If an Assisted Living Residence, in actuality has both residential uses and non-residential uses occurring within the building, should such building be classified as a MIXED USE OCCUPANCY in accordance with the criteria set forth within all applicable portions of 780 CMR Chapter 3?

Answer 3: Yes, except that no portion of an Assisted Living Residence duly certified by the Executive Office of Elder Affairs is to be classified as an INSTITUTIONAL USE; additionally any USE within such building where the actual or calculated occupant load is less than 50 persons and which is accessory to another USE GROUP shall be classified as part of that main USE GROUP and areas that are ancillary to a main USE would be classified as part of the main USE - note that SPECIAL OCCUPANCY AREAS such as boiler rooms, storage rooms of greater than 50 sq. ft or 100 sq. ft., as applicable, etc., as discussed in 780 CMR Table 302.1.1 are to be constructed in compliance with the requirements of Table 302.1.1 and not constructed solely as a RESIDENTIAL USE.

Question 4: Would a dining hall of a duly certified Assisted Living Residence be classified as RESIDENTIAL USE or ASSEMBLY USE?

Answer 4: It would depend on whether or not the actual and/or calculated occupant load was fewer than 50 persons. For the case where the dining hall occupant load is less than 50 persons, the dining hall would be classified as accessory to the main use, i.e., RESIDENTIAL USE. If the occupant load is greater than 49 persons (780 CMR Chapter 3, Section 303.1), then the dining hall should be classified as an ASSEMBLY USE and all applicable State Building Code requirements for such ASSEMBLY USE must be incorporated into the design and construction of such ASSEMBLY space - egress size can be negatively affected if the required means of egress from a true ASSEMBLY USE is incorrectly sized for a RESIDENTIAL USE.

Question 5: If an Assisted Living Residence truly exhibits the characteristics of a MIXED USE OCCUPANCY can the building owner design and construct such building in accordance with any of the MIXED USE options presented in 780 CMR Chapter 3, Section 313 (i.e., Section 313.1.1 or 313.1.2 or 313.1.3 or with combination of such Subsections)?

Answer 5: Yes.

Question 6: Would an Assisted Living Residence of MIXED USE OCCUPANCY and designed as a NON-SEPARATED USE, per 780 CMR Section 313.1.1 be required to: (1) satisfy the HEIGHT AND AREA requirements of 780 CMR Table 503 for the most restrictive USE GROUP, and; (2) be required to incorporate all FIRE PROTECTION systems of 780 CMR Chapter 9 based on the most restrictive requirements of each USE GROUP?

Answer 6: (1) Relative to the use of Table 503 of the State Building Code, the HEIGHT AND AREA Table is utilized to determine CONSTRUCTION TYPE. 780 CMR 3, Section 313.1.1 in part states that the required TYPE OF CONSTRUCTION for the building shall be determined by applying the HEIGHT AND AREA LIMITATIONS (of 780 CMR 5, Table 503) for each of the applicable USE GROUPS (and) the most restrictive TYPE OF CONSTRUCTION so determined, shall apply. (2) Relative to required FIRE PROTECTION SYSTEMS (occupant notification, detection, suppression, smoke control, supervision, etc.), 780 CMR 3, Section 313.1.1, in part, states that the most restrictive applicable provisions of 780 CMR 9 shall apply to these non-separated USE GROUPS (i.e., should one USE require occupant notification but not suppression but another USE requires suppression but not occupant notification, both requirements, per 780 CMR, must be satisfied for the entire NON-SEPARATED USE building).

Question 7: If one or more of the various USES of an Assisted Living Residence of MIXED USE OCCUPANCY requires suppression in accordance with NFPA 13 and another USE within the building requires suppression in accordance with NFPA 13R, and the building is constructed as a NON-SEPARATED USE, per 780 CMR Section 313.1.1, is it necessary to design and install the more restrictive fire suppression system (NFPA 13) throughout the building?

Answer 7: Yes (per 780 CMR 3, Section 313.1.1)

- CONTINUED ON FOLLOWING PAGE -

Question 8: Would an Assisted Living Residence of MIXED USE OCCUPANCY and designed as a SEPARATED USE, per 780 CMR Section 313.1.2 be required to: (1) satisfy the HEIGHT-only requirements of 780 CMR Table 503 for each unique, separated USE based on the CONSTRUCTION TYPE of the building, and; (2) in each story of the building, is it required that the BUILDING AREA shall be such that the sum of the ratio of the floor areas of each USE GROUP divided by the allowable area from 780 CMR 5, Section 503, for each USE shall not exceed one, and; (3) if suppression of certain USES within the SEPARATED USE Assisted Living Residence is required by 780 CMR such that for certain USES an NFPA 13 system is required and for other USES an NFPA 13R system is allowed, is it acceptable to incorporate both suppression system types (NFPA 13 and NFPA 13R), as applicable, within the same building?

Answer 8: Yes* to all three (3) queries raised in the Question above (per 780 CMR 3, Section 313.1.2) - the affirmative answer to queries (1) and (2) addresses the overall issue of HEIGHT AND AREA by assuring that for a given construction type, no singular, separated use is allowed to be constructed to a HEIGHT greater than allowed per 780 CMR 5 and by also assuring that for area purposes that the summation of the area ratios of actual area per USE per floor divided by the ALLOWED AREA per USE (per 780 CMR 5) does not exceed one.

*The affirmative answer to query 3 raised in the Question above acknowledges that because of true fire separation between the various USES in the building, each USE is to be treated independently relative to State Building Code requirements and this also includes how suppression is addressed - the caveat regarding this response is that where an Assisted Living Residence constructed per 780 CMR 3, Section 313.1.2 is either a high-rise building (780 CMR 4, Section 403) or has the RESIDENTIAL portion of the building classified as either R-1 or R-2 USE or has some other non-residential USE that requires suppression per the requirements of 780 CMR 9, Section 904.2 or 904.3, sprinklering per NFPA 13 or NFPA 13R, as applicable, will be required throughout the building. Note also that suppression requirements of Table 904.9 and the construction and suppression requirements as set forth in Table 302.1.1 will also apply as applicable.

Question 9: In an Assisted Living Residence of MIXED USE OCCUPANCY constructed in accordance with any of the allowed methods of 780 CMR 3, Section 313, would: (1) a windowless story as described in 780 CMR 3, Section 904.8 require suppression, and; (2) if such an Assisted Living Residence possesses a commercial kitchen, would the requirements of the BOCA Mechanical Code, 1993 apply to the design, construction and suppression of such commercial kitchen hoods, ducts, grease removal and suppression systems?

Answer 9: Yes to both queries posed in the Question above.

Question 10 For any Assisted Living Residence, do the applicable portions of 780 CMR 10 (Means of Egress) apply and in particular do the locking arrangements and special locking arrangements, as applicable, apply to all MEANS OF EGRESS?

Answer 10: Yes

OFFICIAL INTERPRETATION No. 54-2002.doc

APPENDIX C

RECOMMENDED FASTENING SCHEDULE

Building element	Nail size and type	Number and location
Stud to sole plate	8d common 16d common	4 toe-nail or 2 direct-nail
Stud to cap plate	16d common	2 toe-nail or 2 direct-nail
Double studs	10d common	12" o.c. direct
Corner studs	16d common	24" o.c. direct
Sole plate to joist or blocking	16d common	16" o.c.
Double cap plate	10d common	16" o.c. direct
Cap plate laps	10d common	2 direct-nail
Ribbon strip, 6" or less	10d common	2 each direct bearing
Ribbon strip, 6" or more	10d common	3 each direct bearing
Roof rafter to plate	8d common	3 toe-nail
Roof rafter to ridge	16d common	2 toe-nail or direct nail
Jack rafter to hip	10d common 16d common	3 toe-nail or 2 direct-nail
Floor joists to studs (No ceiling joists)	10d common 10d common	5 direct or 3 direct
Floor joists to studs (With ceiling joists)	10d common	2 direct
Floor joists to sill or girder	3d common	3 toe-nail
Ledger strip	16d common	3 each direct
Ceiling joists to plate	16d common	3 toe-nail
Ceiling joists (laps over partition)	10d common	3 direct-nail
Ceiling joists (parallel to rafter)	10d common	3 direct
Collar beam	10d common	3 direct
Bridging to joists	8d common	2 each direct end
Diagonal brace (to stud & plate)	8d common	2 each direct bearing
Tail beams to headers (When nailing permitted)	20d common	1 each end 4 sq. ft. floor area
Header beams to trimmers	20d common	1 each end 8 sq. ft. floor area
1" roof decking (over 6" in width)	8d common 8d common	2 ea. direct rafter 3 each direct rafter
1 " subflooring (6" or less)	8d common	2 each direct joist
1" subflooring (8" or more)	8d common	3 each direct joist
2" subflooring	16d common	2 each direct joist
1" wall sheathing (8" or less in width)	8d common	2 each direct stud
1" wall sheathing (over 8" in width)	8d common	3 each direct stud
Plywood roof & wall sheathing (½" or less) (⅝" or greater) (5/16", ⅜",or ½") (⅝")	 6d common 8d common 16 gauge galvanized wire staples, ⅜" minimum crown; length of 1" plus plywood thickness Same as immediately above	 6" o.c. direct edges & 12" o.c intermediate 6" o.c. direct edges & 12" o.c. intermediate 4" o.c. edges & 8" o.c. intermediate 2½" o.c. edges & 5" o.c. intermediate
Plywood subflooring: (½") (⅜", ¾") (1", 1⅛") (½") (⅜")	 6d common or 6d annular or spiral thread 8d common or 8d annular or spiral thread 10d common or 8d ring shank or 8d annular or spiral thread 16d galvanized wire staples ⅜" minimum crown, 1⅜" length	 6" o.c. direct edges & 10" o.c. intermediate 6" o.c. direct edges & 10" o.c. intermediate 6" o.c. direct edges & 6" o.c. intermediate 4" o.c. edges & 7" o.c. intermediate 2½" o.c. edge 4" o.c. intermediate
Built-up girders and beams	20d common	32" o.c. direct
Continuous header to stud	8d common	4 toe nail
Continuous header, two pieces	16d common	16" o.c. direct
½" fiber board sheathing	1½" galvanized roofing nail or 16 gauge staple, 1½" long with min. crown of 7/16"	3" o.c. exterior edge 6" o.c. intermediate

Building element	Nail size and type	Number and location
25/32" fiber board sheathing	1¾" galvanized roofing nail or 8d common nail or 16 gauge staple, 1½" long with min. crown of 7/16"	3" o.c. exterior edge 6" o.c. intermediate
Gypsum sheathing	12 gauge 1¾" large head corrosion-resistant	4" o.c. on edge 8" o.c. intermediate
Particle board underlayment (¼"-¾")	6d annular threaded	6" o.c. direct edges 10" o.c. intermediate
Particle board roof and wall sheathing ½" or less	6d common	6" o.c. direct edges 12" o.c. intermediate
⅝" or greater	8d common	6" o.c. direct edges 12" o.c. intermediate
Particle board subflooring (⅝" or greater)	8d common	6" o.c. direct edges 12" o.c. intermediate
Shingles, wood[a]	No. 14 B&S Gage corrosion resistive	2 each bearing
Weather boarding	8d corrosion	2 each bearing

Note a: Shingle nails shall penetrate not less than ¾" into nailing strips, sheathing or supporting construction except as otherwise provided in 780 CMR 1225.4.4.

Table C-1
Maximum Spacing of Gypsum Wallboard Fasteners
(For nonfireresistance rated construction assemblies)

Thickness of gypsum wallboard (inch)	Plane of framing surface	Long dimension of gypsum wall-board sheets in relation to direction of framing members	Maximum spacing of framing members (center-to-center in inches)	Maximum spacing of fasteners (center-to- center in inches)		Nails to wood
				Nails	Screws	
½	Horizontal	Either direction	16	7	12	No. 13 gage, 1⅜" long, 19/54" head
	Horizontal	Perpendicular	24	7	12	No. 098 gage, 1¼" long, Annular ringed
	Vertical	Either direction	24	8	12	5d cooler nail
⅝	Horizontal	Either direction	16	7	12	No. 13 gage, 1⅝" long, 19/64" head
	Horizontal	Perpendicular	24	7	12	No .098 gage, 1⅜" long, Annual ringed 6d
	Vertical	Either direction	24	8	12	cooler nail
Fastening required with adhesive application						
½ or ⅝	Horizontal	Either direction	16	16	16	As required for ½" and ⅝" gypsum wallboard, see above
	Vertical	Perpendicular	24	12	16	
		Either direction	24			
2 layers each ⅜" (¾" total)	Horizontal	Perpendicular	24	16	16	Base ply nailed as required for ½" gypsum wallboard and face ply placed with adhesive
	Vertical	Either direction	24	24	24	

Notes to Table C-1:

Note a. Where the metal framing has a clinching design formed to receive the nails by two edges of metal, the nails shall be not less than ⅝ inch longer than the wallboard thickness, and shall have ringed shanks. Where the metal framing has a nailing groove formed to receive the nails, the nails shall have barbed shanks or be 5d cooler nail (No. 13 ½ gage, 1⅝ inches long, 15/64 inch head) for ½ inch gypsum wallboard; 6d cooler (No. 13 gage, 1⅞ inches long, 15/64 head) for ⅝-inch gypsum wallboard.

Note b. Two nails at 2 inches to 2½ inches apart may be used if the pairs are spaced 12 inches center-to-center except around perimeters.

Note c. Screws shall be No. 6 with tapered head and long enough to penetrate into wood framing not less than ⅝ inch and metal framing not less than ¼ inch

Note d. All nails shall meet ASTM C514 or Federal Specification FF-N-105C.

Note e. For fireresistance rated construction, see the pertinent fire test information.

Note f. 1 inch = 25.4 mm.

Table C-2
Allowable Shear for Wind or Seismic Forces in Pounds Per Foot
For Vertical Diaphragms of Lath and Plaster or Gypsum Board Frame Wall Assemblies

Type of material	Thickness of Material	Wall Construction	Nail spacing maximum (in inches)	Shear value	Minimum nail size
Gypsum lath, plain or perforated	⅜" Lath and ½" Plaster	Unblocked	5	100	No. 13 gage, 1⅛" long, 19/64" head, plasterboard blued nail.
Gypsum sheathing board	½" x 2'x 8' ½"x4' ½"x4'	Unblocked Blocked Unblocked	4 7	75	No. 11 gage, 1¼" long, 7/64" head, diamond point, galvanized.
Gypsum Wallboard or Veneer base	1/2"	Unblocked	7	175	5d Cooler nails
				100	
			4		
		Blocked	7	100	
			4		
			4	125	
	5/8"	Blocked		150	6d cooler nails
		Two ply	Base ply 9		
				175	Base ply-6d cooler nails
			Face ply 7		
				250	Face ply-8d cooler nails

Note a. These vertical diaphragms shall not be used to resist loads imposed by masonry or concrete construction. Values are for short time loading due to wind or earthquake and must be reduced 25% for normal loading

Note b. Applies to nailing at all studs, top and bottom plates and blocking.

Note c. Values shown are for gypsum board applied to one side only. The shear values may be doubled when identical materials are applied to both sides of wall

Note d. 1 inch=25.4 mm.

NON-TEXT PAGE

APPENDIX D

GUIDANCE FOR SELECTION OF FOUNDATION MATERIAL CLASSES IN TABLE 1804.3

D-101.0 Purpose: The purpose of Appendix D is to provide guidance for the selection of the material class and consistency in place when using Table 1804.3.

D-102.0 Application: Appendix D is provided only as a general guide to engineering judgment. All available data should be evaluated and professional engineering judgment exercised in selection of the appropriate material classification for use with Table 1804.3. The references on soil and rock classification and typical ranges of index properties provided in this appendix should not be considered to be code requirements.

D-103.0 Classification of Soil: Guidelines for generally accepted engineering practice in the description and classification of soils are provided in ASTM D2488-84 Description and identification of Soils (Visual-Manual Procedure) and ASTM D2487-85 Classification of Soils for Engineering Purposes.

D-104.0 Classification of Rock: Guidelines for generally accepted engineering practice in the description and classification of rocks are provided in Chapter 1 of Design Manual 7.1 - Soil Mechanics, Naval Facilities Engineering Command, May 1982 (NAVFAC DM-7.1)

D-105.0 Typical Index Properties: Typical ranges of index properties for the Material Classes listed in Table 1804.3 are provided in Table D-1.

TABLE D-1
TYPICAL RANGE OF INDEX PROPERTIES

Material Class	Description	Consistency in Place	Rock Quality Designation (RQD%)	Unconfined Compressive Strength (PSF)	Standard Penetration Resistance
1a 1b	Massive bedrock - granite, diorite, gabbro, basalt, gneiss, quartziet, well-cemented conglomerate	Hard rock, minor jointing Hard sound rock, moderate jointing	>75 50 to 75	>8000	-
2	Folliated bedrock	Medium hard rock minor jointing	>50	>8000	-
3	Sedimentary bedrock-cementation shale, siltstone, sandstone, limestone, dolomite, conglomerate	Soft rock, moderate jointing	>50		-
4	Weakly cemented sedimentary bedrock - compaction shale or other similar rock in sound condition	Very soft rock	<50		
5	Weathered bedrock - any of the above except shale	Very soft rock. weathered and/or major jointing and fracturing	<50		-
6	Slightly cemented sand and/or gravel, glacial till (basal or lodgement), haropan	Very dense	-		>50
7	Gravel, widely graded sand and gravel, and granular abiation till	Very dense Dense Medium dense Loose Very loose	-		>50 41-50 16-40 8-15 <8
8	Sands and non-plastic silty sands with little or no gravel (except for Class 9 materials	Dense Medium dense Loose Very loose	-		>30 11-30 6-10 <6
9	Fine sand, silty sand and non-plastic inorganic silt	Dense Medium dense loose Very loose	-		>30 11-30 6-10 <6
10	Inorganic sandy or silty clay, clayey sand, clayey slit, clay or varied clay low to high plasticity	Hard Stiff Medium Soft	-		>20 9-20 4-8 <4

11	Organic soils - peat organic slits, organic clay	-	-		-

Notes to table D-1

Note 1: For discussion of RQD values see Deere, D.U., Rock Mechanics in Engineering Practice (Chapter 1), Stagg and Zinkiewicz, Eds., 1968, John Wiley and Sons, Inc.

Note 2: For determination of Unconfined Compressive Strength see ASTM D2938.

Note 3:For determination of Standard Penetration Resistance N-value see ASTM D1586. The presence of large particles (coarse gravel, cobbies, boulders) may cause N-values to be unrealistically high. Such values should not be used. Also standard penetration resistance should not be used over depths less than five feet.

APPENDIX E

PROCEDURE FOR ACCOUNTING FOR SERIES AND PARALLEL HEAT FLOW PATHS

E1: For envelope assemblies containing metal framing: The Ui shall be determined by using one of the following methods:

1. Results from laboratory or field test measurements. One of the procedures specified in 780 CMR 3108.2 shall be used.
2. The thermal resistance of those roof and wall assemblies listed in Tables E-1 and E-2 shall be corrected using the following procedures:

The total resistance of the heat flow path (Rt) is determined from the Equation E-1:

$$Rt = Ri + Re$$

Where:

R = 1/U

Rt = the total resistance of the envelope assembly.

Ri for: i = 1 to n, is the resistance of the series elements.

Re is the equivalent resistance of the element containing the parallel path, and the value of Re is:

Re = R value of insulation x Fc
(where Fc is the parallel path correction factor)

The Parallel Path correction Factors (Fc) may be obtained from tests conducted using procedures listing in 780 CMR 3108.2. Parallel Path Correction Factors for some envelope assemblies are listed in Tables E-1 and E-2.

Table E-1
ROOFS: PARALLEL PATH CORRECTION FACTORS[1]

Bridged R-Value	0	5	10	15	20	25	30	40	45	50	55
Correction Factor	1.0	0.96	0.92	0.88	0.85	0.79	0.76	0.73	0.71	0.69	0.67

Note 1. Table E-1 values are based upon: Metal trusses with 4-ft. spacing that penetrate the insulation, and 0.66 inch diameter crossmembers every one ft.

Table E-2
WALL SECTIONS WITH METAL STUDS: PARALLEL PATH CORRECTION FACTORS

Size of Members	Gauge of Stud	Spacing of Framing	Cavity Insulation R-Value	Correction Factor
2 x 4	18 - 16	16" o.c.	R-11	0.50
2 x 4	18 - 16	24" o.c.	R-11	0.60
2 x 6	18 - 16	16" o.c.	R-11	0.40
2 x 6	18 - 16	24" o.c.	R-11	0.45

Table E-3
CALCULATION PROCEDURES FOR EVALUATING ALL SERIES AND PARALLEL HEAT FLOW PATHS

		BRIDGE TYPE	
		Metal	Non-Metal
Type of Material to whuch bridge is attached	Metal	Thermal Bridges in Sheet Metal Construction Method	Parallel Path
	Non-Metal	Zone Method	Parallel Path

3. For elements with internal metallic structures bonded on one or both sides to a metal skin or covering, the "Thermal Bridges in Sheet Metal Construction," the calculation procedure as specified in "Thermal Bridges in Sheet Metal Construction," *Studies in Building Physics* (Johannesson, Gudni. 1981. Division of Building Technology, Lund Institute of Technology, Lund, Sweden. Report of TVBH-3007) shall be used.
4. For elements other than those covered above, the zone method described in Chapter 23 of the ASHRAE Handbook, 1985 Fundamentals Volume shall be used. The formulas on pages 23.13-.14 shall be used for calculation.

E2: For envelope assemblies containing Non-metal Framing, the Ui shall be determined from results from one of the laboratory or field test measurements specified in 780 CMR 3108.2 or from the ASHRAE series parallel method. Formulas in Chapter 23, page 23.2 of the ASHRAE Handbook, 1985 Fundamentals Volume shall be used for these calculations.

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APPENDIX F

REFERENCE DATA FOR REPAIR, ALTERATION, ADDITION AND CHANGE OF USE OF EXISTING BUILDINGS

PART ONE- GUIDELINES FOR APPLICATION

F-101 PURPOSE

F-101.1 Intent of 780 CMR 34: The purpose of Appendix F is to provide guidance to users of 780 CMR (the Massachusetts State Building Code) as to techniques of acceptable practice which can be used to assess the acceptability of various methods of meeting the intent of code provisions of 780 CMR 34 on a case-by-case basis. The purpose of the provisions in 780 CMR 34 and Appendix F is to allow the repair, alteration addition, and change of use of existing buildings without requiring the entire building to be brought up to new construction requirements, while still providing for the public health, safety and general welfare. The provisions of 780 CMR 34 and Appendix F recognize that the provisions of 780 CMR for new construction reflect the latest improvements in materials, construction techniques, standards of living and safety and, therefor, may preclude the repair, alteration, addition, or change of use of existing buildings that have demonstrated their usefulness and safety.

F-102.0 SCOPE

F-102.1 Techniques: Appendix F is intended to demonstrate techniques of analysis and compliance with 780 CMR 34 in the repair, alteration, addition, and change of use of existing buildings.

F-103.0

F-103.1 General conditions: Conceptually, it is the intent of 780 CMR 34 and Appendix F to allow repair, alteration, addition, or change of use of existing buildings without meeting all new construction requirements under the following general conditions:

1. all hazardous conditions must be corrected;
2. the existing building becomes the minimum performance standard; and
3. the degree of compliance of the building after changes must not be below that existing before the changes, except that nothing in 780 CMR 34 will require compliance with requirements more stringent than that required for new construction.

F-104.0 IMPLEMENTATION

F-104.1 Framework: Implementation of the above concept requires that a framework be established for evaluating the condition of the building; determining the potential for modification; and establishing the acceptability of proposed changes.

F-104.2 Evaluation of existing building: Evaluation of existing conditions in a structure is required to determine the existence of any hazardous conditions, which must be corrected; and to provide a basis for evaluating the impact of the proposed changes on the performance of the building.

The following list of evaluation tools described in Appendix F-104.1.1 through F-104.2.7 can be used for determining the condition of the structure. However, this list is not necessarily complete and the use of other methods should not be precluded.

F-104.2.1 Available documentation of existing building: Prime sources of design information for existing buildings are the architectural and engineering drawings and specifications used in the construction of the building. Although the passing of time often obscures depositaries of such documents, the following are likely prospects in attempting to locate such information:

1. If the building is currently in use, an individual or office responsible for its management may have retained drawings and specifications to facilitate maintenance. A building manager, resident engineer, superintendent, custodian, stationary engineer or plant engineer may be the most direct contact at the building site.
2. Other potential sources (especially if the building is not in use) include the original designer-architect or engineer.
3. The building department which issued the permit for construction may have documentation.
4. Documentation may have been retained by the general contractor or numerous subcontractors; i.e.: the mason, carpenter, plumber, electrician, HVAC installer, steel erector, etc., as well as manufacturers of component parts, as potential sources of documentation.
5. In the case of large corporations or government agencies, a separate contracting officer may have developed a technical file on the erection of a building.
6. In some cases, individual consultants are contracted to serve as "clerk-of-the-works" and pursue the inspection of a building project

from start to finish with the keeping of a file likely.

7. Insurance companies sometimes maintain drawings or records of their insured buildings.

8. Historical or archaeological societies may have considered a building to be important enough to develop a file of documentation.

F-104.2.2 Field surveys: Having drawn upon available documentation to help evaluate a building's condition, such documentation may be augmented by on-site data acquired through field survey. The most obvious approach is to make use of detailed visual examination to confirm and/or alter any previously available information pertaining to the building.

F-104.2.3 Testing: Testing is a tool that may be used in evaluating the condition of a building or structure or parts thereof when other methods of evaluation will not suffice. Testing may be initiated voluntarily on the part of the permit applicant or may be required by the building official in the absence of approved rules as indicated in 780 CMR 109.0, 116.0, and 34. The costs of all such tests are to be borne by the permit applicant and should, therefore, be required by the building official only when other methods of evaluation prove inadequate or insufficient. Such testing should be conducted by an approved testing agency under the supervision of a registered architect or engineer. The report of the tests shall be submitted to the building official and shall include the details of test procedures, references to any accepted test standards used, the results of the tests and any conclusions drawn from the test results.

F-104.2.4 Nondestructive testing: This includes techniques where the structural integrity of the building is not affected, such as the following:

1. analyzing various portions of the building to determine dimensions, types and condition of materials, etc.;
2. portable apparatus for impact testing;
3. load application short of failure to determine capacity of materials and components;
4. magnetic methods for detecting flaws in ferrous metal;
5. proximity magnetometers (locating rebars in concrete, concealed ferrous fasteners, etc.);
6. electronic means for measuring the sonic modulus of elasticity of concrete and masonry in assessing its soundness;
7. ultrasonic transmission or reflective methods in detecting flaws in various materials; and
8. x-ray or infrared-ray photographic techniques used to evaluate portions of elements whose integrity is questionable.

F-104.2.6 Destructive testing: In destructive testing a sample of the building could be removed and tested (e.g., concrete core), or components of the building could be reconstructed and tested in the laboratory.

F-104.2.7 Laboratory analysis: In some cases, tests can be performed in the laboratory. Such tests might include the following:

1. chemical or metallurgical test;
2. optical or electronic microscopic examination which can help identify and evaluate the soundness of materials where decay or other molecular degradation is involved;
3. conventional laboratory tests for determining physical properties (strength, ductility, absorption, solubility, permeability, stiffness, etc.; and/or
4. testing of a scale model of the building (computer model, wind tunnel model, etc.).

F-104.3 Evaluation of change in performance level: It is necessary to determine if the level of performance of the building after alteration is below that which existed before the change. The hazard level could be increased for certain attributes (such as fire safety) while decreased for other attributes (such as floor loads) for a given alteration. The evaluation of the change in hazard levels of each attribute can be accomplished using various tools singly or in combination as described below in Appendix F -104.3.1 through F-104.3.5.

F-104.3.1 Data on archaic systems: Performance data on architectural and structural systems encountered are tabulated in Appendix F, Part Four. This data can be compared to the proposed altered systems to determine if the performance is adversely affected.

F-104.3.2 Compliance alternatives: Alternate solutions tabulated in Appendix F, Part Two were developed from appeal data and from accepted practice. The list is not all-inclusive and should not preclude consideration of other alternatives.

F-104.3.3 Analysis methods: Analytical methods based on good engineering practice may be used to determine changes in performance levels.

F-104.3.4 Test methods: Test procedures as discussed in Appendix F-104.2.3 through F-104.2.6 can be used to evaluate the performance of existing construction.

F-104.3.5 Professional judgement: Professional judgement based on previous experience with similar buildings should be used to the fullest extent possible.

PART TWO- SUGGESTED COMPLIANCE ALTERNATIVES

F-201.0 PURPOSE AND SCOPE

F-201.1 Purpose: The purpose of Appendix F-201.0 is to assist the building official and those regulated by 780 CMR in judging the acceptability of compliance alternatives to specific provisions required by 780 CMR.

F-201.2 Application: Appendix F-201.0 contains generally acceptable compliance alternatives and examples. The examples are solely for the purpose of illustrating principles which can be applied to the solution of code compliance problems and are not necessarily acceptable under all circumstances. It is recognized that all building systems interact with each other. Therefore, any consideration of compliance alternatives must take into account all existing and proposed conditions to determine their acceptability. The principles applied can be used for the solution of similar compliance problems in other buildings and occupancy groups. Commentaries are provided where the philosophy in establishing the alternatives is not obvious. The examples were developed from appeal data and accepted practice. They are not all-inclusive and should not preclude consideration of other alternatives.

Note: It is anticipated that additional compliance alternatives will be added to Appendix F-201.0 through the mechanism of appeal decisions and from results of research being conducted by various organizations in the field of relative permanence of life safety systems.

F-202.0 COMPLIANCE ALTERNATIVES FOR EGRESS REQUIREMENTS

F-202.1 Number of exits:

F-202.1.1 General compliance alternatives:

1. Provide connecting fire balconies.
2. Provide alternate egress facilities (windows, etc.).
3. Provide a fire escape.
4. Provide fire-rated areas of refuge.

F-202.1.2 Examples:

Example 1 involves a five-story Building of Use Group B without a fire suppression system and with only one *means of egress*.

Solution A. Add one or more fire escapes as may be necessary to provide all tenants with reasonable access to two *means of egress* in separate directions. Access to a street, public way or area of refuge shall be provided at the termination of the fire escape.

Solution B. Add connecting fire balconies across fire walls if the above solution is impractical due to construction difficulties.

Example 2 involves a building of Use Group R-2 occupancy with an apartment in the basement. There is only one *means of egress* from the basement.

Solution A. Provide egress windows in each apartment that comply with 780 CMR 10.

F-202.2 Travel Distance:

F-202.2.1 General Compliance Alternatives:

1. Add detection system.
2. Add a partial fire suppression system.
3. Add smoke doors.
4. Increase fireresistance rating of corridor walls and doors.

F-202.2.2 Example: This example involves a four story building of Use Group R-2 without a fire suppression system. The length of exitway access travel is 150 feet.

Solution A. Add a partial fire suppression system off the domestic water supply (if adequate) in the exit access corridor.

Solution B. Subdivide corridor into segments, if less than 100 feet, with smoke doors.

Solution C. If not required by other sections of 780 CMR, install smoke and fire detectors with audible alarms in the corridor.

Solution D. Increase the fireresistance rating of the exit access corridor from one hour to two hours and provide "B" label self-closing or automatic closing fire doors in all openings into the corridor.

F-202.3 Enclosure of exitways:

F-202.3.1 General Compliance alternatives:

1. Improve enclosure of exitway.
2. Add a partial fire suppression system.
3. Add a detection system.

F-202.3.2 Examples: This example involves a four story row building of Use Group R-2 with connecting fire balconies and an interior stair. The stair is enclosed with lath and plaster, wood stud partitions and paneled doors.

Solution A. Cover partitions on the apartment side with ⅝" Type X gypsum wallboard or its equivalent. Replace or build up panel doors until minimum solid portion is 1⅜" and install self-closers.

Solution B. Provide a heat and smoke detection system in the stairwell with an alarm audible to all tenants. Provide self-closers on all stairwell doors.

Solution C. Provide a partial fire suppression system in the stairwell off the domestic water supply (if adequate). Provide self-closers on all stairwell doors.

F-202.3.3 Commentary: The above example, while pertaining to a four story, Use Group R-2 building, can also be applied to other buildings of occupancies and floor levels. The principle that the degree of code compliance may not be reduced should be remembered. If the existing

enclosure is of fireresistive construction, it must be maintained. The primary principle to remember, in the required enclosure of exitway, is that an enclosure must be provided, whether fireresistive or not, so as to provide a smoke barrier. The purpose of providing a smoke barrier is to prevent the passage of smoke from a fire on one floor to the exitways and exit access corridors of other floors and thus render them unusable for egress. This principle is illustrated by solutions A, B, and C in the above example.

F-203.0 COMPLIANCE ALTERNATIVES FOR FIRE HAZARDS

F-203.1 Fire separations and partitions;

F-203.1.1 General compliance alternatives:

1. Improve fire separation.
2. Add a fire suppression system.
3. Add a detection system.

F-203.1.2 Examples: **Example 1** involves a three story building of Type 3A construction, containing a Mercantile (M) Use Group, on the first floor and occupancy Business (B) Use on the second and third floors. The required separation is three hours.

Solution A. Add a fire suppression system to the first and second floors.

Solution B. Add ⅝ inch Type X gypsum wallboard or its equivalent to the underside of the second floor and install a system of smoke and heat detectors with audible alarms on the first and second floors.

Example 2 involves the separation between two tenants of wood lath and plaster on a wood studs partition. The required separation is one hour.

Solution A. Add ⅝ inch Type X gypsum wallboard or its equivalent to either side of the existing partition.

Example 3 involves a building of Use Group B with unrated exit access corridors.

Solution A. Install a partial fire suppression system in the exit access corridors.

Solution B. Add ⅝ inch Type X gypsum wallboard or its equivalent to either side of the corridor partition and install self-closers on all corridor doors.

Solution C. Install a smoke and heat detection system in the corridor with and alarm audible to all tenants on the floor and install self-closers on all corridor doors.

F-203.2 Openings and exterior wall protection:

F-203.2.1 General compliance alternatives:

1. Add fire suppression system.
2. Improve fireresistance.
3. Remove or improve openings.

F-203.2.2 Examples: **Example 1** involves a two story of Type 5B construction building, with Use Group M, on the first floor the basement and upper floors. The distance between the building and the side lot line is five feet and ten feet between it and the adjacent building. The adjacent building is of Type 5B construction and Use Group R-2. The former occupant was a grocery store; the new occupant is a hardware store.

Solution A. Install a deluge sprinkler system along the interior side of the wall affected.

Solution B. Add ⅝ inch Type X gypsum wallboard to interior side of the wall affected.

Example 2 is the same as example 1 but with double-hung wood windows in affected wall.

Solution A. Remove windows and close opening with one hour fireresistive construction.

Solution B. Remove windows and install fire windows.

Solution C. Install a deluge sprinkler system as in solution A to example 1.

PART THREE- DETAILED CLASSIFICATION OF OCCUPANCY BY HAZARD INDEX NUMBER AND USE GROUP

Appendix F, Part Three provides a more detailed guide for users of 780 CMR to determine hazard index numbers and use groups for various types of occupancies. It supplements 780 CMR 3 and Table 34 contained in 780 CMR 3404.

APPENDIX F

TABLE F-1
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of Structure	Hazard Index No.	Use Group
Advertising Displays Manufacture including billboards	3	S-1
Airport or other aircraft landing or service facility (see also: Helicopter rooftop landing facility	3	F
Amusement park, indoor	4	A-3
Animal		
Crematorium	3	F-2
Hospital, kennel, pound	2	B
Apartment (see Residences)		
Appliances		
Manufacture	3	F-1
Sales	3	M
Arenas	4	A-3
Asphalt		
Processing and products manufacture	8	H
Athletic equipment		
Manufacture	3	F-1
Sales	3	M
Auditoriums	6	A-1 with stage
	5	A-1 without stage
	4	A-3
Automobile and other motor vehicles		
Gasoline service station	3	M
Rental agency within a building	2	B
Repair	3	S-1
Repair incidental to auto sales with limitation	3	S-1
Sales within a building	3	M
Wrecking	3	F
Washing	3	S-1
Awning manufacturer	3	F-1
Baked goods shop	3	M
Bakeries	3	F-1
Banks	2	B
Banquet halls	5	A-3
Barber shops	2	B
Beauty shops	2	B
Beverages	2	
Bottling		F-1
Manufacture		
Alcoholic	8	H
Less than 0.5% alcohol @ 60°	3	F-1
Bicycle		
Manufacture	3	F-1
Rental or repair conducted within a building	3	S-1
Sales	3	M
Billiard Parlor	4	A-3
Blacksmith shops	3	F-1
Blueprinting, etc. establishments	3	F-1
Boarding house	2	R-1 or R-2
Boats or ships		
Building or repair of boats	3	F-1
Bone distillation	3	F-1
Bowling alleys	4	A-3
Broom or brush manufacture	3	F-1
Building materials		
Wholesale business in roofed structures	3	M or S-1
Bus terminals or stations	4	A-3
Business schools or colleges	4,2 or other	A-4, B or dependent upon use
Camera and other photo equipment		
Manufacture except film sales	3	M
Sales	3	M

TABLE F-1 (continued)
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of Structure	Hazard Index No.	Use Group
Canvas or canvas products		
Manufacture or repair	3	F-1
Carpet and rug		
Cleaning establishments	8 or 3	H, F-1
Manufacture or repair	3	F-1
Catering for outside consumption	3	F-1
Cemeteries		
Crematory in cemetery	3	F-2
Mausoleum, crypt, columbarium	1	S-2
Mortuary chapel in cemetery	4	A-4
Ceramics products manufacture, including pottery, small glazed tile and similar items	3	F-2
Charcoal, fuel, briquettes, or lampblack manufacture	8	H
Chemicals		
Packaging	8 or 3	H or F-1 depending on nature of material
Manufacture	8 or 3	H or F-1 depending on nature of material
Churches or other places of worship	4	A-4
Circuses, temporary	4	A-3
Cleaning (see Drycleaning & dying; Laundries; Automobiles, washing)		
Clothing		
Manufacture	8 or 3	H or F-1 depending on nature of material
Rental establishment		
Retail sales	3	M
Tailoring, custom manufacture or repair (see also Feathers; Felt; Fur; Leather)	3	M
	3	M
Clubs		
Private		
Nightclubs (see Eating & drinking establishments)	4	A-3 without residence
Coal, coke or tar products		
Manufacture	8	H
Colleges and Universities		
Classroom buildings	4	A-3
Dormitories	2	R-2
Fraternities or sororities	2	R-2
Community centers	4 or 2	A-3, or B
Convalescent homes (see Nursing homes)		
Convents	2	R-2
Cosmetics or toiletries manufacture	8	H
Cotton ginning	8	H
Cotton wadding or linters manufacture	8	H
Courthouses	2 or 4	B or A-3
Crematoriums		
Animal	3	F-2
Human	3	F-2
Dance halls	7	A-2
Day care agencies	4	I-2 or E
Day nurseries	4	I-2
Dental offices (see Medical & dental)		
Department stores	3	M
Dormitories	2	R-1 or R-2
Dressmaking shops, custom	8	H
Drinking places (see Eating & drinking establishments)		
Drive-in restaurants	5	A-3
Drug stores	3	M
Dry cleaning and dying establishments	8 or 3	H or F-1 depending on solvents used
Dwellings (see Residences)		

TABLE F-1 (continued)
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of Structure	Hazard Index No.	Use Group
Eating or drinking establishments		
Lunchrooms, restaurants, cafeterias, etc., primarily enclosed	5	A-3
Drive-in	4	A-3
With entertainment or dancing	7	A-2
Electric		
Power or steam generating plants	3	F-1
Substation	3	F-1
Electrical appliances, bulbs, wiring, supplies, etc.		
Manufacture	3	F-1
Sales	3	M
Electronic components & supplies		
Manufacture or repair	3	F-1
Feathers		
Curing, dyeing, washing or bulk processing	8	H
Manufacturing exclusive of above	8	H
Felt		
Curing, dyeing, washing or bulk processing	3	F-1
Products manufacture, exclusive of above	3	F-1
Fertilizer manufacture	8	H
Film, photographic, manufacture	3 or 8	F-1 or H
Storage and studios	3 or 8	F-1 or H
Fire stations	2	B
Fish processing	3	F-1
Florida shops	3	M
Food		
Product processing except meat & fish	3	F-1
Retail sales	3	M
Fraternities or sororities	2	R-1 or R-2
Funeral establishments	4	A-3
Fur		
Curing, dyeing, finishing, tanning	8	H
Products manufacture exclusive of above	3	F-1
Garage (see Parking garage)		
Garbage incineration or reduction	3	F-1
Gas		
Manufacture	8	H
Public utility stations for metering or regulating	2	B
Storage		
2500 cu. ft. or less	3	S-1
more than 2500 cu. ft.	8	H
Gasoline service station (see Automobiles)		
Gelatin manufacture	3	F-1
Generating plants, electric or steam	3	
Gift shops	3	M
Glass products from previously manufactured	3	F-2
Glue manufacture	3	F-1
Golf		
Indoor courses or driving ranges	4	A-3
Gymnasiums	4	A-3
Grain storage	8	H
Hair		
Curing, dyeing, washing, bulk processing	3	F-1
Product manufacture exclusive of above	3	F-1
Hardware		
Manufacture	3	F-1
Retail sales	3	M
Hat bodies manufacture	3	F-1
Helicopter landing facility, rooftop	3	S-1
Home occupations	2	B
Homes for the aged	4	I-2
Hosiery manufacture	3	F-1

TABLE F-1 (continued)
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of Structure	Hazard Index No.	Use Group
Hospitals		
Including convalescent, nursing, or rest homes and sanitariums, provided custodial care is not provided for drug addicts, alcoholics, mentally ill or mentally deficient	4	I-2
For care of drug addicts, mentally ill, or mentally deficient	5	I-3
Research or teaching laboratories (see also Animal hospitals)	2	B
Hotels	2	R-1
Ice manufacturing (dry or natural)	3	F-2
Ice skating rinks	4	A-3
Incineration or reduction of garbage, offal, or dead animals	3	F-1
Industry uses (see specific items)		
Without resulting noise, vibration, special danger, hazard, dust, smoke, fumes, etc.	3	F-2
Other than above	3 or 8	F-1 or H
Ink or inked ribbon manufacture	3	F-1
Jewelry	3	F-1
Kennels (see Animal)		
Laboratories		
Research laboratory not accessory to school or hospital	2	B
Scientific research or teaching laboratory, non-profit, accessory to school, or hospital, subject to limitations	2	B
Laundries		
Hand laundry		
Self service; pick-up and delivery station of laundry or dry cleaner	2	B
Steam laundries without limitations	3	F-1
Leather		
Curing, dyeing, finishing or tanning	3	F-1
Product manufacture exclusive of above	3	F-1
Libraries	4	A-3
Linoleum or oilcloth manufacture	3	F-1
Liquor sales, package	3	M
Luggage manufacture	3	F-1
Lumber (see Wood)		
Manufacturing	3 or 8	F-1 or H
Matches manufacture	8	H
Mattress manufacture and renovation	3	F-1
Meat Markets	3	M
Slaughtering or packaging	3	F-1
Medical & dental offices (see also Laboratories; Orthopedic & medical appliances; Hospitals)	2	B
Meeting hall	4	A-3
Metals, manufacture	3	F-2
Reduction, refining or smelting	8	H
Monasteries	2	R2
Motels	2	R-1
Motor freight stations (see trucking terminals)		
Museums		
Musical instruments manufacture	3	F-1
Newspaper publishing	3	F-1
Newsstands	3	M
Novelty products manufacture	3	F-1
Nursing Homes	4	I-2
Offices	2	B
Oilcloth manufacture	3	F-1
Optical equipment or similar precision instruments manufacture	3	F-1
Orphanages	3	I-2
Orthopedic or medical appliance manufacture	3	F-1
Paint, turpentine or varnish		
Manufacture	8	H
Spraying booths	8	H

TABLE F-1 (continued)
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of Structure	Hazard Index No.	Use Group
Paper products manufacture	3	F-1
Parish houses	4	A-3
Parking garages		
Group 1	3	S-1
Group 2	1	S-2
Petroleum or petroleum products		
Refining	8	H
Storage	3	S-1
Pharmaceutical products manufacture	3	F-1
Photography studio	2	B
Plastics		
Product manufacture	8	H
Raw, manufacture	8	H
Police stations	2	B
Pool rooms	4	A-3
Post offices	2	B
Printing		
Plant	3	F-1
Printing or newspaper publishing	3	F-1
Prisons & other correctional or detention institutions	5	I-3
Pumping station or substation, water or sewage	3	F-2
Radio	3	
Sales	5	M
Studios with audience	2	A-1-B
Studios without audience		B
Railroad		
Freight terminal	4	A-3
Passenger station	3	S-1
Recreation		
Center, indoor	4	A-3
Community center building	4	A-3
Rectories	2	R-2
Residences		
One-family	2	R-3, or R-4
Two-family	2	R-3, or R-4
Apartment	2	R-2
Temporary dwelling structure	2	R-3
Boarding or lodging house	2	R-1 or R-2
Dormitory	2	R-1 or R-2
Fraternity or sorority	2	R-1 or R-2
Hotel, motel apartment with accessory services	2	R-1
Convents, monasteries, rectories	2	R-2
Research laboratories (see Laboratories)		
Restaurant, lunch room, cafeteria or other establishments primarily for eating	5	A-3
Retail business	3	M
Stores with combustible or flammable goods constructing a high hazard	8	H
Rubber		
Manufacture (natural or synthetic), including tires, tubes, or similar products	8	H
Products (exclusive or processing) including washers, gloves, footwear bathing caps and the like	3	F-1
Sanatariums		
Not providing custodial care for drug addicts, alcoholics, mentally ill, or mentally deficient	4	I-2
Providing care for the above	5	I-3
Schools	4	E
Seminaries	4 or 2	A-4 & R-1
Settlement houses (depending on nature of activities)	4 or 2	A-3 or B
Sewage		
Disposal plant	3	F-1
Pumping station	3	F-1 or F-2
Shoddy manufacture	8	H

TABLE F-1 (continued)
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of Structure	Hazard Index No.	Use Group
Shoes		
Manufacture	3	F-1
Repair shop	2	B
Silverware manufacture, plate or sterling	3	F-1
Size manufacture	3	A-3
Skating rinks	4	A-3
Soap and detergents		
Manufacturing, including fat rendering	8	H
Packaging	3	F-1
Solvent extracting	8	H
Sporting or athletic goods		
Manufacture	3	F-1
Stores	3	M
Stables	3	S-1
Stadiums	4	A-5
Wholesale business, including accessory storage other than flammable liquids, gases and explosives, in roofed structures	3 or 1	S-1 or S-2 depending on nature of materials
Stores (see Retail stores; or specific items)		
Tailor shops, custom	2	B
Tanning (see leather; Fur)		
Taxidermist shops	3	M
Telephone exchanges		
Automatic	2	B
Non-automatic	2	B
Television		
Sales	3	M
Studios	3	M
	6	A-1 with scenery
	5	A-1 np scenery
	2	B no audience
Textiles		
Manufacture, including knit & yard goods, thread or cordage, spinning, weaving, dyeing & printing, shoddy manufacture	3	F-1
Theaters	6	A-1 with scenery
	5	A-1 no scenery, motion picture
Tires, manufacture	8	H
Tobacco products manufacture including curing	3	F-1
Tools & hardware		
Manufacture	3	F-1
Sales	3	M
Toys		
Manufacture	3	F-1
Trailer park (see Mobile homes)		
Truck		
Repairs	3	S-1
Sales	3	M
Trucking terminals	3	S-1
Turpentine manufacture	8	H
Warehouses	8, 3, or 1	H, S-1, or S-2 depending on nature of materials
Waterpumping stations	2	F-2
Wax products manufacture	8	H

PART FOUR- ARCHAIC CONSTRUCTION SYSTEMS

F-401.0 PURPOSE AND SCOPE

F-401.1 Purpose: The purpose of of Appendix F, Part Four is to assist the building official and those regulated by780 CMR in evaluating the properties of archaic construction systems.

F-401.2 Scope: Appendix F, Part Four contains data on construction systems no longer in general use but which may be encountered in older existing buildings. It is meant to be used for assessing existing conditions when evaluating how proposed changes will impact upon the performance of the building.

F-401.3 Application: In any given problem, all available data should be collected and professional judgement exercised in arriving at decisions. Evaluative judgment should be used when test data does not exist or when applying the data contained in this standard.

F-402.0 ARCHAIC FIRERESISTIVE SYSTEMS

F-402.1 General: Appendix F, Part Four contains a list of fireresistive materials and construction which are not necessarily currently in common use. Some of the hourly ratings contained in the listing predate ASTM E-119 that is in current use. The hourly ratings may be higher or lower if tested according to ASTM E 119. In addition to the data contained herein, see Report BMS92, Building Materials and Structures, dated October 7, 1942, National Bureau of Standards. The data listed below is extracted from the Boston Building Code, circa 1943.

F-402.2 Fireresistive materials and construction:

F-402.2.1 Minimum qualities: Materials, to be given the fireresistive ratings specified in this part, shall have the following minimum qualities set forth in Appendix F F-402.2.2 through F-402.2.19.

F-402.2.2 Class 1 concrete: Concrete of Class 1 shall be so proportioned as to have a strength of at least 1500 pounds per square inch (psi) and the coarse aggregate shall consist of limestone, trap rock, blast furnace slag, cinders containing not more that 20% of combustive material, burned clay or shale.

F-402.2.3 Class 2 concrete: Concrete of Class 2 shall be so proportioned as to have a strength of at least 1500 pounds psi, the coarse aggregate consisting of sandstone, granite, quartzite, siliceous gravel or other similar material not over one inch in size.

F-402.2.4 Masonry: Masonry shall be laid in lime-cement or cement mortar, or approved masonry cement mortar, except that masonry of gypsum tile shall, and masonry of structural clay tile may, be laid in gypsum mortar. Masonry shall be thoroughly bonded by breaking joints in successive courses or by the use of metal ties.

F-402.2.5 Brick: Brick shall be burned clay or shale, concrete or sand-lime brick of Grade C or better.

F-402.2.6 Stone: Stone shall be limestone, marble, slate or equally fireresistive natural stone. Sandstone, granite or other stone which, because of its crystalline structure or for other reason, is less fireresistive, shall not be considered fire protection for structural metal, but may be used in a masonry wall not less that 12 inches thick required to have fireresistance. Stone masonry shall have the same fireresistive rating as brick masonry.

F-402.2.7 Cast stone: Cast stone masonry shall have the same fireresistive rating as brick masonry.

F-402.2.8 Concrete blocks: Concrete blocks, whether solid or hollow, shall have as coarse aggregate limestone, trap rock, blast furnace slag, cinders containing not more than 20% of combustible material, burned clay or shale.

F-402.2.9 Structural clay tile: Structural clay tile shall conform to the specifications for load-bearing tile, floor tile or partition tile. Where partition tile is specified load-bearing tile may be used.

F-402.2.10 Gypsum: Gypsum tile or pre-cast gypsum concrete, whether solid or hollow, shall conform to Standard Specifications for Gypsum Partition Tile or Block of the American Society for Testing Materials and shall not contain more than 3% by weight of wood or other combustible binder or filler.

F-402.2.11 Gypsum concrete: Gypsum concrete shall not contain more than 12½ by weight of wood or other combustive binder or filler and shall have a compressive strength of at least 500 psi. It shall not be used where exposed to the elements.

F-402.2.12 Lath: Expanded metal or wire lath as a base or reinforcement for plastering shall weigh not less that 2.2 pounds per square yard and shall have not less than 2½ meshes per inch.

F-402.2.13 Metal mesh for masonry: Metal mesh reinforcement specified for masonry fire protection of structural metal shall consist of wire lath strips the full thickness of the masonry, laid in the beds thereof, or its approved equivalent.

F-402.14 Metal mesh for concrete: Metal mesh reinforcement specified for concrete fire protection of structural metal shall consist of wire mesh weighing not less than 1½ pounds per square yard with wire spaced not over four inches, or not less than No. 11 gauge steel wire spaced not over four inches apart, or its approved equivalent.

F-402.2.15 Cement plaster: Cement plaster shall be proportioned of one part Portland cement, and not more than two parts of sand measured by volume dry and loose to which may be added lime putty or hydrated lime not exceeding 15% of the cement.

F-402.2.16 Gypsum plaster: Gypsum plaster, except where otherwise specified, may contain sand, not in excess of three times the weight of the gypsum.

F-402.2.17 Lime plaster: Lime plaster shall consist of a mixture of one part lime, not over three parts sand, and water.

F-402.2.18 Pneumatically projected mortar: Pneumatically projected mortar made of Portland cement, sand nd water shall be rated for fire protection the same as Class 1 concrete.

F-402.2.19 Concrete fill: Concrete fill, where specified in this appendix in connection with hollow masonry units shall consist of Class 1 or Class 2 concrete poured in the hollow spaces of the units as they are laid.

F-402.2.20 Reinforced concrete: Portland cement concrete or gypsum concrete poured in place as fire protection for beams, trusses and other horizontal or inclined members of structural steel and pneumatically projected mortar applied to structural steel as fire protection shall be reinforced with metal mesh reinforcement. Concrete protection for vertical columns of structural metal shall have reinforcing consisting of No. 5 wire spaced not over eight inches apart or its equivalent. Reinforcement shall be wrapped around the structural member and so arranged as to be completely embedded in the fire protection material and to ensure its integrity.

F-402.2.21 Reinforced plaster: Plaster used as fire protection or to resist the spread of fire shall be reinforced with metal lath, except plaster less than one inch thick or masonry or concrete.

F-402.2.22 Replacement material: In the protection of structural metal including reinforcement, ½ inch of cement or gypsum plaster may replace an equal thickness of poured concrete or pneumatically projected mortar as protective material; and one inch of cement or gypsum plaster reinforced with metal lath may replace an equal thickness of poured concrete, pneumatically projected mortar or masonry protection.

F-402.2.23 Plaster: Where plaster is required without other specification, it shall consist of ½ inch of cement or gypsum plaster, except that only gypsum plaster shall be used on gypsum masonry.

F-402.2.24 Thickness: In this appendix, except where otherwise specifically stated, the thickness given in a list of materials applies to the next following item only, and not to the total thickness where additional materials are specified.

F-402.2.25 Embedding limitations: Pipes, wires, conduits and ducts shall not be embedded in or placed behind the fire-protective materials required for the protection of structural steel or iron except as otherwise provided in this paragraph. Above fire-protective hung ceilings and within the enclosed space in building of Type 1 and Type 2 construction within which, other than the enclosure, fire protection of steel is not required, pipes, wires, conduits and ducts may be placed, provided they are so arranged and so secured that they will not, either by expanding in the event of fire, or otherwise impair, the effectiveness of the enclosing protective materials. Electric conduits and wires and gas pipes may be embedded in concrete or masonry fire protection of structural steel where the protective material is reinforced with wire mesh, provided they shall have protective covering except over the tops of beams and girders, at least as thick as required for the steel.

F-402.2.26 Damage protection: In factories, garages, warehouses and other buildings in which the fire-protective covering required for steel or iron columns may be damaged by the movement of vehicles, materials or equipment, such covering shall be protected by metal or other material in a manner satisfactory to the building official.

F-402.2.27 Firestopping: Firestopping shall mean the stopping off or enclosure at the ends and wherever else specified of the spaced between studs of partitions, joists of floors and roofs and other similar spaces to prevent drafts of air and the communication of fire from one such space to another. Fire-stopping shall consist of wood not less than 1½ inches thick, of sheet metal not less than No. 24 gauge or of masonry, or a combination of such materials. Firestopping shall be tightly fitted in the space to be filled, about pipes, wires and ducts and, if cut or disturbed in the placement of pipes, wires and ducts, shall be repaired.

F-402.3 Fire protection of steel columns:

F-402.3.1 Protective thickness: Structural steel columns required to have fire protection of a given rating shall be covered on all sides with

protective material having not less than the thickness necessary for the required rating. Except where "no fill" is specified, re-entrant and other accessible spaces behind the specified outer protection shall be filled with concrete or brick masonry or the material of the outer protection.

F-402.3.2 Fireresistance rating: Materials shall be assumed to afford to steel columns fire protection of the rating indicated in the following Appendix F-402.3.3 through F-402.3.6:

F-402.3.3 Four hour rating:

1. Two inches Class 1 concrete.
2. Three inches Class 2 concrete, metal mesh reinforcement.
3. 3½ inches brick masonry.
4. Two layers two inch structural clay partition tile masonry, metal mesh in beds.
5. Two inches structural clay partition tile masonry, concrete fill, metal mesh in beds, ¾ inch gypsum plaster.
6. Four inches structural clay partition tile masonry, concrete fill, metal mesh in beds, ⅝ inch lime plaster.
7. Four inches structural clay partition tile or concrete block masonry, concrete fill, plaster.
8. Three inches hollow gypsum tile masonry and plaster.
9. Two inches gypsum concrete, metal mesh reinforcement.
10. Two inches solid gypsum tile masonry and plaster.
11. Three inches solid cinder concrete block masonry and plaster.
12. Four inches hollow cinder concrete block masonry and plaster

F-402.3.4 Three hour rating:

1. 1¾ inches Class 1 concrete.
2. Two inches Class 2 concrete, metal mesh reinforcement.
3. Two inches gypsum concrete.
4. Two inches solid cinder concrete block masonry and plaster.
5. Two inches structural clay partition tile masonry, concrete fill.
6. Four inches structural clay partition tile masonry, concrete fill, metal mesh in beds, ⅝ inch lime plaster.

F-402.3.5 Two hour rating:

1. 1½ inches Class 1 concrete.
2. Two inches Class 2 concrete, metal mesh reinforcement.
3. One inch Class 1 or Class 2 concrete encased in standard weight steel or wrought iron pipe.
4. Two inches structural clay partition tile masonry and plaster.
5. Two layers plaster, each on metal lath, with ¾ inch air space between, two inches total thickness.
6. Two inches gypsum concrete.
7. Two inches solid or three inches hollow gypsum tile masonry.

F-402.3.6 One hour rating:

1. One inch Class 1 concrete.
2. 1½ inches Class 2 concrete with metal mesh reinforcement.
3. 2¼ inches brick masonry.
4. Two inches structural clay partition tile or concrete block masonry.
5. One inch cement or gypsum plaster on metal lath.

F-402.3.7 Thickness: The thickness of protection on the outer edges of lugs or brackets need not exceed one inch.

F-402.4 Fire protection of cast iron columns:

F-402.4.1 Protective thickness: Cast iron columns required to have fire protection of a given rating shall be covered on all sides with protective materials having not less than the thickness necessary for the required rating. Re-entrant spaces, if any on the exterior of cast iron columns, and other accessible spaces behind the specified protection, shall be filled with Class 1 concrete or brick masonry or the material of the outer protection.

F-402.4.2 Fireresistance rating: Materials shall be assumed to afford to cast iron columns fire protection of the rating indicating in the following Appendix F-402.4.3 through F-402.4.5:

F-402.4.3 Four hour rating: Cast iron columns shall not be used where the protection of a four hour rating is required.

F-402.4.4 Three hour rating:

1. Two inches Class 2 concrete.
2. Three inches Class 2 Concrete, metal mesh reinforcement.
3. Two inches structural clay partition tile or concrete block masonry concrete fill.
4. 1½ inches cement or gypsum plaster on metal lath and metal furring to form ½ inch air space.
5. 1½ inches Class 1 concrete.
6. Two inches Class 2 concrete with metal mesh reinforcement.

F-402.4.5 One hour rating:

1. One inch Class 1 concrete.
2. 1½ inches Class 2 concrete with metal mesh reinforcement.
3. One inch cement or gypsum plaster on metal lath.

F-402.5 Fire protection of steel in reinforced concrete columns:

F-402.5.1 Protection thickness: The main steel reinforcement, including spiral reinforcement and ties larger than ½ inch, in reinforced concrete columns required to have fire protection of a given rating shall be covered with concrete having not less than the thickness listed in Appendix F-402.5 for the rating indicating in the following Appendix F-402.5.2 through F-402.5.6.

F-402.5.2 Four hour rating:

1. 1½ inches Class 1 concrete.
2. Two inches Class 2 concrete.

F-402.5.3 Three hour rating: 1½ inches Class 1 or Class 2 concrete.

F-402.5.4 Two hour rating:

1. One inch Class 1 concrete.
2. 1½ inches Class 2 concrete.

F-402.5.5 One hour rating: One inch Class 1 or Class 2 concrete.

F-402.5.6 Ties less than ½ inch: The thickness of protection on column ties not larger than ½ inch may be ½ inch may be ½ inch thinner than that listed above.

F-402.6 Fire protection of steel beams, girders, and trusses:

F-402.6.2 Protective thickness: Steel beams, girders and trusses or the members of trusses, required to have fire protection of a given rating, shall be covered on all sides with material having not less than the thickness necessary for the required rating.

F-402.6.3 Four hour rating:

1. Two inches Class 1 concrete.
2. Three inches Class 2 concrete.
3. Three inches structural clay partition tile or concrete block masonry and plaster.
4. Three inches hollow gypsum tile masonry and plaster.
5. Two inches gypsum concrete.
6. Two inches solid gypsum tile masonry and plaster.

F-402.6.4 Three hour rating:

1 1¾ inches Class 1 concrete.
2. 2½ inches Class 2 concrete.
3. Two inches gypsum concrete.
4. Two inches structural clay partition tile, or concrete block masonry and plaster.
5. Two inches solid, or three inches hollow gypsum tile masonry.

F-402.6.5 Two (2) hour rating:

1. 1½ inches of Class 2 concrete.
2. Two inches gypsum concrete.

F-402.6.6 One hour rating:

1. One inch Class 1 concrete.
2. 1½ inches Class 2 concrete.
3. ⅞ inch or cement or gypsum plaster on metal lath.

F-402.7 Fire protection of steel in reinforced concrete beams:

F-402.7.1 Protective thickness: The main steel reinforcement, including stirrups larger than ½ inch, in reinforced concrete beams, girders and trusses, including the ribs of reinforced concrete ribbed floors or roofs where one or both sides of the ribs, in addition to the soffit, are exposed to fire, required to have fire protection of a given rating, shall be covered on all sides with concrete having not less than the thickness listed in Appendix F-402.7 for the required rating. Where a reinforced concrete floor or roof has a flush ceiling formed with approved permanent masonry filler between ribs, the reinforcement shall have the protection required for reinforcing steel of floors and roofs in Appendix F-402.8.

F-402.7.2 Four hour rating:

1. 1½ inches Class 1 concrete.
2. Two inches Class 2 concrete.

F-402.7.3 Three hour rating: 1½ inches Class 1 or Class 2 concrete.

F-402.7.4 Two hour rating:

1. One inch Class 1 concrete.
2. 1½ inches Class 2 concrete.

F-402.7.5 One hour rating: One inch Class 1 or Class 2 concrete.

F-402.7.6 Stirrups less than ½ inch: The thickness of protection on stirrups not larger than ½ inch may be less than that listed by not more than ½ inch.

F-402.8 Fire protection of steel reinforcing in floors and roofs:

F-402.8.1 Protection thickness: The steel reinforcement in reinforced concrete floors and roofs with flush or plane ceiling, such that the exposure to fire is on the soffit only, required to have fire protection of a given rating, shall be covered with concrete having not less than the thickness listed in Appenfix F-402.8 for the required rating. In floors or roofs having reinforced concrete ribs where the concrete surrounding the steel reinforcement is exposed to fire on one or both sides in addition to the soffit, such reinforcement shall have the protection specified in Appendix F-402.7 for steel in reinforced concrete beams.

F-402.8.2 Four hour rating:

1. One inch Class 1 concrete.

2. 1¼ inches Class 2 concrete.

F-402.8.3 Three hour rating: One inch Class 1 or Class 2 concrete.

F-402.8.4 Two hour rating:

1. ¾ inch Class 1 concrete.
2. One inch Class 2 concrete.

F-402.8.5 One hour rating: ¾ inch Class 1 or Class 2 concrete.

F-402.9 Fireresistive floor and roof construction:

F-402.9.1 Protective thickness: Floors and roofs required to have resistance of a given rating to the spread of fire shall have such thickness of the materials of which it is constructed, as shall be necessary for the required rating, and structural metal forming a part of such floors or roofs shall have protection against fire of such required rating. Floors and roofs required to have two hour or longer resistance to fire be constructed of noncombustible materials. Granolithic, burned clay tile, ceramic tile or other similar incombustible floor finish of a given thickness may be substituted for an equal thickness, and sand, cinder or other incombustible filling material, with or without embedded wooden screeds, may be substituted for ⅔ its thickness, of the floor or roof construction material specified in Appendix F-402.9, provided that such floors and roofs shall have adequate thickness for structural purposes.

F-402.9.2 Fireresistance rating: Floor or roof construction shall be assumed to afford resistance to the spread of fire of the rating indicated in the following Appendix F-402.9.3 through F-4029.6:

F-402.9.3 Four hour rating:

1. Four inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.
2. Four inches solid masonry arched or slabs.
3. Four inches structural clay floor tile masonry arches or slabs with top covering of not less than two inches of solid masonry or reinforced concrete.
4. Five inches combination reinforced Portland cement concrete slab consisting of permanent fillers of concrete block, gypsum or structural clay tile and 1½ inches of concrete topping; but if structural clay partition tiles are used for fillers, they shall be plastered on the soffit.

F-402.9.4 Three hour rating:

1. Three inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.
2. Three inches solid masonry arches or slabs.
3. Four inches structural clay floor tile masonry, arches or slabs with top covering of not less than 1½ inches of solid masonry or reinforced concrete.
4. Four inches combination reinforced Portland cement concrete slab consisting of permanent fillers of concrete block, gypsum or structural clay tile and one inch concrete topping; but if structural clay partition tiles are used for fillers, they shall be plastered on the soffit.

F-402.9.5 Two hour rating:

1. 2½ inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.
2. 2½ inches solid masonry arches or slabs.
3. Three inches structural clay floor tile masonry, arches or slabs with top covering of not less than one inch of solid masonry or reinforced concrete.

F-402.9.6 One hour rating:

1. Three inches structural clay floor tile masonry, arches or slabs with all joints thoroughly filled with cement or gypsum mortar.
2. Wood floor or roof construction with joists not less than 1⅝ inches in least dimension, firestopped, double board floor, approved asbestos felt between lay of boards, and with a ceiling of at least ¾ inch cement or gypsum plaster on metal lath.
3. Steel beams or steel joists not more than 36 inches apart on centers with noncombustible floor and a ceiling of at least ¾ inch cement or gypsum plaster on metal lath furring.

F-402.10 Fireresistive ceiling construction:

F-402.10.1 Protective thickness: Ceilings required to afford fire protection of a given rating to the floor or roof framing under which it is supported shall be of fireresistive materials of at least the thickness necessary for the given rating. A fireresistive ceiling and all hangers and fastenings necessary for its support to the protected framing shall be of noncombustible materials. It shall be capable of sustaining its own weight without exceeding allowable stresses. Metal reinforcement in such a ceiling shall be protected from fire as specified in Appendix F-402.8 for reinforcing in a floor.

F-402.10.2 Fireresistance rating: Ceiling construction shall be assumed to afford to floor or roof framing fire protection of the rating indicated in the following Appendix F-402.10.3 through F-402.10.6.

F-402.10.3 Four hour rating:

1. 2½ inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.

2. Two inches precast reinforced gypsum concrete, plastered.

F-402.10.4 Three hour rating:
1. Two inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.
2. Two inches precast reinforced gypsum concrete, lapped or rabbeted joints.

F-402.10.5 Two hour rating: 1½ inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.

F-402.10.6 One hour rating: ¾ inch cement or gypsum plaster on metal lath.

F-402.11 Fireresistive bearing walls and partitions:

F-402.11.1 Protective thickness: Bearing walls and partitions required to have resistance to fire or the spread of fire of a given rating shall be constructed of fireresistive materials and shall have at least the thickness necessary for the required rating. Walls required to have two hour or longer rating shall be of noncombustible materials. Steel reinforcement in reinforced concrete walls shall have the same protection for the given rating as is required in Appendix F-402.9 for floors.

F-402.11.2 Fireresistance rating: Bearing walls and partitions shall be assumed to have resistance to fire and the spread of fire of the rating indicated in the following Appendix F-402.11.3 through F-40211.6:

F-402.11.3 Four hour rating:
1. Eight inches solid brick masonry.
2. 12 inches hollow wall of brick masonry, minimum eight inch masonry thickness.
3. 12 inches structural clay load-bearing tile masonry with two units and not less than three cells in the thickness of the wall.
4. Eight inches structural clay load-bearing tile masonry with one unit and not less than two cells in the thickness of the wall, plastered both sides.
5. 12 inches concrete block masonry with one unit and not less than two cells in the thickness of the wall.
6. Eight inches one piece concrete block masonry with shells and webs at least 1½ inches thick, plastered both sides.
7. 12 inches total thickness of brick masonry facing bonded to structural clay load-bearing tile masonry backing.
8. Eight inches solid concrete.
9. Six inches solid reinforced concrete.
10. A steel or reinforced concrete frame bearing wall in which the steel has fire protection of four hour rating, with panel filling as specified in Appendix F-402.12 for a nonbearing wall of four hour rating.

F-402.11.4 Three hour rating:
1. Eight inches structural clay load-bearing tile masonry with two units and not less than four cells in the thickness of the wall.
2. 12 inches structural clay load-bearing tile masonry with one unit and not less than three cells in the thickness if the wall.
3. Eight inches one piece concrete block masonry with shells and webs not less than 1½ inches thick, plastered both sides.
4. Eight inches one piece concrete block masonry with shells and webs not less than two inches thick.
5. Five inches solid reinforced concrete.
6. A steel or reinforced concrete frame bearing wall in which the steel has fire protection of three hour rating, with panel filling as specified in Appemdix F-402.12 for a nonbearing wall of three hour rating.

F-402.11.5 Two hour rating:
1. Eight inches structural clay load-bearing tile masonry with not less than three cells in the thickness of the wall.
2. Eight inches concrete block masonry with shells and webs not less than 1½ inches thick.
3. A steel or reinforced concrete frame bearing wall in which the steel has fire protection of two hour rating, with panel filling as specified in Appendix F-402.12 for a nonbearing wall of two hour rating.

F-402.11.6 One hour rating:
1. A steel or wooden stud bearing wall covered on both sides with one inch cement or gypsum plaster on metal lath, firestopped if of wood.
2. A steel or reinforced concrete frame bearing wall in which the steel has fire protection of one hour rating, with panel filling as specified in Appendix F-402.12 for a nonbearing wall of one hour rating.

F-402.12 Fireresistive nonbearing walls and partitions:

F-402.12.1 Protective thickness: Nonbearing walls and partitions required to have resistance to fire and the spread of fire of a given rating shall be constructed of fireresistive materials and shall have at least the thickness necessary for the required rating. Walls required to have two hour or longer rating shall be of incombustible materials. Steel reinforcement in reinforced concrete walls shall have the same protection for the given rating as is required in Appendix F-402.8.

F-402.12.2 Fireresistance rating: Nonbearing walls and partitions shall be assumed to have resistance to fire and the spread of fire of the rating indicated in the following Appendix F-402.12.3 through F-402.12.6.

F-402.12.3 Four hour rating:

1. Eight inches solid brick masonry.
2. 3½ inches solid brick masonry, plastered goth sides.
3. Six inches structural clay load-bearing tile, plastered both sides.
4. Six inches solid concrete.
5. Four inches solid reinforced concrete.
6. Any wall which, as a bearing wall, has a three hour or four hour rating in Appendix F-402.11, except the steel or reinforced concrete frame bearing wall.

F-402.12.4 Three hour rating:

1. 3½ inches solid brick masonry.
2. Four inches structural clay load-bearing tile, plastered both sides.
3. Four inches solid concrete.
4. Three inches reinforced concrete.
5. Any wall which, as a bearing wall, has a two hour rating in Appendix F-402.11 except the steel or reinforced concrete frame bearing wall.

F-402.12.5 Two hour rating:

1. Three inches gypsum tile masonry plastered both sides except in exterior walls.
2. Eight inches structural clay partition tile masonry, plastered both sides.
3. Eight inches structural clay load-bearing tile, with three cells in the thickness of the wall.
4. 2½ inches solid cement or sanded gypsum plaster on metal lath and noncombustible studding.
5. Three inches total thickness of hollow wall, ¾ inch cement or gypsum plaster on metal lath and noncombustible studding.
6. Three inches total thickness of hollow wall, ¾ inch cement or gypsum plaster on metal lath and wooden studding, firestopped.

F-402.13 Fireresistive doors:

F-402.13.1 General: Doors which are required to be fire doors, fireresistive doors, or of fireresistive construction shall conform to the requirements of Appendix F-402.13 and Appendix F-402.14

F-402.13.2 Classification: Fire doors shall be classified for the proposes of this code as Class A, Class B, and Class C.

F-402.13.3 Class A fire doors: Class A fire doors shall be doors of the following construction and as specified in Appendix F-402.14:

1. Tin-clad, three ply wood core, sliding.
2. Tin-clad, three ply wood core, swinging single leaf, doorway not over six feet wide.
3. Tin-clad, three ply wood core, swinging in pairs, doorway not over feet wide.
4. Hollow metal, swinging single leaf, doorway not over four feet wide.
5. Hollow metal, swinging in pairs, doorway not over eight feet wide.
6. Sheet metal, sliding, single, doorway not over ten feet wide.
7. Sheet metal, sliding in pairs, doorway not over 12 feet wide.
8. Sheet metal, swinging single leaf, doorway not over feet wide.
9. Sheet metal, swinging in pairs, doorway not over ten feet wide.
10. Steel rolling doorway not over 12 feet wide.
11. Steel plate, doorway not over four feet wide.
12. Any other construction equal or superior to a tin-clad three ply wood core door in a standard fire test, for resistance to fire, the spread of fire and smoke, and transmission of heat.

F-402.13.4 Class B fire doors: Class B fire doors shall be doors of the following construction and as specified in Appendix F-402.14:

1. Tin-clad, three ply wood core.
2. *Tin-clad, two ply wood core, sliding, doorway not over ten feet wide.*
3. Tin-clad, two ply wood core, swinging single leaf, doorway not over six feet wide.
4. Tin-clad, two ply wood core, swinging in pairs, doorway not over ten feet wide.
5. Hollow metal, sliding, doorway not over eight feet wide.
6. Metal-clad, paneled, swinging single leaf, doorway not over three feet wide.
7. Metal-clad, paneled, swinging in pairs, doorway not over six feet wide.
8. Any other construction equal or superior to a tin-clad two ply wood core door in a standard fire test, for resistance to fire, the spread of fire and smoke, and transmission of heat.

F-402.13.5 Class C fire doors: Class C Fire doors shall be doors of the following construction and as specified in Appendix F-402.14:

1. Metal-clad, paneled, swinging single leaf, doorway not over four feet wide.
2. Metal-clad, paneled, swinging in pairs, doorway not over eight feet wide.

F-402.13.6 Substitution: A Class A door may be used where Class b or Class C is specified; a Class B door may be used where Class C is specified. Two Class B or Class C doors on opposite sides of the wall may be used where a single Class A or Class B door is specified.

F-402.13.7 Overlap: Fireresistive doors, when closed, shall completely cover the doorways in the walls and partitions or the openings in the floors or roofs to which they ar fitted. A swinging fire door shall either overlap both jambs and the head of the opening not less than four inches or be fitted to a fireresistive frame with a rabbet the full thickness of the door and with not less than ½ inch overlap on the door. A sliding fire door, except in enclosures about passenger elevators, shall overlap both jambs and the head of the opening not less than four inches. A sliding fire door in an enclosure about a passenger elevator shall overlap jambs, head and adjoining panels not less than ½ inch. Fire doors shall fit closely at the floor with clearance of not over ¼ inch.

F-402.13.8 Thresholds: In buildings with combustible floors, doorways required to have fire doors shall have noncombustible thresholds the full thickness of the wall, extending at least four inches from the face of the wall where a door is hung and extending laterally at least six inches behind each jamb of the doorway. Thresholds may be flush with the floor.

F-402.13.9 Rabbeted frame: The rabbeted frame of a swinging fire door shall be constructed of structural steel built into the concrete, masonry or other fireresistive material of the wall about the opening and secured thereto, except that the rabbeted frame of a Class B or C door may be of wood, covered with sheet metal not less than No. 26 gauge in thickness, secured to the wall in the opening.

F-402.13.10 Fit: Fire doors when closed shall fit tightly against the wall or frame so as to provide an effective stop for fire and smoke. Except for the metal-covered wooden frame specified in Appendix F-402.10, combustible material shall not intervene between the door and the fireresistive material of the wall, floor or roof to which it is fitted.

F-402.13.11 Hardware: Hinge hardware for fire doors shall be of malleable iron or rolled structural steel not less than ¼ inch thick except that tubular steel track for sliding doors may be not less than ⅛ inch thick. Equivalent thickness of solid bronze or brass may be used. Fire doors shall not depend upon cords, cables or chains to support them in closed position except in elevator shafts.

F-402.13.12 Tracks: Tracks for sliding fire doors shall be so supported that a track hanger comes at each door hanger when the door is closed. Track hangers shall be secured to wood stud walls by through bolts and to concrete walls by through bolts or approved built-in inserts. Expansion shields shall not be used to support fire doors.

F-402.13.13 Hinges: Hinges for swinging fire doors, except in wooden stud walls, shall be riveted or through-bolted to the structural steel frame of the opening, through-bolted to the wall if of masonry or concrete or secured by approved inserts in the concrete or built into masonry in an approved manner

F-402.13.14 Strap hinges: Strap hinges and sliding door hangers shall be secured to fire doors by through-bolting, riveting or welding. Swinging fire doors in rabbeted frames, except tin-clad, wood core doors, may be hung on butts. Other swinging fire doors shall have strap hinges.

F-402.13.15 Straps, locks and latches: Sliding fire doors shall have adequate stops for the closed position. Swinging Class A fire doors shall have surface lathes or unit locks. Class B and C doors shall have surface latches, unit or mortise locks. The latch bolts of unit or mortise locks on fire doors shall have a throw of ¾ inch. When mounted in pairs, fire doors shall be rabbeted by means of an astragal or otherwise where they come together. One of a pair of swinging fire doors shall have push bolts at top and bottom with a throw of ¾ inch and the other shall be held by latch to the first.

F-402.13.16 Opening hardware: Except in detention buildings, fire doors hung in required exits shall be so fitted with hardware that they can be opened from inside without use of a key when the building is occupied.

F-402.14 Fire door construction:

F-402.14.1 Fastening: In the construction of fire doors, solder shall not be used except for filling joints. Sheet metal shall be fastened to wood by nailing and to metal frame by bolting, riveting or welding.

F-402.14.2 Glass: Class A doors shall not have glass panels. Class B doors may have glass panels not larger than 100 square inches in exposed area nor more than 12 inches in width or height. Class C doors amy have glass panels not larger than 2,016 square inches in total exposed area, and any single light shall not have an exposed area exceeding 1,296 square inches. Glass in fire doors shall be wire glass not less than ¼ inch thick and shall be set ⅝ inch in grooves ¾ of an inch deep.

F-402.14.3: Deleted

F-402.14.4 Tin-clay, two ply: In-clad, two ply wood core doors shall be shall be constructed in accordance with the specifications of the National Board of Fire Underwriters for such doors in Class B openings and shall bear the label of the Underwriters' Laboratories to this effect.

F-402.14.5 Hollow metals: Hollow metal doors shall have substantial stiles and rails of heavy pressed steel, reinforced for hinges and other hardware. Panels shall be of sheet filled with asbestos board or other approved insulating materials. The door shall be assembled by welding or riveting.

F-402.14.6 Sheet metals: Sheet metal doors shall be constructed with a rolled steel rigid frame covered both sides with $^1/_{16}$ inch asbestos board and No. 26 gauge corrugated steel metal, with corrugations vertical on one side and horizontal on the other, bound on the edges with rolled steel or pressed steel shapes.

F-402.14.7 Steel rolling: A steel rolling fire door shall be constructed of sheet steel interlocking slats, sliding in grooves, counterweighted by springs, with the roller and mechanism enclosed in heavy sheet metal.

F-402.14.8 Steel plate: A steel plate fire door shall be constructed of not less than No. 12 gauge steel plate mounted on a rolled steel frame, assembled by welding or riveting.

F-402.14.9 Metal clad: A metal clad, paneled fire door shall have a wood core with stiles and rails not less than 1¾ inches thick covered with No. 26 gauge sheet steel; panels ¾ inch thick covered with No. 26 gauge sheet steel, set ¾ inch in grooves; joints of metal lapped and well nailed.

F-402.14.10 Class A label: A door properly bearing the Underwriters' label certifying that it is suitable for the protection of a Class A opening shall be acceptable as a Class A door.

F-402.14.11 Class B label: A door properly bearing the Underwriters' label certifying that it is suitable for the protection of a Class B opening shall be acceptable as a Class B door, except that metal clad doors wider than three feet shall not be accepted as Class B doors.

F-402.14.12 Class C label: A door properly bearing the Underwriters' label certifying that it is suitable for the protection of a Class C opening shall be acceptable as a Class C door.

F-402.15 Fireresistive shutters: Shutters required to be fire shutters or fireresistive shutters shall be constructed and hung as specified for Class B fireresistive doors in Appendix F-402.13 and F-402.14.

F-402.16 Fireresistive windows:

F-402.16.1 General: Windows which are required to be fire windows, fireresistive windows, or of fireresistive construction shall conform to the requirements of Appendix F-402.16.

F-402.16.2 Moveable: Firereisistive windows may be fixed or arranged to open and close. Fixed fireresistive windows shall be so secured in the walls in which they are placed that they may expand in case of fire without buckling. Moveable firereisitive windows shall be opened or closed in one of the following manners:

1. One or more sashes may slide horizontally in a fireresistive frame.
2. One or more sashes may slide vertically with counterweights or with tow sashes counterbalanced and hung on chains. If a sash is closed in raised position, it shall have a fastening.
3. A sash may be hinged at top, bottom, or either side.
4. A sash may be pivoted at top and bottom or at the sides.
5. A sash may be arranged to open and close in any other approved manner, with approved hardware.

F-402.16.3 Sash: Moveable sashes in fireresistive windows shall be furred to fireresistive frames of the same or similar construction. Both sashes and frames, and metal mullions between window units, shall be so fitted in the walls in which they are placed as to be continuous with the fireresistive material of the wall and so secured that they may expand in case of fire without buckling.

F-402.16.4 Glass: Glass in firereisistive windows shall be wired glass not less than ¼ inch thick and the area of a single light shall not exceed 720 square inches. Glass shall be set ⅜ inch grooves at least ½ inch deep. Glass shall be secured by glazing angles or molding screwed to the sash and forming continuous grooves for the glass.

F-402.16.5 Construction: Fireresistive windows shall be of the following construction:

1. Hollow sheet metal sashes and frames fabricated by pressing, welding, riveting or crimping without the use of solder or other fusible alloy, except for filling joints, and bearing the label of Underwriters' Laboratories.
2. Rolled steel or pressed steel sashes fabricated by pressing, welding, riveting or crimping, of a make and style approved by the commissioner.
3. Any other approved constructions as fireresistive as that specified in Appendix F-402.16.5 item.

F-402.16.6 Hollow sheet metal: Fired fireresistive windows of hollow sheet metal construction shall not exceed seven feet in width not ten feet in height. Fireresistive windows of hollow sheet metal construction with moveable sashes shall not exceed six feet in width nor ten feet in height.

F-402.16.7 Rolled steel: Fireresistive windows of rolled steel construction shall not exceed 84 square feet in area not 12 feet in either height or width.

F-402.16.8 Wind pressure: Fireresistive windows and their fastenings shall be capable of resisting the wind pressure on the wall of the building applied either on he inside or the outside of the window exceeding allowable stresses.

F-402.16.9 Substitution: Where fireresistive windows are required, wooden windows and plain glass may be substituted provided the openings are protection by fireresistive doors or shutters, or, in buildings of approved occupancy and construction, by an approved system of open sprinklers.

F-402.17 Fireresistive roof covering:

F-402.17.1 Classification: Roof covering allowed under this code shall be classified as fire-retardant or ordinary, according to resistance to fire outside, as provided in Appendix F-402.17. Fire-retardant roof covering is the more firereisistive and may be used where fire-retardant roofing is specified. Roof covering less fireresistive than ordinary roof covering shall not be used on any building.

F-402.17.2 Fire-retardant roofing: Fire-retardant roofing shall be any roof covering than meets the requirements of Class A or Class B roofing under the specifications of the Underwriters' Laboratories, Inc. The following roof covering shall be assumed to meet the requirements for fire-retardant roofing:

1. Built-up roofing consisting of successive layers of roofing felt impregnated with asphalt; a final layer of asphalt in which, while molten, is embedded a continuous layer of roofing gravel or slag.
2. Built-up roofing consisting of successive layers of roofing felt impregnated with coal tar; a final layer of tar in which, while molten, is embedded a continuous layer of roofing gravel or slag.
3. Built-up roofing consisting of successive layers of roofing felt impregnated with asphalt; a final layer of asbestos roofing felt impregnated with asphalt weighing not less than 14 pounds per 100 square feet, or a final layer of asphalt-saturated prepared roofing coated with granulated slate or other similar material.
4. Built-up roofing consisting of successive layers of roofing felt impregnated with tar or asphalt and a finish of burned clay floor tile, stone flagging, cement concrete or other similar material.
5. Sheet metal with locked and soldered joints not less than No. 26 gauge in thickness.
6. Shingles of natural slate.
7. Shingles of burned clay tile.
8. Shingles of sheet metal not less than No. 26 gauge in thickness.
9. Shingles of asbestos board not less than ⅛ inch thick.
10. Shingles of asphalt saturated felt surfaced with granulated slate or other similar material and carrying the Underwriters Class "C" label.
11. Corrugated sheet metal with lapped joints not less than No. 26 gauge in thickness.
12. Corrugated asbestos board not less than $^{3}/_{16}$) inch thick.

F-402.17.3 Ordinary roofing: Ordinary roofing shall be of any roof covering which meets the requirements of Class C roofing under the specifications of the Underwriters' Laboratories, Inc. The following roof covering shall be assumed to meet the requirements for ordinary roofing:

1. Built-up roofing consisting of successive layers of roofing felt impregnated with asphalt, coal tar or other approved material, not equal in fireresistance to a fire-retardant roofing.
2. Prepared roofing consisting of felt or fabric impregnated or coated, or both, with asphalt, tar or other approved material or shingles of such prepared roofing, not equal in fireresistance to fire-retardant roofing.
3. Canvas stretched tightly and coated with paint.

F-402.17.4 Means of securing: Built up roofing shall be secured to the roof deck in the following manner:

1. Over masonry slab, the first layer shall be laid in molted asphalt or tar mopped on the roof deck, after the deck is properly primed, or by nailing a layer of building paper to nailing inserts other than wood placed in the deck.
2. Over wood decks, the built-up roofing shall be secured by nailing a layer of building paper to the roof deck over which the prepared roofing is to be laid with the first layer laid in molten asphalt or tar.
3. Roofings other than built-up roofings, such as shingles, slates, and tile roll roofing shall be well secured to the deck by nailing, bolting, wiring, or other approved methods.

APPENDIX G

UNIT DEAD LOADS FOR DESIGN PURPOSES

The intent of 780 CMR Appendix G is to assist the designer and building official in establishing the minimum weights for materials commonly used in building construction. Some material assemblies have a range in weight. A typical figure is indicated, but when there is reason to suspect a considerable deviation, the actual weight should be determined.

Note on use of 780 CMR Appendix G tables: When making calculations based on the tables in 780 CMR Appendix G, the weights of masonry include mortar but not plaster. For plaster, add 5 psf for each face plastered. Values given represent averages. In some cases there is a considerable range of weight for the same construction. For metric conversion, 1 psf equals 4.882 kg/m^3.

Table G-1
UNIT DESIGN DEAD LOADS FOR CONCRETE SLABS

Concrete slabs	Pounds per square foot
Concrete, reinforced stone, per inch of thickness	12½
Concrete, reinforced lightweight sand, per inch of thickness	9½
Concrete, reinforced, lightweight, per inch of thickness	9
Concrete, plain stone, per inch of thickness	12
Concrete, plain, lightweight, per inch of thickness	8½

Table G-2
UNIT DESIGN DEAD LOADS FOR RIBBED SLABS

	Pounds per square foot					
Ribbed slabs Depth in inches (rib depth plus slab thickness)*	Width of rib, in inches					
	4	5	6	7	8	9
12-inch clay tile fillers (normal weight concrete)						
4 plus 2	49	51	52	54	-	-
6 plus 2	60	63	65	67	-	-
8 plus 2½	79	82	85	87	-	-
10 plus 3	96	100	103	106	-	-
12 plus 3	108	112	116	120	-	-
20-inch wide forms:						
6 plus 2½	45	48	50	50	-	-
8 plus 2½	51	54	57	60	-	-
10 plus 2½	57	60	64	68	-	-
12 plus 2½	63	67	72	76	-	-
14 plus 2½	-	74	79	84	-	-
16 plus 2½	-	-	88	93	98	-
20 plus 2½	-	-	-	111	118	-

* Make appropriate allowances for tapered ends.

Table G-2 (continued)
UNIT DESIGN DEAD LOADS FOR RIBBED SLABS

Ribbed slabs Depth,, in inches (rib depth plus slab thickness)*	Pounds Per square foot Width of rib, in inches					
	4	5	6	7	8	9
30-inch wide forms:						
6 plus 2½	41	43	45	47	-	-
8 plus 2½	45	47	50	53	-	-
10 plus 2½	49	52	55	58	-	-
12 plus 2½	53	57	60	64	-	-
14 plus 2½	-	62	66	70	-	-
16 plus 2½	-	-	72	76	80	-
20 plus 2½	-	-	-	90	95	101
Two-way clay tile fillers (12x12):						
4 plus 2	61	62	64	-	-	-
6 plus 2	87	89	90	-	-	-
8 plus 2½	100	103	107	-	-	-
10 plus 3	121	126	131	-	-	-
12 plus 3	136	141	146	-	-	-

Table G-3
UNIT DESIGN DEAD LOADS FOR WAFFLE SLABS

Waffle slabs Depth, in inches (Rib depth plus slab thickness)	Pounds per square foot
19x19, 5 @ 24	
6 plus 2½	66
8 plus 2½	78
10 plus 2½	84
12 plus 2½	101
30x30, 6 @ 36	
8 plus 3	73
10 plus 3	83
12 plus 3	95
14 plus 3	106
16 plus 3	114
20 plus 3	135

Table G-4
UNIT DESIGN DEAD LOADS FOR FLOOR FINISH

Floor finish	Pounds per square foot
Double ⅞-inch wood on sleepers, light concrete fill	19
Double ⅞-inch wood on sleepers, stone concrete fill	28
Single ⅞-inch wood on sleepers, light concrete fill	16
Single ⅞-inch wood on sleepers, light concrete fill	25
3-inch wood block on mastic, no fill	10
1-inch cement finish on stone concrete fill	32
1-inch terrazzo on stone concrete fill	32
Marble and mortar on stone concrete fill	33
Linoleum on stone concrete fill	32
Linoleum on light concrete fill	22
1½-inch asphalt mastic flooring	18
3-inch wood block on ½-inch mortar base	16
Solid flat tile on 1-inch mortar base	23
2-inch asphalt block, ½- mortar	30
1-inch terrazzo, 2-inch stone concrete	32
Floor finish tile per inch depth	12
Cement finish per inch depth	12
Gypsum slabs per inch depth	4
Precast concrete plank per inch	(as determined by test)
Hardwood flooring per inch depth	4
Underflooring per inch depth	3
Linoleum	2
Asphalt tile	2
Brick pavers per inch thickness	10

Table G-5
UNIT DESIGN DEAD LOADS FOR WATERPROOFING

Waterproofing	Pounds per square foot
Five-ply membrane	5

Table G-6
UNIT DESIGN DEAD LOADS FOR FLOOR FILL

Floor Fill	Pounds per square foot
Cinder fill, per inch	5
Cinder concrete per inch	9
Lightweight concrete, per inch	7
Sand, per inch	8
Stone, concrete, per inch	12

Table G-7
UNIT DESIGN DEAD LOADS FOR WOOD JOIST FLOORS

Wood joist floors (no plaster) - double wood floor joist sizes in inches	Pounds per square foot	
	12-inch spacing	16-inch spacing
2 x 6	6	5
2 x 8	6	6
2 x 10	7	6
2 x 12	8	7
3 x 6	7	6
3 x 8	8	7
3 x 10	9	8
3 x 12	11	9
3 x 14	12	10

Table G-8
UNIT DESIGN DEAD LOADS FOR MATERIALS

Materials	Pounds per cubic foot
Cast stone masonry (cement, stone, sand)	144
Cinder fill	57
Concrete, plain:	
Cinder	108
Expanded slag aggregate	100
Haydite (burned clay aggregate)	90
Slag	132
Stone (including gravel)	144
Vermiculite and perlite aggregate, nonloadbearing	25-50
Other light aggregate, loadbearing	70-105
Concrete, reinforced:	
Cinder	111
Slag	138
Stone (including gravel)	150
Earth (dry)	96
Earth (damp)	108
Earth (wet)	120
Cork	15
Masonry, ashler:	
Granite	168
Limestone, crystalline	168
Limestone, oolitic	135
Marble	173
Sandstone	144
Masonry, rubble mortar:	
Granite	153
Limestone, crystalline	147
Limestone, oolitic	138
Marble	156
Sandstone	137
Rubble stone masonry	156
Terra cotta, architectural:	
Voids filled	120
Voids unfilled	72
Timber, seasoned:	
Ash, commercial white	41
Cypress, southern	32
Fir, Douglas, Coast region	34
Oak, commercial reds and whites	45
Redwood	28
Spruce, red, white, and Sitka	28
Southern pine, short leaf	39
Southern pine, long leaf	48
Timber, hemlock	30

Table G-9
UNIT DESIGN DEAD LOADS FOR ROOF AND WALL COVERINGS

Roof and wall coverings	Pounds per square foot
Asphalt shingles	2
Cement asbestos shingles	4
Cement tile	16
Clay tile (for mortar add 10 lb):	
2-inch book tile	12
3-inch book tile	20
Roman	12
Ludowici	19
Composition:	10
Three-ply ready roofing	
Four-ply felt and gravel	1
Five-ply felt and gravel	5½
Copper or tin	6
Corrugated asbestos cement roofing	1
Fiber board, ½ inch	1-3
Formed sheet steel	(see manufacturer)
Formed steel decking	2
Gypsum sheathing, ½ inch	¾
Rigid insulation, ½ inch	3
Sheet lead	8
Skylight, metal frame, ⅜-inch wired glass	7
Slate 3/16-inch	10
Slate ¼ inch	20
Spanish tile	3
Wood sheathing, per inch thickness	3
Wood shingles	

Table G-10
UNIT DESIGN DEAD LOADS FOR SUSPENDED CEILINGS

Suspended ceilings	Pounds per square foot
Cement on wood lath	12
Cement on metal lath	15
Gypsum on wood or metal lath	10
Plaster on tile or concrete	5
Suspended metal lath and gypsum plaster	10
Suspended metal lath and cement plaster	15
Plaster on wood lath	8

Table G-11
UNIT DESIGN DEAD LOADS FOR UNPLASTERED WALLS AND PARTITIONS

Walls and partitions (unplastered)	Pounds per square foot
4 -inch clay brick, high absorption	34
4 -inch clay brick, medium absorption	39
4 -inch clay brick, low absorption	46
4 -inch sand/lime brick	38
4 -inch concrete brick, heavy aggregate	46
4 -inch concrete, light aggregate	33
8 -inch clay brick, high absorption	69
8 -inch clay brick, medium absorption	79
8 -inch clay brick, low absorption	89
8 -inch sand/lime brick	74
8 -inch concrete brick, heavy aggregate	89
8 -inch concrete brick, light aggregate	68
12 -inch common brick	120
12 -inch pressed brick	130
12 -inch sand/lime brick	105
12½ - inch concrete brick, heavy aggregate	130
12½ - inch concrete brick, light aggregate	98
17 -inch clay brick, high absorption	134
17 -inch clay brick, medium absorption	155
17 -inch clay brick, low absorption	173
17 -inch sand/lime brick	138
17 -inch concrete brick, heavy aggregate	174
17 -inch concrete brick, light aggregate	130
22 -inch clay brick, high absorption	168
22 -inch clay brick, medium absorption	194
22 -inch clay brick, low absorption	216
22 -inch sand/lime brick	173
22 -inch concrete brick, heavy aggregate	216
22 -inch concrete brick, light aggregate	160
4 -inch brick, 4 inch load bearing structural clay - tile backing	60
4 -inch brick, 8 inch loadbearing structural clay - tile backing	75
8 -inch brick, 4 inch loadbearing structural clay - tile backing	102
8 -inch combination brick and concrete block	72
12 -inch combination brick and concrete block	90
8 -inch loadbearing structural clay tile	42
12 -inch loadbearing structural clay tile	58
8 -inch concrete block, heavy aggregate	55
12 -inch concrete block, heavy aggregate	85
8 -inch concrete block, light aggregate	38
12 -inch concrete block, light aggregate	55
2 -inch furring tile, one side of masonry wall, - add to above figures	12
4 -inch hollow concrete block - stone aggregate	30
-lightweight	20
6 -inch hollow concrete block - stone aggregate	42
-lightweight	30
8 -inch hollow concrete block	55
-lightweight	38
10 -inch hollow concrete block - stone aggregate	62
-lightweight	46
12 -inch hollow concrete block - stone aggregate	85
-lightweight	55
4 -inch solid concrete block - stone aggregate	45
-lightweight	34
6 -solid concrete block - stone aggregate	50
-lightweight	37

Table G-11 (continued)
UNIT DESIGN DEAD LOADS FOR UNPLASTERED WALLS AND PARTITIONS

Walls and partitions (unplastered)	Pounds per square foot
8 -inch solid concrete block - stone aggregate	67
-lightweight	48
10 -inch solid concrete block - stone aggregate	84
-lightweight	52
12 -inch concrete block - stone aggregate	108
-lightweight	72
4 -inch loadbearing clay tile	24
6 -inch loadbearing clay tile	36
2 -inch nonloadbearing clay tile	11
3 -inch nonloadbearing clay tile	18
4 -inch nonloadbearing clay tile	20
6 -inch nonloadbearing clay tile	30
8 -inch nonloadbearing clay tile	36
10 -inch nonloadbearing clay tile	40
4 -inch nonloadbearing hollow concrete block	20
6 -inch nonloadbearing hollow concrete block	30
8 -inch nonloadbearing hollow concrete block	40
T.C. 1½-inch split terra cotta furring	8
2 -inch split terra cotta furring	10
3 -inch split terra cotta furring	12
2 -inch hollow gypsum block	9.5
3 -inch hollow gypsum block	10
4 -inch hollow gypsum block	15
5 -inch hollow gypsum block	18
6 -inch hollow gypsum block	24
2 -inch solid gypsum block	12
3 -inch solid gypsum block	18
4 -inch solid gypsum block	24
2 -inch facing tile	15
4 -inch facing tile	25
6 -inch facing tile	38
2 -inch solid plaster	20
4 -inch solid plaster	32
4 -inch hollow plaster	22
Wood studs 2x4, unplastered	4
Wood studs 2x4, plastered one side	12
Wood studs 2x4, plastered two sides	20
4 -inch glass block	18

Table G-12
UNIT DESIGN DEAD LOADS FOR LATH AND PLASTER PARTITIONS

Lath and plaster partitions	Pounds per square foot
2 -inch solid cement on metal lath	25
2 -inch solid gypsum on metal lath	18
2 -inch solid gypsum on gypsum lath	18
2 -inch metal studs, gypsum and metal lath both sides	18
3 -inch metal studs, gypsum and metal lath both sides	19
4 -inch metal studs, gypsum and metal lath both sides	20
6 -inch wood studs, plaster and wood lath both sides	18
6 -inch wood studs, plaster and metal lath both sides	18
6 -inch wood studs, plaster and plaster boards both sides	18
6 -inch wood studs, unplastered gypsum board both sides (dry wall)	10

Table G-13
UNIT DESIGN DEAD LOADS FOR PLASTER WORK

Plaster Work	Pounds per square foot
Gypsum (one side)	5
Cement (one side)	10
Gypsum on wood lath	8
Gypsum on metal lath	8
Gypsum on plaster board or fiber board	8
Cement on wood lath	10
Cement on metal lath	10

APPENDIX H

HISTORIC STRUCTURES

Historic structures eligible for individual listing in the National Register of Historic Places, qualifying as totally preserved buildings (see 780 CMR 3409.0).

Acton	Faulkner Homestead, High Street
Agawam	Capt. Charles Leonard House, Main Street
Amesbury	Rocky Hill Meetinghouse, Portsmouth Road
Arlington	Fowle-Reed-Wyman House, 64 Old Mystic Street Jason Russell, 7 Jason Street Old Schwamb Mill, 17 Mill Lane
Barre	Barre Historical Society, Common Street
Barnstable	Barnstable Custom House, Route 6A
Bedford	Job Lane House, 295 North Road
Beverly	John Balch House, 448 Cabot Street Capt. John Cabot House, 117 Cabot Street Rev. John Hale House, 39 Hale Street
Boston	Gleason House, Beacon Street James Blake House, E. Cottage Street (Dor.) Clapp Houses, 105 Boston Street (Dor.) Loring-Greenough House, 12 South Street (JP) Old State House, 15 State Street Pierce House, 24 Oakten Avenue (Dor.) South End Historical Soc., 532 Mass. Avenue Isabella Stewart Gardner Museum, 280 The Fenway
Boxford	Holyoke-French House, Elm Street Sylvanius-Thayer Birthplace, 786 Washington St
Brookline	Edward Devotion House, 347 Harvard Street
Burlington	Francis Wyman House, Francis Wyman Road
Cambridge	Cooper-Frost-Austin House, 21 Linnaean St.
Charlton	Ryder Tavern, Stafford Street
Chelmsford	Old Chelmsford Garrison House, 105 Garrison Road
Chelsea	Gov. Bellingham-Cary House, 34 Parker Street
Cohasset	Caleb Lothrop House, 14 Summer Street
Cummington	William Cullen Bryant Homestead, Bryant Road
Danvers	Fowler House, 166 High Street Rebecca Nurse House Glen Magna House
Dennis	Josiah Dennis Manse, Nobscuset Road West Schoolhouse

Duxbury	Gershom Bradford House, 931 Tremont Street King Caesar House, King Caesar Road Nathaniel Winsor House, 479 Washington Street
Gloucester	Beauport, Eastern Pt. Blvd. Hammond Castle, 80 Hesperus Avenue
Hadley	Hadley Farm Museum, Russell Street Porter Phelps Huntinghouse, 130 River Drive
Haverhill	The Whittier House, 305 Whittier Road
Holyoke	Wisteriahurst, 238 Cabot Street
Ipswich	Castle Hill, Argilla Road
Lee	Merrell Tavern, Route 102
Lenox	Ventfort Hall, 104 Walker Street
Lexington	Buckman Tavern, 1 Bedford Street Sanderson House, 314 Massachusetts Ave. Monroe Tavern, 1332 Massachusetts Ave.
Lincoln	The Grange, Codman Road
Lowell	Whistler House, Worthen Street
Lynnfield	Meetinghouse
Medford	Peak House, 347 Main Street
Milton	Dr. Amos Holbrook House, 203 Adams Street Daniel Vose House, 1370 Canton Avenue
Nantucket	Whaling Museum, Broad Street Fire Hose Cart House, 8 Gardner Street Greater Light, 8 Howard Court Old Gaol, 15 Vestal Street 1800 House, 4 Mill Street Old Mill, 50 Prospect Street Hawden House, 96 Main Street Nathaniel Macy House, 12 Liberty Street Thomas Macy Warehouse, 10 Straight Wharf Fair Street Museum, 7 Fair Street Quaker Meeting House, 7 Fair Street
New Bedford	Benjamin Rodman House, 50 North Second Street
New Salem	Whitaker-Clary House, Elm Street
Newbury	Tristram Coffin House, 16 High Road Spencer-Pierce-Little House, Little Lane
Newton	Jackson Homestead, 527 Washington Street
No. Andover	Parson Barnard House, Osgood Street
No. Easton	Old Colony Railroad Station, Oliver Street
Norwood	Fred Holland Day, 93 Bay Street
Orleans	French Cable Station, Cove Road

Oxford	Clara Barton Homestead, Clara Barton Road
Peabody	Gen. Gideon Foster House, 35 Washington Street
Pittsfield	Herman melville House, 78 Holmes Road
Plymouth	Plymouth Antiquarian Society, 126 Water Street Harlow Old Ft. House, 19 Sandwich Street Pilgrim Hall, 75 Court Street Richard Sparrow House, 42 Summer Street
Quincy	Adams Academy, 8 Adams Quincy Homestead, 34 Butler Street Josiah Quincy House, 20 Muirhead Street
Randolph	Johnathan Belcher House, 360 N. Main
Reading	Parker Tavern, 103 Washington Street
Rockport	Old Castle, Castle Lane
Salem	House of 7 Gables, 46-54 Turner Street Essex Institute, Essex Street The Norbone House Witch Museum Crowningshield Bently, Essex Street Gardner-Pingree House, 128 Essex Street Gedney House, 21 High Street Cox House, 19 High Street
Sandwich	Hoxie House, 18 Water Street Eldred House, 4 Water Street Wing Fort House, Spring Hill Road
Sheffield	Col. John Ashley House, Cooper Hill Road
Shrewsbury	Gen. Artemas Ward Homestead, Main Street
Springfield	Alexander House, State Street George Walter Vincent Smith Art Museum
Stockbridge	Naumkeag, Prospect Hill
Swansea	The Luther Store, 160 Old Warren Road The Martin House, 22 Stoney Hill Road
Taunton	Old Colony Historical Society, 66 Church Green Parson Capen House
Waltham	Robert Treat Paine House, 577 Beaver Street
Watertown	Edmund Fowle House, 26 Marshall Street
Wenham	Claflin-Richard House, 132 Main
West Springfield	Josiah Day House, 70 Park Street
Weston	Gold Ball Tavern, Old Post Road
Woburn	Loammi Baldwin Mansion, 2 Alfred Street
Wilmington	Harden Tavern, 436 Salem Street

Worcester Timothy Paine House, 140 Lincoln Street

National Historic Landmarks

Amesbury	John Greenleaf Whittier Home, 86 Friend Street
Boston	African Meeting House, 8 Smith Court Nichols House, 55 Mt. Vernon Street Brook Farm, 678 Baker Street (Rox.) Christ Church, 191 Salem Street Faneuil Hall, Dock Square 1st Harrison Gray Otis House, 141 Beacon Street Paul Revere House, 19 North Street
Concord	Ralph Waldo Emerson House, 28 Cambridge Tpk. The Old Manse Orchard House, 299 Lexington Road
Dedham	Fairbanks House
Deerfield	Old Deerfield Village Historic District
Hancock	Hancock Shaker Village
Harvard	Fruitlands, Prospect Street
Hingham	Old Ship Meetinghouse, Main Street
Ipswich	John Whipple House, 53 S. Main Street
Lexington	Hancock Clarke House, 35 Hancock Street
Marblehead	Jeremiah Lee House, Washington Street King Hooper Mansion, Hooper Street
Marshfield	Daniel Webster Law Office, Webster Street
Medford	Peter Tufts House, 350 Riverside Drive Isaac Royal House, 15 George Street
Milton	Capt. R. B. Forbes House, 215 Adams
Nantucket	Nantucket Historic District Jethro Coffin House, Sunset Hill
New Bedford	New Bedford Historic District
Newburyport	Caleb Cushing House, 98 High Street
Quincy	John Adams Birthplace, 133 Franklin Street John Quincy Adams Birthplace, 141 Franklin Street
Salem	Peabody Museum The Custom House, 178 Derby Street
Saugus	Scotch Boardman House, 117 Howard Street
Stockbridge	Chesterwood, Williamsville Road The Mission House, Main Street
Waltham	The Vale, Lyman Street

	Gore Place, 52 Gore Street
Woburn	Count Rumford Birthplace, 90 Elm Street
Worcester	American Antiquarian Society, 185 Salisbury Street

Historic structures determined eligible for listing in the National Register of Historic Places not qualifying as totally preserved buildings (see Partially preserved buildings, 780 CMR 3409.0). Refer to:

1. National Register of Historic Places,
   U.S. Federal Register, February 1, 1978, Part II.
2. National Register of Historic Place (additions). Contact the Massachusetts Historical Commission at the Massachusetts Archives Building, 220 Morrissey Boulevard, Boston, MA 02125.

Historic districts listed in the National Register of Historic Places. Refer to:

1. National Register of Historic Places, U.S. Federal Register, February 1, 1979, Part II.
2. National Register of Historic Place (additions). Contact the Massachusetts Historical Commission at the Massachusetts Archives Building, 220 Morrissey Boulevard, Boston, MA 02125.

Structures proposed for certification as partially preserved not listed in the national register of historic places. Refer to Massachusetts Historical Commission Inventory Forms.

Contact the Massachusetts Historical Commission at the Massachusetts Archives Building, 220 Morrissey Boulevard, Boston, MA 02125.

NON-TEXT PAGE

APPENDIX I

INDEPENDENT STRUCTURAL ENGINEER REVIEW

I-1 Primary structure: For the purposes of the independent structural engineering review, the primary structure shall be defined as the structural frame, the load supporting parts of floors, roofs, and walls, and the foundations. Cladding, cladding framing, stairs, equipment supports, ceiling supports, non-load bearing partitions, and railings are excluded from this definition of primary structure.

I-2 Reviewing engineer: The reviewing engineer shall be engaged by the owner.

I-2.1 Qualifications: The reviewing engineer shall be a registered professional engineer, registered in Massachusetts, qualified by experience and training and who shall have had structural design experience with buildings or structures similar to that covered by the application for the building permit. The reviewing engineer shall be impartial, and shall be independent of the architect of record, structural engineer of record, and contractors and suppliers who will be involved in the construction of the structure.

I-3 Criteria for review: The reviewing engineer shall review the plans and specifications submitted with the application for the building permit for compliance with the structural and foundation design provisions of the Code. The reviewing engineer shall perform the following tasks:

1. Check to assure that the design loads conform with 780 CMR;
2. Check that other design criteria, and design assumptions, conform to 780 CMR and are in accordance with accepted engineering practice;
3. Review geotechnical and other engineering investigations that are related to the structural design to determine if the design properly incorporates the results and recommendations of the investigations;
4. Check that the organization of the structure is conceptually correct ; and
5. Make independent calculations for a representative fraction of systems, members, and details to check their adequacy. The number of representative systems, members, and details shall be sufficient to form a basis for the reviewer's conclusions.

I-3.1 Structural Calculations: The structural calculations prepared by the structural engineer of record shall be submitted to the reviewing engineer, upon the reviewing engineer's request, for his or her reference only. The reviewing engineer shall not be obligated to review or check these calculations. If the design criteria and design assumptions are not shown on the drawings or in the computations, the structural engineer of record shall provide a statement of these criteria and assumptions for the review.

I-4 Structural engineer of record: The structural engineer of record shall retain sole responsibility for the structural design, and the activities and reports of the reviewing engineer shall not relieve the structural engineer of record of this responsibility.

I-5 Report and follow-up:

1. The reviewing engineer shall prepare a report to the building official stating whether or not the structural design shown on the drawings and the specifications conform with the structural and foundation requirements of 780 CMR. Said report shall be based on the review as prescribed in this appendix and shall include a summary of all deficiencies, if any, which cannot be resolved with the structural engineer of record.
2. The structural engineer of record shall review the report of the reviewing engineer, and notify the building official in writing, whether or not he agrees with or disputes the conclusions and recommendations of the reviewing engineer.
3. Unresolved disputes between the structural engineer of record and the reviewing engineer shall be submitted by the building official, the owner, the structural engineer of record or the reviewing engineer to the Structural Peer Review Advisory Board for resolution.
4. Any changes to the structural design subsequent to the original submission of the plans and specifications shall be shown on revised drawings and specifications, submitted with an amendment to the application for permit. The reviewing engineer shall review the changes on the revised drawings and specifications, and, if the original report does not account for the changes in said drawings and specifications, a supplementary report relating to the changes and prepared by the reviewing engineer shall be made to the building official.

I-6 Foundation permits: When the plans and specifications are partially complete and an application is made for a foundation permit, the reviewing engineer may review the foundation plans and specifications on a conditional basis, provided that the reviewing engineer is given sufficient documentation so that he can perform Appendix I-3 Tasks 1, 2, 3, and 4 for the whole structure, and so that he can perform Appendix I-3 Task 5 for that

part of the foundation covered by the application for foundation permit. The reviewing engineer shall prepare a report on that part of the foundation covered by the application for foundation permit, as prescribed in Appendix I-5, stating all conditions upon which the report is based. When the reviewing engineer reviews the completed plans and specifications as prescribed in Appendix I-3, the reviewing engineer shall reperform Tasks 1, 2, 3, and 4, as necessary, to include all the revisions to the design subsequent to the application for the foundation permit.

APPENDIX J

ENERGY CONSERVATION FOR NEW CONSTRUCTION LOW-RISE RESIDENTIAL BUILDINGS

(780 CMR Appendix J is based upon the Council of American Building Officials Model Energy Code 1995 Edition.)

780 CMR J1.0 ADMINISTRATION AND ENFORCEMENT

J1.1 Scope and General Requirements:

J1.1.1 Title: Appendix J reflects the technical requirements of the Model Energy Code 1995 Edition, but also contains material which reflects the unique requirements of Massachusetts.

J1.1.2 Scope: 780 CMR Appendix J sets forth minimum requirements for the design and construction of new residential occupancy buildings and additions to existing residential occupancy buildings three stories or less in height by regulating the design and construction of building envelopes for adequate thermal resistance and low air leakage, and by the design, selection, and installation of mechanical, electrical, and service water heating systems and equipment to enable efficient use of energy. It is intended that these provisions provide flexibility to permit the use of innovative approaches and techniques to achieve effective utilization of energy. 780 CMR Appendix J is not intended to abridge safety, health, or environmental requirements under other applicable code sections or ordinances.

Note: For alterations to existing buildings, see 780 CMR J1.1.2.3 and Chapter 34.

J1.1.2.1 Building Types:

J1.1.2.1.1 Group R residential buildings: New construction buildings, or new portions thereof, that must comply with the requirements of Appendix J are:

1. Detached one- and two-family dwellings (Use Groups R-4 or R-5 in 780 CMR 310); and,
2. All other residential buildings, three stories or less in height (Use Groups R-2, R-3, or R-5 in 780 CMR 310). Note that Use Group R-1 buildings are to be treated as *commercial buildings*.

J1.1.2.1.2 Other Buildings: New construction buildings and structures not included in 780 CMR J1.1.2.1.1. shall be classified as Commercial/High-Rise Buildings and shall be designed and constructed to comply with the requirements of 780 CMR 13.

J1.1.2.2 Exempt buildings: The following buildings or structures shall be exempt from the requirements of 780 CMR Appendix J:

1. Buildings and structures or portions thereof whose peak design rate of energy usage is less than 3.4 Btu/h per square foot (10.7 W/m^2) or 1.0 watt per square foot (10.7 W/m^2) of floor area for all purposes;
2. Greenhouses that are free-standing, or attached to a building and separated by a wall having the same thermal value as an exterior wall, and provided with a separate temperature control system;
3. Buildings with less than 100 square feet of gross floor area, and;
4. Buildings and structures or portions thereof which are neither heated nor cooled.

J1.1.2.3 Application to existing buildings:

J1.1.2.3.1 Additions to existing buildings: Additions to existing buildings or structures shall comply with one of the applicable criteria below:

1. The new addition, by itself, shall conform to the applicable provisions of Appendix J, **or;**
2. The new addition plus the existing building/dwelling unit may be considered together to ensure compliance with all applicable provisions of Appendix J, **or;**
3. Additions that are open to or separated by an exterior wall from the existing house/ dwelling unit shall meet the prescriptive envelope component criteria of Table J1.1.2.3.1. The total area (rough opening or unit dimensions) of glazed fenestration products (windows, skylights, and glazed portion of doors) shall not exceed 40% of the gross wall and gross ceiling area of the addition combined. If any individual fenestration component exceeds the maximum U-value listed in Table J1.1.2.3.1, then the area-weighted average U-value for all fenestration components must be less than or equal to the listed value. The R-value requirements for opaque thermal envelope

components indicate insulation products (cavity and/or insulating sheathing), and shall be equal to or exceed the applicable listed values found in Table J1.1.2.3.1. If such additions are separated from the main house by a wall and are conditioned, then a readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to the addition space. That portion of a wall that separates the addition from the existing building/dwelling unit, if an existing exterior wall, shall be allowed to remain and neither that portion of said wall or any fenestration within said portion of wall common to the addition need comply with the thermal envelope requirements of Appendix J.

TABLE J1.1.2.3.1
Prescriptive Envelope Component Criteria Additions to Existing Low-Rise Residential Buildings

MAXIMUM	MINIMUM				
Fenestration U-value	Ceiling R-Value	Wall R-Value	Floor R-Value	Basement Wall R-Value	Slab Perimeter R-Value and Depth
0.39	R-37[1]	R-13	R-19	R-10	R-10, 4 ft

[1] R-30 ceiling insulation may be used in place of R-37 if the insulation achieves the full R-value over the entire ceiling area (i.e. - not compressed over exterior walls, and including any access openings.)

Exception: *Sunroom* Additions / Consumer Notification: *Sunrooms*, as defined in 780 CMR Appendix J2.0 DEFINITIONS, shall be exempt from the compliance requirements set forth in 780 CMR J1.1.2.3.1 and J1.1.3 provided that the actual property owner (not the owner's agent or representative) of the structure onto which the *sunroom* addition is being made, provides a signed copy of the Sunroom "CONSUMER INFORMATION FORM" (found in 780 CMR, Appendix B) to the Building Department. This signed "CONSUMER INFORMATION FORM" shall be submitted to the building official as a requirement of building permit issuance, and shall remain as part of the construction documents. If such *sunroom* additions are separated from the main house by a wall and are conditioned spaces, then a readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to the *sunroom* addition space. That portion of a wall that separates the *sunroom* addition from the existing building/dwelling unit, if an existing exterior wall, shall be allowed to remain and neither that portion of said wall or any fenestration within said portion and common to the *sunroom* addition, need comply with the thermal envelope requirements of Appendix J.

J1.1.2.3.2 Historic buildings: Historic buildings, as defined in 780 CMR 3409, are exempt from Appendix J.

J1.1.2.3.3 Change of occupancy: A change in the occupancy or change in use of an existing building or structure shall be permitted, subject to the provisions of 780 CMR 3407.

J1.1.2.4 Mixed occupancy: When a building houses more than one occupancy, each portion of the building shall conform to the requirements for the occupancy housed therein. Where minor accessory uses do not occupy more than 10% of the area of any floor of a building, the major use shall be considered the building occupancy.

J1.1.3 Compliance: Compliance with Appendix J shall be determined by one of the following alternatives:

1. 780 CMR J5.0, Residential Building Design by Prescriptive Practice (or Default Package Approach) in which the U and R values are given for the thermal envelope. Additional requirements are stated in 780 CMR J4.0, or;
2. 780 CMR J6.0, Residential Building Design by Component Performance (or Manual Trade-off Approach) which allows trade-offs between building envelope components and heating and cooling equipment efficiencies to minimize cost. Additional requirements are stated in 780 CMR J4.0, or;
3. 780 CMR J7.0, Residential Building Design by MAS*check* Software which achieves similar results as the Manual Trade-off Approach. Additional requirements are stated in 780 CMR J4.0, or;
4. 780 CMR J8.0, the Systems Approach or Total Energy Analysis for the entire building and its energy using sub-systems, or;
5. 780 CMR J9.0, Buildings Utilizing Renewable Energy Resources.
6. 780 CMR J11.0, a Home Energy Rating issued for the home with a score of 83.0 or more points

J1.2 Construction Documents:

J1.2.1 General: Construction documents including necessary computations shall be submitted to the building official as part of the building permit application process. Such construction documents shall indicate conformance with 780 CMR J1.2 and other applicable sections of 780 CMR, and in accordance with 780 CMR 110.

J1.2.2 Details: The construction documents shall show in sufficient detail pertinent data and features of the building project and the equipment and systems as herein governed, including, but not limited to, design criteria, exterior envelope component materials, *U*-values of the envelope systems, *R*-values of insulating materials, size and type of apparatus and equipment, equipment and

systems controls, energy calculations if applicable, and other pertinent data to indicate conformance with the requirements of the Building Code.

When HVAC equipment sizing information is not available at the time of initial building permit application, such information shall be submitted prior to the installation of said equipment, and supporting calculations shall demonstrate compliance with 780 CMR J4.4. Installed equipment must meet or exceed the efficiency rating listed in the submitted construction documents.

J1.3 Inspections

J1.3.1 General: Construction or work for which a permit is required shall be subject to 780 CMR 111 and 115.

J1.4 Precedence: When provisions of 780 CMR Appendix J and a section of a referenced standard specify different materials, methods of construction, or other requirements, the explicit provisions of 780 CMR shall govern.

J1.5 Materials and Equipment

J1.5.1 Identification:

J1.5.1.1 General: Materials and equipment shall be identified in a manner that will allow a determination of their compliance with the applicable provisions of Appendix J.

J1.5.1.2 Building envelope insulation: A thermal resistance (*R*) identification mark shall be required on each piece of building envelope insulation 12 inches (305 mm) or greater in width.

Alternatively, the insulation installer shall provide a signed and dated certification for the insulation installed in each element of the building envelope, listing the type of insulation, the manufacturer and the *R*-value. For blown-in or sprayed insulation, the installer shall also provide the initial installed thickness, the settled thickness, the coverage area and number of bags installed. The installer shall post the certification in a conspicuous place on the job site.

J1.5.1.3 Insulation installation: Roof-ceiling, floor and wall cavity insulation shall be installed in accordance with manufacturer's instructions, and in a manner which will permit inspection of the manufacturer's *R*-value identification mark.

Alternatively, the thickness of roof-ceiling insulation that is either blown or sprayed shall be identified by thickness markers that are labeled in inches installed at least one for every 300 square feet (28 m^2) through the attic space. The markers shall be affixed to the trusses or joists, and marked with the minimum initial installed thickness and the minimum settled thickness with numbers at least 1.0 inch (25 mm) in height. Each marker shall face the attic access. The thickness of installed insulation shall meet or exceed the minimum initial installed thickness shown by the marker.

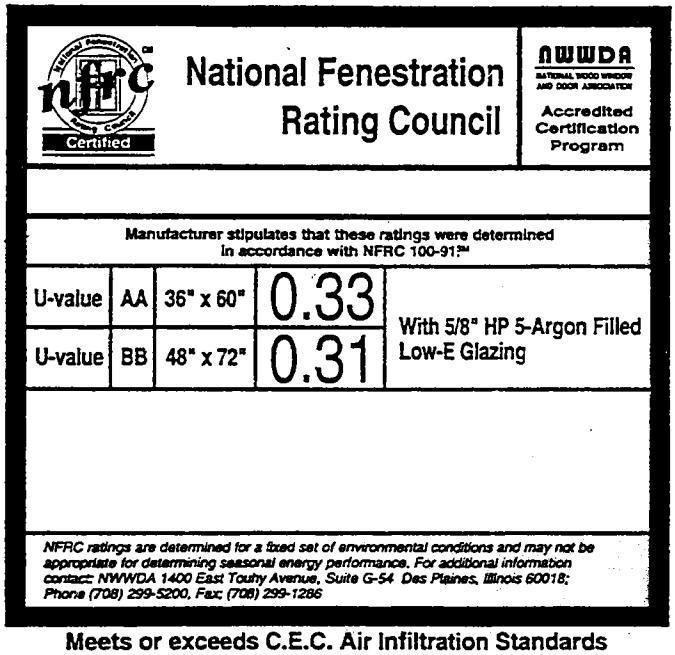
J1.5.2 Maintenance information: Required regular maintenance actions shall be clearly stated and incorporated on a readily accessible label on the equipment or made otherwise available for permanent reference. Such label may be limited to identifying, by title or publication number, the operation and maintenance manual for that particular model and type of product. Maintenance instructions shall be furnished for equipment which requires preventive maintenance for efficient operation.

J1.5.3 Fenestration product rating, certification and labeling: U-values of fenestration products (windows, doors and skylights) shall be determined in accordance with the NFRC 100, as listed in Appendix A, and labeled (see Figure J1.5.3 below) and certified by the manufacturer. Such certified and labeled values shall be accepted for purposes of determining compliance with the building envelope requirements of Appendix J.

Note 1: NFRC certification and labeling requirements take effect January 1, 1999. Prior to January 1, 1999, window, door, and skylight U-values may be assigned using manufacturers' calculations or the default values in Tables J1.5.3a and J1.5.3b.

Note 2: After January 1, 1999, when a manufacturer of windows, glazed and unglazed doors or skylights has not determined product U-value in accordance with J1.5.3for a particular product line, compliance with the building envelope requirements of Appendix J shall be determined only by assigning such products a default U-value in accordance with Tables J1.5.3a and J1.5.3b. Product features must be verifiable for the product to qualify for the default value associated with those features. Where the existence of a particular feature cannot be determined with reasonable certainty, the product shall not receive credit for that feature. Where a composite of materials from two different product types are used, the product shall be assigned the higher U-value.

FIGURE J1.5.3



Meets or exceeds C.E.C. Air Infiltration Standards

Table J1.5.3a
U-value Default Table for Windows, Glazed Doors, and Skylights

	Single Glazed	Double Glazed and Single Glazed with Storm
Metal Without Thermal Break		
Operable	1.30	0.87
Fixed	1.17	0.69
Door	1.26	0.80
Skylight	1.92	1.30
Metal with Thermal Break		
Operable	1.07	0.67
Fixed	1.11	0.63
Door	1.10	0.66
Skylight	1.93	1.13
Metal-Clad Wood		
Operable	0.98	0.60
Fixed	1.05	0.58
Door	0.99	0.57
Skylight	1.50	0.88
Wood/Vinyl		
Operable	0.94	0.56
Fixed	1.04	0.57
Door	0.98	0.56
Skylight	1.47	0.85

For SI: 1 inch = 25.4 mm.
Glass block assemblies shall have a U-value of 0.60.

Table J1.5.3b
U-value Default Table for Non-glazed Doors

	With Foam Core	Without Foam Core
Steel Doors (1-¾ Inches Thick)	0.35	0.60
	Without Storm Door	With Storm Door
Wood Doors (1-¾ Inches Thick)		
Panel with 7/16-inch panels	0.54	0.36
Hollow core flush	0.46	0.32
Panel with 1-⅛-inch panels	0.39	0.28
Solid core flush	0.30	0.26

For SI: 1 inch = 25.4 mm.

J1.6 Alternate Materials — Method of Construction, Design Or Insulating Systems: The provisions of Appendix J are not intended to prevent the use of any material, method of construction, design or insulating system not specifically prescribed herein, provided that such construction, design or insulating system has been approved, if necessary, by the BBRS as meeting the intent of Appendix J.

780 CMR J2.0 DEFINITIONS

780 CMR J2.1 General Definitions

J2.2 Meaning: Unless otherwise expressly stated, the following terms shall, for the purpose of 780 CMR Appendix J, have the meaning indicated in 780 CMR J2.0.

J2.3 Tense, gender and number: Words used in the present tense include the future; words used in the masculine gender include the feminine and neuter; the singular number includes the plural and the plural the singular.

J2.4 Terms not defined: Where terms are not defined, they shall have their ordinarily accepted meanings or such as the context may imply. Any terms relating to plumbing and electrical wiring shall have their terms as defined by the Regulations of the Commonwealth of Massachusetts pertaining to plumbing and electrical wiring.

ACCESSIBLE (AS APPLIED TO EQUIPMENT): Admitting close approach because not guarded by locked doors, elevation or other effective means (see "Readily accessible").

AIR CONDITIONING, COMFORT: The process of treating air so as to control simultaneously its temperature, humidity, cleanliness, and distribution to meet requirements of the conditioned space.

AIR TRANSPORT FACTOR: The ratio of the rate of useful sensible heat removal from the conditioned space to the energy input to the supply and return fan motor(s), expressed in consistent units and under the designated operating conditions.

ANNUAL FUEL UTILIZATION EFFICIENCY (AFUE): The ratio of annual output energy to annual input energy which includes any non-heating season pilot input loss, and for gas or oil-fired furnaces or boilers, does not include electrical energy.

AUTOMATIC: Self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength, pressure, temperature or mechanical configuration (see "Manual").

BASEMENT WALL: The opaque portion of a wall which encloses one side of a basement and is partially or totally below grade.

BOILER CAPACITY: The rate of heat output in Btu/h (W) measured at the boiler outlet, at the design inlet and outlet conditions and rated fuel/energy input.

BUILDING ENVELOPE: The elements of a building which enclose conditioned spaces through which thermal energy may be transferred to or from the exterior or to or from spaces exempted by the provisions of 780 CMR J1.1.2.2.

BUILDING PROJECT: A building or group of buildings, including on-site energy conversion or electric-generating facilities, which utilize a single submittal for a construction permit or are within the boundary of a contiguous area under one ownership.

COEFFICIENT OF PERFORMANCE (COP)—COOLING: The ratio of the rate of heat removal to the rate of energy input in consistent units, for a complete cooling system or factory assembled equipment, as tested under a nationally recognized standard or designated operating conditions.

COEFFICIENT OF PERFORMANCE (COP)—HEAT PUMP—HEATING: The ratio of the rate of heat delivered to the rate of energy input, in consistent units, for a complete heat pump system under designated operating conditions. Supplemental heat shall not be considered when checking compliance with the heat pump equipment (COPs listed in the tables in 780 CMR J4.4).

COMFORT: The physical conditions represented in the area on a psychometric chart enclosing all those conditions described in Figure 1 in ASHRAE 55, as listed in Appendix A, as being comfortable.

COMMERCIAL BUILDINGS: For purposes of energy conservation, a commercial building is any

building other than a *low-rise residential building*, as defined in 780 CMR J2.0.

CONDITIONED FLOOR AREA: The horizontal projection of that portion of interior space which is contained within exterior walls and which is conditioned directly or indirectly by an energy-using system.

CONDITIONED SPACE: Space within a building which is provided with positive heat supply (see definition), or which has heated and/or cooled air or surfaces, or where required, with humidification or dehumidification means so as to be capable of maintaining a space condition falling within the comfort zone set forth in ASHRAE 55, as listed in Appendix A.

COOLED SPACE: Space within a building which is provided with a positive cooling supply.

CRAWL SPACE WALL: The opaque portion of a wall which encloses a crawl space and is partially or totally below grade.

DEADBAND: The temperature range in which no heating or cooling is used.

DEGREE DAY, COOLING: A unit, based upon temperature difference and time, used in estimating cooling energy consumption. For any one day, when the mean temperature is more than 65°F (18°C), there are as many degree days as degrees Fahrenheit (Celsius) temperature difference between the mean temperature for the day and 65°F. (18°C.). Annual Cooling Degree Days (CDD) are the sum of the degree days over a calendar year.

DEGREE DAY, HEATING: A unit, based upon temperature difference and time, used in estimating fuel consumption and specifying nominal heating load of a building in winter. For any one day, when the mean temperature is less than 65°F (18°C), there exists as many degree days as there are Fahrenheit degrees difference in temperature between the mean temperature for the day and 65°F (18°C).

DWELLING UNIT: A single housekeeping unit comprised of one or more rooms providing complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation.

EFFICIENCY, HVAC SYSTEM: The ratio of useful energy output (at the point of use) to the energy input in consistent units for a designated time period, expressed in percent.

ENERGY: The capacity for doing work taking a number of forms which may be transformed from one into another, such as thermal (heat), mechanical (work), electrical and chemical in customary units, measured in kilowatt-hours (kWh) or British thermal units (Btu) (J) (see "New Energy").

ENERGY EFFICIENCY RATIO (EER): The ratio of net equipment cooling capacity in Btu/h to total rate of electric input in watts (W) under designated operating conditions. If the output capacity in Btu/h is converted to watts (to create consistent units) the result is equal to the cooling COP (EER 3.41 = COP.) See also Coefficient of Performance.

ENERGY, RECOVERED: See "Recovered energy."

EXISTING BUILDINGS: For purposes of energy conservation, and existing building which has been legally occupied and/or used for a period of at least five years. (Also see 780 CMR 2.0 and 780 CMR 3400.3.1.)

EXTERIOR ENVELOPE: See "Building envelope."

FURNACE, DUCT: A furnace normally installed in distribution ducts of air conditioning systems to supply warm air for heating and which depends on a blower not furnished as part of the duct furnace for air circulation.

FURNACE, WARM AIR: A self-contained, indirect-fired or electrically heated furnace that supplies heated air through ducts to spaces that require it.

GLAZING AREA: Interior surface area of all glazed surfaces (such as windows, sliding glass doors, skylights, etc.), sash, curbing, jambs, or other framing elements that enclose conditioned spaces.

GROSS AREA OF EXTERIOR WALLS: The normal projection of the building envelope wall area bounding interior space which is conditioned by an energy-using system including opaque wall, window and door area.

The gross area of exterior walls consists of all opaque wall areas, including between floor spandrels, peripheral edges of floors, roof and basement knee walls, walls enclosing a mansard roof, window areas including sash, and door areas when such surfaces are exposed to outdoor air, unconditioned spaces, or mechanically cooled space, including interstitial areas between two such spaces. For each basement wall that encloses heated space, if the average below-grade area is less than 50% of the total area for that wall, including openings, the entire wall, including the below-grade portion is included as part of the gross area of exterior walls. Non-opaque areas (windows, doors, etc.) of all basement walls are included in the gross area of exterior walls. (Note: if the basement is not heated space, and if the basement ceiling is insulated, then the basement walls are not included in the gross area of exterior walls.

GROSS FLOOR AREA: The sum of the areas of the several floors of the building, including basements, cellars, mezzanine and intermediate floored tiers and penthouses of headroom height, measured from the exterior faces of exterior walls or from the center line of walls separating buildings, but excluding:

1. Covered walkways, open roofed-over areas, porches and similar spaces.
2. Pipe trenches, exterior terraces or steps, chimneys, roof overhangs and similar features.

GROUP R RESIDENTIAL BUILDINGS: For the purpose of Appendix J, Group R residential buildings include:

1. Detached one and two family dwellings (Use Groups R-4 and R-5 in 780 CMR 310); and,
2. All other residential buildings, three stories or less in height (Use Groups R-1, R-2, R-3, R-5 in 780 CMR 310).

HEAT: The form of energy that is transferred by virtue of a temperature difference or a change in state of a material.

HEATED SLAB: Slab-on-grade construction in which the heating elements or hot air distribution system is in contact with or placed within the slab or the sub-grade.

HEATED SPACE: Space within a building which is provided with a positive heat supply. Space within a basement with registers or heating devices designed to supply heat to a basement space shall automatically define that space as heated space.

HEATING SEASONAL PERFORMANCE FACTOR (HSPF): The total heating output of a heat pump during its normal annual usage period for heating, in Btu, divided by the total electric energy input during the same period, in watt hours, as determined by Code of Federal Regulations, 10 CFR Part 430, Subpart B, Test procedures and based on Region 4, as listed in Appendix A.

HUMIDISTAT: A regulatory device, actuated by changes in humidity, used for automatic control of relative humidity.

HVAC: Heating, ventilating, and air conditioning.

HVAC SYSTEM: The equipment, distribution network, and terminals that provide either collectively or individually the processes of heating, ventilating, or air conditioning to a building.

HVAC SYSTEM COMPONENTS: HVAC system components provide, in one or more factory-assembled packages, means for chilling and/or heating water with controlled temperature for delivery to terminal units serving the conditioned spaces of the building. Types of HVAC system components include, but are not limited to, water chiller packages, reciprocating condensing units and water source (hydronic) heat pumps (see "HVAC system equipment").

HVAC SYSTEM EFFICIENCY: See "Efficiency, HVAC system."

HVAC SYSTEM EQUIPMENT: HVAC system equipment provides, in one (single package) or more (split system) factory-assembled packages, means for air circulation, air cleaning, air cooling with controlled temperature and dehumidification, and, optionally, either alone or in combination with a heating plant, the functions of heating and humidifying. The cooling function may be either electrically or heat operated and the refrigerant condenser may be air, water or evaporatively cooled. Where the equipment is provided in more than one package, the separate packages shall by designed by the manufacturer to be used together. The equipment may provide the heating function as a heat pump or by the use of electric or fossil-fuel-fired elements. (The word "equipment" used without modifying adjective may, in accordance with common industry usage, apply either to HVAC system equipment or HVAC system components.)

INFILTRATION: The uncontrolled inward air leakage through cracks and interstices in any building element and around windows and doors of a building caused by the pressure effects of wind and/or the effect of differences in the indoor and outdoor air density.

INTEGRATED PART-LOAD VALUE (IPLV): A single number figure of merit based on part-load EER or COP expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

LOW-RISE RESIDENTIAL BUILDINGS: Residential occupancy buildings (R-2, R-3, R-4, or R-5) three stories or less in height. (Exception: For purposes of energy conservation, R-1 use group buildings shall be treated as *commercial buildings* as defined in 780 CMR J2.0.)

MANUAL: Capable of being operated by personal intervention (see "Automatic").

MULTIFAMILY DWELLING: A building containing three or more dwelling units.

NET AREA OF EXTERIOR WALLS: The gross area of exterior walls, minus the total rough opening area of all windows and doors set in the exterior walls.

NEW ENERGY: Energy, other than recovered energy, utilized for the purpose of heating or cooling (see "Energy").

OPAQUE AREAS: All exposed areas of a building envelope which enclose conditioned space, except openings for windows, skylights, doors and building service systems.

OUTDOOR AIR: Air taken from the outdoors, (i.e. - not previously circulated through the HVAC system.)

PACKAGED TERMINAL AIR CONDITIONER (PTAC): A factory-selected wall sleeve and separate unencased combination of heating and cooling components, assemblies or sections

(intended for mounting through the wall to serve a single room or zone). It includes heating capability by hot water, steam, or electricity. (For the complete technical definition, see ARI Standard 310 listed in Appendix A.)

PACKAGED TERMINAL HEAT PUMP: A PTAC capable of using the refrigeration system in reverse cycle or heat pump mode to provide heat. (For complete technical definition, see ARI 380 listed in Appendix A.)

POSITIVE COOLING SUPPLY: Mechanical cooling deliberately supplied to a space, such as through a supply register. Also, mechanical cooling indirectly supplied to a space through uninsulated surfaces of space-cooling components, such as evaporator coil cases and cooling distribution systems which continually maintain air temperatures within the space of 85°F (29°C) or lower during normal operation. To be considered exempt from inclusion in this definition, such surfaces shall comply with the insulation requirements of Appendix J4.

POSITIVE HEAT SUPPLY: Heat deliberately supplied to a space by design, such as a supply register, radiator or heating element. Also, heat indirectly supplied to a space through uninsulated surfaces of service water heaters and space heating components, such as furnaces, boilers and heating and cooling distribution systems which continually maintain air temperature within the space of 50°F (10°C) or higher during normal operation. To be considered exempt from inclusion in this definition, such surfaces shall comply with the insulation requirements of Appendix J4.

READILY ACCESSIBLE: Capable of being reached quickly for operation, renewal or inspections, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders or access equipment (see "Accessible).

RECOOLING: The removal of heat by sensible cooling of the supply air (directly or indirectly) that has been previously heated above the temperature to which the air is to be supplied to the conditioned space for proper control of the temperature of that space.

RECOVERED ENERGY: Energy utilized which would otherwise be wasted (i.e., not contribute to a desired end use) from an energy utilization system.

REHEAT: The application of sensible heat to supply air that has been previously cooled below the temperature of the conditioned space by either mechanical refrigeration or the introduction of outdoor air to provide cooling.

RENEWABLE ENERGY SOURCES: Sources of energy (excluding minerals and solid fuels) derived from incoming solar radiation, including natural daylighting and photosynthetic processes; from phenomena resulting therefrom, including wind, waves and tides, lake or pond thermal differences: and from the internal heat of the earth, including nocturnal thermal exchanges.

RESET: Adjustment of the set point of a control instrument to a higher or lower value automatically or manually to conserve energy.

RESIDENTIAL BUILDINGS: For the purposes of Appendix J, Group R residential buildings include:

1. Type I (R-4, R-5): Detached one and two family dwellings; and,
2. Type II (R-1, R-2, R-3, R-5): All other residential buildings, three stories or less in height.

ROOF ASSEMBLY: A roof assembly shall be considered as all components of the roof/ceiling envelope through which heat flows, thus creating a building transmission heat loss or gain, where such assembly is exposed to outdoor air and encloses a heated or mechanically cooled space.

The gross area of a roof assembly consists of the total interior surface of such assembly, including skylights exposed to the heated or mechanically cooled space.

ROOM AIR CONDITIONER: An encased assembly designed as a unit for mounting in a window or through a wall, or as a console. It is designed primarily to provide free delivery of conditioned air to an enclosed space, room or zone. It includes a prime source of refrigeration for cooling and dehumidification and means for circulating and cleaning air, and may also include means for ventilating and heating.

SASH CRACK: The sum of all perimeters of all window sashes, based on overall dimensions of such parts, expressed in linear feet. If a portion of one sash perimeter overlaps a portion of another sash perimeter, only count the length of the overlapping portions once.

SEASONAL ENERGY EFFICIENCY RATIO (SEER): The total cooling output of an air conditioner during its normal annual usage period for cooling, in Btu/h (W), divided by the total electric energy input during the same period, in watt-hours, as determined by Code of Federal Regulations, 10 CFR Part 430, Subpart B, Test procedures, as listed in Appendix A.

SEQUENCE: A consecutive series of operations.

SERVICE SYSTEMS: All energy-using systems in a building that are operated to provide services for the occupants or processes housed therein, including HVAC, service water heating, illumination, transportation, cooking or food preparation, laundering and similar functions.

SERVICE WATER HEATING: Supply of hot water for purposes other than space heating.

SLAB-ON-GRADE FLOOR INSULATION: Insulation around the perimeter of the floor slab or its supporting foundation when the top edge of the floor perimeter slab is above the finished grade or 12 inches (305 mm) or less below the finished grade.

SOLAR ENERGY SOURCE: Source of natural daylighting and of thermal, chemical or electrical energy derived directly from conversion of incident solar radiation.

SUNROOM: An *addition* to an existing building/dwelling unit where the total area (rough opening or unit dimensions) of glazed fenestration products of said *addition* exceeds 40% of the combined gross wall and ceiling area of the *addition*.

SYSTEM: A combination of central or terminal equipment or components and/or controls, accessories, interconnecting means, and terminal devices by which energy is transformed so as to perform a specific function, such as HVAC, service water heating or illumination.

THERMAL CONDUCTANCE (C): Time rate of heat flow through a body (frequently per unit area) from one of its bounding surfaces to the other for a unit temperature difference between the two surfaces, under steady conditions (Btu/h·ft.^{2}·°F) [W/(m^2·k)].

THERMAL RESISTANCE (*R*): The reciprocal of thermal conductance (h·ft.^{2}·°F/Btu) [(m^2·K)/W].

THERMAL RESISTANCE, OVERALL (R_o): The reciprocal of overall thermal conductance (h·ft.^{2}·°F/Btu) [(m^2·k)/W]. The overall thermal resistance of the gross area or individual component of the exterior building envelope (roof/ceiling, exterior wall, floor, crawl space wall, foundation, window, skylight, door, or opaque wall, etc.) which includes the weighted *R*-values of the component assemblies (such as air-film, insulation, drywall, framing, glazing, etc.).

THERMAL TRANSMITTANCE (*U*): The coefficient of heat transmission (air to air). It is the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films (Btu/h· ft.^{2}·°F) [W/(m^2·k)]. The *U*-value applies to combinations of different materials used in series along the heat flow path, single materials that comprise a building section, cavity air spaces and surface air films on both sides of a building element. The term **F-value** applies to U properties for concrete slabs.

THERMAL TRANSMITTANCE, OVERALL (U_o): The overall (average) heat transmission of a gross area of the exterior building envelope (Btu/h·ft.^{2}·°F) [W/(m^2·k)]. The U_o value applies to the combined effect of the time rate of heat flow through the various parallel paths, such as windows, doors and opaque construction areas, comprising the gross area of one or more exterior building components, such as walls, floors or roof/ceilings.

THERMOSTAT: An automatic control device actuated by temperature and designed to be responsive to temperature.

UNITARY COOLING AND HEATING EQUIPMENT: One or more factory-made assemblies which include an evaporator or cooling coil, a compressor and condenser combination, and may include a heating function as well. When heating and cooling equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together.

UNITARY HEAT PUMP: One or more factory-made assemblies which include an indoor conditioning coil, compressor(s) and outdoor coil or refrigerant-to-water heat exchanger, including means to provide both heating and cooling functions. When heat pump equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together.

VENTILATION: The process of supplying or removing air by natural or mechanical means to or from any space. Such air may or may not have been conditioned.

VENTILATION AIR: That portion of supply air which comes from outside (outdoors) plus any recirculated air that has been treated to maintain the desired quality of air within a designated space. (See BOCA Mechanical Code, as listed in Appendix A, 780 CMR J3, and definition of "Outdoor air.")

WATER HEATER, NON-STORAGE: A water heater with an input rating of at least 4,000 Btu/h per gallon (310 W/L) stored water and a storage capacity of less than ten gallons (38 L).

WATER HEATER, STORAGE: A water heater with an input rating of less than 4,000 Btu/h per gallon (310 W/L) of stored water or storage capacity of at least ten gallons (38 L).

ZONE: A space or group of spaces within a building with heating and/or cooling requirements sufficiently similar so that comfort conditions can be maintained throughout by a single controlling device.

780 CMR J3.0 DESIGN CONDITIONS

J3.1 Design Criteria:

J3.1.1 General: The criteria of 780 CMR J3.0 establish the design conditions for use with 780 CMR J5, J6, J7, J8 and J9.

J3.2 Thermal Design Parameters

J3.2.1 Exterior design conditions. As applicable, the design parameters in Table J3.2.1 shall be used for calculations required under Appendix J.

TABLE J3.2.1
Exterior Design Conditions
Heating Degree Days Base 65 (HDD_{65})

Location	Outside Ambient			
	Heating Degrees (°F) Winter[1]	Cooling Degrees (°F) Dry Bulb Summer[1]	Cooling Degrees (°F) Wet Bulb Summer[1]	Heating Degree Days[2] Base 65
Boston	9	88	74	5641
Clinton	2	87	73	6698
Fall River	9	84	73	5774
Framingham	6	86	73	6262
Gloucester	5	86	74	-
Greenfield	-2	85	73	-
Lawrence	0	87	74	6322
Lowell	1	88	74	6339
New Bedford	9	82	73	5426
Pittsfield	-3	84	72	7578
Springfield	0	87	73	5754
Taunton	9	86	74	6346
Worcester	4	84	72	6979

For SI: °F.=1.8°C. + 32.

1 The outdoor design temperature shall be selected from the columns of 97½% values for winter and 2½% values for summer from tables in the ASHRAE Handbook of Fundamentals, as listed in Appendix A. Adjustments may be made to reflect local climates which differ from the tabulated temperatures, or local weather experience determined by the building official.

2 The Degree Days Heating (base 65°F.) and cooling (base 65°F.) shall be selected from "NOAA Annual Degree Days to Selected Bases Derived from the 1961-1990 Normals," ASHRAE Handbook of Fundamentals, as listed in Appendix A, data available from adjacent military installations, Table J3.2.1, or other source of local weather data acceptable to the building official.

J3.2.2 Interior design conditions.

J3.2.2.1 Indoor design temperature: Indoor design temperature shall be 72°F for heating and 78°F for cooling.

J3.2.2.2 Design humidity: Indoor design relative humidity for heating shall not exceed 30%. For cooling, the actual design relative humidity within the comfort envelope as defined in ASHRAE Standard 55-92 listed in Appendix A shall be selected for minimum total HVAC system energy use in accordance with accepted practice.

J3.3 Living Space Ventilation Criteria.

J3.3.1 Ventilation: Living space fresh air ventilation shall conform to the requirements of 780 CMR 12 and the BOCA Mechanical Code, as listed in Appendix A.

Exception: If outdoor air quantities other than those specified in the BOCA Mechanical Code are used or required because of special occupancy or process requirements, source control of air contamination, health and safety, or other standards, the required outdoor air quantities shall be used as the basis for caiculating the heating and cooling design loads.

780 CMR J4.0 GENERAL REQUIREMENTS

J4.1 Scope.

J4.1.1 General: All buildings that are mechanically heated or cooled and meet the provisions of Appendix J using the compliance paths of 780 CMR J5.0, J6.0, or J7.0 shall also meet the requirements of 780 CMR J4.0. Buildings that meet the provisions using the compliance paths of 780 CMR J8.0 or J9.0 are exempt from the requirements of 780 CMR J4.0.

Exception: All buildings must comply with the requirements of 780 CMR J4.2.1

J4.2 Building Envelope Requirements.

J4.2.1 Vapor Retarder: The design shall not create conditions of accelerated deterioration from moisture condensation. In all frame walls, floors, and ceilings not ventilated to allow moisture to escape, an approved vapor retarder having a maximum rating of 1.0 perm, when tested in accordance with Standard ASTM E 96, as listed in Appendix A, shall be installed on the warm-in-winter side of the thermal insulation.

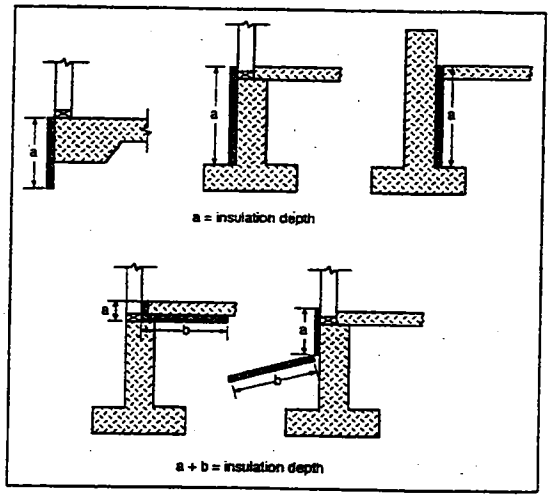
Exception: In construction where moisture or its freezing will not damage the materials or adversely affect the performance of the insulation.

J4.2.2 Basements: The exterior walls of basements below uninsulated floors shall be insulated from the top of the foundation wall to a depth of ten feet (3048 mm) below the outside finish ground level, or to the level of the basement floor, whichever is less. Basement walls shall be insulated if the basement is a conditioned space.

J4.2.3 Slab-on-grade floors: Insulation shall be placed on the outside of the foundation or on the inside of a foundation wall. In climates with less than 6,000 annual Fahrenheit heating degree days (HDD_{65}), the insulation shall extend downward from the elevation of the top of the slab for a

minimum distance of 24 inches (610 mm), or downward to at least the bottom of the slab and then horizontally to the interior or exterior for a minimum total distance of 24 inches (610 mm) and shall be an approved type. In climates equal to or greater than 6,000 annual Fahrenheit heating degree days (HDD_{65}), the insulation shall extend downward from the elevation of the top of the slab for a minimum of 48 inches (1219 mm), or downward to at least the bottom of the slab and then horizontally to the interior or exterior for a minimum total distance of 48 inches (1219 mm). In all climates, the horizontal insulation extending outside of the foundation shall be covered by pavement or by soil a minimum of ten inches (254 mm) thick. The top edge of the insulation installed between the exterior wall and the edge of the interior slab shall be permitted to be cut at a 45-degree angle away from the exterior wall. (see Figure J4.2.2.)

Figure J4.2.2
Typical Slab-on-grade Insulation Examples



J4.2.4 Crawl spaces: The floor above a crawl space shall be insulated to a minimum of R-19. See also 780 CMR 3603.6.8.2

J4.2.5 Access openings: Access doors, hatches, scuttles, pull down staircases and similar constructions that are part of the building envelope shall be insulated to a level equivalent to the insulation of the surrounding floor, wall, and ceiling.

Exception: If the access opening has less insulation than the surrounding area, for calculation purposes the U-value of the surrounding floor, wall, and ceiling shall be increased accordingly.

J4.2.6 Masonry veneer: When insulation is placed on the exterior of a foundation supporting a masonry veneer exterior, the horizontal foundation surface supporting the veneer is not required to be insulated to satisfy the foundation insulation requirement.

J4.2.7 Return-Air Ceiling Plenums: When return-air ceiling plenums are employed, the roof/ceiling assembly shall:

1. For thermal transmittance purposes, not include the ceiling proper nor the plenum space as part of the assembly; and,
2. For gross area purposes, be based upon the interior face of the upper plenum surface.

780 CMR J4.3 Air leakage.

J4.3.1 The requirements of 780 CMR J4.3 shall apply to those locations separating outdoor ambient conditions or exempted portions of the building (e.g.- attics, unconditioned basements) from interior conditioned spaces.The requirements are not applicable to the separation of interior conditioned spaces from each other.

J4.3.2 Window and Door Assemblies: Exterior doors and windows shall be designed to limit air leakage into and from the building envelope. Manufactured doors and windows shall comply with the maximum allowable infiltration rates in Table J4.3.2.

Exception: Site constructed windows and doors sealed in accordance with 780 CMR J4.3.3.

Table J4.3.2
Allowable Air Infiltration Rates[1]

Frame Type	Windows (cfm per ft of operable sash crack)	Doors (cfm per ft² of door area)	
Wood[2]	0.34	0.35[5]	0.5[6]
Alum[3]	0.37	0.37	0.5[6]
PVC[4]	0.37	0.37	0.5[6]

1. When tested in accordance with Standard ASTM E 283, as listed in Appendix A.
2. See Standard ANSI/NWWDA I.S.2, as listed in Appendix A.
3. See Standard ANSI/AAMA 101, as listed in Appendix A.
4. See Standards AAMA 101V and ASTM D 4099, each as listed in Appendix A.
5. Requirement based on door area specified in Standard ANSI/NWWDA I.S.3, as listed in Appendix A.
6. Requirement based on assembly area; except for manufactured (mobile) housing for which the requirement shall be 1.0 cfm/ft² (5.08 L/s/m²) of door area; in accordance with Standard AAMA 1701.2 as listed in Appendix A.

J4.3.3 Joints, seams or penetrations in the building envelope that are sources of air leakage shall be sealed with durable caulking materials, closed with gasketing systems, taped or covered with moisture vapor permeable house-wrap per manufacturer's directions. Air leakage locations

to be treated shall include openings, cracks and joints between framing members and window or door frames; between wall assemblies or their sill-plates and foundations; between walls and roof/ceilings or attic/ceiling seals and between separate wall panels; between walls and floor assemblies; penetrations of utility services through walls, floors and roof assemblies, penetration through the wall cavity of top and/or bottom plates; and all other such openings in the building envelope. Sealing materials shall be compatible with the construction materials, location, and anticipated conditions. Sealing materials spanning joints between dissimilar construction materials shall allow for differential expansion and contraction of the construction materials.

This includes sealing around tubs and showers, at the attic and crawl space access panels, at recessed lights and around all plumbing, electrical, and HVAC penetrations. These are openings located in the building envelope between conditioned space and unconditioned space or between the conditioned space and the outside.

J4.3.4 Recessed lighting fixtures: When installed in the building envelope, recessed lighting fixtures shall meet one of the following requirements:

1. Type IC rated, manufactured with no penetrations between the inside of the recessed fixture and ceiling cavity and sealed or gasketed to prevent air leakage into the unconditioned space.
2. Type IC rated, in accordance with Standard ASTM E 283, as listed in Appendix A, with no more than 2.0 cfm (0.944 L/s) air movement from the conditioned space to the ceiling cavity. The lighting fixture shall have been tested at 75 Pa or 1.57 lbs/ft.^{2} pressure difference and shall be labeled.

J4.4 Building Mechanical Systems

J4.4.1 General: 780 CMR J4.4 covers the determination of heating and cooling loads, design requirements, system and component performance control requirements, insulating systems and duct construction.

Note: 780 CMR J4.4 addresses, in depth, requirements for "simple" heating and cooling systems. "Simple" systems are characterized as those typically found in one-and two-family houses (such as standard design boilers, furnaces, air conditioners, or heat pumps that provide heating and/or cooling). 780 CMR J4.4 also covers requirements for more "complex" systems (such as those designed to deliver heating and cooling simultaneously, evaporative coolers, water chillers, and others,) but such "complex" systems are only cited in this section, with reference to the other sections of 780 CMR where detailed criteria are given.

J4.4.2 Calculation of heating and cooling loads:

J4.4.2.1 Calculation procedures: For the purpose of sizing HVAC systems, heating and cooling design loads shall be determined in accordance with techniques recommended in the ASHRAE Handbook of Fundamentals or the Air Conditioning Contractors Association's Manual "J", or other procedure approved by the Board of Building Regulations and Standards. The design parameters specified in 780 CMR J3.0 shall apply for all computations.

J4.4.2.1.1 System heating/cooling capacity: The rated output capacity of the heating/cooling system at design conditions shall not be greater than 125% of the design load calculated in accordance with this article. Equipment designed for standby purposes is not included in the capacity limitation requirement. For a single piece of equipment which has both heating and cooling capability, only one function, either the heating or the cooling, need meet the requirements of 780 CMR J4.4. Capacity for the other function shall be, within available equipment options, the smallest size necessary to meet the load.

Exception 1: If the rated output capacity of available equipment options exceeds 125% of the design load, then equipment with the smallest output capacity above 125% of the load shall be utilized.

Exception 2: Where the HVAC system for the building uses interconnected equipment designed to sequence with the load and it can be shown that such design will use less energy on an annual basis than one large unit.

J4.4.2.1.3 Simultaneous heating and cooling: See 780 CMR 1305.3.5.

J4.4.2.2 Infiltration: Infiltration for heating and cooling design loads shall be calculated for all buildings except one- and two-family dwellings by the procedures in Chapter 22 of the ASHRAE Handbook of Fundamentals. Calculations for one and two family dwellings may use the methods identified above or other accepted engineering practices.

J4.4.3 HVAC equipment performance requirements.

J4.4.3.1 Equipment and components:

J4.4.3.1.1 The requirements of 780 CMR J4.4.3.1 apply to equipment and mechanical component performance for heating, ventilating, and air-conditioning systems. Equipment efficiency levels are specified. Data furnished by the equipment supplier or certified under a nationally recognized certification program or rating procedure shall be used to satisfy these requirements.

J4.4.3.1.2 Where components from more than one manufacturer are assembled into systems regulated under 780 CMR J4.4.3, compliance shall be as specified in 780 CMR J4.4.3.2 through J4.4.3.6.

J4.4.3.1.3 Omission of minimum performance requirements for certain classes of HVAC equipment does not preclude use of such equipment where appropriate.

J4.4.3.2 HVAC system combustion equipment: Gas- and oil-fired comfort heating equipment shall have minimum efficiency levels not less than the values in Table J4.4.3.2a through J4.4.3.2c.

TABLE J4.4.3.2a
GAS- AND OIL-FIRED STEAM AND HOT WATER BOILERS-
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE

REFERENCE STANDARD	CATEGORY	RATING CONDITION	MINIMUM PERFORMANCE	
Code of Federal Regulations, 10 CFR	Gas-Fired <300,000 Btu/h	Seasonal Rating	AFUE	80%[3,4]
Part 430, Subpart B, Appendix N	Oil-Fired <300,000 Btu/h	Seasonal Rating	AFUE	80%[3]
ANSI Z21.13, as listed in Appendix A	Gas-Fired ≥300,000 Btu/h	1. Maximum Rating Capacity[1] Steady-State	E_c[2]	80%
ANSI/ASME PTC 4.1, UL 795, each as listed in Appendix A		2. Minimum Rating Capacity[1] Steady-State		
UL 726, as listed in Appendix A	Oil-Fired ≥300,000 Btu/h	1. Maximum Rating Capacity[1] Steady-State	E_c[2]	83%
ANSI/ASME PTC 4.1, as listed in Appendix A		2. Minimum Rating Capacity[1] Steady-State		
Hydronics Institute, Testing & Ratings Standard for Heating Boilers, 1982 ANSI/ASME PTC 4.1, as listed in Appendix A	Oil-Fired (Residual) ≥300,000 Btu/h	1. Maximum Rating Capacity[1] Steady-State	E_c[2]	83%
		2. Minimum Rating Capacity[1] Steady-State		

For SI: 1 Btu/h = 0.2931 W.
1 Provided and allowed by the controls.
2 E_c = combustion efficiency, 100% minus flue losses. See reference standard for detailed information.
3 To be consistent with National Appliance Energy Conservation Act of 1987 (Public Law 100-12).
4 Except for gas-fired steam boilers for which minimum AFUE is 75%.

TABLE J4.4.3.2b
WARM AIR DUCT FURNACES AND UNIT HEATERS-
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE

REFERENCE STANDARD	CATEGORY	RATING CONDITION	MINIMUM PERFORMANCE	
ANSI Z83.9, as listed in Appendix A	Duct Furnaces Gas-Fired	1. Maximum Rating Capacity[1] Steady-State	E_t[2]	78%
		2. Minimum Rating Capacity[1] Steady-State	E_t[2]	75%
ANSI Z83.8, as listed in Appendix A	Unit Heaters Gas-Fired	1. Maximum Rating Capacity[1] Steady-State	E_t[2]	78%
		2. Minimum Rating Capacity[1] Steady-State	E_t[2]	74%
UL 731, as listed in Appendix A	Unit Heaters Oil-Fired	1. Maximum Rating Capacity[1] Steady-State	E_t[2]	81%
		2. Minimum Rating Capacity[1] Steady-State	E_t[2]	81%

1 Provided and allowed by the controls.
2 E_t = thermal efficiency, 100% minus flue losses. See reference standard for detailed definition.

TABLE J4.4.3.2c
WARM AIR FURNACES AND COMBINATION WARM AIR FURNACES/AIR-CONDITIONING UNITS- STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE

REFERENCE STANDARD	CATEGORY	RATING CONDITION	MINIMUM PERFORMANCE	
Code of Federal Regulations, 10 CFR Part 430, Subpart B, Appendix N	Gas-Fired <225,000 Btu/h	Seasonal Rating	AFUE E_t	78%[3] 80%
	Oil-Fired <225,000 Btu/h	Seasonal Rating	AFUE E_t	78%[3] 80%
ANSI Z21.47, as listed in Appendix A	Gas-Fired ≥225,000 Btu/h	1. Maximum Rating Capacity[1] Steady-State	E_t[4]	80%
		2. Minimum Rating Capacity[1] Steady-State	E_t[4]	78%
UL 727, as listed in Appendix A	Oil-Fired ≥225,000 Btu/h	1. Maximum Rating Capacity[1] Steady-State	E_t[4]	81%
		2. Minimum Rating Capacity[1] Steady-State	E_t[4]	81%

For SI: °F. = 1.8°C. + 32, 1 Btu/h = 0.2931 W.
1 Minimum and maximum ratings as provided for and allowed by the unit's controls.
2 These requirements apply to combination units not covered by NAECA (three phase power or cooling capacity > 65,000 Btu/h).
3 This is used to be consistent with National Appliance Energy Conservation Act (NAECA) of 1987 (Public Law 100-12). These values apply to furnace and combination units covered by NAECA.
4 See referenced standard for detailed definition of thermal efficiency (E_t) = (100% minus flue losses).

J4.4.3.3 HVAC system heating equipment, heat pump, heating mode. Heat pumps whose purchased energy input is entirely electric shall have efficiency levels for heating not less than the values in Table J4.4.3.3a through J4.4.3.3d. (NOTE: When more than one rating condition is listed by the manufacturer for a single piece of equipment, the rating type closer to the intended design conditions should be chosen.)

J4.4.3.3.1 780 CMR J4.4.3 applies to, but is not limited to, unitary (central) heat pumps (air source and water source) in the heating mode, to water-source (hydronic) heat pumps as used in multiple-unit hydronic HVAC systems, and to heat pumps in the packaged terminal air-conditioner and room air-conditioner forms in the heating mode.

TABLE J4.4.3.3a
HEAT PUMPS - AIR COOLED, ELECTRICALLY-OPERATED, <135,000 Btu/h COOLING CAPACITY STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE

REFERENCE STANDARD[1]	CATEGORY	SUB-CATEGORY & RATING CONDITIONS (Outdoor Temperature °F.)[2]	MINIMUM PERFORMANCE
ARI 210/240, as listed in Appendix A	<65,000 Btu/h	Seasonal Rating[1]	
	Cooling Capacity Heating Mode (Heat Pump)	Split systems	6.8 HSPF
		Single Package	6.6 HSPF
	≥65,000 Btu/h	Split Systems & Single Package	
	<135,000 Btu/h Cooling Capacity Heating Mode	High Temperature Rating (47°F db/43°F wb)	3.0 COP
		Low Temperature Rating (17°F db/15°F wb)	2.0 COP

For SI: °F = 1.8°C + 32, 1 Btu/h = 0.2931 W.
1 For multi-capacity equipment, the minimum performance shall apply to each capacity step provided. Multi- capacity refers to manufacturer published rating for more than one capacity mode allowed by the products' controls.
2 db = dry bulb; wb = wet bulb.

TABLE J4.4.3.3b
PACKAGED TERMINAL HEAT PUMPS - AIR COOLED, ELECTRICALLY OPERATED
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE

REFERENCE STANDARD	CATEGORY PTAC HEAT PUMPS	SUB-CATEGORY & RATING CONDITIONS (Outdoor Temperature °F)[1]	EFFICIENCY RATING	MINIMUM PERFORMANCE[2]
ARI 380, as listed in Appendix A	Heating Mode	Standard Rating (47°F db/43°F wb)	COP	2.9 - (0.026 x Cap/1,000)

For SI: °F = 1.8°C + 32, 1 Btu/h = 0.2931 W.
1 db = dry bulb; wb = wet bulb.
2 Capacity (Cap) means the rated cooling capacity of the product in Btu/h in accordance with Standard ANSI Z21.13, as listed in Appendix A. If the unit's capacity is less than 7,000 Btu/h, use 7,000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

TABLE J4.4.3.3c
WATER-SOURCE AND GROUNDWATER SOURCE HEAT PUMPS -
ELECTRICALLY-OPERATED <135,000 Btu/h COOLING CAPACITY
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE

REFERENCE STANDARDS	RATING CONDITION °F[1]	MINIMUM PERFORMANCE
Water Source Heat Pumps: ARI 320, as listed in Appendix A	Standard Rating 70°F entering water[2]	3.8 COP
Groundwater-Source Heat Pumps: ARI 325, as listed in Appendix A	1. High Temperature Rating 70°F entering water[2]	3.4 COP
	2. Low Temperature Rating 50°F entering water[2]	3.0 COP

For SI: °°F = 1.8°C + 32.
1 Air entering indoor section 70°F db/60°F wb (max.).
2 Water flow rate per manufacturer's specifications.

TABLE J4.4.3.3d
LARGE UNITARY HEAT PUMPS - AIR COOLED HEATING MODE-ELECTRICALLY-
OPERATED > 135,000 Btu/h COOLING CAPACITY
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE

REFERENCE STANDARDS	EFFICIENCY RATING	MINIMUM PERFORMANCE
ARI 340, as listed in Appendix A	COP (47°F)	2.9
Unitary Heat Pump Equipment	COP (17°F)	2.0

J4.4.3.3.2 Heat Pump Supplementary heater. The rated output capacity of a heat pump supplementary heating source shall not be greater than 125% of the design load as calculated in accordance with 780 CMR J4.4.2.1. The heat pump shall be installed with a control to prevent supplementary heater operation when the operating load can be met by the heat pump alone.

Supplementary heater operation is permitted during transient periods, such as start-ups, following room thermostat set-point advance and during defrost.

A two-stage thermostat, which controls the supplementary heat on its second stage, shall be accepted as meeting this requirement. The cut-on temperature for the compression heating shall be lower than the cut-on temperature for the supplementary heat, and the cut-off temperature for the compression heating shall be lower than the cut-off temperature for the supplementary heat. Supplementary heat may be derived from any source including, but not limited to, electric resistance, combustion heating or solar or stored-energy heating.

J4.4.3.4 HVAC system equipment, electrically operated, cooling mode. HVAC system equipment whose energy input in the cooling mode is entirely electric, shall have efficiency levels not less than the values in Tables J4.4.3.4a through J4.4.3.4f.

TABLE J4.4.3.4a
UNITARY AIR CONDITIONERS AND HEAT PUMPS - AIR COOLED, ELECTRICALLY OPERATED, <135,000 Btu/h COOLING CAPACITY - EXCEPT PACKAGED TERMINAL AND ROOM AIR CONDITIONERS STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE

REFERENCE STANDARD	CATEGORY	SUB-CATEGORY & RATING CONDITIONS (Outdoor Temperature °F)[1]	MINIMUM PERFORMANCE
ARI 210/240, as listed in Appendix A	<65,000 Btu/h Cooling Capacity Cooling Mode	Seasonal Rating[2]	
		Split systems	10.0 SEER
		Single Package	9.7 SEER
	≥65,000 Btu/h and <135,000 Btu/h Cooling Capacity Cooling Mode	Standard Rating (95°F db)	8.9 EER
		Integrated Part Load Value (80°F db)	8.3 IPLV

For SI: °F = 1.8°C + 32, 1 Btu/h = 0.2931 W.
1 db = dry bulb.
2 This is consistent with the National Appliance Energy Conservation Act of 1987 (Public Law 100-12).

TABLE J4.4.3.4b
UNITARY AIR CONDITIONERS AND HEAT PUMPS - EVAPORATIVELY COOLED, ELECTRICALLY OPERATED, AND COOLING MODE <135,000 Btu/h COOLING CAPACITY EXCEPT PACKAGED TERMINAL AND ROOM AIR CONDITIONERS STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE

REFERENCE STANDARD	CATEGORY (Cooling Capacity)	RATING CONDITIONS INDOOR / OUTDOOR (Temperature °F)[1]	MINIMUM PERFORMANCE
ARI 210/240, as listed in Appendix A	<65,000 Btu/h	Standard Rating 80°F db/67°F wb / 95°F db/75°F wb	9.3 EER
	<65,000 Btu/h	Integrated Part Load Value (80°F db/67°F wb)	8.5 IPLV
CTI Standard 201, as listed in Appendix A	≥65,000 but <135,000 Btu/h	Standard Rating 80°F db/67°F wb / 95°F. db/75°F wb	10.5 EER
	≥65,000 but <135,000 Btu/h	Integrated Part Load Value (80°F db/67°F wb)	9.7 IPLV

For SI: °F = 1.8°C + 32, 1 Btu/h = 0.2931 W.
1 db = dry bulb; wb = wet bulb.

TABLE J4.4.3.4c
WATER COOLED AIR CONDITIONERS AND HEAT PUMPS - ELECTRICALLY OPERATED, AND COOLING MODE <135,000 Btu/h COOLING CAPACITY STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE

REFERENCE STANDARD	CATEGORY (Cooling Capacity)	RATING CONDITIONS (Temperature °F)[1] INDOOR AIR	ENTERING WATER	MINIMUM PERFORMANCE
Water Source Heat Pump ARI 320, as listed in Appendix A CTI Standard 201, as listed in Appendix A	<65,000 Btu/h	Standard Rating 80°F db/67°F wb	85°F	9.3 EER
		Low Temperature Rating 80°F db/67°F wb	75°F	10.2 EER
	≥65,000 but <135,000 Btu/h	Standard Rating 80°F db/67°F wb	85°F	10.5 EER
Groundwater Cooled Heat Pumps ARI 325, as listed in Appendix A	<135,000 Btu/h	Standard Rating	70°F	11.0 EER
		Low Temperature Rating	50°F	11.5 EER
Water Cooled Unitary Air Conditioners ARI 210/240, as listed in Appendix A CTI Standard 201, as listed in Appendix A	≤65,000 Btu/h	Standard Rating 80°F db/67°F wb	85°F	9.3 EER
		Integrated Part Load Value	75°F	8.3 IPLV
	≥65,000 but <135,000 Btu/h	Standard Rating 80°F db/67°F wb	85°F	10.5 EER

For SI: °F = 1.8°C + 32, 1 Btu/h = 0.2931 W.
1 db = dry bulb; wb = wet bulb.

TABLE J4.4.3.4d
PACKAGED TERMINAL AIR CONDITIONERS - AIR COOLED, ELECTRICALLY OPERATED
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE

REFERENCE STANDARD	CATEGORY PTAC's & PTAC HEAT PUMPS	SUB-CATEGORY & RATING CONDITIONS (Outdoor Temperature)[1]	EFFICIENCY RATING	MINIMUM PERFORMANCE[2]
ARI Standard 310, as listed in Appendix A	Cooling Mode	Standard Rating (95°F db)	EER	10.0 - (0.16 x Cap/1,000)
		Low Temperature Rating (82°F db)	EER	12.2 - (0.20 x Cap/1,000)

For SI: °F = 1.8°C + 32, 1 Btu/h = 0.2931 W.
1 db = dry bulb.
2 Capacity (Cap) means the rated cooling capacity of the product in Btu/h in accordance with the cited ARI Standard. If the unit's capacity is less than 7,000 Btu/h, use 7,000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

TABLE J4.4.3.4e
ROOM AIR CONDITIONERS AND ROOM AIR CONDITIONER HEAT PUMPS
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE

REFERENCE STANDARDS	CATEGORY	MINIMUM PERFORMANCE[1]
ANSI/AHAM RAC-1-, as listed in Appendix A	Without Reverse Cycle and With Louvered Sides	
	<6,000 Btu/h	8.0 EER
	≥6,000 Btu/h and <8,000 Btu/h	8.5 EER
	≥8,000 Btu/h and <14,000 Btu/h	9.0 EER
	≥14,000 Btu/h and <20,000 Btu/h	8.8 EER
	≥20,000 Btu/h	8.2 EER
	Without Reverse Cycle and Without Louvered Sides	
	<6,000 Btu/h	8.0 EER
	≥6,000 Btu/h and <20,000 Btu/h	8.5 EER
	≥20,000 Btu/h	8.2 EER
	With Reverse Cycle and With Louvered Sides	8.5 EER
	With Reverse Cycle and Without Louvered Sides	8.0 EER

For SI: 1 Btu/h = 0.2931 W.
1 To be consistent with National Appliance Energy Conservation Act of 1987 (Public Law 100-12).

TABLE J4.4.3.4f
LARGE UNITARY AIR CONDITIONERS AND HEAT PUMPS ELECTRICALLY-OPERATED >135,000 Btu/h COOLING CAPACITY
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE

REFERENCE STANDARDS	EFFICIENCY RATING	MINIMUM PERFORMANCE	
Air-Conditioners	EER	≤760,000 Btu/h: 8.5	>760,000 Btu/h: 8.2
Air Cooled ARI 360, as listed in Appendix A	IPLV	7.5	
Air-Conditioners	EER	9.6	
Water/Evap. Cooled	IPLV	0.9	
CTI Standard 201, ARI 360, each as listed in Appendix A			
Heat Pumps[1]		<760,000 Btu/h	≥760,000 Btu/h
Air Cooled-Cooling.	EER	8.5	8.2
ARI 340, as listed in Appendix A	IPLV	7.5	
Condensing Units[2]	EER	9.9	
Air Cooled ARI 365, as listed in Appendix A	IPLV	11.0	
Condensing Units[2]	EER	12.9	
Water/Evap. Cooled	IPLV	12.9	
CTI Standard 201, ARI 365, each as listed in Appendix A			

For SI: 1 Btu/h = 0.2931 W.
1 For units that have a heating section, deduct 0.2 from all required EER's and IPLV's.
2 Condensing unit requirements are based on single-number ratings defined in paragraph 5.1.3.2 of UL 731, as listed in Appendix A

J4.4.3.5 Mechanical Ventilation: Each mechanical ventilation system (supply and/ or exhaust) shall be equipped with a readily accessible switch or other means for shutoff or volume reduction and shutoff when venti-lation is not required. Automatic or gravity dampers that close when the system is not operating, or other acceptable method to prevent air leakage through ducts, shall be provided for outdoor air intake and exhausts.

J4.4.3.5.1 780 CMR J4.4.3.5 applies to, but is not limited to, unitary (central) cooling equipment (air cooled, water cooled and evaporatively cooled), the cooling mode of unitary (central) and packaged terminal heat pumps (air source and water source), and packaged terminal air conditioners and room air conditioners.

J4.4.3.6 Applied HVAC system components, electrically operated, cooling mode: See 780 CMR 1305.3.3c.

J4.4.4 Transport energy: See 780 CMR 1305.3.9.

J4.4.5 Balancing: The HVAC system design shall provide means for balancing air and water systems. In doing so, the considerations shall include, but not be limited to, dampers, temperature and pressure test connections and balance valves.

J4.4.6 Controls.

J4.4.6.1 Temperature control: Each system shall be provided with at least one adjustable thermostat for the regulation of temperature. Each thermostat shall be capable of being set by adjustment or selection of sensors as follows:

J4.4.6.1.1 When used to control heating only: 55 to 75°F (12.8 to 23.9°C).

J4.4.6.1.2 When used to control cooling only: 70 to 85°F (21.1 to 29.4°C).

J4.4.6.1.3 When used to control both heating and cooling, it shall be capable of being set from 55 to 85°F (12.8 to 29.4°C) and shall be capable of operating the system heating and cooling in sequence. The thermostat and/or control system shall have an adjustable deadband of 10°F (5.6°C) or more.

J4.4.6.2 Humidity control: See 780 CMR 1305.2.4.2, 1305.3.4.5, and 1305.3.4.6.

J4.4.6.3 Zoning for temperature control.

J4.4.6.3.1 One and two family dwellings: At least one thermostat for regulation of space temperature shall be provided for each separate HVAC system. In addition, a readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to each zone or floor.

J4.4.6.3.2 Multifamily dwellings three stories or less in height: For multifamily dwellings, each individual dwelling unit shall have at least one thermostat for regulation of space temperature. A readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to each room. For spaces other than living units at least one thermostat for regulation of space temperature shall be provided for:

1. Each separate system.
2. Each separate zone as defined in 780 CMR J2. As a minimum, each floor of a building shall be consid-ered as a separate zone. In a multi-story building where the perimeter system offsets only the transmission losses of the exterior wall, an entire side of uniform exposure may be zoned separately. A readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to each floor.

J4.4.6.3.3 Control setback and shutoff: The thermostat required in 780 CMR J4.4.6.3.1 and J4.4.6.3.2 or an alternate means, including, but not limited to, a switch or a clock, shall provide a readily accessible manual or automatic means for reducing the energy required for heating and cooling during periods of non-use or reduced need including, but not limited to, unoccupied periods and sleeping hours. Lowering thermostat set points to reduce energy consumption of heating systems shall not cause energy to be expended to reach the reduced setting.

J4.4.7 Air-handling duct system insulation: Ducts, plenums, and enclosures installed in or on buildings shall be thermally insulated as follows:

J4.4.7.1 Duct systems, or portions thereof, shall be insulated to provide thermal resistance, as specified in Table J4.4.7.1.

Exceptions: Duct insulation, except as required to prevent condensation, is not required in the following cases:

1. When supply- or return-air ducts are installed in basements or cellars having insulated walls.
2. When the heat gain or loss of the ducts, without insulation, will not increase the energy requirements of the building.
3. Within HVAC equipment.
4. Exhaust air ducts.

TABLE J4.4.7.1
MINIMUM DUCT INSULATION[1]

	COOLING[2]		HEATING[3]	
Duct location	Annual Cooling Degree Days base 65°F CDD	Insulation *R*-Value[7] (h·ft²·°F)/Btu	Annual Heating Degree Days base 65°F	Insulation *R*-Value[7] (h·ft²·°F)/Btu
Exterior of building	below 500	3.3	4,501 to 7,500	6.5
	500 to 1,150	5.0	above 7,500	8.0
Inside of building envelope or in unconditioned spaces[4]				
TD[5]≤15	—	Not Required	—	Not Required
40≥TD[5]>15	—	3.3	—	3.3
TD[5]>40	—	5.0[6]	—	5.0[6]

For SI: °F = 1.8°C + 32, 1 (h·ft²·°F)/Btu = 0.176 m²k/W, 1 ft = 304.5 mm.

1. Insulation *R*-values shown are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and condensation. Where control of condensation is required, additional insulation, vapor retarders, or both, shall be provided to limit vapor transmission and condensation. For ducts which are designed to convey both heated and cooled air, duct insulation shall be as required by the most restrictive condition. Where exterior walls are used as plenum walls, wall insulation shall be as required by the most restrictive condition of 780 CMR J4.4.7.
2. Cooling ducts are those designed to convey mechanically cooled air or return ducts in such systems.
3. Heating ducts are those designed to convey mechanically heated air or return ducts in such systems.
4. Unconditioned spaces include basements, crawl spaces, and attics.
5. TD is defined as the temperature difference at design conditions between the space within which the duct is located and the design air temperature in the duct.
6. Insulation resistance for runouts to terminal devices less than ten feet in length is not required to exceed an R-value of R-3.3. [(h·ft²·°F)/Btu.]
7. Insulation resistance measured on a horizontal plane in accordance with ASTM C 518-85, Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus, at a mean temperature of 75°F at the installed thickness.

J4.4.8 Duct construction: As applicable, ductwork shall be constructed and erected in accordance with:

ACCA Manual D;
BOCA National Mechanical Code;
ASHRAE Handbook HVAC Systems and Equipment;
SMACNA, Installation Standards for Residential Heating and Air Conditioning Systems;
SMACNA, HVAC Duct Construction Standards - Metal and Flexible;
SMACNA Fibrous Glass Duct Construction Standards;
ASHRAE HVAC Applications Handbook;
NAIMA Fibrous Glass Duct Construction Standards, each as listed in Appendix A.

J4.4.8.1 High-pressure and medium-pressure ducts: See 780 CMR 1305.3.13.2.

J4.4.8.2 Duct sealing: The accessible joints, seams, and connections of all low-pressure supply and return ductwork that is located outside conditioned space, including stud bays or joist cavities/spaces used to transport air, shall be sealed using mastic with fibrous backing tape installed in accordance with the manufacturer's installation instructions. Other sealants may be approved by the Board of Building Regulations and Standards. For fibrous ducts, pressure sensitive tape may be used if installed in accordance with NAIMA Fibrous Glass Duct Construction Standards, as listed in Appendix A. Duct tape is not permitted as a sealant on any ducts.

Exception 1: Fibrous backing tape need not be used in the following cases:
1. On duct connections which are overlapped.
2. Where gaps are less than 1/8" in any dimension.
3. On flex duct connections with properly installed tension straps.

Exception 2: Lengthwise snap-lock joints on round or rectangular ducts need not be sealed if they are tight fitting.

J4.4.9 Piping insulation: Piping installed for space conditioning shall be thermally insulated in accordance with Table J4.4.9. For service water-heating systems, see 780 CMR J4.5.

Exceptions: Piping insulation is not required in the following cases:
1. Piping installed within HVAC equipment.
2. Piping at fluid temperatures between 55°F and 120°F (12.7°C and 48.9°C) when not required for energy conservation purposes.
3. When the heat loss and/or heat gain of the piping without insulation does not increase the energy requirement of the building.
4. When piping is installed in basements or cellars having insulated walls in one and two family dwellings.

TABLE J4.4.9
MINIMUM PIPE INSULATION[1] (Thickness in Inches)

PIPING SYSTEM TYPES	FLUID TEMPERATURE RANGE, °F	Pipe Sizes					
		Run Outs 2"[2]	1" and Less	1¼" to 2"	2½" to 4"	5" to 6"	8" and Larger
HEATING SYSTEMS Steam and hot water High pressure/temp	306-450	1½	2½	2½	3	3½	3½
Med. pressure/temp	251-305	1½	2	2½	2½	3	3
Low pressure/temp	201-250	1	1½	1½	2	2	2
Low temperature	120-200	½	1	1	1½	1½	1½
Steam condensate (for feed water)	Any	1	1	1½	2	2	2
COOLING SYSTEMS Chilled water,	40-55	½	½	¾	1	1	1
Refrigerant, or brine	below 40	1	1	1½	1½	1½	1½

For SI: 1 inch = 25.4 mm, °F = 1.8°C + 32, 1 ft = 304.8 mm.
1. For piping exposed to outdoor air, increase insulation thickness by ½ inch.
2. Runouts not exceeding 12 feet in length to individual terminal units.

J4.4.9.1 Other insulation thicknesses: Insulation thicknesses in Table J4.4.9 are based on insulation having thermal resistivity in the range of 4.0 to 4.6 h·ft²·°F/Btu per inch (0.704 to 0.810 m²k/W per 25 mm) of thickness on a flat surface at a mean temperature of 75°F (24°C).

Minimum insulation thickness shall be increased for materials having values less than 4.0, or may be reduced for materials having values greater than 4.6 as follows.

For materials with thermal resistively greater than 4.6, the minimum insulation thickness may be reduced as follows:

$$\frac{\text{4.6 x Table 503.9 Thickness}}{\text{Actual Resistivity}} = \text{New Minimum Thickness}$$

For materials with thermal resistively less than 4.0, the minimum insulation thickness shall be increased as follows:

$$\frac{\text{4.0 x Table 503.9 Thickness}}{\text{Actual Resistivity}} = \text{New Minimum Thickness}$$

J4.5 Service Water Heating

J4.5.1 Scope: The purpose of 780 CMR J4.5 is to provide criteria for design and equipment selection that will produce energy savings when applied to service water heating. Water supplies to ice making machines, refrigerators, and toilets shall be taken from a cold-water line of the water distribution system.

J4.5.2 Water heaters, storage tanks and boilers.

J4.5.2.1 Performance efficiency: Water heaters and hot water storage tanks shall meet the minimum performance of water heating equipment specified in Table J4.5.2. Where multiple criteria are listed, all criteria shall be met.

Exception: Storage water heaters. Storage water heaters and hot water storage tanks having more than 140 gallons (530L) of storage capacity need not meet the standby loss (*SL*) or heat loss (*HL*) requirements of table J4.5.2 if the tank surface area is thermally insulated to *R*-12.5 and if a standing pilot light is not used.

J4.5.2.2 Insulation: Heat loss from unfired hot-water storage tanks shall be limited to a maximum of 6.5 Btu/h/ft.² (20.5 W/m²) of external tank surface area, based on 80°F (176°C) water-air temperature difference.

Exception: Unfired hot water storage tanks having more than 500 gallons (1893 L) of storage capacity thermally insulated to *R*-12.5.

J4.5.2.3 Combination service water heating/ space heating boilers: Service water-heating equipment shall not be dependent on year-round operation of space heating boilers; that is, boilers that have as another function winter space heating.

Exceptions:
1. Systems for which the input rating of the combined system is less than 150,000 Btu.
2. Systems for which the combined system capacity (input rating or storage volume) is less than twice that of the smaller of the separate heaters required in a system with separate space and water heating.
3. Systems with service/space heating boilers having a standby loss (Btu/h) (W) less than:

$$\frac{13.3\ pmd\ 400}{n}$$

determined by the fixture count method where:
pmd =probable maximum demand in gallons/hour as determined in accordance with Chapter 37 of the ASHRAE HVAC Systems and Applications Handbook, as listed in Appendix A.
n =fraction of year when outdoor daily mean temperature exceeds 64.9°F (18.3°C)
The standby loss is to be determined for a test period of 24 hour duration while maintaining a boiler water temperature of 90°F (32.2°C) above an ambient of 60 to 90°F (15.6 to 32.2°C) and a five-foot (1524 mm) stack on appliance.

TABLE J4.5.2
MINIMUM PERFORMANCE OF WATER HEATING EQUIPMENT

CATEGORY	TYPE	FUEL	INPUT RATING	V_T[1]	INPUT TO V_r RATIO (Btu/h/gal)	TEST METHOD	ENERGY FACTOR[3]	THERMAL EFFICIENCY E_T%	STANDBY LOSS %/hr[7]
NAECA Covered Water Heating Equipment[4]	all	electric	≤12 kW	all[6]		Code of Federal Regulations, 10 CFR Part 430 Subpart B, Appendix E ANSI Z21.56, as listed in Appendix A	≥0.93-0.00132V		
	storage	gas	≤75,000 Btuh	all[6]			≥0.62-0.0019V		
	instantaneous	gas	≤200,000 Btuh[6]	all			≥0.62-0.0019V		
	storage	oil	≤105,000 Btuh	all			≥0.59-0.0019V		
	instantaneous	oil	≤210,000 Btuh	all			≥0.59-0.0019V		
pool heater		gal/oil	all	all				≥78%	
Other Water Heating Equipment[5]	storage	electric	all	all		ANSI Z21.10.3, as listed in Appendix A			≤0.30+27/V_r
			≥155,000 Btuh	all					
	storage/ instantaneous	gas/oil	>155,000 Btuh	all	<4,000			≥78%	≤1.3+114/V_r
				<10	<4,000			≥78%	≤1.3+95/V_r
				≥10	≥4,000			≥80%	—
					≥4,000			≥77%	≤2.3+67/V_r
Unfired Storage Tanks				all					≤6.5 Btuh/ square foot[8]

For SI: 1 Btuh/ft.^{2} = 3.155 W/m^2, 1 Btuh = 0.2931 W, 1 gallon = 3.785 L, °F. = 1.8°C + 32.

1. V_T is the storage volume in gallons as measured during the standby loss test. For the purpose of estimating the standby loss requirement using the rated volume shown on the rating plate, V_T should be no less than 0.95V for gas and oil water heaters and no less than 0.90V for electric water heaters.
3. V is rated storage volume in gallons as specified by the manufacturer.
4. Consistent with National Appliance Energy Conservation Act (NAECA) of 1987.
5. All except those water heaters covered by NAECA.
6. Code of Federal Regulations, 10 CFR Part 430 Subpart B, Appendix E, as listed in Appendix A, applies to electric and gas storage water heaters with rated volumes 20 gallons and gas instantaneous water heaters with input ratings of 50,000 to 200,000 Btuh.
7. When testing an electric storage water heater for standby loss using the test procedure of Section 2.9 of ANSI Z21.10.3-1990 Gas Water Heaters, Volume III, Circulating Tank, Instantaneous and Large Automatic Storage-Type Water Heaters, the electrical supply voltage shall be maintained within ±1% of the center of the voltage range specified on the voltage range specified on the water heater nameplate. Also, when needed for calculations, the thermal efficiency (Et) shall be 98%.

When testing an oil water heater using the test procedures of Section 2.8 and 2.9 of ANSI Z21.10.3, as listed in Appendix A, the following modifications will be made:

A vertical length of flue pipe shall be connected to the flue gas outlet of sufficient height to establish the minimum draft specified in the manufacturer's installation instructions. All measurements of oil consumption will be taken by instruments with an accuracy of ±1% or better.

The burner rate shall be adjusted to achieve an hourly Btu input rate within ±2% of the manufacturer's specified input rate with the CO_2 reading as specified by the manufacturer with smoke no greater than 1 and the fuel pump pressure within ±1% of the manufacturer's specification.

8. Heat loss of tank surface area (Btuh/ft.^{2}) based on 80°F. water-air temperature difference.

J4.5.3 Automatic controls: Service water-heating systems shall be equipped with automatic temperature controls capable of adjustment from the lowest to the highest acceptable temperature settings for the intended use. Temperature setting range shall be in accordance with Table 2 in Chapter 37 of ASHRAE HVAC Systems and Applications Handbook, as listed in Appendix A.

J4.5.4 Shutdown: A separate switch shall be provided to permit turning off the energy supplied to electric service water-heating systems. A separate valve shall be provided to permit turning off the energy supplied to the main burner(s) of all other types of service water-heating systems.

J4.5.5 Pump operation: Circulating hot-water systems shall be arranged so that the circulation pump(s) can be conveniently turned off, automatically or manually, when the hot-water system is not in operation.

J4.5.6 Pipe insulation: For re-circulating systems, piping heat loss shall be limited to a maximum of 17.5 Btu/h per linear foot (5.13 W per m^2) of pipe in accordance with Table J4.5.6, which is based on design external temperature no lower than 65°F (18.3°C). Other design temperatures must be calculated.

Exception: Piping insulation is not required when the heat loss of the piping, without insulation, does not increase the annual energy requirements of the building.

TABLE J4.5.6
MINIMUM PIPE INSULATION
(Thickness in Inches)

SERVICE WATER HEATING	PIPE SIZES[1]			
	Noncirculating Runouts	Circulating Mains and Runouts		
TEMPERATURES °F	Up to 1"	Up to 1¼"	1½" to 2"	Over 2"
170-180	0.5	1.0	1.5	2.0
140-160	0.5	0.5	1.0	1.5
100-130	0.5	0.5	0.5	1.0

For SI: 1 inch = 25.4 mm, °F = 1.8°C + 32.
1. Nominal iron pipe size and insulation thickness. Conductivity K = 0.27

J4.5.7 Swimming pools.

J4.5.7.1 All pool heaters shall be equipped with an ON-OFF switch mounted for easy access to allow shutting off the operation of the heater without adjusting the thermostat setting and to allow restarting without re-lighting the pilot light.

J4.5.7.2 Pool covers: Heated swimming pools shall be equipped with a pool cover.

Exception: Outdoor pools deriving over 20% of the energy for heating from renewable sources (computed over an operating season) are exempt from this requirement.

J4.5.7.3 Time clocks: Time clocks shall be installed so that the pump can be set to run in the off-peak electric demand period and can be set for the minimum time necessary to maintain the water in a clear and sanitary condition in keeping with applicable health standard.

J4.5.8 Conservation of hot water.

J4.5.8.1 Showers: Shower heads shall have a maximum flow rate of 2.5 gallons per minute (gpm) (0.158 L/s) at a pressure of 80 pounds per square inch (psi) (551 kPa) when tested in accordance with ASME A112.18.1, as listed in Appendix A.

J4.6 Electrical Power and Lighting.

J4.6.1 Electrical energy consumption: In multifamily dwellings, provisions shall be made to determine the electrical energy consumed by each tenant by separately metering individual dwelling units.

Exception: Motels, hotels, college dormitories and other transient facilities.

J4.6.2 Lighting power budget: The lighting system shall meet the applicable provisions of 780 CMR 1308.

Exception: One-and Two-Family dwellings and the dwelling portion of multifamily residential buildings.

780 CMR J5.0 RESIDENTIAL BUILDING DESIGN BY PRESCRIPTIVE PACKAGE

(Also see 780 CMR J1.1.3)
Compliance Approach #1

Notes:

1. The Prescriptive Package Approach is expectedly the most conservative for building envelope compliance. It does not require calculation of a building's thermal performance, but allows the user to simply select a set of components from a pre-determined group after establishing the weather site and glazing area of the building.
2. There is no interpolation or extrapolation allowed between packages in Table J5.2.1b.
3. The Prescriptive Package Approach (780 CMR J5.0) is intended for one and two-family detached buildings heated with fossil fuels and having glazing representing no more than 18% of the gross wall area. Also, such buildings must be either wood frame or mass wall construction (concrete, masonry, log): metal frame buildings are excluded.
4. For one and two-family buildings that do not meet the requirements in Note 3, and for all multi-family buildings, refer to 780 CMR J1.1.3. compliance alternatives 2. through 5.
5. Table J5.2.1b is based on a number of assumptions about the buildings it covers. These assumptions are stated fully in the Footnotes to that table, and should be reviewed to assure that the Table is suitable for use with any given proposed building.

J5.1 Scope.

J5.1.1 General: Buildings constructed to 780 CMR J5.0 that are heated and/or mechanically cooled shall meet the applicable requirements of 780 CMR J5.0 and 780 CMR J4.0.

J5.2 Exterior Envelope Requirements

J5.2.1 General: The various building assemblies (window, wall, ceiling, floor, etc.) shall conform to the thermal transmittance and resistance values in Table J5.2.1b.

TABLE J5.2.1a
HEATING DEGREE DAYS BASE 65 (HDD_{65})

City	HDD_{65}	City	HDD_{65}
Amherst	6404	Hyannis	6137
Barre Falls Dam	7699	Knightville Dam	7439
Bedford	6521	Lawrence	6322
Birch Hill Dam	7739	Lowell	6339
Blue Hill	6398	Middleton	6268
Boston	5641	Nantucket	5848
Brockton	6225	New Bedford	5426
Chatham	6058	Plymouth	6333
Chester	7279	Provincetown	6044
Clinton	6698	Reading	6573
Cummington Hill	7658	Rochester	6267
East Brimfield Lake	7027	South Weymouth	5936
East Wareham	6297	Springfield[1]	5754
Edgartown	5916	Stockbridge	7060
Falmouth	5713	Taunton	6346
Framingham	6262	Tully Lake	7552
Great Barrington	7445	West Medway	6650
Haverhill	6413	Worcester	6979
Hingham	6072		

Note 1: Table J5.2.1a is only utilized to support Table J5.2.1b.
Note 2: The heating degree day value for Springfield is only to be used for the cities and towns of Chicopee, Holyoke, West Springfield, Springfield, Agawam and Longmeadow. For all other surrounding towns of Springfield, design to the HDD value of Amherst.

Table J5.2.1b
Prescriptive Packages for One- and Two-Family Residential Buildings Heated with Fossil Fuels

	MAXIMUM		MINIMUM					
Package	Glazing Area[1] (%)	Glazing U-value[2]	Roof & Ceiling R-value[3]	Wall R-value[4]	Floor R-value[5]	Basement Wall R-value[6]	Slab Perimeter R-value[7]	Heating/Cooling Equipment Efficiency[8]
			Less than 5501 Heating Degree Days[9]					
A	up to 12%	0.50	38	13	19	10	6	minimum from J4 Tables
B	up to 12%	0.52	30	13	19	10	6	82 AFUE
C	12.1 to 15%	0.42	38	13	19	10	6	minimum from J4 Tables
D	12.1 to 15%	0.50	38	13	19	10	6	85 AFUE
E	15.1 to 18%	0.39	38	13	25	N/A	N/A	minimum from J4 Tables
F	15.1 to 18%	0.42	38	13	19	10	6	85 AFUE
			5501 to 5700 Heating Degree Days[9]					
G	up to 12%	0.46	38	13	19	10	6	minimum from J4 Tables
H	up to 12%	0.52	30	13	19	10	6	85 AFUE
I	12.1 to 15%	0.41	38	13	25	N/A	N/A	minimum from J4 Tables
J	12.1 to 15%	0.50	38	19	19	10	6	minimum from J4 Tables
K	12.1 to 15%	0.46	38	13	19	10	6	85 AFUE
L	15.1 to 18%	0.36	38	13	25	N/A	N/A	minimum from J4 Tables
M	15.1 to 18%	0.43	38	19	19	10	6	minimum from J4 Tables
N	15.1 to 18%	0.42	38	13	25	N/A	N/A	85 AFUE
O	15.1 to 18%	0.46	38	13	19	10	6	90 AFUE
P	15.1 to 18%	0.50	30	19	19	10	6	87 AFUE
			5701 to 6500 Heating Degree Days[9]					
Q	up to 12%	0.40	38	13	19	10	6	minimum from J4 Tables
R	up to 12%	0.52	30	19	19	10	6	minimum from J4 Tables

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	MAXIMUM		MINIMUM					
Package	Glazing Area[1] (%)	Glazing U-value[2]	Roof-Ceiling R-value[3]	Wall R-value[4]	Floor R-value[5]	Basement Wall R-value[6]	Slab Perimeter R-value[7]	Heating/Cooling Equipment Efficiency[8]
S	up to 12%	0.50	38	13	19	10	6	85 AFUE
T	12.1 to 15%	0.36	38	13	25	N/A	N/A	minimum from J4 Tables
U	12.1 to 15%	0.46	38	19	19	10	6	minimum from J4 Tables
V	12.1 to 15%	0.44	38	13	25	N/A	N/A	85 AFUE
W	12.1 to 15%	0.52	30	19	19	10	6	85 AFUE
X	15.1 to 18%	0.32	38	13	25	N/A	N/A	minimum from J4 Tables
Y	15.1 to 18%	0.42	38	19	25	N/A	N/A	minimum from J4 Tables
Z	15.1 to 18%	0.42	38	13	19	10	6	90 AFUE
AA	15.1 to 18%	0.50	30	19	19	10	6	90 AFUE
	Greater Than 6500 Heating Degree Days[9]							
BB	up to 12%	0.31	38	13	25	N/A	N/A	minimum from J4 Tables
CC	up to 12%	0.43	38	19	19	10	6	minimum from J4 Tables
DD	up to 12%	0.45	38	13	19	10	6	90 AFUE
EE	up to 12%	0.50	30	19	19	10	6	85 AFUE
FF	12.1 to 15%	0.40	38	13	25	N/A	N/A	90 AFUE
GG	12.1 to 15%	0.50	38	19	19	10	6	90 AFUE
HH	12.1 to 15%	0.43	38	19	19	10	6	85 AFUE
II	15.1 to 18%	0.35	38	13	25	N/A	N/A	90 AFUE
JJ	15.1 to 18%	0.35	30	19	19	10	6	90 AFUE
KK	15.1 to 18%	0.42	38	19	19	10	6	90 AFUE

N/A - This package may not be used for buildings with insulated Basement Walls or Slabs.

Footnotes to Table J5.2.1b:

1. Glazing area is the ratio of the rough opening area of the glazing assemblies (including sliding-glass doors, skylights, and basement windows if located in walls that enclose conditioned space, but excluding opaque doors) to the exterior wall gross area, expressed as a percentage. Up to 1% of the total glazing area may be excluded from the U-value requirement. For example, 3 ft^2 of decorative glass may be excluded from the U-value requirement of a building design with 300 ft^2 of glazing area.
2. After January 1, 1999, glazing U-values must be tested and documented by the manufacturer in accordance with the National Fenestration Rating Council (NFRC) test procedure, or taken from Table J1.5.3a. U-values are for whole units: center-of-glass U-values cannot be used.
3. The ceiling R-values do not assume raised or oversized framing construction. If the insulation achieves the full insulation thickness over the exterior walls without compression, or if non-compressible insulation is used to achieve full R-value, R-30 insulation may be substituted for R-38 insulation. Ceiling R-values represent the sum of cavity insulation plus insulating sheathing (if used). For ventilated ceilings, insulating sheathing must be placed between the conditioned space and the ventilated portion of the roof.
4. Wall R-values represent the sum of the wall cavity insulation plus insulating sheathing (if used). Do not include exterior siding, structural sheathing, and interior drywall. For example, an R-19 requirement could be met EITHER by R-19 cavity insulation OR R-13 cavity insulation plus R-6 insulating sheathing. Wall requirements apply to wood-frame or mass (concrete, masonry, log) wall constructions, but do not apply to metal-frame construction.
5. The floor requirements apply to floors over unconditioned spaces (such as unconditioned crawlspaces, basements, or garages). Floors over outside air must meet the ceiling requirements.
6. The entire opaque portion of any individual basement wall with an average depth less than 50% below grade must meet the same R-value requirement as above-grade walls. Windows and sliding glass doors of conditioned basements must be included with the other glazing. Basement doors must meet the door U-value requirement described in Note b.
7. The R-value requirements are for unheated slabs. Add an additional R-2 for heated slabs.
8. If the building utilizes electric resistance heating use the compliance approaches found in 780 CMR J6, 7, 8, or 9. If you plan to install more than one piece of heating equipment or more than one piece of cooling equipment, the equipment with the lowest efficiency must meet or exceed the efficiency required by the selected package.
9. For Heating Degree Day requirements of the closest city or town see Table J5.2.1a

NOTES:

a) Glazing areas and U-values are maximum acceptable levels. Insulation R-values are minimum acceptable levels. R-value requirements are for insulation only and do not include structural components.

b) Opaque doors in the building envelope must have a U-value no greater than 0.35. Door U-values must be tested and documented by the manufacturer in accordance with the NFRC test procedure or taken from the door U-value in Table J1.5.3b. If a door contains glass and an aggregate U-value rating for that door is not available, include the glass area of the door with your windows and use the opaque door U-value to determine compliance of the door. One door may be excluded from this requirement (i.e., may have a U-value greater than 0.35).

c) If a ceiling, wall, floor, basement wall, slab-edge, or crawl space wall component includes two or more areas with different insulation levels, the component complies if the average R-value is greater than or equal to the R-value requirement for that component. Average R-value must be calculated by applying area-weighted U-values to the components, and determining the reciprocals. Glazing or door components comply if the area-weighted average U-value of all windows or doors is less than or equal to the U-value requirement (0.35 for doors).

780 CMR J6.0 RESIDENTIAL BUILDING DESIGN BY COMPONENT PERFORMANCE

(Manual Trade-off or "Paper and Pencil" Approach)
(Also see 780 CMR J1.1.3)
Compliance Approach #2

Notes:

1. The Component Performance Approach shown in 780 CMR J6.0 is a design-specific alternative to the Prescriptive Package Approach of 780 CMR J5.0.
2. The Component Performance Approach allows for trade-offs between all building envelope components, and heating and cooling equipment efficiencies. This approach allows greater flexibility than that allowed in the Prescriptive Packages listed in Table J5.2.1b.
3. The Component Performance Approach may be used only for wood or metal framed buildings, 16" or 24" on center. For other framing materials or configurations, use 780 CMR J7.0, J8.0, or J9.0.

J6.1 Scope

J6.1.1 General: Buildings constructed to 780 CMR J6.0 that are heated and/or mechanically cooled shall meet all applicable requirements of 780 CMR J6.0 and 780 CMR J4.0.

J6.2 Exterior Envelope Requirements

J6.2.1 General: To determine thermal transmittance compliance with the various wall, roof and floor assemblies, the Trade-Off Worksheet must be completed using the figures and tables provided.

J6.2.2 Instructions for Using the Trade-off Approach:

STEP 1: Find your climate zone based on the county in which your building is to be located shown in Figure J6.2.2.

STEP 2: Complete the general information at the top of the Trade-off Worksheet.

STEP 3: Complete the PROPOSED section of the Trade-off Worksheet. Provide the area, R-value and U-value of each component. Use net areas for walls and roof assemblies that contain windows, doors, or skylights. U-values can be found in Tables J6.2.2a through J6.2.2g. R-values in tables are based on cavity insulation plus insulating sheathing (if used).

If more than one type of insulation or glass is used for a building component (i.e. two different R-values in the ceiling) use the additional blank lines for each R or U value provided in each block of the proposed section.

(**Note**: Remember that, for heated basements, foundation walls that are 50% and greater above grade are considered "Walls" while foundation walls less that 50% above grade are considered "Basement Walls."

STEP 4: Compute the total Proposed UA. Multiply all proposed U-values by their corresponding area. Enter the results in the UA column. Sum the proposed UAs for all components and enter this sum in the *Total Proposed UA* box. Also sum the areas for Ceilings and Walls, and enter in the "Total Area" boxes. Transfer these "Total Areas" to the respective Required "Area" boxes.

STEP 5: Complete the REQUIRED section of the Trade-Off Worksheet. Table J6.2.2h lists building component U-value requirements for each climate zone in Massachusetts. Enter the required U-values in the appropriate *Required U-value* column. Copy the total areas to the *Area* column of the *Required* side.

STEP 6: Multiply U-values in the Required column by their corresponding area; enter results in the UA column. Sum the UAs on the right side of the worksheet.

STEP 7: If high efficient HVAC is to be taken into account, complete the HVAC Trade-off Worksheet. Replace *Total Required UA* with HVAC adjusted UA (the new required UA will increase) from HVAC Trade-off worksheet.

STEP 8: Check for compliance. If the *Total Proposed UA* is less than or equal to the *Total Required UA* then your building complies with the thermal envelope requirements of Appendix J. If not, you must adjust insulation R-values, areas, and/or HVAC system efficiency in your proposed building.

FIGURE J6.2.2
State Map with Climate Zones

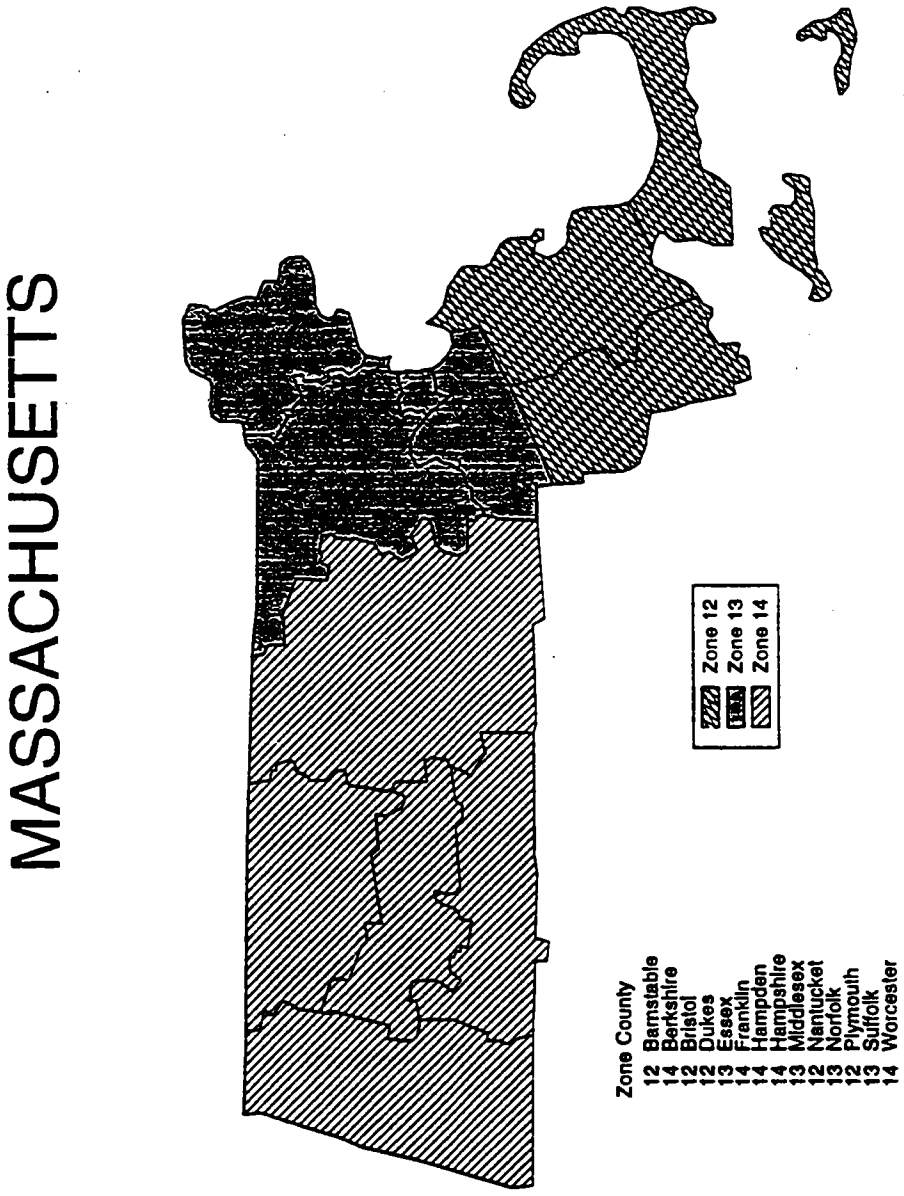

TABLE J6.2.2a
Ceiling U-values

Insulation R-Value[a]	Standard Framing *U-Value*	*Raised Framing* U-Value[b]	Insulation *R-Value*[a]	Standard Framing *U-Value*	*Raised Framing* U-Value[b]
R-0	0.568	0.568	R-33	0.033	0.029
R-7	0.119	0.119	R-34	0.032	0.028
R-8	0.108	0.108	R-35	0.032	0.028
R-9	0.098	0.098	R-36	0.031	0.027
R-10	0.089	0.089	R-37	0.031	0.026
R-11	0.082	0.082	R-38	0.030	0.025
R-12	0.076	0.076	R-39	0.030	0.025
R-13	0.070	0.070	R-40	0.029	0.024
R-14	0.066	0.066	R-41	0.029	0.024
R-15	0.062	0.061	R-42	0.028	0.023
R-16	0.059	0.058	R-43	0.028	0.023
R-17	0.056	0.055	R-44	0.027	0.022
R-18	0.053	0.052	R-45	0.027	0.022
R-19	0.051	0.049	R-46	0.027	0.021
R-20	0.048	0.047	R-47	0.026	0.021
R-21	0.047	0.045	R-48	0.026	0.020
R-22	0.045	0.043	R-49	0.026	0.020
R-23	0.043	0.041	R-50	0.026	0.020
R-24	0.042	0.040	R-51	0.025	0.019
R-25	0.040	0.038	R-52	0.025	0.019
R-26	0.039	0.037	R-53	0.025	0.019
R-27	0.038	0.035	R-54	0.025	0.018
R-28	0.037	0.034	R-55	0.024	0.018
R-29	0.036	0.033	R-56	0.024	0.018
R-30	0.035	0.032	R-57	0.024	0.018
R-31	0.034	0.031	R-58	0.024	0.017
R-32	0.034	0.030	R-59	0.024	0.017

(a) R-values represent the sum of the ceiling cavity insulation plus the R-value of insulating sheathing (if used.) For example, R-19 cavity insulation plus R-5 sheathing is reported as R-24 ceiling insulation. For ventilated ceilings, insulating sheathing must be placed between the conditioned space and the ventilated portion of the roof (typically applied to the trusses or rafters immediately behind the drywall or other ceiling finish material.)
(b) To receive credit for raised framing, the insulation must achieve its full thickness over the exterior walls, or non-compressible insulation must be used to achieve full R-value.

TABLE J6.2.2b
Wood Frame Wall U-values

Insulation R-Value[c]	16-in. O.C. *Wall U-Value*	*24-in. O.C.* Wall U-Value
R-0	0.238	0.241
R-7	0.105	0.104
R-8	0.099	0.097
R-9	0.094	0.092
R-10	0.090	0.088
R-11	0.089	0.087
R-12	0.085	0.083
R-13	0.082	0.080
R-14	0.079	0.077
R-15	0.077	0.074
R-16	0.066	0.064
R-17	0.064	0.062
R-18	0.062	0.060
R-19	0.060	0.059
R-20	0.059	0.057
R-21	0.057	0.056

Insulation R-Value[a]	16-in. O.C. *Wall U-Value*	*24-in. O.C.* Wall U-Value
R-22	0.056	0.054
R-23	0.055	0.053
R-24	0.054	0.052
R-25	0.053	0.051
R-26	0.052	0.050
R-27	0.051	0.049
R-28	0.050	0.048

(a) U-values are for **uncompressed** insulation.
(b) Wall R-values are the sum of the cavity insulation plus insulating sheathing (if used.)

TABLE J6.2.2c
16 inches O.C. Metal Frame Wall U-values

	Insulating Sheathing R-Value									
Cavity *R-Value*	R-0	*R-2*	R-3	*R-4*	R-5	*R-6*	R-7	*R-8*	R-9	*R-10*
R-0	0.270	0.205	0.170	0.146	0.127	0.113	0.101	0.092	0.084	0.078
R-11	0.120	0.106	0.096	0.087	0.080	0.074	0.069	0.065	0.061	0.057
R-13	0.114	0.100	0.091	0.084	0.077	0.072	0.067	0.063	0.059	0.056
R-15	0.109	0.096	0.088	0.081	0.075	0.070	0.065	0.061	0.058	0.054
R-19	0.101	0.090	0.083	0.077	0.071	0.066	0.062	0.059	0.055	0.052
R-21	0.098	0.088	0.081	0.075	0.070	0.065	0.061	0.058	0.054	0.052
R-25	0.094	0.085	0.078	0.073	0.068	0.063	0.060	0.056	0.053	0.051

TABLE J6.2.2d
24 inches O.C. Metal Frame Wall U-values

	Insulating Sheathing R-Value									
Cavity *R-Value*	R-0	*R-2*	R-3	*R-4*	R-5	*R-6*	R-7	*R-8*	R-9	*R-10*
R-0	0.270	0.205	0.170	0.146	0.127	0.113	0.101	0.092	0.084	0.078
R-11	0.106	0.104	0.086	0.080	0.074	0.069	0.064	0.060	0.057	0.054
R-13	0.100	0.98	0.082	0.076	0.071	0.066	0.062	0.058	0.055	0.052
R-15	0.094	0.093	0.078	0.073	0.068	0.063	0.060	0.056	0.053	0.051
R-19	0.088	0.086	0.074	0.069	0.064	0.060	0.057	0.054	0.051	0.049
R-21	0.085	0.084	0.072	0.067	0.063	0.059	0.056	0.053	0.050	0.048
R-25	0.081	0.080	0.069	0.064	0.060	0.057	0.054	0.051	0.049	0.046

TABLE J6.2.2e
Floor U-values

Insulation R-Value	Floor U-Value
R-0	0.249
R-7	0.096
R-11	0.072
R-13	0.064
R-15	0.057
R-19	0.047
R-21	0.044
R-26	0.037
R-30	0.033

TABLE J6.2.2f
Basement U-values

Insulation R-Value	Basement Wall *U-Value*	*Insulation* R-Value	Basement Wall *U-Value*
R-0	0.360	R-10	0.072
R-1	0.244	R-11	0.067
R-2	0.188	R-12	0.062
R-3	0.155	R-13	0.059
R-4	0.132	R-14	0.055
R-5	0.115	R-15	0.052
R-6	0.102	R-16	0.050
R-7	0.092	R-17	0.047
R-8	0.084	R-18	0.045
R-9	0.077	R-19	0.043
		R-20	0.041

(a) Insulation R-values represent the sum of exterior and/or interior insulation. Basement walls must be insulated from the top of the basement wall to ten ft. below ground level, or to the floor of the basement, whichever is less.

TABLE J6.2.2g
Slab F-values

	Slab U-Value	
Perimeter Insulation *R-Value*	*24-in.* Insulation Depth	48-in. *Insulation Depth*
R-0	1.04	1.04
R-1	0.91	0.89
R-2	0.86	0.83
R-3	0.83	0.79
R-4	0.82	0.76
R-5	0.80	0.74
R-6	0.79	0.73
R-7	0.79	0.71
R-8	0.78	0.70
R-9	0.77	0.69
R-10	0.77	0.68
R-11		0.68
R-12		0.67
R-13		0.66
R-14		0.66
R-15		0.65
R-16		0.65
R-17		0.65
R-18		0.64
R-19		0.64
R-20		0.64

TABLE J6.2.2h
U-value Requirements by Climate Zone

Climate Zone	Ceiling U-value	Single Family Wall *U-value*[1]	Multi-Family Wall *U-value*	*Floor U-value*	Basement Wall *U-value*	Unheated Slab *F-value*	Heated Slab *F-value*
12	0.026	0.13	0.22	0.05	0.079	0.80	0.79
13	0.026	0.12	0.20	0.05	0.078	0.74	0.71
14	0.026	0.11	0.18	0.05	0.077	0.73	0.70

Note 1: Buildings heated by electric resistance require a U=0.105 for a Single Family Wall U-value in all zones.

780 CMR: STATE BOARD OF BUILDING REGULATIONS AND STANDARDS

THE MASSACHUSETTS STATE BUILDING CODE

Manual Trade-Off Worksheet

Permit #
Checked By
Date

Builder Name _____ Date _____

Builder Address _____

Site Address _____ Zone ☐12 ☐13 ☐14

Submitted By _____ Phone _____

PROPOSED REQUIRED

Ceilings, Skylights, and Floors Over Outside Air

Description	Insulation R-Value	U-Value	x Net Area	=	UA	Required U-Value (Table J6.2.2h)	x Area	= UA
Ceiling (Table J6.2.2a)	19	.051	1530 ft²	→		.031		
Floor Over Outside Air (Table J6.2.2a)	23	.048	1530 ft²	→				
			ft²					
			ft²					
		Total Area	ft²	→				

Walls, Windows, and Doors

Description	Insulation R-Value	U-Value	x Net Area	=	UA	Required U-Value	x Area	= UA
Walls (Table J6.2.2b,c,d)			ft²	→				
Windows (NFRC or Table J1.5.3a)	—		ft²	→				
Doors (NFRC or Table J1.5.3b)	—		ft²	→				
Sliding Glass Doors (NFRC or Table J1.5.3a)	—		ft²	→				
			ft²					
			ft²					
		Total Area	ft²	→				

Floors and Foundations

Description	Insulation Depth	Insulation R-Value	U-Value	x Area or Perimeter	= UA	Required U-Value	x Area	= UA
Floor Over Unconditioned Space	(Table J6.2.2e)			ft²				
Basement Wall	(Table J6.2.2f)			ft²				
Unheated Slab (Table J6.2.2g)	in.			ft				
Heated Slab (Table J6.2.2g)	in.			ft				
				ft²				
				ft²				

Total Proposed UA **must be less than or equal to** ***Total (or Adjusted) Required UA***

Total Proposed UA

↔ ***Total Required UA***

OR ***Adjusted Required UA***

Statement of Compliance: The proposed building design represented in *these documents is consistent with the building plans, specifications,* and other calculations submitted with the permit application.

Builder/Designer *Company Name* *Date*

HVAC Trade-Off Worksheet

1. Calculate efficiency Increase in percent:

$\frac{EFF_{installed} - EFF_{standard}}{EFF_{standard}}$ = % increase ⟶ [ ]

2. Adjust the % increase according to Trade-off Ratio (Table 1 below):

(% increase X Trade-off Ratio) + 1 = **Adjusted Ratio** ⟶ [ ]

3. Adjust *Total Required UA* (from Manual Trade -Off Worksheet):

Total Required UA X **Adjusted Ratio = Adjusted Required UA** ⟶ [ ]

4. Use Adjusted Required UA as new *Total Required UA*, and check if *Total Proposed UA* is now less than or equal to it.

Total Proposed UA (from Manual Trade-Off Worksheet) [ ] ⟷ *Total Required UA* [ ]

Work Space:

Table 1
Trade-off Ratios

City/Town	HDD_{65}	Ratio, ß	City/Town	HDD_{65}	Ratio, ß
Amherst	6404	1.15	Hyannis	6137	1.13
Bedford	6521	1.15	Lawrence	6322	1.14
Blue Hill	6398	1.15	Middleton	6268	1.14
Boston	5641	1.11	Nantucket	5848	1.12
Brocton	6225	1.14	New Bedford	5426	1.10
Chatham	6058	1.13	Plymouth	6333	1.14
Clinton	6698	1.16	Provincetown	6044	1.13
East Wareham	6297	1.14	Rochester	6267	1.14
Edgartown	5916	1.13	Springfield	5754	1.12
Falmouth	5713	1.12	Stockbridge	7060	1.17
Framingham	6262	1.14	Taunton	6346	1.14
Haverhill	6413	1.15	Tully Lake	7552	1.19
			Worcester	6979	1.17

Table 2
NAECA Minimum Equipment Efficiencies[1]

Equipment Type	Minimum	Equipment Type	Minimum
Furnace	78 AFUE	Heat Pump: Heating Mode	6.8 HSPF
Boiler: Except Gas Steam	80 AFUE	Heat Pump: Cooling Mode	10 SEER
Boiler: Gas Steam	75 AFUE	Air Conditioner	10 SEER

1. Note: No Trade-off available for electric Resistance Heating.

780 CMR J7.0 RESIDENTIAL BUILDING DESIGN BY MAScheck SOFTWARE

(Also see 780 CMR J1.1.3)
Compliance Approach #3

Notes:

1. The MA*Scheck* Software produces similar results to the Component Performance Approach stated in 780 CMR J6.0. However, the software produces results in less time, performs trade-offs quickly, and creates a spread sheet of building components and an inspection report.
2. Installation and operating instructions are contained in the Users Guide, which comes with MAScheck Software.
3. Minimum computer requirements for operating MAScheck Software are:
   (a) a personal computer with the Intel 80386 (386) processor (or higher),
   (b) a 3½" diskette drive,
   (c) 530 kilobytes (KB) of conventional *RAM* memory,
   (d) a hard disk with 1 megabyte (MB) of free disk space,
   (e) *VGA* or Super *VGA* monitor,
   (f) MS-DOS Version 3.1 or later,
   (g) Microsoft-compatible mouse is highly recommended but not required.

J7.1 Scope

J7.1.1 General: Buildings constructed to 780 CMR J7.0 that are heated and/or mechanically cooled shall meet the applicable requirements of 780 CMR J7.0 and 780 CMR J4.0.

J7.2 Exterior Envelope Requirements

J7.2.1 General: To determine thermal transmittance compliance with the various wall, roof and floor assemblies, the MA*Scheck* Software analysis must be completed, and the "Your Home" UA value must be less than or equal to the "Required" UA value calculated by the software.

780 CMR J8.0 RESIDENTIAL BUILDING DESIGN BY SYSTEMS ANALYSIS

("Total Energy Analysis")
(Also see 780 CMR J1.1.3)
Compliance Approach #4

Notes:

1. The Systems Design Analysis outlined in 780 CMR J8.0 is the most refined means for Energy Code compliance.
2. If the proposed design takes credit for reduced air changes per hour (below 0.5 ACH), documentation of post-construction testing to verify air change rate shall be provided.
3. Calculation tools shall be approved by the BBRS.

J8.1 Scope

J8.1.1 General: 780 CMR J8 establishes design criteria in terms of total energy use by a residential building, including all of its systems.

J8.2 Systems Analysis

J8.2.1 Energy Analysis: Compliance with 780 CMR J8 will require an analysis of the annual energy usage, hereinafter called an annual energy analysis.

Exception: 780 CMR J4 and J6 establish criteria for different energy-consuming and enclosure elements of the building which, if followed, will eliminate the requirement for an annual energy analysis while meeting the intent of Appendix J.

A building designed in accordance with 780 CMR J8 will be deemed as complying with Appendix J if the calculated annual energy consumption is not greater than a similar building (defined as a "standard design") whose enclosure elements and energy-consuming systems are designed in accordance with 780 CMR J4 and J6.

For a proposed alternate building design to be considered similar to a "standard design," it shall utilize the same energy source(s) and equipment types for the same functions and have equal floor area and the same ratio of thermal envelope area to floor area, exterior design conditions, occupancy, climate data, and usage operational schedule.

Building designs and energy calculations shall be supported by documentation consistent with Massachusetts registration laws for engineers and architects, and otherwise consistent with the requirements of Appendix J.

J8.2.1.1 Input values for Group R buildings: The following input values shall be used in calculating annual energy performance. The requirements of 780 CMR J8 specifically indicate which variables shall remain constant between the standard building and the proposed building calculations. The standard building shall be a base-version of the design that directly complies with the provisions of Appendix J4 and J6. The proposed building may utilize a design that is demonstrated, through calculations satisfactory to the building official, to have equal or lower annual energy use than the standard design.

Glazing Systems	
Orientation of the standard design	Equal area on north, south, east and west exposures.
Shading, standard design	Draperies shall be assumed to be closed during periods of mechanical air conditioning operation. Glazing areas in the standard design shall not be provided with extra exterior shading beyond shading that is provided by typical construction practices—such as roof overhangs. Energy performance impacts of added exterior shading for glazing areas may be accounted for in the proposed design for a specific building, provided that the actual installation of such systems is approved by the building official. Results from exterior shading calculations on one proposed building shall not be used for groups of buildings.
Heat Storage (Thermal Mass)	
Internal mass	8 pounds per square foot (39 kg/m^2)
Structural mass	3.5 pounds per square foot (17 kg/m^2)
Passive solar building designs shall utilize at least 45 Btu/°F (26 kJ/°C) of additional thermal mass, per square foot (m^2) of added glass area, when added south-facing glass area exceeds 33% of the total glass area in walls.	
Building Thermal Envelope—Surface Area and Volume	
Floor, walls, ceiling	The standard and proposed designs shall have equal areas.
Foundation and floor type:	The foundation and floor type for both the standard and the proposed design shall be equal.
Glazings, including skylights	The area of glazing in the standard design shall not be greater than the area of glazing in the proposed design. The U_g-value of the standard design shall be selected to permit calculated U_o-wall compliance of the standard design.
Doors of TYPE I structures	The standard design shall have at least 40 square feet (3.7 m^2) of door area.
Building volume	The volumes of both the standard and proposed design shall be equal.
PARAMETER	**VALUE**
Thermostat (constants)	
Heating set point	68°F. (20°C.)
Cooling set point	78°F. (26°C.)
Night set back	60°F. (16°C.)
Set back duration	7 hours
Number of set-back periods	1(n)[a]
Maximum number of zones	2
Number of thermostats per zone	1
Internal Sensible Heat Gains (constants)	
TYPE I Units	1,500 Btu/hr (440 W)
TYPE II Units	3,000 Btu/hr (879 W)
Domestic Water Heater (calculate, then constants)	
Temperature set point	120°F (49°C)
Daily hot water consumption	Gallons = (30 x n^b - units) + (10 x n - bedrooms)

a units = number of living units in proposed design (n).
b bedrooms = number of bedrooms in each living unit.

Site Weather Data (constants)
The typical meteorological year (TMY), or its "Ersatz" equivalent, from the National Oceanic and Atmospheric Administration (NOAA), Table J3.2.1, or an approved equivalent, for the closest available location shall be used.

Distribution System Loss Factors

	Duct Location	
Mode	**Outside**	**Inside**
Heating	0.75	1.00
Cooling	0.80	1.00

The Heating and Cooling Systems Efficiency shall be proportionally adjusted for those portions of the ductwork located outside or inside the conditioned space using the values shown above, in the following equation:

Total Adjusted System Efficiency = Equipment Efficiency x Distribution Loss Factor x percent of ducts outside + Equipment Efficiency x Distribution Loss Factor x percent of ducts inside.

Note: Ducts located in a space which contains a positive heat supply shall be considered as in an inside location.

Air Infiltration

Air changes per hour (ACH) for the standard design is 0.50 (for purposes of calculation only).

If the proposed design takes credit for ACH levels below 0.50, results of a post-construction blower-door test shall be provided to the building official using Standard ASTM E 779, as listed in Appendix A.

J8.2.2 Design: The standard design, conforming to the criteria of Residential Building Design by Component Performance Approach or Residential Building Design by Acceptable Practice and the proposed alternative design shall be designed on a common basis as specified herein:

1. The comparison shall be expressed as Btu input per square foot of gross floor area per year at building site.
2. If the proposed alternative design results in an increase in consumption of one energy source and a decrease in another energy source, even though similar sources are used for similar purposes, the difference in each energy source shall be converted to equivalent energy units for purposes of comparing the total energy used.
3. The different energy sources shall be compared on the basis of energy use at the site where: 1 kWh = 3,413 Btu.

J8.2.3 Analysis Procedure: The analysis of the annual energy usage of the standard and the proposed alternative building and system design shall meet the following criteria:

1. The building heating and cooling load calculation procedures used for annual energy consumption analysis shall be detailed to permit the evaluation of effect of factors specified in 780 CMR J8.2.4.
2. The calculation procedure used to simulate the operation of the building and its service systems through a full-year operating period shall be detailed to permit the evaluation of the effect of system design, climatic factors, operational characteristics, and mechanical equipment on annual energy usage. Manufacturer's data or comparable field test data shall be used when available in the simulation of systems and equipment. The calculation procedure shall be based upon 8,760 hours of operation of the building and its service systems and shall utilize the design methods specified in ASHRAE Handbook of Fundamentals, ASHRAE HVAC Systems and Applications Handbook, ASHRAE, Energy Calculations I, ASHRAE, Energy Calculations II, each as listed in Appendix A.

J8.2.4 Calculation Procedure: The calculation procedure shall cover the following items:

1. Design requirements -- Environmental requirements as required in 780 CMR J3.
2. Climatic data -- Coincident hourly data for temperatures, solar radiation, wind and humidity of typical days in the year representing seasonal variation.
3. Building data -- Orientation, size, shape, mass, air, moisture, and heat transfer characteristics.
4. Operational characteristics -- Temperature, humidity, ventilation, illumination, control mode for occupied and unoccupied hours.
5. Mechanical equipment -- Design capacity, part load profile.
6. Building loads -- Internal heat generation, lighting, equipment, number of people during occupied and unoccupied periods.

J8.2.4.1 Use of Approved Calculation Tool: The same calculation tool shall be used to estimate the annual energy usage for space heating and cooling of the standard design and the proposed design.

J8.2.5 Documentation: Proposed alternative designs, submitted as requests for exception to the standard design criteria, shall be accompanied by an energy analysis comparison report. The report shall provide technical detail on the two building and system designs and on the data used in and resulting from the comparative analysis to verify that both the analysis and the designs meet the criteria of 780 CMR J8 of Appendix J.

Exception: Proposed alternative designs for one and two family dwellings and multifamily buildings having a conditioned floor area of 5,000 square feet (464 m^2) or less are exempted from the full-year analysis described in 780 CMR J8.3 and J8.4. However, comparison of heating, cooling and service water heating equipment energy consumption between the alternative design and the standard design shall be provided.

780 CMR J9.0 RESIDENTIAL BUILDING DESIGN UTILIZING RENEWABLE ENERGY SOURCES

(Also see 780 CMR J1.1.3)
Compliance Approach #5

Notes:

1. The Renewable Energy approach outlined in 780 CMR J9.0 allows for portions of a proposed building's energy use to be discounted when performing energy compliance calculations.
2. 780 CMR J9.0 must be used in conjunction with 780 CMR J8.0.

J9.0 Renewable Energy Source Analysis

J9.1 General: A proposed building utilizing solar, geothermal, wind or other renewable energy sources for all or part of its energy source shall meet the requirements of 780 CMR J8.0, except such renewable energy may be excluded from the total annual energy consumption allowed for the building by 780 CMR J8.0.

J9.1.1 To qualify for this exclusion, such renewable energy must be derived from a specific collection, storage, and distribution system. The solar energy passing through windows shall also be considered as qualifying if such windows are provided with:

Operable insulation shutters or other devices which, when drawn or closed, shall cause the window area to reduce maximum outward heat flows to those in accordance with 780 CMR J4.3.2.

J9.1.2 Exclusion shall be granted for solar energy passing through windows provided:

1. The glass is double or triple pane insulating glass with a low emittance coating on one or more air space surfaces of the glass, or insulating glass with a low-emittance plastic film suspended in the air space, and
2. The glass areas are shaded from direct solar radiation during periods when mechanical cooling is requested.

J9.1.3 Other criteria covered in 780 CMR J8.0 shall apply to the proposed alternative designs utilizing renewable energy sources of energy.

J9.2 Documentation: Proposed alternative designs submitted as requests for exception to the standard design criteria shall be accompanied by an energy analysis, as specified in 780 CMR J8.0. The report shall provide technical detail on the alternative building and systems designs and on the data employed in and resulting from the comparative analysis as to verify that both the analysis and the designs meet criteria of 780 CMR J8.0.

The energy derived from renewable sources and the reduction in conventional energy requirements derived from nocturnal cooling shall be separately identified from the overall building energy use. Supporting documentation on the basis of performance estimates for the aforementioned renewable energy sources or nocturnal cooling means must be submitted.

Exception: Proposed alternative designs for residential buildings of less than 20,000 square feet (1858 m^2) that derive a minimum of 30% of their total annual energy usage from renewable energy sources or from nocturnal cooling shall be exempt from the requirement of a full-year energy system analysis, providing that the annual input of such renewable sources or the extent of such nocturnal cooling can be expected to meet the demands imposed by the proposed alternative design.

780 CMR J10.0 VALIDITY

If a section, subsection, sentence, clause or phrase of Appendix J is, for any reason, held to be unconstitutional, such section shall not affect the validity of the remaining portions of 780 CMR.

J11.0 Home Energy Rating

J11.1 General: A proposed building, for which the builder or the buyer obtains a Home Energy Rating by an accredited Home Energy Rating System (HERS), will be considered to comply with the intent of Appendix J if the rating score on the building is 83.0 or more points.

J11.1.1 Accreditation: Accreditation of the rating organization or agency with the Residential Energy Services Network (RESNET) or the Massachusetts Division of Energy Resources is required for acceptance of the energy rating as a compliance tool for *Appendix J.*

J11.1.2 Rating Score: The minimum compliance score of 83 points will be based on the national HERS Council's guidelines for Home Energy Ratings, and the rating score shall be determined with an acceptable software analysis program as required by RESNET accreditation procedures, on a scale of 0-100 points.

J11.2 Documentation: Compliance report which includes a proposed Energy Rating score of 83.0 or more points, a description of the building's energy features, and a statement that the rating score is "based on plans" will be required for issuance of a building permit. A copy of the final rating certificate indicating the score of 83.0 or more points for the finished building will be submitted to the building official before the Certificate of Occupancy is issued.

APPENDIX J REFERENCED STANDARDS	
Standard Reference Number	**Where Referenced in Appendix J (by Section Number)**
ACCA Manual D	J4.4.8
ANSI/ASME PTC 4.1	Table J4.4.3.2a
ANSI/AHAM RAC-1	Table J4.4.3.4e
ANSI Z21.10.3	J4.5.2
ANSI Z21.47	Table J4.4.2.2c
ANSI Z21.56	J4.5.2
ANZI Z21.13	Tables J4.4.3.2a; J4.4.3.3b
ANZI Z83.8	Table J4.4.3.2b
ANZI Z83.9	Table J4.4.3.2b
ASHRAE HVAC Applications Handbook	J4.4.8
ASHRAE Handbook HVAC Systems and Equipment	J4.4.8
ASHRAE 55	J2.0
ASTM E 779	J8.2.1.1
ARI 210/240	Tables J4.4.3.3a; J4.4.3.4a-d
ARI 320	Tables J4.4.3.3c; J4.4.3.4c
ARI 325	Tables J4.4.3.3d; J4.4.3.4d
ARI 340	Tables J4.4.3.3d; J4.4.3.4f
ARI 360	Table J4.4.3.4f (also see 780 CMR 13, Table 1311.6)
ARI 365	Table J4.4.3.4f
ARI 380	J2.0; Table J4.4.3.3b
ARI 550	Table J4.4.3.4f (also see 780 CMR 13, Table 1311.6)
CTI Standard 201	Tables J4.4.3.4b,c and f (also see 780 CMR 13, Table 1311.6)
Code of Federal Regulations, 10 CFR Part 430, Subpart B, Test Procedures	J2.0; Tables J4.4.3.2a and c; Table J4.5.2
NAIMA Fibrous Glass Duct Construction Standards	J4.4.8
SMACNA Duct Construction Standards, Metal and Flexible	J4.4.8
SMACNA Fibrous Glass Duct Construction Standards	J4.4.8
UL 726	Table J4.4.3.2a
UL 727	Table J4.4.3.2c
UL 731	Tables J4.4.3.2b; J4.4.3.4f
UL 795	Table J4.4.3.2a

ACCA Air Conditioning Contractors of America, Washington, DC
ANSI American National Standards Institute, Inc.., New York, NY
ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA
ASTM American Society for Testing and Materials, Philadelphia, PA
ARI Air Conditioning and Refrigeration Institute, Arlington, VA
CTI Cooling Tower Institute, Houston, TX
NAIMA North American Insulation Manufacturers Association, Alexandria, VA
SMACNA Sheet Metal and Air Conditioning Contractors National Association, Inc., Chantilly, VA
UL Underwriters Laboratories, Northbrook, IL

APPENDIX K

FLOOR PROTECTOR THERMAL CONDUCTIVITY CALCULATIONS

(Reference 780 CMR 3610.7.1 and 3610.6.7.1.1)

OVERVIEW

Floor protection requirements for heat producing appliances are typically included as part of the tested/listed installation criteria for such appliances.

Such floor protection, listed as a thermal conductivity factor is often developed utilizing NFPA SUBJECT 1618, "OUTLINE OF INVESTIGATION FOR WALL PROTECTORS, FLOOR PROTECTORS, AND HEARTH EXTENSIONS". (Note that an NFPA SUBJECT is not treated nor maintained in the same manner as an NFPA STANDARD).

When floor protection is developed utilizing NFPA SUBJECT 1618, or developed via "good Engineering Practice", such methodology will typically establish floor protection based on 3/8 inch millboard.

As the thermal conductivity of such millboard can vary from manufacturer to manufacturer, it will be necessary to obtain the thermal conductivity value from a specific manufacturer for a specific millboard product.

Typical thermal conductivity values can range from:

$k = 0.21$ (Btu) (inch) / (foot^2) (hour) (°F)

to

$k = 0.84$ (Btu) (inch) / (foot^2) (hour) (°F)

Thus the necessity for product specific thermal conductivity.

Note that the lower the algebraic value of "k", the lower the thermal conductivity and the less heat per given time that is transferred across the *floor protector*.

Note that in the following discussions it is necessary to maintain consistent dimensions - i.e.; in dealing with the thickness of materials, do not mix feet with inches, but rather keep all dimensions in inches.

COMPLIANCE

If the manufacturer of the appliance specifies an acceptable material and thickness for floor protection it is necessary, utilizing that specific material with specific thermal conductivity, k, to meet or exceed the thickness specified in order to assure compliance with the listed floor protection requirements of the appliance.

ESTABLISHING EQUIVALENCY

If it is determined that another material of different thermal conductivity is desired to be utilized for floor protection (i.e., perhaps for aesthetic reasons or in order to minimize the thickness of the floor protector) and noting that the thermal conductivity, k, is linear as a function of thickness (for a given single material) then:

$$k_1/t_1 = k_2/t_2,$$

where:

k = thermal conductivity in

(Btu) (inch) / (foot^2) (hour) (°F) and

t = thickness in inches

and therefore knowing any three of the variables of k and t allows one to solve for the remaining variable; i.e.,

Knowing k_1, t_1 and t_2, one can solve for k_2:

$$k_2 = (k_1)\,(t_2)/(t_1)$$

Knowing k_1, t_1 and k_2, one can solve for t_2:

$$t_2 = (k_2)\,(t_1)/(k_1)$$

COMPOSITE FLOOR PROTECTOR ASSEMBLIES

When an assembly consists of more than one material, the assembly is defined as a composite "material".

When a floor protector is constructed of more than one material; i.e., some form of backer board with decorative tile over, it is helpful to first establish the thermal resistance, r, of each material as thermal resistances may be directly added together and then convert the resulting total R to an equivalent thermal conductivity.

r = (foot^2) (hour) (°F)/(Btu) (inch) and;

$R = (r)\,(t)$

where r is for a particular material in the composite and t is the thickness of that particular material.

Thus for the two-material example of backer board plus decorative tile,

$$R_{total} = R_{backer\ Board} + R_{decorative\ tile}$$

and;

$$R_{backer\ board} = (r_{backer\ board})\,(t_{backer\ board})$$

and;

$$R_{tile} = (r_{tile})\,(t_{tile})$$

RELATIONSHIP BETWEEN k AND R

By definition:

$R = (1/k)\,(t)$ for each distinct material

NON-TEXT PAGE

APPENDIX L

SCHEDULE OF FEES

L 1.0 Fee Schedule: In accordance with the authority conferred by M.G.L. c 143, § 94, the State Board of Building Regulations and Standards hereby establishes the following fees as specified in Table L-1.

Exceptions:

1. Fees for projects which are under the jurisdiction of a city or town shall be as duly established by said city or town in accordance with 780 CMR 114.0.
2. Fees for construction related licenses issued by a city or town shall be in accordance with fee schedules established by said city or town.
3. Fees for administrative appeals hearings in cities of towns having duly established building code appeals boards in accordance with 780 CMR 122 shall be as established by said city or town.

Table L-1

Fee Item	Period of Certification or Licensure	Fee (Dollars)	780 or M.G.L. Authority or Reference
Concrete Testing Laboratory			**780 CMR R1**
Initial license	One year	150.00	780 CMR R1.1.8
Renewal	One year	150.00	780 CMR R1.1.10
Concrete Test Technician - Class A			**780 CMR R2**
Initial license	One year	50.00	780 CMR R2.1.9
Renewal	One year	50.00	780 CMR R2.1.11
Initial license & Renewal Fees for employees of: municipalities, counties, Federal Government, Commonwealth of Massachusetts or any department, commission, agency or authority of, or created by the Commonwealth	One year	No Fee	780 CMR R2.1.9
Examination	Per exam	Note 1	780 CMR R2.1.7
Manufactured Buildings			**780 CMR R3**
Manufacturer - initial certification (per system)	One year	1200.00	780 CMR R3.18.1
Manufacturer -renewal of certification	One year	650.00	780 CMR R3.18.3
Labels per unit	Per label	50.00	780 CMR R3.18.4
Replacement label	Per label	2.00	780 CMR R3.18.4
Labels per component	Per label	2.00	780 CMR R3.18.4
Inspection Agency - initial certification	One year	500.00	780 CMR R3.18.2
Inspection Agency - certification renewal	One year	500.00	780 CMR R3.18.3
Registration of Producers of Native Lumber			**780 CMR R4**
Initial registration fee	Two years	50.00	780 CMR R4.1.4
Registration renewal	Two years	25.00	780 CMR R4.1.5
Construction Supervisor License (CSL)			**780 CMR R5**
Unrestricted license (any building enclosing up to 35,000 cubic feet of space)			
Initial license	Three years	150.00	780 CMR R5.2.5
Renewal	Two years	100.00	780 CMR R5.2.5
Examination fee	Per exam	Note 1	780 CMR R5.2.5
Restricted License (one and two family dwellings)			
Initial license	Three years	150.00	780 CMR R5.2.5
Renewal	Two years	100.00	780 CMR R5.2.5
Examination fee	Per exam	Note 1	780 CMR R5.2.5
Restricted License - Masonry only			
Initial license	Three years	150.00	780 CMR R5.2.5
Renewal	Two years	100.00	780 CMR R5.2.5
Examination fee	Per exam	25.00	780 CMR R5.2.5

780 CMR: STATE BOARD OF BUILDING REGULATIONS AND STANDARDS

THE MASSACHUSETTS STATE BUILDING CODE

Fee Item	Period of Certification or Licensure	Fee (Dollars)	780 or M.G.L. Authority or Reference
Home Improvement Contractor Registration			M.G.L. c 142A & 780 CMR R6
Initial Certification (applicants holding CSL License)	Two years	No fee	
Initial Application (all other applicants)	Two years	100.00	
Renewal (applicants holding CSL License)	Two years	No fee	
Renewal (all other applicants)	Two years	100.00	
Guaranty Fund Payment (upon initial registration - all applicants)			
0-3 employees	Note 2	100.00	
4-10 employees	Note 2	200.00	
11-30 employees	Note 2	300.00	
over 30 employees	Note 2	500.00	
Certification of Building Commissioners, Inspectors of Buildings and Local Inspectors.			M.G.L. c 143 § 3 & 780 CMR R7
Certification fee		no fee	
Examination registration		Note 1	
Continuing education programs provided directly by the Board of Building Regulations and Standards		Reserved	
State Building Code Appeal Board			M.G.L. c 143 § 100
Administrative Hearing	Per hearing	150.00	780 CMR 122.3.1
Structural Peer Review Advisory Board			780 CMR 125
Mediation Hearing		No fee	780 CMR 125.3
Building Permits and Construction Inspection for State Projects (except Massachusetts Bay Transportation Authority Projects) subject to 780 CMR and under the jurisdiction of the Department of Public Safety, Division of Inspections.			M.G.L. c 143 §§ 93 & 94 M.G.L. c 143 § 3A
Plans examination, construction inspection, issuance of building permit and certificate of and occupancy Note: This fee structure shall be deemed to include, but not be limited to, electrical, plumbing mechanical and fire protection work. Fees shall not be permitted to be levied by local jurisdictions.	Per building or structure.	0.001 times the contract amount (Note 3)	M.G.L. c 143 §§ 93 & 94
Massachusetts Bay Transportation Authority Projects			M.G.L. c 161A § 18
Massachusetts Bay Transportation Authority Projects subject to 780 CMR.		No fee	M.G.L. c 161A § 18
Periodic Inspections of Existing Buildings under the jurisdiction of the Division of Inspections, Department of Public Safety			780 CMR 106.5 & M.G.L. c 111
Hospitals and Clinics (certificate of inspection)			
First 100 beds	Two years	50.00	M.G.L. c 111§ 51
Each additional 25 beds	Two years	10.00	
Infirmaries; Convalescent Homes; Nursing Homes; Charitable Homes for the Aged; Rest Homes; Intermediate Care Facilities for the Mentally Retarded. (certificate of inspection)	Two years	50.00	M.G.L. c 111 § 71

780 CMR: STATE BOARD OF BUILDING REGULATIONS AND STANDARDS

SCHEDULE OF FEES

Fee Item	Period of Certification or Licensure	Fee (Dollars)	780 or M.G.L. Authority or Reference
Periodic Inspections of all other existing buildings.			M.G.L. c 143 § 94
Periodic inspections of specified use groups as specified by 780 CMR 106.5 and Table 106	As specified by 780CMR Table 106	As specified by 780CMR Table 106	780 CMR 106.5 and Table 106
Certification of Building Commissioners, Inspectors of Buildings, and Local Inspectors			M.G.L c.143 § 94 & § 99 & 780 CMR R7
Certification Preparation Course of Instruction		zero - 500.00 See Note 4	M.G.L c.143 § 94 & § 99 & 780 CMR R7 & the General Appropriation Act
Building Code Training			
One to Two Hour Session	.....	zero - 25.00 See Note 4	"
½ Day Training Session	.....	zero - 50.00 See Note 4	"
1 day Training Session	.....	zero - 100.00 See Note 4	"
Multi Session Training	.....	zero - 1000.00 See Note 4	"
Subscription to "Codeword" Educational Newsletter	1 year	16.00	"

Notes:

1. Examination fees established by examining institution.
2. M.G.L. c 142 A § 11 provides that additional payments into the guaranty fund may be required if the fund administrator determines that the amount of the fund is insufficient to maintain it at a level commensurate with claims made against said fund.
3. Contract amount, for the basis calculation of permit fees, shall include the entire scope of work of the project and shall include all incidental constructions. Contract amount, for the basis of calculation of permit fees, shall not be deemed to include design fees or any other professional fees associated with construction observation or supervision or construction management.
4. Fees for continuing education of building officials and building code training will be established by the agency and may vary due to costs associated with each individual training session. Cost of materials, space rental, and contracted instructors, may influence fees.