# INTRODUCTION

## Purpose and Structure

The Legislature, by s. 35.93 and ch. 227, Stats., directed the publication of the rules of executive agencies having rule–making authority in a loose–leaf, continual revision system known as the Wisconsin Administrative Code. The Code is kept current by means of new and replacement pages. The pages are issued monthly, together with notices of hearings, notices of proposed rules, notices of emergency rules, instructions for insertion of new material, and other information relating to administrative rules and the administrative rulemaking process. This service is called the Wisconsin Administrative Register, and comes to the subscriber near the middle and at the end of each month. Code pages are issued to subscribers only with the end of the month Register. The editing and publishing of the Register and Code is done by the Revisor of Statutes Bureau, Suite 800, 131 W. Wilson St., Madison, Wisconsin, 53703. E–mail–gary.poulson@legis.state.wi.us Telephone (608–266–7275).

## Availability

The complete code and the upkeep service are distributed to the county law libraries; to the libraries of the University of Wisconsin Law School and Marquette University Law School; to the State Historical Society; to the Legislative Reference Bureau and to the State Law Library, and to certain designated public libraries throughout the state.

The sale and distribution of the printed Register, Code and of its parts is handled by Department of Administration, Document Sales, P.O. Box 7840, Madison, Wisconsin 53707. (608–266–3358 information) (1–800–362–7253 or 608 264–9419 charge card orders).

The entire Code and Registers from January, 1996, can be found on the WisLaw® CD–ROM. End–user license and subscription order forms are available from Document Sales and Distribution.

The Code and Register can also be found on the internet at www.legis.state.wi.us/rsb

## Arrangement and Table of Contents

The Code is arranged in the complete set alphabetically by agency. Certain descriptors such as "Department" and "Wisconsin" are ignored for arrangement purposes. Several agencies further subdivide their rules either by program e.g. Department of Commerce – Plumbing or by division within the agency e.g. Department of Health & Family Services – Health, chs. HFS 110–. These Codes are arranged in numerical order within the appropriate alphabetical arrangement for the agency.

Each agency adopts a prefix to identify their rules. For example, the Department of Natural Resources uses "NR" before each chapter number.

Each Code with more than one chapter will have a table of chapters. After the title of each chapter will be the page numbers on which the chapter begins. Each chapter will have a table of sections.

## History Notes

Each page of the Code as it was originally filed and printed pursuant to the 1955 legislation, had a date line "1–2–56". A rule which is revised or created subsequent to the original printing date is followed by a history note indicating the date and number of the Register in which it was published and the date on which the revision or creation of the rule became effective. Additions to a section's history note will be shown in bold face when those affected code sections are first released. The absence of a history note at the end of a section indicates that the rule has remained unchanged since the original printing in 1956. The date line at the bottom of the page indicates the month in which the page was released, but does not necessarily mean a substantive change has occurred on that page. Some common abbreviations used in the history notes are: cr. - created, am. - amend, r. - repeal, recr. - recreate, renum. - renumber, eff. - effective and emerg. - emergency.

In some instances an *entire* chapter has been repealed and recreated or renumbered subsequent to the original printing date. When this occurs a note has been placed at the beginning of the chapter after the table of sections to contain this information. A separate history note appears after each section indicating the date when the revision or creation became effective.

## Emergency Rules

The Legislature has granted state agencies the authority to enact rules without using the normal rule–making process by publishing those rules in the official state newspaper. To justify the use of the emergency rule process, an agency must find that the preservation of the public peace, health, safety or welfare will be jeopardized without the emergency rule. Readers should review the current Wisconsin Administrative Register to see if a particular published rule is also affected by an emergency rule. Most emergency rules are eventually adopted as permanent rules and published in the Code.

## Index

The index for the complete Wisconsin Administrative Code will be found in the last volume of the complete set. It will be recompiled, reprinted and distributed at least 3 times a year. Some Codes have a separate index prepared by the agency involved. Agency prepared indexes tend to be more comprehensive than the general index prepared by the Revisor of Statutes. See the Uniform Dwelling Code (chs. Comm 20–25) and the Building and Heating Code (chs. Comm 50–64) as examples.

# Table of Contents

## DEPARTMENT OF COMMERCE

**Chapter**

# Chapter Comm 20

## ADMINISTRATION AND ENFORCEMENT



**Note:** Chapter ILHR 20 was renumbered chapter Comm 20 under s. 13.93 (2m) (b) 1., Stats., and corrections made under s. 13.93 (2m) (b) 6. and 7., Stats., Register, January, 1999, No. 517.

### Subchapter I—Purpose and Scope

**Comm 20.01 Purpose.** The purpose of this code is to establish uniform statewide construction standards and inspection procedures for one– and 2–family dwellings and manufactured dwellings in accordance with the requirements of ss. 101.60 and 101.70, Stats.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. Register, March, 1992, No. 435, eff. 4–1–92.

**Comm 20.02 Scope.** The provisions of chs. Comm 20 to 25 shall apply to the construction and inspection procedures used for all new one– and 2–family dwellings, manufactured buildings for dwellings and newly constructed community–based residential facilities providing care, treatment and services for 3 to 8 unrelated adults.

**(1)** MUNICIPAL ORDINANCES. (a) A municipality may not adopt an ordinance on any subject falling within the scope of this code including establishing restrictions on the occupancy of dwellings for any reason other than noncompliance with the provisions of this code as set forth in s. Comm 20.10 (1) (c). This code does not apply to occupancy requirements occurring after the first occupancy for residential purposes following the final inspection required under s. Comm 20.10 (1) (b) 4.

(b) This code shall not be construed to affect local requirements relating to land use, zoning, fire districts, side, front and rear setback requirements, property line requirements or other similar requirements. This code shall not affect the right of municipalities to establish safety regulations for the protection of the public from hazards at the job site.

(c) Any municipality may, by ordinance, require permits and fees for any construction, additions, alterations or repairs not within the scope of this code.

(d) Any municipality may, by ordinance, adopt the provisions of chs. Comm 20 to 25 to apply to any additions or alterations to existing dwellings.

**(2)** LEGAL RESPONSIBILITY. The department or the municipality having jurisdiction shall not assume legal responsibility for the design or construction of dwellings.

**(3)** RETROACTIVITY. The provisions of this code are not retroactive, except as specified in s. Comm 21.09.

**(4)** INNOVATIVE DWELLINGS. No part of this code is intended to prohibit or discourage the construction of innovative dwellings such as a dwelling built below ground, a geodesic dome, a concrete house, a fiber–glass house or any other nonconventional structure.

**(5)** LANDSCAPING. Except for construction erosion control, the scope of this code does not extend to driveways, sidewalks, landscaping and other similar features not having an impact on the dwelling structure.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (1) (intro.), cr. (1) (d), r. and recr. (6), Register, February, 1985, No. 350, eff. 3–1–85; r. (6), Register, January, 1989, No. 397, eff. 2–1–89; am. (3), Register, April, 1990, No. 412, eff. 5–1–90; am. (5), Register, September, 1992, No. 441, eff. 12–1–92; am. (1) (a), Register, November, 1995, No. 479, eff. 12–1–95.

**Comm 20.03 Effective date.** The effective date of ch. Comm 22 is December 1, 1978. The effective date of chs. Comm 20, 21, 23, 24 and 25 is June 1, 1980.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. Register, January, 1989, No. 397, eff. 2–1–89; correction made under s. 13.93 (2m) (b) 4., Stats., Register, January, 1989, No. 397.

**Comm 20.04 Applications. (1)** NEW DWELLINGS. (a) This code applies to all dwellings, dwelling units and foundations for dwelling units, for which the building permit application was made or construction commenced on or after the effective date of this code.

(b) All dwellings covered under par. (a) shall meet the requirements of ch. Comm 21.

(c) 1. The installation of heating, air conditioning, plumbing or electrical systems is not required.

2. If any of the systems under subd. 1. are installed, the systems and their installation shall comply with this code.

3. If a heating or air conditioning system is installed, the dwelling shall comply with ch. Comm 22.

**(2)** ADDITIONS OR ALTERATIONS. Additions or alterations to dwellings covered by this code shall comply with all provisions of this code, including the soil erosion provisions, at the time of permit application for addition or alteration.

**(3)** BED AND BREAKFAST ESTABLISHMENTS. The following portions of a bed and breakfast establishment shall comply with the provisions of this code:

(a) The third floor when used for other than storage.

(b) A structural addition, for which no use other than as a bed and breakfast establishment is proposed.

**Note:** See s. 254.61, Stats., for further conditions and limitations relating to bed and breakfast establishments.

**(4)** CHANGE OF USE. A building previously used for another purpose, such as a barn or garage, shall comply with this code upon conversion to residential use.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; cr. (3), Register, January, 1989, No. 397, eff. 2–1–89; am. (1), r. and recr. (3), Register, March, 1992, No. 435, eff. 4–1–92; r. and recr. (1), renum. (2) and (3) to be (3) and (4), cr. (2) and (5), Register, November, 1995, No. 479, eff. 12–1–95; **r. (3) and (4), renum. (1) to be (1) (a) and (5) to be (4), and cr. (1) (b), (c), and (3), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 20.05 Exemptions. (1)** EXISTING DWELLINGS. The provisions of this code shall not apply to dwellings and dwelling units, the construction of which was commenced prior to the effective date of this code, or to additions or alterations to such dwellings.

**Note:** The provisions of chs. Comm 20 to 25 may be adopted by a municipality to apply to any additions or alterations to existing dwellings.

**(2)** MULTIFAMILY DWELLINGS. The provisions of this code shall not apply to residences occupied by 3 or more families living independently or occupied by 2 such families and used also for business purposes.

**(3)** REPAIRS. The provisions of this code do not apply to repairs or maintenance to dwellings or dwelling units, or to the repair of electrical, plumbing, heating, ventilating, air conditioning and other systems installed therein.

**(4)** MOVING OF DWELLINGS. The status of a dwelling, new or existing, shall not be affected by the moving of the dwelling.

**(5)** ACCESSORY BUILDINGS. With the exception of s. Comm 21.08 (5), the provisions of this code do not apply to detached garages or to any accessory buildings detached from the dwelling.

**(6)** DETACHED DECKS. The provisions of this code do not apply to detached decks provided the deck does not serve an exit from the dwelling.

**(7)** FARM BUILDINGS. The provisions of this code do not apply to the buildings used exclusively for farm operations.

**(8)** INDIAN RESERVATIONS. The provisions of this code do not apply to dwellings located on Indian reservation land held in trust by the United States.

**(9)** RECREATIONAL VEHICLES AND MANUFACTURED OR MOBILE HOMES. The provisions of this code apply only to onsite installation or construction of an addition or alteration to a recreational vehicle or manufactured or mobile home, such as a stoop, deck, porch or exterior stairs, provided the recreational vehicle or manufactured or mobile home was produced after June 1, 1980.

**Note:** Chapter Comm 27 applies to the installation of piers if the manufacturer does not specify the pier requirements.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (5), r. (9), Register, January, 1989, No. 397, eff. 2–1–89; r. and recr. (8), Register, March, 1992, No. 435, eff. 4–1–92; am. (3), Register, November, 1995, No. 479, eff. 12–1–95; **r. (8), renum. (6) and (7) to be (7) and (8) and cr. (6) and (9), Register, March, 2001, No. 543, eff. 4–1–01.**

## Subchapter II—Jurisdiction

**Comm 20.06 Procedure for municipalities exercising jurisdiction. (1)** MUNICIPAL JURISDICTION. Pursuant to ss. 101.65 and 101.76, Stats., cities, villages, towns and counties may exercise jurisdiction over the construction and inspection of new dwellings. Municipalities intending to exercise jurisdiction shall adopt the Uniform Dwelling Code in its entirety. No additional standards within the scope of this code shall be adopted by the municipality unless specific approval has been granted by the department pursuant to s. Comm 20.20. No such municipality shall exercise jurisdiction except in accordance with the following procedure.

(a) *Intent to exercise jurisdiction.* Municipalities intending to exercise jurisdiction shall notify the department, in writing, at least 30 days prior to the date upon which the municipality intends to exercise jurisdiction under this code. The notification of intent shall include a statement by the municipality as to which of the following methods will be used for enforcement:

1. Individual municipal enforcement;
2. Joint municipal enforcement;
3. Contract with certified UDC inspector or inspectors or independent inspection agency;
4. Contract with another municipality;
5. Contract with the department.

(b) *Submission of ordinances.* Municipalities intending to exercise jurisdiction shall submit all ordinances adopting the uniform dwelling code to the department at the same time as the notice of intent. The department shall review and make a determination regarding municipal intent to exercise jurisdiction over new dwellings within 15 business days of receipt of the municipal ordinances adopting the uniform dwelling code. A municipality may appeal a determination by the department that an ordinance does not comply with the code. Any appeal shall follow the procedure set out in s. Comm 20.21 (2).

(c) *Passage of ordinances.* A certified copy of all adopted ordinances and subsequent amendments thereto shall be filed with the department within 30 days after adoption.

**Note:** A copy of a model ordinance for adoption is available from the department.

**(2)** COUNTY JURISDICTION. A county ordinance shall apply in any city, village or town which has not enacted ordinances pursuant to this section. No county ordinance may apply until after 30 business days after the effective date of this code unless a municipality within the county informs the department of its intent to have this code administered and enforced by the county. This section shall not be construed to prevent or prohibit any municipality from enacting and administering this code at any time after the effective date of this code. The department shall review and make a determination regarding county jurisdiction over new buildings within 15 business days of receipt of the county ordinances adopting the uniform dwelling code.

**Note:** Section 101.651 (3m) and (3s), Stats., allows counties to adopt just the provisions of this code relating to construction site erosion control.

**Note:** Section 101.651 (3m) and (3s), Stats., state that counties with a uniform dwelling code erosion control ordinance enforcement program shall enforce the erosion control ordinance provisions on a county–wide basis in all townships which have not adopted the Uniform Dwelling Code and may do so in cities and villages which have not adopted the Uniform Dwelling Code.

**(3)** DEPARTMENTAL JURISDICTION. Pursuant to ss. 101.63 and 101.73, Stats., the department will administer and enforce this code in any municipality which has not adopted, or is not covered by, an ordinance adopted in accordance with this section.

**Note:** Every 3 years the department will perform performance audits of the erosion control programs of the municipalities administering the program and issue a written determination on whether the municipality complies with the erosion control ordinances and the erosion control standards.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (1) (b) and (2), Register, February, 1985, No. 350, eff. 3–1–85; am. (1) (a) 3., Register, October, 1996, No. 490, eff. 11–1–96.

## Subchapter III—Definitions

**Comm 20.07 Definitions.** In chs. Comm 20 to 25:

**(1)** "Accessory building" means a detached building, not used as a dwelling unit but is incidental to that of the main building and which is located on the same lot. Accessory building does not mean farm building.

**(2)** "Addition" means new construction performed on a dwelling which increases the outside dimensions of the dwelling.

**(3)** "Allowable stress" means the specified maximum permissible stress of a material expressed in load per unit area.

**(4)** "Alteration" means an enhancement, upgrading or substantial change or modification other than an addition or repair to a dwelling or to electrical, plumbing, heating, ventilating, air conditioning and other systems within a dwelling.

**(5)** "Approved" means an approval by the department or its authorized representative. (Approval is not to be construed as an

assumption of any legal responsibility for the design or construction of the dwelling or building component.)

**(6)** "Attic" means a space under the roof and above the ceiling of the topmost part of a dwelling.

**(7)** A "balcony" is a landing or porch projecting from the wall of a building.

**(7m)** "Base flood elevation" means the depth or peak elevation of flooding, including wave height, which has a one percent or greater chance of occurring in any given year.

**(8)** "Basement" means that portion of a dwelling below the first floor or groundfloor with its entire floor below grade.

**(8m)** "Best management practices" is defined in s. 101.653, Stats., and means practices, techniques or measures that the department determines to be effective means of preventing or reducing pollutants of surface water generated from construction sites.

**(9)** "Building component" means any subsystem, subassembly or other system designed for use in or as part of a structure, which may include structural, electrical, mechanical, plumbing and fire protection systems and other systems affecting health and safety.

**(10)** "Building system" means plans, specifications and documentation for a system of manufactured building or for a type or a system of building components, which may include structural, electrical, mechanical, plumbing and variations which are submitted as part of the building system.

**(10m)** "Business day" means any day other than Saturday, Sunday or a legal holiday.

**(11)** "Ceiling height" means the clear vertical distance from the finished floor to the finished ceiling.

**(12)** "Certified inspector" means a person certified by the department to engage in the administration and enforcement of this code.

**(13)** A "chimney" is one or more vertical, or nearly so, passageways or flues for the purpose of conveying flue gases to the atmosphere.

**(14)** "Chimney connector". Same as smoke pipe.

**(15)** "Closed construction" means any building, building component, assembly or system manufactured in such a manner that it cannot be inspected before installation at the building site without disassembly, damage or destruction.

**(15g)** "Coarse aggregate" means granular material, such as gravel or crushed stone, that is predominately retained on a sieve with square openings of 4.75 mm or 0.18 inch.

**(15m)** "Coastal floodplain" means an area along the coast of Lake Michigan or Lake Superior below base flood elevation that is subject to wave runup or wave heights of 3 feet or more.

**(16)** "Code" means chs. Comm 20 to 25, the Wisconsin uniform dwelling code.

**(17)** "Combustion air" means the total amount of air necessary for the complete combustion of a fuel.

**(19)** "Compliance assurance program" means the detailed system documentation and methods of assuring that manufactured dwellings and dwelling components are manufactured, stored, transported, assembled, handled and installed in accordance with this code.

**(19m)** "Composting toilet system" means a method that collects, stores and converts by bacterial digestion nonliquid–carried human wastes or organic kitchen wastes, or both, into humus.

**(20)** "Cooling load" is the rate at which heat must be removed from the space to maintain a selected indoor air temperature during periods of design outdoor weather conditions.

**(21)** "Dead load" means the vertical load due to all permanent structural and nonstructural components of the building such as joists, rafters, sheathing, finishes and construction assemblies such as walls, partitions, floors, ceilings and roofs, and systems.

**(21m)** "Deck" means an unenclosed exterior structure, attached or adjacent to the exterior wall of a building, which has a floor, but no roof.

**(23)** "Department" means the department of commerce.

**(24)** "Detached building" means any building which is not physically connected to the dwelling.

**(24m)** "Dilution air" means air that is provided for the purpose of mixing with flue gases in a draft hood or draft regulator.

**(24r)** "Direct–vent appliance" means a gas–burning appliance that is constructed and installed so that all air for combustion is derived directly from the outside atmosphere and all flue gases are discharged to the outside atmosphere.

**(25)** "Dwelling" means any building, the initial construction of which is commenced on or after the effective date of this code, which contains one or 2 dwelling units.

**(26)** "Dwelling contractor" means any person, firm or corporation engaged in the business of performing erosion control or construction work such as framing, roofing, siding, insulating, masonry or window replacement work covered under this code and who takes out a building permit. "Dwelling contractor" does not include the owner of an existing dwelling, an owner who will reside in a new dwelling or a person, firm or corporation engaging exclusively in electrical, plumbing, or heating, ventilating and air conditioning work.

**(27)** "Dwelling unit" means a structure, or that part of a structure, which is used or intended to be used as a home, residence or sleeping place by one person or by 2 or more persons maintaining a common household, to the exclusion of all others.

**(28t)** "Erosion" means the detachment and movement of soil, sediment or rock fragments by water, wind, ice or gravity.

**(28v)** "Erosion control procedure" means a practice or a combination of practices implemented to prevent or reduce erosion and the resulting deposition of soil, sediment or rock fragments into waters of the state, public sewers or off the owner's land. These procedures include, but are not limited to, silt or filter fences, straw or hay bales, tarps or riprap, berms, sediment basins or vegetative strips.

**Note:** See Appendix for examples and illustrations.

**(29)** "Exit" means a continuous and unobstructed means of egress to a street, alley or open court and includes intervening doors, doorways, corridors, halls, balconies, ramps, fire escapes, stairways and windows.

**(29m)** "Existing dwelling" means a dwelling erected prior to the effective date of this code, one for which a valid building permit exists, or one for which lawful construction has commenced prior to the effective date of this code.

**Note:** See s. Comm 20.03 for the effective date of chs. Comm 20–25.

**(30)** "Farm operation" is the planting and cultivating of the soil and growing of farm products substantially all of which have been planted or produced on the farm premises.

**Note:** According to s. 102.04 (3), Stats., the farm operation includes the management, conserving, improving and maintaining of the premises, tools, equipment improvements and the exchange of labor or services with other farmers; the processing, drying, packing, packaging, freezing, grading, storing, delivery to storage, carrying to market or to a carrier for transportation to market and distributing directly to the consumer; the clearing of such premises and the salvaging of timber and the management and use of wood lots thereon but does not include logging, lumbering and wood–cutting operations unless the operations are conducted as an accessory to other farm operations.

**(31)** "Farm premises" is defined to be the area which is planted and cultivated. The farm premises does not include greenhouses, structures or other areas unless used principally for the production of food or farm products.

**(32)** "Farm products" are defined as agricultural, horticultural and arboricultural crops. Animals considered within the definition of agricultural include livestock, bees, poultry, fur–bearing animals, and wildlife or aquatic life.

**(33)** "Farming" means the operation of a farm premises owned or rented by the operator.

**(33m)** "Fireblocking" means a material or device used to retard or prevent the spread of flame or hot gases through concealed spaces into adjacent rooms or areas.

**(34)** "Firebox" means that part of the fireplace used as the combustion chamber.

**(34e)** "First floor" means the first floor level above any groundfloor or basement or, in the absence of a groundfloor or basement, means the lowest floor level in the dwelling.

**(34f)** "Flight" means a continuous series of steps with no intermediate landings.

**(34g)** "Floodfringe area" means that portion of the floodplain outside of the floodway that is at or below base flood elevation. The term "floodfringe" is intended to designate an area of standing, rather than flowing, water.

**(34h)** "Floodplain" means land which is subject to flooding which is at or below base flood elevation. The floodplain includes the floodway and floodfringe areas.

**(34i)** "Floodway" means the channel of a river or stream and those portions of the floodplain adjoining the channel required to carry the flood discharge. The term "floodway" is intended to designate an area of flowing, rather than standing, water.

**(34m)** "Floor area" means the area of a room that has a ceiling height of at least 7 feet. Rooms with ceilings less than 7 feet in height for more than 50% of the room are not considered to be floor areas.

**(35)** "Garage" means an unenclosed or enclosed portion of a dwelling used for storing motorized vehicles.

**(36)** "Gas appliance" means any device that uses gas as a fuel or raw material to produce light, heat, power, refrigeration or air conditioning.

**(36m)** "Groundfloor" means that level of a dwelling, below the first floor, located on a site with a sloping or multilevel grade and which has a portion of its floor line at grade.

**(37)** "Habitable room" means any room used for sleeping, living or dining purposes, excluding such enclosed places as kitchens, closets, pantries, bath or toilet rooms, hallways, laundries, storage spaces, utility rooms, and similar spaces.

**(38)** "Hearth" means the floor area within the fire chamber of a fireplace.

**(38m)** "Hearth extension" means the surfacing applied to the floor area extending in front of and at the sides of the fireplace opening.

**(40)** "Heating load" is the estimated heat loss of each room or space to be heated, based on maintaining a selected indoor air temperature during periods of design outdoor weather conditions. The total heat load includes: the transmission losses of heat transmitted through the wall, floor, ceiling, glass or other surfaces; and either the infiltration losses or heat required to warm outdoor air used for ventilation.

**Note:** Infiltration losses include heat required to warm outside air which leaks through cracks and crevices, around doors and windows or through open doors and windows.

**(40m)** "Hollow unit" means a masonry unit which has a net cross–sectional area parallel to the bearing face which is less than 75% of the gross cross–sectional area.

**(40t)** "Incinerating toilet" means a self–contained device for the treatment of nonliquid carried wastes that deposits the wastes directly into a combustion chamber, reduces the solid portion to ash and evaporates the liquid portion.

**(41)** "Independent inspection agency" means any person, firm, association, partnership or corporation certified by the department to perform certified inspections under this code.

**(42)** "Initial construction" means the date of issuance of the Wisconsin uniform building permit.

**(43)** "Insignia." See "Wisconsin insignia."

**(44)** "Installation" means the assembly of a manufactured building on site and the process of affixing a manufactured building to land, a foundation, footing or an existing building.

**(46)** "Kitchen" means an area used, or designed to be used, for the preparation of food.

**(47)** "Landing" means the level portion of a stairs located between flights of stairs or located at the top and foot of a stairs.

**(48)** "Listed and listing" means equipment or building components which are tested by an independent testing agency and accepted by the department.

**(49)** "Live load" means the weight superimposed on the floors, roof and structural and nonstructural components of the dwelling through use and by snow, ice or rain.

**(50)** "Loft" means an upper room or floor which has at least 50% of the common wall open to the floor below. The opening may be infringed upon by an open guardrail constructed in compliance with s. Comm 21.04 (2), but not by a window or half–wall guardrail. All habitable rooms of lofts are open to the floor below.

**(51)** "Manufacture" means the process of making, fabricating, constructing, forming or assembling a product from raw, unfinished, semifinished or finished materials.

**(52)** (a) "Manufactured dwelling" means any structure or component thereof which is intended for use as a dwelling and:

1. Is of closed construction and fabricated or assembled on site or off site in manufacturing facilities for installation, connection or assembly and installation at the building site; or

2. Is a building of open construction which is made or assembled in manufacturing facilities away from the building site for installation, connection, or assembly and installation on the building site and for which certification is sought by the manufacturer.

(b) The term manufactured dwelling does not include a building of open construction which is not subject to par. (a) 2. A single or double width manufactured (mobile) home is not considered a manufactured dwelling and is not subject to this code.

**(53)** "Mechanical draft venting system" means a venting system for a gas burning appliance that is designed to remove flue or vent gases by mechanical means, such as a fan, which may consist of an induced draft portion under non–positive static pressure or a forced draft portion under positive static pressure.

**(53m)** "Multiple station smoke alarm" means an assembly that incorporates the smoke detector, the control equipment and the alarm–sounding device in one unit that is capable of being interconnected with one or more additional alarms so that the actuation of one alarm causes the operation of all interconnected alarms.

**(54)** A "multi–wythe wall" is a masonry wall composed of 2 or more wythes of masonry units tied or bonded together.

**(55)** "Municipality" means any city, village, town or county in this state.

**(55m)** "Naturally vented appliance" means an appliance with a venting system designed to remove flue or vent gases under non–positive static vent pressure entirely by natural draft.

**(56)** "Open construction" means any building, building component, assembly or system manufactured in such a manner that it can be readily inspected at the building site without disassembly, damage or destruction.

**(57)** "Owner" means any person having a legal or equitable interest in the dwelling.

**(58)** "Perm" means a unit of permeance which is measured in grains per (hour) (square foot) (inch of mercury vapor pressure difference).

**Note:** The lower the perm rating of a material is, the more difficult it is for water vapor to pass through it.

**(59)** "Pilaster" is a projection of masonry or a filled cell area of masonry for the purpose of bearing concentrated loads or to stiffen the wall against lateral forces.

**(59m)** "Porch" means an unenclosed exterior structure at or near grade attached or adjacent to the exterior wall of any building, and having a roof and floor.

**(59t)** "Privy" means an enclosed nonportable toilet into which nonwater–carried human wastes are deposited to a subsurface storage chamber.

**(61)** "Repair" means the act or process of restoring to original soundness, including redecorating, refinishing, nonstructural repairs or maintenance, or the replacement of existing fixtures, systems or equipment with the equivalent fixture, system or equipment.

**(62)** "Shingle" means a unit of roof covering material that has been manufactured to specific dimensions and is applied in overlapping fashion. 'Shingle' includes all of the following:

(a) "Fiberglass asphalt shingle" means a type of shingle with an internal mat composed of nonwoven, resin–bonded glass fibers, that is impregnated and coated with asphalt.

(b) "Laminated shingle" means a shingle with a second layer of asphalt and mat laminated to the first layer, usually in a design pattern to simulate the dimensional appearance of natural slate or wood shakes.

(c) "Organic asphalt shingle" means a shingle with an internal mat composed of organic fibers, such as cellulose, that is saturated and coated with asphalt.

(d) "Strip shingle" means a rectangular shingle that relies either on a sealant or on a combination of weight and stiffness to resist wind uplift, rather than using interlocking tabs.

**(63)** A "single–wythe wall" is a masonry wall consisting of one unit of thickness.

**(63m)** "Site" means all contiguous property under single ownership where land–disturbing activity has been proposed for the purpose of constructing a dwelling.

**(64)** A "smoke chamber" is that part of a fireplace which acts as a funnel to compress the smoke and gases from the fire so that they will enter the chimney above.

**(65)** A "smoke pipe" is a connector between the solid or liquid fuel–burning appliance and the chimney.

**(65m)** "Solid unit" means a masonry unit which has a net cross–sectional area parallel to the bearing face which is 75% or more of the gross cross–sectional area.

**(65r)** "Stabilized" means actions taken at a site to minimize erosion by mulching and seeding, sodding, landscaping, placing concrete or gravel, or other techniques to prevent soil loss.

**(66)** A "stairway" is one or more flights of steps, and the necessary platforms or landings connecting them, to form a continuous passage from one elevation to another.

**(67)** "Step(s)" is a unit(s) consisting of one riser and one tread, alone or in series.

**(68)** A "story" is that portion of a building located above the basement, between the floor and the ceiling.

**(69)** A "stove" is a nonportable solid–fuel–burning, vented, nonducted heat–producing appliance located in the space that it is intended to heat. This definition does not include cooking appliances.

**(70)** "Stovepipe." Same as smoke pipe.

**(71)** "Strain" means a change in the physical shape of a material caused by stress.

**(72)** "Stress" means internal resistance to an external force expressed in load per unit area; stresses acting perpendicular (compression or tension) to the surface, shear stresses acting in the plane of the surface, or bending stresses which cause curving.

**(73)** "Structural analysis" is a branch of the physical sciences which uses the principles of mechanics in analyzing the impact of loads and forces and their effect on the physical properties of materials in the form of internal stress and strain.

**(75)** The "throat" of a fireplace is the slot–like opening above the firebox through which flames, smoke and other products of combustion pass into the smoke chamber.

**(76)** "Vent" means a vertical flue or passageway to vent fuel–burning appliances.

**(77)** A "vent connector" is a connector between a fuel–burning appliance and the chimney or vent.

**(77m)** "Waters of the state" includes those portions of Lake Michigan and Lake Superior within the boundaries of Wisconsin, and all lakes, bays, rivers, streams, springs, ponds, wells, impounding reservoirs, marshes, watercourses, drainage systems and other surface waters or groundwaters, natural or artificial, public or private, within the state or its jurisdiction.

**(78)** "Window" means a glazed opening in an exterior wall, including glazed portions of doors, within a conditioned space.

**(78m)** "Wisconsin Administrative Permit" means a permit issued by a municipality that does not conduct inspections or plan reviews under this code.

**(79)** "Wisconsin insignia" means a device or seal approved by the department to certify compliance with this code.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; cr. (34m) and (36m), Register, February, 1985, No. 350, eff. 3–1–85; am. (8), (22), (36m), (50), (58), (62) and (74), r. (18) and (53), renum. (26) to (29m) and am., cr. (34r), (38m), (40m), (59m) and (65m), r. and recr. (38), Register, January, 1989, No. 397, eff. 2–1–89; am. (16), (34m), (40), (52) (a) (intro.) and (b), cr. (21m), Register, March, 1992, No. 435, eff. 4–1–92; am. (16), cr. (intro), (8m), (28t), (28v), (63m), (65r) and (77m), Register, September, 1992, No. 441, eff. 12–1–92; am. (4) and (65r), renum. (62) to be (73r), cr. (26), (62), (78m), Register, November, 1995, No. 479, eff. 12–1–95; emerg. cr. (7m), (34L) and (40f), eff. 5–8–96; correction in (23) made under s. 13.93 (2m) (b) 7., Stats., Register, October, 1996, No. 490; emerg. cr. (7m), (34L) and (40f), eff. 5–8–96; cr. (7m), (15m), (34g), (34h) and (34i), renum. (34k) to be (34e), Register, February, 1997, No. 494, eff. 3–1–97; r. (22), (27m), (39), (73r) and (74), Register, January, 1999, No. 517, eff. 2–1–99; cr. (19m), (40t) and (59t), Register, April, 2000, No. 532, eff. 7–1–00; **r. (4m), (28), (28r), (41m), (45), (56m), (60) and (73m), cr. (10m), (15g), (24m), (24r), (33m), (34f), (53), (53m), and (55m), r. and recr. (17) and (36) and am. (47) and (61), Register, March, 2001, No. 543, eff. 4–1–01.**

## Subchapter IV—Approval and Inspection of One– and 2–Family Dwellings

**Comm 20.08 Wisconsin uniform building permit.** A Wisconsin uniform building permit shall be obtained from the department or the municipality administering and enforcing this code before any on–site construction, including excavation for a structure, within the scope of this code is commenced, except where a permit to start construction has been issued in accordance with s. Comm 20.09 (5) (b) 2. A Wisconsin uniform building permit shall not be required for repairs.

**Note:** Section Comm 20.09 (5) (b) 2. permits the issuance of a footing and foundation permit prior to the issuance of the Wisconsin uniform building permit.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. Register, September, 1992, No. 441, eff. 12–1–92.

**Comm 20.09 Procedures for obtaining uniform building permit. (1)** APPLICATION FOR A WISCONSIN UNIFORM BUILDING PERMIT. Application for a Wisconsin uniform building permit shall be on the forms obtained from the department or the municipality administering and enforcing this code. No application shall be accepted that does not contain all the information requested on the form.

**Note:** See appendix for a copy of the Wisconsin uniform building permit and application.

**Note:** Any municipality exercising jurisdiction may require reasonable supplementary information not contained on the Wisconsin building permit application.

**(2)** FILING OF PERMITS. (a) *Wisconsin uniform building permit application.* The Wisconsin uniform building permit application shall be filed with the municipality administering and enforcing this code or its authorized representative. The municipality shall forward a copy of all applications to the department within 30 business days after permit issuance. Pursuant to s. 101.65 (1m), Stats., a municipality may not issue a building permit for construction work covered under chs. Comm 21 and 22 to a dwelling con-

tractor unless the contractor has a dwelling contractor financial responsibility certification issued by the department.

**Note:** See s. Comm 20.07 (26) for the definition of "dwelling contractor".

(b) *Wisconsin administrative permit.* The Wisconsin administrative permit shall be filed with the municipality and the department when the dwelling is located in a municipality that does not enforce the code.

**(3)** FEES. (a) *Municipal fees.* Fees shall be submitted to the municipality at the time the Wisconsin uniform building permit application for new construction is filed. The municipality shall, by ordinance, determine fees to cover expenses of plan examination, inspection and the issuance of the Wisconsin uniform building permit. The municipality shall collect and send to the department the fee for Wisconsin uniform building permits issued for new dwellings in accordance with s. Comm 2.34.

(b) *Department fees.* Where the department administers and enforces the code, the fees for plan examination, inspection, and the issuance of the Wisconsin uniform building permit, in accordance with s. Comm 2.34, shall be submitted to the department, or its authorized representative, at the time the Wisconsin uniform building permit application is filed.

(c) *Soil erosion fees.* Counties enforcing construction site erosion control provisions of the code shall collect and submit the fee for Wisconsin uniform building permits to the department.

**(4)** SUBMISSION OF PLANS. At least 2 sets of plans for all one– and 2–family dwellings shall be submitted to the department, or the municipality administering and enforcing this code, for examination and approval at the time the Wisconsin uniform building permit application is filed. A municipality exercising jurisdiction may require a third set of plans at its option.

(a) *Required building plans.* The required building plans shall be legible and drawn to scale or dimensioned and shall include the following:

1. Plot plan. a. The plot plan shall show the location of the dwelling and any other buildings, wells, surface waters and disposal systems on the site with respect to property lines. The location of the non–tracking access roadway, as required under s. Comm 21.125 (1) (c), shall be shown. For sites greater than 5 acres, the plot plan shall indicate the area of land–disturbing activity within the site.

b. The plot plan shall show the direction of all slopes on the site. Sectors within the area of land disturbing activity shall be designated and labeled on the plot plan in the appropriate slope category: less than 12% slope; 12% to 20% slope; and greater than 20% slope. The plot plan shall indicate initial erosion control measures as specified in s. Comm 21.125 based on slopes existing immediately prior to building construction.

**Note:** A 12% slope equals 6.8 degrees from the horizontal and has a rise to run ratio of 3 to 25.

**Note:** A 20% slope equals 11.3 degrees from the horizontal and has a rise to run ratio of 1 to 5.

**Note:** See Appendix for examples of plot plans indicating erosion control measures.

2. Floor plans. Floor plans shall be provided for each floor. The size and location of all rooms, doors, windows, structural features, exit passageways and stairs shall be indicated. The use of each room shall be indicated. The location of plumbing fixtures, chimneys, and heating and cooling appliances, and, when requested, a heating distribution layout shall be included.

3. Elevations. The elevations shall contain information on the exterior appearance of the building, indicate the location, size and configuration of doors, windows, roof, chimneys, exterior grade, footings and foundation walls, and include the type of exterior materials.

(b) *Data required.* All required plans submitted for approval shall be accompanied by sufficient data, calculations and information to determine if the dwelling will meet the requirements of this code. The data and information for determining compliance with the energy conservation standards shall be submitted on forms provided by the department or other approved forms. Except as required under s. Comm 21.33, a municipality exercising jurisdiction may not require plans or calculations to be stamped by an architect or engineer.

(c) *Master plans.* Where a dwelling is intended to be identically and repetitively constructed at different locations, a master plan may be submitted for approval. The plans shall include floor plans, elevations and data as required in par. (a) 2. and 3. If the plans conform to the provisions of the code, an approval and a master plan number shall be issued. The number issued may be used in lieu of submitting building plans for each location. A plot plan shall be submitted for each location at the time of application for the Wisconsin uniform building permit.

**(5)** APPROVAL OF PLANS AND ISSUANCE OF PERMITS. (a) *Plan approval.* If the department, or the municipality administering and enforcing the code, determines that the plans, including the plans indicating the erosion control procedures as specified in sub. (4), submitted for a one– or 2–family dwelling substantially conform to the provisions of this code and other legal requirements, an approval shall be issued. The plans shall be stamped "conditionally approved" by a certified inspector who holds the respective credential for the plans reviewed. One copy shall be returned to the applicant; one copy shall be retained by the department or the municipality administering and enforcing the code. The conditions of approval shall be indicated by a letter or on the permit. All conditions of the approval shall be met during construction.

(b) *Issuance of permits.* 1. Uniform building permit. a. The Wisconsin uniform building permit shall be issued if the requirements for filing and fees are satisfied and the plans have been conditionally approved.

b. Pursuant to s. 145.195, Stats., a Wisconsin uniform building permit may not be issued to a person unless the person holds a credential issued by the department as a dwelling contractor financial responsibility registration under s. Comm 5.31, except as provided under s. 101.654 (1) (b), Stats.

**Note:** Section 101.654 (1) (b), Stats., exempts an owner of a dwelling who resides or will reside in the dwelling and who applies for a building permit to perform work on the dwelling from obtaining a dwelling contractor financial responsibility registration.

c. The permit shall expire 24 months after issuance if the dwelling exterior has not been completed.

d. The municipality issuing the Wisconsin uniform building permit shall send a copy of the application to the department.

2. Permit to start construction of footings and foundation. Construction may begin on footings and foundations prior to the issuance of the Wisconsin uniform building permit where a permit to start construction is obtained. Upon submittal of the application for a permit to start construction, a plot plan as specified in sub. (4) (a) 1., complete footing and foundation information including exterior grading, and a fee, the department or the municipality enforcing this code may issue a permit to start construction of the footings and foundation. The issuance of a permit to start construction shall not influence the approval or denial of the Wisconsin uniform building permit application.

3. Pursuant to s. 145.195, Stats., if the proposed construction requires connection to a private onsite wastewater treatment system, a Wisconsin uniform building permit may not be issued unless conformance with s. Comm 83.25 (2) has first been determined.

**Note:** See appendix for a reprint of s. Comm 83.25 (2).

(c) *Posting of permit.* The Wisconsin uniform building permit shall be posted in a conspicuous place at the dwelling site.

**Note:** Section 101.63 (7), Stats., requires the name and license number of the master plumber to be identified on the Wisconsin uniform building permit card.

**(6)** DISAPPROVAL OF PLANS AND DENIAL OF PERMITS. If the department, or the municipality administering and enforcing the code, determines that the Wisconsin uniform building permit application or the plans, including the plans indicating the erosion control procedures as specified in sub. (4), do not substantially

conform to the provisions of this code or other legal requirements are not met, approval shall be denied.

(a) *Denial of application.* A copy of the "denied" application, accompanied by a written statement specifying the reasons for denial, shall be sent to the applicant and to the owner as specified on the Wisconsin uniform building permit application.

(b) *Stamping of plans.* Plans which do not substantially conform to the provisions of the code shall be stamped "not approved." One copy shall be returned to the person applying for the Wisconsin uniform building permit; one copy shall be retained by the department or the municipality administering and enforcing the code.

(c) *Appeals.* The applicant may appeal a denial of the application in accordance with the procedure outlined in s. Comm 20.21.

**(7)** ACTION TO APPROVE OR DENY. Action to approve or deny a uniform building permit application shall be completed within 10 business days of receipt of all forms, fees, plans and documents required to process the application, and completion of other local prerequisite permitting requirements.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. (7), Register, February, 1985, No. 350, eff. 3–1–85; am. (4) (b) and (5) (b) 1., Register, January, 1989, No. 397, eff. 2–1–89; am. (3) (a) and (4) (a) 2., Register, March, 1992, No. 435, eff. 4–1–92; am. (4) (a) 1., (5) (a), (b) 2. and (6) (intro.), Register, September, 1992, No. 441, eff. 12–1–92; renum. (2) to be (2) (a) and am., am. (3) and (7), cr. (2) (b), (3) (c), Register, November, 1995, No. 479, eff. 12–1–95; r. and recr. (5) (b) 1., Register, October, 1996, No. 490, eff. 11–1–96; am. (4) (a) 1. a. and (b), r. and recr. (4) (a) 1. b., r. (4) (a) 1. c. and d., Register, February, 1997, No. 494, eff. 3–1–97; am. (5) (a), Register, March, 1998, No. 507, eff. 4–1–98; cr. (5) (b) 1. c. and d., Register, January, 1999, No. 517, eff. 2–1–99; cr. (5) (b) 3., Register, April, 2000, No. 532, eff. 7–1–00; correction in (5) (b) 3. made under s. 13.93 (2m) (b) 7., Stats; **correction in (5) (b) 3. made under s. 13.93 (2m) (b) 7., Stats., Register, March, 2001, No. 543.**

**Comm 20.10 Inspections.** All inspections, for the purpose of administering and enforcing this code, shall be performed by a certified inspector who holds the respective credential for the inspection performed.

**(1)** REQUIRED INSPECTIONS. Inspections shall be conducted by the department or the municipality administering and enforcing this code to ascertain whether or not the construction or installations conform to the conditionally approved plans, the Wisconsin uniform building permit application and the provisions of this code and shall notify the permit holder and the owner of any violations to be corrected.

(a) *Inspection notice.* The applicant or an authorized representative shall, in writing or orally, request inspections of the department or the municipality administering and enforcing this code. The department, or the municipality administering and enforcing this code, shall perform the requested inspection within 2 business days after notification, except the final inspection. Construction shall not proceed beyond the point of inspection until the inspection has been completed. Construction may proceed if the inspection has not taken place within 2 business days of the notification, except if otherwise agreed between the applicant and the department or the municipality administering and enforcing the code.

(b) *Inspection types.* The following sequence of inspections shall be performed for the purpose of determining if the work complies with this code:

1. Footing and foundation inspection. The excavation shall be inspected after the placement of forms, shoring and reinforcement, where required, and prior to the placement of footing materials. Where below–grade drain tiles, waterproofing or exterior insulation is required, the foundation shall be inspected prior to backfilling.

2. Rough inspection. A rough inspection shall be performed for each inspection category listed in subd. 2. a. through e. after the rough work is constructed but before it is concealed. All categories of work for rough inspections may be completed before the notice for inspection is provided. The applicant may request one rough inspection or individual rough inspections. A separate fee may be charged for each individual inspection.

a. General construction, including framing.

b. Rough electrical.

c. Rough plumbing.

d. Rough heating, ventilating and air conditioning.

e. Basement drain tiles.

3. Insulation inspection. An inspection shall be made of the insulation and vapor retarder after they are installed but before they are concealed.

4. Final inspection. a. Except as provided under subd. 4. b., the dwelling may not be occupied until a final inspection has been made that finds no critical violations of this code that could reasonably be expected to affect the health or safety of a person using the dwelling.

b. Occupancy may proceed in accordance with local ordinances if the inspection has not been completed within 5 business days after notification or as otherwise agreed between the applicant and the department or municipality.

5. Erosion control inspection. Erosion control inspections shall be performed concurrently with all other required construction inspections. Additional inspections for erosion control may be performed by the delegated authority.

(c) *Notice of compliance and noncompliance.* 1. General. Notice of compliance or noncompliance with this code shall be written on the building permit and posted at the job site. Upon finding of noncompliance, the department or municipality enforcing this code shall also notify the applicant of record and the owner, in writing, of the violations to be corrected. Except as specified in subd. 2., the department or municipality shall order all cited violations corrected within 30 days after written notification, unless an extension of time is granted under s. Comm 20.21.

2. Soil erosion control requirements. a. The department or municipality shall order all cited violations of erosion control requirements under s. Comm 21.125 (1) (a) to (c) and (e) to (f) corrected within 72 hours after notification and may issue a special order directing an immediate cessation of work for failure to comply with the corrective order. Work may continue when the conditions of the cessation order have been met.

**Note:** The sediment cleanup requirements of s. Comm 21.125 (1) (d) have different time limits and are unaffected by the 72–hour notice provision.

b. If written notification is delivered in person, the 72–hour compliance period shall begin at the time of delivery. If faxed or sent through the mail, the compliance period shall begin at the time the notification was received by the applicant of record.

c. If verbal notification, in person or by telephone, is given prior to delivery of written notification, the 72–hour notification shall begin at the time of verbal notification. The written notification shall then be delivered, in person or via mail or fax, to the applicant of record at their business address and shall include the date and time of verbal notification.

**(2)** VOLUNTARY INSPECTION. The department or its authorized representative may, at the request of the owner or the lawful occupant, enter and inspect dwellings, subject to the provisions of this code, to ascertain compliance with this code.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (1) (a), Register, February, 1985, No. 350, eff. 3–1–85; cr. (1) (b) 2. f., Register, January, 1989, No. 397, eff. 2–1–89; correction (1) (b) 2. intro. made under s. 13.93 (2m) (b) 4., Stats., Register, January, 1989, No. 397; r. (1) (b) 2. e., renum. (1) (b) 2. f. and 3. and (3) to be (1) (b) 2. e. and 4. and (2), cr. (1) (b) 3., Register, March, 1992, No. 435, eff. 4–1–92; am. (1) (c), Register, September, 1992, No. 441, eff. 12–1–92; cr. (1) (b) 5., Register, November, 1995, No. 479, eff. 12–1–95; am. (intro.), Register, October, 1996, No. 490, eff. 11–1–96; r. and recr. (1) (c), Register, February, 1997, No. 494, eff. 3–1–97; am. (intro.), Register, March, 1998, No. 507, eff. 4–1–98; **r. and recr. (1) (b) 4., Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 20.11 Suspension or revocation of Wisconsin uniform building permit.** The department, or the municipality administering and enforcing this code, may suspend or revoke any Wisconsin uniform building permit where it appears that the permit or approval was obtained through fraud or deceit, where the applicant has willfully refused to correct a violation order or where the inspector is denied access to the premises. No

construction shall take place on the dwelling after suspension or revocation of the permit.

**(1)** Any person aggrieved by a determination made by the municipality exercising jurisdiction may appeal the decision in accordance with s. Comm 20.21.

**(2)** Any person aggrieved by a determination made by the department may appeal the decision in accordance with s. Comm 20.21.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

## Subchapter V—Approval and Inspection of Manufactured Dwellings and Their Components

**Comm 20.12 Scope.** This part shall govern the design, manufacture, installation and inspection of manufactured dwellings, manufactured building systems and the components of the building systems displaying the Wisconsin insignia.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

**Comm 20.13 Manufacture, sale and installation of dwellings. (1)** MANUFACTURE AND SALE. No manufactured dwelling, manufactured building system or component of the building system subject to this part shall be manufactured for use, sold for initial use or installed in this state unless it is approved by the department and it bears the Wisconsin insignia issued or a state seal or an insignia reciprocally recognized by the department.

**(2)** INSTALLATION. A Wisconsin uniform building permit shall be obtained in accordance with the procedures outlined in s. Comm 20.09 (1), (2), (3) and (4) (a) 1. before any on–site construction falling within the scope of this code is commenced for a manufactured dwelling. The permit shall be issued in accordance with s. Comm 20.09 (5) (b) 1.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

**Comm 20.14 Approval procedures. (1)** APPLICATION FOR APPROVAL. An application for the approval of any manufactured dwelling, building system or component shall be submitted to the department, in the form required by the department, along with the appropriate fees in accordance with s. Comm 2.34. The department shall review and make a determination on an application for approval of a manufactured dwelling within 3 months of receipt of all forms, fees, plans and documents required to complete the review.

**(2)** APPROVAL OF BUILDING SYSTEMS AND COMPONENTS. (a) *Approval of building systems.* 1. Plans and specifications. All plans and specifications shall be submitted to the department according to subd. 1. a. or b.:

a. Three complete sets of building, structural, mechanical and electrical plans, (including elevations, sections and details), specifications and calculations shall be submitted to the department on behalf of the manufacturer for examination and approval.

b. At least one complete set of building, structural, mechanical and electrical plans, (including elevations, sections and details), specifications and calculations shall be submitted to the department on behalf of a manufacturer. All plans and specifications submitted to the department shall be stamped "conditionally approved" by a UDC certified inspector or inspectors.

2. Compliance assurance program. Three sets of the compliance assurance program shall be submitted for examination and approval. The compliance assurance program submitted to the department on behalf of the manufacturer shall meet the standards of the Model Documents for the Evaluation, Approval, and Inspection of Manufactured Buildings as adopted under s. Comm 20.24 (8) or equivalent as determined by the department.

(b) *Approval of building components.* 1. Plans and specifications. All plans and specifications shall be submitted to the department according to subd. 1. a. or b.:

a. At least 3 complete sets of plans and specifications for manufactured dwelling building components shall be submitted to the department on behalf of the manufacturer for examination and approval.

b. At least one complete set of plans and specifications for manufactured dwelling building components shall be submitted to the department on behalf of the manufacturer. All plans and specifications submitted to the department shall be stamped "conditionally approved" by a UDC certified inspector or inspectors.

2. Compliance assurance program. Three sets of the compliance assurance program shall be submitted to the department on behalf of the manufacturer for examination and approval of components. The compliance assurance program shall meet the requirements established by the department or, where applicable, be in the form of the NBS "Model Rules and Regulations" [Comm 20.24 (3)].

**(3)** NOTIFICATION OF APPROVAL OR DENIAL OF PLANS, SPECIFICATIONS AND COMPLIANCE ASSURANCE PROGRAM. (a) *Conditional approval.* If the department determines that the plans, specifications, compliance assurance program and application for approval submitted for such building system or component substantially conform to the provisions of this code, a conditional approval shall be issued. A conditional approval issued by the department shall not constitute an assumption of any liability for the design or construction of the manufactured building.

1. Written notice. The conditional approval shall be in writing and sent to the manufacturer and the person submitting the application for approval. Any noncompliance specified in the conditional approval shall be corrected before the manufacture, sale or installation of the dwelling, building system or component.

2. Stamping of plans, specifications and compliance assurance program. Approved plans, specifications and compliance assurance programs shall be stamped "conditionally approved." At least 2 copies shall be returned to the person designated on the application for approval; one copy shall be retained by the department.

(b) *Denial.* If the department determines that the plans, specifications, compliance assurance program or the application for approval do not substantially conform to the provisions of this code, the application for approval shall be denied.

1. Written notice. The denial shall be in writing and sent to the manufacturer and the person submitting the application for approval. The notice shall state the reasons for denial.

2. Stamping of plans, specifications and compliance assurance program. Plans, specifications and compliance assurance programs shall be stamped"not approved." At least 2 copies shall be returned to the person submitting the application for approval; one copy shall be retained by the department.

**(4)** EVIDENCE OF APPROVAL. The manufacturer shall keep at each manufacturing plant where such building system or component is manufactured, one set of plans, specifications and compliance assurance program bearing the stamp of conditional approval. The conditionally approved plans, specifications and compliance assurance program shall be available for inspection by an authorized representative of the department during normal working hours.

**(5)** INSPECTIONS. Manufacturers shall contract with the department or an independent inspection agency to conduct in–plant inspections to assure that the building system and components manufactured are in compliance with the plans, specifications and the compliance assurance program approved by the department. All inspections, for the purpose of administering and enforcing this code, shall be performed by a certified UDC inspector or inspectors.

**(6)** WISCONSIN INSIGNIA. Upon departmental approval of the plans, specifications and compliance assurance program, and satisfactory in–plant inspections of the building system and compo-

nents, Wisconsin insignias shall be purchased from the department in accordance with the fee established in s. Comm 2.34. A manufacturer shall be entitled to display the Wisconsin insignia on any approved system or component.

(a) *Lost or damaged insignia.* 1. Notification. If Wisconsin insignias become lost or damaged, the department shall be notified immediately, in writing, by the manufacturer or dealer.

2. Return of damaged insignias. If Wisconsin insignias become damaged, the insignia shall be returned to the department with the appropriate fee to obtain a new insignia.

(b) *Affixing Wisconsin insignias.* Each Wisconsin insignia shall be assigned and affixed to a specific manufactured dwelling or component in the manner approved by the department before the dwelling is shipped from the manufacturing plant.

(c) *Insignia records.* 1. Manufacturer's insignia records. The manufacturer shall keep permanent records regarding the handling of all Wisconsin insignias, including construction compliance certificates, indicating the number of Wisconsin insignias which have been affixed to manufactured dwellings or manufactured building components (or groups of components); which Wisconsin insignias have been applied to which manufactured dwelling or manufactured building component; the disposition of any damaged or rejected Wisconsin insignias; and the location and custody of all unused Wisconsin insignias. The records shall be maintained by the manufacturer or by the independent inspection agency for at least 10 years. A copy of the records shall be sent to the department upon request.

2. Construction compliance certificate. Within 30 days after receiving the original Wisconsin insignias from the department, and at the end of each month thereafter, the manufacturer shall submit a construction compliance certificate, in the form determined by the department, for each manufactured dwelling intended for sale, use or installation in the state.

(d) *Unit identification.* Each manufactured dwelling and major transportable section or component shall be assigned a serial number. The serial number shall be located on the manufacturer's data plate.

(e) *Manufacturer's data plate.* The manufacturer's data plate for building systems shall contain the following information, where applicable:

1. Manufacturer's name and address;
2. Date of manufacture;
3. Serial number of unit;
4. Model designation;
5. Identification of type of gas required for appliances and directions for water and drain connections;
6. Identification of date of the codes or standards complied with;
7. State insignia number;
8. Design loads;
9. Special conditions or limitations of unit;
10. Electrical ratings; instructions and warnings on voltage, phase, size and connections of units and grounding requirements.

**(7)** RECIPROCITY. Upon request, the department will make available to any person a list of those states whose dwelling codes are considered equal to the codes established by the department and whose products are accepted reciprocally by Wisconsin.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (1) (a), r. and recr. (2) (a) 1. and (b) 1., Register, February, 1985, No. 350, eff. 3–1–85; correction in (6) (intro.) made under s. 13.93 (2m) (b) 7., Stats., Register, September, 1992, No. 441; am. (1), (2) (a) 2., Register, November, 1995, No. 479, eff. 12–1–95; am. (2) (a) 1. b., (b) 1. b., (5), Register, October, 1996, No. 490, eff. 11–1–96; correction in (6) (intro.) made under s. 13.93 (2m) (b) 7., Stats., Register, October, 1996, No. 490; correction in (1) made under s. 13.93 (2m) (b) 7., Stats., Register, March, 1998, No. 507.

**Comm 20.15 Effect of approval. (1)** RIGHT TO BEAR INSIGNIA. A manufactured dwelling or building component approved by the department, manufactured and inspected in accordance with this code, shall be entitled to bear the Wisconsin insignia.

**(2)** EFFECT OF INSIGNIA. Manufactured dwellings and manufactured building components bearing the Wisconsin insignia are deemed to comply with this code, except as to installation site requirements, regardless of the provisions of any other ordinance, rule, regulation or requirement.

**(3)** RIGHT TO INSTALL. Manufactured dwellings and components bearing the Wisconsin insignia may be manufactured, offered for sale and shall be entitled to be installed anywhere in Wisconsin where the installation site complies with the other provisions of this code.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

**Comm 20.16 Suspension and revocation of approval.** The department shall suspend or revoke its approval of a manufactured building system or manufactured building component if it determines that the standards for construction or the manufacture and installation of a manufactured building system or manufactured building component do not meet this code or that such standards are not being enforced as required by this code. The procedure for suspension and revocation of approval shall be as follows:

**(1)** FILING OF COMPLAINT. Proceedings to suspend or revoke an approval shall be initiated by the department or an independent inspection agency or UDC certified inspector having a contract with the manufacturer whose approval is sought to be suspended or revoked. Initiation shall be by a signed, written complaint filed with the department. Any alleged violation of the code shall be set forth in the complaint with particular reference to time, place and circumstance.

**(2)** INVESTIGATION AND NOTIFICATION. The department may investigate alleged violations on its own initiative or upon the filing of a complaint. If it is determined that no further action is warranted, the department shall notify the persons affected. If the department determines that there is probable cause, it shall order a hearing and notify the persons affected.

**(3)** MAILING. Unless otherwise provided by law, all orders, notices and other papers may be served by the department by certified mail to the persons affected at their last known address. If the service is refused, service may be made by sheriff without amendment of the original order, notice or other paper.

**(4)** RESPONSE. Upon receipt of notification of hearing from the department, the person charged with noncompliance or nonenforcement may submit to the department a written response within 30 days of the date of service. If the person charged files a timely written response, such person shall thereafter be referred to as the respondent.

**(5)** CONCILIATION AGREEMENT PRIOR TO HEARING. If the department and the respondent are able to reach agreement on disposition of a complaint prior to hearing, such agreement shall:

(a) Be transmitted in writing to the secretary;

(b) Not be binding upon any party until signed by all parties and accepted by the secretary;

(c) Not be considered a waiver of any defense nor an admission of any fact until accepted by the secretary.

**(6)** HEARINGS. (a) *Subpoenas; witness fees.* Subpoenas shall be signed and issued by the department or the clerk of any court of record. Witness fees and mileage of witnesses subpoenaed on behalf of the department shall be paid at the rate prescribed for witnesses in circuit court.

(b) *Conduct of hearings.* All hearings shall be conducted by persons selected by the department. Persons so designated may administer oaths or affirmations and may grant continuances and adjournments for cause shown. The respondent shall appear in person and may be represented by an attorney–at–law. Witnesses may be examined by persons designated by all parties.

**(7)** FINDINGS. The department shall make findings and enter its order within 14 days of the hearing. Any findings as a result of petition or hearing shall be in writing and shall be binding unless appealed to the secretary.

**(8)** APPEAL ARGUMENTS. Appeal arguments shall be submitted to the department in writing in accordance with ch. 227, Stats., unless otherwise ordered. The department shall review and make a determination on an appeal of notification of suspension or revocation of approval within 45 business days of receipt of the appeal.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (8), Register, February, 1985, No. 350, eff. 3–1–85; am. (1), Register, October, 1996, No. 490, eff. 11–1–96.

**Comm 20.17 Effect of suspension and revocation.** **(1)** BEARING OF INSIGNIA. Upon suspension or revocation by the department of the approval of any manufactured dwelling or manufactured building component, no further insignia shall be attached to any dwelling or building component manufactured with respect to which the approval was suspended or revoked. Upon termination of such suspension or revocation, insignias may again be attached to the dwelling or building component manufactured after the date approval is reinstated. Should any dwelling or building component have been manufactured during the period of suspension or revocation, it shall not be entitled to bear the Wisconsin insignia unless the department has inspected, or caused to be inspected, such manufactured dwelling or manufactured building component and is satisfied that all requirements for certification have been met.

**(2)** RETURN OF INSIGNIAS. The manufacturer shall return to the department all insignias allocated for a manufactured dwelling or manufactured building component no later than 30 days from the effective date of any suspension or revocation of the approval by the department. The manufacturer shall also return to the department all insignias which it determines for any reason are no longer needed.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

## Subchapter VI—Approval of Products

**Comm 20.18 Building product approvals.** **(1)** VOLUNTARY APPROVAL. (a) Materials, equipment and products regulated by this code may receive a written approval from the department indicating code compliance.

(b) 1. Approval of materials, equipment and products shall be based on sufficient data, tests and other evidence that prove the material, equipment or product is in compliance with the standards specified in this code.

2. Tests, compilation of data, and calculations for materials, equipment and products shall be conducted by a qualified independent third party.

**(2)** ALTERNATE APPROVAL. (a) Materials, equipment and products which meet the intent of this code and which are not approved under sub. (1) shall be permitted if approved in writing by the department.

(b) 1. Approval of materials, equipment and products shall be based on sufficient data, tests and other evidence that prove the material, equipment or product meets the intent of the standards specified in this code.

2. Tests, compilation of data, and calculations for materials, equipment and products shall be conducted by a qualified independent third party.

**(3)** EXPERIMENTAL APPROVAL. (a) The department may allow use of an experimental material, equipment or product for the purpose of proving compliance with the intent of this code.

(b) The department may require the submission of any information deemed necessary for review.

(c) The department may limit the number of applications it will accept for approval of experimental materials, equipment or products.

(d) Installations of a material, equipment or product under an experimental approval shall comply with all of the following:

1. Plans detailing the installation for each project where the experimental material, equipment or product is to be used shall be submitted to the department.

2. A copy of the experimental approval shall be attached to the submitted plans and approved plans.

3. a. A letter of consent from the owner of the installation shall be attached to the submitted plans and approved plans.

b. The letter under subpar. a. shall acknowledge that the owner has received and read a copy of the experimental approval and is in compliance with all conditions of the approval.

4. A person responsible for construction of the project shall be designated in writing by the owner.

5. The person designated as responsible for the construction of the project shall, upon completion of construction, certify in writing to the department that the installation is in compliance with the experimental approval, approved plans, specifications and data.

(e) 1. Any onsite inspections shall be performed by the department, or other person authorized by the department, at time intervals as specified by the department, but not less than once a year. The inspector shall write an inspection report.

2. The department may assess a fee for each inspection conducted under subd. 1.

(f) Five years and 6 months after the date of the completed installation, the department shall order the removal of the experimental material, equipment or product, or issue an approval for the material, equipment or product.

(g) Paragraphs (e) and (f) do not apply to an experimental system if this code is revised to include or enable the experimental system to conform to the intent of this code.

**(4)** REVIEW, APPROVAL AND REVOCATION PROCESSES. (a) 1. Upon receipt of a fee and a written request, the department may issue an approval for a material, equipment or product.

2. The department shall review and make a determination on an application for approval after receipt of all forms, fees, plans and information required to complete the review.

3. For voluntary and alternate approvals, a determination shall be made within 40 business days of receipt of all required materials.

4. For an experimental approval, a determination shall be made within 6 months of receipt of all required materials.

(b) 1. The department may include specific conditions in issuing an approval, including an expiration date for the approval.

2. Violations of the conditions under which an approval is issued shall constitute a violation of this code.

(c) If the department determines that the material, equipment or product does not comply with this code or the intent of this code, or that an experimental approval will not be issued, the request for approval shall be denied in writing.

(d) If an approved material, equipment or product is modified, the approval shall be considered null and void, unless the material, equipment or product is resubmitted to the department for review and approval is granted.

(e) 1. The department may revoke or deny an approval of a material, equipment or product for any false statements or misrepresentations of relevant facts or data, unacceptability of a third party providing information, or as a result of material, equipment or product failure.

2. The department may re–examine an approved material, equipment or product and issue a revised approval at any time.

(f) The department may revoke an approval if the department determines that the material, equipment or product does not comply with this code or the intent of this code due to a change in the code or department interpretation of the code.

(g) An approval issued by the department may not be construed as an assumption of any responsibility for defects in design, construction or performance of the approved material, equipment or product nor for any damages that may result.

(h) Fees for the review of a material, equipment or product under this section and any onsite inspections shall be submitted in accordance with ch. Comm 2.

**(5)** UNGRADED OR USED MATERIALS. (a) Ungraded or used building materials may be used or reused as long as the material possesses the essential properties necessary to achieve the level of performance required by the code for the intended use.

(b) The department or the municipality enforcing this code may require tests in accordance with subs. (1) or (2).

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; cr. (3), Register, February, 1985, No. 350, eff. 3–1–85; am. (1), Register, November, 1995, No. 479, eff. 12–1–95; correction in (1) (intro.) made under s. 13.93 (2m) (b) 7., Stats., Register, October, 1996, No. 490; r. and recr., Register, September, 2000, No. 537, eff. 10–1–00.

## Subchapter VII—Variances, Appeals, Violations and Penalties

**Comm 20.19 Petition for variance.** The department may grant a variance to a rule only if the variance does not result in lowering the level of health, safety and welfare established or intended by the rule. The department may consider other criteria in determining whether a variance should be granted including the effect of the variance on uniformity.

**(1)** APPLICATION FOR VARIANCE. The applicant shall submit the petition for variance application to the municipality exercising jurisdiction in order to receive the municipal recommendation. Where no municipality exercises jurisdiction, the application shall be submitted to the department. The following items shall be submitted when requesting a variance:

(a) A clear written statement of the specific provisions of this code from which a variance is requested and the method of establishing equivalency to those provisions.

(b) A fee in accordance with s. Comm 2.52. The municipality may require a fee for the processing of the application in addition to the department's fee.

**Note:** A copy of the Petition for Variance form (SBD–9890) is contained in the Appendix.

**(2)** MUNICIPAL RECOMMENDATION. The municipality administering and enforcing this code shall submit all applications for variance to the department, together with a municipal recommendation within 10 business days after receipt of the application. The recommendation of the municipality shall include the following items:

(a) Inspections performed on the property.

(b) The issuance of correction orders on the property.

(c) An assessment of the overall impact of the variance on the municipality.

**Note:** A copy of the Municipal Recommendation form (SBD–9890) is contained in the Appendix.

**(3)** DEPARTMENTAL ACTION. Where a municipality administers and enforces the code, the department shall decide petitions for variance and shall mail notification to the municipality and the applicant within 5 business days after receipt of the application and municipal recommendation. Where the department enforces the code, the department shall decide petitions for variance within 15 business days after receipt of the application and fees.

**(4)** APPEALS. A person or municipality may appeal the determination of the department in the manner set out in s. 101.02 (6) (e) to (i) and (8), Stats.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. Register, November, 1995, No. 479, eff. 12–1–95; correction in (1) (b) made under s. 13.93 (2m) (b) 7., Stats., Register, October, 1996, No. 490.

**Comm 20.20 Municipal variance from the code.** Any municipality exercising or intending to exercise jurisdiction under this code may apply to the department for a variance permitting the municipality to adopt an ordinance not in conformance with this code. The department shall review and make a determination on a municipal request to adopt an ordinance not in conformance with this code within 60 business days of receipt of the request.

**(1)** APPLICATION FOR VARIANCE. The department may grant an application only under the following circumstances:

(a) The municipality has demonstrated that the variance is necessary to protect the health, safety or welfare of individuals within the municipality because of specific climate or soil conditions generally existing within the municipality.

(b) The municipality has demonstrated that the granting of the variance, when viewed both individually and in conjunction with other variances requested by the municipality, does not impair the statewide uniformity of this code.

**(2)** DEPARTMENTAL INQUIRY. Prior to making a determination, the department shall solicit within the municipality and consider the statements of any interested persons as to whether or not said application should be granted.

**(3)** APPEALS. Any municipality aggrieved by the denial of an application may appeal the determination in accordance with the procedure set out in s. 101.02 (6) (e) to (i) and (8), Stats. The department shall review and make a determination on an appeal of denial of a municipal request to adopt an ordinance not in conformance with this code within 60 business days of receipt of the appeal.

**(4)** UNIFORMITY. This section shall be strictly construed in accordance with the goal of promoting statewide uniformity.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (intro.) and (3), Register, February, 1985, No. 350, eff. 3–1–85.

**Comm 20.21 Appeals of orders, determinations, and for extension of time.** **(1)** APPEALS OF ORDERS AND DETERMINATIONS BY A MUNICIPALITY EXERCISING JURISDICTION. Appeals of an order or determination of a municipality exercising jurisdiction under this code, including denials of application for permits, shall be made in accordance with the procedure set out in ch. 68, Stats., except as follows:

(a) *Appeals of final determinations by a municipality exercising jurisdiction.* Appeals of final determination by municipalities shall be made to the department after the procedures prescribed in ch. 68, Stats., have been exhausted. All appeals to the department shall be in writing stating the reason for the appeal. All appeals shall be filed with the department within 10 business days of the date the final determination is rendered under ch. 68, Stats. The department shall render a written decision on all appeals within 60 business days of receipt of all calculations and documents necessary to complete the review.

**Note:** Chapter 68, Stats., provides that municipalities may adopt alternate administrative appeal procedures that provide the same due process rights as ch. 68, Stats. Municipalities having adopted such alternate procedures may follow those alternate procedures.

**(2)** APPEALS OF ORDERS AND DETERMINATIONS BY THE DEPARTMENT. Appeals of an order of the department made pursuant to the provisions of this code, including denials of application for permits, shall be in accordance with the procedure set out in s. 101.02 (6) (e) to (i) and (8), Stats. The department shall review and make a determination on an appeal of an order or determination within 60 business days of receipt of all calculations and documents necessary to complete the review.

**(3)** EXTENSIONS OF TIME. (a) The time for correction of cited orders as set out in s. Comm 20.10 shall automatically be extended in the event that an appeal of said orders is filed. The extension of time shall extend to the termination of the appeal procedure and for such additional time as the department or municipality administering and enforcing this code may allow.

(b) The department or municipality administering and enforcing this code may grant additional reasonable time in which to comply with a violation order.

**(4)** APPEALS OF SOIL EROSION CONTROL ORDERS BY A MUNICIPALITY FOR CESSATION OF WORK. (a) Appeals of orders for cessation of work issued under s. Comm 20.10 (1) (c) may be made to the authority issuing the cessation of work order. The authority shall make a determination on such appeal within 3 business days. Determination of appeals by a municipality may be conducted in consultation with the department.

(b) Appeals of a final determination by a municipality on cessation of work orders may be made to the department. The department shall issue a final determination on the appeal within 3 business days after receipt of such appeal.

(c) If the issuing authority determines the site to be compliant with s. Comm 21.125, orders shall be rescinded and work may commence.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (1) (a) and (2), Register, February, 1985, No. 350, eff. 3–1–85; cr. (4), Register, September, 1992, No. 441, eff. 12–1–92.

**Comm 20.22 Penalties and violations. (1)** VIOLATIONS. No person shall construct or alter any dwelling in violation of any of the provisions of this code.

(a) *Injunction.* When violations occur, the department may bring legal action to enjoin any violations.

(b) *Ordinances.* This code shall not affect the enforcement of any ordinance or regulation, the violation of which occurred prior to the effective date of this code.

**(2)** PENALTIES. Pursuant to ss. 101.66 and 101.77, Stats., whoever violates this code shall forfeit to the state not less than $25 nor more than $500 for each violation. Each day that the violation continues, after notice, shall constitute a separate offense.

**(3)** MUNICIPAL ENFORCEMENT. Any municipality which administers and enforces this code may provide, by ordinance, remedies and penalties for violation of that jurisdiction exercised under s. 101.65, Stats. These remedies and penalties shall be in addition to those which the state may impose under subs. (1) and (2).

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (3), Register, March, 1992, No. 435, eff. 4–1–92.

## Subchapter IX—Adoption of Standards

**Comm 20.24 Adoption of standards. (1)** CONSENT. Pursuant to s. 227.21 (2), Stats., the attorney general and the revisor of statutes have consented to the incorporation by reference of the standards listed in subs. (4) to (17).

**(2)** ADOPTION OF STANDARDS. The standards referenced in subs. (4) to (17) are incorporated by reference into this chapter.

**Note:** Copies of the adopted standards are on file in the offices of the department, the secretary of state and the revisor of statutes. Copies of the standards may be purchased through the respective organizations listed in subs. (4) to (17).

**(3)** ALTERNATE STANDARDS. (a) Alternate standards that are equivalent to or more stringent than the standards incorporated by reference in this chapter may be used in lieu of incorporated standards when approved by the department or if written approval is issued by the department in accordance with par. (b).

(b) 1. a. Upon receipt of a fee and a written request, the department may issue an approval for the use of the alternate standard.

b. The department shall review and make a determination on an application for approval within 40 business days of receipt of all forms, fees, and documents required to complete the review.

2. Determination of approval shall be based on an analysis of the alternate standard and the incorporated standard, prepared by a qualified independent third party or the organization that published the incorporated standard.

3. The department may include specific conditions in issuing an approval, including an expiration date for the approval. Violations of the conditions under which an approval is issued shall constitute a violation of this code.

4. If the department determines that the alternate standard is not equivalent to or more stringent than the standards incorporated by reference, the request for approval shall be denied in writing.

5. The department may revoke an approval for any false statements or misrepresentations of facts on which the approval was based. The department may re–examine an approved alternate standard and issue a revised approval at any time.

6. Fees for review of standards under this paragraph shall be submitted in accordance with ch. Comm 2.

**(4)** American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, Michigan 48333.

(a) BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE, ACI 318–95.

(b) BUILDING CODE REQUIREMENTS FOR MASONRY STRUCTURES, ACI–530–99 and SPECIFICATION FOR MASONRY STRUCTURES, ACI 530.1–99.

**(5)** American Forest & Paper Association, 1111 19th Street NW, Suite 800, Washington, D.C. 20036.

(a) NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION, 1997 EDITION, INCLUDING 1997 SUPPLEMENT.

(b) THE PERMANENT WOOD FOUNDATION SYSTEM, BASIC REQUIREMENTS, TECHNICAL REPORT NO. 7, JANUARY, 1987, EXCEPT FOR SECTION 3.3.1.

**(6)** American Institute of Steel Construction (AISC), One E. Wacker Drive, Suite 3100, Chicago, IL 60601. SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS, ALLOWABLE STRESS DESIGN AND PLASTIC DESIGN, WITH COMMENTARY, JUNE 1, 1989.

**(7)** American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania 19103.

(a) STANDARD SPECIFICATION FOR BUILDING BRICK (SOLID MASONRY UNITS MADE FROM CLAY OR SHALE), ASTM C 62–92C.

(b) STANDARD SPECIFICATION FOR HOLLOW LOAD–BEARING CONCRETE MASONRY UNITS, ASTM C 90–94A.

(c) STANDARD SPECIFICATION FOR FACING BRICK (SOLID MASONRY UNITS MADE FROM CLAY OR SHALE), ASTM C 216–94A.

(d) STANDARD SPECIFICATION FOR MORTAR FOR UNIT MASONRY, ASTM C 270–94.

(e) TEST METHOD FOR STEADY STATE HEAT TRANSFER PROPERTIES OF HORIZONTAL PIPE INSULATION, ASTM C 335–95.

(f) STANDARD SPECIFICATION FOR GROUT FOR MASONRY, ASTM C 476–99.

(g) TEST METHOD FOR STEADY–STATE HEAT FLUX MEASUREMENTS AND THERMAL TRANSMISSION PROPERTIES BY MEANS OF THE HEAT FLOW METER APPARATUS, ASTM C 518–91.

(h) STANDARD SPECIFICATION FOR HOLLOW BRICK (HOLLOW MASONRY UNITS MADE FROM CLAY OR SHALE), ASTM C 652–94.

(i) STANDARD SPECIFICATION FOR ASPHALT SHINGLES (ORGANIC FELT) SURFACED WITH MINERAL GRANULES, ASTM D 225–86.

(j) STANDARD SPECIFICATION FOR ASPHALT–SATURATED ORGANIC FELT USED IN ROOFING AND WATER PROOFING, ASTM D 226–89.

(k) STANDARD CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES (UNIFIED SOIL CLASSIFICATION SYSTEM), ASTM D 2487–98.

(L) STANDARD TEST METHOD FOR WIND–RESISTANCE OF ASPHALT SHINGLES (FAN–INDUCED METHOD), ASTM D 3161–93.

(m) STANDARD SPECIFICATION FOR ASPHALT SHINGLES MADE FROM GLASS FELT AND SURFACED WITH MINERAL GRANULES, ASTM D 3462–93A.

(n) STANDARD SPECIFICATION FOR ASPHALT–SATURATED ORGANIC FELT SHINGLE UNDERLAYMENT USED IN ROOFING, ASTM D 4869–88.

(o) TEST METHODS FOR WATER VAPOR TRANSMISSION OF MATERIALS, PROCEDURE A, ASTM E 96–95.

(p) STANDARD TEST METHOD FOR FIRE TESTS OF ROOF COVERINGS, ASTM E 108–93.

(q) STANDARD TEST METHOD FOR THE RATE OF AIR LEAKAGE THROUGH EXTERIOR WINDOWS, CURTAIN WALLS AND DOORS UNDER SPECIFIED PRESSURE DIFFERENCES ACROSS THE SPECIMEN, ASTM E 283–91.

(r) TEST METHOD FOR DETERMINING AIR LEAKAGE RATE BY FAN PRESSURIZATION, ASTM E 779–87.

**(8)** American Society of Heating, Refrigerating, and Air–conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, N.E., Atlanta, Georgia 30329.

(a) ASHRAE HANDBOOK, FUNDAMENTALS, 1997 EDITION.

(b) ASHRAE HVAC APPLICATIONS HANDBOOK, 1995.

(c) ASHRAE HANDBOOK HVAC SYSTEMS AND EQUIPMENT, 1996 EDITION.

**(9)** American Wood Preservers Association (AWPA), P.O. Box 849, Stevensville, Maryland 21666.

(a) STANDARD FOR COAL TAR CREOSOTE FOR LAND AND FRESH WATER AND MARINE (COASTAL WATER) USE, P1/P13–91.

(b) STANDARD FOR CREOSOTE SOLUTIONS, P2–90.

(c) STANDARD FOR CREOSOTE–PETROLEUM OIL SOLUTIONS, P3–67.

(d) STANDARDS FOR WATERBORNE PRESERVATIVES, P5–93.

(e) STANDARDS FOR OIL–BORNE PRESERVATIVES, P8–93.

(f) STANDARDS FOR SOLVENTS AND FORMULATIONS FOR ORGANIC PRESERVATIVE SYSTEMS, P9–92.

(g) ALL TIMBER PRODUCTS—PRESERVATIVE TREATMENT BY PRESSURE PROCESSES, C1–93.

(h) LUMBER, TIMBERS, BRIDGE TIES AND MINE TIES—PRESERVATIVE TREATMENT BY PRESSURE PROCESSES, C2–93.

(i) PILES—PRESERVATIVE TREATMENT BY PRESSURE PROCESSES, C3–93.

(j) POLES—PRESERVATIVE TREATMENT BY PRESSURE PROCESSES, C4–93.

(k) PLYWOOD—PRESERVATIVE TREATMENT BY PRESSURE PROCESSES, C9–93.

(L) STANDARD FOR PRESSURE TREATED MATERIAL IN MARINE CONSTRUCTION, C18–92.

(m) LUMBER AND PLYWOOD FOR PERMANENT WOOD FOUNDATIONS—PRESERVATIVE TREATMENT BY PRESSURE PROCESSES, C23–93.

(n) ROUND POLES AND POSTS USED IN BUILDING CONSTRUCTION—PRESERVATIVE TREATMENT BY PRESSURE PROCESSES, C23–92.

(o) SAWN TIMBER PILES USED FOR RESIDENTIAL AND COMMERCIAL BUILDING, C24–93.

(p) STANDARD FOR PRESERVATIVE TREATMENT OF STRUCTURAL GLUED LAMINATED MEMBERS AND LAMINATIONS BEFORE GLUING OF SOUTHERN PINE, COASTAL DOUGLAS FIR, HEMFIR AND WESTERN HEMLOCK BY PRESSURE PROCESSES, C28–91.

(q) STANDARD FOR THE CARE OF PRESERVATIVE–TREATED WOOD PRODUCTS, M4–91.

**(10)** North American Insulation Manufacturers Association (NAIMA), 44 Canal Canter Plaza, Suite 310, Alexandria, Virginia 22314. FIBROUS GLASS DUCT CONSTRUCTION STANDARDS, THIRD EDITION, 1998.

**(11)** National Fenestration Rating Council, (NFRC), 962 Wayne Ave., Suite 750, Silver Spring, Maryland 29010. PROCEDURE FOR DETERMINING FENESTRATION PRODUCT THERMAL PROPERTIES, NFRC 100, 1997.

**(12)** National Fire Protection Association, (NFPA), Batterymarch Park, Box 9101, Quincy, Massachusetts 02269. NATIONAL FUEL GAS CODE, NFPA 1999, Chapters 2, 3, and 4.

**(13)** National Institute of Standards and Technology, U.S. Department of Commerce, Washington, D.C. 20234. MODEL DOCUMENTS FOR THE EVALUATION, APPROVAL, AND INSPECTION OF MANUFACTURED BUILDINGS, NBS BUILDING SCIENCE SERIES 87, JULY 1976.

**(14)** National Wood Window and Door Association, (NWWDA), 1400 East Touhy Avenue, Suite 470, Des Plaines, IL 60018. VOLUNTARY SPECIFICATIONS FOR ALUMINUM, VINYL (PVC) AND WOOD WINDOWS AND GLASS DOORS, AAMA/NWWDA 101/I.S.2–97.

**(15)** Portland Cement Association, 5420 Old Orchard Road, Skokie, Illinois 60077. CONCRETE MASONRY HANDBOOK FOR ARCHITECTS, ENGINEERS, BUILDERS, FIFTH EDITION, 1991.

**(16)** Sheet Metal and Air Conditioning Contractors National Association, (SMACNA), Vienna, Virginia 22180.

(a) RESIDENTIAL COMFORT SYSTEM INSTALLATION STANDARDS MANUAL, SEVENTH EDITION, 1998.

(b) HVAC DUCT CONSTRUCTION STANDARDS–METAL AND FLEXIBLE, SECOND EDITION, 1995, INCLUDING ADDENDUM NO. 1, NOVEMBER 1997.

(c) FIBROUS GLASS DUCT CONSTRUCTION STANDARDS, SIXTH EDITION, 1992.

**(17)** Truss Plate Institute, Inc., (TPI), 583 D'Onofrio Drive, Madison, Wisconsin 53719. NATIONAL DESIGN STANDARD FOR METAL PLATE CONNECTED WOOD TRUSS CONSTRUCTION, ANSI/TPI 1–1995.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (intro.) and (2), cr. (2m) and (2n), r. and recr. (4), Register, February, 1985, No. 350, eff. 3–1–85; renum. (2m) to be (2k) and am., cr. (2m), Register, July, 1986, No. 367, eff. 1–1–87; am. (intro.), (1), (2k) and (4), r. (2n), cr. (2p), (2s) and (3m), Register, January, 1989, No. 397, eff. 2–1–89; am. (intro.), (1), (2), (2k), (2m), (2p), (2s), (3m), (4), (5), cr. (6), Register, March, 1992, No. 435, eff. 4–1–92; r. and recr., Register, November, 1995, No. 479, eff. 12–1–95; r. and recr., Register, January, 1999, No. 517, eff. 2–1–99; renum. (1) to (14) to be (4) to (17), r. and recr. (intro.) and cr. (2) and (3), Register, September, 2000, No. 537, eff. 10–1–00; **renum. (1) to be (1) (a), (1) (b) to be (4) (b), (7) (f) to (i) to be (g) to (j), and (j) to (p) to be (L) to (r), cr. (1) (b), (7) (f), and (k), and am. (4) and (12), Register, March, 2001, No. 543, eff. 4–1–01.**

# Chapter Comm 21

## CONSTRUCTION STANDARDS



**Note:** Chapter Ind 21 was renumbered to be chapter Comm 21, Register, February, 1985, No. 350, eff. 3–1–85. Chapter ILHR 21 was renumbered chapter Comm 21 under s. 13.93 (2m) (b) 1., Stats., and corrections made under s. 13.93 (2m) (b) 6. and 7., Stats., Register, January, 1999, No. 517.

### Subchapter I — Scope

**Comm 21.01 Scope.** The provisions of this chapter shall apply to the design and construction of all one– and 2–family dwellings.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

### Subchapter II — Design Criteria

**Comm 21.02 Loads and materials.** Every dwelling shall be designed and constructed in accordance with the requirements of this section.

**(1)** DESIGN LOAD. Every dwelling shall be designed and constructed to support the actual dead load, live loads and wind loads acting upon it without exceeding the allowable stresses of the material.

(a) *Dead loads.* Every dwelling shall be designed and constructed to support the actual weight of all components and materials. Earth–sheltered dwellings shall be designed and constructed to support the actual weight of all soil loads.

(b) *Live loads.* 1. Floors and ceilings. Floors and ceilings shall be designed and constructed to support the minimum live loads listed in Table 21.02. The design load shall be applied uniformly over the component area.

TABLE 21.02

| Component | Live Load (pounds per sq. ft.) |
|---|---|
| Floors | 40 |
| Garage floors | 50 |
| Exterior balconies, decks, porches | 40 |
| Ceilings (with storage) | 20 |
| Ceilings (without storage) | 5 |

2. Snow loads. Roofs shall be designed and constructed to support the minimum snow loads listed on the zone map. The loads shall be assumed to act vertically over the roof area projected upon a horizontal plane.

(c) *Wind loads.* 1. Dwellings shall be designed and constructed to withstand a horizontal and uplift pressure of 20 pounds per square foot acting over the surface area.

2. Roof framing members spanning more than 6 feet measured from the outermost edge of the roof shall be permanently fastened to the top plate of load bearing walls using engineered clips, straps or hangers.

3. Roof framing members spanning 6 feet or less measured from the outermost edge of the roof shall be permanently fastened to the top plate of load bearing walls using toe–nailing, or engineered clips, straps or hangers.

**Note:** For information on toe–nailing, see the fastener schedule table in the appendix.

(d) *Fasteners.* All building components shall be fastened to withstand the dead load, live load and wind load. Where the effect of the dead load exceeds the wind load effect, the dwelling need not be anchored to the foundation.

**Note:** See the Appendix for a schedule of fasteners that will be acceptable to the department for compliance with this subsection. Other fastening methods may be allowed if engineered under s. Comm 21.02 (3).

**(2)** METHODS OF DESIGN. All dwellings shall be designed by the method of structural analysis or the method of accepted practice specified in each part of this code.

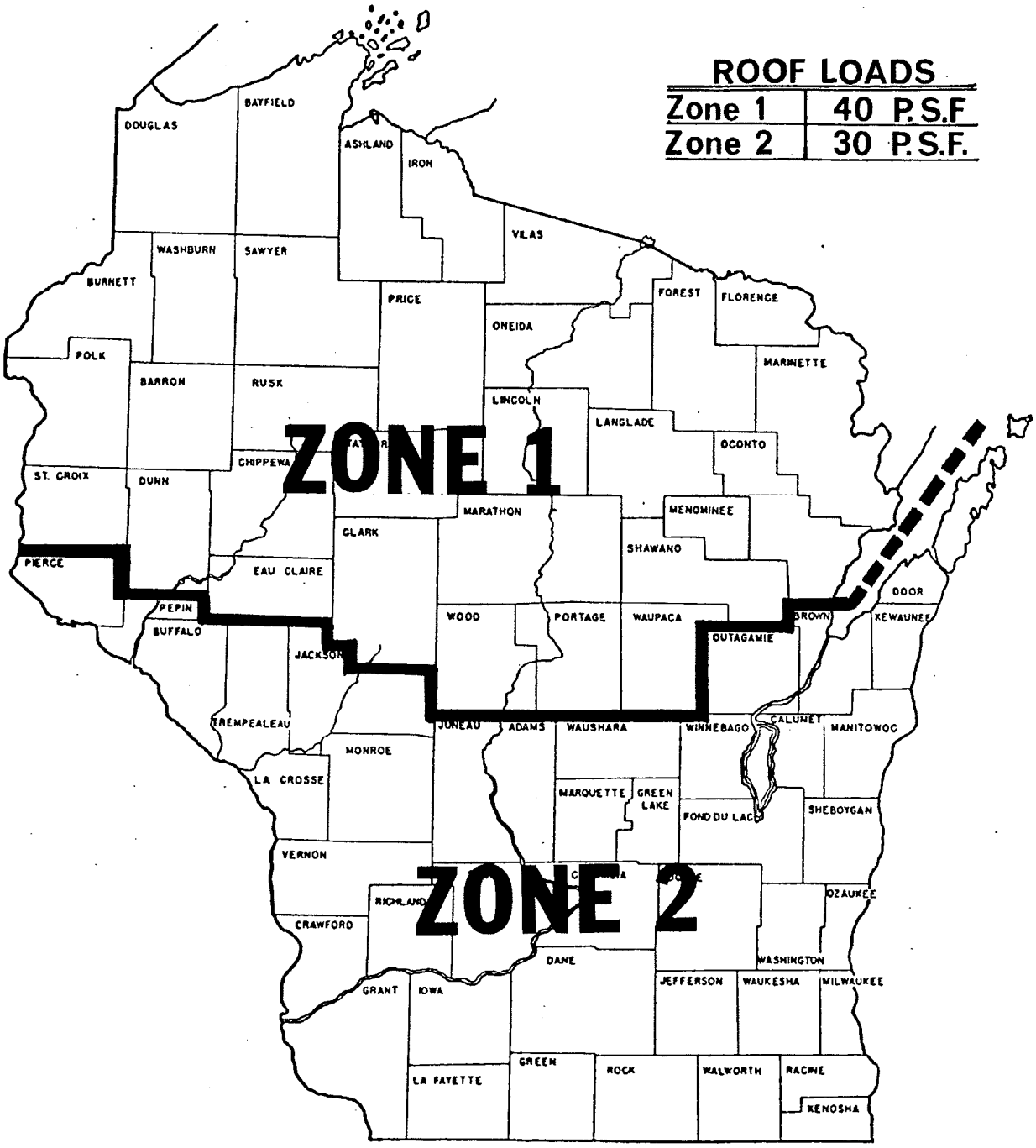
**Note:** See ch. NR 116, rules of the department of natural resources, for special requirements relating to buildings located in flood plain zones. Information regarding the elevation of the regional flood may be obtained from the local zoning official.

**(3)** STRUCTURAL ANALYSIS STANDARDS. Structural analysis shall conform to the following nationally recognized standards.

(a) *Wood.* 1. Except as provided in subd. 1. a. and b., structural lumber, glue–laminated timber, timber pilings and fastenings shall be designed in accordance with the "National Design Specification for Wood Construction" and the "Design Values for Wood Construction," a supplement to the National Design Specification for Wood Construction.

Figure 21.02

ZONE MAP FOR ROOF LOADS




a. Section 2.2.5.3. The cumulative effects of short–time loads, such as snow, shall be considered in determining duration of load. For snow load, no greater duration of load factor than 1.15 shall be used.

b. Section 4.1.7. The provisions of this section shall also apply to reused lumber. Reused lumber shall be considered to have a duration of load factor of 0.90.

2. Span tables for joists and rafters printed in the appendix or approved by the department may be used in lieu of designing by structural analysis.

(b) *Structural steel.* The design, fabrication and erection of structural steel for buildings shall conform to Specification for Structural Steel Buildings, Allowable Stress Design and Plastic

Design and the provisions of the accompanying commentary as adopted under s. Comm 20.24 (6).

(c) *Concrete.* Plain, reinforced or prestressed concrete construction shall conform to the following standards:

1. ACI Standard 318, "Building Code Requirements for Reinforced Concrete".

2. ACI Standard 318.1, "Building Code Requirements for Structural Plain Concrete".

(d) *Masonry.* The design and construction of masonry shall conform to the provisions of the Concrete Masonry Handbook for Architects, Engineers, Builders as adopted under s. Comm 20.24 (15).

(e) *Engineered structural components.* Engineered structural components shall be used in accordance with structural analysis or with load tables supplied by the manufacturer, provided those load tables were developed using structural analysis or load testing.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. (3) (a), am. (3) (c) and Table 21.02, cr. (3) (c) 2., Register, February, 1985, No. 350, eff. 3–1–85; cr. (3) (a) 3., am. (3) (b), renum. (3) (e) to be (3) (d), and am., Register, November, 1995, No. 479, eff. 12–1–95; renum. and am. (1) (c) to be (1) (c) 1., cr. (1) (c) 2. and 3., am. (3) (d), Register, January, 1999, No. 517, eff. 2–1–99; **r. (3) (a) 3. and cr. (3) (e), Register, March, 2001, No. 543, eff. 4–1–01; correction in (3) (b) made under s. 13.93 (2m) (b) 7., Stats., Register, March, 2001, No. 543.**

**Comm 21.03 Exits, doors and hallways.** Exits, doors and hallways shall be constructed as specified in this section.

**(1)** EXITS FROM THE FIRST FLOOR. (a) Every dwelling unit shall be provided with at least 2 exits from the first floor.

(b) At least one of the exits shall discharge to grade. This exit may include interior or exterior stairs.

(c) An additional exit may discharge to an outside balcony that complies with sub. (10).

(d) An additional exit may discharge into an attached garage provided the garage has an exit door that discharges to grade. An overhead garage door may not be used as an exit door.

(e) The 2 required exits shall be located as far apart as practical.

**Note:** See appendix for examples of exit separation design.

**(2)** EXITS FROM THE SECOND FLOOR. (a) At least 2 exits shall be provided from the second floor. One of the exits shall be a stairway or ramp and lead to the first floor or discharge to grade. The second exit may be via a stairway or ramp which discharges to grade or may discharge to a balcony which complies with sub. (10).

(b) Except as provided in par. (c), windows which comply with sub. (6) may be provided in each second floor bedroom in lieu of the second exit from the floor.

(c) Where the second floor is the lowest floor level in a dwelling unit, as in an up–and–down duplex, windows may not be provided as the second exit from the floor.

**(3)** EXITS ABOVE THE SECOND FLOOR. At least 2 exits shall be provided for each habitable floor above the second floor. The exits shall be located such that in case any exit is blocked some other exit will still be accessible to the second floor. The exits shall be stairways or ramps that lead to the second floor or discharge to grade.

**(4)** EXITS FROM LOFTS. (a) At least one stairway exit shall be provided, to the floor below, for a loft exceeding 400 square feet in area.

(b) At least one stairway or ladder exit shall be provided to the floor below for a loft, 400 square feet or less, in area.

**(5)** EXITS FROM BASEMENTS AND GROUND FLOORS. (a) *General.* All basements and ground floors shall be provided with at least one exit of the following types:

1. A door to the exterior of the dwelling.

2. A stairway or ramp that leads to the floor above.

(b) *Basements and ground floors used for sleeping.* 1. Basements and ground floors used for sleeping shall be provided with at least 2 exits.

2. The exits shall be located as far apart as practical.

3. The exits may not be accessed from the same ramp or stairway.

4. In addition to the exit type required under par. (a), the second exit from a basement or ground floor used for sleeping shall be one of the following types:

a. A door to the exterior of the dwelling.

b. A stairway or ramp that leads to the floor above.

c. A stairway that leads to a garage provided the garage has an exit door other than the overhead door.

d. An egress window that complies with sub. (6), located in each bedroom.

**(6)** WINDOWS USED FOR EXITING. Windows which are installed for exit purposes shall comply with the requirements of this subsection.

(a) The window shall be openable from the inside without the use of tools or the removal of a sash. If equipped with a storm or screen, it shall be openable from the inside.

(b) 1. The nominal size of the net clear window opening shall be at least 20 inches by 24 inches irrespective of height or width. Nominal dimensions shall be determined by rounding up fractions of inches if they are $^1/_2$–inch or greater or rounding down fractions of inches if they are less than $^1/_2$–inch.

2. No portion of the window, including stops, stools, meeting rails and operator arms, shall infringe on the required opening.

(c) The area and dimension requirements of par. (b) may be infringed on by a storm window.

(d) 1. For any window used for exiting, the lowest point of clear opening shall be no more than 60 inches above the floor.

2. If the lowest point of clear opening is more than 46 inches above the floor, a permanent platform or fixture shall be installed such that a flat surface at least 20 inches wide and 9 inches deep is located no more than 46 inches directly below the clear opening.

3. The topmost surface of the platform or fixture shall be no more than 24 inches above the floor.

4. The topmost surface of the platform or fixture shall support a live load of at least 200 pounds.

5. A Step used for the sole purpose of reaching the top of the platform or fixture is exempt from the requirements of s. Comm 21.04.

(e) 1. An egress window with any point of clear opening below adjacent grade shall be provided with an areaway in accordance with this section.

2. The width of the areaway shall be a minimum of 36 inches measured perpendicular from the outer surface of the below–grade wall.

3. The areaway shall be a minimum of 36 inches measured perpendicular from the outer surface of the below–grade wall.

4. If the bottom of the areaway is more than 46 inches below adjacent grade or the top of the areaway enclosure, the areaway shall be provided with a ladder or at least one additional step to aid egress. Steps used to comply with this section are exempt from the requirements of s. Comm 21.04.

5. Ladders or other steps used to comply with subd. 4. may infringe on the required area of the areaway by a maximum of 6 inches.

6. The areaway shall be constructed such that water entering the areaway does not enter the dwelling.

**(7)** DOORS USED FOR EXITING. Doors used for exiting shall comply with the following requirements:

(a) One of the exit doors from a dwelling unit shall be a swing–type door at least 36 inches wide by 80 inches high.

(b) 1. Except as allowed under subd. 2., all other required exit doors shall be at least 32 inches wide by 76 inches high.

2. Sliding patio doors used as a required exit shall have a clear opening of at least 30 inches.

(c) Where double doors are used as a required exit, each door leaf shall be at least 30 inches wide and the doors may not have an intermediate mullion.

(d) All exit doors shall be openable from the interior without the use of a key.

**(8)** INTERIOR CIRCULATION. All doors or openings to the following areas shall be at least 80 inches high and either provide a minimum net clear opening width of 30 inches or be a 32–inch door:

(a) At least 50% of the bedrooms.

(b) All common use areas including kitchens, dining rooms, living rooms, family rooms, basements and garages.

(c) At least one full bathroom, including doors or openings to the sink, toilet and tub or shower.

**(9)** HALLWAYS. Hallways shall be at least 3 feet in width except that door hardware, finish trim and heating registers may infringe upon this dimension.

**(10)** BALCONIES. (a) Balconies shall be made of concrete, metal or wood which is treated, protected or naturally decay–resistive in accordance with s. Comm 21.10.

(b) Balconies shall be provided with guardrails in accordance with s. Comm 21.04 (2).

(c) Balconies which are required for exit purposes shall also comply with all of the following requirements:

1. The balcony guardrail shall terminate no more than 46 inches above the floor level of the balcony.

2. The floor level of the balcony shall be no more than 15 feet above the grade below.

3. The floor of the balcony shall have minimum dimensions of 3 feet by 3 feet. The guardrail and its supports may infringe on the dimensions of the required area.

**(11)** SPLIT LEVEL DWELLINGS. In determining the exit requirement in a split level dwelling, all levels that are to be considered a single story shall be within 5 feet of each other.

**(12)** TWO–FAMILY DWELLINGS. In a 2–family dwelling, each dwelling unit shall be provided with exits in compliance with this section.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. Register, February, 1985, No. 350, eff. 3–1–85; emerg. am. (1) (b), (2) and (5) (b) 2., eff. 5–7–85; r. (1) (b), renum. (1) (a) to be (1), am. (2), (7) and (8), r. and recr. (5) to (6), cr. (6m) and (10) to (12), Register, January, 1989, No. 397, eff. 2–1–89; am. (3) and (7), r. and recr. (10) and (11), Register, March, 1992, No. 435, eff. 4–1–92; am. (8), r. and recr. (10) (a), Register, November, 1995, No. 479, eff. 12–1–95; am. (6m) (b) 1. and 2., r. (6m) (b) 3., Register, January, 1999, No. 517, eff. 2–1–99; **r. and recr. (1), (5), (7) and (8), am. (2) (b), r. (6), renum. (6m) to be (6) and r. and recr. (6) (d) and (e) as renum., Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 21.04 Stairways and elevated areas.** **(1)** SCOPE. Every interior and exterior stairway, including tub access steps but excluding nonrequired basement stairways which lead directly to the building exterior and stairways leading to attics or crawl spaces, shall conform to the requirements of this section.

**(2)** DETAILS. (a) *Width.* 1. Except for spiral staircases under subd. 2., stairways shall measure at least 36 inches in width. Handrails and associated trim may project a maximum of 4.5 inches into the required width at each side of the stairway.

2. Spiral staircases shall be at least 26 inches wide measured from the outer edge of the supporting column to the inner edge of the handrail.

(b) *Riser height.* 1. Except for spiral staircases under subd. 2., risers may not exceed 8 inches in height measured vertically from tread to tread.

2. Risers in spiral staircases may not exceed 9.5 inches in height measured vertically from tread to tread.

(c) *Tread depth.* 1. Rectangular treads. Rectangular treads shall have minimum tread depth of 9 inches measured horizontally from nosing to nosing.

2. Spiral staircase treads. Spiral staircase treads shall have a minimum tread depth of 7 inches from nosing to nosing measured at a point 12 inches from the narrow end of the tread.

3. Winder treads in series. Two or more winder treads may be placed immediately adjacent to each other anywhere in a stairway provided both of the following conditions are met:

a. The winder treads shall have a minimum tread depth of 7 inches measured at a point 12 inches from the narrow end of the tread.

b. The depth of the immediately adjoining winder treads shall be equal at a point 12 inches from the narrow end.

4. Individual winder treads. a. An individual winder tread may be placed between rectangular treads or at the end of a flight of rectangular treads provided the tread depth, measured at a point 12 inches from the narrow end, is equal to the tread depth of the rectangular steps in the flight.

b. There may be more than one individual winder tread in a stairway or in a flight of stairs.

(d) *Headroom.* 1. Stairways shall be provided with a minimum headroom clearance of 76 inches measured vertically from a line parallel to the nosing of the treads to the ceiling, soffit or any overhead obstruction directly above that line.

2. The headroom clearance shall be maintained over an intermediate landing.

3. The headroom clearance shall be maintained over a landing that is at the top or bottom of a stairway for a minimum distance of 36 inches in the direction of travel of the stairway.

(e) *Uniformity.* 1. Within a stairway flight, tread widths and riser heights may vary by a maximum of 3/16 inch.

2. The allowed variation in uniformity under subd. 1. may not be used to exceed the maximum riser height under par. (b) or to decrease the minimum tread depth under par. (c).

**(3)** HANDRAILS AND GUARDRAILS. (a) *General.* Stairs with more than 3 risers shall be provided with at least one handrail for the full length of the stairs. Handrails or guardrails shall be provided on all open sides of stairs consisting of more than 3 risers and on all open sides of areas that are elevated more than 24 inches above the floor or exterior grade. Handrails and guardrails shall be constructed to prevent the through–passage of a sphere with a diameter of 6 inches or larger. Handrails and guardrails shall be designed and constructed to withstand a 200 pound load applied in any direction. Exterior handrails and guardrails shall be constructed of metal, decay resistant or pressure–treated wood, or shall be protected from the weather.

(b) *Handrails.* 1. Height. Handrails shall be located at least 30 inches, but no more than 38 inches above the nosing of the treads. Measurement shall be taken from the hard structural surface beneath any finish material to the top of the rail. Variations in uniformity are allowed only when a rail contacts a wall or newel post or where a turnout or volute is provided at the bottom step.

2. Clearance. The clearance between a handrail and the wall surface shall be at least $1^1/_2$ inches.

3. Winders. Handrails on winder steps shall be placed on the side where the treads are wider.

4. Projection. Handrails and associated trim may project into the required width of stairs and landings a maximum of $4^1/_2$ inches on each side.

5. Size and configuration. Handrails shall be symmetrical about the vertical centerline to allow for equal wraparound of the thumb and fingers.

a. Handrails with a round or truncated round cross sectional gripping surface shall have a maximum whole diameter of 2 inches.

b. Handrails with a rectangular cross sectional gripping surface shall have a maximum perimeter of $6^1/_4$ inches with a maximum cross sectional dimension of $2^7/_8$ inches.

c. Handrails with other cross sections shall have a maximum cross sectional dimension of the gripping surface of $2^7/_8$ inches with a maximum linear gripping surface measurement of $6\ ^1/_4$ inches and a minimum linear gripping surface of 4 inches.

**Note:** See appendix for further information on handrail measurement.

6. Continuity. Handrails shall be continuous for the entire length of the stairs except in any one of the following cases:

a. A handrail may be discontinuous at an intermediate landing.

b. A handrail may have newel posts.

c. A handrail may terminate at an intermediate wall provided the lower end of the upper rail is returned to the wall or provided with a flared end, the horizontal offset between the 2 rails is no more than 12 inches measured from the center of the rails, and both the upper and lower rails can be reached from the same tread without taking a step.

(c) *Guardrails.* 1. Application. All openings between floors, and open sides of landings, platforms, balconies or porches that are more than 24 inches above grade or a floor shall be protected with guardrails.

2. Height. Guardrails shall be located at least 36 inches above the floor. Measurement shall be taken from the hard structural surface beneath any finish material to the top of the rail.

**(4)** LANDINGS. (a) *Intermediate landings.* 1. A level intermediate landing shall be provided in any stairway with a height of 12 feet or more.

2. Intermediate landings that connect 2 or more straight flights of stairs, or 2 flights of stairs at a right angle, shall be at least as wide as the stairway and shall measure at least 36 inches in the direction of travel.

3. Curved or irregular landing shall have a radius of at least 36 inches.

4. Curved or irregular landings shall have a minimum straight line measurement of 26 inches between the nosing of the 2 connecting treads measured at a point 18 inches from the narrow end of the landing measured along the nosing of the 2 treads.

(b) *Landings at the top and base of stairs.* A level landing shall be provided at the top and base of every stairs. The landing shall be at least as wide as the stairs and shall measure at least 3 feet in the direction of travel.

(c) *Doors at landings.* Except as provided in subds. 1. to 4., level landings shall be provided on each side of any door located at the top or base of a stairs, regardless of the direction of swing. In the following exceptions, stairways to attached garages or porches are considered interior stairs:

1. A landing is not required between the door and the top of interior stairs if the door does not swing over the stairs.

2. A landing is not required between the door and the top of an interior stairs of 1 or 2 risers regardless of the direction of swing.

3. A landing is not required between a sliding glass door and the top of an exterior stairway of 3 or fewer risers.

4. The exterior landing, platform or sidewalk at an exterior doorway shall be located a maximum of 8 inches below the interior floor elevation. The landing, platform or sidewalk shall have a length at least equal to the width of the door.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. Register, February, 1985, No. 350, eff. 3–1–85; am. (intro.), r. and recr. (1) (c), renum. (3) (f) to Comm 21.042, Register, January, 1989, No. 397, eff. 2–1–89; r. and recr. (intro.) and (3) (c), am. (1) (a), (2) (a) and (c) 2. and (3) (a), cr. (2) (c) 6., March, 1992, No. 435, eff. 4–1–92; r. and recr., Register, November, 1995, No. 479, eff. 12–1–95; am. (1) (c) 1. and (d), renum. (2) (intro.) to (b) to be (2) (a) to (c) and am. (a), r. (2) (b) (intro.), Register, February, 1997, No. 494, eff. 3–1–97; reprinted to restore dropped copy, Register, March, 1997, No. 495; **r. (1), renum. (intro.) to be (1) and am., renum. (2) and (3) to be (3) and (4), cr. (2) and r. and recr. (4) (a), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 21.042 Ladders.** Ladders which are used as part of a required exit shall conform to this section.

**(1)** DESIGN LOAD. Ladders shall be designed to withstand loads of at least 200 pounds.

**(2)** TREAD OR RUNGS. (a) Minimum tread requirements shall be specified in Table 21.042. Treads less than 9 inches in width shall have open risers. All treads shall be uniform in dimension.

TABLE 21.042

| Pitch of Ladder Angle to Horizontal (degrees) | Maximum rise (inches) | Minimum Tread (inches) |
|---|---|---|
| 41.6 to 48.4 | 8 | 9 |
| greater than 48.4 to 55.0 | 9 | 8 |
| greater than 55.0 to 61.4 | 10 | 7 |
| greater than 61.4 to 67.4 | 11 | 6 |
| greater than 67.4 to 71.6 | 12 | 5 |
| greater than 71.6 to 75.9 | 12 | 4 |
| greater than 75.9 to 80.5 | 12 | 3 |
| greater than 80.5 to 90 | 12 | 2 |

(b) Rungs may only be used for ladders with a pitch range of 75° to 90°. Rungs shall be at least 1 inch in diameter for metal ladders and $1^1/_2$ inch for wood ladders. All rungs shall be uniform in dimension.

**(3)** RISERS. Risers shall be uniform in height and shall conform with Table 21.042.

**(4)** WIDTH. The width of the ladder shall be a minimum of 20 inches wide and a maximum of 30 inches wide.

**(5)** HANDRAILS. (a) Handrails shall be required for ladders with pitches less than 65°.

(b) Handrails shall be located so the top of the handrail is at least 30 inches, but not more than 38 inches, above the nosing of the treads.

(c) Open handrails shall be provided with intermediate rails or an ornamental pattern such that a sphere with a diameter of 6 inches or larger cannot pass through.

(d) The clearance between the handrail and the wall surface shall be at least $1^1/_2$ inches.

(e) Handrails shall be designed and constructed to withstand a 200 pound load applied in any direction.

**(6)** CLEARANCES. (a) The ladder shall have a minimum clearance of at least 15 inches on either side of the center of the tread.

(b) The edge of the tread nearest to the wall behind the ladder shall be separated from the wall by at least 7 inches.

(c) A passage way clearance of at least 30 inches parallel to the slope of a 90° ladder shall be provided. A passage way clearance of at least 36 inches parallel to the slope of a 75° ladder shall be provided. Clearances for intermediate pitches shall vary between these 2 limits in proportion to the slope.

(d) For ladders with less than a 75° pitch the vertical clearance above any tread or rung to an overhead obstruction shall be at least 6 feet 4 inches measured from the leading edge of the tread or rung.

**History:** Renum. from Comm 21.04 (3) (f), cr. (intro.), Register, January, 1989, No. 397, eff. 2–1–89; am. (6) (b), Register, November, 1995, No. 479, eff. 12–1–95; am. (5) (b) and (c), Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 21.045 Ramps.** Every exterior or interior ramp which leads to or from a required exit shall comply with the requirements of this section.

**(1)** SLOPE. Ramps shall not have a gradient greater than 1 in 8 or one foot of rise in 8 feet of run. Walkways with gradients less than 1 in 20 or one foot of rise in 20 feet of run are not considered to be ramps.

**(2)** SURFACE AND WIDTH. Ramps shall have a slip resistant surface and shall have a minimum width of 36 inches measured between handrails.

**(3)** HANDRAILS. Handrails shall be provided on all open sides of ramps. Every ramp that overcomes a change in elevation of more than 8 inches shall be provided with at least one handrail.

(a) Ramps which have a gradient greater than 8.33% or 1:12 or one foot rise in 12 feet of run and which overcome a change in

elevation of more than 24 inches, shall be provided with handrails on both sides.

(b) Handrails shall be located so the top of the handrail is at least 30 inches, but not more than 38 inches above the ramp surface.

(c) Open–sided ramps shall have the area below the handrail protected by intermediate rails or an ornamental pattern to prevent the passage of a sphere with a diameter of 6 inches or larger.

(d) The clear space between the handrail and any adjoining wall shall be at least $1^1/_2$ inches.

**(4)** LANDINGS. A level landing shall be provided at the top, at the foot and at any change in direction of the ramp. The landing shall be at least as wide as the ramp and shall measure at least 3 feet in the direction of travel.

**History:** Cr. Register, January, 1989, No. 397, eff. 2–1–89; am. (3) (intro.), Register, March, 1992, No. 435, eff. 4–1–92; am. (3) (c), Register, November, 1995, No. 479, eff. 12–1–95; am. (3) (b), Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 21.05 Light and ventilation. (1)** NATURAL LIGHT. All habitable rooms shall be provided with natural light by means of glazed openings. The area of the glazed openings shall be at least 8% of the net floor area, except under the following circumstances:

(a) *Exception.* Habitable rooms, other than bedrooms, located in basements need not be provided with natural light.

(b) *Exception.* Natural light may be obtained from adjoining areas through glazed openings, louvers or other approved methods. Door openings into adjoining areas may not be used to satisfy this requirement.

**(2)** VENTILATION. (a) *Natural ventilation.* Natural ventilation shall be provided to all habitable rooms by means of openable doors, skylights or windows. The net area of the openable doors, skylights or windows shall be at least 3.5% of the net floor area of the room. Balanced mechanical ventilation may be provided in lieu of openable exterior doors, skylights or windows provided the system is capable of providing at least one air change per hour of fresh outside air while the room is occupied. Infiltration may not be considered as make–up air for balancing purposes.

(b) *Exhaust ventilation.* All exhaust ventilation shall terminate outside the building.

**(3)** ATTIC VENTILATION. Ventilation above the ceiling or attic insulation shall be provided as specified in s. Comm 22.08 (1).

**(4)** CRAWL SPACE VENTILATION. (a) *General.* Unheated crawl spaces shall be ventilated in accordance with s. Comm 22.08 (2).

(b) *Vapor retarder.* 1. Crawl spaces shall be provided with a vapor retarder that has a transmission rate of 0.1 perm or less.

2. All decayable organic material, including topsoil, shall be removed from crawl space floors prior to placing the vapor retarder.

**(5)** SAFETY GLASS. Except as provided in par. (e), glazing shall consist of safety glass meeting the requirements of ANSI Z 97.1 when installed in any of the following locations:

(a) In any sidelight adjacent to a door where the nearest point is within 2 feet of the door.

(b) In a wall that comprises part of a tub or shower enclosure where the glazing is within 5 feet vertically of the lowest drain inlet.

(c) Within 4 feet vertically of a tread or landing in a stairway and within one foot horizontally of the near edge of the tread or landing.

(d) Within 4 feet vertically of the floor and 3 feet horizontally of the nosing of the top or bottom tread of a stair.

(e) Safety glass is not required where the size of an individual pane of glass is 8 inches or less in the least dimension.

**Note:** The U.S. Consumer Product Safety Commission requires safety glass for glazing in internal and external doors, including storm doors and patio doors, as well as for the tub or shower enclosures themselves. These federal rules, contained in 16 CFR, subchapter B, part 1201, apply in addition to any state rules or statutes.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. (1) and (2), Register, February, 1985, No. 350, eff. 3–1–85; r. and recr. (3) and (4), Register, July, 1986, No. 367, eff. 1–1–87; am. (4), Register, January, 1989, No. 397, eff. 2–1–89; am. (2) (a), (4) and (5), Register, March, 1992, No. 435, eff. 4–1–92; am. (2) (a), Register, November, 1995, No. 479, eff. 12–1–95; am. (3), r. and recr. (4) and (5), Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 21.06 Ceiling height.** All habitable rooms, kitchens, hallways, bathrooms and corridors shall have a ceiling height of at least 7 feet. Habitable rooms may have ceiling heights of less than 7 feet provided at least 50% of the room's floor area has a ceiling height of at least 7 feet. Beams and girders or other projections shall not project more than 8 inches below the required ceiling height.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. Register, February, 1985, No. 350, eff. 3–1–85.

**Comm 21.07 Attic and crawl space access. (1)** ATTIC. Attics with 150 or more square feet of area and 30 or more inches of clear height between the top of the ceiling framing and the bottom of the rafter or top truss chord framing shall be provided with an access opening of at least 14 by 24 inches, accessible from inside the structure.

**(2)** CRAWL SPACES. Crawl spaces with 18 inches of clearance or more between the crawl space floor and the underside of the house floor joist framing shall be provided with an access opening of at least 14 by 24 inches.

**Note:** Access to plumbing or electrical systems may be required under chs. Comm 82–87, Plumbing Code or ch. Comm 16, Electrical Code, Volume 2.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. Register, March, 1992, No. 435, eff. 4–1–92; am. (1), Register, November, 1995, No. 479, eff. 12–1–95.

**Comm 21.08 Fire separation and living unit separation. (1)** FIRE SEPARATION. Dwelling units shall be separated from garage spaces, accessory buildings and other dwelling units in accordance with Table 21.08 and the following requirements:

**TABLE 21.08**

| Between Dwelling And: | Distance Between Objects[1] | Fire Rated Construction[2, 5] |
|---|---|---|
| Detached garage or accessory building on same property | Less than 5 feet | 3/4–hour wall[3]<br>1/3–hour door or window[3] |
| Another dwelling on same property | Less than 5 feet | 3/4–hour wall[4]<br>1/3–hour door or window[4] |
| Detached garage, accessory building, or other dwelling on same property | 5 to 10 feet | 3/4–hour wall[3]<br>No requirement on openings |
| Detached garage, accessory building, or other dwelling on same property | More than 10 feet | No requirements |
| Property Lines | Less than 3 feet | 3/4–hour wall<br>1/3–hour door or window |
| Property Lines | 3 feet or more | No Requirements |

[1] Distance shall be measured perpendicular from wall to wall or property line, ignoring overhangs.

[2] Fire rated construction shall protect the dwelling from an exterior fire source.

[3] Fire rated construction may be in either facing wall.

[4] Fire rated construction shall be in both facing walls.

[5] The methods for garage separation in par. (a) 1. are examples of 3/4 hour wall construction.

(a) *Attached garages.* 1. The walls and ceiling between an attached garage and any portion of the dwelling, including attic or soffit areas, shall be hour fire–resistive construction or shall be constructed as specified in any of the following:

a. One layer of $^5/_8$–inch Type X gypsum drywall shall be used on the garage side of the separation wall or ceiling.

b. One layer of $^1/_2$–inch gypsum drywall shall be used on each side of the separation wall or ceiling.

c. Two layers of $^1/_2$–inch gypsum drywall shall be used on the garage side of the separation wall or ceiling.

2. For all methods listed under subd. 1., drywall joints shall comply with one of the following:

a. Joints shall be taped or sealed.

b. Joints shall be fitted so that the gap is no more than 1/20–inch with joints backed by either solid wood or another layer of drywall such that the joints are staggered.

**Note:** 1/20–inch is approximately the thickness of a U.S. dime.

3. Vertical separations between an attached garage and a dwelling shall extend from the top of a concrete or masonry foundation to the underside of the roof sheathing or fire–resistive ceiling construction.

4. Adjoining garage units are not required to be separated from each other.

(b) *Structural elements exposed in an attached garage.* Beams, columns and bearing walls which are exposed to the garage and which provide support for habitable portions of the dwelling shall be protected by one of the methods specified in par. (a) 1. a. or c. or other ¾ hour fire–resistive protection.

(c) *Doors.* The door and frame assembly between the dwelling unit and an attached garage shall be labeled by an independent testing agency as having a minimum fire–resistive rating of 20 minutes. The test to determine the 20–minute rating is not required to include the hose stream portion of the test.

**Note:** Acceptable tests for fire rating of door assemblies include ASTM E–152, UL 10B, and NFPA 252.

(d) *Other openings.* 1. Access openings in fire separation walls or ceilings shall maintain the required separation and shall have any drywall edges protected from physical damage.

2. The cover or door of the access opening shall be permanently installed with hardware that will maintain it in the closed position when not in use.

**(2)** LIVING UNIT SEPARATION. (a) *General.* In 2–family dwellings, living units shall be separated from each other, from common use areas, from shared attics, and from exit access corridors.

(b) *Doors.* Any door installed in the living unit separation shall have the door and frame assembly labeled by an independent testing agency as having a minimum fire–resistive rating of 20 minutes. The test to determine the 20–minute rating is not required to include the hose stream portion of the test.

(c) *Walls.* Walls in the living unit separation shall be protected by not less than one layer of ½–inch gypsum wallboard or equivalent on each side of the wall with joints in compliance with sub. (1) (a) 2.

(d) *Floors and ceilings.* A fire protective membrane of one layer of 5/8–inch Type X gypsum wallboard with joints in compliance with sub. (1) (a) 2., shall be provided on the ceiling beneath the floor construction that provides the separation.

(e) *Attics and concealed roof spaces.* 1. Attic areas, mansards, overhangs and other concealed roof spaces shall be totally separated above and in line with the tenant separation wall.

2. Acceptable attic separation materials include:

a. 2–inch nominal lumber.

b. Two layers of one–inch nominal lumber.

c. 1/2–inch nominal plywood or wood structural panel.

d. 1/2–inch gypsum board.

e. Fiberglass or mineral wool batt insulation may be used in an unsupported condition provided the least dimension of the opening does not exceed 4 inches.

**(3)** PENETRATIONS. (a) *Ducts.* 1. Except as allowed under subd. 2., all heating and ventilating ducts that penetrate a required separation shall be protected with a listed fire damper with a rating of at least 90 minutes.

2. The fire damper required under subd. 1. may be omitted in any of the following cases:

a. There is a minimum of 6 feet of continuous steel ductwork on at least one side of the penetration.

b. The duct has a maximum cross–sectional area of 20 square inches.

(b) *Electrical and plumbing components.* Penetrations of a required separation by electrical and plumbing components shall be firmly packed with noncombustible material or shall be protected with a listed through–penetration firestop system with a rating of at least one hour.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. Register, February, 1985, No. 350, eff. 3–1–85; cr. (1m), am. (2), (5) (c) and Table, Register, January, 1989, No. 397, eff. 2–1–89; am. (2), (4) and (5) (a) (intro.), renum. (5) (b) and (c) to be (5) (c) and (d) and am. (5) (d), cr. (5) (b) and (e), (6), Register, March, 1992, No. 435, eff. 4–1–92; r. (3) (a), (5) (d), renum. (3) (b) and (c), (5) (e) to be (3) (a) and (b), (5) (d), am. (5) (a) (intro.), (6), cr. (6) (c) to (e), Register, November, 1995, No. 479, eff. 12–1–95; r. and recr. (5) and (6) (b), am. (6) (c) and (d), r. (6) (e) and cr. (7), Register, January, 1999, No. 517, eff. 2–1–99; **r. (1) to (4), renum. (5) to (7) to be (1) to (3), and cr. (2) (e), Register, March, 2001, No. 543, eff. 4–1–01; corrections in (2) (c) and (d) were made under s. 13.93 (2m) (b) 7., Stats., Register, March, 2001, No. 543.**

**Comm 21.085 Fireblocking. (1)** FIREBLOCKING LOCATIONS. Fireblocking shall be provided in all of the following locations:

(a) In concealed spaces of walls and partitions, including furred spaces, at the ceiling and floor levels.

(b) At all interconnections between concealed vertical and horizontal spaces.

(c) In concealed spaces between stair stringers at the top and bottom of the run and at any intervening floor level.

(d) At all openings around wires, cables, vents, pipes, ducts, chimneys and fireplaces at ceiling and floor level.

**(2)** FIREBLOCKING MATERIALS. Fireblocking shall consist of one of the following:

(a) 2–inch nominal lumber.

(b) Two layers of one–inch nominal lumber.

(c) One thickness of 3/4–inch nominal plywood or wood structural panel with any joints backed with the same material.

(d) One thickness of 1/2–inch gypsum wallboard, face nailed or face screwed to solid wood, with any joints backed with the same material.

(e) Fiberglass or mineral wool batt insulation may be used if both of the following conditions are met:

1. The least dimension of the opening may not exceed 4 inches.

2. The batt shall be installed to fill the entire thickness of the opening or stud cavity.

(f) For wires, cables, pipes and vents only, non–shrinking caulk, putty mortar, or similar material may be used provided no dimension of the opening exceeds 1/2 inch around the penetrating object.

(g) For chimneys, fireplaces and metal vents, fireblocking shall be metal, cement board or other noncombustible material.

**History: Cr. Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 21.09 Smoke detectors. (1)** A listed and labeled multiple–station smoke alarm with battery backup shall be installed in all of the following locations:

(a) An alarm shall be installed inside each sleeping room.

(b) On floor levels that contain one or more sleeping areas, an alarm shall be installed outside of the sleeping rooms, in the vicinity of each sleeping area.

(c) On floor levels that do not contain a sleeping area, an alarm shall be installed in a common area on each floor level.

**Note:** Section 50.035 (2), Stats., requires the installation of a complete low voltage, interconnected or radio–transmitting smoke detection system in all community–based residential facilities including those having 8 or fewer beds.

**Note:** Section 101.645 (3), Stats., requires the owner of a dwelling to install a functional smoke detector in the basement of the dwelling and on each floor level except the attic or storage area of each dwelling unit. The occupant of such a dwelling unit shall maintain any smoke detector in that unit, except that if any occupant who is not the owner, or any state, county, city, village or town officer, agent or employee charged under statute or municipal ordinance with powers or duties involving inspection of real or personal property, gives written notice to the owner that the smoke detector is not functional the owner shall provide, within 5 days after receipt of that notice, any maintenance necessary to make that smoke detector functional.

**Note:** Section 101.745 (4), Stats., requires the manufacturer of a manufactured building to install a functional smoke detector in the basement of the dwelling and on each floor level except the attic or storage area of each dwelling unit.

**(2)** Smoke detectors required by this section shall be continuously powered by the house electrical service, and shall be interconnected so that activation of one detector will cause activation of all detectors.

**(3)** For family living units with one or more communicating split levels or open adjacent levels with less than one full story separation between levels, one smoke detector on the upper level shall suffice for an adjacent lower level, including basements.

Where there is an intervening door between one level and the adjacent lower level, smoke detectors shall be installed on each level.

**(4)** Smoke alarms and detectors shall be maintained in accordance with the manufacturer's specifications.

**(5)** For envelope dwellings, at least 3 smoke alarms shall be placed in the air passageways. The alarms shall be placed as far apart as possible.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. Register, February, 1985, No. 350, eff. 3–1–85; r. and recr. Register, April, 1990, No. 412, eff. 5–1–90; renum. to be (1), cr. (2) and (3), Register, March, 1992, No. 435, eff. 4–1–92; renum. (2) and (3) to be (3) and (4), cr. (2), Register, November, 1995, No. 479, eff. 12–1–95; **r. and recr. (1), r. (2), renum. (3) and (4) to be (2) and (3), and cr. (4) and (5), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 21.10 Protection against decay and termites. (1)** Wood used in any of the locations specified under this section shall meet both of the following requirements:

(a) The wood shall be pressure treated with preservative or shall be a naturally durable and decay–resistant species or shall be engineered to be decay resistant.

(b) The wood shall be pressure treated with preservative or shall be naturally termite–resistant unless additional steps are taken to make the wood termite–resistant.

**(2)** Wood used in the following locations shall be as required under sub. (1):

(a) Embedded in earth.

(b) Floor joists that span directly over and within 18 inches of earth.

(c) Girders that span directly over and within 12 inches of earth.

(d) Sills and rim joists that rest on concrete or masonry and are within 8 inches above exterior grade.

(e) Siding within 6 inches of earth.

(f) Ends of wood structural members built into masonry or concrete walls and having clearances of less than 1/2 inch on the top, sides and ends.

(g) Bottom plates of load bearing walls on slab floors in basements or garages.

(h) Bottom plates of garage walls that rest on concrete or masonry and are within 8 inches of exterior grade.

(i) Columns in direct contact with concrete or masonry unless supported by a structural pedestal or plinth block at least 3 inches above the floor.

(j) Any structural part of an outdoor deck, including the decking.

**(3)** Wood girders that rest directly on exterior concrete or masonry shall be protected by one of the following methods:

(a) The wood shall be pressure treated with preservative or shall be a naturally durable and decay–resistant species.

(b) Material, such as pressure–treated plywood, flashing material, steel shims, or water–resistant membrane material shall be placed between the wood and the concrete or masonry.

**(4)** (a) All pressure–treated wood and plywood shall be identified by a quality mark or certificate of inspection of an approved inspection agency which maintains continued supervision, testing and inspection over the quality of the product in accordance with the adopted standards of the American Wood Preservers Association.

(b) Pressure–treated wood used below grade in foundations shall be labeled to show conformance with AWPA C–22 "Lumber and Plywood for Permanent Wood Foundations – Preservative Treatment by Pressure Processes" and labeled by an inspection agency accredited by the American Lumber Standards Committee.

**Note:** Heartwood of redwood, cypress, black walnut, catalpa, chestnut, sage orange, red mulberry, white oak, or cedar lumber are considered by the department to be naturally decay–resistant. Heartwood of bald cypress, redwood, and eastern red cedar are considered by the department to be naturally termite resistant.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. Register, February, 1985, No. 350, eff. 3–1–85; am. (1) (b) and (3), Register, January, 1989, No. 397, eff. 2–1–89; r. and recr. (1) (intro.) and (b), am. (1) (f), renum. (3) (intro.) to be (3) (a), cr. (3) (b), Register, March, 1992, No. 435, eff. 4–1–92; am. (1) (a), (b), (3), cr. (1) (g), Register, November, 1995, No. 479, eff. 12–1–95; **r. (1) and (2), renum. (3) to be (4), and cr. (1) to (3), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 21.11 Foam plastic. (1)** (a) *General.* Foam plastic insulation shall have a flame–spread rating of 75 or less and a smoke–developed rating of 450 or less when tested in accordance with ASTM E–84.

(b) *Thermal barrier.* Except as provided in par. (c), foam plastic insulation shall be separated from the interior of the dwelling by one of the following thermal barriers:

1. 1/2–inch gypsum wallboard.
2. 1/2–inch nominal wood structural panel.
3. 3/4–inch sawn lumber with tongue–and–groove or lap joints.
4. 1–inch of masonry or concrete.
5. A product or material shown by an independent laboratory to limit the temperature rise on the unexposed surface to 250° F for 15 minutes when tested in accordance with ASTM E–119.
6. For doors only, sheet metal with a minimum thickness of 26 standard steel gauge or aluminum with a minimum thickness of 0.032 inch.

**Note:** Number 26 standard steel gauge is approximately equal to 0.018–inch.

(c) *Exemptions from thermal barrier requirement.* The following applications of foam plastic do not require a thermal barrier:

1. On overhead garage doors.
2. In the box sill of the basement or ground floor, above the bottom of the floor joists.

**(2)** Insulation that does not meet the requirements of this section may be approved by the department in accordance with s. Comm 20.18. Approval will be based on tests that evaluate materials or products representative of actual end–use applications.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (1) (b), Register, January, 1989, No. 397, eff. 2–1–89; r. and recr. (1) (intro.), am. (1) (a), renum. (1) (b) and (c) to be (1) (c) and (d) and am. (1) (c), cr. (1) (b), Register, March, 1992, No. 435, eff. 4–1–92; am. (1) (d), (2), Register, November, 1995, No. 479, eff. 12–1–95; **r. and recr., Register, March, 2001, No. 543, eff. 4–1–01.**

## Subchapter III — Excavations

**Comm 21.12 Grade.** The grade shall slope away from the dwelling to provide drainage away from the dwelling.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

**Comm 21.125 Erosion control procedures. (1)** PERFORMANCE STANDARDS. (a) *General.* Perimeter erosion control measures shall be placed within 24 hours after beginning the excavating. Erosion control measures shall be placed along downslope areas and along sideslope areas as required to prevent or reduce erosion where erosion during construction will result in a loss of soil to waters of the state, public sewer inlets or off–site. The best management practices as defined in s. Comm 20.07 (8m) or alternative measures that provide equivalent protection to these practices may be utilized to satisfy the requirements of this section. When the disturbed area is stabilized, the erosion control measures may be removed.

(b) *Stabilization by seeding and mulching.* Slopes greater than or equal to 12%, with a downslope length of 10 feet or more, are not considered stabilized with seeding and mulching unless used in conjunction with a tackifier, netting, or matting. Asphalt emulsion may not be used as a tackifier.

(c) *Tracking.* Sediment tracked by construction equipment from a site onto a public or private paved road or sidewalk shall be minimized by providing a non–tracking access roadway. The access roadway shall be installed as approved on the plot plan, prior to framing above the first floor decking. The sediment cleanup provisions of par. (d) are unaffected by the presence or absence of an access roadway.

**Note:** It is not the intent of par. (c) to require a gravel access roadway where natural conditions, such as sandy soils or solidly frozen soil, already provide non–tracking access.

(d) *Sediment cleanup.* Off–site sediment deposition occurring as a result of a storm event shall be cleaned up by the end of the next work day following the occurrence. All other off–site sedi-

ment deposition occurring as a result of construction activities shall be cleaned up at the end of the work day.

(e) *Public sewer inlet protection.* Downslope, on–site public sewer inlets shall be protected with erosion control procedures.

(f) *Building material waste disposal.* All building material waste shall be properly managed and disposed of to prevent pollutants and debris from being carried off the site by runoff.

**Note:** For proper disposal of flammable, combustible and hazardous liquids, contact the local fire department.

**(2)** BEST MANAGEMENT PRACTICES. (a) *General.* Appropriate best management practices, as defined in s. Comm 20.07 (8m) or specified in chapter 3, Wisconsin Construction Site Best Management Practices Handbook, published by the department of natural resources, may be selected, installed, maintained and remain in place until the site is stabilized to meet the performance standards specified in sub. (1).

**Note:** The best management practices for slopes is covered under section B. 1, chapter 3, Wisconsin Construction Site Best Management Practices Handbook. For a reprint, see appendix.

(b) *Exceptions and clarification.* All references to a model ordinance and planning considerations within chapter 3, Wisconsin Construction Site Best Management Practices Handbook, are not adopted by the department.

**(3)** MAINTENANCE OF EROSION CONTROL PROCEDURES. (a) *General.* During the period of construction at a site, all erosion control procedures necessary to meet the performance standards of this section shall be properly implemented, installed and maintained by the building permit applicant or subsequent landowner. If erosion occurs after building construction activities have ceased, some or all of the erosion control procedures shall be maintained until the site has been stabilized.

(b) *Exceptions and clarification.* The maintenance procedures and inspection sequences within chapter 3, Wisconsin Construction Site Best Management Practices Handbook, are not adopted as a part of this code.

**Note:** The handbook is available from Document Sales, 202 South Thornton Avenue, P.O. Box 7840, Madison, Wisconsin 53707–8480; phone (608) 266–3358.

**Note:** For examples of acceptable erosion control maintenance procedures, see appendix.

**History:** Cr. Register, September, 1992, No. 441, eff. 12–1–92; am. (1) (b), Register, November, 1995, No. 479, eff. 12–1–95; am. (1) (a), renum. (1) (b) to (e) to be (1) (c) to (f) and am. (c), cr. (1) (b), Register, February, 1997, No. 494, eff. 3–1–97.

**Comm 21.13 Excavations adjacent to adjoining property. (1)** NOTICE. Any person making or causing an excavation which may affect the lateral soil support of adjoining property or buildings shall provide at least 30 days written notice to all owners of adjoining buildings of the intention to excavate. The notice shall state that adjoining buildings may require permanent protection.

(a) *Exception.* The 30–day time limit for written notification may be waived if such waiver is signed by the owner(s) of the adjoining properties.

**(2)** RESPONSIBILITY FOR UNDERPINNING AND FOUNDATION EXTENSIONS. (a) *Excavations less than 12 feet in depth.* If the excavation is made to a depth of 12 feet or less below grade, the person making or causing the excavation shall not be responsible for any necessary underpinning or extension of the foundations of any adjoining buildings.

(b) *Excavations greater than 12 feet in depth.* If the excavation is made to a depth in excess of 12 feet below grade, the owner(s) of adjoining buildings shall be responsible for any necessary underpinning or extension of the foundations of their buildings to a depth of 12 feet below grade. The person making or causing the excavation shall be responsible for any underpinning or extension of foundations below the depth of 12 feet below grade.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

**Comm 21.14 Excavations for footings and foundations. (1)** EXCAVATIONS BELOW FOOTINGS AND FOUNDATIONS. No excavation shall be made below the footing and foundation unless provisions are taken to prevent the collapse of the footing or foundation.

**(2)** EXCAVATIONS FOR FOOTINGS. All footings shall be located on undisturbed or compacted soil, free of organic material, unless the footings are reinforced to bridge poor soil conditions.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

## Subchapter IV — Footings

**Comm 21.15 Footings.** The dwelling shall be supported on a structural system designed to transmit and safely distribute the loads to the soil. The loads for determining the footing size shall include the weight of the live load, roof, walls, floors, pier or column, plus the weight of the structural system and the soil over the footing. Footings shall be sized to not exceed the allowable material stresses. The bearing area shall be at least equal to the area required to transfer the loads to the supporting soil without exceeding the bearing values of the soil.

**(1)** SIZE AND TYPE. Unless designed by structural analysis, unreinforced concrete footings shall comply with the following requirements:

(a) *Continuous footings.* The minimum width of the footing on each side of the foundation wall shall measure at least 4 inches wider than the wall. The footing depth shall be at least 8 inches nominal. Footing placed in unstable soil shall be formed. Lintels may be used in place of continuous footings when there is a change in footing elevation.

**Note:** Unstable soil includes soils which are unable to support themselves.

(b) *Column or pier footing.* The minimum width and length of column or pier footings shall measure at least 2 feet by 2 feet. The depth shall measure at least 12 inches nominal. The column shall be so placed as to provide equal projections on each side of the column.

(c) *Trench footings.* Footings poured integrally with the wall may be used when soil conditions permit. The minimum width shall be at least 8 inches nominal.

(d) *Chimney and fireplace footings.* Footing for chimneys or fireplaces shall extend at least 4 inches on each side of the chimney or fireplace. The minimum depth shall measure at least 12 inches nominal.

(e) *Floating slabs.* Any dwelling supported on a floating slab on grade shall be designed through structural analysis. Structures supported on floating slabs may not be physically attached to structures that are supported by footings that extend below the frost line unless an isolation joint is used between the structures.

(f) *Deck footings.* Decks attached to dwellings and detached decks which serve an exit shall be supported on a structural system designed to transmit and safely distribute the loads to the soil. Footings shall be sized to not exceed the allowable material stresses. The bearing area shall be at least equal to the area required to transfer the loads to the supporting soil without exceeding the bearing values of the soil.

**(2)** SOIL–BEARING CAPACITY. No footing or foundation shall be placed on soil with a bearing capacity of less than 2,000 pounds per square foot unless the footing or foundation has been designed through structural analysis. The soil–bearing values of common soils may be determined through soil identification.

**Note:** The department will accept the soil–bearing values for the types of soil listed in the following table:

| Type of soil | PSF |
|---|---|
| 1. Wet, soft clay; very loose silt; silty clay | 2,000 |
| 2. Loose, fine sand; medium clay; loose sandy clay soils | 2,000 |
| 3. Stiff clay; firm inorganic silt | 3,000 |
| 4. Medium (firm) sand; loose sandy gravel; firm sandy clay soils; hard dry clay | 4,000 |
| 5. Dense sand and gravel; very compact mixture of clay, sand and gravel | 6,000 |
| 6. Rock | 12,000 |

(a) *Minimum soil–bearing values.* If the soil located directly under a footing or foundation overlies a layer of soil having a smaller allowable bearing value, the smaller soil–bearing value shall be used.

(b) *Unprepared fill material, organic material.* No footing or foundation shall be placed upon unprepared fill material, organic soil, alluvial soil or mud unless the load will be supported. When requested, soil data shall be provided.

**Note:** The decomposition of organic material in landfill sites established for the disposal of organic wastes may produce odorous, toxic and explosive concentrations of gas which may seep into buildings through storm sewers and similar underground utilities unless provisions are taken to release the gases to the atmosphere.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (1) (a), Register, January, 1989, No. 397, eff. 2–1–89; cr. (1) (f), Register, March, 1992, No. 435, eff. 4–1–92; am. (1) (e), Register, November, 1995, No. 479, eff. 12–1–95; **am. (1) (e), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 21.16 Frost penetration. (1)** GENERAL. Footings and foundations, including those for ramps and stoops, shall be placed below the frost penetration level, but in no case less than 48 inches below grade measured adjacent to the footing or foundation. Footings shall not be placed over frozen material.

**(2)** EXCEPTIONS. (a) Floating slabs constructed on grade need not be installed below the minimum frost penetration line provided measures have been taken to prevent frost forces from damaging the structure.

(b) Grade beams need not be installed to the minimum frost penetration line provided measures are taken to prevent frost forces from damaging the structure.

(c) Stoops or ramps need not be installed below the minimum frost penetration level provided measures are taken to prevent frost forces from damaging the structure.

(d) Footings or foundations may bear directly on rock located less than 48 inches below grade. Prior to placement, the rock shall be cleaned of all earth. All clay in the crevices of the rock shall be removed to the level of frost penetration or $1\text{–}1/2$ times the width of the rock crevice. Provisions shall be taken at grade to prevent rain water from collecting along the foundation wall of the building.

(e) Portions of footings or foundations which are located directly below window areaways which are required to be installed in accordance with s. Comm 21.03 (6), are exempt from the requirements of sub. (1).

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (intro.), Register, February, 1985, No. 350, eff. 3–1–85; renum. (intro.) and (1) to be (1) and (2) and am. (2) (d), cr. (2) (e), Register, January, 1989, No. 397, eff. 2–1–89; am. (1), Register, November, 1995, No. 479, eff. 12–1–95; **correction in (2) (e) made under s. 13.93 (2m) (b) 7., Stats., Register, March, 2001, No. 543.**

**Comm 21.17 Drain tiles. (1)** DETERMINATION OF NEED. (a) *New construction.* 1. Except as provided under sub. (2), a complete drain tile or pipe system shall be installed around the foundation of dwellings under construction where groundwater occurs above the bottom of the footing.

2. For the purposes of this section, a complete drain tile or pipe system includes the drain tile or pipe installed inside and outside the foundation at the footing level, bleeders connecting the inside tile or pipe to the outside tile or pipe, the sump pit, the discharge piping, and a pump or means of discharging water to natural grade.

(b) *Optional systems.* 1. If a complete drain tile or pipe system is not required by natural conditions under par. (a) or by a municipality exercising jurisdiction under sub. (2) (a), a partial drain tile or pipe system may be installed.

2. For the purposes of this section, a partial drain tile or pipe system may include any of the elements under par. (a) 2.

**(2)** MUNICIPALITIES EXERCISING JURISDICTION. (a) *New construction.* 1. For new dwelling construction, a municipality exercising jurisdiction under this code may determine the soil types and natural or seasonal groundwater levels for which a complete drain tile or pipe system is required.

2. For new dwelling construction, a municipality may not enact requirements for other than complete drain tile or pipe systems.

(b) *Alterations to an existing dwelling.* For an alteration to an existing dwelling covered by this code, a municipality may not require a complete drain tile or pipe system.

(c) *Partial systems.* Municipalities may allow partial drain tile or pipe systems for new dwellings under construction or existing dwellings.

**(3)** MATERIAL AND INSTALLATION REQUIREMENTS FOR REQUIRED SYSTEMS. (a) *General.* Complete drain tile or pipe systems required by natural conditions under sub. (1) (a) or by a municipality exercising jurisdiction under sub. (2) (a) shall comply with the requirements of this subsection.

(b) *Basement floor slabs.* The basement slab shall be placed on at least 4 inches of clean graded sand, gravel or crushed stone.

(c) *Manufactured drainage systems.* Manufactured drainage systems not meeting the requirements of this section shall be submitted to the department for review and approval prior to installation.

(d) *Drain tile or pipe installation.* Drain tile or pipe used for foundation drainage shall comply with the following requirements:

1. Drain tile or pipe shall have an inside diameter of at least 3 inches.

2. Drain tile or pipe shall have open seams, joints or perforations to allow water to enter.

3. Where individual tiles are used, they shall be laid with 1/8 inch open joints. Joints between tiles shall be covered with a strip of asphalt or tar impregnated felt.

4. The tile or pipe shall be placed upon at least 2 inches of coarse aggregate and shall be covered on the top and the side facing away from the dwelling with at least 12 inches of coarse aggregate that meets all of the following criteria:

a. 100% of the aggregate shall pass a 1–inch sieve.

b. 90–100% of the aggregate shall pass a 3/4–inch sieve.

c. 0–55% of the aggregate shall pass a 3/8–inch sieve.

d. 0–5% of the aggregate shall pass a #8 sieve.

**Note:** A #8 sieve has square openings of 2.36 mm or 0.09 inch.

**Note:** These specifications encompass aggregate sizes #6 and #67 per ASTM standard C 33. Of the two sizes, #6 is coarser.

5. Bleeder tiles or pipes shall be provided at no more than 8–foot intervals to connect the exterior drain tile or pipe to the interior drain tile or pipe.

6. The drain tiles or pipe that lead from the footing tiles to the sump pit shall be laid at a grade of at least 1/8 inch per foot leading to the sump pit. The remaining drain tiles or pipe shall be level or graded downward to the line leading to the sump pit.

(e) *Drain tile or pipe discharge.* 1. Drain tiles or pipe shall be connected to the sump pit.

2. The sump pit shall discharge to natural grade or be equipped with a pump.

3. All other aspects of drain tile discharge shall be in accordance with the uniform plumbing code, chs. Comm 82 to 87.

**Note:** The following is a reprint of the pertinent sections of the plumbing code:

**Comm 82.36 (11)** SUMPS AND PUMPS. (a) *Sumps.* 2. Construction and installation. The sump shall have a rim extending at least one inch above the floor immediately adjacent to the sump, except where the sump is installed in an exterior meter pit. The sump shall have a removable cover of sufficient strength for anticipated loads. The sump shall have a solid bottom.

3. *Location.* All sumps installed for the purpose of receiving clear water, basement or foundation drainage water shall be located at least 15 feet from any water well.

4. *Size.* The size of each clear water sump shall be as recommended by the sump pump manufacturer, but may not be smaller than 16 inches in diameter at the top, 14 inches in diameter at the bottom, and 22 inches in depth.

5. *Removable covers.* Penetrations through the top of removable sump covers shall be limited to those for the electrical supply, the vent piping and the discharge piping for the pump or pumps.

(b) *Sump pump systems.* 1. Pump size. The pump shall have a capacity appropriate for anticipated use.

2. Discharge piping. Where a sump discharges into a storm building drain or sewer, a free flow check valve shall be installed.

**Comm 82.36 (3)** DISPOSAL. (a) *Storm sewer.* Storm water, surface water, groundwater and clear water wastes shall be discharged to a storm sewer system or a combined sanitary–storm sewer system where available. Combined public sanitary–storm sewer systems shall be approved by the department of natural resources. Combined private sanitary–storm sewer systems shall be approved by the department.

(b) *Other disposal methods.* 1. Where no storm sewer system or combined sanitary–storm sewer system is available or adequate to receive the anticipated load, the final disposal of the storm water, surface water, groundwater or clear water wastes

shall be discharged in accordance with local governmental requirements. If the final disposal of such waters or wastes is by means of subsurface discharge, documentation shall be submitted to this department to determine whether the method of disposal is acceptable.

2. Where approved by the local governmental authority, storm water, surface water, groundwater and clear water wastes of the properties of one– and 2–family dwellings may be discharged onto flat areas, such as streets or lawns, so long as the water flows away from the buildings and does not create a nuisance.

3. a. The clear water wastes from a drinking fountain, water heater relief valve, storage tank relief valve or water softener shall be discharged to either a sanitary drain system or a storm drain system.

b. The clear water wastes from equipment other than those listed in subpar. a. may be discharged to a sanitary drain system if not more than 20 gallons of clear water wastes per day per building are discharged.

(c) *Segregation of wastes.* 1. a. Except as provided in subpar. b., where a sanitary sewer system and a storm sewer system are available the drain piping for storm water or clear water wastes may not connect to any part of the sanitary drain system.

b. Where a combined sanitary–storm sewer system is available storm water wastes, clear water wastes and sanitary wastes may not be combined until discharging to the building sewer.

2. Storm water wastes and clear water wastes shall not be combined until discharging into the storm building drain.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. Register, February, 1985, No. 350, eff. 3–1–85; r. and recr. (3) (a) 3. and (4), Register, May, 1988, No. 389, eff. 6–1–88; am. (2) (f), Register, January, 1989, No. 397, eff. 2–1–89; r. and recr, (4) (c) 3., Register, August, 1991, No. 428, eff. 9–1–91; cr. (5), Register, March, 1992, No. 435, eff. 4–1–92; r. and recr. Register, January, 1999, No. 517, eff. 2–1–99; **am. (3) (d) 4., Register, March, 2001, No. 543, eff. 4–1–01.**

## Subchapter V — Foundations

**Comm 21.18 Foundations. (1)** GENERAL. (a) *Design.* Foundation walls shall be designed and constructed to support the vertical loads of the dwelling, lateral soil pressure, and other loads without exceeding the allowable stresses of the materials of which the foundations are constructed.

(b) *Lateral support at base.* Lateral support such as floor slabs or framing shall be provided at the base of foundation walls.

(c) *Lateral support at top.* Lateral support shall be provided at the top of the foundation walls by one of the following:

1. Ledger blocks. Ledger blocks at the perimeter of the floor consisting of 2–inch thick nominal lumber attached with at least 2 16d nails at each joist such that the dwelling meets the requirements of s. Comm 21.02 (1) (d).

2. Structural analysis. A system designed through structural analysis.

3. Anchor bolts. a. Structural steel anchor bolts, at least 1/2 inch in diameter, embedded at least 7 inches into the [concrete or] grouted masonry with a maximum spacing of 72 inches and located within 18 inches of wall corners.

b. A properly sized nut and washer shall be tightened on each bolt to the plate or sill.

c. When vertical–reinforcing steel is provided in masonry construction, as required under sub. (3), the location requirements under subd. 3. a. shall be modified as necessary so anchor bolts are placed in the same core as the reinforcement without exceeding the limits of subd. 3. a.

4. Other mechanical fasteners. a. Mechanical fasteners used in accordance with the manufacturer's testing and listing.

b. When vertical–reinforcing steel is provided in masonry construction, as required under sub. (3), the location requirements under subd. 4. a. shall be modified as necessary so the fasteners are placed in the same core as the reinforcement without exceeding the limits of subd. 4. a.

(d) *Soil lateral load.* Unless designed through structural analysis, soil lateral loads shall be determined from Table 21.18–A.

TABLE 21.18–A
**SOIL LATERAL LOAD**

| Description of Backfill Material[c] | Unified Soil Classification | Design Lateral Soil Load[a] PSF per Foot of Depth |
|---|---|---|
| Well graded, clean gravels; gravel–sand mixes | GW | 30[c] |
| Poorly graded clean gravels; gravel–sand mixes | GP | 30[c] |
| Silty gravels, poorly graded gravel–sand mixes | GM | 40[c] |
| Clayey gravels, poorly graded gravel–and–clay mixes | GC | 45[c] |
| Well–graded, clean sands; gravelly sand mixes | SW | 30[c] |
| Poorly graded clean sands; sand–gravel mixes | SP | 30[c] |
| Silty sands, poorly graded sand–silt mixes | SM | 45[c] |
| Sand–silt clay mix with plastic fines | SM–SC | 45[d] |
| Clayey sands, poorly graded sand–clay mixes | SC | 60[d] |
| Inorganic silts and clayey silts | ML | 45[d] |
| Mixture of inorganic silt and clay | ML–CL | 60[d] |
| Inorganic clays of low to medium plasticity | CL | 60[d] |
| Organic silts and silt clays, low plasticity | OL | [b] |
| Inorganic clayey silts, elastic silts | MH | [b] |
| Inorganic clays of high plasticity | CH | [b] |
| Organic clays and silty clays | OH | [b] |

[a]Design lateral soil loads are given for moist conditions for the specified soils at their optimum densities. Actual field conditions shall govern. Submerged or saturated soil pressures shall include the weight of the buoyant soil plus the hydrostatic loads.

[b]Unsuitable as backfill material.

[c]For relatively rigid walls, as when braced by floors, the design lateral soil load shall be increased for sand and gravel type soils to 60 psf per foot of depth. Basement walls extending not more than 8 feet below grade and supporting flexible floor systems are not considered relatively rigid walls.

[d]For relatively rigid walls, as when braced by floors, the design lateral load shall be increased for silt and clay type soils to 100 psf per foot of depth. Basement walls extending not more than 8 feet below grade and supporting flexible floor systems are not considered relatively rigid walls.

[e]The definition and classification of soil materials shall be in accordance with ASTM D2487.

**(2)** CONCRETE FOUNDATION WALLS. (a) Except as provided in par. (b), unless designed through structural analysis, the minimum thickness of concrete foundation walls shall be determined from Table 21.18–B, but in no case shall the thickness of the foundation wall be less than the thickness of the wall it supports.

(b) A 6–inch nominal wall thickness may be used provided the fill on one side of the wall is within 12 inches vertically of the fill on the other side of the wall.

TABLE 21.18–B
**CONCRETE WALL THICKNESSES**

| Type of Concrete | Nominal Thickness (inches) | Maximum Height of Unbalanced Fill[1] for Material of Wall Being Supported (Wood frame – feet) |
|---|---|---|
| 3000 psi | 8 | 8 |
| Unreinforced concrete | 10 | 9 |
| | 12[2] | 10 |
| | 14 | 11.5 |

[1]Unbalanced fill is the difference in elevation between the outside grade and the basement floor.

[2]The maximum height of unbalanced fill for a 12–inch thick plain concrete wall may be increased to 12 feet provided the wall is constructed of concrete with a minimum compressive value of 6,000 psi at 28 days.

**(3)** MASONRY FOUNDATION WALLS. (a) *Dampproofing.* Masonry foundation walls shall be dampproofed by applying to the exterior surface from footing to finished grade, a continuous coating of one of the following:

1. Portland cement and sand coat mortar, at least 3/8 inch thick.

2. Type M or S mortar, at least 3/8 inch thick.

3. Structural surface bonding material, at least 1/4 inch thick.

4. Equivalent dampproofing material, applied in accordance with the manufacturer's instructions and acceptable to the department.

(b) *Structural requirements.* Unless designed through structural analysis, the masonry foundation walls shall be constructed in accordance with ACI 530.1 and the following requirements:

1. The minimum thickness of unreinforced masonry foundation walls shall be determined by Table 21.18–C, but in no case shall the thickness be less than the thickness of the wall it supports.

TABLE 21.18–C

**PLAIN MASONRY FOUNDATION WALLS[d]**

| Maximum Wall Height (ft–in) | Depth of unbalanced backfill height (ft) | Minimum nominal wall thickness (inches) | | |
|---|---|---|---|---|
| | | Soil classes and lateral soil load[a] (psf per foot below exterior grade | | |
| | | GW, GP, SW and SP soils 30 | GM, SM, SM–SC, ML, inorganic CL and ML–CL soils 45 | GC, SC and MH soils 60 |
| 7–8 | 4 (or less) | 8 | 8 | 8 |
| | 5 | 8 | 10 | 10 |
| | 6 | 10 | 12 | 10 (solid[b]) |
| | 7 | 12 | 10 (solid[b]) | 12 (solid[b]) |
| 8–4 | 4 (or less) | 8 | 8 | 8 |
| | 5 | 8 | 10 | 12 |
| | 6 | 10 | 12 | 12 (solid[b]) |
| | 7 | 12 | 12 (solid[b]) | Note c |
| | 8 | 10 (solid[b]) | 12 (solid[b]) | Note c |
| 9–1 | 4 (or less) | 8 | 8 | 8 |
| | 5 | 8 | 10 | 12 |
| | 6 | 12 | 12 | 12 (solid[b]) |
| | 7 | 12 (solid[b]) | 12 (solid[b]) | Note c |
| | 8 | 12 (solid[b]) | Note c | Note c |
| | 9 | Note c | Note c | Note c |

[a] For design lateral soils and descriptions of soil classes, see s. Comm 21.18 (1) (d). Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist soil conditions without hydrostatic pressure.

[b] Solid grouted hollow units.

[c] An analysis in compliance with ACI 530 or reinforcement in accordance with Table 21.18–D, 21.18–E or 21.18–F is required.

[d] Mortar shall be Type M or S and masonry shall be laid in running bond.

2. Reinforced masonry walls shall be reinforced in accordance with the requirements of Tables 21.18–D, 21.18–E or 21.18–F. Vertical reinforcement shall be provided on each side of any opening and at intervals indicated in the appropriate table.

TABLE 21.18–D[b,c,d]

**8, 10 OR 12 IN. REINFORCED MASONRY FOUNDATION WALLS WHERE d $\geq$ 5 in.[e]**

| Maximum Wall Height (ft–in) | Height of unbalanced backfill (ft) | Vertical reinforcement | | |
|---|---|---|---|---|
| | | Soil classes and lateral soil load[a] (psf per foot below exterior grade) | | |
| | | GW, GP, SW and SP soils 30 | GM, GC, SM, SM–SC and ML soils 45 | SC, MH, ML–CL and inorganic CL soils 60 |
| 7–8 | 4 (or less) | #4 at 48″ o.c. | #4 at 48″ o.c. | #4 at 48″ o.c. |
| | 5 | #4 at 48″ o.c. | #4 at 48″ o.c. | #4 at 40″ o.c. |
| | 6 | #4 at 48″ o.c. | #5 at 48″ o.c. | #5 at 40″ o.c. |
| | 7 | #4 at 40″ o.c. | #5 at 40″ o.c. | #6 at 48″ o.c. |
| 8–4 | 4 (or less) | #4 at 48″ o.c. | #4 at 48″ o.c. | #4 at 48″ o.c. |
| | 5 | #4 at 48″ o.c. | #4 at 48″ o.c. | #4 at 40″ o.c. |
| | 6 | #4 at 48″ o.c. | #5 at 48″ o.c. | #5 at 40″ o.c. |
| | 7 | #5 at 48″ o.c. | #6 at 48″ o.c. | #6 at 40″ o.c. |
| | 8 | #5 at 40″ o.c. | #6 at 40″ o.c. | #7 at 40″ o.c. |
| 9–1 | 4 (or less) | #4 at 48″ o.c. | #4 at 48″ o.c. | #4 at 48″ o.c. |
| | 5 | #4 at 48″ o.c. | #4 at 48″ o.c. | #5 at 48″ o.c. |
| | 6 | #4 at 48″ o.c. | #5 at 48″ o.c. | #6 at 48″ o.c. |
| | 7 | #5 at 48″ o.c. | #6 at 48″ o.c. | #7 at 48″ o.c. |
| | 8 | #5 at 40″ o.c. | #7 at 48″ o.c. | #8 at 48″ o.c. |
| | 9 | #6 at 40″ o.c. | #8 at 48″ o.c. | #8 at 32″ o.c. |

[a] For design lateral soil loads, see s. Comm 21.18 (1) (d). Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist soil conditions without hydrostatic pressure.

[b] Provisions for this table are based on construction requirements specified in s. Comm 21.18 (3) (b).

[c] For alternative reinforcement, see s. Comm 21.18 (3) (b).

[d] Mortar shall be Type M or S and masonry shall be laid in running bond.

[e] The specified location of the reinforcement shall equal or exceed the effective depth distance, d, measured from the face of the soil side of the wall to the center of vertical reinforcement.

TABLE 21.18–E[b,c,d]

**10 OR 12 IN. REINFORCED MASONRY FOUNDATION WALLS WHERE d $\geq$ 6.75 in.[e]**

| Maximum Wall Height (ft–in) | Height of unbalanced backfill (ft) | Vertical reinforcement | | |
|---|---|---|---|---|
| | | Soil classes and lateral soil load[a] (psf per foot below exterior grade) | | |
| | | GW, GP, SW and SP soils 30 | GM, GC, SM, SM–SC and ML soils 45 | SC, MH, ML–CL and inorganic CL soils 60 |
| 7–8 | 4 (or less) | #4 at 56″ o.c. | #4 at 56″ o.c. | #4 at 56″ o.c. |
| | 5 | #4 at 56″ o.c. | #4 at 56″ o.c. | #4 at 56″ o.c. |
| | 6 | #4 at 56″ o.c. | #4 at 48″ o.c. | #4 at 40″ o.c. |
| | 7 | #4 at 56″ o.c. | #5 at 56″ o.c. | #5 at 40″ o.c. |
| 8–4 | 4 (or less) | #4 at 56″ o.c. | #4 at 56″ o.c. | #4 at 56″ o.c. |
| | 5 | #4 at 56″ o.c. | #4 at 56″ o.c. | #4 at 48″ o.c. |
| | 6 | #4 at 56″ o.c. | #4 at 48″ o.c. | #5 at 56″ o.c. |
| | 7 | #4 at 48″ o.c. | #4 at 32″ o.c. | #6 at 56″ o.c. |
| | 8 | #5 at 56″ o.c. | #5 at 40″ o.c. | #7 at 56″ o.c. |
| 9–1 | 4 (or less) | #4 at 56″ o.c. | #4 at 56″ o.c. | #4 at 56″ o.c. |
| | 5 | #4 at 56″ o.c. | #4 at 56″ o.c. | #4 at 48″ o.c. |
| | 6 | #4 at 56″ o.c. | #4 at 40″ o.c. | #4 at 32″ o.c. |
| | 7 | #4 at 40″ o.c. | #5 at 48″ o.c. | #6 at 48″ o.c. |
| | 8 | #4 at 32″ o.c. | #6 at 48″ o.c. | #4 at 16″ o.c. |
| | 9 | #5 at 40″ o.c. | #6 at 40″ o.c. | #7 at 40″ o.c. |

[a] For design lateral soil loads, see s. Comm 21.18 (1) (d). Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist soil conditions without hydrostatic pressure.

[b] Provisions for this table are based on construction requirements specified in s. Comm 21.18 (3) (b).

[c] For alternative reinforcement, see s. Comm 21.18 (3) (b).

[d] Mortar shall be Type M or S and masonry shall be laid in running bond.

[e] The specified location of the reinforcement shall equal or exceed the effective depth distance, d, measured from the face of the soil side of the wall to the center of vertical reinforcement.

TABLE 21.18–F[b,c,d]

**12 IN. REINFORCED MASONRY FOUNDATION WALLS WHERE d ≥ 8.75 in.[e]**

| | | Vertical reinforcement | | |
|---|---|---|---|---|
| | | Soil classes and lateral soil load[a] (psf per foot below exterior grade) | | |
| Maximum Wall Height (ft–in) | Height of unbalanced backfill (ft) | GW, GP, SW and SP soils 30 | GM, GC, SM, SM–SC and ML soils 45 | SC, MH, ML–CL and inorganic CL soils 60 |
| 7–8 | 4 (or less) | #4 at 72″ o.c. | #4 at 72″ o.c. | #4 at 72″ o.c. |
| | 5 | #4 at 72″ o.c. | #4 at 72″ o.c. | #4 at 72″ o.c. |
| | 6 | #4 at 72″ o.c. | #4 at 64″ o.c. | #4 at 48″ o.c. |
| | 7 | #4 at 72″ o.c. | #4 at 48″ o.c. | #5 at 56″ o.c. |
| 8–4 | 4 (or less) | #4 at 72″ o.c. | #4 at 72″ o.c. | #4 at 72″ o.c. |
| | 5 | #4 at 72″ o.c. | #4 at 72″ o.c. | #4 at 72″ o.c. |
| | 6 | #4 at 72″ o.c. | #4 at 56″ o.c. | #5 at 72″ o.c. |
| | 7 | #4 at 64″ o.c. | #5 at 64″ o.c. | #4 at 32″ o.c. |
| | 8 | #4 at 48″ o.c. | #4 at 32″ o.c. | #5 at 40″ o.c. |
| 9–1 | 4 (or less) | #4 at 72″ o.c. | #4 at 72″ o.c. | #4 at 72″ o.c. |
| | 5 | #4 at 72″ o.c. | #4 at 72″ o.c. | #4 at 64″ o.c. |
| | 6 | #4 at 72″ o.c. | #4 at 56″ o.c. | #5 at 64″ o.c. |
| | 7 | #4 at 56″ o.c. | #4 at 40″ o.c. | #6 at 64″ o.c. |
| | 8 | #4 at 64″ o.c. | #6 at 64″ o.c. | #6 at 48″ o.c. |
| | 9 | #5 at 56″ o.c. | #7 at 72″ o.c. | #6 at 40″ o.c. |

[a] For design lateral soil loads, see s. Comm 21.18 (1) (d). Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist soil conditions without hydrostatic pressure.
[b] Provisions for this table are based on construction requirements specified in s. Comm 21.18 (3) (b).
[c] For alternative reinforcement, see s. Comm 21.18 (3) (b).
[d] Mortar shall be Type M or S and masonry shall be laid in running bond.
[e] The specified location of the reinforcement shall equal or exceed the effective depth distance, d, measured from the face of the soil side of the wall to the center of vertical reinforcement.

3. Vertical reinforcement shall have a minimum yield strength of 60,000 psi.

4. Solid–grouted hollow units or cores containing vertical reinforcement shall be filled with masonry grout that complies with ASTM C 476.

5. In lieu of the reinforcement provisions of Tables 21.18–D, 21.18–E and 21.18–F, alternative reinforcing bar size and spacing having an equivalent cross–sectional area or reinforcement per linear foot of wall is permitted, provided the spacing of the reinforcement does not exceed 72 inches and reinforcing bar size does not exceed No. 11.

6. The depth below grade, wall height and reinforcement spacing may exceed the maximum values indicated in Tables 21.18–D, 21.18–E and 21.18–F only if the design is based on structural analysis.

**(4)** WOOD FOUNDATIONS. Wood foundations shall be designed and constructed in accordance with "The Permanent Wood Foundation System, Basic Requirements, Technical Report No. 7", as adopted under s. Comm 20.24 (5) (b) and the following exception. The thickness of the foundation wall shall be no less than the thickness of the wall it supports.

(a) *Exception.* Section 3.3.1. *Fasteners.* Fasteners shall be of silicon bronze, copper or stainless steel types 304 or 316.

**Note:** Additional explanatory information regarding wood foundations can be obtained in "All–Weather Wood Foundation Systems, Design, Fabrication, Installation Manual", published by the American Forest & Paper Association.

(b) *Materials.* All lumber and plywood shall be pressure treated with preservative and labeled to show conformance with AWPA C–22 as adopted under s. Comm 20.24 (9).

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (3) (intro), Register, February, 1985, No. 350, eff. 3–1–85; cr. (2) (c) to (e), r. and recr. Tables C and D, r. (3) (a) 2., renum. (3) (a) 1. to be (a), Register, January, 1989, No. 397, eff. 2–1–89; am. (intro.), (2) (b), (3) (b) and Table 21.18–D, cr. Table 21.18, r. (2) (c), renum. (2) (d) and (e) to be (2) (c) and (d), Register, March, 1992, No. 435, eff. 4–1–92; renum. (1) to (3) to be (2) to (4), and am. (3) (b), (4) (intro.) and (b), Table 21.18–A, r. (intro.) and Table 21.18, cr. (1), (3) (e), Register, November, 1995, No. 479, eff. 12–1–95; am (2), Register, January, 1999, No. 517, eff. 2–1–99; **r. and recr. (1) (b), (3), Tables 21.18–C and D, am. (2) (a), r. Table 21.18–B, renum. Table 21.18–A to be Table 21.18–B and cr. (1) (c), (d), Tables 21.18–A, E and F.**

## Subchapter VI — Floors

**Comm 21.19 Floor design.** Floors shall support all dead loads plus the minimum unit live loads as set forth in s. Comm 21.02. The live loads shall be applied to act vertically and uniformly to each square foot of horizontal floor area. Basements shall be provided with wood or concrete or similar type floors that comply with s. Comm 21.20 or 21.205.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr., Register, March, 1992, No. 435, eff. 4–1–92.

**Comm 21.20 Concrete floors. (1)** When concrete floors are provided, the thickness of the concrete shall measure at least 3 inches.

**(2)** When a concrete floor is placed in clay soils, a 4–inch thick base course shall be placed in the subgrade consisting of clean graded sand, gravel or crushed stone.

**(3)** When a concrete floor is placed on sand or gravel soils, the base course may be omitted unless drain tile is installed. If drain tile is installed, the requirements of s. Comm 21.17 shall be met.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. Register, January, 1989, No. 397, eff. 2–1–89; r. and recr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 21.203 Garage floors. (1)** MATERIALS. Garage floors shall be constructed of concrete or other noncombustible materials which are impermeable to petroleum products. Slab–on–grade concrete garage floors shall be at least 4 inches thick and placed over at least 4 inches of granular fill.

**Note:** It is not the intent of sub. (1) to require a concrete floor to be sealed to make it completely impermeable.

**(2)** CONFIGURATION. The floor shall slope toward the main exterior garage opening or toward an interior drain.

**Note:** See s. Comm 82.34 (4) (b) for floor drain requirements.

**History:** Cr. Register, November, 1995, No. 479, eff. 12–1–95.

**Comm 21.205 Wood floors in contact with ground.** Wood may be used for floors in contact with ground unless prohibited by ordinance by the municipality exercising jurisdiction in accordance with s. Comm 20.20. The floor shall conform to the standards specified in ss. Comm 20.24 (5) (b) and 21.10 (1).

**History:** Cr. Register, January, 1989, No. 397, eff. 2–1–89; am. Register, January, 1999, No. 517, eff. 2–1–99; **correction made under s. 13.93 (2m) (b) 7., Stats., Register, March, 2001, No. 543.**

**Comm 21.21 Precast concrete floors.** Precast concrete floors shall be designed through structural analysis, or load tables furnished by the precast product fabricator may be used, provided the load tables were developed using structural analysis or load testing.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. Register, March, 1992, No. 435, eff. 4–1–92.

**Comm 21.22 Wood frame floors.** Unless designed through structural analysis, wood frame floors shall comply with the following requirements:

**(1)** FLOOR JOISTS. Wood floor joists shall comply with the requirements of s. Comm 21.02 (3) (a). The minimum live loads shall be determined from s. Comm 21.02. Where sill plates are provided, the sill plates shall be fastened to the foundation. Double floor joists shall be provided underneath all bearing walls which are parallel to the floor joists.

**(1m)** FLOOR JOISTS ON MASONRY WALLS. (a) On masonry walls, the floor joists shall rest upon one of the following:

1. A mortar–filled or grout–filled core masonry block.
2. A solid–top masonry block.
3. A sill plate at least as wide as the nominal width of the wall.

**Note:** See s. Comm 21.10 for treatment requirements for wood in contact with masonry.

**(2)** FLOOR TRUSSES. Metal plate connected wood floor trusses shall be designed in accordance with the Design Specifications for Metal Plate Connected Parallel Chord Wood Trusses and the

National Design Specification for Wood Construction. Truss members shall not be cut, bored or notched.

**(3)** GIRDERS AND BEAMS. Girders and beams shall be selected from Table 21.22–A1 or Table 21.22–A2 or shall be designed through structural analysis.

(a) Wood girders and beams shall be fitted at the post or column. Adjoining ends shall be fastened to each other to transfer horizontal loads across the joint. Beams shall also be fastened to the posts with framing anchors, angle clips, or equivalent.

(b) Where intermediate beams are used, they shall rest on top of the girders; or shall be supported by ledgers or blocks fastened to the sides of the girders; or they may be supported by approved metal hangers into which the ends of the beams shall be fitted.

**(4)** BEARING AND END CONFIGURATION. (a) *Sawn lumber.* 1. Joists. Wood joists made of sawn lumber shall meet the following bearing requirements:

a. Wood joists supported on wood or metal shall have a bearing surface of at least $1^1/_2$–inches measured from the end of the joist.

b. Wood joists supported on masonry or concrete shall have a bearing surface of at least 3 inches measured from the end of the joist.

c. The tail end of a floor joist may not extend past the edge of a beam by more than the depth of the floor joist.

d. Wood floor joists with ends that intersect over a beam shall have the ends overlap at least 3 inches and be securely fastened together with at least two 12d common nails or the ends shall be butt–jointed or face–jointed and fastened with ties, straps, plates or solid blocking.

2. Beams and girders. Beams and girders made of sawn lumber shall have a bearing surface on their supports of at least 3 inches parallel to the beam or girder and be at least as wide as the beam or girder.

(b) *Engineered wood products.* Bearing surface for engineered wood products shall be in accordance with the manufacturer's instructions provided those instructions were developed through structural analysis or product testing and are applicable to the configuration.

**(5)** NOTCHING AND BORING. Notching and boring of beams or girders is prohibited unless determined through structural analysis.

(a) *Notching of floor joists.* 1. Notches located in the top or bottom of floor joists shall not have a depth exceeding $^1/_6$ the depth of the joist, shall not have a length exceeding $^1/_3$ the joist depth nor be located in the middle $^1/_3$ of the span of the joist.

2. Where floor joists are notched on the ends, the notch shall not exceed $^1/_4$ the depth of the joist. Notches over supports may extend the full bearing width of the support.

(b) *Boring of floor joists.* 1. General. A hole may not be bored in a floor joist within 2 inches of a notch.

2. Holes near the edge. Holes bored in the top or bottom 2 inches of a joist shall follow the limitations for notching under par. (a).

3. Other holes. Holes bored in floor joists that are not within 2 inches of the top or bottom of the joist shall have their diameter limited to 1/3 the depth of the joist.

(c) *Engineered wood products.* Notching or boring of engineered wood products shall be done in accordance with the manufacturer's instructions provided those instructions were developed through structural analysis or product testing.

**(6)** OVERHANG OF FLOORS. (a) Unless designed through structural analysis under s. Comm 21.02, floor joists which are at right angles to the supporting wall shall not be cantilevered more than 2 feet over the supporting wall, and shall support only the wall and roof above it.

(b) Where overhanging floor joists are perpendicular to the main joists, a double floor joist may be used to support lookout joists extending not more than 2 feet over the wall line below. The double joist shall be located a distance of twice the overhang from the lower wall. The lookout joists shall be fastened to the double joists with metal hangers. Lookout joists that extend more than 2 feet over the wall line below shall be designed through structural analysis under s. Comm 21.02.

**(7)** FLOOR OPENINGS. Trimmers and headers shall be doubled when the span of the header exceeds 4 feet. Headers which span more than 6 feet shall have the ends supported by joist hangers or framing anchors, unless the ends are supported on a partition or beam. Tail joists (joists which frame into headers) more than 8 feet long shall be supported on metal framing anchors or on ledger strips of at least 2 inches by 2 inches nominal.

TABLE 21.22–A1
MINIMUM SIZES FOR BEAMS AND GIRDERS OF STEEL OR WOOD

| Column Spacing | One Floor Only | | Roof/Ceiling and One Floor | | | | Roof/Ceiling+ One Floor/Ceiling + One Floor | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Wood Beams[1] (in., nominal) | A 36 Steel Beams[2] | Wood Beams[1,3] (in., nominal) | | A 36 Steel Beams[2] | | Wood Beams[1,3] (in., nominal) | | A 36 Steel Beams[2] | |
| | | | Zone 2 | Zone 1 | Zone 2 | Zone 1 | Zone 2 | Zone 1 | Zone2 | Zone 1 |
| 24 ft. wide house: | | | | | | | | | | |
| 8 ft. | 8x8 | — | 8x10 | 10x10 | — | — | 8x12 | 10x12 | — | — |
| | | | 6x12 | 6x12 | — | — | 6x14 | 8x14 | — | — |
| 10 ft. | 8x10 | — | 8x12 | 10x12 | M 10x9 | M 10x9 | 10x14 | 10x14 | M 12x11.8 | M 12x11.8 |
| | | | 6x14 | 8x14 | W 6x12 | W 8x10 | 8x16 | 8x16 | W8x15 | W 8x15 |
| 12 ft. | 8x12 | — | 12x12 | 10x14 | W 12x10 | M 12x11.8 | 14x14 | 14x14 | W 12x16 | W 12x16 |
| | | | 10x14 | 8x16 | W 10x11.5 | W 8x15 | 10x16 | 12x16 | W10x17 | W 8x21 |
| 15 ft. | 12x12 | — | — | — | W 12x16 | W 12x16 | — | — | W 12x22 | W 14x22 |
| | | | — | — | W 10x17 | W 6x25 | — | — | W 8x28 | W 8x31 |
| 26 ft. wide house: | | | | | | | | | | |
| 8 ft. | 6x10 | — | 10x10 | 10x10 | — | — | 10x12 | 10x12 | — | — |
| | | | 6x12 | 8x12 | — | — | 8x14 | 8x14 | — | — |
| 10 ft. | 10x10 | — | 10x12 | 10x12 | M 10x9 | M 12x10 | 10x14 | 12x14 | M 12x11.8 | W 12x14 |
| | | | 8x14 | 8x14 | W 8x10 | W 8x13 | 8x16 | 8x16 | W 8x15 | W 8x17 |
| 12 ft. | 8x12 | — | 10x14 | 10x14 | M 12x11.8 | M 12x11.8 | 14x14 | 12x16 | W 12x16 | W 10x19 |
| | | | 8x16 | 8x16 | W 8x15 | W 6x20 | 12x16 | 10x18 | W 8x21 | W 8x24 |
| 15 ft. | 10x14 | — | — | — | W 12x16 | W 10x19 | — | — | W 14x22 | W 14x22 |
| | | | — | — | W 8x21 | W 8x24 | — | — | W 8x31 | W 8x35 |
| 28 ft. wide house: | | | | | | | | | | |
| 8 ft. | 6x10 | — | 10x10 | 8x12 | — | — | 10x12 | 10x12 | — | — |
| | | | 8x12 | 4x16 | — | — | 8x14 | 8x14 | — | — |
| 10 ft. | 10x10 | M 10x7.5 | 10x12 | 12x12 | M 12x10 | W 10x12 | 12x14 | 12x14 | W 12x14 | W 12x14 |
| | | W 6x9 | 8x14 | 8x14 | W 8x13 | W 8x13 | 8x16 | 10x16 | W 8x17 | W 10x15 |
| 12 ft. | 10x12 | M 10x9 | 10x14 | 12x14 | M 12x11.8 | W 12x14 | 12x16 | 12x16 | W 10x19 | M 14x18 |
| | | W 6x12 | 8x16 | 10x16 | W 8x15 | W 8x18 | 10x18 | 10x18 | W 8x24 | W 8x24 |
| 15 ft. | 10x14 | M 12x10 | — | — | W 10x19 | M 14x18 | — | — | W 14x22 | W 14x26 |
| | | W 8x13 | — | — | W 8x24 | W 8x24 | — | — | W 8x35 | W 8x35 |
| 30 ft. wide house: | | | | | | | | | | |
| 8 ft. | 8x10 | — | 10x10 | 8x12 | — | — | 10x12 | 12x12 | — | — |
| | | | 8x12 | 6x14 | — | — | 8x14 | 8x14 | — | — |
| 10 ft. | 10x10 | M 10x7.5 | 10x12 | 12x12 | M 12x10 | M 12x10 | 12x14 | 12x14 | W 12x14 | W 12x14 |
| | | W 6x9 | 8x14 | 10x14 | W 8x13 | W 8x13 | 10x16 | 10x16 | W 10x15 | W 10x15 |
| 12 ft. | 10x12 | M 10x9 | 12x14 | 12x14 | W 12x14 | W 12x14 | 12x16 | 14x16 | M 14x18 | M 14x18 |
| | | W 6x12 | 8x16 | 10x16 | W 8x18 | W 8x18 | 10x18 | 12x18 | W 8x24 | W 8x24 |
| 15 ft. | 12x14 | M 12x11.8 | — | — | M 14x18 | W 10x21 | — | — | W 14x26 | W 14x26 |
| | | W 8x15 | — | — | W 8x24 | W 8x28 | — | — | W 8x35 | W 10x33 |
| 32 ft. wide house: | | | | | | | | | | |
| 8 ft. | 8x10 | — | 8x12 | 8x12 | — | — | 12x12 | 12x12 | — | — |
| | | | 6x14 | 6x14 | — | — | 8x14 | 10x14 | — | — |
| 10 ft. | 10x10 | M 10x7.5 | 12x12 | 12x12 | W 10x12 | W 10x12 | 12x14 | 14x14 | W 12x14 | W 12x16 |
| | | W 6x9 | 8x14 | 10x14 | W 8x13 | W 6x16 | 10x16 | 10x16 | W 10x15 | W 10x17 |
| 12 ft. | 10x12 | M 10x9 | 12x14 | 14x14 | W 12x14 | W 12x14 | 14x16 | 14x16 | M 14x18 | W 12x22 |
| | | W 6x12 | 10x16 | 10x16 | W 10x15 | W 10x17 | 12x18 | 12x18 | W 8x24 | W 8x28 |
| 15 ft. | 12x14 | M 12x11.8 | — | — | M 14x18 | W 12x22 | — | — | W 14x26 | W 14x26 |
| | | W 8x15 | — | — | W 8x24 | W 8x28 | — | — | W 10x33 | W 10x33 |

[1]This table is based upon wood with a fiber bending stress of 1,000 psi. Two acceptable wood beam selections are listed for each loading condition.

[2]Two acceptable steel beam selections are listed for each loading condition. The first entry is the most economical selection based upon beam weight.

[3]Wood main beams or girders may be built up from nominal 2–inch members. The 2–inch members shall be laid on edge and fastened together with a double row of common nails not less than 3 $^{1}/_{2}$–inches in length. Nails shall be spaced not more than 18 inches apart in each row with the end nails placed 4 inches to 6 inches from the end of each piece. Where built–up beams are employed over a single span, the length of each individual piece used to fabricate the beam shall equal the length of the beam.

TABLE 21.22–A2

**MINIMUM SIZES FOR BUILT–UP WOOD BEAMS IN BASEMENTS AND CRAWL SPACES SUPPORTING ONE FLOOR ONLY**

| | $F_b$=800 psi | | $F_b$=1000 psi | | $F_b$=1200 psi | | $F_b$=1400 psi | |
|---|---|---|---|---|---|---|---|---|
| **HOUSE WIDTH** | **Col. Spacing ft–in** | **Beam size** | **Col. Spacing ft–in** | **Beam size** | **Col. Spacing ft–in** | **Beam size** | **Col. Spacing ft–in** | **Beam size** |
| 16 ft. | 7–8 | 3–2x8 | 8–7 | 3–2x8 | 9–4 | 3–2x8 | 10–2 | 3–2x8 |
| | 8–11 | 4–2x8 | 9–11 | 4–2x8 | 10–11 | 4–2x8 | 11–10 | 4–2x8 |
| | 9–11 | 3–2x10 | 11–1 | 3–2x10 | 12–1 | 3–2x10 | 13–1 | 3–2x10 |
| | 11–4 | 4–2x10 | 12–8 | 4–2x10 | 13–1 | 4–2x10 | 15–0 | 4–2x10 |
| | 12–0 | 3–2x12 | 13–5 | 3–2x12 | 14–8 | 3–2x12 | 15–10 | 3–2x12 |
| | 13–10 | 4–2x12 | 15–7 | 4–2x12 | 17–0 | 4–2x12 | 18–4 | 4–2x12 |
| 20 ft. | 6–11 | 3–2x8 | 7–8 | 3–2x8 | 8–5 | 3–2x8 | 9–1 | 3–2x8 |
| | 7–11 | 4–2x8 | 8–11 | 4–2x8 | 9–9 | 4–2x8 | 10–7 | 4–2x8 |
| | 8–10 | 3–2x10 | 9–11 | 3–2x10 | 10–10 | 3–2x10 | 11–8 | 3–2x10 |
| | 10–2 | 4–2x10 | 11–4 | 4–2x10 | 12–6 | 4–2x10 | 13–6 | 4–2x10 |
| | 10–9 | 3–2x12 | 12–0 | 3–2x12 | 13–2 | 3–2x12 | 14–3 | 3–2x12 |
| | 11–5 | 4–2x12 | 13–11 | 4–2x12 | 15–2 | 4–2x12 | 16–5 | 4–2x12 |
| 24 ft. | 6–3 | 3–2x8 | 7–1 | 3–2x8 | 7–8 | 3–2x8 | 8–4 | 3–2x8 |
| | 7–3 | 4–2x8 | 8–2 | 4–2x8 | 8–11 | 4–2x8 | 9–8 | 4–2x8 |
| | 8–1 | 3–2x10 | 9–0 | 3–2x10 | 9–11 | 3–2x10 | 10–8 | 3–2x10 |
| | 9–4 | 4–2x10 | 10–4 | 4–2x10 | 11–5 | 4–2x10 | 12–4 | 4–2x10 |
| | 9–9 | 3–2x12 | 10–11 | 3–2x12 | 12–0 | 3–2x12 | 12–11 | 3–2x12 |
| | 11–3 | 4–2x12 | 12–7 | 4–2x12 | 13–11 | 4–2x12 | 15–0 | 4–2x12 |
| 28 ft. | 5–10 | 3–2x8 | 6–6 | 3–2x8 | 7–2 | 3–2x8 | 7–8 | 3–2x8 |
| | 6–8 | 4–2x8 | 7–6 | 4–2x8 | 8–3 | 4–2x8 | 8–11 | 4–2x8 |
| | 7–5 | 3–2x10 | 8–4 | 3–2x10 | 9–1 | 3–2x10 | 9–11 | 3–2x10 |
| | 8–7 | 4–2x10 | 9–8 | 4–2x10 | 10–6 | 4–2x10 | 11–4 | 4–2x10 |
| | 9–0 | 3–2x12 | 10–1 | 3–2x12 | 11–1 | 3–2x12 | 10–11 | 3–2x12 |
| | 10–5 | 4–2x12 | 11–8 | 4–2x12 | 12–10 | 4–2x12 | 13–10 | 4–2x12 |
| 32 ft. | 5–4 | 3–2x8 | 6–1 | 3–2x8 | 6–8 | 3–2x8 | 7–3 | 3–2x8 |
| | 6–3 | 4–2x8 | 7–1 | 4–2x8 | 7–8 | 4–2x8 | 8–4 | 4–2x8 |
| | 7–0 | 3–2x10 | 7–9 | 3–2x10 | 8–7 | 3–2x10 | 9–2 | 3–2x10 |
| | 8–1 | 4–2x10 | 8–11 | 4–2x10 | 9–10 | 4–2x10 | 10–8 | 4–2x10 |
| | 8–5 | 3–2x12 | 9–6 | 3–2x12 | 10–4 | 3–2x12 | 11–1 | 3–2x12 |
| | 9–9 | 4–2x12 | 11–0 | 4–2x12 | 12–0 | 4–2x12 | 12–11 | 4–2x12 |
| 36 ft. | 5–1 | 3–2x8 | 5–9 | 3–2x8 | 6–3 | 3–2x8 | 6–9 | 3–2x8 |
| | 5–11 | 4–2x8 | 6–7 | 4–2x8 | 6–9 | 4–2x8 | 7–10 | 4–2x8 |
| | 6–6 | 3–2x10 | 7–4 | 3–2x10 | 8–1 | 3–2x10 | 8–8 | 3–2x10 |
| | 7–6 | 4–2x10 | 8–6 | 4–2x10 | 9–4 | 4–2x10 | 10–0 | 4–2x10 |
| | 7–11 | 3–2x12 | 8–11 | 3–2x12 | 9–9 | 3–2x12 | 10–7 | 3–2x12 |
| | 9–2 | 4–2x12 | 10–4 | 4–2x12 | 11–4 | 4–2x12 | 12–4 | 4–2x12 |

[1]This table provides maximum allowable spans in feet and inches for main beams or girders which are built–up from nominal 2–inch members.

[2]Fiber bending stress for various species and grades of wood is given in Appendix A21.

[3]The 2–inch members shall be laid on edge and fastened together with a double row of common nails not less than 3 $^1/_2$–inches in length. Nails shall be spaced not more than 18 inches apart in each row with the end nails placed 4 inches to 6 inches from the end of each piece.

[4]Where built–up wood beams are employed over a single span, the length of each individual piece used to fabricate the beam shall equal the length of the beam.

[5]Where built–up wood beams are continued over more than one span and where lengths of individual pieces are less than the total length of the complete beam, butt joints shall be located over supports or within 6 inches of the quarter points of the clear span. Where located near the quarter points, the joints in built–up beams shall be separated by at least one lamination and shall not exceed the beam width.

**(8)** FLOOR SHEATHING, BOARDS AND PLANKS. (a) *Plywood sheathing.* Plywood sheathing used for floors shall be limited to the allowable loads and spans shown in Table 21.22–B.

(b) *Plywood underlayment.* Plywood underlayment shall be installed in accordance with Table 21.22–C.

(c) *Combination subfloor – underlayment.* Combination subfloor–underlayment shall be installed in accordance with Table 21.22–D.

(d) *Floor boards.* Where wood boards are used for floor sheathing, the boards shall comply with the minimum thicknesses shown in Table 21.22–E.

(e) *Planks.* Planks shall be tongue and groove or splined and at least 2 inches, nominal, in thickness. Planks shall terminate over beams unless the joints are end matched. The planks shall be laid so that no continuous line of joints will occur except at points of support. Planks shall be nailed to each beam.

**(9)** BRIDGING. (a) *Sawn lumber.* Bridging shall be provided for sawn lumber framing at intervals not exceeding 8 feet where the nominal depth to thickness ratio is greater than 4 to 1.

(b) *Engineered products.* Bridging shall be provided for engineered framing products in accordance with the manufacturer's recommendations.

TABLE 21.22–B

**ALLOWABLE SPANS FOR PLYWOOD FLOOR SHEATHING CONTINUOUS OVER TWO OR MORE SPANS AND FACE GRAIN PERPENDICULAR TO SUPPORTS[1]**

| Span Rating[2] | Plywood Thickness (in inches) | Maximum span[3] (in inches) |
|---|---|---|
| $^{32}/_{16}$ | $^{15}/_{32}$, $^{1}/_{2}$, $^{5}/_{8}$ | 16[5] |
| $^{40}/_{20}$ | $^{19}/_{32}$, $^{5}/_{8}$, $^{3}/_{4}$, $^{7}/_{8}$ | 20[4,5] |
| $^{48}/_{24}$ | $^{23}/_{32}$, $^{3}/_{4}$, $^{7}/_{8}$ | 24 |

[1]These values apply to C–D, C–C, and Structural I and II grades only. Spans shall be limited to values shown because of possible effect of concentrated loads.

[2]Span Rating appears on all panels in the construction grades listed in footnote 1.

[3]Plywood edges shall have approved tongue and groove joints or shall be supported with blocking, unless $^{1}/_{4}$–inch minimum thickness underlayment or $1^{1}/_{2}$ inches of approved cellular or lightweight concrete is installed or finished floor is $^{25}/_{32}$–inch wood strip. Allowable uniform load based on deflection of $^{1}/_{360}$ of span is 165 pounds per square foot.

[4]For joists spaced 24 inches on center, plywood sheathing with Span Rating $^{40}/_{20}$ or greater can be used for subfloors when supporting $1^{1}/_{2}$ inches lightweight concrete.

[5]May be 24 inches if $^{25}/_{32}$–inch wood strip flooring is installed at right angles to joists.

TABLE 21.22–C

**MINIMUM THICKNESS FOR PLYWOOD UNDERLAYMENT**

| Plywood Grades and Species Group | Application[1] | Minimum Plywood Thickness (inches) |
|---|---|---|
| Groups 1, 2, 3, 4, 5 APA | Over Smooth Subfloor | $^{1}/_{4}$ |
| UNDERLAYMENT INT (with interior or exterior glue) APA UNDERLAYMENT EXT APA C–C Plugged EXT | Over Lumber Subfloor or Other Uneven Surfaces | $^{11}/_{32}$ |
| Same Grades as Above But Group I Only | Over Lumber Floor Up to 4″ Wide. Face Grain Must Be Perpendicular to Boards | $^{1}/_{4}$ |
| APA UNDERLAYMENT Sanded Exterior Grade | Over 16″ Joist Spacing, 19/32 Subfloor, Under Tile With Organic Adhesive | $^{11}/_{32}$ |
| | Over 16″ Joist Spacing, 19/32 Subfloor, Under Tile With Epoxy Mortar | $^{15}/_{32}$ |

[1]Place face grain across supports and end joints over framing.

[2]Leave $^{1}/_{4}$″ space at panel ends and edges, trim panels as necessary to maintain end spacing and panel support on framing. Fill joints with epoxy mortar. With single layer floors, use solid lumber backing or framing under all panel and edge joints, including T & G joints.

TABLE 21.22–D

**MINIMUM THICKNESS FOR PLYWOOD COMBINATION SUBFLOOR–UNDERLAYMENT. PLYWOOD CONTINUOUS OVER TWO OR MORE SPANS AND FACE GRAIN PERPENDICULAR TO SUPPORTS[1,2]**

| | | Maximum Support Spacing[3] | | |
|---|---|---|---|---|
| | | 16″ o.c. | 20″ o.c. | 24″ o.c. |
| Plywood Grade | Plywood Species Group | Panel Thickness (inches) | Panel Thickness (inches) | Panel Thickness (inches) |
| Sanded exterior type | 1 | $^{1}/_{2}$ | $^{5}/_{8}$ | $^{3}/_{4}$ |
| | 2 & 3 | $^{5}/_{8}$ | $^{3}/_{4}$ | $^{7}/_{8}$ |
| | 4 | $^{3}/_{4}$ | $^{7}/_{8}$ | 1 |
| Underlayment C–C Plugged Sturd–I–Floor[4] | All Groups | APA Rated Sheathing and APA Rated Sturd–I–Floor shall be installed consistent with their rating. | | |

[1]Spans shall be limited to values shown, based on possible effect of concentrated loads.

[2]Unsupported edges shall be tongue and groove or blocked except where $^{1}/_{4}$–inch underlayment or $^{25}/_{32}$–inch finish floor is used.

[3]Underlayment, C–C Plugged, sanded exterior type: allowable uniform load based on deflection of L/360 span for spans 24 inches or less is 125 psf; and for spans 48 inches, 65 psf.

[4]The department will accept subfloor underlayment panels such as Sturd–I–Floor which meet the requirements of APA manufacturing specifications for Sturd–I–Floor panels.

TABLE 21.22–E

**MINIMUM THICKNESS OF FLOOR BOARDS**

| Joist Spacing (inches) | Minimum Net Thickness (inches) | |
|---|---|---|
| | Perpendicular to Joist | Diagonal to Joist |
| 24 | 11/16 | 3/4 |
| 16 | 5/8 | 5/8 |

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (1) and cr. (1m), Register, February, 1985, No. 350, eff. 3–1–85; renum. (8) (c) and (d) to be (8) (d) and (e) and am. (8) (d), renum. Table 21.22–A and D to be Table 21.22 A1 and E, cr. (8) (c), Table 21.22 A2, r. and recr. Tables 21.22 B and C, Register, January, 1989, No. 397, eff. 2–1–89; am. (2), (4), (5), (6) and (9), r. and recr. Table 21.22–A2, Register, March, 1992, No. 435, eff. 4–1–92; am. (5) (b) and cr. (5) (c), Table 21.22–A1, r. Table 21.22–A, Register, November, 1995, No. 479, eff. 12–1–95; r. and recr. (9), Register, January, 1999, No. 517, eff. 2–1–99; **r. and recr. (1m), (4), and (5) (b), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 21.225 Decks.** Decks attached to dwellings and detached decks which serve an exit shall comply with the applicable provisions of this chapter, including but not limited to:

**(1)** Excavation requirements of s. Comm 21.14;

**(2)** Footing requirements of s. Comm 21.15 (1) (f);

**(3)** Frost penetration requirements of s. Comm 21.16;

**(4)** Load requirements of s. Comm 21.02;

**(5)** Stair, handrail and guardrail requirements of s. Comm 21.04; and

**(6)** Decay protection requirements of s. Comm 21.10.

**History:** Cr. Register, March, 1992, No. 435, eff. 4–1–92.

## Subchapter VII — Walls

**Comm 21.23 Wall design. (1)** LIVE AND DEAD LOADS. All walls shall support all superimposed vertical dead loads and live loads from floors and roofs.

**(2)** HORIZONTAL WIND LOAD. Walls shall be designed to withstand a horizontal wind pressure of at least 20 pounds per square foot applied to the vertical projection of that portion of the dwelling above grade. No wind load reduction shall be permitted for the shielding effect of other buildings.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

**Comm 21.24 Exterior covering. (1)** The exterior walls shall be covered with a permanent weather resistant finish.

**(2)** During construction, wall cavity insulation may not be installed until a water–resistant exterior covering is in place over the wall cavity.

**Note:** An example of acceptable water–resistant covering is foam sheathing with taped joints and the permanent doors and windows installed.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; **r. and recr., Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 21.25 Wood frame walls.** Unless designed through structural analysis, wood frame walls shall comply with the following requirements.

**(1)** STUD CONFIGURATION AND BRACING. (a) *Studs.* Wood studs shall comply with the size and spacing requirements indicated in Table 21.25–A. Studs in the exterior walls shall be placed with the wide faces perpendicular to the plane of the wall.

(b) *Bracing.* Exterior walls shall be braced at the corners.

1. Nominal 1 inch by 4 inch continuous diagonal members set into the face of the studs at an angle between 45° and 60°; or

2. Four feet by 8 feet plywood sheathing panels not less than 5/16–inch thick for 16–inch stud spacing and not less than 3/8 inch thick for 24–inch stud spacing; or

3. Preformed metal T–bracing not less than 22 gage (.0296 inches) thick and 1 3/4 inch wide; or

4. Other approved wind bracing materials.

**Note:** See Appendix for acceptable nailing schedule.

**Note:** See s. Comm 21.10 for requirements on treating wood for decay and termite resistance.

**(2)** TOP PLATES. (a) *General.* Except as allowed under subd. 3., top plates shall be provided and configured as follows:

1. Studs at bearing walls shall be capped with double top plates.

2. End joints in double top plates shall be offset at least 2 stud spaces.

3. Double top plates shall be overlapped at the corners and at intersections of partitions.

4. The plate immediately above the stud may have a joint only when directly over the stud.

(b) *Notching and boring.* 1. When piping or ductwork is placed in an exterior wall or an interior load–bearing wall, such that at least half of the top plate is removed, the plate shall be reinforced with a steel angle at least 2 inches by 2 inches by 20 gauge thick.

**Note:** 20 gauge is approximately 0.036 inch.

2. The steel angle shall span the gap and extend at least to the midpoint of the adjacent stud spaces.

3. Other equivalent materials may be used in accordance with s. Comm 21.02.

(c) *Exceptions.* 1. A single top plate may be used in place of a double top plate provided a rafter is located directly over the studs and the plate is securely tied at the end joints, corners and intersecting walls. Joints may occur in single top plates only when directly over a stud.

2. A continuous header, consisting of two 2–inch members set on edge, may be used in lieu of a double plate if tied to the adjacent wall.

**(3)** WALL OPENINGS. Where doors or windows occur, headers shall be used to carry the load across the opening.

(a) *Header size.* The size of headers shall be determined in accordance with the spans and loading conditions listed in Tables 21.25–B, 21.25–C and 21.25–D. Headers for longer spans shall be designed by an engineering method under s. Comm 21.02.

(b) *Header support.* Headers in bearing walls shall be supported in accordance with subd. 1. or 2. or 3.

1. Headers 3 feet or less in length shall be directly supported on each end by either:

a. The single common stud and a shoulder stud; or

b. The single common stud with a framing anchor attached.

2. Headers greater than 3 feet but less than or equal to 6 feet in length shall be directly supported on each end by the single common stud and a shoulder stud.

3. Headers greater than 6 feet in length shall be directly supported on each end by the single common stud and 2 shoulder studs.

(c) *Flashing.* Unless sealed or caulked, flashing shall be provided at the top and sides of all exterior window and door openings.

**(4)** NOTCHING. Notching and boring of columns or posts is prohibited unless designed through structural analysis. Studs shall not be cut or bored more than 1/3 the depth of the stud, unless the stud is reinforced.

**(5)** PARTITIONS. Load–bearing partitions shall be placed over beams, girders, or other load–bearing partitions. Load–bearing partitions running at right angles to the joists shall not be offset from the main girder or walls more than the depth of the joist unless the joists are designed to carry the load.

**(6)** POSTS AND COLUMNS. (a) *General.* 1. Posts and columns shall be installed to resist imposed loads.

2. Posts and columns shall bear directly over the middle 1/3 of a footing.

3. Posts and columns shall be restrained at the top and bottom to resist displacement.

4. Posts and columns that use a height adjustment mechanism shall have the mechanism imbedded in concrete or permanently disabled after installation.

(b) *Bearing surface.* Posts and columns shall have a steel bearing plate affixed to one or both ends to distribute any applied loads and to prevent fiber crushing of any structural member being supported.

(c) *Steel posts or columns.* Steel posts or columns shall be sized according to one of the following methods:

1. Manufactured columns shall follow the manufacturer's testing and listing.

2. Columns made solely of steel pipe stock shall follow Table 21.25–E.

3. Columns made of steel stock, not meeting the requirements of subd. 1.or 2., shall follow a nationally accepted design specification or the size shall be determined through structural analysis or load testing.

(d) *Wood posts or columns.* Wood posts or columns shall be sized according to Table 21.25–F or the size shall be determined through structural analysis or load testing.

TABLE 21.25–A

**MAXIMUM UNBRACED STUD LENGTH WITH SPACING AND LOADING**

| | | | Spacing (inches) | | | |
|---|---|---|---|---|---|---|
| **Size** | **Grade** | **Max. Height (feet)** | **Supporting roof and ceiling only** | **Supporting one floor, roof and ceiling** | **Supporting two floors, roof and ceiling** | **Interior and non–load–bearing** |
| 2x3 | Standard & better | 8 | 16 | N/P | N/P | 24 |
| 2x4 or larger | Utility | 8 | 24 | 16 | 12 | 24 |
| 2x4 | Standard or better | 10 | 24 | 24 | 12 | 24 |
| 2x6 or larger | No. 3 & better | 10 | 24 | 24 | 16 | 24 |

N/P = Not permitted.

**Note:** A 3–story frame house with walls constructed of 2 x 4 standard grade studs would require a 12–inch stud spacing on the lowest level, a 24–inch stud spacing on the intermediate level, and a 24–inch stud spacing on the upper level.

TABLE 21.25–B

**ALLOWABLE SPANS (FEET) FOR HEADERS SUPPORTING ROOF/CEILING ASSEMBLIES***

| | Header Members | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Two 2 x 4s** | | **Two 2 x 6s** | | **Two 2 x 8s** | | **Two 2 x 10s** | | **Two 2 x 12s** | |
| **House Width (feet)** | **Zone 2/Zone 1** | | **Zone 2/Zone 1** | | **Zone 2/Zone 1** | | **Zone2/Zone 1** | | **Zone 2/Zone 1** | |
| 24 | 2.5 | 2.5 | 4 | 4 | 5 | 5 | 7 | 6 | 9 | 8 |
| 26 | 2.5 | 2 | 4 | 3 | 5 | 5 | 7 | 6 | 8 | 7 |
| 28 | 2.5 | 2 | 4 | 3 | 5 | 4 | 6 | 6 | 8 | 7 |
| 30 | 2.5 | 2 | 4 | 3 | 5 | 4 | 6 | 6 | 8 | 7 |
| 32 | 2 | 2 | 3 | 3 | 5 | 4 | 6 | 5 | 7 | 7 |

TABLE 21.25–C

**ALLOWABLE SPANS (FEET) FOR HEADERS SUPPORTING ONE FLOOR***

| | Header Members | | | | |
|---|---|---|---|---|---|
| **House Width (feet)** | **Two 2 x 4s** | **Two 2 x 6s** | **Two 2 x 8s** | **Two 2 x 10s** | **Two 2 x 12s** |
| 24 | 2.5 | 4 | 5 | 6 | 8 |
| 26 | 2.5 | 3 | 5 | 6 | 8 |
| 28 | 2 | 3 | 5 | 6 | 7 |
| 30 | 2 | 3 | 4 | 6 | 7 |
| 32 | 2 | 3 | 4 | 5 | 7 |

TABLE 21.25–D

**ALLOWABLE SPANS (FEET) FOR HEADERS SUPPORTING ONE FLOOR AND ROOF/CEILING ASSEMBLY***

| | Header Members | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Two 2 x 4s** | | **Two 2 x 6s** | | **Two 2 x 8s** | | **Two 2 x 10s** | | **Two 2 x 12s** | |
| **House Width (feet)** | **Zone 2/Zone 1** | | **Zone 2/Zone 1** | | **Zone 2/Zone 1** | | **Zone2/Zone 1** | | **Zone 2/Zone 1** | |
| 24 | 1.5 | 1.5 | 3 | 2.5 | 4 | 3 | 5 | 4 | 6 | 5 |
| 26 | 1.5 | 1.5 | 2.5 | 2.5 | 3 | 3 | 4 | 4 | 5 | 5 |
| 28 | 1.5 | 1.5 | 2.5 | 2.5 | 3 | 3 | 4 | 4 | 5 | 5 |
| 30 | 1.5 | 1.5 | 2.5 | 2.5 | 3 | 3 | 4 | 4 | 5 | 5 |
| 32 | 1.5 | 1.5 | 2.5 | 2 | 3 | 3 | 4 | 4 | 5 | 5 |

*These tables are based on wood with a fiber bending stress of 1,000 psi. For other species with different fiber bending stresses, multiply the span by the square root of the ratio of the actual bending stress to 1,000 psi. Example: From Table 21.25–B, the allowable roof/ceiling span for a 28–foot wide house in zone 2, using two 2 x 8 header members with a 1400 psi bending stress, is 5 feet $\times \sqrt{1400/1000}$ = 5.9 feet.

TABLE 21.25–E

**COLUMNS MADE OF STEEL PIPE STOCK[1,2]**

| Column Diameter (inches) | Wall Thickness (inches) | Weight/ft (pounds) | Height (feet) | Allowable Load (pounds) |
|---|---|---|---|---|
| 3 | 0.216 | 7.58 | 8 | 34,000 |
| | | | 10 | 28,000 |
| | | | 12 | 22,000 |
| 3.5 | 0.226 | 9.11 | 8 | 44,000 |
| | | | 10 | 38,000 |
| | | | 12 | 32,000 |
| 4 | 0.237 | 10.79 | 8 | 54,000 |
| | | | 10 | 49,000 |
| | | | 12 | 43,000 |
| 5 | 0.258 | 14.62 | 8 | 78,000 |
| | | | 10 | 73,000 |
| | | | 12 | 68,000 |
| 6 | 0.280 | 18.97 | 8 | 106,000 |
| | | | 10 | 101,000 |
| | | | 12 | 95,000 |

[1]This Table is based on a yield strength or Fy of 36,000 psi.

[2]This table is for columns made solely of steel pipe stock. The addition of any adjustment mechanism or other feature will alter the load–carrying capacity of the column.

TABLE 21.25–F

**WOOD COLUMNS**

| Wood Nominal Size (inches) | Cross Section Area (inches) | Height (feet) | Allowable Load (pounds) |
|---|---|---|---|
| 4 x 4 | 12.25 | 8 | 4,900 |
| | | 10 | 3,100 |
| | | 12 | 2,150 |
| 4 x 6 | 19.25 | 8 | 7,700 |
| | | 10 | 4,900 |
| | | 12 | 3,400 |
| 6 x 6 | 30.25 | 8 | 30,000 |
| | | 10 | 18,900 |
| | | 12 | 13,300 |

**Note:** This Table is based on a modulus of elasticity or E of 1,000,000 psi and a fiber bending strength or $F_b$ of 1,000 psi.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; cr. (1) (d) and am. (3) (b), Register, February, 1985, No. 350, eff. 3–1–85; r. and recr. (3) (b), am. Table 21.25 B and E, Register, January, 1989, No. 397, eff. 2–1–89; am. (3) (a) and (6), Register, March, 1992, No. 435, eff. 4–1–92; r. and recr. (1) (c), am. Table 21.25–D, cr. Table 21.25–F, Register, November, 1995, No. 479, eff. 12–1–95; am. Table 21.25–A, Register, January, 1999, No. 517, eff. 2–1–99; **r. (1) (b) and (c), renum. (1) (d) to be (b), r. and recr. (2), (6) and Tables 21.25–E and F, and am. (3) (b) 3., Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 21.26 Masonry walls.** Masonry walls shall be constructed in accordance with the requirements of this section.

**(1)** COLD WEATHER WORK. In cold weather, provisions shall be taken to prevent masonry from being damaged by freezing.

**Note:** It will be the practice of the department to accept performance with "Recommended Practices for Cold Weather Masonry Construction," available from International Masonry Institute, 823 15th Street NW, Washington, D.C. 20005.

**(2)** MASONRY UNITS. (a) *Unused concrete units.* Previously unused concrete masonry units shall conform to the ASTM C 90 standard.

(b) *Unused clay or shale units.* Previously unused clay or shale masonry units shall conform to the appropriate ASTM standard: C 62; C 216; or C 652. Units which will be exposed to weathering or frost action shall be Grade SW as specified in these standards.

(c) *Used masonry units.* All previously used masonry units shall be free from physical defects which interfere with the installation or impair the structural properties of the unit.

**(3)** TYPES OF MORTAR. The type of masonry mortar to be used for various kinds of masonry work shall be determined from Table 21.26–A. The mortar shall conform to the property requirements of Table 21.26–B1 and to the requirements of ASTM C–270 or shall be mixed in accordance with the proportions specified in Table 21.26–B.

(a) *Surface bond mortars.* Surface bond mortars for masonry walls shall be mixed in accordance with the proportions specified on the bag.

**(4)** MORTAR COMPONENTS. Mortar components shall comply with the following requirements:

(a) *Water.* Water shall be clean and free of deleterious amounts of acids, alkalies, or organic materials.

(b) *Admixtures or mortar colors.* Admixtures or mortar colors shall not be added to the mortar unless the resulting mortar conforms to the requirements of the mortar specifications. Only calcium chloride may be used as an accelerant and shall be limited to 2% by weight of the cement used. Calcium chloride may not be used for any other purpose. Only mineral oxide may be used as mortar color and shall not exceed 10% by weight of the cement used.

(c) *Mixing.* Mortar shall be mixed for at least 3 minutes after all ingredients have been added with the maximum amount of water to produce a workable consistency. Mortars that have stiffened due to water evaporation shall be retempered by adding water as frequently as needed to restore the required consistency. Mortars shall be used and placed in final position within $2\frac{1}{2}$ hours after mixing.

**Note:** To ensure proper mortar mixing, machine mixing is recommended.

TABLE 21.26–A

**TYPES OF MORTAR FOR VARIOUS KINDS OF MASONRY**

| Kind of Masonry | Types of Mortar |
|---|---|
| Foundations: | |
| Footings | M, S |
| Walls of solid units | M, S, N |
| Walls of hollow units | M, S |
| Hollow walls | M, S |
| Masonry other than foundation masonry: | |
| Piers of solid masonry | M, S, N |
| Piers of hollow units | M, S |
| Walls of solid masonry | M, S, N, O |
| Walls of solid masonry not less than 12 in. thick or more than 35 ft. in height, supported laterally at intervals not exceeding 12 times the wall thickness | M, S, N, O |
| Walls of hollow units; load–bearing or exterior, and hollow walls 12 in. or more in thickness | M, S, N |
| Hollow walls, less than 12 in. thick | M, S, N |
| Linings of existing masonry, either above or below grade | M, S |
| Masonry other than above | M, S, N |

TABLE 21.26–B

**MORTAR SPECIFICATIONS BY PROPORTION[1]**

| Mortar Type, ASTM C 270 | Parts by Volume | | | |
|---|---|---|---|---|
| | Portland Cement | Masonry Cement | Hydrated Lime | Sand, Damp Loose Volume |
| M | 1 | — | $\frac{1}{4}$ | |
| | 1 | 1 (Type II) | — | Not less than $2\frac{1}{4}$ |
| S | 1 | — | $\frac{1}{4}$ to $\frac{1}{2}$ | and not more than 3 |
| | $\frac{1}{2}$ | 1 (Type II) | — | times the sum of |
| N[2] | 1 | — | $\frac{1}{2}$ to $1\frac{1}{4}$ | the volumes of the |
| | — | 1 (Type II) | — | cements and lime. |

[1]All cements are one cubic foot per sack; lime equals $1\frac{1}{4}$ cubic foot per sack.

[2]Limited to walls with a maximum depth of 5 feet below grade.

TABLE 21.26–B1

**MORTAR PROPERTY REQUIREMENTS**

| Mortar Type | Compressive Strength Min. (psi) | Water Retention Min. (%) | Air Content Max. (%) |
|---|---|---|---|
| M | 2,500 | 75 | 18 |
| S | 1,800 | 75 | 18 |
| N | 750 | 75 | 18 |

(d) *Cementitious material.* Cementitious material shall conform to the standards approved by the department.

**Note:** The department will accept cementitious material conforming to the following standards: ASTM C91, Masonry Cement; ASTM C150, Portland Cement; ASTM C595, Portland Blast–Furnace Slag Cement; ASTM C207, Hydrated Lime for Masonry Purposes; and ASTM C5, Quick Lime for Structural Purposes.

(e) *Aggregates.* Aggregates for use in masonry mortar shall consist of natural sand or manufactured sand and shall be graded.

**Note:** The department will accept aggregates in accordance with ASTM C144.

**(5)** CAVITY WALL. (a) *Corbeling.* Cavity wall construction may be supported on an 8–inch foundation wall provided the 8–inch wall is corbeled with solid masonry to the width of the cavity wall. Individual corbels shall not exceed 2 inches nor more than one–third the height of each corbeled unit.

(b) *Projections.* The projection of a wall beyond the edge of a supporting member other than masonry, such as a shelf angle or edge of a beam, shall not exceed $1\frac{1}{4}$ inches, unless at least $\frac{2}{3}$ the mass of the wythe of masonry involved is located directly over the load–carrying member.

(c) *Flashing.* In exterior hollow walls exposed to the weather, flashing shall be installed at the bottom of the cavity formed by openings such as lintels over doors and windows and the backsides of chimneys so as to drain any water outward. Open vertical joints or weep holes of $\frac{3}{8}$–inch minimum diameter shall be provided in the facing directly above the flashing at a horizontal spacing not exceeding 3 feet.

**(6)** OPENINGS AND LINTELS. (a) *Openings.* The masonry above openings shall be supported. The bearing length of structural elements which support the masonry above the opening shall be not less than 4 inches.

(b) *Lintels.* Unless designed through structural analysis, lintels shall be provided using either steel angles or reinforcing bars in accordance with Table 21.26–C.

TABLE 21.26–C

**ALLOWABLE SPANS FOR LINTELS SUPPORTING MASONRY VENEER**

| Size of Steel Angle[1,3] | No Story Above | One Story Above | Two Stories Above | No. of $\frac{1}{2}$" or Equivalent Reinforcing Bars[2] |
|---|---|---|---|---|
| L 3 x 3 x $\frac{1}{4}$ | 6' – 0" | 3' –6" | 3' – 0" | 1 |
| L 4 x 3 x $\frac{1}{4}$ | 8' – 0" | 5' –0" | 3' – 0" | 1 |
| L 6 x $3\frac{1}{2}$ x $\frac{1}{4}$ | 14' – 0" | 8' –0" | 3' – 6" | 2 |
| 2 – L 6 x $3\frac{1}{4}$ x $\frac{1}{4}$ | 20' – 0" | 11'–0" | 5' – 0" | 4 |

[1] Long leg of the angle shall be placed in a vertical position.

[2] Depth of reinforced lintels shall be not less than 8 inches and all cells of hollow masonry lintels shall be grouted solid. Reinforcing bars shall extend not less than 8 inches into the support.

[3] Steel members indicated are adequate typical examples; other steel members meeting structural design requirements may be used.

**(7)** MASONRY VENEERS. (a) *Veneer over frame construction.* 1. Masonry veneers may be corbeled over the foundation wall, but the corbeling shall not exceed one inch.

2. An air space shall be provided between the veneer and the sheathing.

3. Where no brick ledge is formed in the foundation wall, corrosion resistant metal or other water–resistant flashing shall extend over the top of the foundation wall from the outside face of the wall and shall extend at least 6 inches up on the sheathing. The flashing shall be installed to drain any water outward.

4. Weep holes shall be provided at the bottom masonry course at maximum intervals of 3 feet.

(b) *Veneer over masonry back–up.* Corrosion–resistant metal or other water–resistant base flashing shall be provided at the bottom of the veneer and shall extend over the top of the foundation and up at least 6 inches and be embedded in the back–up course. The flashing shall be installed to drain any water outward. Weep holes shall be provided at maximum intervals of 3 feet.

**(8)** VENEER ANCHORAGE. All veneers, supports and attachments shall be mechanically or adhesively anchored.

(a) *Mechanical anchorage.* All anchors shall be corrosion–resistant.

1. Conventional size veneer (one square foot or less) shall be securely attached to its backing by anchors the equivalent of No. 22 U.S. gauge corrugated sheet steel $\frac{7}{8}$–inch wide with at least one such tie located in every 2 square feet of wall. Ties shall be embedded 2 inches in a masonry joint and nailed to the framing with an 8d nail.

2. Large size veneer (greater than one square foot) shall be securely attached with anchors the equivalent of not less than $\frac{1}{4}$–inch diameter bolts in accordance with either of the following:

a. Each unit individually anchored to the supporting framework with at least 3 anchors.

b. Individual units doweled to each other at all horizontal joints and anchored to the backing at all horizontal and vertical joints so that one anchor is provided for every 6 square feet of wall surface.

(b) *Adhesive anchorage.* Veneer may be cemented to a masonry or concrete wall or to exterior portland cement plaster in high rib galvanized metal lath with an adhesive, provided that the bond is sufficient to withstand a shearing stress of 50 psi after curing for 28 days.

**(9)** BEARING. (a) *Concentrated loads.* Beams, girders, trusses, joists and other members producing concentrated loads shall bear a minimum of 3 inches on one of the following:

1. Concrete beam. The equivalent of a nominally reinforced 2,500 psi concrete beam 8 inches in height.

2. Solid masonry. At least 8 inches in height of masonry composed of solid masonry units with all voids and joints completely filled with mortar.

3. Metal plate. A metal plate of sufficient thickness and size to distribute the load to masonry units. For piers and columns, the bearing plate shall not exceed 60% of the cross–sectional area of the pier or column and the resultant reaction of all vertical and horizontal loads shall fall within the middle third of the member.

4. Bond beam. The bond beam shall be the equivalent of not less than an 8–inch lintel (bond beam) block with 2 No. 4 bars embedded in high strength mortar fill or equivalent. The loads shall bear on the fill.

(b) *Continuous loads.* Joists, trusses and beams other than wood, spaced 4 feet or less on center and 40 feet or less in length, slabs or other members causing continuous loads shall be transmitted to masonry with a minimum bearing of 3 inches upon solid masonry at least $2\frac{1}{2}$ inches in height, or as indicated for concentrated loads.

(c) *Stack bond walls.* Concentrated loads shall be distributed into masonry laid in stack bond by a concrete beam or bond beam [as defined in par. (a)]. For masonry of solid units, 2 additional rows of a continuous tie assembly may be used instead of a concrete beam or bond beam.

(d) *Support of wood floor members.* Where a wood structural member is buried in masonry for support, it shall be firecut or a self–releasing device shall be used. Where the end of a wood structural member is built into an exterior wall, a $^1/_2$ –inch air space shall be provided at the sides, top and end of such member.

**(10)** BONDING. Unless designed through structural analysis, all masonry walls shall be bonded as follows:

(a) *Single–wythe walls.* Masonry units in single–wythe walls shall be lapped at least 2 inches or one–third the height of the masonry unit, whichever is greater, or through the use of continuous tie assemblies spaced at 16–inch vertical intervals.

(b) *Multi–wythe walls.* Adjacent wythes shall be bonded with continuous tie assemblies spaced at vertical intervals not exceeding 16 inches; or individual ties of at least $^3/_{16}$–inch diameter for each $4^1/_2$ square feet of wall area, spaced at a maximum vertical distance of 18 inches and a maximum horizontal distance of 36 inches; or bonded with a full course of masonry headers every seventh course. The clear distance between bond courses shall not exceed 16 inches for solid masonry units and 24 inches for hollow masonry units. Hollow walls shall not be bonded with headers.

**(11)** BOLTS AND ANCHORS. The allowable shear on steel bolts and anchors shall not exceed the values given in Table 21.26.

TABLE 21.26

**ALLOWABLE SHEAR ON BOLTS AND ANCHORS**

| Bolt or Anchor Diameter (inches) | Embedment[1] (inches) | Allowable Shear (pounds) |
|---|---|---|
| $^1/_4$ | 4 | 270 |
| $^3/_8$ | 4 | 410 |
| $^1/_2$ | 4 | 550 |
| $^5/_8$ | 4 | 750 |
| $^3/_4$ | 5 | 1100 |
| $^7/_8$ | 6 | 1500 |
| 1 | 7 | 1850 |
| $1^1/_8$ | 8 | 2250 |

[1]Bolts and anchors shall be solidly embedded in mortar or grout.

**(12)** JOINTS. (a) The maximum thickness of a mortar joint shall be $^1/_2$ inch.

(b) Except for head joints used for weepholes and ventilation, solid masonry units shall be laid to achieve full head and bed joints.

(c) Hollow masonry units shall be laid with full head joints and full bed joints under the full bearing areas of the face shells and under webs where the adjacent cells are to be filled with grout.

**(13)** CLEANING. Chemical cleaning agents shall be prevented from harming the metal reinforcement of structural components and shall not be of a strength which will adversely affect the mortar.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (3) and cr. Table 21.26–B1 Register, February, 1985, No. 350, eff. 3–1–85; am. (9) (b), Register, January, 1989, No. 397, eff. 2–1–89; am. (6) (b), Register, March, 1992, No. 435, eff. 4–1–92; r. and recr. (2), am. (5) (c), (7) (a) 3., 4., (b), r. (14), Register, November, 1995, No. 479, eff. 12–1–95.

## Subchapter VIII — Roof and Ceilings

**Comm 21.27 Roof design. (1)** ROOF LOADS. (a) *General.* Roof and roof/ceiling assemblies shall support all dead loads plus the minimum live loads as set forth in par. (b) and s. Comm 21.02.

(b) *Slope roof snow loads.* Snow loads specified in s. Comm 21.02 (1) (b) 2. may be reduced for roof slopes greater than 30° by multiplying the snow load by Cs. The value of Cs shall be determined by the following: $Cs = 1 - \frac{(a-30)}{40}$ where a is the slope of the roof expressed in degrees.

**(2)** UPLIFT AND SUCTION FORCES. Roofs shall withstand a pressure of at least 20 pounds per square foot acting upward normal to the roof surface. Roof overhangs, eaves, canopies and cornices shall withstand an upward wind pressure of at least 20 pounds per square foot applied to the entire exposed area.

(a) *Anchorage.* Roofs shall be anchored to walls and columns to resist uplift.

(b) *Stress increase.* All stresses may be increased by a maximum of one third for wind forces.

**(3)** WATER. All roofs shall be designed and constructed to assure drainage of water.

(a) *Roofing.* 1. General. a. Underlayment consisting of number 15 asphalt–impregnated felt paper or equivalent or other type I material that shows no water transmission when tested in accordance with ASTM D 226 or ASTM D 4869 shall be provided under shingles.

**Note:** Underlayment materials meeting the requirements of ASTM D 1970 meet the performance requirements of this section.

b. Fasteners shall be corrosion resistant.

**Note 1:** See s. Comm 20.07 (62) for definitions of shingle terms.

**Note 2:** *The Residential Asphalt Roofing Manual* can be purchased from the Asphalt Roofing Manufacturers Association at 6000 Executive Boulevard, Suite 201, Rockville, Maryland 20852–3803. This manual contains extensive information on shingles from manufacture through installation, inspection and maintenance. It includes a recommendation that properly driven and applied nails are the preferred fastening system for asphalt shingles.

**Note 3:** Section Comm 20.04 (2) requires compliance with all parts of this code, including these roofing provisions, for an alteration to any dwelling that is regulated under this code.

2. Asphalt shingles.

a. Organic asphalt shingles shall conform to ASTM D 225 and the Class C requirements of ASTM E 108, and shall pass the wind resistance test of ASTM D 3161.

b. Fiberglass asphalt shingles shall conform to ASTM D 3462 except that laminated shingles shall have a tear strength of at least 1450 grams in each ply.

c. Shingles that have a self–sealing adhesive strip shall include a sealant which has an average bond strength of at least 1.5 pounds per 3.75 inches of shingle width, at 32° F.

**Note:** The department will accept the results of testing conducted in accordance with an approved test method for verifying compliance with the sealant uplift resistance required in this subparagraph. Information on the applicable test method may be obtained from the department.

d. Each shingle package shall be labeled by the manufacturer to indicate conformance to the applicable ASTM standard for each type of shingle or the exception in subd. 2. b.

e. Shingles shall be installed in accordance with the manufacturer's recommendations. Shingles shall have at least 4 fasteners per strip shingle or 2 fasteners per interlocking shingle. Shingle head lap shall be at least 2 inches.

(b) *Eave protection for shingles and shakes.* Sheet metal, asphalt–impregnated felt paper or similar eave protection shall be provided on roof slopes of less than 4:12 (18.4°), extending from the edge of the roof a minimum distance of 2 feet 6 inches up the roof slope to a line not less than 12 inches inside the inner face of the exterior wall; except over unheated garages or porches.

**(4)** FLASHING. Flashings shall be installed at the junction of chimneys and roofs, in all valleys, and around all roof openings.

(a) *Valley flashing.* 1. Open valleys. Open valleys shall be flashed with at least No. 28 gauge galvanized, corrosion–resistant sheet metal, 16 inches wide, or a layer of at least 50–pound roll roofing, 16 inches wide, placed over a layer of 15–pound roofing underlayment. Flashing sections shall be overlapped by at least 4 inches.

2. Closed valleys. Where shingles are laced or woven over the valley, the valley shall be flashed with at least one layer of 50–pound roofing, at least 20 inches wide, over the layer of 15–pound roofing underlayment.

(b) *Chimney flashing.* 1. Chimney crickets shall be installed where the upper side of a chimney is more than 30 inches wide on

a sloping roof. The intersection of the cricket and the chimney shall be flashed and counter–flashed to a height of at least 4 inches.

2. Chimneys not exceeding 30 inches wide shall be flashed and counter–flashed to a height of at least 6 inches.

3. Chimney sides shall be flashed to a height of at least 4 inches.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am (3) (a), Register, January, 1989, No. 397, eff. 2–1–89; r. and recr. (1), am. (3) (a), Register, March, 1992, No. 435, eff. 4–1–92; r. and recr. (3) (a), Register, November, 1995, No. 479, eff. 12–1–95; r. and recr. (3) (a) 1. and 2. c., Register, January, 1999, No. 517, eff. 2–1–99; **am. (3) (a) 1. a., Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 21.28 Roof and ceiling wood framing.** Unless designed through structural analysis, wood rafters and ceiling joists, and components, shall comply with the requirements of s. Comm 21.02 (3).

**(1)** ROOF RAFTERS. (a) *Ridge boards.* Where rafters meet to form a ridge, the rafters shall be placed directly opposite and secured to each other or to a ridge board a minimum of one inch, nominal, in thickness. Where rafters are offset more than the thickness of the rafter, a ridge board 2 inches, nominal, in thickness shall be used.

(b) *Bearing.* The required bearing for wood rafters shall be in accordance with the National Design Specification for Wood Construction published by American Forest & Paper Association. In no case shall the bearing be less than $1^1/_2$ inches on wood or metal or less than 3 inches on masonry or concrete.

**(2)** ANCHORAGE. Roofs shall be anchored to resist horizontal thrust and uplift. Provisions shall be taken to absorb the horizontal thrust produced by the sloping roof, rafters or beams through collar ties installed in the upper third of the roof rafters on every third pair of rafters; or through the use of cross ties connecting beams; or through the use of metal straps or metal plates located at the ridge which tie the roof beams together. Rafters shall be notched to fit the exterior wall plate and fastened to the wall.

**(2m)** CATHEDRAL CEILINGS. In cathedral ceilings, the upper end of the rafters shall be supported by a ridge beam or bearing wall, or thrust restraint shall be provided per s. Comm 21.02.

**(3)** CEILING JOISTS. Ceiling joists shall be nailed to exterior walls and to the ends of rafters. Where joining over interior partitions, they shall be nailed to the plate or to each other. Where ceiling joists are placed at right angles to the rafters, as in flat or hip roofs, the lookout joist or ties shall be fastened to the parallel ceiling joists or rafters.

**(4)** VALLEY AND HIP RAFTERS; LADDERS. (a) *Valley rafters.* Where no bearing is provided under valley rafters at the intersection of 2 roof areas, the valley rafters shall be doubled in thickness and shall be at least 2 inches deeper than the required common rafter to permit full bearing at the beveled end. Where ridges are provided at different elevations, care should be taken to provide vertical support for the interior end of the lower ridge board.

(b) *Hip rafters.* Where no bearing is provided under hip rafters, the hip rafters shall be of the same thickness as common rafters and shall be at least 2 inches deeper to permit full contact with the jack rafter.

(c) *Ladders.* Overhangs at gable end walls of more than 12 inches shall be provided with ladders (rafters which extend over the wall) which extend into the structure a distance no less than the length of the overhang. The ladders shall be fastened at the wall. The interior end of each ladder shall be attached to a rafter or truss with a hanger.

**(5)** ROOF TRUSSES. Metal plate connected wood roof trusses shall be designed in accordance with the Design Specifications for Metal Plate Connected Wood Trusses and the National Design Specification for Wood Construction. Truss members shall not be cut, bored or notched.

**(6)** NOTCHING AND BORING. Notching and boring of beams or girders is prohibited unless determined through structural analysis. Notching and boring of ceiling joists shall comply with pars. (a) and (b).

(a) *Notching.* 1. Notches located in the top or bottom of ceiling joists shall not have a depth exceeding the depth of the joist, shall not have a length exceeding $^1/_3$ the joist depth, and shall not be located in the middle third of the span of the joist.

2. Where ceiling joists are notched on the ends, the notch shall not exceed $^1/_4$ the depth of the joist. Notches over supports shall be permitted to extend the full bearing length of the support.

3. Bird–mouth cuts shall not exceed the $^1/_3$ depth of the rafter unless the seat cut bears fully on the wall plate.

(b) *Boring.* Holes bored in ceiling joists shall be located no closer than 2 inches to the top or bottom edges of the joist. Where holes are located outside the middle $^1/_3$ of the span, the diameter of the hole shall not exceed one third the depth of the joist. Where the joist is notched, the hole shall not be closer than 2 inches to the notch.

(c) *Engineered wood products.* Notching or boring of engineered wood products shall be done in accordance with the manufacturer's instructions provided those instructions were developed through structural analysis or product testing. Trusses shall be anchored in accordance with standards and recommendations published by the Truss Plate Institute.

**(7)** ROOF SHEATHING, BOARDS AND PLANKING. (a) *Plywood sheathing.* Plywood sheathing and similar sheathing materials which are rated by the American Plywood Association shall be grade marked and stamped and limited to the allowable loads and spans indicated in Table 21.28–A.

(b) *Roof boards.* Roof boards shall comply with the minimum thicknesses shown in Table 21.28–B.

(c) *Roof planks.* Roof planks shall be tongue and groove or splined and at least 2 inches, nominal, in thickness. Planks shall terminate over beams unless the joints are end matched. The planks shall be laid so that no continuous line of joints will occur except at points of support. Planks shall be nailed or fastened to each beam.

TABLE 21.28–A

**ALLOWABLE LOADS AND SPANS FOR PLYWOOD ROOF SHEATHING CONTINUOUS OVER TWO OR MORE SPANS AND FACE GRAIN PERPENDICULAR TO SUPPORTS[1,2,3]**

| Panel Span Rating | Plywood Thickness (inches) | Maximum Span (inches) | | Load (in pounds per square foot) | |
|---|---|---|---|---|---|
| | | Edges Blocked | Edges Unblocked | Total Load | Live[4] Load |
| 12/0 | 5/16 | 12 | 12 | 40 | 30 |
| 16/0 | 5/16, 3/8 | 16 | 16 | 40 | 30 |
| 20/0 | 5/16, 3/8 | 20 | 20 | 40 | 30 |
| 24/0 | 3/8 | 24 | 20 | 40 | 30 |
| 24/16 | 7/16, 1/2 | 24 | 24 | 50 | 40 |
| 32/16 | 15/32, 1/2, 5/8 | 32 | 28 | 40 | 30 |
| 40/20 | 19/32, 5/8, 3/4, 7/8 | 40 | 32 | 40 | 30 |
| 48/24 | 23/32, 3/4, 7/8 | 48 | 36 | 45 | 35 |

[1] Spans shall be limited to values shown, based on possible effect of concentrated loads.

[2] Underlayment, C–C Plugged, sanded exterior type: allowable uniform load based on deflection of L/360 span for spans 24 inches or less is 125 psf; and for spans 48 inches, 65 psf.

[3] Plywood sheathing may be installed with face grain parallel to supports in accordance with the "APA Design/Construction Guide", American Plywood Association, P.O. Box 11700, Tacoma, WA 98411.

[4] Assumes 10 psf dead load.

TABLE 21.28–B

**MINIMUM THICKNESS OF ROOF BOARDS**

| Rafter Spacing (inches) | Minimum Net Thickness (Inches) | |
|---|---|---|
| | Solid Sheathing | Spaced Sheathing |
| 24 | 5/8 | 3/4 |

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (7) (a), r. and recr. Table 21.28–A, Register, January, 1989, No. 397, eff. 2–1–89; am. (1), (5) and (6), cr. (2m) and (6) (a) 3., r. and recr. (4) (c), Register, March, 1992, No. 435, eff. 4–1–92; cr. (6) (c), Register, November, 1995, No. 479, eff. 12–1–95.

## Subchapter IX — Fireplace Requirements

**Comm 21.29 Masonry fireplaces.** Masonry fireplaces shall be constructed of masonry, stone or concrete. Masonry fireplaces shall be supported on foundations of concrete or masonry. Structural walls shall be at least 8 inches thick. Masonry fireplaces shall conform to the following requirements:

**(1)** FLUE SIZE. The fireplace flue size shall be based on the type of flue and the fireplace opening indicated in Table 21.29.

TABLE 21.29

**MINIMUM FLUE SIZE FOR MASONRY FIREPLACES**

| Type of Flue | Minimum Cross–Sectional Area |
|---|---|
| Round | 1/12 of fireplace opening but not less than 75 square inches. |
| Square or rectangular | 1/10 of fireplace opening but not less than 75 square inches. |

**(2)** TERMINATION OF CHIMNEY. Masonry fireplace chimneys shall extend at least 3 feet above the highest point where the chimney passes through the roof and at least 2 feet higher than any portion of the dwelling within 10 feet of the chimney.

**(3)** FIREBOX MATERIALS. The firebox shall be of the preformed metal type, at least 1/4–inch thick, or listed by a nationally recognized laboratory; or shall be lined with firebrick, at least 2 inches thick and laid in thin joints of refractory cement. The back and sidewalls of the firebox, including the lining, shall be at least 8 inches nominally thick masonry, at least 4 inches of which shall be solid.

**(4)** LINTEL. Masonry over the fireplace opening shall be supported by a lintel of steel or masonry.

**(5)** DUCTS. Warm–air circulating ducts shall be constructed of masonry or metal.

**(5m)** RETURN AIR GRILLES. Return air grilles shall not be located in bathrooms, kitchens, garages, utility spaces or in a confined space defined under s. Comm 23.06 in which a draft diverter or draft regulator is located.

**(6)** HEARTH EXTENSION. (a) Masonry fireplaces shall have a hearth extension made of noncombustible material.

(b) The structural support for the hearth and hearth extension shall be a minimum of 4 inches of reinforced concrete.

(c) There shall be no structural framing material within 1 inch of the hearth or hearth extension in any direction. Any wooden forms or supports used during construction shall be removed.

(d) The minimum dimensions of the hearth extension shall be in accordance with Table 21.29–1.

TABLE 21.29–1

**HEARTH EXTENSION DIMENSIONS**

| Fireplace Opening (Sq. Ft.) | Extension from Fireplace Opening (inches) | |
|---|---|---|
| | Side | Front |
| Less than 6 | 8 | 16 |
| 6 or Greater | 12 | 20 |

**(7)** DAMPERS. Dampers shall be made of cast iron or at least No. 12 gauge sheet metal. The area of the damper opening shall be at least 90% of the required flue area when in the open position.

**(8)** HOODS. Metal hoods, used in lieu of a masonry smoke chamber, shall be constructed of at least No. 19 gauge corrosion–resistant metal with all seams and connections of smokeproof construction. The hood shall be sloped at an angle of 45° or less from the vertical and shall extend horizontally at least 6 inches beyond the firebox limits. Metal hoods shall be kept a minimum of 18 inches from the combustible materials unless approved for reduced clearances.

**Note:** The department will accept dampers and hoods listed by nationally recognized laboratories.

**(9)** FLUE LINERS. (a) Flue liners shall be installed in accordance with s. Comm 21.30 (7) and this section.

(b) Flue liners shall start at the top of the fireplace throat and extend to a point at least 4 inches above the top of the chimney cap.

(c) Firebrick may be used in the throat of the fireplace as an inlet to the flue liner.

**(10)** CLEANOUT OPENINGS. Fireplaces with ash dumps shall be provided with cleanout openings at the base. Doors and frames of the opening shall be made of ferrous materials.

**(11)** MANTEL SHELVES AND COMBUSTIBLE TRIM. Woodwork or other combustible materials shall not be placed within 6 inches of the fireplace opening. Combustible materials located within 12 inches of the fireplace opening shall not project perpendicularly more than $^1/_8$–inch for each inch distance from the opening.

**(12)** FRAMING AROUND FIREPLACES. Combustible materials located near fireplaces shall be installed in accordance with s. Comm 21.30 (9).

**(13)** CORBELING. Unless designed through structural analysis, masonry chimneys shall not be corbeled from a wall more than 6 inches nor shall a masonry chimney be corbeled from a wall less than 12 inches in nominal thickness unless it projects equally on each side of the wall. The corbeling shall not exceed one–inch projection for each brick course.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. Register, February, 1985, No. 350, eff. 3–1–85; am. (6) and Table 21.29–1, Register, January, 1989, No. 397, eff. 2–1–89; am. (intro.) and (12), cr. (5m), r. and recr. (6), Register, March, 1992, No. 435, eff. 4–1–92; r. (12) and renum. (13) and (14) to be (12) and (13), Register, January, 1999, No. 517, eff. 2–1–99; **r. and recr. (6) and (9), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 21.30 Masonry chimneys.** Masonry chimneys shall conform to the following provisions:

**(1)** MATERIALS. No masonry chimney shall rest upon wood. The foundation shall be designed and built in conformity with the requirements for foundations. Masonry chimney walls shall be at least 4 inches in nominal thickness. Hollow cored masonry units may be used to meet the 4 inch nominal thickness requirement.

**(2)** FLUE SIZE. Chimney flues for appliances shall be at least equal in area to that of the area of the connector from the appliance.

**(3)** MULTIPLE FLUE SEPARATION. When more than one flue is contained in the same chimney, a masonry separation of at least 4 inches nominal in thickness shall be provided between the individual flues. The joints of adjacent flue linings shall be staggered by at least 7 inches.

**(4)** CORBELING. Unless designed through structural analysis, masonry chimneys shall not be corbeled from a wall more than 6 inches nor shall a masonry chimney be corbeled from a wall less than 12 inches in nominal thickness unless it projects equally on each side of the wall. The corbeling shall not exceed one–inch projection for each brick course.

**(5)** INLETS. Inlets to masonry chimneys shall enter the side and be provided with thimbles. Thimbles shall be at least No. 24 manufacturer's standard gauge (0.024 inch) or $^5/_8$–inch thick, refractory material. Each chimney shall have an inlet installed at the time of construction.

**(6)** CLEAN–OUT OPENING. Every masonry chimney shall be provided with a clean–out opening at the base. Such openings shall be equipped with metal doors and frames arranged to remain closed when not in use. Clean–out openings shall be located below the lowest inlet to the flue.

**(7)** FLUE LINERS. (a) Masonry chimneys shall be lined with a material that will resist corrosion, softening and cracking at temperatures up to 1800° F, such as vitrified clay sewer pipe or minimum 5/8–inch thick fireclay lining material.

(b) All flue liners shall be laid in a full mortar bed.

(c) Variations in inside and outside dimensions shall not exceed $^1/_4$ inch for clay flue liners.

(d) There shall be a minimum clearance of 1/2 inch between the flue liner and the chimney walls.

(e) Unless serving a masonry fireplace under s. Comm 21.29, flue liners shall commence at the chimney footing.

**(8)** CHIMNEY CAPS. Chimneys shall be provided with precast or cast–in–place concrete chimney caps. Chimney caps shall have a minimum thickness of 2 inches, shall slope outwards away from the flue, and shall provide a one–inch overhang and drip edge on all sides. A slip joint shall be installed between the flue and the cap. The slip joint shall be filled with $^1/_4$–inch felt or similar material and shall be caulked with high–temperature caulk or similar material to prevent water infiltration.

**(9)** CLEARANCE TO COMBUSTIBLES. (a) The minimum clearance between combustibles and masonry chimneys which have any portion located within the exterior wall of the dwelling shall be 2 inches. The minimum clearance between combustibles and masonry chimneys which have all parts completely outside the dwelling, exclusive of soffit or cornice areas, shall be one inch.

(b) Except as required under pars. (c) and (d), the clearance spaces shall remain completely open.

(c) The clearance spaces between chimneys and wood joists, beams, headers or other structural members shall be fireblocked at each floor level from chimney footing all the way to the roof flashing with galvanized steel, at least 26 gage thick or with noncombustible sheet material.

(d) Noncombustible material shall be used to prevent entry of debris into the clearance spaces.

**History:** Cr. Register, February, 1985, No. 350, eff. 3–1–85; am. (8), Register, March, 1992, No. 435, eff. 4–1–92; r. and recr. (8) and (9); Register, November, 1995, No. 479, eff. 12–1–95; **r. and recr. (7) (a), cr. (7) (d) and (e), and am. (9) (c), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 21.32 Factory–built fireplaces.** Factory–built fireplaces consisting of a fire chamber assembly, one or more chimney sections, a roof assembly and other parts shall be tested and listed by a nationally recognized testing laboratory.

**(1)** FIREPLACE ASSEMBLY AND MAINTENANCE. The fireplace assembly shall be erected and maintained in accordance with the conditions of the listing.

(a) All joints between the wall or decorative facing material and the fireplace unit shall be completely sealed, firestopped or draft–stopped with a noncombustible caulk or equivalent.

(b) Doors installed on factory built fireplaces shall conform with the terms of the listing and the manufacturers installation instructions for the fireplace unit.

**(2)** DISTANCE FROM COMBUSTIBLES. Portions of the manufactured chimney extending through combustible floors or roof/ceiling assemblies shall be installed in accordance with the distances listed on the chimney in order to prevent contact with combustible materials.

**(3)** HEARTH EXTENSIONS. Hearth extensions shall be provided in accordance with the manufacturer's listing. Where no hearth extension is specified in the listing, a hearth extension shall be provided in accordance with s. Comm 21.29 (6).

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; renum. from Ind 21.30 and r. and recr. (3), Register, February, 1985, No. 350, eff. 3–1–85; cr. (1) (a) and (b), am. (3) and Table 21.32–1, Register, January, 1989, No. 397, eff. 2–1–89; r. and recr. Register, March, 1992, No. 435, eff. 4–1–92.

## Subchapter X — Construction In Floodplains

**Comm 21.33 Construction in floodplains. (1)** GENERAL. Where dwelling construction is allowed by local zoning ordinances to take place in floodfringe areas of floodplains, the dwelling shall meet the requirements of this subchapter.

**Note:** The department of natural resources (DNR) and the federal emergency management agency (FEMA) also have regulations that apply to construction in floodfringe areas.

**(2)** ELEVATION. (a) *General.* Except as provided in pars. (b) and (c), all dwellings constructed within a floodfringe area shall be elevated so the lowest floor and all basement floor surfaces are located at or above the base flood elevation.

(b) *Certified floodproof basements.* Floodproof basements may have the top of the basement floor no more than 5 feet below the base flood elevation provided the basement is designed by a registered architect or engineer to be watertight and impermeable. No limitation is placed on the use or occupancy of a certified floodproof basement by the provisions of this subchapter.

(c) *Other enclosed spaces.* 1. Enclosed spaces not meeting the requirements of par. (b) are allowed at any depth below the base flood elevation provided the spaces are used only for one or more of the following purposes:

a. Means of egress.

b. Entrance foyers.

c. Stairways.

d. Incidental storage of portable or mobile items.

2. Fully enclosed spaces used only for those purposes listed in subd. 1. shall be designed to automatically equalize the hydrostatic pressure on exterior walls by allowing the entry and exit of floodwaters. Designs for meeting this requirement shall be certified by a registered architect or engineer or shall meet all of the following requirements:

a. There shall be at least 2 pressure relieving openings and the openings shall have a total net area of not less than one square inch for every square foot of enclosed area subject to flooding.

b. The bottom of all openings shall be no more than 12 inches above grade.

c. Openings may not be equipped with screens, louvers, valves or other coverings or devices unless such devices permit the automatic entry and discharge of floodwaters.

**(3)** CERTIFICATION OF ELEVATION. A registered land surveyor, architect or engineer shall certify the actual elevation in relation to mean sea level of the lowest structural member required to be elevated by the provisions of this subchapter.

**(4)** ANCHORAGE. The structural systems of all dwellings shall be designed, connected and anchored to resist flotation, collapse or permanent lateral movement due to structural loads and stresses at the base flood elevation.

**(5)** PROTECTION OF ELECTRICAL AND MECHANICAL SYSTEMS. Electrical and mechanical equipment shall be placed above the base flood elevation or shall be designed to prevent water contact with the equipment in case of a flood up to the base flood elevation.

**(6)** CONSTRUCTION MATERIALS AND METHODS. All dwellings constructed in floodplains shall be constructed using materials and methods designed to minimize flood and water damage.

**History:** Emerg. cr. eff. 5–8–96; cr. Register, February, 1997, No. 494, eff. 3–1–97.

## Comm 21.34 Construction in coastal floodplains.

**(1)** GENERAL. All dwellings constructed in coastal floodplains shall be designed by a registered architect or engineer and shall meet the requirements of this section and s. Comm 21.33.

**(2)** ELEVATION. All dwellings constructed in a coastal floodplain shall be elevated so the lowest portion of all structural members supporting the lowest floor, with the exception of mat or raft foundations, pilings, piling caps, columns, grade beams and bracing, is located at or above the base flood elevation.

**(3)** ENCLOSURES BELOW BASE FLOOD ELEVATION. Enclosures below the base flood elevation in a coastal floodplain may not be used for human occupancy and shall be free of all obstructions, except for non–loadbearing walls and partitions. Non–loadbearing walls and partitions below base flood elevation shall be constructed to break away without causing any structural damage to the elevated portion of the dwelling or foundation system due to the effect of wind loads and water loads acting simultaneously.

**(4)** FOUNDATIONS. All dwellings located in a coastal floodplain shall be supported and anchored on pilings or columns. The piling or column shall have adequate soil penetration to resist combined water and wind loads at the base flood elevation. Piling or column design shall consider the effect of scour of soil strata. Mat or raft foundations to support columns may not be used where soil under the mat or raft is subject to scour or other erosion from wave flow conditions.

**History:** Emerg. cr. eff. 5–8–96; cr. Register, February, 1997, No. 494, eff. 3–1–97.

# Chapter Comm 22

## ENERGY CONSERVATION



**Note:** Chapter Ind 22 was renumbered to be chapter ILHR 22, Register, February, 1985, No. 350, eff. 3–1–85. Chapter ILHR 22 was repealed and recreated to be chapter Comm 22, Register, January, 1999, No. 517, eff. 2–1–99.

## Subchapter I — Scope and Application

**Comm 22.01 Scope.** This chapter applies to all one– and 2–family dwellings covered by this code.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.02 Application. (1)** This chapter is not intended to conflict with any safety or health requirements. Where such conflict occurs, the safety and health requirements shall govern.

**(2)** This chapter allows the designer the option of using subchs. V and VI or VII to demonstrate compliance with equipment and thermal performance requirements. The designer shall identify on the plan submittal form what method or subchapter is being used, and indicate the design criteria and how it is being applied. Requirements of all other subchapters apply regardless of choice.

**Note:** The UDC Energy Worksheet specifies the insulation requirements to apply to the dwelling envelope. A copy of the worksheet is in the appendix. Other code requirements apply to material and equipment identification, sealing of the building envelope, the heating and cooling system including ducts, and the hot water system. Copies of worksheets may be obtained from the Department of Commerce, Safety and Buildings Division P.O. Box 2509 Madison, WI 53701.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

## Subchapter II — Materials and Equipment.

**Comm 22.03 Identification. (1)** DWELLING ENVELOPE INSULATION. (a) Except as provided in par. (b), a thermal resistance identification mark shall be applied by the manufacturer to each piece of dwelling envelope insulation 12 inches or greater in width.

(b) Insulation without a thermal resistance identification mark may be used if the insulation installer provides 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 calculated settled thickness, the coverage area and the number of bags installed. The installer shall post the certification in a readily accessible conspicuous place on the job site.

**(2)** INSULATION INSTALLATION. (a) Roof and ceiling, floor and wall cavity batt or board insulation shall be installed in a manner which will permit inspection of the manufacturer's R–value identification mark.

(b) The thickness of roof and ceiling insulation that is either blown in or sprayed shall be identified by thickness markings that are labeled in inches installed at least one for every 300 square feet through the attic space. The markers shall be affixed to trusses or joists marking the minimum initial installed thickness and minimum settled thickness with numbers a minimum of one inch 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.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.04 Protection of insulation. (1)** BLANKET INSULATION. Except in the box sill, insulating blankets or batts shall be held in place with a covering or other means of mechanical or adhesive fastening.

**Note:** Acceptable covering or fastening for interior or warm–side applications includes drywall, vapor retarder material, foil or kraft paper backing or other means of holding the blankets in place. Air barrier material may be used for cold–side support.

**(2)** FOAM PLASTIC INSULATION. Exterior foam plastic insulation shall be protected from physical damage and damage from ultraviolet light.

**Note:** For interior applications, a thermal barrier may be required under s. Comm 21.11.

**History: Cr. Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 22.05 Fenestration product rating certification and labeling. (1)** CERTIFIED PRODUCTS. Except as provided in sub. (2), fenestration product rating, certification and labeling, U–values of windows, doors and skylights shall be determined in accordance with the National Fenestration Rating Council standard 100, Procedures for Determining Fenestration Product Thermal Properties, by an accredited, independent laboratory. Fenestration products shall be labeled and certified by the

manufacturer. Such certified and labeled values shall be accepted for purposes of determining compliance with the dwelling envelope requirements of this code.

**(2)** DEFAULT VALUES. When a manufacturer has not determined product U–value in accordance with NFRC 100 for a particular product line, compliance with the dwelling envelope requirements of the code shall be determined by assigning such products a default U–value in accordance with Tables 22.05–1 and 22.05–2. 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 of two different product types is used, the product shall be assigned the higher U–value.

**TABLE 22.05–1**
**U–VALUE DEFAULT TABLE FOR WINDOWS, GLAZED DOORS AND SKYLIGHTS***

| METAL WITHOUT THERMAL BREAK | Single Glazed | Double Glazed |
|---|---|---|
| Operable | 1.27 | 0.87 |
| Fixed | 1.13 | 0.69 |
| Garden Window | 2.60 | 1.81 |
| Curtain Wall | 1.22 | 0.79 |
| Door | 1.26 | 0.80 |
| Skylight | 1.98 | 1.31 |
| Site Assembled Skylight | 1.36 | 0.82 |
| **METAL WITH THERMAL BREAK** | | |
| Operable | 1.08 | 0.65 |
| Fixed | 1.07 | 0.63 |
| Curtain Wall | 1.11 | 0.68 |
| Door | 1.10 | 0.66 |
| Skylight | 1.89 | 1.11 |
| Site Assembled Skylight | 1.25 | 0.70 |
| **REINFORCED VINYL OR METAL–CLAD WOOD** | | |
| Operable | 0.90 | 0.57 |
| Fixed | 0.98 | 0.56 |
| Door | 0.99 | 0.57 |
| Skylight | 1.75 | 1.05 |
| **WOOD/VINYL/FIBERGLASS** | | |
| Operable | 0.89 | 0.55 |
| Fixed | 0.98 | 0.56 |
| Garden Window | 2.31 | 1.61 |
| Door | 0.98 | 0.56 |
| Skylight | 1.47 | 0.84 |

* Glass block assemblies shall have a default U–value of 0.60.

**TABLE 22.05–2**
**U–VALUE DEFAULT TABLE FOR NON–GLAZED DOORS**

| STEEL DOORS (1–3/4 inches thick ) | With Foam Core | Without Foam Core |
|---|---|---|
| | 0.35 | 0.60 |
| **WOOD DOORS (1–3/4 inches thick)** | **Without Storm Door** | **With Storm Door** |
| Panel with 7/16–inch panels | 0.54 | 0.36 |
| Hollowcore flush | 0.46 | 0.32 |
| Panel with 1–1/8–inch panels | 0.39 | 0.28 |
| Solid core flush | 0.40 | 0.26 |

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

## Subchapter III – Definitions

**Comm 22.06 Definitions.** In ch. Comm 22:

**(1)** "Accessible", as applied to equipment, means admitting close approach to equipment not guarded by locked doors, elevation or other effective means.

**Note:** See "Readily accessible".

**(2)** "Air conditioning" means the process of treating air to control simultaneously its temperature, humidity, cleanness, and distribution to meet the requirements of the conditioned space.

**(3)** "Automatic" means self–acting, operating by its own mechanism when actuated by some impersonal influence, such as a change in current strength, pressure, temperature or mechanical configuration.

**(4)** "Basement wall" is the opaque portion of a wall that encloses one side of a basement and is partially or totally below grade.

**(5)** "Conditioned space" means space within the dwelling envelope which is provided with heated or cooled air or surfaces to provide a heated space or a cooled space.

**(6)** "Cooled space" means a space directly or indirectly supplied with mechanical cooling to maintain air temperature within the space of 85°F or less at design conditions.

**(7)** "Crawl space wall" means the opaque portion of a wall which encloses a crawl space and is partially or totally below grade.

**(8)** "Deadband" means the range of values within which an input variable can be varied without initiating any noticeable change in the output variable.

**(9)** "Dwelling envelope" means the elements of a dwelling with enclosed conditioned space through which thermal energy may be transferred to or from the exterior.

**(10)** "Electrically heated" means provided with permanently installed electrical space heating equipment which has an input capacity of 3 kilowatts or more to meet all or part of the space heating requirements.

**(11)** "Energy" means the capacity for doing work, taking a number of forms which may be transformed from one form into another, such as thermal heat, mechanical work, electrical and chemical in customary units, measured in kilowatt–hours (kWh) or British thermal units (Btu).

**Note:** See "New energy".

**(12)** "Energy, Recovered". See "Recovered energy".

**(13)** "F–value" means the rate of heat loss through a slab per foot of perimeter measured in Btu/h • ft • °F.

**(14)** "Glazing area" means the interior surface area of all glazed surfaces including sash, curbing or other framing elements that enclose conditioned spaces.

**Note:** Glazed surfaces include windows, sliding glass doors, and skylights.

**(15)** "Gross exterior wall area " means the normal projection of the dwelling 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, box sills, window area including sash, and door areas when they are exposed to outdoor air or unconditioned spaces and enclosed heated or mechanically cooled space, including interstitial area between 2 such spaces. The gross exterior wall area includes the total basement wall area if it is less than 50% below grade. The gross exterior wall area includes non–opaque areas such as windows and doors of all basement walls.

**(16)** "Gross floor area" means the sum of areas of all floors of the structure, including basements, cellars, and intermediate floored tiers measured from the exterior faces of exterior walls or from the center line of interior walls, excluding covered walkways, open roofed–over areas, porches, pipe trenches, exterior terraces or steps, chimneys, roof overhangs and similar features.

**(17)** "Heat" means energy that is transferred by virtue of a temperature difference or a change in state of a material.

**(18)** "Heated slab" means 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 subgrade.

**(19)** "Heated space" means any enclosed space provided with a direct or indirect supply of heat to maintain the temperature of the space to at least 50° F at design conditions.

**(20)** "Humidistat" means a regulating device, actuated by changes in humidity, used for automatic control of relative humidity.

**(21)** "HVAC" means heating, ventilating and air conditioning.

**(22)** "HVAC system" means the equipment, distribution network, and terminals that provide either collectively or individually the processes of heating, ventilating, or air conditioning to a building.

**(23)** "Infiltration" means the uncontrolled inward air leakage through cracks and interstices in any dwelling element and around windows and doors of a dwelling caused by the pressure effects of wind, and the effect of differences in the indoor and outdoor air density.

**(24)** "Inherently protected type IC" means tested and listed by an independent testing laboratory as being suitable for installation in a cavity where the fixture may be in direct contact with thermal insulation or combustible materials and the fixture construction is such that, even without a thermal protector, the fixture cannot be overlamped or mislamped.

**(25)** "Manual" means capable of being operated by personal intervention.

**Note:** See "Automatic ".

**(26)** "New energy" means energy other than recovered energy, utilized for the purpose of heating or cooling.

**Note:** See "Energy".

**(27)** "Opaque areas" means all exposed areas of a dwelling envelope which enclose conditioned space except openings for windows, skylights, doors and dwelling service systems.

**(28)** "Readily accessible" means capable of being reached quickly for operation, renewal or inspections, without requiring a person to climb over or remove obstacles or to resort to portable ladders or access equipment.

**Note:** See "Accessible".

**(29)** "Recovered energy" means energy utilized which would otherwise be wasted and would not contribute to a desired end use, from an energy utilization system.

**(30)** "Renewable energy sources" means sources of energy, excluding minerals, 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.

**(31)** "Roof assembly" means all components of the roof and 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 the assembly, including skylights exposed to the heated or mechanically cooled space.

**(32)** "Sequence" means a consecutive series of operations.

**(33)** "Service systems" means all energy–using systems in a dwelling 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.

**(34)** "Service water heating" means a supply of hot water for purposes other than comfort heating.

**(35)** "Service water heating demand" means the maximum design rate of energy withdrawal from a service water heating system in a designated period of time; usually an hour or a day.

**(36)** "Slab–on–grade floor insulation" means insulation around the perimeter of the floor slab or its supporting foundation.

**(37)** "Solar energy source" means a source of natural daylighting and of thermal, chemical or electrical energy derived directly from conversion of incident solar radiation.

**(38)** "System" means a combination of central or terminal equipment and their components, 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.

**(39)** "Thermal conductance" means the 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 state conditions. It is expressed as Btu/h • $ft^2$ • °F.

**(40)** "Thermal resistance" or "R" means a measure of the ability to retard the flow of heat. The R–value is the reciprocal of thermal transmittance or U–value expressed as R= 1/U.

**Note:** The higher the R–value of a material, the more difficult it is for heat to be transmitted through the material.

**(41)** "Thermal resistance overall" or "$R_o$" means the reciprocal of overall thermal conductance expressed as Btu/h • $ft^2$ • °F. The overall thermal resistance of the gross area or individual component of the exterior dwelling envelope such as, roof and ceiling, exterior walls, floors, crawl space walls, foundation walls, windows, skylights, doors, and opaque walls, includes the weighted R–values of the component assemblies, including air–film, insulation, drywall, framing, and glazing.

**(42)** "Thermal transmittance" or "U" means the time rate of heat flow through a body or assembly which is located in between 2 different environments, expressed in Btu/h • $ft.^2$ • °F. The U–value applies to combinations of different materials used in series along the heat flow path and also to single materials that comprise a dwelling section, including cavity air spaces and air films on both sides of a dwelling element.

**Note:** The lower the U–value of a material, the more difficult it is for heat to be transmitted through the material.

**Note:** The thermal transmittance is also referred to as the coefficient of heat transfer or the coefficient of heat transmission.

**(43)** "Thermal transmittance overall" or "$U_o$" means the overall, average heat transmission of a gross area of the exterior dwelling envelope expressed as Btu/h • $ft^2$ • °F. The $U_o$–value applies to the combined effect of the time rate of heat flow through various paths, such as windows, doors and opaque construction areas, comprising the gross area of one or more exterior dwelling components, such as walls, floors or roof and ceilings.

**(44)** "Thermally protected type IC " means tested and listed by an independent testing laboratory as being suitable for installation in a cavity where thermal insulation will be in direct contact with the fixture.

**(45)** "Thermostat" means an automatic control device actuated by temperature and designed to be responsive to temperature.

**(46)** "Ventilation" means 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.

**(47)** "Zone" means a space or group of spaces within a dwelling with heating or cooling requirements sufficiently similar so that comfort conditions can be maintained throughout by a single controlling device.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99

## Subchapter IV – Design Criteria

**Comm 22.07 Indoor and outdoor temperatures.** The indoor temperatures listed in Table 22.07–1 and the outdoor temperatures listed in Table 22.07–2 shall be used to determine the total dwelling heat loss or heat gain and to select the size of the heating or cooling equipment.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99; **am. Table 22.07–1, Register, March, 2001, No. 543, eff. 4–1–01.**

**TABLE 22.07–1**
**INDOOR DESIGN TEMPERATURES**

| Season | Location | Design Temperature |
|---|---|---|
| Winter | All areas except nonhabitable basement areas | 70°F |
| | Unheated, nonhabitable basement areas only | Less than 50°F |
| Summer | All areas | 78°F |

**TABLE 22.07–2**
**OUTDOOR DESIGN CONDITIONS BASED ON FIGURE 22.07**

| | |
|---|---|
| Zone 1 | 25° below zero F |
| Zone 2 | 20° below zero F |
| Zone 3 | 15° below zero F |
| Zone 4 | 10° below zero F |

**Note:** See Figure 22.07 for zone boundaries.

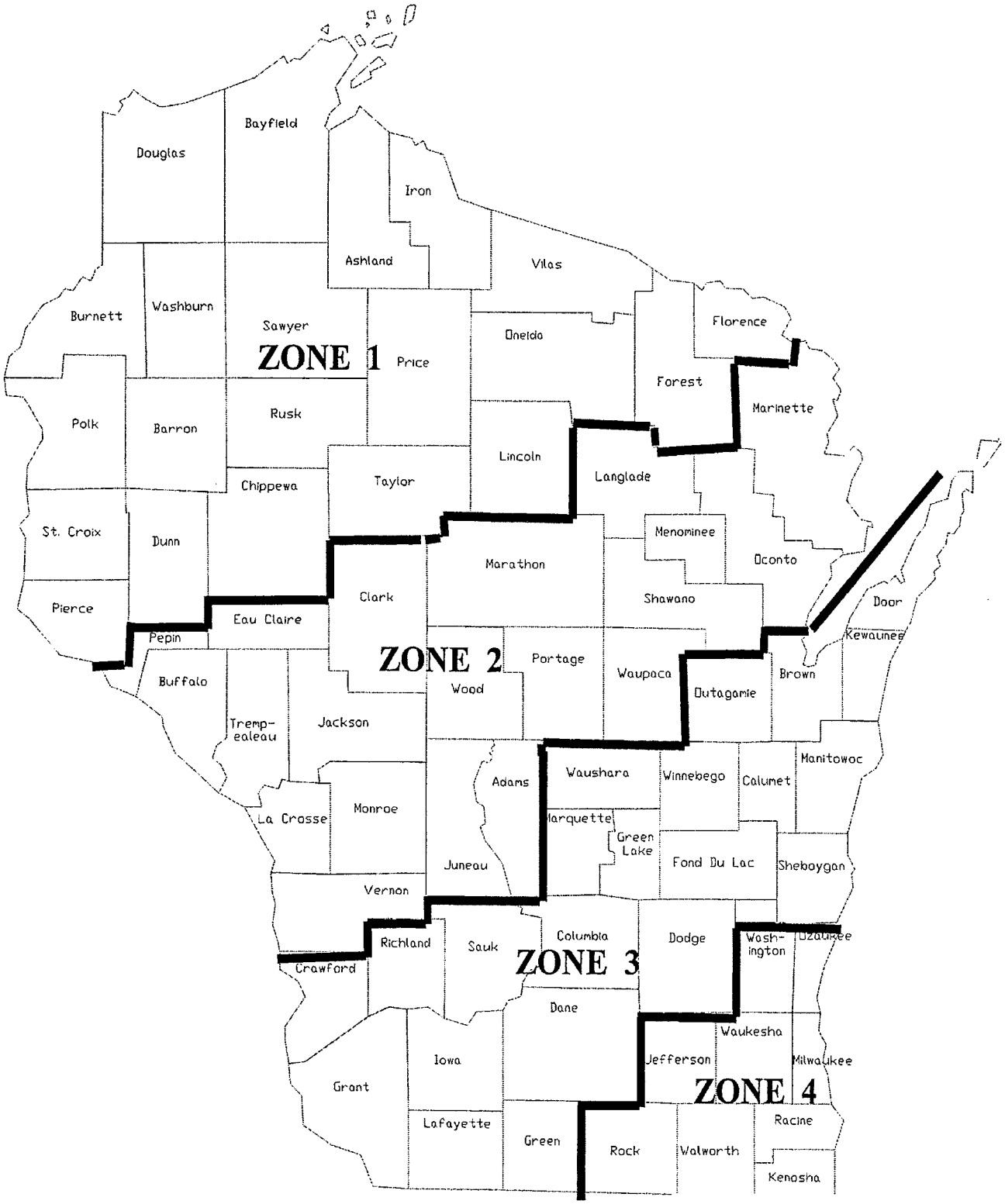

Douglas
Bayfield
Iron
Ashland
Vilas
Florence
Burnett
Washburn
Sawyer
ZONE 1
Price
Oneida
Forest
Marinette
Polk
Barron
Rusk
Lincoln
Langlade
Chippewa
Taylor
St. Croix
Dunn
Menominee
Oconto
Marathon
Clark
Shawano
Door
Pierce
Eau Claire
Pepin
ZONE 2
Portage
Waupaca
Brown
Kewaunee
Buffalo
Wood
Outagamie
Trempealeau
Jackson
Adams
Waushara
Winnebago
Calumet
Manitowoc
La Crosse
Monroe
Marquette
Green Lake
Fond Du Lac
Sheboygan
Juneau
Vernon
Richland
Sauk
Columbia
Dodge
Washington
Ozaukee
Crawford
ZONE 3
Dane
Waukesha
Iowa
Jefferson
Milwaukee
Grant
ZONE 4
Lafayette
Green
Rock
Walworth
Racine
Kenosha

FIGURE 22.07

**Comm 22.08 Ventilation and moisture control.** **(1)** ATTICS. (a) Ventilation shall be provided above the ceiling or attic insulation. At least 50% of the net free ventilating area shall be distributed at the low sides of the roof. The remainder of the net free ventilating area shall be distributed in the upper one–half of the roof or attic area.

1. If more than 50%, but less than 75% of the net free ventilating area is provided at the low sides of the roof, the total net free ventilating area shall be a minimum of 1/300 of the horizontal area of the ceiling.

2. If 75% or more of the net free ventilating area is provided at the low sides of the roof, the total net free ventilating area shall be at least 1/150 of the horizontal area of the ceiling.

(b) As an exception to par. (a), the ventilation space above any non–rigid insulation in a cathedral ceiling assembly shall be at least one inch in height.

(c) Engineered systems that provide equivalent ventilation to that specified in par. (a) may be used.

(d) The ventilation area required in par. (a) shall be maintained after the installation of insulation.

**(2)** CRAWL SPACES. Ventilation shall be provided in crawl spaces which are outside the dwelling envelope. The area of ventilation shall be at least 1/1500 of the floor space. At least 50% of the ventilating area shall be provided at opposite sides of the crawl space or as far apart as possible.

**(3)** CLOTHES DRYERS. If clothes dryers are provided, the dryers shall be vented to the outside of the dwelling. The dryer vents may not terminate in an attic space or crawl space or basement.

**Note:** See s. Comm 23.14 for vent material requirements.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

## Subchapter V – Heating and Air Conditioning Equipment and Systems

**Comm 22.09 Scope.** This subchapter covers the determination of system heating and cooling loads, design requirements, system and component performance, control requirements, and distribution system construction and insulation.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.10 Calculating heating and cooling loads.** The design requirements specified in Subchapter IV shall apply for all computations.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.11 Calculation procedures.** **(1)** Heating and cooling design loads including ventilation loads for the purpose of sizing systems shall be determined in accordance with one of the procedures described in Chapter 25 of ASHRAE Handbook of Fundamentals.

**(2)** Infiltration for heating and cooling design loads shall be calculated based on a maximum of 0.5 air change per hour in the heated or cooled space.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.12 Selection of equipment.** **(1)** GENERAL. Except as provided in sub. (2), the output capacity of the mechanical heating equipment shall not exceed the calculated heating load by more than 15%, except to satisfy the manufacturer's next closest nominal size.

**(2)** WATER HEATERS USED FOR SPACE HEATING. The output capacity of water heaters that are used for simultaneous space heating shall exceed the calculated space heating load by at least 43%, but by no more than 49%. Other sizing methods may be used if approved by the department for water heaters providing simultaneous space and domestic water heating.

**Note:** Heat exchanger units that are part of the plumbing system shall meet the requirements of Chs. Comm 81–84.

**(3)** EQUIPMENT EFFICIENCY. The efficiency of equipment installed in a dwelling shall match the efficiency used to claim any credit under the method of design by system analysis or other approved compliance method.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99; **cr. (3), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 22.13 Supplementary heater for heat pumps.** **(1)** If a heat pump is installed, it shall include a control to prevent supplementary heater operation when the operating load can be met by the heat pump alone.

**(2)** Supplementary heater operation is permitted during transient periods, such as start–up periods, following room thermostat set–point advance, and during defrost periods.

**(3)** 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 higher than the cut–on temperature for the supplementary heat. Supplementary heat may be derived from any source including, electric resistance, combustion heating, and solar stored–energy heating.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.14 Mechanical ventilation.** **(1)** Mechanical ventilation system supply and exhaust shall be equipped with a readily accessible means for shutoff when ventilation is not required.

**(2)** Automatic or gravity dampers that close when the system is not operating shall be provided for outdoor air intake and exhaust.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.15 Temperature control.** **(1)** A readily accessible manual or automatic means shall be provided to restrict or shut off the heating or cooling input to each zone or floor.

**(2)** Each system shall be provided with an adjustable thermostat for the regulation of temperature. A thermostat shall be capable of being set by adjustment or selection of sensors as follows:

(a) When used to control heating only, the thermostat shall be capable of being set from 55°F to 75°F.

(b) When used to control cooling only, the thermostat shall be capable of being set from 70°F to 85°F.

(c) When used to control both heating and cooling, the thermostat shall be capable of being set from 55°F to 85°F and shall be capable of operating the system heating and cooling in sequence. The thermostat or control system shall have an adjustable deadband of at least 10°F.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.16 Humidity control.** If a system is equipped with a means for adding or removing moisture to maintain a selected relative humidity in spaces or zones, a humidistat shall be provided.

**(1)** Humidistats of humidifiers shall be capable of being set to prevent new energy from being used to produce a space or zone relative humidity above 30%.

**(2)** Humidistats of dehumidifiers shall be capable of being set to prevent new energy from being used to produce a space or zone relative humidity of less than 60%.

**Note:** This requirement does not restrict the actual operation of the equipment. The only requirement is that the specified setpoints be available to the occupants so that they can minimize energy consumption. The controls are not limited to the specified settings alone.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.17 Duct system insulation.** **(1)** Except as provided in sub. (4), all heating and cooling duct systems, or portions thereof, that are located in unheated or uncooled spaces respectively, shall be provided with insulation with a thermal resistance of at least R–5.

**Note:** Where control of condensation is required for compliance with s. Comm 22.22, additional insulation, vapor retarders, or both, may need to be provided to limit vapor transmission and condensation.

**(2)** Where exterior walls are used as plenum walls, wall insulation shall be as required by the most restrictive condition of this section or s. Comm 22.21.

**(3)** Insulation resistance shall be measured on a horizontal plane in accordance with ASTM standard C 518 at a mean temperature of 75°F at the installed thickness.

**(4)** Duct insulation, except as required to prevent condensation, is not required on any of the following ducts:

(a) Supply–air or return–air ducts that are installed in basements, cellars or unventilated crawl spaces having insulated walls.

(b) Ducts for which heat gain or loss, without insulation, will not increase the energy requirements of the building.

(c) Ducts located within HVAC equipment.

(d) Exhaust air ducts.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99; **am. (1), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 22.18 Duct and plenum sealing. (1)** Sections of supply and return ducts not located entirely within the conditioned space and the unconditioned side of enclosed stud bays or joist cavities or spaces used to transport air shall be sealed.

**(2)** Sealing shall be accomplished using welds, gaskets, mastics, mastic–plus–embedded–fabric systems or tapes installed in accordance with the manufacturer's instructions.

**(3)** Insulation that provides a continuous air barrier may be used in lieu of sealing metal ducts.

**(4)** Tapes and mastics used with rigid fibrous glass ducts shall be listed and labeled as complying with UL 181A.

**(5)** Tapes and mastics used with flexible air ducts shall be listed and labeled as complying with UL 181B.

**(6)** Tapes with rubber–based adhesives may not be used.

**Note:** Standard duct tape has a rubber–based adhesive and does not comply with the requirements under this section.

**History: Cr. Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 22.19 Pipe insulation. (1)** Except as provided in sub. (2), all heating pipes in unheated spaces and all cooling pipes in uncooled spaces shall be insulated with material providing a minimum thermal resistivity of R–4 as measured on a flat surface in accordance with ASTM standard C 335 at a mean temperature of 75 °F.

**(2)** Piping insulation is not required in any of the following cases:

(a) Pipes installed within heating and air conditioning equipment, installed in conditioned spaces.

(b) Piping at fluid temperatures between 55°F and 120°F when not required for energy conservation purposes.

(c) When the heat loss or gain of the piping without insulation does not increase the energy requirements of the dwelling.

(d) When piping is installed in basements, cellars or unventilated crawl spaces having insulated walls.

**Note:** Additional insulation and vapor retarders may be necessary to prevent condensation in accordance with s. Comm 22.22.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

## Subchapter VI – Dwelling Envelope Design

**Comm 22.20 General.** The dwelling envelope of all 1– and 2–family dwellings shall comply with this subchapter, unless the requirements of system analysis design of subch. VII are met.

**Note:** See appendix for a copy of the UDC Energy Worksheet used to show compliance with the envelope insulation requirements of ss. Comm 22.21 to 22.28. Copies of the worksheets may be obtained from the Department of Commerce, Safety and Buildings Division, P. O. Box 2509 Madison, WI 53701. Other forms or software may be used when approved by the department. WIScheck software may be used to show compliance and is available from the Safety and Buildings page on the Department of Commerce Website www.commerce.state.wi.us.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.21 Envelope requirements. (1)** GENERAL. The stated $U_o$ – , U – or R–value of an assembly may be increased, or the stated $U_o$ – , U – or R–value of an assembly may be decreased, provided the total heat gain or loss for the entire dwelling does not exceed the total $U_o$ – ,U – or R–value of an assembly resulting from conformance to the values specified in ss. Comm 22.23 to 22.28.

**(2)** APPLICATION OF STANDARDS FOR ELECTRICALLY HEATED DWELLINGS. (a) *New dwellings.* New dwellings that are electrically heated shall meet the thermal performance standards of this subchapter for electrically heated dwellings.

(b) *Additions.* If the combined input capacity of permanently installed electrical space heating equipment of the original dwelling and a new addition exceeds 3 kilowatts, either the addition shall meet the thermal performance standards of this subchapter for electrically heated dwellings or the entire dwelling and addition shall meet the thermal performance standards of this subchapter for electrically heated dwellings.

(c) *Alterations.* If an alteration results in the addition of permanently installed electrical space heating equipment with a combined input capacity of permanently installed electrical space heating equipment of the altered dwelling exceeds 3 kilowatts, either the area served by the new electrical space heating equipment shall meet the thermal performance standards of this subchapter for electrically heated dwellings or the entire dwelling, and the addition shall meet the thermal performance standards of this sub–chapter for electrically heated dwellings.

**TABLE 22.21**
**HEATING AND COOLING CRITERIA [g]**

| Component of Dwelling Envelope | Maximum Overall Thermal Transmittance, $U_0$ or Minimum Thermal Resistance, R | |
|---|---|---|
| | Non–electrically Heated | Electrically Heated |
| *Roof and Ceiling*[a] | $U_0 = 0.026$ | $U_0 = 0.020$ |
| *Walls:* | | |
| crawl space[c, f] | $U_0 = 0.060$ | $U_0 = 0.060$ |
| basement[c, f] | $U_0 = 0.091$ | $U_0 = 0.091$ |
| walls[b] | $U_0 = 0.110$ | $U_0 = 0.080$ |
| *Floors:* | | |
| heated slab–on–grade[c, d,f] | R = 8.5 | R = 10 |
| over unheated space[e] | $U_0 = 0.050$ | $U_0 = 0.050$ |
| unheated slab–on–grade[c, d,f] | R = 6.5 | R = 10 |
| over outside air (overhang) | $U_0 = 0.033$ | $U_0 = 0.033$ |

a Roof and ceiling assemblies include attic access panels and skylights.
b See definition of gross exterior wall area.
c Insulation installed below grade shall be suitable for that application.
d "Heated slab" means 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 subgrade. The required U–value refers to the insulation only.
e Includes unheated crawl spaces, basements, garages, and other spaces outside of the dwelling envelope.
f The required U–value applies to the floor or wall assembly only, excluding the effect of soil.
g The maximum overall heat loss requirement may be increased when an equivalent amount of energy savings is provided by equipment that exceeds the federal efficiency standards of 10 CFR part 230. See Energy Worksheets in the Appendix for how the credit is applied. A more exact calculation of this credit may be submitted to the department for review in accordance with s. Comm 22.34.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.22 Vapor retarders. (1)** GENERAL. (a) Designs shall prevent deterioration from moisture condensation.

(b) Vapor retarders shall have a rating of 1.0 perm or less when tested in accordance with ASTM standard E 96, Procedure A.

(c) The vapor retarder shall be continuous. All joints in the vapor retarder shall be overlapped and secured or sealed. Rips and punctures in the vapor retarder shall be patched with vapor retarder materials and taped or sealed.

**(2)** FRAME ASSEMBLIES. In all frame walls, floors and ceilings, the vapor retarder shall be installed on the warm side of the thermal insulation. The vapor retarder shall cover the exposed insulation and the interior face of studs, joists and rafters. No vapor retarder is required in the box sill.

**(3)** CONCRETE FLOORS. A vapor retarder shall be installed under the slab or under the base course of slabs and basement floors unless the slab is in an unheated attached garage.

**(4)** CONCRETE OR MASONRY BASEMENT WALLS. A vapor retarder is not required in concrete or masonry basement wall below–ground applications.

**(5)** CRAWL SPACES. A vapor retarder shall be provided over crawl space floors in accordance with s. Comm 21.05 (4).

**(6)** WOOD FOUNDATIONS. Vapor retarders for wood foundations shall be in accordance with the standards adopted under s. Comm 20.24 (5) (b).

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99; **correction in (6) made under s. 13.93 (2m) (b) 7., Stats., Register, March, 2001, No. 543.**

**Comm 22.23 Walls. (1)** GENERAL. The combined thermal transmittance value ($U_0$) of the gross area of exterior walls shall not exceed the value given in Table 22.21. Equation 1 in s. Comm 22.31 (1) shall be used to determine acceptable combinations to meet this requirement.

**(2)** METAL STUD FRAMING. When metal stud framing is used, the value of $U_w$ used in Equation 1 in s. Comm 22.31 (1) shall be recalculated using a series–parallel heat flow path procedure to correct for parallel path thermal bridging. The $U_w$ for purposes of Equation 1 in s. Comm 22.31 (1), of metal stud walls shall be determined as follows:

$$U_w = \frac{1}{R_1 + (R_{ins} \times F_c)}$$

where:

$R_1$ = the total thermal resistance of the elements, in series along the path comprising the wall assembly of heat transfer, excluding the cavity insulation and the metal stud.

$R_{ins}$ = the R–value of the cavity insulation.

$F_c$ = the correction factor listed in Table 22.23.

**TABLE 22.23**

**$F_c$ Values For Wall Sections With Metal Studs Parallel Path Correction Factors**

| Size of Member | Gage of Stud[1] | Spacing of Framing Inches | Cavity Insulation R–Value | Correction Factor |
|---|---|---|---|---|
| 2 X 4 | 18 – 16 | 16 o.c. | R – 11 | 0.50 |
| | | | R – 13 | 0.46 |
| | | | R – 15 | 0.43 |
| 2 X 4 | 18 – 16 | 24 o.c. | R – 11 | 0.60 |
| | | | R – 13 | 0.55 |
| | | | R – 15 | 0.52 |
| 2 X 6 | 18 – 16 | 16 o.c. | R – 19 | 0.37 |
| | | | R – 21 | 0.35 |
| 2 X 6 | 18 – 16 | 24 o.c. | R – 19 | 0.45 |
| | | | R – 21 | 0.43 |
| 2 X 8 | 18 – 16 | 16 o.c. | R – 25 | 0.31 |
| 2 X 8 | 18 – 16 | 24 o.c. | R – 25 | 0.38 |

1These factors shall be applied to metal studs of this gage or thinner.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.24 Roof and ceiling.** The combined thermal transmittance value ($U_o$ ) of the gross area of the roof or ceiling assembly shall not exceed the value given in Table 22.21. Equation 2 in s. Comm 22.31 (1) shall be used to determine acceptable combinations to meet this requirement.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.25 Floors over unheated spaces.** The combined thermal transmittance value $U_o$ of the gross area of floors that are over unheated spaces and of floors over outdoor air, such as overhangs, shall not exceed the values given in Table 22.21. Equation 3 in s. Comm 22.31 (1) shall be used to determine acceptable combinations to meet this requirement.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99; **am., Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 22.26 Slab–on–grade floors. (1)** Where the perimeter edge of a slab–on–grade floor is above grade or less than 12 inches below the finished grade, the thermal resistance of the insulation around the perimeter of the floor shall not be less than the value given in Table 22.21.

**(2)** Insulation shall be placed on the outside of the foundation or on the inside of a foundation wall. The insulation shall extend downward from the top of the slab for a minimum of 48–inches 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.

**(3)** Horizontal insulation extending outside of the foundation shall be covered by pavement or by soil a minimum of 10 inches thick. The top edge of insulation installed between the exterior wall and the edge of the interior slab may be cut at a 45° angle away from the exterior wall.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.27 Crawl space walls. (1)** If the crawl space does not meet the requirements of s. Comm 22.25 and does not have ventilation openings which communicate directly with outside air, then the exterior walls of the crawl space shall have a thermal transmittance value not exceeding the value given in Table 22.21.

**(2)** (a) The vertical wall insulation shall extend from the top of the wall to at least the inside ground surface.

(b) Where the vertical wall insulation stops less than 12 inches below the outside finish ground level, crawl space wall insulation shall extend horizontally and vertically downward a minimum total distance of 24 inches linearly from the outside finish ground level.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99; **r. and recr. (2), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 22.28 Basement walls. (1)** Except as provided in subs. (3) and (4), the exterior walls of basements below uninsulated floors shall have a transmittance value not exceeding the value given in Table 22.21.

**(2)** (a) Except as provided in par. (b), the insulation shall extend to the level of the basement floor.

(b) Changes in the exterior insulation area and basement wall minimum thermal transmittance may be included as part of a tradeoff allowed under the method of design by system analysis or other approved compliance method.

(c) If interior insulation is used for code compliance, it shall extend the full height of the wall from basement floor to the underside of the joists above unless tradeoffs are justified by supporting calculations that consider lateral heat conduction in the wall.

**(3)** Where the total gross basement wall area is less than 50% below grade, the entire wall area, including the below–grade portion, is included as part of the gross area of exterior walls.

**(4)** For the purpose of determining compliance with dwelling envelope performance requirements, non–opaque areas, including windows and doors, of all basement walls shall be included in the gross area of exterior walls.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99; **r. and recr. (2), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 22.29 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.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.30 Air leakage. (1)** GENERAL. The requirements of this section apply to those dwelling components that separate interior dwelling conditioned space from the outdoor ambient conditions, or unconditioned spaces such as crawl spaces, and exempted portions of the dwelling from interior spaces that are heated or mechanically cooled. The requirements are not applicable to the separation of interior conditioned spaces from each other.

**(2)** EXTERIOR DOORS AND WINDOWS. Exterior doors and windows shall be designed to limit air leakage into or from the dwelling envelope. Manufactured doors and windows shall have air infiltration rates of less than 0.3 cfm/sq. ft, determined in accor-

dance with ASTM standard E 283 and AAMA/NWWDA standard 101/I.S.2. Door and window units constructed or fabricated in the field shall be sealed in accordance with sub. (3).

**Note:** Windows and doors that meet the maximum air infiltration rate specified in the 1997 edition of AAMA/NWWDA standard 101/I.S.2 when tested in accordance with ASTM standard E 283 are acceptable to the department as meeting the 0.3 cfm/sq. ft. infiltration limit.

**(3)** JOINT PENETRATION SEALING. (a) Exterior joints, seams or penetrations in the dwelling 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. Exterior joints to be treated include all of the following:

1. Openings, cracks and joints between wall cavities and window or door frames.

2. Between separate wall assemblies or their sill–plates and foundations.

3. Between walls, roof, ceilings or attic, ceiling seals, and between separate wall panel assemblies.

4. Penetrations of utility services through walls, floor and roof assemblies, and penetrations through the wall cavity of top and bottom plates.

(b) Sealing shall be provided around tubs and showers, at the attic and crawl space panels, at recessed lights and around all plumbing and electrical penetrations, where these openings are located in the dwelling envelope between conditioned space or between the conditioned space and the outside.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.31 Calculations.** The following equations shall be used as specified in this chapter:

**(1)** EQUATION 1.

$$U_o = \frac{(U_w\ A_w) + (U_g\ A_g) + (U_d\ A_d)}{A_o}$$

where:

$U_o$ = the overall thermal transmittance of the gross exterior wall area.

$A_o$ = the gross area of the exterior walls.

$U_w$ = the overall thermal transmittance of the various paths of heat transfer through the opaque exterior wall area.

$A_w$ = area of exterior walls that are opaque.

$U_g$ = the thermal transmittance of the windows.

$A_g$ = the area of all windows within the gross wall area.

$U_d$ = the thermal transmittance of the door area.

$A_d$ = door area.

(a) When more than one type of wall, window or door is used, the U and A terms for those items shall be expanded into sub–elements as:

$(U_{w1}A_{w1}) + (U_{w2}A_{w2}) + (U_{w3}A_{w3})$ ( etc. )

(b) Unless exact areas are calculated, the gross exterior wall area with framing 24–inches on center shall be assumed to be at least 22% framing area, and the gross exterior wall area with framing 16–inches on center shall be assumed to be at least 25% framing area.

**(2)** EQUATION 2.

$$U_o = \frac{(U_R\ A_R) + (U_S\ A_S)}{A_o}$$

where:

$U_o$ = the overall thermal transmittance of the roof and ceiling gross area.

$A_0$ = the gross area of the roof and ceiling assembly.

$U_R$ = the thermal transmittance of all elements of the opaque roof and ceiling area.

$A_R$ = the gross area of the opaque roof and ceiling assembly.

$U_S$ = the thermal transmittance of the area of all skylight elements in the roof and ceiling assembly.

$A_S$ = the area, including the frame, of all skylights in the roof and ceiling assembly.

(a) When more than one type of roof or ceiling, skylight or door is used, the U and A terms for those items shall be expanded into sub–elements as:

$(U_{R1}A_{R1}) + (U_{R2}A_{R2})$ + (etc.)

(b) Access doors, hatches, plenums, or other areas in a roof and ceiling assembly shall be included as a sub–element of the roof and ceiling assembly.

(c) Unless exact areas are calculated, wood frame ceilings shall be assumed to be 7% framing area for joists 24–inches on center and 10% framing area for joists 16–inches on center.

**(3)** EQUATION 3.

$$U_0 = \frac{(U_{f1} \times A_{f1}) + (U_{f2} \times A_{f2}) + (U_{fn} \times A_{fn})}{A_0}$$

where:

$U_o$ = the overall thermal transmittance of the floor assembly.

$A_o$ = the gross area of the floor assembly.

$U_{fn}$ = the thermal transmittance of the various heat transfer paths through the floor.

$A_{fn}$ = the area associated with the various paths of heat transfer.

Unless exact areas are calculated, wood frame floors shall be assumed to be 7% framing area for joists 24–inches on center and 10% framing area for joists 16–inches on center.

**(4)** ACCURACY OF CALCULATIONS. The thermal transmittance ($U_o$) values and dwelling dimensions used in heat gain or loss calculations shall have a minimum decimal accuracy of 3 places rounded to 2, except that the $U_o$ values used for calculating ceiling transmission shall have a minimum decimal accuracy of 4 places rounded to 3.

**(5)** VALUES. Unless otherwise specified in this chapter, the thermal transmittance and resistance values used in heat gain or loss calculations shall be determined by one of the following methods:

(a) The values shall be those given in the ASHRAE Handbook of Fundamentals as adopted under s. Comm 20.24 (8).

**Note:** See the appendix under "Typical Thermal Properties of Building Materials" for the ASHRAE values.

(b) 1. Testing to a nationally–recognized test standard by an independent third party that is submitted for department review and approval under s. Comm 20.18.

2. The testing shall verify the claimed thermal resistance for the specific application of the product or assembly.

3. For foam plastic insulation that uses a blowing agent other than air, the independent third–party tests shall use samples that have been aged for the equivalent of 5 years or until the R–value has stabilized.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99; **r. and recr. (5), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 22.32 Recessed lighting fixtures.** When installed in the dwelling envelope, recessed lighting fixtures shall meet any one of the following requirements:

**(1)** The fixture shall be inherently or thermally protected type IC and installed inside an air–tight assembly maintaining any clearances required by the listing.

**(2)** The fixture shall be inherently or thermally protected type IC, 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.

**(3)** The fixture shall be inherently or thermally protected type IC, and labeled as being tested in accordance with ASTM E 283 at a pressure difference of 75 pascals or 1.57 lb/ft$^2$ with no more than 2.0 cfm air movement from the conditioned space to the ceiling cavity.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

## Subchapter VII – Design By Systems Analysis and Design of Dwellings Utilizing Renewable Energy Sources

**Comm 22.33 General.** The requirements of subch. V,"Heating and Air Conditioning Equipment and Systems" and the requirements of subch. VI, "Dwelling Envelope Design"establish design criteria for energy–consuming and enclosure elements of the dwelling. As an alternative, an energy use analysis may be used to show equivalent compliance. The analysis shall comply with this subchapter or shall be approved by the department.

**Note:** The department recognizes the use of tradeoffs between higher efficiency furnaces and lower insulation levels. See appendix for an example of the UDC Energy Worksheet. Copies of the worksheet may be obtained from the Department of Commerce, Safety and Buildings Division, P. O. Box 2509, Madison, WI 53701. Other forms or software may be used when approved by the department. WIScheck software may be used to show compliance and is available from the Safety & Buildings page on the Department of Commerce Website www.commerce.state.wi.us.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.34 Energy analysis. (1)** Newly constructed one– and 2–family dwellings designed in accordance with this subchapter comply with subchs. V and VI if the calculated annual energy consumption is not greater than a similar dwelling, designed as a standard design, whose energy–consuming systems and enclosure elements are designed in accordance with subchs. V and VI.

**Note:** In this subchapter, "standard design" means a dwelling whose enclosure elements and energy–consuming systems are designed in accordance with subchs. V and VI.

**(2)** For a proposed alternate dwelling design to be considered similar to a standard design, it shall utilize the same energy sources for the same functions and have equal floor area and the same ratio of dwelling envelope area to floor area, exterior design conditions, climate data, and usage operational schedule.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.35 Input values. (1)** GENERAL. The input values in this section shall be used in calculating annual energy performance. The requirements of this section specifically indicate which variables shall remain constant between the standard dwelling and proposed dwelling calculations. The standard dwelling shall be a base–version of the design that directly complies with the provisions of this chapter. The proposed dwelling may utilize a design that is demonstrated, through calculations satisfactory to the department, to have equal or lower annual energy use than the standard design.

**(2)** INPUT VALUES FOR GLAZING AREAS. (a) The orientation of the standard design shall have equal area on the north, south, east, and west exposures.

(b) Shading in the form of draperies, roller shades or blinds shall be assumed to be closed during periods of mechanical air conditioning operation.

(c) Glazed areas shall not be provided with extra exterior shading beyond shading that is provided by typical construction practices such as with tinted glass, outside fixed shading devices and roof overhangs. The energy performance impacts of added exterior shading for glazed areas may be accounted for in the proposed design for a specific dwelling, provided that the actual installation of such systems is approved by the department.

(d) Passive solar designs shall provide documentation acceptable to the department, that fixed external or other acceptable shading is provided to limit excessive summer cooling energy gains to the dwelling interior.

**(3)** INPUT VALUES FOR HEAT STORAGE AND THERMAL MASS. (a) Internal mass shall be 8 pounds per square foot.

(b) Structural mass shall be 3.5 pounds per square foot.

(c) Passive solar designs shall utilize at least 45 Btu/°F of additional thermal mass, per square foot of added glass area, when south–facing glass exceeds 33% of the total glass area in walls.

**(4)** INPUT VALUES FOR DWELLING ENVELOPE. (a) *Surface area and volume.* 1. Floors, walls and ceilings of the standard and proposed designs shall have equal areas.

2. The foundations and floor types for both the standard and the proposed designs shall be equal.

3. The glazing area including skylights in the standard design shall not be greater than the glazing area in the proposed design. The U– value of the glazing in the standard design shall be selected to permit calculated compliance of the $U_o$ of the wall in the standard design.

4. The standard design of doors shall have at least 40 square feet of door area.

5. Building volume of both the standard and proposed design shall be equal.

(b) *HVAC controls.* Input values are given in Table 22.35–1.

**TABLE 22.35–1**

**INPUT VALUES FOR HVAC CONTROLS**

| Parameter | | Value |
|---|---|---|
| Thermostat (constant) | 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 | equals the number of dwelling units |
| | Maximum number of zones | 2 |
| | Number of thermostats per zone | 1 |
| Internal Sensible Heat Gain (constant) | Btu/hr per dwelling unit | 1500 Btu/hr |
| Domestic Water Heater (calculate, then use as constants) | Temperature set point | 120°F |
| | Daily hot water consumption | Gallons = (30 x the number of dwelling units) + (10 x the number of bedrooms) |

**(5)** SITE WEATHER DATA CONSTANTS. Weather data from the typical meteorological year or its equivalent from the National Oceanic and Atmospheric Administration or an approved equivalent for the closest available location shall be used.

**(6)** DISTRIBUTION SYSTEM LOSS FACTORS. 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 in the following equations:

Adjusted Efficiency = Equipment Efficiency x Distribution Loss Factor

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 ).

**TABLE 22.35–2**
**DISTRIBUTION LOSS FACTORS**

| Mode | Duct Location * | |
|---|---|---|
| | Outside | Inside |
| Heating | 0.75 | 1.00 |
| Cooling | 0.80 | 1.00 |

* Ducts located in a heated or cooled space are considered as being in an inside location.

**(7)** AIR INFILTRATION. (a) For the purpose of calculation, air changes per hour for the standard design is 0.50.

(b) If the proposed design takes credit for a reduced air change per hour level, documentation of the measures providing such a reduction or the results of a post–construction blower–door test conducted in accordance with ASTM standard E 779 shall be provided to the department.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.36 Design.** The standard design and the proposed alternative design shall be designed on a common basis as specified in this section:

**(1)** The comparison shall be expressed in Btu input per square foot of gross floor area per year or other time unit, at the dwelling 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 dwelling site where 1 kWh = 3,413 Btu.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.37 Analysis procedure.** The dwelling heating and cooling load calculation procedures shall be detailed to permit the evaluation factors specified in s. Comm 22.38 to provide a comparison of energy consumption between the alternative design and the standard design.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.38 Calculation procedure.** The calculation procedure shall cover all of the following items that are expected to have a significant impact on the comparison of the energy consumption between the alternate design and the proposed design:

**(1)** Environmental design requirements as specified in subch. IV.

**(2)** Coincident hourly climatic data for temperatures, solar radiation, wind and humidity of typical days in the year representing seasonal variation.

**(3)** Dwelling orientation, size, shape, mass and volume.

**(4)** Air, moisture and heat transfer characteristics.

**(5)** Operational characteristics of controls for inside air temperature, humidity, ventilation, lighting, and the control mode for occupied and unoccupied hours.

**(6)** Mechanical equipment design capacity load profile.

**(7)** Dwelling loads of internal heat generation, lighting, equipment, and the number of occupants during occupied and unoccupied periods.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.39 Use of approved calculation tool.** The same calculation tool or method shall be used to estimate the energy usage for space heating and cooling of the standard design and the proposed design. The calculation tool or method and the documentation shall be approved by the department.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.40 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 2 dwellings, system designs, and data used in and resulting from the comparative analysis verifying that both analysis designs meet the criteria of of this chapter.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.41 Renewable energy source analysis.** **(1)** A proposed dwelling utilizing solar, geothermal, wind or other renewable energy sources for all or part of its energy sources shall meet the requirements of s. Comm 22.33, except such renewable energy may be excluded from the total annual energy consumption allowed for the proposed dwelling by this subchapter.

**(2)** To qualify for the exclusion in sub (1), the 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 one of the following:

(a) Operable insulation shutters or other devices which, when drawn or closed, cause the window area to reduce maximum outward heat flows to those in accordance with s. Comm 22.31 (2), and the windows are shaded from direct solar radiation during periods when mechanical cooling is requested.

(b) The glass is double or triple pane insulated glass with a low–emittant coating on one or both surfaces of the glass, or insulated glass with a low–emittant plastic film suspended in the air space, and the glass areas are shaded from direct solar radiation during periods when mechanical cooling is requested.

**(3)** Other criteria covered in ss. Comm 22.23 to 22.39 shall apply to the proposed alternative designs utilizing renewable sources of energy.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 22.42 Documentation.** **(1)** Proposed alternative designs submitted as requests for an exception to the standard design criteria, shall be accompanied by an energy analysis, as specified in s. Comm 22.40. The report shall provide technical detail on the alternative dwelling, system designs, and the data employed in and resulting from the comparative analysis to verify that both the analysis and the designs meet the criteria of this code.

**(2)** The energy derived from renewable sources and the reduction in conventional energy requirements derived from nocturnal cooling shall be separately identified from the overall dwelling energy use. Supporting documentation on the basis of the performance estimates for the renewable energy sources and nocturnal cooling means specified in this subchapter shall be submitted to the department.

**History:** Cr. Register, January, 1999, No. 517, eff. 2–1–99.

# Chapter Comm 23

# HEATING, VENTILATING AND AIR CONDITIONING



**Note:** Chapter Ind 23 was renumbered to be chapter ILHR 23, Register, February, 1985, No. 350, eff. 3–1–85. Chapter ILHR 23 was renumbered Chapter Comm 23 under s. 13.93 (2m) (b) 1., Stats., and corrections made under s. 13.93 (2m) (b) 7., Stats., Register, January, 1999, No. 517.

## Subchapter I —Scope

**Comm 23.01 Scope.** The provisions of this chapter shall apply to the design, installation and construction of all heating, ventilating and air conditioning systems in dwellings covered by this code.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

## Subchapter II —Design

**Comm 23.02 Design.** Every dwelling shall be equipped with a heating system designed in accordance with this section. Heating equipment requirements may be waived for recreational dwellings used only during the non–heating season. Where a cooling system is provided, the cooling requirements of this section shall be met.

**(1)** HEATING AND COOLING SYSTEM DESIGN. (a) Indoor and outdoor design temperatures shall be selected from s. Comm 22.07.

(b) The heating and cooling systems shall be designed to maintain the indoor design temperature at outdoor design conditions.

(c) When requested, room–by–room heat loss and heat gain calculations shall be furnished.

**(2)** DISTRIBUTION SYSTEMS. Distribution systems shall be sized and located to satisfy the heating and cooling loads of each conditioned space. When requested, a layout of the distribution system shall be furnished to show that the system meets the requirements of this code.

**(3)** VENTILATION. (a) *General.* All exhaust vents shall terminate outside the structure.

(b) *Balancing.* 1. General. Except as provided under subd. 2., mechanical ventilation systems shall be balanced.

2. Exception. Passive intake air ducts providing makeup air for intermittent exhaust fans shall be sized to provide at least 40% of the total air that would be exhausted with all intermittent exhaust ventilation in the dwelling operating simultaneously.

3. Kitchen range hoods. a. Kitchen range hoods that exhaust air from the kitchen area are considered as exhaust ventilation for balancing and makeup purposes.

b. Kitchen range hoods that are listed and installed to recirculate air without exhausting it are not required to be balanced.

4. Infiltration. a. Infiltration may be considered as makeup air for balancing purposes only where there are no naturally vented space– or water–heating appliances in the dwelling.

b. For the purpose of complying with this subdivision, naturally vented space– or water–heating appliances are those that take combustion or dilution air from inside the dwelling, including unsealed fireplaces and draft hood appliances with power venting.

**Note:** Whole–house fans that are used in the summer to bring cool night air in through open windows and exhaust into the attic are considered to be a supplemental cooling system rather than part of the ventilation system.

**Note:** See s. Comm 22.14 for additional requirements on mechanical ventilation.

(c) *Habitable rooms.* Habitable rooms without openable windows shall be provided with a balanced mechanical ventilation system producing one air change per hour of fresh outside air while the room is occupied.

(d) *Rooms with toilets, tubs or showers.* Any room with a toilet, tub or shower shall be provided with exhaust ventilation capable of exhausting 50 cubic feet per minute on an intermittent basis or 20 cubic feet per minute on a continuous basis.

**Note:** The department will accept designs which meet the Air Conditioning Contractors of America manual; the Mechanical Contractors Association manual; and the Sheet Metal and Air Conditioning Contractors National Association standards for heating and air conditioning systems for one– and 2–family dwellings.

**(4)** CONTROLS. The temperature rise through the equipment shall not exceed 100° F unless listed. Controls shall be provided to maintain the inside temperature. Where forced, warm–air systems are used, controls shall be installed to control air movement.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (1) Register, January, 1989, No. 397, eff. 2–1–89; am. (3), Register, March, 1992, No. 435, eff. 4–1–92; r. and recr. (3), Register, November, 1995, No. 479, eff. 12–1–95; r. and recr. (1) and (3) (a), Register, January, 1999, No. 517, eff. 2–1–99; **r. and recr. (3) (a), renum. (3) (b) and (c) to be (3) (c) and (d), and cr. (3) (b), Register, March, 2001, No. 543, eff. 4–1–01.**

## Subchapter III —Heating Equipment

**Comm 23.03 Selection of equipment.** All heating and central cooling equipment shall be selected on the basis of air–handling capacity, pumping capacity, and thermal capacity to handle the calculated design heating or cooling load.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

**Comm 23.04 Types and location of equipment.** All heat producing appliances and cooling appliances shall be listed by a testing agency acceptable to the department. The clearances from combustible materials in Tables 23.04–A and 23.04–B shall apply unless otherwise shown on listed appliances.

**Note:** The following agencies are acceptable to the department: The American Gas Association (AGA), Underwriter's Laboratories (UL), PFS Corporation, Warnock Hersey International, ETL Testing Laboratories, and other testing agencies approved per s. Comm 20.18.

## TABLE 23.04–A
## STANDARD INSTALLATION CLEARANCES (INCHES) FOR HEAT–PRODUCING APPLIANCES

| | | Appliance[1] | | | | |
|---|---|---|---|---|---|---|
| **Residential Type Appliances for Installation in Rooms Which are Large (See Note 2)** | | **Above Top of Casing or Appliance** | **From Top and Sides of Warm–Air Bonnet or Plenum** | **From Front See Note 3** | **From Back** | **From Sides** |
| Boilers and Water Heaters | | | | | | |
| Automatic Oil | | | | | | |
| Steam Boilers – 15 psi | or | 6 | — | 24 | 6 | 6 |
| Water Boilers – 250°F | Comb. Gas–Oil | | | | | |
| Water Heaters – 200°F | Automatic Gas | 6 | 18 | 6 | 6 | |
| All Water Walls | | | | | | |
| or Jacketed | Electric | 6 | — | 18 | 6 | 6 |
| Furnaces – Central | Automatic Oil | | | | | |
| Gravity, Upflow, Downflow, | or | 6[4] | 6 | 24 | 6 | 6 |
| Horizontal and Duct, | Comb. Gas–Oil | | | | | |
| Warm–Air – 250° F | Automatic Gas | 6[4] | 6 | 18 | 6 | 6 |
| | Electric | 6[4] | 6 | 18 | 6 | 6 |
| Furnaces – Floor | Automatic Oil | | | | | |
| For Mounting in | or | 36 | — | 12 | 12 | 12 |
| Combustible Floors | Comb. Gas–Oil | | | | | |
| | Automatic Gas | 36 | — | 12 | 12 | 12 |
| | Electric | 36 | — | 12 | 12 | 12 |
| Heat Exchanger | | | | | | |
| Steam – 15 psi Max. | | | | | | |
| Hot Water – 250° F Max. | — | 1 | 1 | 1 | 1 | 1 |
| Room Heaters | | | | | | |
| Circulating Type | Oil | 36 | — | 24 | 12 | 12 |
| Vented or Unvented | Gas | 36 | — | 24 | 12 | 12 |
| | Oil | 36 | — | 36 | 36 | 36 |
| Radiant or Other Type | Gas | 36 | — | 36 | 18 | 18 |
| Vented or Unvented | Gas with dbl | | | | | |
| | metal or | 36 | — | 36 | 12 | 18 |
| | ceramic back | | | | | |
| Radiators | | | | | | |
| Steam or Hot Water | Gas | 36 | — | 6 | 6 | 6 |
| | | See Note 5 | | | Firing Side | Opp. Side |
| Ranges – Cooking Stoves | Oil | 30 | — | — | — | |
| Vented or Unvented | Gas | 30 | — | — | 6 | 6 |
| | Electric | 30 | — | — | 6 | 6 |
| Clothes Dryers | Gas | 6 | — | 24 | 6 | 6 |
| Listed Types | Electric | 6 | — | 24 | 0 | 0 |
| Incinerators | | See Note 6 | | | | |
| Residential Types | — | 36 | — | 48 | 36 | 36 |

[1]Standard clearances may be reduced by affording protection to combustible material in accordance with Table 23.04–B.

[2]Rooms which are large in comparison to the size of the appliance are those having a volume equal to at least 12 times the total volume of a furnace and at least 16 times the total volume of a boiler. If the actual ceiling height of a room is greater than 8 feet, the volume of a room should be figured on the basis of a ceiling height of 8 feet.

[3]The minimum dimension should be that necessary for servicing the appliance including access for cleaning and normal care, tube removal, etc.

[4]For a listed oil, combination gas–oil, gas, or electric furnace this dimension may be 2 inches if the furnace limit control cannot be set higher than 250° F or this dimension may be one inch if the limit control cannot be set higher than 200° F.

[5]To combustible material or metal cabinets. If the underside of such combustible material or metal cabinet is protected with asbestos millboard at least 1/4–inch thick covered with sheet metal of not less than No. 28 gauge, the distance may be not less than 24 inches.

[6]Clearance above charging door should be not less than 48 inches.

**TABLE 23.04–B**
**CLEARANCES, INCHES, WITH SPECIFIED FORMS OF PROTECTION***

| Type of Protection Applied to the combustible material unless otherwise specified and covering all surfaces within the distance specified as the required clearance with no protection. Thicknesses are minimum. | | Where required clearance with no projection is: | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 36 inches | | | 18 inches | | | 12 inches | | | 6 inches | | |
| | | Above | Sides & Rear | Vent Connector | Above | Sides & Rear | Vent Connector | Above | Sides & Rear | Vent Connector | Above | Sides & Rear | Vent Connector |
| (a) | 1/4–in. insulating millboard** spaced out 1"*** | 30 | 18 | 30 | 15 | 9 | 12 | 9 | 6 | 6 | 3 | 2 | 3 |
| (b) | 28 gage sheet metal on 1/4" insulating millboard** | 24 | 18 | 24 | 12 | 9 | 12 | 9 | 6 | 4 | 3 | 2 | 2 |
| (c) | 28 gage sheet metal spaced out 1"*** | 18 | 12 | 18 | 9 | 6 | 9 | 6 | 4 | 4 | 2 | 2 | 2 |
| (d) | 28 gage sheet metal on 1/4" insulating millboard**spaced out 1"*** | 18 | 12 | 18 | 9 | 6 | 9 | 6 | 4 | 4 | 2 | 2 | 2 |
| (e) | 1/4" insulated millboard** on 1" mineral wool batts reinforced with wire mesh or equivalent | 18 | 12 | 18 | 6 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 |
| (f) | 22 gage sheet metal on 1" mineral wool batts reinforced with wire or equivalent | 18 | 12 | 12 | 4 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| (g) | 1/4" insulated millboard** | 36 | 36 | 36 | 18 | 18 | 18 | 12 | 12 | 9 | 4 | 4 | 4 |

*All clearances shall be measured from the outer surface of the equipment to the combustible material disregarding any intervening protection applied to the combustible material.

**A factory fabricated board formed with noncombustible materials, normally fibers, and having a thermal conductivity in the range of 1 Btu inch per square foot per °F, or less.

***Spacers shall be of noncombustible material.

**(1)** FURNACES. The input and output capacity of furnaces shall be listed on the nameplate. All nameplates shall show evidence that the equipment has been listed by a recognized testing laboratory.

(a) *Fuel supply.* Furnaces shall be fired with the fuel for which they have been approved, except as provided in par. (d). Fuels shall be supplied to the furnace in the volume and at the pressure required on the label.

(b) *Unvented furnaces and space heaters.* The use of unvented furnaces and space heaters fueled by natural gas, kerosene, alcohol or other fuel shall be prohibited due to concerns about oxygen depletion; contamination from carbon monoxide, carbon dioxide, nitrogen dioxide, formaldehyde and other combustion related contaminants; and water vapor buildups.

(c) *Vented wall furnaces.* Vented wall furnaces shall not be equipped with duct extensions beyond the vertical and horizontal limits of the enclosure unless listed. Vented wall furnaces shall be located to prevent the restriction of air circulation by doors, projections, or other openings. Vented wall furnaces shall be provided with combustion air.

(d) *Conversion burners.* Conversion burners shall be listed by a recognized testing laboratory. The existing equipment shall be reconditioned and defective parts replaced before a conversion burner is installed. Conversion burners shall be installed in accordance with the installation instructions.

**(2)** HEAT PUMP APPLIANCES. (a) *Size.* Heat pump appliances shall be sized to provide control of the wet and dry bulb temperatures during cooling and maximum performance during heating. The heating balance point shall be considered to determine the outdoor temperature at which the heat pump must operate 100% of the time to offset the dwelling heat loss.

(b) *Auxiliary heaters.* Provisions for auxiliary heat to supplement the heat pump at outdoor temperatures below the balance point shall be provided. Auxiliary heaters shall be sized so that the heat pump auxiliary will offset the dwelling heat loss down to the heating design temperature.

**(3)** BOILERS. Boilers shall comply with chs. Comm 41–42, Boiler and Pressure Vessels, ss. Comm 41.10 and 41.42 through 41.45.

**Note:** The department will accept equipment listed by the American Society of Mechanical Engineers, Underwriters' Laboratories, and the American Gas Association.

**(4)** LOCATION. (a) *Enclosed spaces.* Except as provided in par. (c), no space heating or water–heating appliance shall be installed in a bedroom, bathroom, closet, or garage unless listed for such installation.

(b) *Garages.* Appliances installed in garages shall have burners and burner ignition devices located at least 18 inches above the floor and shall be protected or located so the furnace is not subject to damage from a vehicle.

(c) *Exceptions.* 1. Vented decorative gas appliances and decorative gas appliances for installation in vented fireplaces may be installed in bedrooms or bathrooms only when both of the following conditions are met:

a. The volume of the space in which the appliance is located is not less than 50 cubic feet per 1000 Btu/h of the combined input rating of all fuel–burning appliances installed in that space. The space may be made up of more than one room if the rooms are connected through doorway openings without doors.

b. The vapor retarder is not continuous on walls and ceilings exposed to the outside atmosphere as allowed under s. Comm 22.22.

2. Water heaters may be installed in a closet located in a bathroom or bedroom where the closet is used exclusively for the water heater, where the enclosed space has a weather–stripped solid door with a self–closing device, and where all air for combustion is obtained from the outdoors.

**Note:** Section Comm 23.06 still requires combustion air to be provided to the appliance.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. (1) (b), and am. (4) (b), Register, February, 1985, No. 350, eff. 3–1–85; correction in (3) made under s. 13.93 (2m) (b) 7., Stats., Register, February, 1985, No. 350; am. (intro.) and Table 23.04–A, r. (4), renum. Figures to ILHR 23.045, Register, January, 1989, No. 397, eff. 2–1–89; correction in (3) made under s. 13.93 (2m) (b) 7., Stats., Register, January, 1989, No. 397; am. (intro.) and (1) (e), r. and recr. Table 23.04–B, Register, March, 1992, No. 435, eff. 4–1–92; **r. (1) (e) and cr. (4), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 23.045 Solid–fuel–burning appliances.** **(1)** GENERAL. Solid–fuel–burning appliances shall be installed as specified in this section unless the manufacturer or listing specifies the use of protection or clearances other than those specified

in this section. All solid–fuel–burning appliances shall be tested and listed by an accepted testing agency.

**Note:** Factory–built fireplaces shall comply with s. Comm 21.32.

**(2)** LOCATION OF APPLIANCES. (a) *Servicing.* Every appliance shall be located to permit access to the appliance. Sufficient clearance shall be maintained around the equipment to permit cleaning of surfaces; the replacement of air filters, blowers, motors, controls and chimney connectors; the lubrication and servicing of moving parts; and the adjustment and servicing of stokers and appliance components.

(b) *Garages.* Solid–fuel–burning appliances may not be installed in a garage.

**(3)** CHIMNEYS. (a) Solid–fuel–burning appliances shall be connected to one of the following types of chimneys:

1. 'Factory–built chimneys or vents'. A listed residential–type and building heating appliance chimney may be used with solid–fuel–burning appliances if the chimneys have been tested 3 times to a minimum flue gas temperature exposure of 2100°F, under the conditions specified by the listing agency, for at least 10 minutes each time.

**Note:** Products listed and labeled as complying with UL 103 – "Type HT" meet this requirement. UL 103 uses several temperature ranges for different products but only the "Type HT"–designated products have met the 2100°F testing requirement.

2. 'Masonry chimneys'. Masonry chimneys shall be constructed as specified in s. Comm 21.30.

(b) Wood–burning equipment shall not be connected to a flue serving a fireplace or other equipment.

(c) The chimney shall be designed to create a natural draft to carry away the products of combustion or provision shall be made for mechanically maintaining constant updraft during equipment operation.

(d) A cleanout opening shall be provided.

(e) A listed, multifuel appliance may be vented into a single flue.

**(4)** CHIMNEY CONNECTORS. (a) All solid–fuel–burning appliances shall be connected to chimneys with factory–built chimney material, Type L vent material or steel pipe with minimum thicknesses as specified in Table 23.045–A.

**TABLE 23.045–A**
**METAL THICKNESS FOR PIPE CONNECTORS**

| Diameter of Connector (inches) | Sheet Gage No. | Minimum Thickness (inches) |
|---|---|---|
| 6 to 10 | 24 | .023 |
| over 10 to 16 | 22 | .029 |
| over 16 | 16 | .056 |

(b) The required clearance to combustibles for chimney connectors shall be 18 inches. This clearance may be reduced in accordance with Table 23.045–B. The specified protection shall be applied to and cover all combustible material as specified in Figure 23.045–A.

(c) Connectors and chimneys for solid fuel–burning appliances shall be designed, located and installed to permit ready access for internal inspection and cleaning.

(d) 1. Chimney connectors shall have no more than two 90° elbows.

2. The horizontal length shall not exceed 75% of the total vertical height of the entire venting system measured from the appliance outlet.

3. The connector shall maintain a rise of at least 1/4 inch per foot from the appliance outlet to the chimney inlet.

4. Connectors shall be securely supported and joints fastened with a minimum of 3 sheet metal screws or rivets.

5. Appliances used mainly for wood burning shall have the joints assembled so that the crimped end points towards the stove. Appliances burning coal shall have the joints assembled so that the crimped end points away from the appliance.

6. A connector to a masonry chimney shall extend through the wall to the innerface of the liner but not beyond.

7. The effective area of the connector shall not be less than the area of the appliance flue collar.

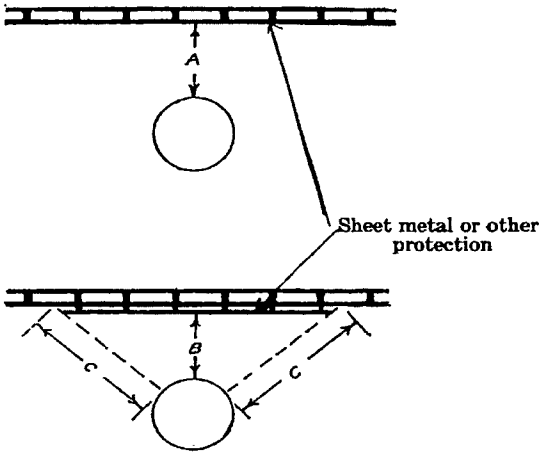
(e) No chimney connectors may pass through any floor, ceiling, window, door or combustible wall nor be concealed in any closet, attic or similar space. A connector may pass through a combustible wall if the connector is guarded at the point of passage by one of the following methods:

1. Metal ventilated thimble not less than 12 inches larger in diameter than the connector.

2. All combustible material in the wall is cut away from the connector a sufficient distance to provide the required 18–inch clearance. Any material used to close up such openings shall be noncombustible.

(f) A manual, cast iron damper to control draft shall be provided in the chimney connector. The damper shall not obstruct more than 80% of the connector area. Listed solid–fuel appliances whose listing prohibits the use of manual dampers in the connector shall not require a manual damper to be installed.

**FIGURE 23.045–A**
**CONSTRUCTION USING COMBUSTIBLE MATERIAL**




"A" Equals the required clearance with no protection, specified in s. Comm 23.045 (4) (b).

"B" Equals the reduced clearance permitted in accordance with Table 23.045–B. The wall protection should extend far enough in each direction to make 'C' equal to 'A'.

**TABLE 23.045–B**
**CONNECTOR CLEARANCES WITH SPECIFIED FORMS OF PROTECTION[1,2,3,4]**

| Type of Protection | Minimum Required Connector Clearances (inches) |
|---|---|
| 0.013 in. (28 gage) sheet metal spaced out a minimum of one inch. | 9 |
| 31/2 in. thick masonry wall spaced out a minimum of one inch and adequately tied to the wall being protected (see Note 4). | 9 |
| 0.027 in. (22 gage) sheet metal on one–inch mineral wool batts reinforced with wire or equivalent spaced out a minimum of one inch. | 3 |

[1] Spacers and ties shall be of noncombustible material.

[2] All methods of protection require adequate ventilation between protective material and adjacent combustible walls and ceilings.

[3] Mineral wool batts (blanket or board) shall have a minimum density of 8 pounds per cubic foot and a minimum melting point of 1550° F.

[4] If a single wall connector passes through the masonry wall there shall be at least 1/2 inch of open ventilated air space between the connector and the masonry.

**(5)** MOUNTING ON FLOORS. (a) Appliances shall be placed on surfaces as described in Table 23.045–C. Solid–fuel–burning appliances listed specifically for installation on a floor constructed of combustible material may be installed in accor-

dance with the terms of the listing and the manufacturer's instructions.

**TABLE 23.045–C**
**FLOOR MOUNTINGS FOR SOLID FUEL–BURNING APPLIANCES**

| Kind of Appliance | Allowed Mounting |
|---|---|
| (1) All forced air and gravity furnaces, steam and water boilers. or | Floors of fire–resistive construction with noncombustible flooring and surface finish, or fire–resistive arches or slabs. This construction may not have combustible material against the underside. Such construction shall extend at least 18 inches beyond the appliance on all sides. |
| (2) Residential–type ranges, water heaters, fireplace stoves,room heaters and combination fireplace stove/room heaters, having less than 2 inches of ventilated open space beneath the fire chamber or base of the appliance. | These appliances shall not be placed on combustible floors. |
| (3) Residential–type ranges, water heaters, fireplace stoves, room heaters and combination fireplace stove/room heaters having legs or pedestals providing 2 to 6 inches of ventilated open space beneath the fire chamber or base of the appliance. | On combustible floors when such floors are protected by 4 inches of hollow masonry, laid to provide air circulation through the masonry layer. Such masonry shall be covered with 24 gage sheet metal.<br><br>The required floor protection shall extend at least 18inches on all sides of the appliance.<br><br>Noncombustible floors shall extend at least 18 inches on all sides of the appliance. |
| (4) Residential–type ranges, water heaters, fireplace stoves, room heaters and combination fireplace stove/room heaters having legs or pedestals providing over 6 inches of ventilated open space beneath the fire chamber or base of the covered appliance. | On combustible floors when such floors are protected by closely spaced masonry units of brick, concrete or stone, which provide at least 2 inches of thickness. Such masonry shall be covered by or placed over a sheet of 24 gage sheet metal.<br><br>The required floor protection shall extend at least 18 inches on all sides of the appliance.<br><br>Noncombustible floors shall extend at least 18 inches on all sides of the appliance. |

**(6)** CLEARANCES. (a) Solid–fuel–burning appliances shall be installed with clearances not less than specified in Table 23.045–D.

1. 'Listed appliances exception'. Listed appliances shall be installed in accordance with the terms of their listing if greater clearances other than those specified by Table 23.045–D are required in accordance with the listing.

2. 'Clearance with protection exception'. Solid–fuel–burning appliances may be installed with reduced clearances provided the combustible material is protected as described in Table 23.045–E. The specified protection shall be applied to and cover all combustible material as specified in Figure 23.045–B.

**TABLE 23.045–D**
**STANDARD CLEARANCES FOR SOLID–FUEL–BURNING APPLIANCES**

| Type of Appliance | Above Top of Casing or Appliance, Above Top and Sides of Furnace Plenum or Bonnet (inches) | Minimum Standard Clearances (inches) From Front | From Back | From Sides |
|---|---|---|---|---|
| *Residential Appliances* | | | | |
| Steam Boilers – 15 psi<br>Water Boilers – 250° F max.<br>Water Boilers – 200° F max.<br>All Water Walled or Jacketed | 6 | 48 | 6 | 6 |
| *Furnaces* | | | | |
| Gravity and Forced Air | 18 | 48 | 18 | 18 |
| *Room Heaters, Fireplace* Stoves, Combinations | 36 | 36 | 36 | 36 |
| | | | Firing Side | Opp. Side |
| *Ranges* | | | | |
| Lined Firechamber | 30 | 36 | 24 | 18 |
| Unlined Firechamber | 30 | 36 | 36 | 18 |

## TABLE 23.045–E
## MINIMUM ALLOWABLE APPLIANCE CLEARANCE WITH PROTECTION[1,2,3,4,5,6]

| Type of Protection | Unprotected Clearances (inches) From Table 23.045–D | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | For Ceilings | | | | For Walls | | | | |
| | 6 | 18 | 30 | 36 | 6 | 18 | 24 | 36 | 48 |
| 3 1/2 in. thick masonry wall without ventilated air space | – | – | – | – | 4 | 12 | 16 | 24 | 32 |
| 1/2 in. thick noncombustible insulation board over 1 in. glass fiber or mineral wool batts without ventilated air space | 4 | 12 | 20 | 24 | 3 | 9 | 12 | 18 | 24 |
| 0.024 in. (24 gage) sheet metal over 1 in. glass fiber or mineral wool batts reinforced with wire, or equivalent, or rear face with ventilated air space | 3 | 9 | 15 | 18 | 2 | 6 | 8 | 12 | 16 |
| 3 1/2 in. thick masonry wall with ventilated air space | – | – | – | – | 2 | 6 | 8 | 12 | 16 |
| 0.024 in. (24 gage) sheet metal with ventilated air space | 3 | 9 | 15 | 18 | 2 | 6 | 8 | 12 | 16 |
| 1/2 in. thick noncombustible insulation board with ventilated air space | 3 | 9 | 15 | 18 | 2 | 6 | 8 | 12 | 16 |
| 0.024 in. (24 gage) sheet metal with ventilated air space over0.024 in. (24 gage) sheet metal with ventilated air space | 3 | 9 | 15 | 18 | 2 | 6 | 8 | 12 | 16 |
| 1 in. glass fiber or mineral wool batts sandwiched between two sheets 0.024 in. (24 gage) sheet metal with ventilated air space | 3 | 9 | 15 | 18 | 2 | 6 | 8 | 12 | 16 |

[1] Spacers and ties shall be of noncombustible material. No spacers or ties shall be used directly behind appliance or conductor.

[2] With all clearance reduction systems using a ventilated air space, at least two sides of the protection shall be open to provide adequate air circulation. There shall be at least one inch between the clearance reduction system and combustible walls and ceilings.

[3] Mineral wool bats, blanket or board shall have a minimum density of 8 lb. per cubic foot and have a minimum melting point of 1,500°F.

[4] Insulation material used as part of a clearance reduction system shall have a thermal conductivity (k) of One (Btu) (in)/(Sq. ft.) (Hr.) (°F) or less. Insulation board shall be formed of noncombustible material.

[5] If a single wall connector passes through a masonry wall used as a wall shield, there shall be at least 1/2 inch of open, ventilated space between the connector and the masonry.

[6] Clearances in front of the loading door or ash removal door of the appliance shall not be reduced.

## FIGURE 23.045–B
## PROTECTION OF COMBUSTIBLE WALLS AND FLOORS

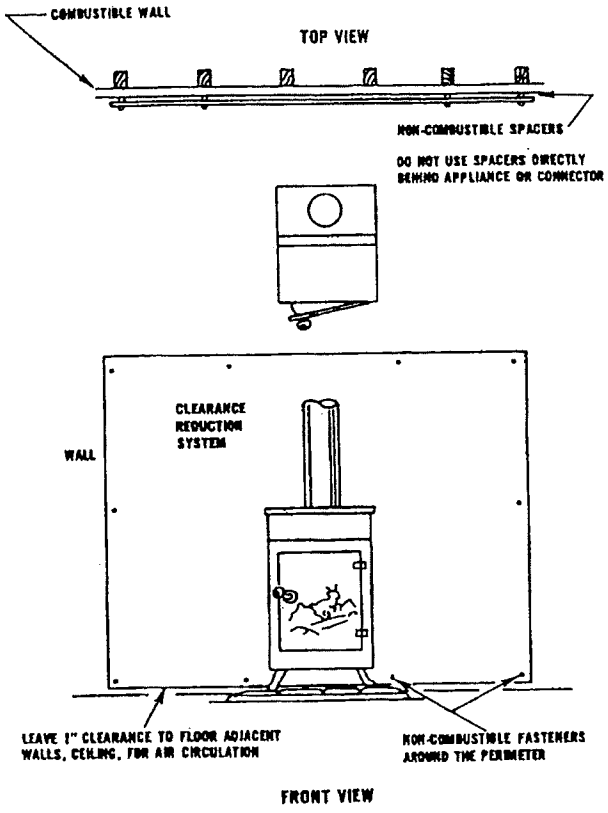
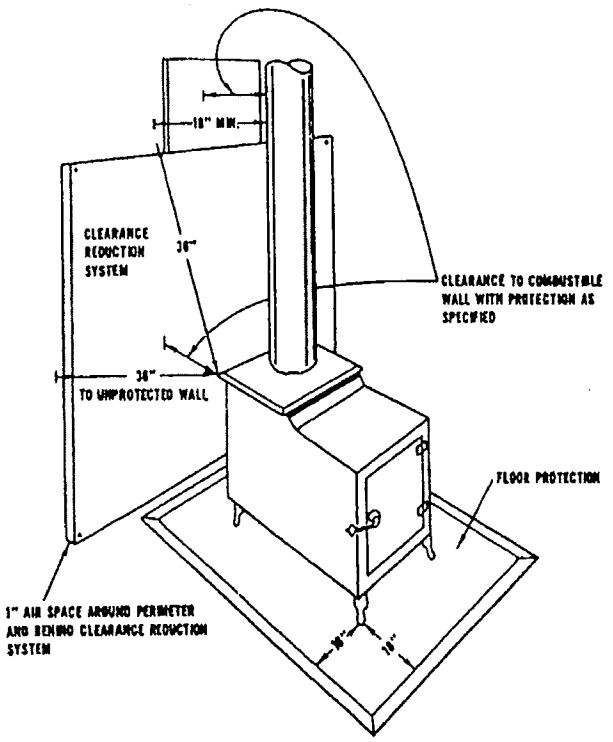


FIGURE 23.045–B (continued)




**(7)** ACCESSORIES. Accessories for solid fuel–burning appliances such as heat exchangers, stove mats, floor pad and protection shields, shall be listed and shall be installed in accordance with the terms of their listing.

**(8)** SUPPLEMENTAL UNITS. Supplemental solid–fuel–burning units connected to a furnace shall be connected to the warm air side of the furnace as illustrated in Figures 23.045–C to E.

(a) *Return air duct.* The area of the return air duct shall be at least equal to the area of the warm air supply duct. The return air duct shall be of the same material as specified for supply air ducts. Return air grilles shall not be located in bathrooms, kitchens, garages, utility spaces or in a confined space defined under s. Comm 23.06 in which a draft diverter or draft regulator is located.

(b) *Blower.* The blower on the furnace shall maintain the manufacturer's specifications for cubic feet per minute air flow and static pressure when the supplemental unit is in operation.

(c) *Outside air intake.* The outside air intake shall be connected to the cold air return plenum of the furnace. A volume damper shall be placed in the duct for the fresh air intake.

FIGURE 23.045–C

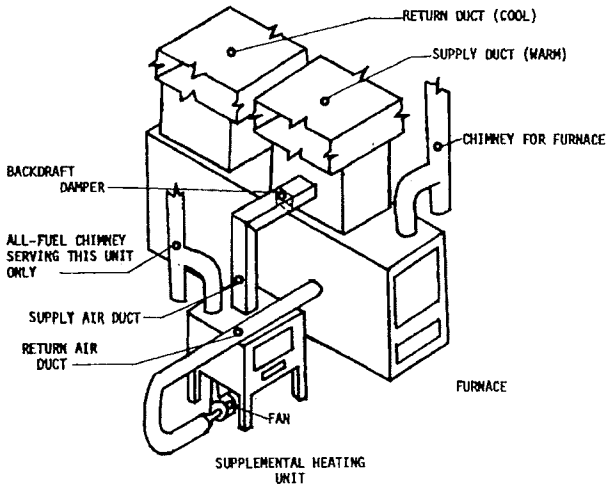



FIGURE 23.045–D

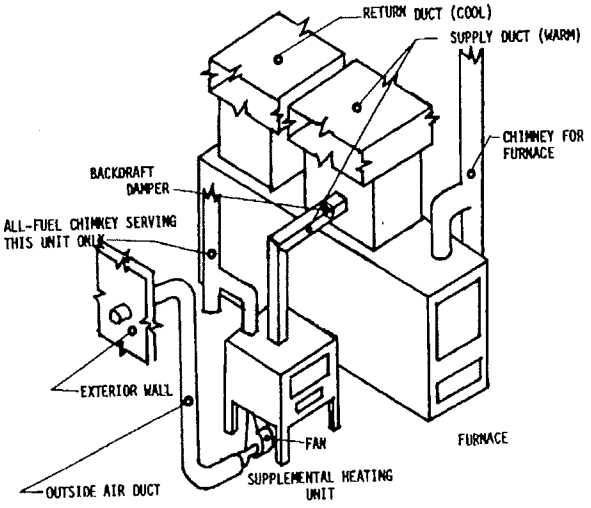
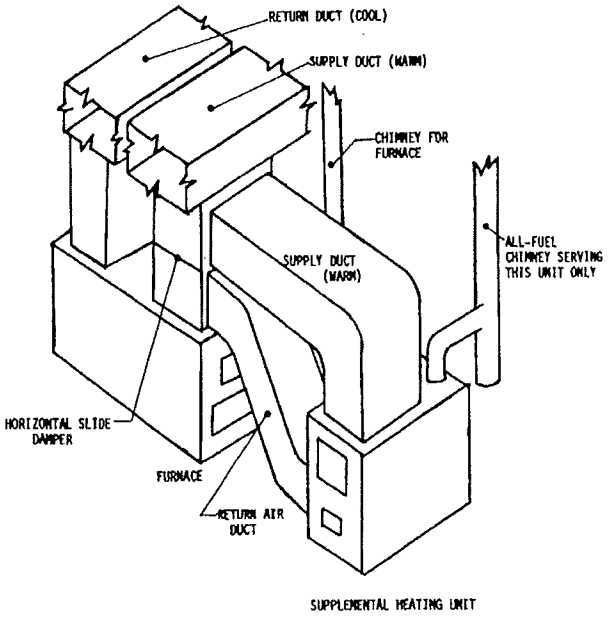


FIGURE 23.045–E




(d) *Thermostat.* The thermostat control on the supplemental heating unit shall activate the blower motor at a temperature between 100° and 120° F.

(e) *Supplemental units.* Supplemental solid–fuel–burning units shall be installed to maintain a 3–foot clearance between the unit and the furnace or shall be installed in accordance with the listings of both the supplemental unit and the furnace if such an installation is specifically covered by the listings.

**(9)** SUPPLY DUCTS. Supply ducts connected to solid–fuel–burning appliances shall have the following minimum clearances to combustibles:

(a) *Horizontal ducts.* The clearance from combustibles for horizontal ducts shall be as specified in Table 23.045–F.

TABLE 23.045–F

| Distance of Ducts From Bonnet or Plenum (inches) | Clearance to Combustibles[1] Required (inches) |
|---|---|
| 0 to 36 | 18 |
| over 36 to 72 | 6 |
| over 72 | 1 |

[1] Clearance can be reduced in accordance with Table 23.045–B

(b) *Vertical ducts.* 1. Air shall travel 6 feet and change directions equivalent to one 90° turn before entering an enclosure of combustible material.

2. Ducts shall have 3/16 inch clearance between the duct and any combustible material.

**(10)** COMBINATION APPLIANCES. Appliances capable of burning multi–types of fuel shall be listed and installed in accordance with their listing.

**History:** Cr. Register, February, 1985, No. 350, eff. 3–1–85; am. (1), (3) (a) 1., (4) (b), (5), (6) (a), (6) (b) 2., (8) (intro.) and (9) (a), renum. Tables 23.045–B to E to be Tables 23.045–C, D, B and F and am. B and F, Figures 23.045–C to E renum. from Figures 23.01–A to C, cr. (2) (c), (3) (b) to (e) and (8) (e), Table 23.045–E and Figure 23.045–B, r. and recr. (6) (b) 1., Register, January, 1989, No. 397, eff. 2–1–89; am. (1), (2) (b) (intro.), (3) (a) 1., (8) (a) and Table A, cr. (2) (b) 4., r. and recr. Table C, Register, March, 1992, No. 435, eff. 4–1–92; am. Table C, Register, November, 1995, No. 479, eff. 12–1–95; **r. (2) (b) and renum. and am. (2) (c) to be (2) (b), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 23.05 Safety controls.** High limit, maximum outlet air temperature and similar safety controls shall be provided on heating equipment.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

**Comm 23.06 Combustion air. (1)** SCOPE. (a) Naturally vented appliances and other appliances that require air for combustion and dilution of flue gases to be taken from within the building shall comply with this section.

(b) Appliances that are provided with a direct supply of outside air for combustion in accordance with the manufacturer's installation instructions and listing are not required to comply with this section.

(c) Where the appliance listing and manufacturer's instructions are more stringent than the provisions of this section, the listing and manufacturer's instructions apply.

**(2)** METHODS FOR PROVIDING AIR. Air for combustion and dilution shall be provided in accordance with one of the following:

(a) If the vapor retarder is not continuous on walls and ceilings exposed to the outside atmosphere as allowed by s. Comm 22.22, air may be provided from inside the building in accordance with sub. (3).

(b) Air may be provided from outside the building in accordance with sub. (4).

(c) The appliance may be installed in accordance with its listing and manufacturer's instructions. Where all walls and ceilings exposed to the outside atmosphere are provided with a continuous vapor retarder, any requirements for unusually tight construction shall be met.

(d) An engineered system providing an adequate supply of air for combustion ventilation and dilution of flue gases may be installed if approved by the department.

**(3)** AIR FROM INSIDE THE BUILDING. (a) 1. The equipment shall be located in a space with a volume not less than 50 cubic feet per 1000 Btu/h of the combined input rating of all fuel–burning appliances drawing combustion and dilution air from that space.

2. The space may be made up of more than one room if the rooms are connected through doorways without doors or connected through sets of openings described in par. (b).

(b) 1. When needed to connect rooms, two openings shall be provided, one within one foot of the ceiling of the room and one within one foot of the floor.

2. The net free area of openings shall be calculated in accordance with sub. (5).

3. The net free area of each opening shall be a minimum of one square inch per 1000 Btu/h of combined input rating of the fuel burning appliances drawing combustion and dilution air from the communicating rooms, but shall be not less than 100 square inches.

**(4)** AIR FROM OUTSIDE THE BUILDING. (a) When air for combustion and dilution is provided from outside the building, as allowed under sub. (2) (b), one of the methods specified in pars. (b) to (d) shall be used.

(b) Openings may be provided to connect rooms containing appliances to the outdoors.

1. a. Two openings shall be provided, one within one foot of the ceiling of the room and one within one foot of the floor.

b. Openings may connect directly to the outdoors or to the outdoors through a horizontal or vertical duct.

c. The net free area of openings shall be calculated in accordance with sub. (5).

2. The net free area of each direct opening to the outdoors not using a duct shall be a minimum of one square inch per 4000 Btu/h of combined input rating of the fuel–burning appliances drawing combustion and dilution air from the room.

3. a. The net free area of each opening connected to the outdoors through a horizontal duct shall be a minimum of one square inch per 2000 Btu/h of combined input rating of the fuel–burning appliances drawing combustion and dilution air from the room.

b. The cross–sectional area of the duct shall be equal to or greater than the required size of the opening.

4. a. The net free area of each opening connected to the outdoors through a vertical duct shall be a minimum of one square

inch per 4000 Btu/h of combined input rating of the fuel–burning appliances drawing combustion and dilution air from the room.

b. The cross–sectional area of the duct shall be equal to or greater than the required size of the opening.

(c) 1. Where all appliances drawing air for combustion and dilution from the room are gas appliances, air may be provided via a single opening to connect the room to the outdoors in accordance with this paragraph.

2. a. The opening shall be located within one foot of the ceiling of the room.

b. The opening may connect directly to the outdoors, may connect to the outdoors through a horizontal duct, or may connect to the outdoors through a vertical duct.

c. The net free area of the opening shall be calculated in accordance with sub. (5).

3. a. The net free area of the opening shall be a minimum of one square inch per 3000 Btu/h of combined input rating of the fuel–burning appliances drawing combustion and dilution air from the room, and not less than the combined cross–sectional flow areas of the appliance flue collars or draft hood outlets.

b. The cross–sectional area of the duct shall be equal to or greater than the required size of the opening.

4. The appliances shall have a minimum clearance to the surfaces of the room of one inch at the sides and back of the appliance and 6 inches at the front of the appliance.

(d) 1. A combination of openings to the outside and openings to other rooms may be used in accordance with this paragraph.

2. a. One opening shall connect directly to the outdoors, connect to the outdoors through a horizontal duct, or connect to the outdoors through a vertical duct.

b. The net free area of the openings shall be calculated in accordance with sub. (5).

c. The net free area of the opening shall be a minimum of one square inch per 5000 Btu/h of combined input rating of the fuel burning appliances drawing combustion and dilution air from the room.

d. The cross–sectional area of a duct, if used, shall be equal to or greater than the required size of the opening.

3. a. The equipment shall be located in a space with a volume not less than 50 cubic feet per 1000 Btu/h of the combined input rating of all fuel–burning appliances installed in that space.

b. The space may be made up of more than one room if the rooms are connected through openings without doors or connected through sets of openings described in subd. 4.

4. a. When needed to connect rooms, two openings shall be provided, one within one foot of the ceiling of the room and one within one foot of the floor.

b. The net free area of openings shall be calculated in accordance with sub. (5).

c. The net free area of each opening shall be a minimum of one square inch per 1000 Btu/h of combined input rating of the fuel burning appliances drawing combustion and dilution air from the communicating rooms, but shall be not less than 100 square inches.

**(5)** NET FREE AREA CALCULATION. (a) The required size of openings for combustion and dilution air shall be based on the net free area of each opening.

(b) The net free area of an opening shall be that specified by the manufacturer of the opening covering or by a source approved by the department.

(c) In the absence of such information, openings covered with metal louvers shall be deemed to have a net free area of 75 percent of the area of the opening, and openings covered with wood louvers shall be deemed to have a net free area of 25 percent of the area of the opening.

**(6)** INTERLOCKING OF DAMPERS. (a) Where the combustion air openings are provided with volume, smoke or fire dampers, the dampers shall be electronically interlocked with the firing cycle of the appliances served, so as to prevent operation of any appliance that draws combustion and dilution air from the room when any of the dampers are closed.

(b) Manually operated dampers shall not be installed in combustion air openings.

**(7)** SIMULTANEOUS OPERATION. (a) The equipment and appliance within every room containing fuel–burning appliances shall be installed so as to allow the free circulation of air.

(b) Provisions shall be made to allow for the simultaneous operation of mechanical exhaust systems, fireplaces, clothes dryers or other equipment and appliances operating in the same room or space from which combustion air and dilution air is being drawn. The provisions shall prevent the operation of the appliances, equipment and systems from affecting the supply of combustion and dilution air.

**Note:** Wood typically has a heating value of 8600 BTU per pound.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (intro.), (1) (a) and (2) (a), Register, January, 1989, No. 397, eff. 2–1–89; **r. and recr., Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 23.062 Mechanical draft systems.** Where a mechanical draft system, such as a fan is used, provision shall be made to prevent the flow of gas to the main burners when the draft system is not performing so as to satisfy the operating requirements of the system for safe performance.

**History: Cr. Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 23.065 Equipment maintenance information.** Required regular maintenance actions for equipment shall be clearly stated and incorporated on a readily accessible label. The label may be limited to identifying, by title or publication number, the operation and maintenance manual for that particular model and type of equipment. Maintenance instructions shall be furnished for equipment which requires preventive maintenance for efficient operation. Manufacturer's manuals for all installed heating and cooling equipment and service water heating equipment shall be provided.

**History:** Cr., Register, January, 1999, No. 517, eff. 2–1–99.

## Subchapter IV —Delivery Systems

**Comm 23.07 Air distribution systems. (1)** SIZING. All air distribution systems shall be sized using the velocities and static pressure losses listed in Table 23.07.

**TABLE 23.07**
**DUCT VELOCITIES**

| Designation | Maximum Static Pressure Loss (in WG/100 ft) | Minimum Velocity (feet/minute) | Maximum Velocity (feet/minute) |
|---|---|---|---|
| Main trunk duct | .10 | 700–900 | 800–1200 |
| Branch duct | .10 | 600 | 700–1000 |
| Branch riser | .10 | 500 | 650–800 |
| Outdoor intake | .10 | 500 | 800 |
| Grilles or openings | .10 | 400 | 600 |
| Return air door undercuts | .10 | 200 | 300 |
| Return air door or wall louvers | .10 | 200 | 300 |

WG = Water gauge per 100 feet.

**(2)** SYSTEM SIZING. The distribution system, including the evaporator coil, air filters (installed external to the heating unit), ducts, fittings, grilles and registers, shall be sized so that the total external static pressure shall not exceed the static pressure capacity of the fan at the system rated air flow.

**(3)** CHANGES IN DUCT SIZE. Where duct sizes are changed, the slope angle of the transition duct shall not exceed 45°.

**History:** Cr. Register, November, 1979, No. 287 eff. 6–1–80.

**Comm 23.08 Ductwork. (1)** DUCT USE. Ducts designed for the transmission of air shall be used for no other purpose.

**(2)** INTERIOR DUCTS. All interior ducts shall be constructed in accordance with the following:

(a) *Supply and return air ducts.* Supply and return air ducts shall comply with this paragraph except that ducts attached to appliances may be constructed of materials specified in the appliance listing.

1. Kitchen exhaust ducts and ducts for air exceeding 250°F shall be constructed of sheet metal or lined with sheet metal or constructed of other noncombustible noncorrugated materials.

2. Ducts connected to furnaces shall be constructed of sheet metal for at least 6 feet from the furnace.

3. Spaces formed by unlined wood joists, studs or wood I–joists with solid webs may be used as return air ducts. Spaces used as return air ducts shall be cut off from all remaining unused portions of the space by tight–fitting stops of sheet metal or of wood joist material. Bridging shall be removed from the joist space.

(b) *Under–floor plenums.* An under–floor space may be used as a plenum in a single dwelling unit in accordance with this section.

1. The use of the under–floor space shall be limited to buildings not more than 2 stories in height. Except for the floor immediately above the under–floor plenum, supply ducts shall be provided extending from the plenum to registers or other floor levels.

2. The under–floor spaces shall not be used for storage, shall be cleaned of all loose scrap material and shall be tightly and substantially enclosed.

3. The enclosing material of the under–floor space, including the side wall insulation and vapor barriers, shall not be more flammable than one–inch (nominal) wood boards (flame spread classification of 200).

4. Access shall be through an opening in the floor which shall be 18 inches by 24 inches.

5. The furnace supplying warm air to the under–floor space shall be equipped with an automatic control which will start the air circulating fan when the air in the furnace bonnet reaches a temperature not higher than 150° F. Such control shall be one that cannot be set higher than 150° F.

6. The furnace supplying warm air to the under–floor space shall be equipped with an approved temperature limit control that will limit outlet air temperature to 200° F.

7. A noncombustible receptacle shall be placed below each floor opening into the air chamber. The receptacle shall be securely suspended from the floor members and shall be not more than 18 inches below the floor opening. The area of the receptacle shall extend 3 inches beyond the opening on all sides. The perimeter of the receptacle shall have a vertical lip at least one inch high at the open sides if it is at the level of the bottom of the joist, or 3 inches high if the receptacle is suspended.

8. Floor registers shall be designed for easy removal to permit access for cleaning the receptacles.

9. Exterior walls and interior stud partitions shall be firestopped at the floor.

10. Each wall register shall be connected to the air chamber by a register box or boot.

11. A duct conforming to par. (a) shall extend from the furnace supply outlet at least 6 inches below combustible framing.

12. The entire ground surface and enclosing exterior walls of the under–floor space shall be covered with a vapor barrier having a vapor permeability rating of one perm or less and a flame spread rating of 200 or less.

13. Fuel gas lines may not be located within the under–floor space.

14. A smoke detector shall be placed in the under–floor space. The alarm and low–battery signal of the smoke detector shall be audible in the occupied areas of the dwelling, when actuated.

15. The exterior walls of the under–floor spaces shall be insulated in accordance with subch. VI of ch. Comm 22. The insulation may not be omitted under the provisions of s. Comm 22.21 or subch. VII of ch. Comm 22.

16. Electrical wiring installed in the plenum shall be in conformance with the Wisconsin Administrative Electrical Code Volume 2.

**(3)** EXTERIOR DUCTS. (a) *General.* Except as provided in par. (b), ducts, which are located in garages, storage attics and similar spaces susceptible to physical damage, shall be constructed of galvanized steel or corrosion–resistive metal.

(b) *Exception.* Plastic may be used for bath fan or air–to–air heat exchanger exhaust runs located in spaces outside the dwelling.

**(4)** UNDERGROUND DUCTS. Ducts, plenums and fittings constructed of metal encased in concrete or ceramic, or other approved materials, may be installed in the ground. Supply air ducts shall be insulated with a moistureproof material having a resistance value of at least R–5.

**(5)** DUCT CONSTRUCTION. Ductwork shall be constructed and installed in accordance with any one of the appropriate following standards:

(a) ASHRAE Handbook HVAC Systems and Equipment.

(b) SMACNA, Residential Comfort System Installation Standards Manual

(c) SMACNA, HVAC Duct Construction Standards–Metal and Flexible.

(d) SMACNA Fibrous Glass Duct Construction Standards.

(e) ASHRAE HVAC Applications Handbook.

(f) NAIMA Fibrous Glass Duct Construction Standards.

**(6)** THICKNESS. Sheet metal ducts shall conform to the minimum thicknesses listed in Table 23.08–A.

**(7)** DUCT SUPPORT. Ductwork shall be fastened in place and braced to prevent lateral displacement in accordance with Table 23.08–B.

**TABLE 23.08–A**
**DUCT CONSTRUCTION MINIMUM SHEET METAL GAUGES**

| | Minimum thickness galvanized sheet gauge | Minimum thickness aluminum B & S gauge |
|---|---|---|
| Metal gauges (duct not enclosed in partitions) | | |
| Round ducts | | |
| Diameter, inches | | |
| Less than 12 | 30 | 26 |
| 12–14 | 28 | 26 |
| 15–18 | 26 | 24 |
| Over 18 | 24 | 22 |
| Rectangular Ducts | | |
| Width, inches | | |
| Less than 14 | 28 | 24 |
| 14–24 | 26 | 22 |
| 25–30 | 24 | 22 |
| Over 30 | 22 | 20 |
| Metal gauges (ducts enclosed in partition) | | |
| Width, inches | | |
| 14 or less | 30 | 26 |
| Over 14 | 28 | 24 |

**TABLE 23.08–B**
**DUCT SUPPORT MATERIAL**

| Duct Type | Maximum Size of Diameter (inches) | Duct Position | Hanger or Strap Size and Spacing |
|---|---|---|---|
| Circular | 10 | Vertical | No. 18 gauge galvanized steel x 2″ @ 12′ o.c. |
| | | Horizontal | No. 30 gauge galvanized steel x 1″ or No. 18 steel wire @ 10′ o.c. |
| | 20 | Vertical | No. 16 gauge galvanized steel x 2″ @ 12′ o.c. |
| | | Horizontal | No. 28 gauge galvanized steel x 1″ or No. 18 steel wire @ 10′ o.c. |
| Rectangular[1] | 24 | Vertical | 1″ x 1/8″ steel galvanized strap @ 12′ o.c. |
| | | Horizontal | No. 18 gauge galvanized steel x 1″ @ 10′ o.c. |
| | | Vertical | 1″ x 1–1/8″ galvanized steel angle @ 12′ o.c. |
| | | Horizontal | 1″ x 1/8″ galvanized steel strap @ 10′ o.c. |

[1] Rectangular metal duct supports should consist of one hanger attached to one–inch wide circular bands of the duct extending around and supporting ducts exceeding 10 inches in diameter.

**Note:** This table does not prohibit nailing for duct support.

**(8)** JOINTS AND SEAMS. All joints and seams shall be securely fastened or locked. Round pipe slip joints shall be lapped at least one inch.

**(9)** VIBRATION CONTROL. When used, vibration isolation connectors shall be installed at the joint between the duct and fan or heating equipment. Vibration isolation connectors shall not be used where the air temperature is in excess of 250° F.

**(10)** AIR PASSAGEWAYS OF ENVELOPE DWELLINGS. The air passageways of envelope type dwellings shall comply with this subsection.

(a) No heating equipment shall be placed in the air passageways.

(b) Wood exposed to the air passageways shall be of at least 2 inches nominal thickness.

(c) Finishes and insulation exposed to the air passageway shall have a flame spread rating of 25 or less and a smoke development rating of 50 or less.

(d) A vapor barrier shall be installed on the warm side of insulation which forms a part of the thermal envelope of the dwelling. In the roof–ceiling air passageway, a vapor barrier for the insulation of the ceiling may be omitted if heated air is circulated on both sides of the ceiling insulation. The insulation on the roof side of the air passageway shall be provided with a vapor barrier on the warm side of the insulation. Any vapor barrier exposed to circulating air shall have a flame spread rating of 25 or less and a smoke development rating of 50 or less.

**Note:** Also see s. Comm 21.08 (1m), Equivalent Firestopping Requirements for Envelope Dwellings.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; cr. (2) (b) and (10), Register, January, 1989, No. 397, eff. 2–1–89; r. and recr. (2) (a), am. (3) and (6), Register, March, 1992, No. 435, eff. 4–1–92; am. (2) (a) 3., (2) (b) 15., (3) (a), and (4), Register, November, 1995, No. 479, eff. 12–1–95; r. and recr. (2) (b) 15. and (5), Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 23.09 Dampers, registers and grilles.** **(1)** VOLUME AND BACKDRAFT DAMPERS. Volume duct dampers shall be provided to permit balancing of the system. No supply ducts shall terminate in a garage without a backdraft damper.

**(2)** AIR REGISTERS AND GRILLES. (a) *Supply air registers.* All supply air outlets shall be provided with registers or devices which will provide a uniform distribution of air.

(b) *Return air grilles.* Return air grilles shall not be located in bathrooms, kitchens, garages, utility spaces or a confined space in which a draft diverter or draft regulator is located. All other habitable spaces shall have permanent openings to a return air grille equal in area to the supply outlet serving those areas. At least one return air opening shall be provided for each floor.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

**Comm 23.10 Piping.** **(1)** PIPE SIZES AND ARRANGEMENT. All steam and hot water supply and return piping, air–line piping and auxiliary equipment shall be of appropriate sizes, elevations and arrangements to accomplish the calculated results without stress or other detriment.

**Note:** The sizes of pipe to be used for mains and risers may be selected from the ASHRAE Guide and Data Book, published by the American Society of Heating, Refrigerating and Air Conditioning Engineers; or the manuals published by the Institute of Boiler and Radiator Manufacturers or the Mechanical Contractors Association of America.

**(2)** EXPANSION AND CONTRACTION. The piping for the heating system shall be equipped with anchors, expansion swings or joints, supports and similar devices to relieve stress and strain caused by temperature change of the pipe material.

**(3)** PIPE INSULATION. Unguarded steam, hot water supply and return piping shall be covered with insulating material where the pipes pass through occupied areas and the surface temperature exceeds 180° F.

**(4)** STEAM AND HOT WATER PIPES. No pipe carrying hot water or steam at a surface temperature exceeding 250° F shall be placed within one inch of any combustible material, pass through a combustible floor, ceiling or partition unless the pipe is protected by a metal sleeve one inch larger in diameter than the pipe or with approved pipe covering.

**(5)** BALANCING. Balancing cocks shall be provided in each circuit of a hot water distribution system.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

## Subchapter V —Chimneys and Vents

**Comm 23.11 General requirements. (1)** TYPES OF CHIMNEYS AND VENTS. All heating appliances using solid, liquid or gas fuels shall be vented to the outside by an all–fuel factory–built, masonry chimney or other listed venting system designed to remove the products of combustion.

**(2)** TERMINATION. (a) *Chimneys.* All listed factory manufactured chimneys depending on a principle of gravity for the removal of the products of combustion shall terminate at the location specified in the product listing. For masonry chimneys or where termination location is not specified as a part of the listing, the chimney shall extend at least 3 feet above the highest point where the chimney passes through the roof of the building, and at least 2 feet higher than any ridge, peak, wall, or roof within 10 feet horizontally of the chimney.

(b) *Vents.* Gas and oil appliance vents shall terminate in locations specified in their listings.

**(3)** SIZING. Vents for new or replacement equipment shall be sized to adequately exhaust combustion products from the dwelling.

**Note:** The department recommends vent sizing in accordance with NFPA 54, National Fuel Gas Code or its appendix.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; renum. (intro) to (2) to be (1) to (3) and am. (1), Register, February, 1985, No. 350, eff. 3–1–85; r. (3), Register, January, 1989, No. 397, eff. 2–1–89; am. (2), Register, March, 1992, No. 435, eff. 4–1–92; cr. (3), Register, November, 1995, No. 479, eff. 12–1–95.

**Comm 23.12 Masonry chimneys.** Masonry chimneys shall conform to the requirements of s. Comm 21.30.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. Register, February, 1985, No. 350, eff. 3–1–85; am. (8), Register, March, 1992, No. 435, eff. 4–1–92; r. and recr., November, 1995, No. 479, eff. 12–1–95.

**Comm 23.13 Factory–built chimneys or vents.** Factory–built chimneys or vents shall be of an approved type.

**Note:** The department recognizes as approved, factory–built chimneys or vents designated as "residential type and building heating appliance," "building heating appliance," "B," "BW," and "L" types listed by Underwriters' Laboratories, Inc.

**(1)** RESIDENTIAL TYPE AND BUILDING HEATING APPLIANCE. An approved"residential type and building heating appliance" chimney may be used with liquid or gas–fired heating appliances where the flue gas temperature does not exceed 1000° F continuously, and does not exceed 1400° F for infrequent brief periods of forced firing.

**(2)** TYPE "B". An approved type "B" gas vent may be used with a vented, recessed wall heater.

**(3)** TYPE "BW". An approved type "BW" gas vent may be used with a vented, recessed wall heater.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (1), Register, March, 1992, No. 435, eff. 4–1–92.

**Comm 23.14 Gas vents. (1)** GENERAL. All gas–fired equipment shall be provided with vent pipes conforming with s. Comm 23.15 (2) (e), unless the manufacturer specifies other materials.

**(2)** DRYER VENTING. (a) Gas–fired clothes dryers shall be provided with metal venting that terminates outside the dwelling.

**Note:** s. Comm 22.08 (3) requires all dryer venting to terminate outside the structure.

(b) Where dryer vent piping is concealed, a rigid metal vent pipe conforming with s. Comm 23.15 (2) (e) shall be used.

**(3)** VENTING SYSTEM LOCATION. (a) A venting system shall terminate at least 3 feet above any forced air inlet located within 10 feet horizontally. This provision does not apply to the combustion air intake of a direct–vent appliance.

(b) The venting system of other than a direct–vent appliance shall terminate at least 4 feet below, 4 feet horizontally from, or one foot above any door, window, or gravity air inlet into any building. The bottom of the vent shall be located at least 12 inches above grade.

(c) The vent terminal of a direct–vent appliance with an input of 10,000 Btu per hour or less shall be located at least 6 inches from any air opening into a building.

(d) The vent terminal of a direct–vent appliance with an input over 10,000 Btu per hour but not over 50,000 Btu per hour shall be located at least 9 inches from any air opening into a building.

(e) The vent terminal of a direct–vent appliance with an input over 50,000 Btu per hour shall be located at least 12 inches from any air opening into a building.

(f) The bottom of the vent terminal and the air intake of a direct–vent appliance shall be located at least 12 inches above grade.

(g) The exit terminal of a mechanical draft system shall be not less than 7 feet above grade where located within 3 feet of a public walkway that is intended for use by the general public.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; correction made under s. 13.93 (2m) (b) 7., Stats., Register, March, 1992, No. 435; r. and recr., November, 1995, No. 479, eff. 12–1–95; **cr. (3), Register, March, 2001, No. 543, eff. 4–1–01.**

**Comm 23.15 Chimney connectors, smoke pipes and stovepipes. (1)** DEFINITION. Chimney connectors, smoke pipes or stovepipes are passages for conducting the products of combustion from a fuel–fired appliance to the chimney.

**(2)** CONSTRUCTION AND INSTALLATION. The construction and installation of chimney connectors of solid–fuel–burning appliances shall comply with s. Comm 23.045 (4). The chimney connectors of all other fuel–fired appliances shall conform with the following requirements:

(a) *Concealed space.* No chimney connector shall pass through any outside window, door or combustible outside wall, nor be concealed in any closet, attic or similar space.

(b) *Combustible partitions.* Connectors for appliances shall not pass through walls or partitions constructed of combustible material unless they are guarded at the point of passage by:

1. Metal ventilated thimbles not less than 12 inches larger in diameter than the connector;

2. Metal or burned fireclay thimbles built in brickwork or other approved fireproofing materials extending not less than 8 inches beyond all sides of the thimble.

(c) *Pitch and length.* Chimney or vent connectors shall have no more than two 45° offsets with the vertical. The horizontal length shall not exceed 75% of the total vertical height of the total venting system measured from the appliance outlet. Chimney or vent connectors shall be pitched at least 1/4–inch per foot from the appliance outlet collar vent to the chimney inlet.

(d) *Dampers.* 1. Manually operated dampers are prohibited in chimney or vent connectors of all appliances except wood–burning appliances.

2. A listed, automatically operated damper may be used with any heating appliance provided it is installed and used in accordance with the appliance and damper listing.

(e) *Materials and thickness.* Chimney or vent connectors serving liquid fuel or gas appliances shall conform to the type of material and thickness indicated in Table 23.15–A or 23.15–B.

(f) *Clearance.* Single wall metal connectors shall be installed with clearance to combustibles as indicated in Table 23.15–C. These clearances may be reduced if the combustible material is protected in accordance with the requirements of Table 23.04–B.

**TABLE 23.15–A**
**MINIMUM CHIMNEY CONNECTOR GAUGES FOR OIL–FIRED APPLIANCES**

| | Galvanized Steel Gauge Number | |
|---|---|---|
| Diameter of Connector | Min. thickness (inch) | Gauge |
| Less than 6 inches | .019 | 26 |
| 6 inches to less than 10 inches | .024 | 24 |
| 10 inches to 13 inches | .030 | 22 |
| 14 inches to 16 inches | .036 | 20 |
| Greater than 16 inches | .058 | 16 |

**TABLE 23.15–B**
**MINIMUM VENT CONNECTOR GAUGES FOR GAS**

| | Galvanized Steel Gauge Number | |
|---|---|---|
| Diameter of Connector | Min. thickness (inch) | Gauge |
| 1 inch through 4 inches | .016 | 28 |
| 5 inches or over | .026 | 24 |

**TABLE 23.15–C**
**CHIMNEY CONNECTOR AND VENT CONNECTOR CLEARANCES FROM COMBUSTIBLE MATERIALS (See Note 4)**

| Description of Appliance | Minimum Clearance Inches (See Note 1) |
|---|---|
| Single–Wall Metal Pipe Connectors | |
| Gas Appliances Without Draft Hoods | 18 |
| Electric, Gas, and Oil Incinerators | 18 |
| Oil Appliances | 18 |
| Unlisted Gas Appliances With Draft Hoods | 9 |
| Boilers and Furnaces Equipped With Listed Gas Burners and With Draft Hoods | 9 |
| Oil Appliances Listed as Suitable for Use With Type L Venting Systems, but only when connected to chimneys | 9 |
| Listed Gas Appliances With Draft Hoods. See Note 3. | 6 |
| Type L Vent Piping Connectors | |
| Gas Appliances Without Draft Hoods | 9 |
| Electric, Gas, and Oil Incinerators | 9 |
| Oil Appliances | 9 |
| Unlisted Gas Appliances With Draft Hoods | 6 |
| Boilers and Furnaces Equipped With Listed Gas Burners and With Draft Hoods | 6 |
| Oil Appliances Listed as Suitable for Use with Type L Vents | (See Note 2) |
| Listed Gas Appliances With Draft Hoods | (See Note 3) |
| Type B Gas Vent Piping Connectors | |
| Listed Gas Appliances With Draft Hoods | (See Note 3) |

[1] These clearances apply except if the listing of an appliance specifies different clearance, in which case the listed clearance takes precedence.
[2] If listed type L venting system piping is used, the clearance may be in accordance with the venting system listing.
3 If listed type B or type L venting system piping is used, the clearance may be in accordance with the venting system listing.
[4] The clearances from connectors to combustible materials may be reduced if the combustible material is protected in accordance with Table 23.04–B.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. (2) (intro.) and (g), Tables 23.15–A and C, renum. (2) (d) to be ILHR 23.155, Register, January, 1989, No. 397, eff. 2–1–89; r. (2) (c) and (f), renum. (2) (e), (g) and (h) to be (2) (c), (e) and (f), cr. (2) (d), Register, March, 1992, No. 435, eff. 4–1–92; r. and recr. (2) (d), Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 23.155 Multiple appliance venting.** Two or more listed gas–or liquid–fueled appliances may be connected to a common gravity–type flue provided the appliances are equipped with listed primary safety controls and listed shutoff devices and comply with the following requirements.

**(1)** The appliances shall be located in the same story, except for engineered venting systems.

**(2)** The appliances shall be joined at a manifold or Y–type fitting as close to the chimney as possible, unless the connector from each appliance enters a separate chimney inlet and the inlets are offset at least 12 inches vertically or the separate inlets occur at right angles to each other.

**(3)** The chimney connector and chimney flue shall be sized to accommodate the total volume of flue gases. For gas–burning appliances the venting area shall be at least equal to the size of the largest vent connectors plus at least 50% of the area of the other vent connectors.

**History:** Renum. from ILHR 23.15 (2) (d) and am. Register, January, 1989, No. 397, eff 2–1–89; r. (2), renum. (1) (intro.), (a) to (c) to be (intro.), (1) to (3), Register, March, 1992, No. 435, eff. 4–1–92.

**Comm 23.156 Condensate drains.** Provisions shall be made so that condensate from heating equipment drains into the sanitary drain system.

**History:** Cr. Register, January, 1989, No. 397, eff. 2–1–89.

## Subchapter VI —Fuel Supply Systems

**Comm 23.16 Fuel storage. (1)** LIQUEFIED PETROLEUM GAS STORAGE TANKS. All liquefied petroleum gas storage tanks shall be constructed to conform with the applicable sections of chs. Comm 11 and 12, Liquefied Petroleum Gases and Liquefied Natural Gases.

(a) No tanks shall be located inside dwellings.

(b) Tanks shall have welded steel supports and be permanently installed on concrete pads or foundations.

**(2)** OIL STORAGE TANKS. (a) Except as provided in pars. (b) and (c), oil storage tanks shall be installed in accordance with ch. Comm 10, Flammable and Combustible Liquids.

(b) The total storage capacity inside any dwelling unit shall be limited to 550 gallons in one tank, or not more than 275 gallons in each of 2 tanks cross–connected to a single burner.

(c) Oil storage tanks on the inside of any dwelling shall be located at the same level as the burner it serves.

**(3)** GAS PIPING SYSTEMS. Gas piping systems, extending from the point of delivery to the connection with each gas–fired appliance or device, shall be installed to conform with NFPA 54, National Fuel Gas Code.

**(4)** SHUTOFF AND CONTROL DEVICES. (a) Any oil–fired appliance or device connected to a fuel piping system shall have an accessible, approved manual shutoff valve installed upstream of any connector.

(b) Automatic gas–burning heating appliances shall be equipped with listed devices which will shut off the gas to the pilot light and main burner(s) in the event of pilot failure.

(c) Liquid fuel–burning appliances shall be equipped with primary safety controls which will shut off the flow of fuel to the burner(s) in the event of ignition failure.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; correction in (1) (intro.), made under s. 13.93 (2m) (b) 7., Stats. Register, February, 1985, No. 350, 3–1–85; r. and recr. (2), (3) and (4) (a), Register, January, 1989, No. 397, eff. 2–1–89; r. (1) (b), renum. (1) (c) to be (1) (b), am. (2), Register, March, 1992, No. 435, eff. 4–1–92.

## Subchapter VII —Equipment Location and Operation

**Comm 23.17 Equipment location. (1)** OUTDOOR EQUIPMENT. Outdoor equipment shall be located so as to not restrict the air flow or recirculation of air. Outdoor equipment so located as to be subject to damage shall be protected.

**(2)** INDOOR EQUIPMENT. All indoor equipment shall be installed with a minimum of 24 inches of clearance for service.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

**Comm 23.18 Operation. (1)** INSTRUCTIONS. Written instructions shall be provided the owner for the operation and maintenance of the system and equipment.

**(2)** FINAL TEST REQUIRED. The installer shall test and balance every heating, ventilating and air conditioning system.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80.

# Chapter Comm 24

## ELECTRICAL STANDARDS



**Note:** Chapter Ind 24 was renumbered to be chapter ILHR 24, Register, February, 1985, No. 350, effective 3–1–85. Chapter ILHR 24 was renumbered to be chapter Comm 24 under s. 13.93 (2m) (b) 1., Stats., and corrections made under s. 13.93 (2m) (b) 7., Stats., Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 24.01 Electrical standards.** All electrical wiring, installations, equipment and materials used in the construction of dwellings shall comply with the requirements of the Wisconsin Administrative Electrical Code, Vol. 2., ch. Comm 16.

**Note:** Section 101.865, Stats., requires that the company furnishing the electric current obtain proof that the wiring complies with these standards before furnishing the current. Proof must be a certificate furnished by the inspection department or officer, or if there is no officer, an affidavit furnished by the person doing the wiring.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; am. Register, March, 1992, No. 435, eff. 4–1–92.

# Chapter Comm 25

## PLUMBING



**Note:** Chapter Ind 25 was renumbered to be chapter ILHR 25, Register, February, 1985, No. 350, eff. 3–1–85; ch. ILHR 25 as it existed on February 29, 1992, was repealed and a new chapter ILHR 25 was created effective March 1, 1992. Chapter ILHR 25 was renumbered to be chapter Comm 25 under s. 13.93 (2m) (b) 1., Stats., and corrections made under s. 13.93 (2m) (b) 7., Stats., Register, January, 1999, No. 517, eff. 2–1–99.

**Comm 25.01 Plumbing.** The design, construction and installation of plumbing shall comply with the requirements of the Wisconsin Plumbing Code, chs. Comm 82 to 87.

**History:** Cr. Register, March, 1992, No. 435, eff. 4–1–92; am., Register, November, 1995, No. 479, eff. 12–1–95.

**Comm 25.02 Sanitation facilities and devices.** The design, construction, installation and maintenance of sanitation facilities and devices such as composting toilets, incinerating toilets and privies to serve one– and 2–family dwellings shall comply with the requirements of ch. Comm 91.

**History:** Cr. Register, April, 2000, No. 532, eff. 7–1–00.

# UDC Appendix

# Table of Contents

| Wisconsin Division of Safety and Buildings<br>Wisconsin Stats. 101.63, 101.73 | **WISCONSIN UNIFORM BUILDING PERMIT APPLICATION**<br>**Instructions on back of yellow ply.** The information you provide may be used by other government agency programs (Privacy Law, s. 15.04 (1)(m) | Application No.<br>Parcel No. |
|---|---|---|

**PERMIT REQUESTED** ☐ Constr. ☐ HVAC ☐ Electric ☐ Plumbing ☐ Erosion Control Other:

| Owner's Name | Mailing Address | | Tel. |
|---|---|---|---|
| Contractor's Name: ☐Con ☐Elec ☐HVAC ☐Plbg | Lic/Cert# | Mailing Address | Tel.<br>FAX |
| Contractor's Name: ☐Con ☐Elec ☐HVAC ☐Plbg | Lic/Cert# | Mailing Address | Tel.<br>FAX |
| Contractor's Name: ☐Con ☐Elec ☐HVAC ☐Plbg | Lic/Cert# | Mailing Address | Tel.<br>FAX |
| Contractor's Name: ☐Con ☐Elec ☐HVAC ☐Plbg | Lic/Cert# | Mailing Address | Tel.<br>FAX |

| **PROJECT LOCATION** | Lot area Sq. ft. | of Section , T N, R E (or) W | |
|---|---|---|---|
| Building Address | Subdivision Name | Lot No. | Block No. |

| Zoning District(s) | Zoning Permit No. | **Setbacks:** | Front ft. | Rear ft. | Left ft. | Right ft. |
|---|---|---|---|---|---|---|

**1. PROJECT**
☐ New ☐ Repair
☐ Alteration ☐ Raze
☐ Addition ☐ Move
☐ Other:

**2. AREA INVOLVED**
Unfin. Bsmt _____Sq Ft
Living Area _____Sq Ft
Garage _____Sq Ft
Deck _____Sq Ft.

**3. OCCUPANCY**
☐ Single Family
☐ Two Family
☐ Garage
☐ Other:

**4. CONST. TYPE**
☐ Site-Built
☐ Mfd: ☐ UDC ☐ HUD

**5. STORIES**
☐ 1-Story
☐ 2-Story
☐ Other:
☐ Plus Basement

**6. ELECTRICAL**
Entrance Panel Amps:
☐ Underground
☐ Overhead

**7. FOUNDATION**
☐ Concrete
☐ Masonry
☐ Treated Wood
☐ Other:

**8. USE**
☐ Seasonal
☐ Permanent
☐ Other:

**9. HVAC EQUIPMENT**
☐ Forced Air Furnace
☐ Radiant Baseb/ Panel
☐ Heat Pump
☐ Boiler
☐ Central Air Cond.
☐ Other:

**10. SEWER**
☐ Municipal
☐ Septic Permit No.:

**11. WATER**
☐ Municipal Utility
☐ Private On-Site Well

**12. ENERGY SOURCE**

| Fuel | Nat Gas | LP | Oil | Elec | Solid | Solar |
|---|---|---|---|---|---|---|
| Space Htg | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Water Htg | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

☐ Dwelling unit has 3 kilowatt or more electric space heating equip. Infiltration control option is ☐ Sealing of all joints ☐ Blower door test. ☐ Exterior air infiltration barri

**13. HEAT LOSS (Calculated)**
Envelope _____ BTU/HR
Infiltration _____ BTU/HR

**14. EST. BUILDING COST**
$



I agree to comply with all applicable codes, statutes and ordinances and with the conditions of this permit; understand that the issuance of the permit creates no legal liability, express or implied, on the state or municipality; and certify that all the above information is accurate. If I am an owner applying for an erosion control or construction permit, I have read the cautionary statement regarding contractor financial responsibility on the reverse side of the pink ply. I expressly grant the building inspector, or the inspector's authorized agent, permission to enter the premises for which this permit is sought at all reasonable hours and for any proper purpose to inspect the work which is being done.

**APPLICANT'S SIGNATURE** _____ **DATE SIGNED** _____

**APPROVAL CONDITIONS** This permit is issued pursuant to the following conditions. Failure to comply may result in suspension or revocation of this permit or other penalty.

**ISSUING JURISDICTION** ☐ Town ☐ Village ☐ City ☐ State of: Municipality Number of Dwelling Location ___ ___ - ___ ___ ___

| **FEES:** | | **PERMIT(S) ISSUED** | **WIS PERMIT SEAL #** | **PERMIT ISSUED BY:** |
|---|---|---|---|---|
| Plan Review | $_____ | ☐ Construction | | Name _____ |
| Inspection | $_____ | ☐ HVAC | | |
| Wis. Permit Seal | $_____ | ☐ Electrical | | Date _____ Tel. _____ |
| Other | $_____ | ☐ Plumbing | | |
| | | ☐ Erosion | | |
| Total | $_____ | _____ | | Cert No. _____ |

SBD-5823(R 05/98) WHITE - Issuing Jurisdiction YELLOW - State w/in 30 days if new dwelling GREEN - Inspector PINK - Owner/Agent

INSTRUCTIONS

The owner, builder or agents shall complete the application form down through the Signature of Applicant block and submit it and building plans and specifications to the enforcing municipality. Permit application data is used for statewide statistical gathering on new one– and two–family dwellings, as well as for local code administration.

PERMIT REQUESTED
- Check off type of Permit Requested, such as structural, HVAC, Electrical or Plumbing.
- Fill in owner's current Mailing Address and Telephone Number.

PROJECT LOCATION
- Fill in Building Address (number and street or sufficient information so that the building inspector can locate the construction site.
- Fill in Contractor Information. Note, per s. 101.63 (7) Wis. Stats., that the master plumber name and number must be entered before issuing a plumbing permit.
- Local zoning, land use and flood plain requirements must be satisfied before a building permit can be issued. County approval may be necessary.
- Fill in Zoning District, lot area and required building setbacks.

---

PROJECT DATA – Fill in all numbered project data blocks (1–14) with the required information. All data blocks must be filled in, including the following:

2. Area (involved in project):
   Basements – include unfinished area only
   Living area – include any finished area including finished areas in basements
   Two–family dwellings – include total combined areas
3. Occupancy – Check only "Single–Family" or "Two–Family" if that is what is being worked on. In other words, do not check either of these two blocks if only a new detached garage is being built, even if it serves a one or two family dwelling. Instead, check "Garage" and number of stalls. If the project is a community based residential facility serving 3 to 8 residents, it is considered a single–family dwelling.
9. HVAC Equipment – Check only the major source of heat, plus central air conditioning if present. Only check "Radiant Baseboard or Panel" if there is no central source of heat.
10. Plumbing – A building permit cannot be issued until a county sanitary permit has been issued for any new of affected existing on–site sewage system.
14. Estimated Cost – Include the total cost of construction, including materials and market rate labor, but not the cost of land or landscaping.

SIGNATURE – Sign and date this application form.

CONDITIONS OF APPROVAL – The authority having jurisdiction uses this section to state any conditions that must be complied with pursuant to issuing the building permit.

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ISSUING JURISDICTION: This must be completed by the authority having jurisdiction.
- Check off Municipality Status, such as town, village or city.
- Fill in Municipality Name and Municipality Number of inspection authority.
- Fill in Municipality Number of Dwelling Location if different from municipality where inspection authority is located. (applies to county or state enforcement)
- Check off type of Permit Issued, such as construction, HVAC, electrical or plumbing.
- Fill in Wisconsin Uniform Permit Seal Number, if project is a new one– or two–family dwelling.
- Fill in Name and Inspector Certification Number of person reviewing building plans and date building permit issued.

**PLEASE RETURN YELLOW COPY WITHIN 30 DAYS AFTER ISSUANCE TO (You may fold along the dashed lines and insert this form into a window envelope.):**

**Safety & Buildings Division**
**P O Box 2509**
**Madison, WI 53701–2509**

## CAUTIONARY STATEMENT TO OWNERS OBTAINING BUILDING PERMITS

101.65 (1r) of the Wisconsin Statutes requires municipalities that enforce the Uniform Dwelling Code to provide an owner who applies for a building permit with a statement advising the owner that:

If the owner hires a contractor to perform work under the building permit and the contractor is not bonded or insured as required under s. 101.654 (2) (a), the following consequences might occur:

(a) The owner may be held liable for any bodily inquiry to or death of others or for any damage to the property of others that arises out of the work performed under the building permit or that is caused by any negligence of the contractor that occurs in connection with the work performed under the building permit.

(b) The owner may not be able to collect from the contractor damages for any loss sustained by the owner because of a violation by the contractor of the one– and 2– family dwelling code or an ordinance enacted under sub. (1) (a), because of any bodily injury to or death of others or damage to the property of others that arises out of the work performed under the building permit or because of any bodily injury to or death of others or damage to the property of others that is caused by any negligence by the contractor that occurs in connection with the work performed under the building permit.

SBD–5823 (R.05/98)

## SITE INFO

SUBDIVISION _____

LOT NO. _____ BLOCK NO. _____

ZONING DISTRICT _____

_____ 1/4, _____ 1/4, SEC _____, T _____, N, R _____ E or W

PARCEL NO. _____

SETBACKS:
FRONT _____ ft REAR _____ ft

LEFT _____ ft RIGHT _____ ft

## INSPECTIONS

| PHASE | ROUGH | FINAL | EROSION |
|---|---|---|---|
| FOOTING | | | |
| FOUNDATION | | | |
| BSMT DRAIN TILES | | | |
| CONSTRUCTION | | | |
| PLUMBING | | | |
| HEAT/VENT/AC | | | |
| ELECTRICAL | | | |
| INSULATION | | | |
| OCCUPANCY | | | |

Work shall not proceed until the inspector has approved the various stages of construction or the 48 business hr. period since notification has elapsed. This permit will expire 24 months after the date of issuance if the building's exterior has not been completed. **Keep this card posted until final inspection has been made.** (WI Stats. 101.63) _____

# WISCONSIN UNIFORM BUILDING PERMIT #

affix uniform permit seal here (when applicable) Seal No _____

☐ const ☐ hvac ☐ elec ☐ plumb ☐ erosion

**Project:**



**Issued to**

OWNER (AGENT)

BUILDING SITE ADDRESS

CITY, VILLAGE, TOWN

## CONTRACTORS

_____ # _____
G.C.

_____ # _____
HVAC

_____ # _____
ELECT.

_____ # _____
PLBG.

_____ #

**Issued by**

| PERSON ISSUING | CERT. NO. |
|---|---|
| DATE ISSUED | TELEPHONE |

**Comments:** _____

**NOTICE OF NONCOMPLIANCE:** This issuing jurisdiction shall notify the applicant in writing of any violations to be corrected. All cited violations shall be corrected within 30 days of notification, unless extension time is granted.

SBD-5824 (R. 05/96)

Submit to non-enforcing municipalities for new 1- and 2- family dwellings

# WISCONSIN ADMINISTRATIVE BUILDING PERMIT APPLICATION

(Wis. Stats. 101.63 (7) & 101.65 (3))

State of Wisconsin
Safety and Buildings Division

**EE INSTRUCTIONS ON BACK OF YELLOW COPY.**

Personal information you provide may be used for secondary purposes. [Privacy Law 15.04(1)(m)]

**SAMPLE**

| **PERMIT APPLICANT** | | | |
|---|---|---|---|
| Last Name | First Name | Middle Initial | |
| Street Address | | | |
| City | State | Zip Code | Telephone No. (Include area code) |

| **PROJECT LOCATION** | | | |
|---|---|---|---|
| Building Address | Subdivision Name | Lot # | Block # |
| Legal Description<br>____ 1/4, ____ 1/4, Section ____ T ____ N, R ____ E or W | | Parcel No. | |

| **1. PROJECT TYPE** | **2. HVAC EQUIPMENT** | | |
|---|---|---|---|
| ☐ 1 Family | ☐ Forced Air Furnace | ☐ Radiant Baseboard or Panel | ☐ Heat Pump |
| ☐ 2 Family | ☐ Boiler | ☐ Central AC | ☐ Other: |

| **3. ENERGY SOURCE** | Nat. Gas | L.P. | Oil | Elect. | Solid | Solar |
|---|---|---|---|---|---|---|
| Space Heating | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Water Heating | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| **4. CONSTRUCTION TYPE** | **5. FOUNDATION** |
|---|---|
| ☐ Site Constructed<br>☐ Manufactured | ☐ Concrete ☐ Masonry ☐ Treated Wood<br>☐ Other (specify): |
| **6. AREA** | **7. ESTIMATED BUILDING COST** |
| Living area = Square Feet | $ |

I vouch that all the above information is correct, and understand that the issuance of this permit is for administrative purposes only. I understand that onsite construction inspections will **not** be performed by the municipality, but that the Uniform Dwelling Code, Chapters Comm/ILHR 20-25, still applies to all new 1- and 2-family dwellings and must be complied with. I understand that the issuance of this permit does not relieve me of compliance with other applicable codes and ordinances.

Applicant's Signature _____ Date Signed _____

**MUST BE COMPLETED BY THE MUNICIPALITY BEFORE FORWARDING PINK PLY TO THE STATE DIVISION OF SAFETY AND BUILDINGS**

| | | | |
|---|---|---|---|
| **ISSUING JURISDICTION:** | ☐ Town ☐ Village ☐ City ☐ County of: | | |
| **MUNICIPALITY NUMBER:** of Dwelling Location | # ___ ___ - ___ ___ ___ | **FEES:** | |
| **PERMIT ISSUED BY:** | | **DATE ISSUED:** | |

SBD-8254 (R 01/98) **White - Issuing Jurisdiction** **Pink - State Within 30 Days** **Yellow - Applicant**

## INSTRUCTIONS

The owner, builder or agent shall complete and provide all required information on the application form down through the Signature of Applicant block. This data is used for statewide statistical gathering on new one– and two–family dwellings, as well as for local administration. When completed, submit to local municipality having jurisdiction. Plan review or building inspections will not be performed by the municipality.

**PERMIT REQUESTED:**

- Fill in building address.
- Fill in legal description of lot, subdivision name, lot number and block number.

**PROJECT DATA:**

- Fill in **all numbered** project data blocks (1–7) with the required information. All data blocks must be filled in, including the following:

1. **Type** – Check only "1–Family" or "2–Family" if that is what is being built. In other words, do NOT use this form if only a new detached garage is being built, even if it serves a one or two family dwelling.

2. **HVAC Equipment** – Check only the major source of heat, not any supplemental sources. Mark central air conditioning if present. Only check "Radiant Baseboard or Panel" if there is no central source of heat.

6. **Living Area** – Include any finished area including finished areas in basements. For two– family dwellings, include total combined areas.

7. **Estimated Cost** – Include the total cost of construction, but not cost of land or landscaping.

**SIGNATURE:**

- Sign and date application form.

**ISSUING JURISDICTION – This must be completed by the AUTHORITY HAVING JURISDICTION.**

Check off MUNICIPALITY STATUS of issuing jurisdiction, such as town, village, city or county.

Fill in MUNICIPALITY NUMBER OF DWELLING LOCATION. If issued by a county, indicate the specific municipality number where the dwelling will be built.

Fill in name of person issuing permit and date building permit issued.

**PLEASE RETURN PINK COPY WITHIN 30 DAYS AFTER ISSUANCE TO (You may fold along the dashed lines and insert this form into a window envelope.):**

**Safety & Buildings Division**
**P O Box 2509**
**Madison, WI 53701–2509**

## INSPECTION REPORT AND NOTICE OF NONCOMPLIANCE

| Report Date: | Inspection Date | Permit No.: | Parcel No: | |
|---|---|---|---|---|
| Project Address | | Subdivision | Lot No.: | Block No.: |

Inspection Type(s): ☐Footing ☐Erosion Control ☐Foundation ☐Bsmt Drain Tile ☐Construction ☐Heat/Vent/AC ☐Plumbing ☐Electrical ☐Insulation/Energy ☐Occupancy

| **Owner:** | **Contractor:** |
|---|---|
| | |
| | |
| | |
| | |

AN INSPECTION OF THE ABOVE PREMISES HAS DISCLOSED THE FOLLOWING NONCOMPLIANCES:

| ORDER NO. | CODE SECTION | FINDINGS AND REQUIREMENTS |
|---|---|---|
| | | |



**IMPORTANT:** Please report when violation are corrected. AVOID DELAY

**NOTICE OF NONCOMPLIANCE**

**All cited violations shall be corrected within ____30__days after written notification unless an extension of time is granted. Each day that the violatior continues after notice shall constitute a separate offense and is subject to remedies and penalties by the authority having jurisdiction.**

Enforcement Jurisdiction: ☐Town ☐County ☐City ☐Village ☐State **OF**

Authority By Municipal Ordinance Section::

| Inspector's Name: | Violations Explained To: | Compliance Date: |
|---|---|---|
| Inspector's Address: | Office Hours: | Telephone No: |

DO NOT REMOVE

# OFFICIAL MUNICIPAL NOTICE OF VIOLATION

**LOCATION:** _____

☐ **LACKING** _____ **PERMIT(S)** ☐ **NEED FOR** _____ **INSPECTION**
☐ **EXPIRED** _____ **PERMIT** ☐ **PREMISES HOUSEKEEPING**
☐ **UNFIT FOR HUMAN OCCUPANCY**
☐ **EROSION CONTROL PERIMETER MEASURES** ☐ INSTALL ☐ MAINTAIN
☐ **ROCK DRIVEWAY** ☐ INSTALL ☐ MAINTAIN
☐ **SEDIMENT CLEANUP** ☐ STREET & SIDEWALKS ☐ ADJOINING PROPERTY
**OTHER:** _____
_____



**ACTION:**
☐ **CONTACT INSPECTOR** ☐ NOW ☐ AFTER CORRECTIONS
☐ **CORRECT** ☐ NOW ☐ BY END OF TODAY(TRACKING CLEANUP)
☐ BY END OF NEXT WORKDAY (SEDIMENT CLEANUP)
☐ IN 72 HRS (EROSION CONTROLS) ☐ BY _____
☐ **STOP ALL WORK** ☐ EXCEPT CORRECTIONS

**FAILURE TO COMPLY SUBJECTS YOU TO APPLICABLE FINES & PENALTIES**

_____ _____ _____
**MUNICIPAL INSPECTOR** **PHONE NUMBER** **DATE**

SBD-10266 (N.10/95)

Safety and Buildings Division
201 W. Washington Avenue
P O Box 7162
Madison, WI 53707–7162
Telephone: (608) 266–3151

## PETITION FOR VARIANCE
## INFORMATION AND INSTRUCTIONS – ILHR 3

In instances where exact compliance with a particular code requirement cannot be met or alternative designs are desired, the Division has a petition for variance program where it reviews and considers acceptance of alternatives which are not in strict conformance with the letter of the code, but which meet the intent of the code. **A variance is not a waiver from a code requirement.** The petitioner must **provide an equivalency which meets the intent** of the code section petitioned to obtain a variance. Documentation of the rationale for the equivalency is requested below. Failure to provide adequate information may delay your petition. Pictures, sketches, and plans may be submitted to support equivalency. If the proposed equivalency does not adequately safeguard the health, safety, and welfare of building occupants, frequenters, firefighters, etc., the variance request will be denied. NOTE: A SEPARATE PETITION IS REQUIRED FOR EACH BUILDING AND EACH CODE ISSUE PETITIONED (i.e., 57.13 window issue cannot be processed on the same petition as 51.16 stair issue). It should be noted that **a petition for variance does not take the place of any required plan review submittal.**

The Division is unable to process petitions for variance that are not properly completed. Before submitting the application, the following items should be checked for completeness in order to avoid delays:

- Petitioner's name (typed or printed)
- Petitioner's signature
- The Petition For Variance Application must be signed by the owner of the building or project unless a Power of Attorney is submitted.
- Notary Public signature with affixed seal
- Analysis to establish equivalency, including any pictures, illustrations or sketches of the existing and proposed conditions to clearly convey your proposal to the reviewer.
- Proper fee
- Any required position statements by fire chief or municipal official

A position statement from the chief of the local fire department is required for fire safety issues. **No position statement is required for** non–fire safety topics such as sanitary and energy conservation. Position statements for both the fire department and municipality are required for ILHR 69 barrier–free petitions. For rules relating to one– and two–family dwellings, only a position statement from the local enforcing municipality is required. Position statements must be completed and signed by the appropriate fire chief or municipal enforcement official. See the back of SBD–9890, Petition For Variance Application form for these position statement forms. Signatures or seals on all documents must be originals. Photocopies are not acceptable.

SBD–9890 (R.01/98)

**Contact numbers and fees for the Division's review of the petition for variance are as follows:**

Chapters ILHR 20–25, Uniform Dwelling Code ..... (608) 267–5113 ..... $125.00

Chapters ILHR 67–68, Rental Unit Energy Efficiency Code (608) 266–1930 ..... $125.00

Chapters ILHR 50–64, Commercial Building Code ..... (608) 266–1835 ..... $490.00

Chapter ILHR 66, Uniform Multi–Family Dwellings ..... (608) 266–0669 ..... $490.00

- The cities of Milwaukee and Madison may process requests for variances from Chapters ILHR 50 through 64 requirements on projects in their jurisdiction.)

Chapter ILHR 66, Multifamily Dwelling ..... (608) 266–1930 ..... $490.00

Chapter ILHR 69, Barrier–Free Requirements ..... (414) 548–8609 ..... $200.00

Chapter ILHR 70, Historic Building Code ..... (715) 524–3626 ..... $300.00

All Other Chapters ..... $200.00

Boilers and Pressure Vessels ..... (414) 548–8617
Electrical ..... (608) 266–7529
Elevators ..... (414) 521–5444
Flammable Liquids ..... (608) 266–7529

**Priority Review:** Does not apply to Uniform Dwelling Code or Historic Building Code issues which already are treated as a priority ..... Double Above Amounts

Except for special cases, the Division will review and make a determination on a petition for variance within 30 business days of receipt of all calculations, documents, and fees required for the review. Uniform Dwelling Code petitions will be processed within 5 business days. Priority petitions will be processed within 10 business days.

**Petitions for variance should be submitted to:**

**Safety and Buildings Division**
**201 West Washington Avenue**
**P O Box 7162**
**Madison, Wisconsin 53707**
**(608) 266–3151**

**Elevator or barrier–free petitions may be submitted directly to the Waukesha office.**

**General Plumbing or Private Sewage petitions may be submitted to any of the six full–service offices.**

| GREEN BAY S&BD | HAYWARD S&BD | LACROSSE S&BD | MADISON S&BD | SHAWANO S&BD | WAUKESHA S&BD |
|---|---|---|---|---|---|
| 2331 San Luis Place | 15837 USH 63 | 2226 Rose Street | 201 W. Washington Ave. | 1340 Green Bay St | 401 Pilot Court |
| Green Bay, WI 54304 | Hayward, WI 54843 | La Crosse, WI 54603 | P.O. Box 7162 | Shawano, WI 54166 | Waukesha, WI 53188 |
| 920–492–5601 | 715–634–4870 | 608–785–9334 | Madison, WI 53707–7162 | 715–524–3626 | 414–548–8600 |
| FAX: 920–492–5604 | FAX: 715–634–5150 | FAX: 608–785–9330 | 608–261–8490 | FAX: 715–524–3633 | FAX: 414–548–8614 |
| | | | FAX: 608–267–9566 | | |

Dept. Use Only
Plan No.

# PETITION FOR VARIANCE APPLICATION

Safety and Buildings Division
201 W. Washington Ave.
P.O. Box 7162
Madison, WI 53707



PLEASE TYPE OR PRINT CLEARLY - Personal information you provide may be used for secondary purposes [Privacy Law, s.15.04 (1)(m)].

| 1. Owner Information | | 2. Project Information | 3. Designer Information | |
|---|---|---|---|---|
| Name | | Building Occupancy Chapter(s) and Use | Designer | Registration No. |
| Company Name | | Tenant Name (if any) | Design Firm | |
| Number and Street | | Building Location (number and street) | Number and Street | |
| City, State, Zip Code | | ☐ City ☐ Village ☐ Township of | City, State, Zip Code | |
| Contact Person | | County of | Contact Person | |
| Telephone Number ( ) | FAX Number ( ) | Property ID # (tax parcel # - contact county) | Telephone Number ( ) | FAX Number ( ) |

**4. Plan Review Status**

Review by
☐State ☐Municipality

Plan Number _____

☐On hold
☐Preliminary design
☐Approved, requesting revision
☐Submitted with petition
☐Already built
☐Built according to older code but must be brought into compliance with current code
☐Plan will be submitted after petition determination
☐Other

5. State the code section being petitioned AND the specific condition or issue you are requesting be covered under this petition for variance.

6. Reason why compliance with the code cannot be attained without the variance.

7. State your proposed means and rationale of providing equivalent degree of health, safety, or welfare as addressed by the code section petitioned.

8. List attachments to be considered as part of the petitioner's statements (i.e., model code sections, test reports, research articles, expert opinion, previously approved variances, pictures, plans, sketches, etc.).

**VERIFICATION BY OWNER - PETITION IS VALID ONLY IF NOTARIZED WITH AFFIXED SEAL AND ACCOMPANIED BY REVIEW FEE** (See Section Comm 2.52 for complete fee information)

Note: Petitioner must be the owner of the building or project. Tenants, agents, designers, contractors, attorneys, etc., shall not sign petition unless Power of Attorney is submitted with the Petition for Variance Application.

_____, being duly sworn, I state as petitioner that I have read the foregoing petition and I believe it is true and that I have significant ownership rights to the subject building or project.

Petitioner's Name (type or print)

| Petitioner's Signature | Subscribed and sworn to before me this date | Notary Public | My commission expires on |
|---|---|---|---|
| | | | |

**Complete other side for variance requests from ILHR 20-25 and ILHR 50-64.**

SBD-9890 (R.01/98)

| Owner's Name | Project Location | Plan Number |
|---|---|---|
| | | |

Page 2 of _____

## Fire Department Position Statement

To be completed for variances requested from ILHR 50-64, ILHR 69, ILHR 10, and other fire related requirements.

**I have read the application for variance and recommend:** (check appropriate box)

Approval Conditional Approval Denial No Comment

Explanation for recommendation including any conflicts with local rules and regulations and suggested conditions:

| Fire Department Name and Address | |
|---|---|
| Name of Fire Chief or Designee (type or print) | Telephone Number |
| Signature of Fire Chief or Designee | Date Signed |

## MUNICIPAL BUILDING INSPECTION RECOMMENDATION

To be completed for variances requested from ILHR 20-23. Also to be used if ILHR 50-64 plan review is by municipality or orders are written on the building under construction; optional in other cases.

**I have read the application for variance and recommend:** (check appropriate box)

Approval Conditional Approval Denial No Comment

Explanation for recommendation including any conflicts with local rules and regulations and suggested conditions:

| Municipality Exercising Jurisdiction | |
|---|---|
| Name and Address of Municipal Official (type or print) | Telephone Number of Enforcement Official |
| Signature of Municipal Enforcement Official | Date Signed |

SBD-9890 (R.01/98)

## SANITARY PERMIT REQUIREMENTS

Section Comm 20.09 (5) (b) 1. refers to s. Comm 83.25 (2), which reads as follows:

**Comm 83.25 (2)** ISSUANCE OF BUILDING PERMITS. (a) *General.* Pursuant to s. 66.036, Stats., the issuance of building permits by a municipality for unsewered properties shall be in accordance with this subsection.

(b) New construction. A municipality may not issue a building permit to commence construction or installation of a structure that necessitates the use of a POWTS to serve the structure, unless:

1. The owner of the property possesses a sanitary permit for the installation of a POWTS in accordance with s. Comm 83.21; or

**Note:** Section Comm 83.21 outlines the procedures for the issuance of sanitary permits. Sections 145.135 and 145.19, Stats., mandate that no private sewage system may be installed unless the owner of the property holds a valid sanitary permit.

2. A POWTS of adequate capability and capacity to accommodate the wastewater flow and contaminant load already exists to serve the structure.

**Note:** See ss. Comm 83.02 and 83.03 concerning the application of current code requirements to existing POWTS.

(c) *Construction affecting wastewater flow or contaminant load.* 1. A municipality may not issue a building permit to commence construction of any addition or alteration to an existing structure when the proposed construction will modify the design wastewater flow or contaminant load, or both, to an existing POWTS, unless the owner of the property:

a. Possesses a sanitary permit to either modify the existing POWTS or construct a POWTS to accommodate the modification in wastewater flow or contaminant load, or both; or

b. Provides documentation to verify that the existing POWTS is sufficient to accommodate the modification in wastewater flow or contaminant load, or both.

2. For the purpose of this paragraph, a modification in wastewater flow or contaminant load shall be considered to occur:

a. For commercial facilities, public buildings, and places of employment, when there is a proposed change in occupancy of the structure; or the proposed modification affects either the type or number of plumbing appliances, fixtures or devices discharging to the system; and

b. For dwellings, when there is an increase or decrease in the number of bedrooms.

(d) *Documentation of existing capabilities.* Documentation to verify whether an existing POWTS can accommodate a modification in wastewater flow or contaminant load, or both, shall include at least one of the following:

1. A copy of the plan for the existing POWTS that delineates minimum and maximum performance capabilities and which has been previously approved by the department or the governmental unit.

2. Information on the performance capabilities for the existing POWTS that has been recognized through a product approval under ch. Comm 84.

3. A written investigative report prepared by an architect, engineer, designer of plumbing systems, designer of private sewage systems, master plumber, master plumber–restricted service or certified POWTS inspector analyzing the proposed modification and the performance capabilities of the existing POWTS.

(e) *Setbacks.* 1. A municipality may not issue a building permit for construction of any structure or addition to a structure on a site where there exists a POWTS, unless the proposed construction conforms to the applicable setback limitations under s. Comm 83.43 (8) (i).

2. The applicant for a building permit shall provide documentation to the municipality issuing the building permit showing the location and setback distances for the proposed construction relative to all of the following:

a. Existing POWTS treatment components.

b. Existing POWTS holding components.

c. Existing POWTS dispersal components.

**Note:** A municipality which issues building permits may delegate to the governmental unit responsible for issuing sanitary permits the determination of whether the proposed construction will affect or interfere with an existing POWTS relating to capability or location of the existing POWTS.

MINIMUM FASTENER SCHEDULE TABLE

***Other interior and exterior panel products and finishes installed per manufacturer requirements. For engineered connectors, use manufacturer's specified fasteners.***

| Description of Building Materials/Connection | Number and Type of Fastener[1 2 3] |
|---|---|
| **Floor Framing** | |
| Joist to joist, face nailed over support | 2–12d |
| Joist to sill or girder, toe nail | 2–16d, 3–8d |
| *Band or rim joist to joist, end nail* | *3–16d* |
| *Band or rim joist to sill or top plate* | *2–16d at 16" o.c.* |
| Bridging to joist, toe nail each end | 2–8d |
| Built–up girder and beams, top loaded | 10d at 32" o.c. at top and bottom and staggered and two at ends and at each splice |
| Built–up girder and beams, side–loaded | 16d at 16" o.c. at top and bottom and staggered and two at ends and at each splice |
| Ledger strip to beam, face nail | 3–16d each joist |
| Joist on ledger to beam, toe nail | 3–8d |
| **Wall Framing** | |
| Sole plate to joist or blocking, face nail | 16d at 16" o.c. |
| Top or sole plate to stud, end nail | 2–16d |
| Stud to sole plate, toe nail | 4–8d or 3–16d |
| Doubled studs, face nail | 16d at 24" o.c. |
| Doubled top plates, face nail | 16d at 16" o.c. |
| Top plates, laps and intersections, face nail | 2–16d |
| Continuous header, two pieces | 16d at 16" o.c. along each edge |
| Continuous header to stud, toe nail | 4–8d |
| 1" corner brace to each stud and plate, face nail | 2–8d or 2 staples, 1 3/4" |
| Built–up corner studs | 16d at 30" o.c., 16d at 24" o.c. |
| **Roof/Ceiling Framing** | |
| Ceiling joists to plate, toe nail | 2–16d, 3–8d |
| Ceiling joist, laps over partitions, face nail | 3–16d |
| Ceiling joist to parallel rafters, face nail | 3–16d |
| Rafter to plate, toe nail (maximum 6' rafter span, engineered connector for longer) | 2–16d, 3–8d |
| Roof rafters to ridge, valley or hip rafters, toe nail | 4–16d |
| Roof rafters to ridge, valley or hip rafters, face nail | 3–16d |
| Collar ties to rafters, face nail | 3–8d |
| **Boards and planks** | |
| 1" x 6" subfloor or less to each joist, face nail | 2–8d or 2 staples, 1 3/4" |
| Wider than 1" x 6" subfloor toe to each joist, face nail | 3–8d or 4 staples 1 3/4" |
| 2" subfloor to joist or girder, blind and face nail | 2–16d |
| 1" x 6" roof sheathing to each bearing, face nail | 2–8d or 2 staples, 1 3/4" |
| 1" x 8" roof sheathing to each bearing, face nail | 2–8d or 3 staples, 1 3/4" |
| Wider than 1" x 8" roof sheathing to each bearing, face nail | 3–8d or 4 staples, 1 3/4" |
| 2–inch planks | 2–16d at each bearing |

| Panel Sheathing | | | |
|---|---|---|---|
| | | Spacing of Fastener | |
| **Material** | **Fastener** | **Edges** | **Intermediate Supports** |
| Engineered wood panel for subfloor and roof sheathing and wall corner wind bracing to framing | | | |
| 5/16–inch to 1/2–inch | 6d common or deformed nail or staple, 1 1/2" | 6" | 12" [4] |
| 5/8–inch to 3/4–inch | 8d smooth or common, 6d deformed nail, or staple, 14 ga. 1 ¾" | 6" | 12" [4] |
| 7/8–inch to 1–inch | 8d common or deformed nail | 6" | 12" |
| 1 1/8–inch to 1 1/4–inch | 10d smooth or common, or 8d deformed nail | 6" | 12" |
| Combination subfloor/ underlayment to framing | | | |
| 3/4–inch or less | 6d deformed or 8d smooth or common nail | 6" | 12" |
| 7/8–inch to 1–inch | 8d smooth, common or deformed nail | 6" | 12" |
| 1 1/8–inch to 1 1/4–inch | 10d smooth or common or 8d deformed nail | 6" | 12" |
| Wood panel siding to framing | | | |
| 1/2–inch or less | 6d corrosion–resistant siding and casing nails | 6" | 12" |
| 5/8–inch | 8d corrosion–resistant siding and casing nails | 6" | 12" |

[1]All nails are smooth–common, box or deformed shank except where otherwise stated
[2]Nail is a general description and may be T–head, modified round head or round head.
[3]Staples are 16–gauge wire, unless otherwise noted, and have a minimum 7/16–inch o.d. crown width.
[4]Staples shall be spaced at not more than 10 inches o.c. at intermediate supports for floors.

## UDC Floor & Ceiling Joist and Roof Rafter Span Tables And Design Value Tables

Use the following Span Tables to determine the maximum spans for floor and ceiling joists and roof rafters. These spans are based on:

- simple, single spans (although the tables may be safely used for continuous two–span floor joists)
- uniformly distributed loads
- fully supported members with one edge properly sheathed and nailed
- for floor joists and roof rafters, the top edge shall be properly sheathed and nailed

The criteria for each Span Table is given in the upper left hand corner and is also summarized in the table of Span Tables below. Choose the appropriate Span Table based on the member type and required loading. Select your desired member depth, member spacing and span to determine the minimum Fb value. Note that these tables include recommended deflection criteria. However, for strict code compliance, only the Fb strength requirements must be satisfied. The modulus of elasticity (E) values, would be met for serviceability purposes only.

Note that straight–line interpolation is permitted for intermediate spans and design values. Span is measured from face to face of supports plus one–half of the required bearing of 3" at each end. For sloping rafters, the span is measured along the horizontal projection.

Section Comm 21.27 allows reduction of the snow live load for roof slopes greater than 30 degrees (7/12 slope) based on the formula $Cs = 1 - (a–30)/40$, where "a" is the slope of the roof expressed in degrees. Following is a table of tabulated values for certain roof slopes.

| Slope | Angle in Degrees | Zone 1 Live Load (psf) | Zone 2 Live Load (psf) |
|---|---|---|---|
| 7/12 | 30 | 40 | 30 |
| 10/12 | 40 | 30 | 22.5 |
| 12/12 | 45 | 25 | 18.8 |
| 14/12 | 50 | 20 | 15 |

Use the Design Value tables following the Span Tables to determine the acceptable species and grades to satisfy minimum Fb values obtained from the Span Tables. The Design Value tables assume at least three members spaced no more than 24" on center. Use the Normal Duration column Fb values for joists and the Snow Loading column Fb values for rafters.

See the following examples for further guidance.

**Tables are reprinted courtesy of American Forest & Paper Association.**

| Table No. | Member Type | Live Load (psf) | Dead Load (psf) | Condition | (Deflection)* |
|---|---|---|---|---|---|
| F–2 | Floor Joists | 40 | 10 | – | L/360 |
| C–1 | Ceiling Joists | 10 | 5 | Drywall ceiling, no attic storage | L/240 |
| C–2 | Ceiling Joists | 20 | 10 | Attic storage | L/240 |
| R–2 | Roof Rafters | 30 (Zone 2) | 10 | Maximum 2 layers of asphalt shingles or wood shakes/shingles | L/240 |
| R–3 | Roof Rafters | 40 (Zone 1) | 10 | Maximum 2 layers of asphalt shingles or wood shakes/shingles | L/240 |
| R–10 | Roof Rafters | 30 (Zone 2) | 20 | Heavy roof covering (clay tile) | L/240 |
| R–11 | Roof Rafters | 40 (Zone 1) | 20 | Heavy roof covering (clay tile) | L/240 |
| R–14 | Roof Rafters | 30 (Zone 2) | 10 | Maximum 2 layers of asphalt shingles or wood shakes/shingles | L/180 |
| R–15 | Roof Rafters | 40 (Zone 1) | 10 | Maximum 2 layers of asphalt shingles or wood shakes/shingles | L/180 |
| R–22 | Roof Rafters | 30 (Zone 2) | 20 | Heavy roof covering (clay tile) | L/180 |
| R–23 | Roof Rafters | 40 (Zone 1) | 20 | Heavy roof covering (clay tile) | L/180 |

*Deflection criteria are optional. For roof rafters with drywall on the underside, use the stricter L/240 tables to li deflection.

**Example 1. Floor Joists.** Assume a required single span of 12'–9", dead load of 10 psf and joists spaced 16 inches on center. Table F–2 (see following highlighted tables) shows that one solution is a grade of 2x8 having an Fb value of 1255 would allow a span of 12'–10 which satisfies the condition. (Note that the recommended E value to limit deflection would be 1,600,000.) Going to the Design Value Tables, we find that as an example, 2x8 Hem Fir grade No.1 has an Fb value of 1310 for normal duration. (It also has an E value of 1,500,000 which does **not** satisfy the recommended deflection criteria.)

**Example 2. Rafters.** Assume a horizontal projected span of 13'–0", a live load of 40 psf, dead load of 10 psf, a roof slope of 4/12 and rafters spaced 16 inches on center. Since the slope is shallower than 7/12, there is no allowable reduction of the snow live load. Table R–3 shows that a 2x8 having an Fb value of 1300 would allow a span of 13'–1" which satisfies the condition. (Note that the recommended E value to limit deflection would be 1,120,000.) Going to the Design Value Tables, we find that as an example, 2x8 Douglas Fir–Larch grade No.2 has an Fb value of 1390 for snow loading. (It also has an E value of 1,600,000 which satisfies the recommended deflection criteria.)

# Example 1

## TABLE F- 2

## FLOOR JOISTS WITH L/360 DEFLECTION LIMITS

**DESIGN CRITERIA:**
Deflection - For 40 psf live load.
Limited to span in inches divided by 360.
Strength - Live load of 40 psf plus dead load
of 10 psf determines the required bending design value.

| Joist Size (in) | Spacing (in) | 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 |
| | 12.0 | 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- 9 | 11-11 | 12- 1 | 12- 3 |
| | 16.0 | 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- 8 | 10-10 | 11- 0 | 11- 2 |
| 2x 6 | 19.2 | 7- 3 | 7- 7 | 7-10 | 8- 1 | 8- 4 | 8- 7 | 8- 9 | 9- 0 | 9- 2 | 9- 4 | 9- 6 | 9- 8 | 9-10 | 10- 0 | 10- 2 | 10- 4 | 10- 6 |
| | 24.0 | 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 |
| | 12.0 | 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- 6 | 15- 9 | 15-11 | 16- 2 |
| | 16.0 | 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- 1 | 14- 3 | 14- 6 | 14- 8 |
| 2x 8 | 19.2 | 9- 7 | 10- 0 | 10- 4 | 10- 8 | 11- 0 | 11- 3 | 11- 7 | 11-10 | 12- 1 | 12- 4 | 12- 7 | 12-10 | 13- 0 | 13- 3 | 13- 5 | 13- 8 | 13-10 |
| | 24.0 | 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 |
| | 12.0 | 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 | 19- 9 | 20- 1 | 20- 4 | 20- 8 |
| | 16.0 | 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 | 17-11 | 18- 3 | 18- 6 | 18- 9 |
| 2x10 | 19.2 | 12- 3 | 12- 9 | 13- 2 | 13- 7 | 14- 0 | 14- 5 | 14- 9 | 15- 1 | 15- 5 | 15- 9 | 16- 0 | 16- 4 | 16- 7 | 16-11 | 17- 2 | 17- 5 | 17- 8 |
| | 24.0 | 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 |
| | 12.0 | 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- 0 | 24- 5 | 24- 9 | 25- 1 |
| | 16.0 | 15-10 | 16- 5 | 17- 0 | 17- 7 | 18- 1 | 18- 7 | 19- 1 | 19- 6 | 19-11 | 20- 4 | 20- 9 | 21- 1 | 21- 6 | 21-10 | 22- 2 | 22- 6 | 22-10 |
| 2x12 | 19.2 | 14-11 | 15- 6 | 16- 0 | 16- 7 | 17- 0 | 17- 6 | 17-11 | 18- 4 | 18- 9 | 19- 2 | 19- 6 | 19-10 | 20- 2 | 20- 6 | 20-10 | 21- 2 | 21- 6 |
| | 24.0 | 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 |
| $F_b$ | 12.0 | 718 | 777 | 833 | 888 | 941 | 993 | 1043 | 1092 | 1140 | 1187 | 1233 | 1278 | 1323 | 1367 | 1410 | 1452 | 1494 |
| $F_b$ | 16.0 | 790 | 855 | 917 | 977 | 1036 | 1093 | 1148 | 1202 | 1255 | 1306 | 1357 | 1407 | 1456 | 1504 | 1551 | 1598 | 1644 |
| $F_b$ | 19.2 | 840 | 909 | 975 | 1039 | 1101 | 1161 | 1220 | 1277 | 1333 | 1388 | 1442 | 1495 | 1547 | 1598 | 1649 | 1698 | 1747 |
| $F_b$ | 24.0 | 905 | 979 | 1050 | 1119 | 1186 | 1251 | 1314 | 1376 | 1436 | 1496 | 1554 | 1611 | 1667 | 1722 | 1776 | 1829 | 1882 |

Note: The required bending design value, $F_b$, in pounds per square inch is shown at the bottom of each table and is applicable to all lumber sizes shown. Spans are shown in feet-inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# Example 1

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Eastern White Pine** | | | | | |
| Select Structural | 2x4 | 2155 | 2480 | 1,200,000 | NELMA NSLB |
| No.1 | | 1335 | 1535 | 1,100,000 | |
| No.2 | | 990 | 1140 | 1,100,000 | |
| No.3 | | 605 | 695 | 900,000 | |
| Stud | | 570 | 655 | 900,000 | |
| Construction | | 775 | 895 | 1,000,000 | |
| Standard | | 430 | 495 | 900,000 | |
| Utility | | 200 | 230 | 800,000 | |
| Select Structural | 2x6 | 1870 | 2150 | 1,200,000 | |
| No.1 | | 1160 | 1330 | 1,100,000 | |
| No.2 | | 860 | 990 | 1,100,000 | |
| No.3 | | 525 | 600 | 900,000 | |
| Stud | | 520 | 595 | 900,000 | |
| Select Structural | 2x8 | 1725 | 1985 | 1,200,000 | |
| No.1 | | 1070 | 1230 | 1,100,000 | |
| No.2 | | 795 | 915 | 1,100,000 | |
| No.3 | | 485 | 555 | 900,000 | |
| Select Structural | 2x10 | 1580 | 1820 | 1,200,000 | |
| No.1 | | 980 | 1125 | 1,100,000 | |
| No.2 | | 725 | 835 | 1,100,000 | |
| No.3 | | 445 | 510 | 900,000 | |
| Select Structural | 2x12 | 1440 | 1655 | 1,200,000 | |
| No.1 | | 890 | 1025 | 1,100,000 | |
| No.2 | | 660 | 760 | 1,100,000 | |
| No.3 | | 405 | 465 | 900,000 | |
| **Hem Fir** | | | | | |
| Select Structural | 2x4 | 2415 | 2775 | 1,600,000 | WCLIB WWPA |
| No.1 & Btr | | 1810 | 2085 | 1,500,000 | |
| No.1 | | 1640 | 1885 | 1,500,000 | |
| No.2 | | 1465 | 1685 | 1,300,000 | |
| No.3 | | 865 | 990 | 1,200,000 | |
| Stud | | 855 | 980 | 1,200,000 | |
| Construction | | 1120 | 1290 | 1,300,000 | |
| Standard | | 635 | 725 | 1,200,000 | |
| Utility | | 290 | 330 | 1,100,000 | |
| Select Structural | 2x6 | 2095 | 2405 | 1,600,000 | |
| No.1 & Btr | | 1570 | 1805 | 1,500,000 | |
| No.1 | | 1420 | 1635 | 1,500,000 | |
| No.2 | | 1270 | 1460 | 1,300,000 | |
| No.3 | | 750 | 860 | 1,200,000 | |
| Stud | | 775 | 895 | 1,200,000 | |
| Select Structural | 2x8 | 1930 | 2220 | 1,600,000 | |
| No.1 & Btr | | 1450 | 1665 | 1,500,000 | |
| No.1 | | 1310 | 1510 | 1,500,000 | |
| No.2 | | 1175 | 1350 | 1,300,000 | |
| No.3 | | 690 | 795 | 1,200,000 | |
| Select Structural | 2x10 | 1770 | 2035 | 1,600,000 | |
| No.1 & Btr | | 1330 | 1525 | 1,500,000 | |
| No.1 | | 1200 | 1380 | 1,500,000 | |
| No.2 | | 1075 | 1235 | 1,300,000 | |
| No.3 | | 635 | 725 | 1,200,000 | |
| Select Structural | 2x12 | 1610 | 1850 | 1,600,000 | |
| No.1 & Btr | | 1210 | 1390 | 1,500,000 | |
| No.1 | | 1095 | 1255 | 1,500,000 | |
| No.2 | | 980 | 1125 | 1,300,000 | |
| No.3 | | 575 | 660 | 1,200,000 | |

# Example 2

## TABLE R-3

## RAFTERS WITH L/240 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength - Live Load of 40 psf plus
Dead Load of 10 psf determines the required bending design value.
Deflection - For 40 psf live load.
Limited to span in inches divided by 240.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psi) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 |
| | 12.0 | 5-6 | 6-4 | 7-1 | 7-9 | 8-5 | 9-0 | 9-6 | 10-0 | 10-6 | 11-0 | 11-5 | 11-11 | 12-4 | 12-8 | 13-1 | 13-6 | 13-10 | 14-2 | | | | |
| | 16.0 | 4-9 | 5-6 | 6-2 | 6-9 | 7-3 | 7-9 | 8-3 | 8-8 | 9-1 | 9-6 | 9-11 | 10-3 | 10-8 | 11-0 | 11-4 | 11-8 | 12-0 | 12-4 | 12-7 | 12-11 | | |
| 2x 6 | 19.2 | 4-4 | 5-0 | 5-7 | 6-2 | 6-8 | 7-1 | 7-6 | 7-11 | 8-4 | 8-8 | 9-1 | 9-5 | 9-9 | 10-0 | 10-4 | 10-8 | 10-11 | 11-3 | 11-6 | 11-9 | 12-0 | 12-4 |
| | 24.0 | 3-11 | 4-6 | 5-0 | 5-6 | 5-11 | 6-4 | 6-9 | 7-1 | 7-5 | 7-9 | 8-1 | 8-5 | 8-8 | 9-0 | 9-3 | 9-6 | 9-9 | 10-0 | 10-3 | 10-6 | 10-9 | 11-0 |
| | 12.0 | 7-3 | 8-4 | 9-4 | 10-3 | 11-1 | 11-10 | 12-7 | 13-3 | 13-11 | 14-6 | 15-1 | 15-8 | 16-3 | 16-9 | 17-3 | 17-9 | 18-3 | 18-9 | | | | |
| | 16.0 | 6-3 | 7-3 | 8-1 | 8-11 | 9-7 | 10-3 | 10-10 | 11-6 | 12-0 | 12-7 | 13-1 | 13-7 | 14-0 | 14-6 | 14-11 | 15-5 | 15-10 | 16-3 | 16-7 | 17-0 | | |
| 2x 8 | 19.2 | 5-9 | 6-7 | 7-5 | 8-1 | 8-9 | 9-4 | 9-11 | 10-6 | 11-0 | 11-6 | 11-11 | 12-5 | 12-10 | 13-3 | 13-8 | 14-0 | 14-5 | 14-10 | 15-2 | 15-6 | 15-10 | 16-3 |
| | 24.0 | 5-2 | 5-11 | 6-7 | 7-3 | 7-10 | 8-4 | 8-11 | 9-4 | 9-10 | 10-3 | 10-8 | 11-1 | 11-6 | 11-10 | 12-2 | 12-7 | 12-11 | 13-3 | 13-7 | 13-11 | 14-2 | 14-6 |
| | 12.0 | 9-3 | 10-8 | 11-11 | 13-1 | 14-2 | 15-1 | 16-0 | 16-11 | 17-9 | 18-6 | 19-3 | 20-0 | 20-8 | 21-4 | 22-0 | 22-8 | 23-3 | 23-11 | | | | |
| | 16.0 | 8-0 | 9-3 | 10-4 | 11-4 | 12-3 | 13-1 | 13-10 | 14-8 | 15-4 | 16-0 | 16-8 | 17-4 | 17-11 | 18-6 | 19-1 | 19-7 | 20-2 | 20-8 | 21-2 | 21-8 | | |
| 2x10 | 19.2 | 7-4 | 8-5 | 9-5 | 10-4 | 11-2 | 11-11 | 12-8 | 13-4 | 14-0 | 14-8 | 15-3 | 15-10 | 16-4 | 16-11 | 17-5 | 17-11 | 18-5 | 18-11 | 19-4 | 19-10 | 20-3 | 20-8 |
| | 24.0 | 6-6 | 7-7 | 8-5 | 9-3 | 10-0 | 10-8 | 11-4 | 11-11 | 12-6 | 13-1 | 13-7 | 14-2 | 14-8 | 15-1 | 15-7 | 16-0 | 16-6 | 16-11 | 17-4 | 17-9 | 18-1 | 18-6 |
| | 12.0 | 11-3 | 13-0 | 14-6 | 15-11 | 17-2 | 18-4 | 19-6 | 20-6 | 21-7 | 22-6 | 23-5 | 24-4 | 25-2 | 26-0 | | | | | | | | |
| | 16.0 | 9-9 | 11-3 | 12-7 | 13-9 | 14-11 | 15-11 | 16-10 | 17-9 | 18-8 | 19-6 | 20-3 | 21-1 | 21-9 | 22-6 | 23-2 | 23-10 | 24-6 | 25-2 | 25-9 | | | |
| 2x12 | 19.2 | 8-11 | 10-3 | 11-6 | 12-7 | 13-7 | 14-6 | 15-5 | 16-3 | 17-0 | 17-9 | 18-6 | 19-3 | 19-11 | 20-6 | 21-2 | 21-9 | 22-5 | 23-0 | 23-6 | 24-1 | 24-8 | 25-2 |
| | 24.0 | 7-11 | 9-2 | 10-3 | 11-3 | 12-2 | 13-0 | 13-9 | 14-6 | 15-3 | 15-11 | 16-7 | 17-2 | 17-9 | 18-4 | 18-11 | 19-6 | 20-0 | 20-6 | 21-1 | 21-7 | 22-0 | 22-6 |
| E | 12.0 | 0.14 | 0.22 | 0.31 | 0.41 | 0.51 | 0.63 | 0.75 | 0.88 | 1.01 | 1.15 | 1.30 | 1.45 | 1.61 | 1.77 | 1.94 | 2.12 | 2.30 | 2.48 | | | | |
| E | 16.0 | 0.12 | 0.19 | 0.27 | 0.35 | 0.44 | 0.54 | 0.65 | 0.76 | 0.88 | 1.00 | 1.12 | 1.26 | 1.39 | 1.54 | 1.68 | 1.83 | 1.99 | 2.15 | 2.31 | 2.48 | | |
| E | 19.2 | 0.11 | 0.18 | 0.24 | 0.32 | 0.41 | 0.50 | 0.59 | 0.69 | 0.80 | 0.91 | 1.03 | 1.15 | 1.27 | 1.40 | 1.54 | 1.67 | 1.81 | 1.96 | 2.11 | 2.26 | 2.42 | 2.58 |
| E | 24.0 | 0.10 | 0.16 | 0.22 | 0.29 | 0.36 | 0.44 | 0.53 | 0.62 | 0.71 | 0.81 | 0.92 | 1.03 | 1.14 | 1.25 | 1.37 | 1.50 | 1.62 | 1.75 | 1.89 | 2.02 | 2.16 | 2.30 |

Note: The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet-inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

## Example 2

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Cottonwood** | | | | | |
| Select Structural | 2x4 | 1510 | 1735 | 1,200,000 | NSLB |
| No.1 | | 1080 | 1240 | 1,200,000 | |
| No.2 | | 1080 | 1240 | 1,100,000 | |
| No.3 | | 605 | 695 | 1,000,000 | |
| Stud | | 600 | 690 | 1,000,000 | |
| Construction | | 805 | 925 | 1,000,000 | |
| Standard | | 460 | 530 | 900,000 | |
| Utility | | 200 | 230 | 900,000 | |
| Select Structural | 2x6 | 1310 | 1505 | 1,200,000 | |
| No.1 | | 935 | 1075 | 1,200,000 | |
| No.2 | | 935 | 1075 | 1,100,000 | |
| No.3 | | 525 | 600 | 1,000,000 | |
| Stud | | 545 | 630 | 1,000,000 | |
| Select Structural | 2x8 | 1210 | 1390 | 1,200,000 | |
| No.1 | | 865 | 990 | 1,200,000 | |
| No.2 | | 865 | 990 | 1,100,000 | |
| No.3 | | 485 | 555 | 1,000,000 | |
| Select Structural | 2x10 | 1105 | 1275 | 1,200,000 | |
| No.1 | | 790 | 910 | 1,200,000 | |
| No.2 | | 790 | 910 | 1,100,000 | |
| No.3 | | 445 | 510 | 1,000,000 | |
| Select Structural | 2x12 | 1005 | 1155 | 1,200,000 | |
| No.1 | | 720 | 825 | 1,200,000 | |
| No.2 | | 720 | 825 | 1,100,000 | |
| No.3 | | 405 | 465 | 1,000,000 | |
| **Douglas Fir-Larch** | | | | | |
| Select Structural | 2x4 | 2500 | 2875 | 1,900,000 | WCLIB WWPA |
| No.1 & Btr | | 1985 | 2280 | 1,800,000 | |
| No.1 | | 1725 | 1985 | 1,700,000 | |
| No.2 | | 1510 | 1735 | 1,600,000 | |
| No.3 | | 865 | 990 | 1,400,000 | |
| Stud | | 855 | 980 | 1,400,000 | |
| Construction | | 1150 | 1325 | 1,500,000 | |
| Standard | | 635 | 725 | 1,400,000 | |
| Utility | | 315 | 365 | 1,300,000 | |
| Select Structural | 2x6 | 2170 | 2495 | 1,900,000 | |
| No.1 & Btr | | 1720 | 1975 | 1,800,000 | |
| No.1 | | 1495 | 1720 | 1,700,000 | |
| No.2 | | 1310 | 1505 | 1,600,000 | |
| No.3 | | 750 | 860 | 1,400,000 | |
| Stud | | 775 | 895 | 1,400,000 | |
| Select Structural | 2x8 | 2000 | 2300 | 1,900,000 | |
| No.1 & Str | | 1585 | 1825 | 1,800,000 | |
| No.1 | | 1380 | 1585 | 1,700,000 | |
| No.2 | | 1210 | 1390 | 1,600,000 | |
| No.3 | | 690 | 795 | 1,400,000 | |
| Select Structural | 2x10 | 1835 | 2110 | 1,900,000 | |
| No.1 & Btr | | 1455 | 1675 | 1,800,000 | |
| No.1 | | 1265 | 1455 | 1,700,000 | |
| No.2 | | 1105 | 1275 | 1,600,000 | |
| No.3 | | 635 | 725 | 1,400,000 | |
| Select Structural | 2x12 | 1670 | 1920 | 1,900,000 | |
| No.1 & Btr | | 1325 | 1520 | 1,800,000 | |
| No.1 | | 1150 | 1325 | 1,700,000 | |
| No.2 | | 1005 | 1155 | 1,600,000 | |
| No.3 | | 575 | 660 | 1,400,000 | |

# TABLE F– 2
# FLOOR JOISTS WITH L/360 DEFLECTION LIMITS

**DESIGN CRITERIA:**
Deflection – For 40 psf live load.
Limited to span in inches divided by 360.
Strength – Live load of 40 psf plus dead load
of 10 psf determines the required bending design value.

| Joist Size (in) | Spacing (in) | 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 |
| | 12.0 | 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 | 11–9 | 11–11 | 12–1 | 12–3 |
| | 16.0 | 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 | 10–8 | 10–10 | 11–0 | 11–2 |
| 2x 6 | 19.2 | 7–3 | 7–7 | 7–10 | 8–1 | 8–4 | 8–7 | 8–9 | 9–0 | 9–2 | 9–4 | 9–6 | 9–8 | 9–10 | 10–0 | 10–2 | 10–4 | 10–6 |
| | 24.0 | 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 |
| | 12.0 | 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 | 15–6 | 15–9 | 15–11 | 16–2 |
| | 16.0 | 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 | 14–1 | 14–3 | 14–6 | 14–8 |
| 2x 8 | 19.2 | 9–7 | 10–0 | 10–4 | 10–8 | 11–0 | 11–3 | 11–7 | 11–10 | 12–1 | 12–4 | 12–7 | 12–10 | 13–0 | 13–3 | 13–5 | 13–8 | 13–10 |
| | 24.0 | 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 |
| | 12.0 | 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 | 19–9 | 20–1 | 20–4 | 20–8 |
| | 16.0 | 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 | 17–11 | 18–3 | 18–6 | 18–9 |
| 2x10 | 19.2 | 12–3 | 12–9 | 13–2 | 13–7 | 14–0 | 14–5 | 14–9 | 15–1 | 15–5 | 15–9 | 16–0 | 16–4 | 16–7 | 16–11 | 17–2 | 17–5 | 17–8 |
| | 24.0 | 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 |
| | 12.0 | 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 | 24–0 | 24–5 | 24–9 | 25–1 |
| | 16.0 | 15–10 | 16–5 | 17–0 | 17–7 | 18–1 | 18–7 | 19–1 | 19–6 | 19–11 | 20–4 | 20–9 | 21–1 | 21–6 | 21–10 | 22–2 | 22–6 | 22–10 |
| 2x12 | 19.2 | 14–11 | 15–6 | 16–0 | 16–7 | 17–0 | 17–6 | 17–11 | 18–4 | 18–9 | 19–2 | 19–6 | 19–10 | 20–2 | 20–6 | 20–10 | 21–2 | 21–6 |
| | 24.0 | 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 |
| $F_b$ | 12.0 | 718 | 777 | 833 | 888 | 941 | 993 | 1043 | 1092 | 1140 | 1187 | 1233 | 1278 | 1323 | 1367 | 1410 | 1452 | 1494 |
| $F_b$ | 16.0 | 790 | 855 | 917 | 977 | 1036 | 1093 | 1148 | 1202 | 1255 | 1306 | 1357 | 1407 | 1456 | 1504 | 1551 | 1598 | 1644 |
| $F_b$ | 19.2 | 840 | 909 | 975 | 1039 | 1101 | 1161 | 1220 | 1277 | 1333 | 1388 | 1442 | 1495 | 1547 | 1598 | 1649 | 1698 | 1747 |
| $F_b$ | 24.0 | 905 | 979 | 1050 | 1119 | 1186 | 1251 | 1314 | 1376 | 1436 | 1496 | 1554 | 1611 | 1667 | 1722 | 1776 | 1829 | 1882 |

Note: The required bending design value, $F_b$, in pounds per square inch is shown at the bottom of each table and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE C–1
# CEILING JOISTS WITH L/240 DEFLECTION LIMITS

**DESIGN CRITERIA:**
Deflection – For 10 psf live load.
Limited to span in inches divided by 240.
Strength – Live Load of 10 psf plus
dead load of 5 psf determines the required fiber stress value.

| Joist Size (in) | Spacing (in) | 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 |
| | 12.0 | 9–10 | 10–3 | 10–7 | 10–11 | 11–3 | 11–7 | 11–10 | 12–2 | 12–5 | 12–8 | 12–11 | 13–2 | 13–4 | 13–7 | 13–9 | 14–0 | 14–2 |
| | 16.0 | 8–11 | 9–4 | 9–8 | 9–11 | 10–3 | 10–6 | 10–9 | 11–0 | 11–3 | 11–6 | 11–9 | 11–11 | 12–2 | 12–4 | 12–6 | 12–9 | 12–11 |
| 2x 4 | 19.2 | 8–5 | 8–9 | 9–1 | 9–4 | 9–8 | 9–11 | 10–2 | 10–4 | 10–7 | 10–10 | 11–0 | 11–3 | 11–5 | 11–7 | 11–9 | 12–0 | 12–2 |
| | 24.0 | 7–10 | 8–1 | 8–5 | 8–8 | 8–11 | 9–2 | 9–5 | 9–8 | 9–10 | 10–0 | 10–3 | 10–5 | 10–7 | 10–9 | 10–11 | 11–1 | 11–3 |
| | 12.0 | 15–6 | 16–1 | 16–8 | 17–2 | 17–8 | 18–2 | 18–8 | 19–1 | 19–6 | 19–11 | 20–3 | 20–8 | 21–0 | 21–4 | 21–8 | 22–0 | 22–4 |
| | 16.0 | 14–1 | 14–7 | 15–2 | 15–7 | 16–1 | 16–6 | 16–11 | 17–4 | 17–8 | 18–1 | 18–5 | 18–9 | 19–1 | 19–5 | 19–8 | 20–0 | 20–3 |
| 2x 6 | 19.2 | 13–3 | 13–9 | 14–3 | 14–8 | 15–2 | 15–7 | 15–11 | 16–4 | 16–8 | 17–0 | 17–4 | 17–8 | 17–11 | 18–3 | 18–6 | 18–10 | 19–1 |
| | 24.0 | 12–3 | 12–9 | 13–3 | 13–8 | 14–1 | 14–5 | 14–9 | 15–2 | 15–6 | 15–9 | 16–1 | 16–4 | 16–8 | 16–11 | 17–2 | 17–5 | 17–8 |
| | 12.0 | 20–5 | 21–2 | 21–11 | 22–8 | 23–4 | 24–0 | 24–7 | 25–2 | 25–8 | | | | | | | | |
| | 16.0 | 18–6 | 19–3 | 19–11 | 20–7 | 21–2 | 21–9 | 22–4 | 22–10 | 23–4 | 23–10 | 24–3 | 24–8 | 25–2 | 25–7 | 25–11 | | |
| 2x 8 | 19.2 | 17–5 | 18–1 | 18–9 | 19–5 | 19–11 | 20–6 | 21–0 | 21–6 | 21–11 | 22–5 | 22–10 | 23–3 | 23–8 | 24–0 | 24–5 | 24–9 | 25–2 |
| | 24.0 | 16–2 | 16–10 | 17–5 | 18–0 | 18–6 | 19–0 | 19–6 | 19–11 | 20–5 | 20–10 | 21–2 | 21–7 | 21–11 | 22–4 | 22–8 | 23–0 | 23–4 |
| | 12.0 | 26–0 | | | | | | | | | | | | | | | | |
| | 16.0 | 23–8 | 24–7 | 25–5 | | | | | | | | | | | | | | |
| 2x10 | 19.2 | 22–3 | 23–1 | 23–11 | 24–9 | 25–5 | | | | | | | | | | | | |
| | 24.0 | 20–8 | 21–6 | 22–3 | 22–11 | 23–8 | 24–3 | 24–10 | 25–5 | 26–0 | | | | | | | | |
| $F_b$ | 12.0 | 711 | 769 | 825 | 880 | 932 | 983 | 1033 | 1082 | 1129 | 1176 | 1221 | 1266 | 1310 | 1354 | 1396 | 1438 | 1480 |
| $F_b$ | 16.0 | 783 | 847 | 909 | 968 | 1026 | 1082 | 1137 | 1191 | 1243 | 1294 | 1344 | 1394 | 1442 | 1490 | 1537 | 1583 | 1629 |
| $F_b$ | 19.2 | 832 | 900 | 965 | 1029 | 1090 | 1150 | 1208 | 1265 | 1321 | 1375 | 1429 | 1481 | 1533 | 1583 | 1633 | 1682 | 1731 |
| $F_b$ | 24.0 | 896 | 969 | 1040 | 1108 | 1174 | 1239 | 1302 | 1363 | 1423 | 1481 | 1539 | 1595 | 1651 | 1706 | 1759 | 1812 | 1864 |

Note: The required bending design value, $F_b$, in pounds per square inch is shown at the bottom of each table and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE C–2
# CEILING JOISTS WITH L/240 DEFLECTION LIMITS

**DESIGN CRITERIA:**
Deflection – For 20 psf live load.
Limited to span in inches divided by 240.
Strength – Live Load of 20 psf plus
dead load of 10 psf determines the required bending design value.

| Size (in) | Spacing (in) | Joist 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 |
| | 12.0 | 7–10 | 8–1 | 8–5 | 8–8 | 8–11 | 9–2 | 9–5 | 9–8 | 9–10 | 10–0 | 10–3 | 10–5 | 10–7 | 10–9 | 10–11 | 11–1 | 11–3 |
| | 16.0 | 7–1 | 7–5 | 7–8 | 7–11 | 8–1 | 8–4 | 8–7 | 8–9 | 8–11 | 9–1 | 9–4 | 9–6 | 9–8 | 9–9 | 9–11 | 10–1 | 10–3 |
| 2x 4 | 19.2 | 6–8 | 6–11 | 7–2 | 7–5 | 7–8 | 7–10 | 8–1 | 8–3 | 8–5 | 8–7 | 8–9 | 8–11 | 9–1 | 9–3 | 9–4 | 9–6 | 9–8 |
| | 24.0 | 6–2 | 6–5 | 6–8 | 6–11 | 7–1 | 7–3 | 7–6 | 7–8 | 7–10 | 8–0 | 8–1 | 8–3 | 8–5 | 8–7 | 8–8 | 8–10 | 8–11 |
| | 12.0 | 12–3 | 12–9 | 13–3 | 13–8 | 14–1 | 14–5 | 14–9 | 15–2 | 15–6 | 15–9 | 16–1 | 16–4 | 16–8 | 16–11 | 17–2 | 17–5 | 17–8 |
| | 16.0 | 11–2 | 11–7 | 12–0 | 12–5 | 12–9 | 13–1 | 13–5 | 13–9 | 14–1 | 14–4 | 14–7 | 14–11 | 15–2 | 15–5 | 15–7 | 15–10 | 16–1 |
| 2x 6 | 19.2 | 10–6 | 10–11 | 11–4 | 11–8 | 12–0 | 12–4 | 12–8 | 12–11 | 13–3 | 13–6 | 13–9 | 14–0 | 14–3 | 14–6 | 14–8 | 14–11 | 15–2 |
| | 24.0 | 9–9 | 10–2 | 10–6 | 10–10 | 11–2 | 11–5 | 11–9 | 12–0 | 12–3 | 12–6 | 12–9 | 13–0 | 13–3 | 13–5 | 13–8 | 13–10 | 14–1 |
| | 12.0 | 16–2 | 16–10 | 17–5 | 18–0 | 18–6 | 19–0 | 19–6 | 19–11 | 20–5 | 20–10 | 21–2 | 21–7 | 21–11 | 22–4 | 22–8 | 23–0 | 23–4 |
| | 16.0 | 14–8 | 15–3 | 15–10 | 16–4 | 16–10 | 17–3 | 17–9 | 18–1 | 18–6 | 18–11 | 19–3 | 19–7 | 19–11 | 20–3 | 20–7 | 20–11 | 21–2 |
| 2x 8 | 19.2 | 13–10 | 14–5 | 14–11 | 15–5 | 15–10 | 16–3 | 16–8 | 17–1 | 17–5 | 17–9 | 18–1 | 18–5 | 18–9 | 19–1 | 19–5 | 19–8 | 19–11 |
| | 24.0 | 12–10 | 13–4 | 13–10 | 14–3 | 14–8 | 15–1 | 15–6 | 15–10 | 16–2 | 16–6 | 16–10 | 17–2 | 17–5 | 17–9 | 18–0 | 18–3 | 18–6 |
| | 12.0 | 20–8 | 21–6 | 22–3 | 22–11 | 23–8 | 24–3 | 24–10 | 25–5 | 26–0 | | | | | | | | |
| | 16.0 | 18–9 | 19–6 | 20–2 | 20–10 | 21–6 | 22–1 | 22–7 | 23–1 | 23–8 | 24–1 | 24–7 | 25–0 | 25–5 | 25–10 | | | |
| 2x10 | 19.2 | 17–8 | 18–4 | 19–0 | 19–7 | 20–2 | 20–9 | 21–3 | 21–9 | 22–3 | 22–8 | 23–1 | 23–7 | 23–11 | 24–4 | 24–9 | 25–1 | 25–5 |
| | 24.0 | 16–5 | 17–0 | 17–8 | 18–3 | 18–9 | 19–3 | 19–9 | 20–2 | 20–8 | 21–1 | 21–6 | 21–10 | 22–3 | 22–7 | 22–11 | 23–4 | 23–8 |
| $F_b$ | 12.0 | 896 | 969 | 1040 | 1108 | 1174 | 1239 | 1302 | 1363 | 1423 | 1481 | 1539 | 1595 | 1651 | 1706 | 1759 | 1812 | 1864 |
| $F_b$ | 16.0 | 986 | 1067 | 1145 | 1220 | 1293 | 1364 | 1433 | 1500 | 1566 | 1631 | 1694 | 1756 | 1817 | 1877 | 1936 | 1995 | 2052 |
| $F_b$ | 19.2 | 1048 | 1134 | 1216 | 1296 | 1374 | 1449 | 1522 | 1594 | 1664 | 1733 | 1800 | 1866 | 1931 | 1995 | 2058 | 2120 | 2181 |
| $F_b$ | 24.0 | 1129 | 1221 | 1310 | 1396 | 1480 | 1561 | 1640 | 1717 | 1793 | 1866 | 1939 | 2010 | 2080 | 2149 | 2217 | 2283 | 2349 |

Note: The required bending design value, $F_b$, in pounds per square inch is shown at the bottom of each table and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less.Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R–2
# RAFTERS WITH L/240 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 30 psf plus
Dead Load of 10 psf determines the required bending design value.
Deflection – For 30 psf live load.
Limited to span in inches divided by 240.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psi) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 |
| | 12.0 | 6–2 | 7–1 | 7–11 | 8–8 | 9–5 | 10–0 | 10–8 | 11–3 | 11–9 | 12–4 | 12–10 | 13–3 | 13–9 | 14–2 | 14–8 | 15–1 | 15–6 | 15–11 | | | | |
| | 16.0 | 5–4 | 6–2 | 6–10 | 7–6 | 8–2 | 8–8 | 9–3 | 9–9 | 10–2 | 10–8 | 11–1 | 11–6 | 11–11 | 12–4 | 12–8 | 13–1 | 13–5 | 13–9 | 14–1 | 14–5 | | |
| 2x 6 | 19.2 | 4–10 | 5–7 | 6–3 | 6–10 | 7–5 | 7–11 | 8–5 | 8–11 | 9–4 | 9–9 | 10–1 | 10–6 | 10–10 | 11–3 | 11–7 | 11–11 | 12–3 | 12–7 | 12–10 | 13–2 | 13–6 | |
| | 24.0 | 4–4 | 5–0 | 5–7 | 6–2 | 6–8 | 7–1 | 7–6 | 7–11 | 8–4 | 8–8 | 9–1 | 9–5 | 9–9 | 10–0 | 10–4 | 10–8 | 10–11 | 11–3 | 11–6 | 11–9 | 12–0 | 12–4 |
| | 12.0 | 8–1 | 9–4 | 10–6 | 11–6 | 12–5 | 13–3 | 14–0 | 14–10 | 15–6 | 16–3 | 16–10 | 17–6 | 18–1 | 18–9 | 19–4 | 19–10 | 20–5 | 20–11 | | | | |
| | 16.0 | 7–0 | 8–1 | 9–1 | 9–11 | 10–9 | 11–6 | 12–2 | 12–10 | 13–5 | 14–0 | 14–7 | 15–2 | 15–8 | 16–3 | 16–9 | 17–2 | 17–8 | 18–1 | 18–7 | 19–0 | | |
| 2x 8 | 19.2 | 6–5 | 7–5 | 8–3 | 9–1 | 9–9 | 10–6 | 11–1 | 11–8 | 12–3 | 12–10 | 13–4 | 13–10 | 14–4 | 14–10 | 15–3 | 15–8 | 16–2 | 16–7 | 16–11 | 17–4 | 17–9 | |
| | 24.0 | 5–9 | 6–7 | 7–5 | 8–1 | 8–9 | 9–4 | 9–11 | 10–6 | 11–0 | 11–6 | 11–11 | 12–5 | 12–10 | 13–3 | 13–8 | 14–0 | 14–5 | 14–10 | 15–2 | 15–6 | 15–10 | 16–3 |
| | 12.0 | 10–4 | 11–11 | 13–4 | 14–8 | 15–10 | 16–11 | 17–11 | 18–11 | 19–10 | 20–8 | 21–6 | 22–4 | 23–1 | 23–11 | 24–7 | 25–4 | 26–0 | | | | | |
| | 16.0 | 8–11 | 10–4 | 11–7 | 12–8 | 13–8 | 14–8 | 15–6 | 16–4 | 17–2 | 17–11 | 18–8 | 19–4 | 20–0 | 20–8 | 21–4 | 21–11 | 22–6 | 23–1 | 23–8 | 24–3 | | |
| 2x10 | 19.2 | 8–2 | 9–5 | 10–7 | 11–7 | 12–6 | 13–4 | 14–2 | 14–11 | 15–8 | 16–4 | 17–0 | 17–8 | 18–3 | 18–11 | 19–6 | 20–0 | 20–7 | 21–1 | 21–8 | 22–2 | 22–8 | |
| | 24.0 | 7–4 | 8–5 | 9–5 | 10–4 | 11–2 | 11–11 | 12–8 | 13–4 | 14–0 | 14–8 | 15–3 | 15–10 | 16–4 | 16–11 | 17–5 | 17–11 | 18–5 | 18–11 | 19–4 | 19–10 | 20–3 | 20–8 |
| | 12.0 | 12–7 | 14–6 | 16–3 | 17–9 | 19–3 | 20–6 | 21–9 | 23–0 | 24–1 | 25–2 | | | | | | | | | | | | |
| | 16.0 | 10–11 | 12–7 | 14–1 | 15–5 | 16–8 | 17–9 | 18–10 | 19–11 | 20–10 | 21–9 | 22–8 | 23–6 | 24–4 | 25–2 | 25–11 | | | | | | | |
| 2x12 | 19.2 | 9–11 | 11–6 | 12–10 | 14–1 | 15–2 | 16–3 | 17–3 | 18–2 | 19–0 | 19–11 | 20–8 | 21–6 | 22–3 | 23–0 | 23–8 | 24–4 | 25–0 | 25–8 | | | | |
| | 24.0 | 8–11 | 10–3 | 11–6 | 12–7 | 13–7 | 14–6 | 15–5 | 16–3 | 17–0 | 17–9 | 18–6 | 19–3 | 19–11 | 20–6 | 21–2 | 21–9 | 22–5 | 23–0 | 23–6 | 24–1 | 24–8 | 25–2 |
| E | 12.0 | 0.15 | 0.23 | 0.32 | 0.43 | 0.54 | 0.66 | 0.78 | 0.92 | 1.06 | 1.21 | 1.36 | 1.52 | 1.69 | 1.86 | 2.04 | 2.22 | 2.41 | 2.60 | | | | |
| E | 16.0 | 0.13 | 0.20 | 0.28 | 0.37 | 0.47 | 0.57 | 0.68 | 0.80 | 0.92 | 1.05 | 1.18 | 1.32 | 1.46 | 1.61 | 1.76 | 1.92 | 2.08 | 2.25 | 2.42 | 2.60 | | |
| E | 19.2 | 0.12 | 0.18 | 0.26 | 0.34 | 0.43 | 0.52 | 0.62 | 0.73 | 0.84 | 0.95 | 1.08 | 1.20 | 1.33 | 1.47 | 1.61 | 1.75 | 1.90 | 2.05 | 2.21 | 2.37 | 2.53 | |
| E | 24.0 | 0.11 | 0.16 | 0.23 | 0.30 | 0.38 | 0.46 | 0.55 | 0.65 | 0.75 | 0.85 | 0.96 | 1.08 | 1.19 | 1.31 | 1.44 | 1.57 | 1.70 | 1.84 | 1.98 | 2.12 | 2.27 | 2.41 |

Note: The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R–3
# RAFTERS WITH L/240 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 40 psf plus
Dead Load of 10 psf determines the required bending design value.
Deflection – For 40 psf live load.
Limited to span in inches divided by 240.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psi) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 |
| | 12.0 | 5–6 | 6–4 | 7–1 | 7–9 | 8–5 | 9–0 | 9–6 | 10–0 | 10–6 | 11–0 | 11–5 | 11–11 | 12–4 | 12–8 | 13–1 | 13–6 | 13–10 | 14–2 | | | | |
| | 16.0 | 4–9 | 5–6 | 6–2 | 6–9 | 7–3 | 7–9 | 8–3 | 8–8 | 9–1 | 9–6 | 9–11 | 10–3 | 10–8 | 11–0 | 11–4 | 11–8 | 12–0 | 12–4 | 12–7 | 12–11 | | |
| 2x 6 | 19.2 | 4–4 | 5–0 | 5–7 | 6–2 | 6–8 | 7–1 | 7–6 | 7–11 | 8–4 | 8–8 | 9–1 | 9–5 | 9–9 | 10–0 | 10–4 | 10–8 | 10–11 | 11–3 | 11–6 | 11–9 | 12–0 | 12–4 |
| | 24.0 | 3–11 | 4–6 | 5–0 | 5–6 | 5–11 | 6–4 | 6–9 | 7–1 | 7–5 | 7–9 | 8–1 | 8–5 | 8–8 | 9–0 | 9–3 | 9–6 | 9–9 | 10–0 | 10–3 | 10–6 | 10–9 | 11–0 |
| | 12.0 | 7–3 | 8–4 | 9–4 | 10–3 | 11–1 | 11–10 | 12–7 | 13–3 | 13–11 | 14–6 | 15–1 | 15–8 | 16–3 | 16–9 | 17–3 | 17–9 | 18–3 | 18–9 | | | | |
| | 16.0 | 6–3 | 7–3 | 8–1 | 8–11 | 9–7 | 10–3 | 10–10 | 11–6 | 12–0 | 12–7 | 13–1 | 13–7 | 14–0 | 14–6 | 14–11 | 15–5 | 15–10 | 16–3 | 16–7 | 17–0 | | |
| 2x 8 | 19.2 | 5–9 | 6–7 | 7–5 | 8–1 | 8–9 | 9–4 | 9–11 | 10–6 | 11–0 | 11–6 | 11–11 | 12–5 | 12–10 | 13–3 | 13–8 | 14–0 | 14–5 | 14–10 | 15–2 | 15–6 | 15–10 | 16–3 |
| | 24.0 | 5–2 | 5–11 | 6–7 | 7–3 | 7–10 | 8–4 | 8–11 | 9–4 | 9–10 | 10–3 | 10–8 | 11–1 | 11–6 | 11–10 | 12–2 | 12–7 | 12–11 | 13–3 | 13–7 | 13–11 | 14–2 | 14–6 |
| | 12.0 | 9–3 | 10–8 | 11–11 | 13–1 | 14–2 | 15–1 | 16–0 | 16–11 | 17–9 | 18–6 | 19–3 | 20–0 | 20–8 | 21–4 | 22–0 | 22–8 | 23–3 | 23–11 | | | | |
| | 16.0 | 8–0 | 9–3 | 10–4 | 11–4 | 12–3 | 13–1 | 13–10 | 14–8 | 15–4 | 16–0 | 16–8 | 17–4 | 17–11 | 18–6 | 19–1 | 19–7 | 20–2 | 20–8 | 21–2 | 21–8 | | |
| 2x10 | 19.2 | 7–4 | 8–5 | 9–5 | 10–4 | 11–2 | 11–11 | 12–8 | 13–4 | 14–0 | 14–8 | 15–3 | 15–10 | 16–4 | 16–11 | 17–5 | 17–11 | 18–5 | 18–11 | 19–4 | 19–10 | 20–3 | 20–8 |
| | 24.0 | 6–6 | 7–7 | 8–5 | 9–3 | 10–0 | 10–8 | 11–4 | 11–11 | 12–6 | 13–1 | 13–7 | 14–2 | 14–8 | 15–1 | 15–7 | 16–0 | 16–6 | 16–11 | 17–4 | 17–9 | 18–1 | 18–6 |
| | 12.0 | 11–3 | 13–0 | 14–6 | 15–11 | 17–2 | 18–4 | 19–6 | 20–6 | 21–7 | 22–6 | 23–5 | 24–4 | 25–2 | 26–0 | | | | | | | | |
| | 16.0 | 9–9 | 11–3 | 12–7 | 13–9 | 14–11 | 15–11 | 16–10 | 17–9 | 18–8 | 19–6 | 20–3 | 21–1 | 21–9 | 22–6 | 23–2 | 23–10 | 24–6 | 25–2 | 25–9 | | | |
| 2x12 | 19.2 | 8–11 | 10–3 | 11–6 | 12–7 | 13–7 | 14–6 | 15–5 | 16–3 | 17–0 | 17–9 | 18–6 | 19–3 | 19–11 | 20–6 | 21–2 | 21–9 | 22–5 | 23–0 | 23–6 | 24–1 | 24–8 | 25–2 |
| | 24.0 | 7–11 | 9–2 | 10–3 | 11–3 | 12–2 | 13–0 | 13–9 | 14–6 | 15–3 | 15–11 | 16–7 | 17–2 | 17–9 | 18–4 | 18–11 | 19–6 | 20–0 | 20–6 | 21–1 | 21–7 | 22–0 | 22–6 |
| E | 12.0 | 0.14 | 0.22 | 0.31 | 0.41 | 0.51 | 0.63 | 0.75 | 0.88 | 1.01 | 1.15 | 1.30 | 1.45 | 1.61 | 1.77 | 1.94 | 2.12 | 2.30 | 2.48 | | | | |
| E | 16.0 | 0.12 | 0.19 | 0.27 | 0.35 | 0.44 | 0.54 | 0.65 | 0.76 | 0.88 | 1.00 | 1.12 | 1.26 | 1.39 | 1.54 | 1.68 | 1.83 | 1.99 | 2.15 | 2.31 | 2.48 | | |
| E | 19.2 | 0.11 | 0.18 | 0.24 | 0.32 | 0.41 | 0.50 | 0.59 | 0.69 | 0.80 | 0.91 | 1.03 | 1.15 | 1.27 | 1.40 | 1.54 | 1.67 | 1.81 | 1.96 | 2.11 | 2.26 | 2.42 | 2.58 |
| E | 24.0 | 0.10 | 0.16 | 0.22 | 0.29 | 0.36 | 0.44 | 0.53 | 0.62 | 0.71 | 0.81 | 0.92 | 1.03 | 1.14 | 1.25 | 1.37 | 1.50 | 1.62 | 1.75 | 1.89 | 2.02 | 2.16 | 2.30 |

Note: The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R–10
# RAFTERS WITH L/240 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 30 psf plus
Dead Load of 20 psf determines the required bending design value.
Deflection – For 30 psf live load.
Limited to span in inches divided by 240.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psi) | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 2500 | 2600 | 2700 |
| | 12.0 | 5–6 | 6–4 | 7–1 | 7–9 | 8–5 | 9–0 | 9–6 | 10–0 | 9–7 | 10–0 | 10–5 | 10–10 | 11–3 | 11–7 | 11–11 | 12–4 | 12–8 | 13–0 | 13–3 | 13–7 | 13–11 | 14–2 | | | |
| | 16.0 | 4–9 | 5–6 | 6–2 | 6–9 | 7–3 | 7–9 | 8–3 | 8–8 | 8–4 | 8–8 | 9–1 | 9–5 | 9–9 | 10–0 | 10–4 | 10–8 | 10–11 | 11–3 | 11–6 | 11–9 | 12–0 | 12–4 | 12–7 | 12–10 | 13–1 |
| 2x6 | 19.2 | 4–4 | 5–0 | 5–7 | 6–2 | 6–8 | 7–1 | 7–6 | 7–11 | 7–7 | 7–11 | 8–3 | 8–7 | 8–11 | 9–2 | 9–5 | 9–9 | 10–0 | 10–3 | 10–6 | 10–9 | 11–0 | 11–3 | 11–5 | 11–8 | 11–11 |
| | 24.0 | 3–11 | 4–6 | 5–0 | 5–6 | 5–11 | 6–4 | 6–9 | 7–1 | 6–10 | 7–1 | 7–5 | 7–8 | 7–11 | 8–2 | 8–5 | 8–8 | 8–11 | 9–2 | 9–5 | 9–7 | 9–10 | 10–0 | 10–3 | 10–5 | 10–8 |
| | 12.0 | 7–3 | 8–4 | 9–4 | 10–3 | 11–1 | 11–10 | 12–7 | 13–3 | 12–8 | 13–3 | 13–9 | 14–4 | 14–10 | 15–3 | 15–9 | 16–3 | 16–8 | 17–1 | 17–6 | 17–11 | 18–4 | 18–9 | | | |
| | 16.0 | 6–3 | 7–3 | 8–1 | 8–11 | 9–7 | 10–3 | 10–10 | 11–6 | 11–0 | 11–6 | 11–11 | 12–5 | 12–10 | 13–3 | 13–8 | 14–0 | 14–5 | 14–10 | 15–2 | 15–6 | 15–10 | 16–3 | 16–7 | 16–10 | 17–2 |
| 2x8 | 19.2 | 5–9 | 6–7 | 7–5 | 8–1 | 8–9 | 9–4 | 9–11 | 10–6 | 10–0 | 10–6 | 10–11 | 11–4 | 11–8 | 12–1 | 12–5 | 12–10 | 13–2 | 13–6 | 13–10 | 14–2 | 14–6 | 14–10 | 15–1 | 15–5 | 15–8 |
| | 24.0 | 5–2 | 5–11 | 6–7 | 7–3 | 7–10 | 8–4 | 8–11 | 9–4 | 9–0 | 9–4 | 9–9 | 10–1 | 10–6 | 10–10 | 11–2 | 11–6 | 11–9 | 12–1 | 12–5 | 12–8 | 12–11 | 13–3 | 13–6 | 13–9 | 14–0 |
| | 12.0 | 9–3 | 10–8 | 11–11 | 13–1 | 14–2 | 15–1 | 16–0 | 16–11 | 16–2 | 16–11 | 17–7 | 18–3 | 18–11 | 19–6 | 20–1 | 20–8 | 21–3 | 21–10 | 22–4 | 22–10 | 23–5 | 23–11 | | | |
| | 16.0 | 8–0 | 9–3 | 10–4 | 11–4 | 12–3 | 13–1 | 13–10 | 14–8 | 14–0 | 14–8 | 15–3 | 15–10 | 16–4 | 16–11 | 17–5 | 17–11 | 18–5 | 18–11 | 19–4 | 19–10 | 20–3 | 20–8 | 21–1 | 21–6 | 21–11 |
| 2x10 | 19.2 | 7–4 | 8–5 | 9–5 | 10–4 | 11–2 | 11–11 | 12–8 | 13–4 | 12–9 | 13–4 | 13–11 | 14–5 | 14–11 | 15–5 | 15–11 | 16–4 | 16–10 | 17–3 | 17–8 | 18–1 | 18–6 | 18–11 | 19–3 | 19–8 | 20–0 |
| | 24.0 | 6–6 | 7–7 | 8–5 | 9–3 | 10–0 | 10–8 | 11–4 | 11–11 | 11–5 | 11–11 | 12–5 | 12–11 | 13–4 | 13–9 | 14–3 | 14–8 | 15–0 | 15–5 | 15–10 | 16–2 | 16–6 | 16–1 | 17–3 | 17–7 | 17–11 |
| | 12.0 | 11–3 | 13–0 | 14–6 | 15–11 | 17–2 | 18–4 | 19–6 | 20–6 | 19–8 | 20–6 | 21–5 | 22–2 | 23–0 | 23–9 | 24–5 | 25–2 | 25–10 | | | | | | | | |
| | 16.0 | 9–9 | 11–3 | 12–7 | 13–9 | 14–11 | 15–11 | 16–10 | 17–9 | 17–0 | 17–9 | 18–6 | 19–3 | 19–11 | 20–6 | 21–2 | 21–9 | 22–5 | 23–0 | 23–6 | 24–1 | 24–8 | 25–2 | 25–8 | | |
| 2x12 | 19.2 | 8–11 | 10–3 | 11–6 | 12–7 | 13–7 | 14–6 | 15–5 | 16–3 | 15–7 | 16–3 | 16–11 | 17–6 | 18–2 | 18–9 | 19–4 | 19–11 | 20–5 | 21–0 | 21–6 | 22–0 | 22–6 | 23–0 | 23–5 | 23–11 | 24–4 |
| | 24.0 | 7–11 | 9–2 | 10–3 | 11–3 | 12–2 | 13–0 | 13–9 | 14–6 | 13–11 | 14–6 | 15–1 | 15–8 | 16–3 | 16–9 | 17–3 | 17–9 | 18–3 | 18–9 | 19–3 | 19–8 | 20–1 | 20–6 | 21–0 | 21–5 | 21–9 |
| E | 12.0 | 0.11 | 0.17 | 0.23 | 0.31 | 0.38 | 0.47 | 0.56 | 0.66 | 0.77 | 0.88 | 0.99 | 1.10 | 1.22 | 1.35 | 1.48 | 1.61 | 1.75 | 1.89 | 2.03 | 2.18 | 2.33 | 2.48 | | | |
| E | 16.0 | 0.09 | 0.14 | 0.20 | 0.26 | 0.33 | 0.41 | 0.49 | 0.57 | 0.67 | 0.76 | 0.86 | 0.96 | 1.06 | 1.17 | 1.28 | 1.39 | 1.51 | 1.63 | 1.76 | 1.88 | 2.01 | 2.15 | 2.28 | 2.42 | 2.56 |
| E | 19.2 | 0.09 | 0.13 | 0.18 | 0.24 | 0.30 | 0.37 | 0.44 | 0.52 | 0.61 | 0.69 | 0.78 | 0.87 | 0.97 | 1.07 | 1.17 | 1.27 | 1.38 | 1.49 | 1.60 | 1.72 | 1.84 | 1.96 | 2.08 | 2.21 | 2.34 |
| E | 24.0 | 0.08 | 0.12 | 0.16 | 0.22 | 0.27 | 0.33 | 0.40 | 0.46 | 0.54 | 0.62 | 0.70 | 0.78 | 0.87 | 0.95 | 1.04 | 1.14 | 1.23 | 1.33 | 1.43 | 1.54 | 1.64 | 1.75 | 1.86 | 1.98 | 2.09 |

**Note:** The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R–11
# RAFTERS WITH L/240 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 40 psf plus
Dead Load of 20 psf determines the required bending design value.
Deflection – For 40 psf live load.
Limited to span in inches divided by 240.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psi) | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 2500 | 2600 | 2700 |
| | 12.0 | 5–0 | 5–10 | 6–6 | 7–1 | 7–8 | 8–2 | 8–8 | 9–2 | 10–6 | 11–0 | 11–5 | 11–11 | 12–4 | 12–8 | 13–1 | 13–6 | 13–10 | 14–2 | 14–7 | 14–11 | 15–3 | 15–7 | 15–11 | | |
| | 16.0 | 4–4 | 5–0 | 5–7 | 6–2 | 6–8 | 7–1 | 7–6 | 7–11 | 9–1 | 9–6 | 9–11 | 10–3 | 10–8 | 11–0 | 11–4 | 11–8 | 12–0 | 12–4 | 12–7 | 12–11 | 13–2 | 13–6 | 13–9 | 14–0 | 14–3 |
| 2x6 | 19.2 | 4–0 | 4–7 | 5–1 | 5–7 | 6–1 | 6–6 | 6–10 | 7–3 | 8–4 | 8–8 | 9–1 | 9–5 | 9–9 | 10–0 | 10–4 | 10–8 | 10–11 | 11–3 | 11–6 | 11–9 | 12–0 | 12–4 | 12–7 | 12–10 | 13–1 |
| | 24.0 | 3–7 | 4–1 | 4–7 | 5–0 | 5–5 | 5–10 | 6–2 | 6–6 | 7–5 | 7–9 | 8–1 | 8–5 | 8–8 | 9–0 | 9–3 | 9–6 | 9–9 | 10–0 | 10–3 | 10–6 | 10–9 | 11–0 | 11–3 | 11–5 | 11–8 |
| | 12.0 | 6–7 | 7–8 | 8–7 | 9–4 | 10–1 | 10–10 | 11–6 | 12–1 | 13–11 | 14–6 | 15–1 | 15–8 | 16–3 | 16–9 | 17–3 | 17–9 | 18–3 | 18–9 | 19–2 | 19–8 | 20–1 | 20–6 | 20–11 | | |
| | 16.0 | 5–9 | 6–7 | 7–5 | 8–1 | 8–9 | 9–4 | 9–11 | 10–6 | 12–0 | 12–7 | 13–1 | 13–7 | 14–0 | 14–6 | 14–11 | 15–5 | 15–10 | 16–3 | 16–7 | 17–0 | 17–5 | 17–9 | 18–1 | 18–6 | 18–10 |
| 2x8 | 19.2 | 5–3 | 6–0 | 6–9 | 7–5 | 8–0 | 8–7 | 9–1 | 9–7 | 11–0 | 11–6 | 11–11 | 12–5 | 12–10 | 13–3 | 13–8 | 14–0 | 14–5 | 14–10 | 15–2 | 15–6 | 15–10 | 16–3 | 16–7 | 16–10 | 17–2 |
| | 24.0 | 4–8 | 5–5 | 6–0 | 6–7 | 7–2 | 7–9 | 8–1 | 8–7 | 9–10 | 10–3 | 10–8 | 11–1 | 11–6 | 11–10 | 12–2 | 12–7 | 12–11 | 13–3 | 13–7 | 13–11 | 14–2 | 14–6 | 14–10 | 15–1 | 15–5 |
| | 12.0 | 8–5 | 9–9 | 10–11 | 11–11 | 12–11 | 13–9 | 14–8 | 15–5 | 17–9 | 18–6 | 19–3 | 20–0 | 20–8 | 21–4 | 22–0 | 22–8 | 23–3 | 23–11 | 24–6 | 25–1 | 25–7 | | | | |
| | 16.0 | 7–4 | 8–5 | 9–5 | 10–4 | 11–2 | 11–11 | 12–8 | 13–4 | 15–4 | 16–0 | 16–8 | 17–4 | 17–11 | 18–6 | 19–1 | 19–7 | 20–2 | 20–8 | 21–2 | 21–8 | 22–2 | 22–8 | 23–1 | 23–7 | 24–0 |
| 2x10 | 19.2 | 6–8 | 7–8 | 8–7 | 9–5 | 10–2 | 10–11 | 11–7 | 12–2 | 14–0 | 14–8 | 15–3 | 15–10 | 16–4 | 16–11 | 17–5 | 17–11 | 18–5 | 18–11 | 19–4 | 19–10 | 20–3 | 20–8 | 21–1 | 21–6 | 21–11 |
| | 24.0 | 6–0 | 6–11 | 7–8 | 8–5 | 9–1 | 9–9 | 10–4 | 10–11 | 12–6 | 13–1 | 13–7 | 14–2 | 14–8 | 15–1 | 15–7 | 16–0 | 16–6 | 16–11 | 17–4 | 17–9 | 18–1 | 18–6 | 18–11 | 19–3 | 19–7 |
| | 12.0 | 10–3 | 11–10 | 13–3 | 14–6 | 15–8 | 16–9 | 17–9 | 18–9 | 21–7 | 22–6 | 23–5 | 24–4 | 25–2 | 26–0 | | | | | | | | | | | |
| | 16.0 | 8–11 | 10–3 | 11–6 | 12–7 | 13–7 | 14–6 | 15–5 | 16–3 | 18–8 | 19–6 | 20–3 | 21–1 | 21–9 | 22–6 | 23–2 | 23–10 | 24–6 | 25–2 | 25–9 | | | | | | |
| 2x12 | 19.2 | 8–1 | 9–4 | 10–6 | 11–6 | 12–5 | 13–3 | 14–1 | 14–10 | 17–0 | 17–9 | 18–6 | 19–3 | 19–11 | 20–6 | 21–2 | 21–9 | 22–5 | 23–0 | 23–6 | 24–1 | 25–2 | 25–8 | | | |
| | 24.0 | 7–3 | 8–5 | 9–4 | 10–3 | 11–1 | 11–10 | 12–7 | 13–3 | 15–3 | 15–11 | 16–7 | 17–2 | 17–9 | 18–4 | 18–11 | 19–6 | 20–0 | 20–6 | 21–1 | 21–7 | 22–0 | 22–6 | 23–0 | 23–5 | 23–10 |
| E | 12.0 | 0.11 | 0.17 | 0.24 | 0.31 | 0.39 | 0.48 | 0.57 | 0.67 | 0.76 | 0.86 | 0.97 | 1.09 | 1.21 | 1.33 | 1.46 | 1.59 | 1.72 | 1.86 | 2.00 | 2.14 | 2.29 | 2.44 | 2.60 | | |
| E | 16.0 | 0.09 | 0.15 | 0.20 | 0.27 | 0.34 | 0.41 | 0.49 | 0.58 | 0.66 | 0.75 | 0.84 | 0.94 | 1.05 | 1.15 | 1.26 | 1.37 | 1.49 | 1.61 | 1.73 | 1.86 | 1.99 | 2.12 | 2.25 | 2.39 | 2.53 |
| E | 19.2 | 0.09 | 0.13 | 0.19 | 0.24 | 0.31 | 0.38 | 0.45 | 0.53 | 0.60 | 0.68 | 0.77 | 0.86 | 0.95 | 1.05 | 1.15 | 1.25 | 1.36 | 1.47 | 1.58 | 1.70 | 1.81 | 1.93 | 2.05 | 2.18 | 2.31 |
| E | 24.0 | 0.08 | 0.12 | 0.17 | 0.22 | 0.28 | 0.34 | 0.40 | 0.47 | 0.54 | 0.61 | 0.69 | 0.77 | 0.85 | 0.94 | 2.03 | 1.12 | 1.22 | 1.31 | 1.41 | 1.52 | 1.62 | 1.73 | 1.84 | 1.95 | 2.06 |

**Note:** The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R–14
# RAFTERS WITH L/180 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 30 psf plus
Dead Load of 10 psf determines the required bending design value.
Deflection – For 30 psf live load.
Limited to span in inches divided by 180.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psi) | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 2500 | 2600 | 2700 | 2800 | 2900 | 3000 |
| | 12.0 | 3–2 | 3–11 | 4–6 | 5–1 | 5–6 | 6–0 | 6–5 | 6–9 | 7–2 | 7–6 | 7–10 | 8–2 | 8–5 | 8–9 | 9–0 | 9–4 | 9–7 | 9–10 | 10–1 | 10–4 | 15–3 | 10–10 | 11–1 | | | | | | |
| | 16.0 | 2–9 | 3–5 | 3–11 | 4–4 | 4–10 | 5–2 | 5–6 | 5–10 | 6–2 | 6–6 | 6–9 | 7–1 | 7–4 | 7–7 | 7–10 | 8–1 | 8–40 | 8–6 | 8–9 | 9–0 | 13–2 | 9–5 | 9–7 | 9–9 | 10–0 | | | | | |
| 2x4 | 19.2 | 2–6 | 3–1 | 3–7 | 4–0 | 4–4 | 4–9 | 5–1 | 5–4 | 5–8 | 5–11 | 6–2 | 6–5 | 6–8 | 6–11 | 7–2 | 7–4 | 7–7 | 7–9 | 8–0 | 8–2 | 12–0 | 8–7 | 8–9 | 8–11 | 9–1 | 9–3 | 9–5 | | | |
| | 24.0 | 2–3 | 2–9 | 3–2 | 3–7 | 3–11 | 4–3 | 4–6 | 4–10 | 5–1 | 5–4 | 5–6 | 5–9 | 6–0 | 6–2 | 6–5 | 6–7 | 6–9 | 7–0 | 7–2 | 7–4 | 10–9 | 7–8 | 7–10 | 8–0 | 8–2 | 8–4 | 8–5 | 8–7 | 8–9 |
| | 12.0 | 5–0 | 6–2 | 7–1 | 7–11 | 8–8 | 9–5 | 10–0 | 10–8 | 11–3 | 11–9 | 12–4 | 12–10 | 13–3 | 13–9 | 14–2 | 14–8 | 15–1 | 15–6 | 15–11 | 16–3 | 15–3 | 17–0 | 17–5 | | | | | | |
| | 16.0 | 4–4 | 5–4 | 6–2 | 6–10 | 7–6 | 8–2 | 8–8 | 9–3 | 9–9 | 10–2 | 10–8 | 11–1 | 11–6 | 11–11 | 12–4 | 12–8 | 13–1 | 13–5 | 13–9 | 14–1 | 13–2 | 14–9 | 15–1 | 15–4 | 15–8 | | | | | |
| 2x6 | 19.2 | 4–0 | 4–10 | 5–7 | 6–3 | 6–10 | 7–5 | 7–11 | 8–5 | 8–11 | 9–4 | 9–9 | 10–1 | 10–6 | 10–10 | 11–3 | 11–7 | 11–11 | 12–3 | 12–7 | 12–10 | 12–0 | 13–6 | 13–9 | 14–0 | 14–4 | 14–7 | 14–10 | | | |
| | 24.0 | 3–7 | 4–4 | 5–0 | 5–7 | 6–2 | 6–8 | 7–1 | 7–6 | 7–11 | 8–4 | 8–8 | 9–1 | 9–5 | 9–9 | 10–0 | 10–4 | 10–8 | 10–11 | 11–3 | 11–6 | 10–9 | 12–0 | 12–4 | 12–7 | 12–10 | 13–1 | 13–3 | 13–6 | 13–9 | |
| | 12.0 | 6–7 | 8–1 | 9–4 | 10–6 | 11–6 | 12–5 | 13–3 | 14–0 | 14–10 | 15–6 | 16–3 | 16–10 | 17–6 | 18–1 | 18–9 | 19–4 | 19–10 | 20–5 | 20–11 | 21–5 | 20–1 | 22–5 | 22–11 | | | | | | | |
| | 16.0 | 5–9 | 7–0 | 8–1 | 9–1 | 9–11 | 10–9 | 11–6 | 12–2 | 12–10 | 13–5 | 14–0 | 14–7 | 15–2 | 15–8 | 16–3 | 16–9 | 17–2 | 17–8 | 18–1 | 18–7 | 17–5 | 19–5 | 19–10 | 20–3 | 20–8 | | | | | |
| 2x8 | 19.2 | 5–3 | 6–5 | 7–5 | 8–3 | 9–1 | 9–9 | 10–6 | 11–1 | 11–8 | 12–3 | 12–10 | 13–4 | 13–10 | 14–4 | 14–10 | 15–3 | 15–8 | 16–2 | 16–7 | 11–11 | 15–10 | 17–9 | 18–1 | 18–6 | 18–10 | 19–3 | 19–7 | | | |
| | 24.0 | 4–8 | 5–9 | 6–7 | 7–5 | 8–1 | 8–9 | 9–4 | 9–11 | 10–6 | 11–0 | 11–6 | 11–11 | 12–5 | 12–10 | 13–3 | 13–8 | 14–0 | 14–5 | 14–10 | 15–2 | 14–2 | 15–10 | 16–3 | 16–7 | 16–10 | 17–2 | 17–6 | 17–10 | 18–1 | |
| | 12.0 | 8–5 | 10–4 | 11–11 | 13–4 | 14–8 | 15–10 | 16–11 | 17–11 | 18–11 | 19–10 | 20–8 | 21–6 | 22–4 | 23–1 | 23–11 | 24–7 | 25–4 | 26–0 | | | 25–7 | | | | | | | | | |
| | 16.0 | 7–4 | 8–11 | 10–4 | 11–7 | 12–8 | 13–8 | 14–8 | 15–6 | 16–4 | 17–2 | 17–11 | 18–8 | 19–4 | 20–0 | 20–8 | 21–4 | 21–11 | 22–6 | 23–1 | 23–8 | 22–2 | 24–10 | 25–4 | 25–10 | | | | | | |
| 2x10 | 19.2 | 6–8 | 8–2 | 9–5 | 10–7 | 11–7 | 12–6 | 13–4 | 14–2 | 14–11 | 15–8 | 16–4 | 17–0 | 17–8 | 18–3 | 18–11 | 19–6 | 20–0 | 20–7 | 21–1 | 21–8 | 20–3 | 22–8 | 23–1 | 23–7 | 24–1 | 24–6 | 25–0 | | | |
| | 24.0 | 6–0 | 7–4 | 8–5 | 9–5 | 10–4 | 11–2 | 11–11 | 12–8 | 13–4 | 14–0 | 14–8 | 15–3 | 15–10 | 16–4 | 16–11 | 17–5 | 17–11 | 18–5 | 18–11 | 19–4 | 18–1 | 20–3 | 20–8 | 21–1 | 21–6 | 21–11 | 22–4 | 22–9 | 23–1 | |
| E | 12.0 | 0.06 | 0.11 | 0.17 | 0.24 | 0.32 | 0.40 | 0.49 | 0.59 | 0.69 | 0.79 | 0.91 | 1.02 | 1.14 | 1.27 | 1.39 | 1.53 | 1.66 | 1.80 | 1.95 | 2.10 | 2.29 | 2.40 | 2.56 | | | | | | | |
| E | 16.0 | 0.05 | 0.10 | 0.15 | 0.21 | 0.28 | 0.35 | 0.43 | 0.51 | 0.60 | 0.69 | 0.78 | 0.88 | 0.99 | 1.10 | 1.21 | 1.32 | 1.44 | 1.56 | 1.69 | 1.82 | 1.99 | 2.08 | 2.22 | 2.36 | 2.50 | | | | | |
| E | 19.2 | 0.05 | 0.09 | 0.14 | 0.19 | 0.25 | 0.32 | 0.39 | 0.47 | 0.54 | 0.63 | 0.72 | 0.81 | 0.90 | 1.00 | 1.10 | 1.21 | 1.32 | 1.43 | 1.54 | 1.66 | 1.78 | 1.90 | 2.03 | 2.15 | 2.28 | 2.42 | 2.55 | | | |
| E | 24.0 | 0.04 | 0.08 | 0.12 | 0.17 | 0.23 | 0.29 | 0.35 | 0.42 | 0.49 | 0.56 | 0.64 | 0.72 | 0.81 | 0.89 | 0.99 | 1.08 | 1.18 | 1.28 | 1.38 | 1.48 | 1.59 | 1.70 | 1.81 | 1.93 | 2.04 | 2.16 | 2.28 | 2.41 | 2.53 | |

**Note:** The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R–15
# RAFTERS WITH L/180 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 40 psf plus
Dead Load of 10 psf determines the required bending design value.
Deflection – For 40 psf live load.
Limited to span in inches divided by 180.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psi) | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 2500 | 2600 | 2700 | 2800 | 2900 | 3000 |
| | 12.0 | 2–10 | 3–6 | 4–0 | 4–6 | 4–11 | 5–4 | 5–9 | 6–1 | 6–5 | 6–8 | 7–0 | 7–3 | 7–7 | 7–10 | 8–1 | 8–4 | 8–7 | 8–10 | 9–1 | 9–3 | 9–6 | 9–8 | 9–11 | 10–1 | | | | | |
| | 16.0 | 2–6 | 3–0 | 3–6 | 3–11 | 4–3 | 4–8 | 4–11 | 5–3 | 5–6 | 5–10 | 6–1 | 6–4 | 6–7 | 6–9 | 7–0 | 7–3 | 7–5 | 7–8 | 7–10 | 8–0 | 8–2 | 8–5 | 8–7 | 8–9 | 8–11 | 9–1 | | | | |
| 2x4 | 19.2 | 2–3 | 2–9 | 3–2 | 3–7 | 3–11 | 4–3 | 4–6 | 4–10 | 5–1 | 5–4 | 5–6 | 5–9 | 6–0 | 6–2 | 6–5 | 6–7 | 6–9 | 7–0 | 7–2 | 7–4 | 7–6 | 7–8 | 7–10 | 8–0 | 8–2 | 8–4 | 8–5 | 8–7 | |
| | 24.0 | 2–0 | 2–6 | 2–10 | 3–2 | 3–6 | 3–9 | 4–0 | 4–3 | 4–6 | 4–9 | 4–11 | 5–2 | 5–4 | 5–6 | 5–9 | 5–11 | 6–1 | 6–3 | 6–5 | 6–7 | 6–8 | 6–10 | 7–0 | 7–2 | 7–3 | 7–5 | 7–7 | 7–8 | 7–10 |
| | 12.0 | 4–6 | 5–6 | 6–4 | 7–1 | 7–9 | 8–5 | 9–0 | 9–6 | 10–0 | 10–6 | 11–0 | 11–5 | 11–11 | 12–4 | 12–8 | 13–1 | 13–6 | 13–10 | 14–2 | 14–7 | 14–11 | 15–3 | 15–7 | 15–11 | | | | | |
| | 16.0 | 3–11 | 4–9 | 5–6 | 6–2 | 6–9 | 7–3 | 7–9 | 8–3 | 8–8 | 9–1 | 9–6 | 9–11 | 10–3 | 10–8 | 11–0 | 11–4 | 11–8 | 12–0 | 12–4 | 12–7 | 12–11 | 13–2 | 13–6 | 13–9 | 14–0 | 14–3 | | | | |
| 2x6 | 19.2 | 3–7 | 4–4 | 5–0 | 5–7 | 6–2 | 6–8 | 7–1 | 7–6 | 7–11 | 8–4 | 8–8 | 9–1 | 9–5 | 9–9 | 10–0 | 10–4 | 10–8 | 10–11 | 11–3 | 11–6 | 11–9 | 12–0 | 12–4 | 12–7 | 12–10 | 13–1 | 13–3 | 13–6 | |
| | 24.0 | 3–2 | 3–11 | 4–6 | 5–0 | 5–6 | 5–11 | 6–4 | 6–9 | 7–1 | 7–5 | 7–9 | 8–1 | 8–5 | 8–8 | 9–0 | 9–3 | 9–6 | 9–9 | 10–0 | 10–3 | 10–6 | 10–9 | 11–0 | 11–3 | 11–5 | 11–8 | 11–11 | 12–1 | 12–4 |
| | 12.0 | 5–11 | 7–3 | 8–4 | 9–4 | 10–3 | 11–1 | 11–10 | 12–7 | 13–3 | 13–11 | 14–6 | 15–1 | 15–8 | 16–3 | 16–9 | 17–3 | 17–9 | 18–3 | 18–9 | 19–2 | 19–8 | 20–1 | 20–6 | 20–11 | | | | | |
| | 16.0 | 5–2 | 6–3 | 7–3 | 8–1 | 8–11 | 9–7 | 10–3 | 10–10 | 11–6 | 12–0 | 12–7 | 13–1 | 13–7 | 14–0 | 14–6 | 14–11 | 15–5 | 15–10 | 16–3 | 16–7 | 17–0 | 17–5 | 17–9 | 18–1 | 18–6 | 18–10 | | | | |
| 2x8 | 19.2 | 4–8 | 5–9 | 6–7 | 7–5 | 8–1 | 8–9 | 9–4 | 9–11 | 10–6 | 11–0 | 11–6 | 11–11 | 12–5 | 12–10 | 13–3 | 13–8 | 14–0 | 14–5 | 14–10 | 15–2 | 15–6 | 15–10 | 16–3 | 16–7 | 16–10 | 17–2 | 17–6 | 17–10 | |
| | 24.0 | 4–2 | 5–2 | 5–11 | 6–7 | 7–3 | 7–10 | 8–4 | 8–11 | 9–4 | 9–10 | 10–3 | 10–8 | 11–1 | 11–6 | 11–10 | 12–2 | 12–7 | 12–11 | 13–3 | 13–7 | 13–11 | 14–2 | 14–6 | 14–10 | 15–1 | 15–5 | 15–8 | 15–11 | 16–3 |
| | 12.0 | 7–7 | 9–3 | 10–8 | 11–11 | 13–1 | 14–2 | 15–1 | 16–0 | 16–11 | 17–9 | 18–6 | 19–3 | 20–0 | 20–8 | 21–4 | 22–0 | 22–8 | 23–3 | 23–11 | 24–6 | 25–1 | 25–7 | | | | | | | |
| | 16.0 | 6–6 | 8–0 | 9–3 | 10–4 | 11–4 | 12–3 | 13–1 | 13–10 | 14–8 | 15–4 | 16–0 | 16–8 | 17–4 | 17–11 | 18–6 | 19–1 | 19–7 | 20–2 | 20–8 | 21–2 | 21–8 | 22–2 | 22–8 | 23–1 | 23–7 | 24–0 | | | | |
| 2x10 | 19.2 | 6–0 | 7–4 | 8–5 | 9–5 | 10–4 | 11–2 | 11–11 | 12–8 | 13–4 | 14–0 | 14–8 | 15–3 | 15–10 | 16–4 | 16–11 | 17–5 | 17–11 | 18–5 | 18–11 | 19–4 | 19–10 | 20–3 | 20–8 | 21–1 | 21–6 | 21–11 | 22–4 | 22–9 | |
| | 24.0 | 5–4 | 6–6 | 7–7 | 8–5 | 9–3 | 10–0 | 10–8 | 11–4 | 11–11 | 12–6 | 13–1 | 13–7 | 14–2 | 14–8 | 15–1 | 15–7 | 16–0 | 16–6 | 16–11 | 17–4 | 17–9 | 18–1 | 18–6 | 18–11 | 19–3 | 19–7 | 20–0 | 20–4 | 20–8 |
| E | 12.0 | 0.06 | 0.11 | 0.17 | 0.23 | 0.31 | 0.38 | 0.47 | 0.56 | 0.66 | 0.76 | 0.86 | 0.97 | 1.09 | 1.21 | 1.33 | 1.46 | 1.59 | 1.72 | 1.86 | 2.00 | 2.14 | 2.29 | 2.44 | 2.60 | | | | | |
| E | 16.0 | 0.05 | 0.09 | 0.14 | 0.20 | 0.26 | 0.33 | 0.41 | 0.49 | 0.57 | 0.66 | 0.75 | 0.84 | 0.94 | 1.05 | 1.15 | 1.26 | 1.37 | 1.49 | 1.61 | 1.73 | 1.86 | 1.99 | 2.12 | 2.25 | 2.39 | 2.53 | | | |
| E | 19.2 | 0.05 | 0.09 | 0.13 | 0.18 | 0.24 | 0.30 | 0.37 | 0.44 | 0.52 | 0.60 | 0.68 | 0.77 | 0.86 | 0.95 | 1.05 | 1.15 | 1.25 | 1.36 | 1.47 | 1.58 | 1.70 | 1.81 | 1.93 | 2.05 | 2.18 | 2.31 | 2.43 | 2.57 | |
| E | 24.0 | 0.04 | 0.08 | 0.12 | 0.16 | 0.22 | 0.27 | 0.33 | 0.40 | 0.46 | 0.54 | 0.61 | 0.69 | 0.77 | 0.85 | 0.94 | 1.03 | 1.12 | 1.22 | 1.31 | 1.41 | 1.52 | 1.62 | 1.73 | 1.84 | 1.95 | 2.06 | 2.18 | 2.30 | 2.41 |

**Note:** The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R–22
# RAFTERS WITH L/180 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 30 psf plus
Dead Load of 20 psf determines the required bending design value.
Deflection – For 30 psf live load.
Limited to span in inches divided by 180.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psf) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 2500 | 2600 | 2700 | 2800 | 2900 | 3000 |
| | 12.0 | 2–10 | 3–6 | 4–0 | 4–6 | 4–11 | 5–4 | 5–9 | 6–1 | 6–5 | 6–8 | 7–0 | 7–3 | 7–7 | 7–10 | 8–1 | 8–4 | 8–7 | 8–10 | 9–0 | 9–3 | 9–6 | 9–8 | 9–11 | 10–1 | 10–4 | 10–6 | 10–8 | 10–11 | 11–1 |
| | 16.0 | 2–6 | 3–0 | 3–6 | 3–11 | 4–3 | 4–8 | 4–11 | 5–3 | 5–6 | 5–10 | 6–1 | 6–4 | 6–7 | 6–9 | 7–0 | 7–3 | 7–5 | 7–8 | 7–10 | 8–0 | 8–2 | 8–5 | 8–7 | 8–9 | 8–11 | 9–1 | 9–3 | 9–5 | 9–7 |
| 2x4 | 19.2 | 2–3 | 2–9 | 3–2 | 3–7 | 3–11 | 4–3 | 4–6 | 4–10 | 5–1 | 5–4 | 5–6 | 5–9 | 6–0 | 6–2 | 6–5 | 6–7 | 6–9 | 7–0 | 7–2 | 7–4 | 7–6 | 7–8 | 7–10 | 8–0 | 8–2 | 8–4 | 8–5 | 8–7 | 8–9 |
| | 24.0 | 2–0 | 2–6 | 2–10 | 3–2 | 3–6 | 3–9 | 4–0 | 4–3 | 4–6 | 4–9 | 4–11 | 5–2 | 5–4 | 5–6 | 5–9 | 5–11 | 6–1 | 6–3 | 6–5 | 6–7 | 6–8 | 6–10 | 7–0 | 7–2 | 7–3 | 7–5 | 7–7 | 7–8 | 7–10 |
| | 12.0 | 4–6 | 5–6 | 6–4 | 7–1 | 7–9 | 8–5 | 9–0 | 9–6 | 10–0 | 10–6 | 11–0 | 11–5 | 11–11 | 12–4 | 12–8 | 13–1 | 13–6 | 13–10 | 14–2 | 14–7 | 14–11 | 15–3 | 15–7 | 15–11 | 16–2 | 16–6 | 16–10 | 17–1 | 17–5 |
| | 16.0 | 3–11 | 4–9 | 5–6 | 6–2 | 6–9 | 7–3 | 7–9 | 8–3 | 8–8 | 9–1 | 9–6 | 9–11 | 10–3 | 10–8 | 11–0 | 11–4 | 11–8 | 12–0 | 12–4 | 12–7 | 12–11 | 13–2 | 13–6 | 13–9 | 14–0 | 14–3 | 14–7 | 14–10 | 15–1 |
| 2x6 | 19.2 | 3–7 | 4–4 | 5–0 | 5–7 | 6–2 | 6–8 | 7–1 | 7–6 | 7–11 | 8–4 | 8–8 | 9–1 | 9–5 | 9–9 | 10–0 | 10–4 | 10–8 | 10–11 | 11–3 | 11–6 | 11–9 | 12–0 | 12–4 | 12–7 | 12–10 | 13–1 | 13–3 | 13–6 | 13–9 |
| | 24.0 | 3–2 | 3–11 | 4–6 | 5–0 | 5–6 | 5–11 | 6–4 | 6–9 | 7–1 | 7–5 | 7–9 | 8–1 | 8–5 | 8–8 | 9–0 | 9–3 | 9–6 | 9–9 | 10–0 | 10–3 | 10–6 | 10–9 | 11–0 | 11–3 | 11–5 | 11–8 | 11–11 | 12–1 | 12–4 |
| | 12.0 | 5–11 | 7–3 | 8–4 | 9–4 | 10–3 | 11–1 | 11–10 | 12–7 | 13–3 | 13–11 | 14–6 | 15–1 | 15–8 | 16–3 | 16–9 | 17–3 | 17–9 | 18–3 | 18–9 | 19–2 | 19–8 | 20–1 | 20–6 | 20–11 | 21–4 | 21–9 | 22–2 | 22–6 | 22–11 |
| | 16.0 | 5–2 | 6–3 | 7–3 | 8–1 | 8–11 | 9–7 | 10–3 | 10–10 | 11–6 | 12–0 | 12–7 | 13–1 | 13–7 | 14–0 | 14–6 | 14–11 | 15–5 | 15–10 | 16–3 | 16–7 | 17–0 | 17–5 | 17–9 | 18–1 | 18–6 | 18–10 | 19–2 | 19–6 | 19–10 |
| 2x8 | 19.2 | 4–8 | 5–9 | 6–7 | 7–5 | 8–1 | 8–9 | 9–4 | 9–11 | 10–6 | 11–0 | 11–6 | 11–11 | 12–5 | 12–10 | 13–3 | 13–8 | 14–0 | 14–5 | 14–10 | 15–2 | 15–6 | 15–10 | 16–3 | 16–7 | 16–10 | 17–2 | 17–6 | 17–10 | 18–1 |
| | 24.0 | 4–2 | 5–2 | 5–11 | 6–7 | 7–3 | 7–10 | 8–4 | 8–11 | 9–4 | 9–10 | 10–3 | 10–8 | 11–1 | 11–6 | 11–10 | 12–2 | 12–7 | 12–11 | 13–3 | 13–7 | 13–11 | 14–2 | 14–6 | 14–10 | 15–1 | 15–5 | 15–8 | 15–11 | 16–3 |
| | 12.0 | 7–7 | 9–3 | 10–8 | 11–11 | 13–1 | 14–2 | 15–1 | 16–0 | 16–11 | 17–9 | 18–6 | 19–3 | 20–0 | 20–8 | 21–4 | 22–0 | 22–8 | 23–3 | 23–11 | 24–6 | 25–1 | 25–7 | | | | | | | |
| | 16.0 | 6–6 | 8–0 | 9–3 | 10–4 | 11–4 | 12–3 | 13–1 | 13–10 | 14–8 | 15–4 | 16–0 | 16–8 | 17–4 | 17–11 | 18–6 | 19–1 | 19–7 | 20–2 | 20–8 | 21–2 | 21–8 | 22–2 | 22–8 | 23–1 | 23–7 | 24–0 | 24–6 | 24–11 | 25–4 |
| 2x10 | 19.2 | 6–0 | 7–4 | 8–5 | 9–5 | 10–4 | 11–2 | 11–11 | 12–8 | 13–4 | 14–0 | 14–8 | 15–3 | 15–10 | 16–4 | 16–11 | 17–5 | 17–11 | 18–5 | 18–11 | 19–4 | 19–10 | 20–3 | 20–8 | 21–1 | 21–6 | 21–11 | 22–4 | 22–9 | 23–1 |
| | 24.0 | 5–4 | 6–6 | 7–7 | 8–5 | 9–3 | 10–0 | 10–8 | 11–4 | 11–11 | 12–6 | 13–1 | 13–7 | 14–2 | 14–8 | 15–1 | 15–7 | 16–0 | 16–6 | 16–11 | 17–4 | 17–9 | 18–1 | 18–6 | 18–11 | 19–3 | 19–7 | 20–0 | 20–4 | 20–8 |
| E | 12.0 | 0.04 | 0.08 | 0.12 | 0.17 | 0.23 | 0.29 | 0.35 | 0.42 | 0.49 | 0.57 | 0.65 | 0.73 | 0.82 | 0.91 | 1.00 | 1.09 | 1.19 | 1.29 | 1.39 | 1.50 | 1.61 | 1.72 | 1.83 | 1.95 | 2.07 | 2.19 | 2.31 | 2.43 | 2.56 |
| E | 16.0 | 0.04 | 0.07 | 0.11 | 0.15 | 0.20 | 0.25 | 0.31 | 0.36 | 0.43 | 0.49 | 0.56 | 0.63 | 0.71 | 0.78 | 0.86 | 0.95 | 1.03 | 1.12 | 1.21 | 1.30 | 1.39 | 1.49 | 1.59 | 1.69 | 1.79 | 1.89 | 2.00 | 2.11 | 2.22 |
| E | 19.2 | 0.03 | 0.06 | 0.10 | 0.14 | 0.18 | 0.23 | 0.28 | 0.33 | 0.39 | 0.45 | 0.51 | 0.58 | 0.65 | 0.72 | 0.79 | 0.86 | 0.94 | 1.02 | 1.10 | 1.19 | 1.27 | 1.36 | 1.45 | 1.54 | 1.63 | 1.73 | 1.83 | 1.92 | 2.03 |
| E | 24.0 | 0.03 | 0.06 | 0.09 | 0.12 | 0.16 | 0.20 | 0.25 | 0.30 | 0.35 | 0.40 | 0.46 | 0.52 | 0.58 | 0.64 | 0.71 | 0.77 | 0.84 | 0.91 | 1.99 | 1.06 | 1.14 | 1.22 | 1.30 | 1.38 | 1.46 | 1.55 | 1.63 | 1.72 | 1.81 |

**Note:** The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

# TABLE R–23
# RAFTERS WITH L/180 DEFLECTION LIMITATION

**DESIGN CRITERIA:**
Strength – Live Load of 40 psf plus
Dead Load of 20 psf determines the required bending design value.
Deflection – For 40 psf live load.
Limited to span in inches divided by 180.

| Size (in) | Spacing (in) | Rafter Bending Design Value, $F_b$, (psi) | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 2500 | 2600 | 2700 | 2800 | 2900 | 3000 |
| | 12.0 | 2–7 | 3–2 | 3–8 | 4–1 | 4–6 | 4–11 | 5–3 | 5–6 | 5–10 | 6–1 | 6–5 | 6–8 | 6–11 | 7–2 | 7–5 | 7–7 | 7–10 | 8–0 | 8–3 | 8–5 | 8–8 | 8–10 | 9–0 | 9–3 | 9–5 | 9–7 | 9–9 | 9–11 | 10–1 |
| | 16.0 | 2–3 | 2–9 | 3–2 | 3–7 | 3–11 | 4–3 | 4–6 | 4–10 | 5–1 | 5–4 | 5–6 | 5–9 | 6–0 | 6–2 | 6–5 | 6–7 | 6–9 | 7–0 | 7–2 | 7–4 | 7–6 | 7–8 | 7–10 | 8–0 | 8–2 | 8–4 | 8–5 | 8–7 | 8–9 |
| 2x4 | 19.2 | 2–1 | 2–6 | 2–11 | 3–3 | 3–7 | 3–10 | 4–1 | 4–4 | 4–7 | 4–10 | 5–1 | 5–3 | 5–5 | 5–8 | 5–10 | 6–0 | 6–2 | 6–4 | 6–6 | 6–8 | 6–10 | 7–0 | 7–2 | 7–3 | 7–5 | 7–7 | 7–9 | 7–10 | 8–0 |
| | 24.0 | 1–10 | 2–3 | 2–7 | 2–11 | 3–2 | 3–5 | 3–8 | 3–11 | 4–1 | 4–4 | 4–6 | 4–8 | 4–11 | 5–1 | 5–3 | 5–5 | 5–6 | 5–8 | 5–10 | 6–0 | 6–1 | 6–3 | 6–5 | 6–6 | 6–8 | 6–9 | 6–11 | 7–0 | 7–2 |
| | 12.0 | 4–1 | 5–0 | 5–10 | 6–6 | 7–1 | 7–8 | 8–2 | 8–8 | 9–2 | 9–7 | 10–0 | 10–5 | 10–10 | 11–3 | 11–7 | 11–11 | 12–4 | 12–8 | 13–0 | 13–3 | 13–7 | 13–11 | 14–2 | 14–6 | 14–9 | 15–1 | 15–4 | 15–7 | 15–11 |
| | 16.0 | 3–7 | 4–4 | 5–0 | 5–7 | 6–2 | 6–8 | 7–1 | 7–6 | 7–11 | 8–4 | 8–8 | 9–1 | 9–5 | 9–9 | 10–0 | 10–4 | 10–8 | 10–11 | 11–3 | 11–6 | 11–9 | 12–0 | 12–4 | 12–7 | 12–10 | 13–1 | 13–3 | 13–6 | 13–9 |
| 2x6 | 19.2 | 3–3 | 4–0 | 4–7 | 5–1 | 5–7 | 6–1 | 6–6 | 6–10 | 7–3 | 7–7 | 7–11 | 8–3 | 8–7 | 8–11 | 9–2 | 9–5 | 9–9 | 10–0 | 10–3 | 10–6 | 10–9 | 11–0 | 11–3 | 11–5 | 11–8 | 11–11 | 12–2 | 12–4 | 12–7 |
| | 24.0 | 2–11 | 3–7 | 4–1 | 4–7 | 5–0 | 5–5 | 5–10 | 6–2 | 6–6 | 6–10 | 7–1 | 7–5 | 7–8 | 7–11 | 8–2 | 8–5 | 8–8 | 8–11 | 9–2 | 9–5 | 9–7 | 9–10 | 10–0 | 10–3 | 10–5 | 10–8 | 10–10 | 11–0 | 11–3 |
| | 12.0 | 5–5 | 6–7 | 7–8 | 8–7 | 9–4 | 10–1 | 10–10 | 11–6 | 12–1 | 12–8 | 13–3 | 13–9 | 14–4 | 14–10 | 15–3 | 15–9 | 16–3 | 16–8 | 17–1 | 17–6 | 17–11 | 18–4 | 18–9 | 19–1 | 19–6 | 19–10 | 20–3 | 20–7 | 20–11 |
| | 16.0 | 4–8 | 5–9 | 6–7 | 7–5 | 8–1 | 8–9 | 9–4 | 9–11 | 10–6 | 11–0 | 11–6 | 11–11 | 12–5 | 12–10 | 13–3 | 13–8 | 14–0 | 14–5 | 14–10 | 15–2 | 15–6 | 15–10 | 16–3 | 16–7 | 16–10 | 17–2 | 17–6 | 17–10 | 18–1 |
| 2x8 | 19.2 | 4–3 | 5–3 | 6–0 | 6–9 | 7–5 | 8–0 | 8–7 | 9–1 | 9–7 | 10–0 | 10–6 | 10–11 | 11–4 | 11–8 | 12–1 | 12–5 | 12–10 | 13–2 | 13–6 | 13–10 | 14–2 | 14–6 | 14–10 | 15–1 | 15–5 | 15–8 | 16–0 | 16–3 | 16–7 |
| | 24.0 | 3–10 | 4–8 | 5–5 | 6–0 | 6–7 | 7–2 | 7–8 | 8–1 | 8–7 | 9–0 | 9–4 | 9–9 | 10–1 | 10–6 | 10–10 | 11–2 | 11–6 | 11–9 | 12–1 | 12–5 | 12–8 | 12–11 | 13–3 | 13–6 | 13–9 | 14–0 | 14–4 | 14–7 | 14–10 |
| | 12.0 | 6–11 | 8–5 | 9–9 | 10–11 | 11–11 | 12–11 | 13–9 | 14–8 | 15–5 | 16–2 | 16–11 | 17–7 | 18–3 | 18–11 | 19–6 | 20–1 | 20–8 | 21–3 | 21–10 | 22–4 | 22–10 | 23–5 | 23–11 | 24–5 | 24–10 | 25–4 | 25–10 | | |
| | 16.0 | 6–0 | 7–4 | 8–5 | 9–5 | 10–4 | 11–2 | 11–11 | 12–8 | 13–4 | 14–0 | 14–8 | 15–3 | 15–10 | 16–4 | 16–11 | 17–5 | 17–11 | 18–5 | 18–11 | 19–4 | 19–10 | 20–3 | 20–8 | 21–1 | 21–6 | 21–11 | 22–4 | 22–9 | 23–1 |
| 2x10 | 19.2 | 5–5 | 6–8 | 7–8 | 8–7 | 9–5 | 10–2 | 10–11 | 11–7 | 12–2 | 12–9 | 13–4 | 13–11 | 14–5 | 14–11 | 15–5 | 15–11 | 16–4 | 16–10 | 17–3 | 17–8 | 18–1 | 18–6 | 18–11 | 19–3 | 19–8 | 20–0 | 20–5 | 20–9 | 21–1 |
| | 24.0 | 4–11 | 6–0 | 6–11 | 7–8 | 8–5 | 9–1 | 9–9 | 10–4 | 10–11 | 11–5 | 11–11 | 12–5 | 12–11 | 13–4 | 13–9 | 14–3 | 14–8 | 15–0 | 15–5 | 15–10 | 16–2 | 16–6 | 16–11 | 17–3 | 17–7 | 17–11 | 18–3 | 18–7 | 18–11 |
| E | 12.0 | 0.04 | 0.08 | 0.13 | 0.18 | 0.23 | 0.29 | 0.36 | 0.43 | 0.50 | 0.58 | 0.66 | 0.74 | 0.83 | 0.92 | 1.01 | 1.11 | 1.21 | 1.31 | 1.41 | 1.52 | 1.63 | 1.74 | 1.86 | 1.98 | 2.10 | 2.22 | 2.34 | 2.47 | 2.60 |
| E | 16.0 | 0.04 | 0.07 | 0.11 | 0.15 | 0.20 | 0.25 | 0.31 | 0.37 | 0.43 | 0.50 | 0.57 | 0.64 | 0.72 | 0.80 | 0.88 | 0.96 | 1.05 | 1.13 | 1.22 | 1.32 | 1.41 | 1.51 | 1.61 | 1.71 | 1.82 | 1.92 | 2.03 | 2.14 | 2.25 |
| E | 19.2 | 0.04 | 0.06 | 0.10 | 0.14 | 0.18 | 0.23 | 0.28 | 0.34 | 0.40 | 0.46 | 0.52 | 0.59 | 0.65 | 0.73 | 0.80 | 0.88 | 0.95 | 1.04 | 1.12 | 1.20 | 1.29 | 1.38 | 1.47 | 1.56 | 1.66 | 1.75 | 1.85 | 1.95 | 2.05 |
| E | 24.0 | 0.03 | 0.06 | 0.09 | 0.13 | 0.16 | 0.21 | 0.25 | 0.30 | 0.35 | 0.41 | 0.46 | 0.52 | 0.59 | 0.65 | 0.72 | 0.78 | 0.85 | 0.93 | 1.00 | 1.08 | 1.15 | 1.23 | 1.31 | 1.40 | 1.48 | 1.57 | 1.66 | 1.75 | 1.84 |

**Note:** The required modulus of elasticity, E, in 1,000,000 pounds per square inch is shown at the bottom of each table, is limited to 2.6 million psi and less, and is applicable to all lumber sizes shown. Spans are shown in feet–inches and are limited to 26' and less. Check sources of supply for availability of lumber in lengths greater than 20'.

**Design Values for Joists and Rafters**

These "Fb" values are for use where repetitive members are spaced not more than 24 inches. Values for surfaced dry or surfaced green lumber apply at 19% maximum moisture content in use.

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Cottonwood** | | | | | |
| Select Structural | 2x4 | 1510 | 1735 | 1,200,000 | |
| No.1 | | 1080 | 1240 | 1,200,000 | |
| No.2 | | 1080 | 1240 | 1,100,000 | |
| No.3 | | 605 | 695 | 1,000,000 | |
| Stud | | 600 | 690 | 1,000,000 | |
| Construction | | 805 | 925 | 1,000,000 | |
| Standard | | 460 | 530 | 900,000 | |
| Utility | | 200 | 230 | 900,000 | |
| Select Structural | 2x6 | 1310 | 1505 | 1,200,000 | |
| No.1 | | 935 | 1075 | 1,200,000 | |
| No.2 | | 935 | 1075 | 1,100,000 | |
| No.3 | | 525 | 600 | 1,000,000 | |
| Stud | | 545 | 630 | 1,000,000 | |
| Select Structural | 2x8 | 1210 | 1390 | 1,200,000 | NSLB |
| No.1 | | 865 | 990 | 1,200,000 | |
| No.2 | | 865 | 990 | 1,100,000 | |
| No.3 | | 485 | 555 | 1,000,000 | |
| Select Structural | 2x10 | 1105 | 1275 | 1,200,000 | |
| No.1 | | 790 | 910 | 1,200,000 | |
| No.2 | | 790 | 910 | 1,100,000 | |
| No.3 | | 445 | 510 | 1,000,000 | |
| Select Structural | 2x12 | 1005 | 1155 | 1,200,000 | |
| No.1 | | 720 | 825 | 1,200,000 | |
| No.2 | | 720 | 825 | 1,100,000 | |
| No.3 | | 405 | 465 | 1,000,000 | |
| **Douglas Fir–Larch** | | | | | |
| Select Structural | 2x4 | 2500 | 2875 | 1,900,000 | |
| No.1 & Btr | | 1985 | 2280 | 1,800,000 | |
| No.1 | | 1725 | 1985 | 1,700,000 | |
| No.2 | | 1510 | 1735 | 1,600,000 | |
| No.3 | | 865 | 990 | 1,400,000 | |
| Stud | | 855 | 980 | 1,400,000 | |
| Construction | | 1150 | 1325 | 1,500,000 | |
| Standard | | 635 | 725 | 1,400,000 | |
| Utility | | 315 | 365 | 1,300,000 | |
| Select Structural | 2x6 | 2170 | 2495 | 1,900,000 | |
| No.1 & Btr | | 1720 | 1975 | 1,800,000 | |
| No.1 | | 1495 | 1720 | 1,700,000 | |
| No.2 | | 1310 | 1505 | 1,600,000 | |
| No.3 | | 750 | 860 | 1,400,000 | |
| Stud | | 775 | 895 | 1,400,000 | |
| Select Structural | 2x8 | 2000 | 2300 | 1,900,000 | WCLIB |
| No.1 & Str | | 1585 | 1825 | 1,800,000 | WWPA |
| No.1 | | 1380 | 1585 | 1,700,000 | |
| No.2 | | 1210 | 1390 | 1,600,000 | |
| No.3 | | 690 | 795 | 1,400,000 | |
| Select Structural | 2x10 | 1835 | 2110 | 1,900,000 | |
| No.1 & Btr | | 1455 | 1675 | 1,800,000 | |
| No.1 | | 1265 | 1455 | 1,700,000 | |
| No.2 | | 1105 | 1275 | 1,600,000 | |
| No.3 | | 635 | 725 | 1,400,000 | |
| Select Structural | 2x12 | 1670 | 1920 | 1,900,000 | |
| No.1 & Btr | | 1325 | 1520 | 1,800,000 | |
| No.1 | | 1150 | 1325 | 1,700,000 | |
| No.2 | | 1005 | 1155 | 1,600,000 | |
| No.3 | | 575 | 660 | 1,400,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Douglas Fir–Larch (North)** | | | | | |
| Select Structural | 2x4 | 2245 | 2580 | 1,900,000 | NLGA |
| No.1 /No.2 | | 1425 | 1635 | 1,600,000 | |
| No.3 | | 820 | 940 | 1,400,000 | |
| Stud | | 820 | 945 | 1,400,000 | |
| Construction | | 1095 | 1255 | 1,500,000 | |
| Standard | | 605 | 695 | 1,400,000 | |
| Utility | | 290 | 330 | 1,300,000 | |
| Select Structural | 2x6 | 1945 | 2235 | 1,900,000 | |
| No.1 /No.2 | | 1235 | 1420 | 1,600,000 | |
| No.3 | | 710 | 815 | 1,400,000 | |
| Stud | | 750 | 860 | 1,400,000 | |
| Select Structural | 2x8 | 1795 | 2065 | 1,900,000 | |
| No.1 /No.2 | | 1140 | 1310 | 1,600,000 | |
| No.3 | | 655 | 755 | 1,400,000 | |
| Select Structural | 2x10 | 1645 | 1890 | 1,900,000 | |
| No.1 /No–2 | | 1045 | 1200 | 1,600,000 | |
| No.3 | | 600 | 690 | 1,400,000 | |
| Select Structural | 2x12 | 1495 | 1720 | 1,900,000 | |
| No.1 /No.2 | | 950 | 1090 | 1,600,000 | |
| No.3 | | 545 | 630 | 1,400,000 | |
| **Douglas Fir–South** | | | | | |
| Select Structural | 2x4 | 2245 | 2580 | 1,400,000 | WWPA |
| No.1 | | 1555 | 1785 | 1,300,000 | |
| No.2 | | 1425 | 1635 | 1,200,000 | |
| No.3 | | 820 | 940 | 1,100,000 | |
| Stud | | 820 | 945 | 1,100,000 | |
| Construction | | 1065 | 1225 | 1,200,000 | |
| Standard | | 605 | 695 | 1,100,000 | |
| Utility | | 290 | 330 | 1,000,000 | |
| Select Structural | 2x6 | 1945 | 2235 | 1,400,000 | |
| No.1 | | 1345 | 1545 | 1,300,000 | |
| No.2 | | 1235 | 1420 | 1,200,000 | |
| No.3 | | 710 | 815 | 1,100,000 | |
| Stud | | 750 | 860 | 1,100,000 | |
| Select Structural | 2x8 | 1795 | 2065 | 1,400,000 | |
| No.1 | | 1240 | 1430 | 1,300,000 | |
| No.2 | | 1140 | 1310 | 1,200,000 | |
| No.3 | | 655 | 755 | 1,100,000 | |
| Select Structural | 2x10 | 1645 | 1890 | 1,400,000 | |
| No.1 | | 1140 | 1310 | 1,300,000 | |
| No.2 | | 1045 | 1200 | 1,200,000 | |
| No.3 | | 600 | 690 | 1,100,000 | |
| Select Structural | 2x12 | 1495 | 1720 | 1,400,000 | |
| No.1 | | 1035 | 1190 | 1,300,000 | |
| No.2 | | 950 | 1090 | 1,200,000 | |
| No.3 | | 545 | 630 | 1,100,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Eastern Hemlock–Tamarack** | | | | | |
| Select Structural | 2x4 | 2155 | 2480 | 1,200,000 | NELMA NSLB |
| No.1 | | 1335 | 1535 | 1,100,000 | |
| No.2 | | 990 | 1140 | 1,100,000 | |
| No.3 | | 605 | 695 | 900,000 | |
| Stud | | 570 | 655 | 900,000 | |
| Construction | | 775 | 895 | 1,000,000 | |
| Standard | | 430 | 495 | 900,000 | |
| Utility | | 200 | 230 | 800,000 | |
| Select Structural | 2x6 | 1870 | 2150 | 1,200,000 | |
| No.1 | | 1160 | 1330 | 1,100,000 | |
| No.2 | | 860 | 990 | 1,100,000 | |
| No.3 | | 525 | 600 | 900,000 | |
| Stud | | 520 | 595 | 900,000 | |
| Select Structural | 2x8 | 1725 | 1985 | 1,200,000 | |
| No.1 | | 1070 | 1230 | 1,100,000 | |
| No.2 | | 795 | 915 | 1,100,000 | |
| No.3 | | 485 | 555 | 900,000 | |
| Select Structural | 2x10 | 1580 | 1820 | 1,200,000 | |
| No.1 | | 980 | 1125 | 1,100,000 | |
| No.2 | | 725 | 835 | 1,100,000 | |
| No.3 | | 445 | 510 | 900,000 | |
| Select Structural | 2x12 | 1440 | 1655 | 1,200,000 | |
| No.1 | | 890 | 1025 | 1,100,000 | |
| No.2 | | 660 | 760 | 1,100,000 | |
| No.3 | | 405 | 465 | 900,000 | |
| **Eastern Softwoods** | | | | | |
| Select Structural | 2x4 | 2155 | 2480 | 1,200,000 | NELMA NSLB |
| No.1 | | 1335 | 1535 | 1,100,000 | |
| No.2 | | 990 | 1140 | 1,100,000 | |
| No.3 | | 605 | 695 | 900,000 | |
| Stud | | 570 | 655 | 900,000 | |
| Construction | | 775 | 895 | 1,000,000 | |
| Standard | | 430 | 495 | 900,000 | |
| Utility | | 200 | 230 | 800,000 | |
| Select Structural | 2x6 | 1870 | 2150 | 1,200,000 | |
| No.1 | | 1160 | 1330 | 1,100,000 | |
| No.2 | | 860 | 990 | 1,100,000 | |
| No.3 | | 525 | 600 | 900,000 | |
| Stud | | 520 | 595 | 900,000 | |
| Select Structural | 2x8 | 1725 | 1985 | 1,200,000 | |
| No.1 | | 1070 | 1230 | 1,100,000 | |
| No.2 | | 795 | 915 | 1,100,000 | |
| No.3 | | 485 | 555 | 900,000 | |
| Select Structural | 2x10 | 1580 | 1820 | 1,200,000 | |
| No.1 | | 980 | 1125 | 1,100,000 | |
| No.2 | | 725 | 835 | 1,100,000 | |
| No.3 | | 445 | 510 | 900,000 | |
| Select Structural | 2x12 | 1440 | 1655 | 1,200,000 | |
| No.1 | | 890 | 1025 | 1,100,000 | |
| No.2 | | 660 | 760 | 1,100,000 | |
| No.3 | | 405 | 465 | 900,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Eastern White Pine** | | | | | |
| Select Structural | 2x4 | 2155 | 2480 | 1,200,000 | |
| No.1 | | 1335 | 1535 | 1,100,000 | |
| No.2 | | 990 | 1140 | 1,100,000 | |
| No.3 | | 605 | 695 | 900,000 | |
| Stud | | 570 | 655 | 900,000 | |
| Construction | | 775 | 895 | 1,000,000 | |
| Standard | | 430 | 495 | 900,000 | |
| Utility | | 200 | 230 | 800,000 | |
| Select Structural | 2x6 | 1870 | 2150 | 1,200,000 | |
| No.1 | | 1160 | 1330 | 1,100,000 | |
| No.2 | | 860 | 990 | 1,100,000 | |
| No.3 | | 525 | 600 | 900,000 | |
| Stud | | 520 | 595 | 900,000 | NELMA |
| Select Structural | 2x8 | 1725 | 1985 | 1,200,000 | NSLB |
| No.1 | | 1070 | 1230 | 1,100,000 | |
| No.2 | | 795 | 915 | 1,100,000 | |
| No.3 | | 485 | 555 | 900,000 | |
| Select Structural | 2x10 | 1580 | 1820 | 1,200,000 | |
| No.1 | | 980 | 1125 | 1,100,000 | |
| No.2 | | 725 | 835 | 1,100,000 | |
| No.3 | | 445 | 510 | 900,000 | |
| Select Structural | 2x12 | 1440 | 1655 | 1,200,000 | |
| No.1 | | 890 | 1025 | 1,100,000 | |
| No.2 | | 660 | 760 | 1,100,000 | |
| No.3 | | 405 | 465 | 900,000 | |
| **Hem Fir** | | | | | |
| Select Structural | 2x4 | 2415 | 2775 | 1,600,000 | |
| No.1 & Btr | | 1810 | 2085 | 1,500,000 | |
| No.1 | | 1640 | 1885 | 1,500,000 | |
| No.2 | | 1465 | 1685 | 1,300,000 | |
| No.3 | | 865 | 990 | 1,200,000 | |
| Stud | | 855 | 980 | 1,200,000 | |
| Construction | | 1120 | 1290 | 1,300,000 | |
| Standard | | 635 | 725 | 1,200,000 | |
| Utility | | 290 | 330 | 1,100,000 | |
| Select Structural | 2x6 | 2095 | 2405 | 1,600,000 | |
| No.1 & Btr | | 1570 | 1805 | 1,500,000 | |
| No.1 | | 1420 | 1635 | 1,500,000 | |
| No.2 | | 1270 | 1460 | 1,300,000 | |
| No.3 | | 750 | 860 | 1,200,000 | |
| Stud | | 775 | 895 | 1,200,000 | |
| Select Structural | 2x8 | 1930 | 2220 | 1,600,000 | WCLIB |
| No.1 & Btr | | 1450 | 1665 | 1,500,000 | WWPA |
| No.1 | | 1310 | 1510 | 1,500,000 | |
| No.2 | | 1175 | 1350 | 1,300,000 | |
| No.3 | | 690 | 795 | 1,200,000 | |
| Select Structural | 2x10 | 1770 | 2035 | 1,600,000 | |
| No.1 & Btr | | 1330 | 1525 | 1,500,000 | |
| No.1 | | 1200 | 1380 | 1,500,000 | |
| No.2 | | 1075 | 1235 | 1,300,000 | |
| No.3 | | 635 | 725 | 1,200,000 | |
| Select Structural | 2x12 | 1610 | 1850 | 1,600,000 | |
| No.1 & Btr | | 1210 | 1390 | 1,500,000 | |
| No.1 | | 1095 | 1255 | 1,500,000 | |
| No.2 | | 980 | 1125 | 1,300,000 | |
| No.3 | | 575 | 660 | 1,200,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Hem–Fir (North)** | | | | | |
| Select Structural | 2x4 | 2245 | 2580 | 1,700,000 | NLGA |
| No.1 /No.2 | | 1725 | 1985 | 1,600,000 | |
| No.3 | | 990 | 1140 | 1,400,000 | |
| Stud | | 980 | 1125 | 1,400,000 | |
| Construction | | 1325 | 1520 | 1,500,000 | |
| Standard | | 720 | 825 | 1,400,000 | |
| Utility | | 345 | 395 | 1,300,000 | |
| Select Structural | 2x6 | 1945 | 2235 | 1,700,000 | |
| No.1 /No.2 | | 1495 | 1720 | 1,600,000 | |
| No.3 | | 860 | 990 | 1,400,000 | |
| Stud | | 890 | 1025 | 1,400,000 | |
| Select Structural | 2x8 | 1795 | 2065 | 1,700,000 | |
| No.1 /No.2 | | 1380 | 1585 | 1,600,000 | |
| No.3 | | 795 | 915 | 1,400,000 | |
| Select Structural | 2x10 | 1645 | 1890 | 1,700,000 | |
| No.1 /No.2 | | 1265 | 1455 | 1,600,000 | |
| No.3 | | 725 | 835 | 1,400,000 | |
| Select Structural | 2x12 | 1495 | 1720 | 1,700,000 | |
| No.1 /No.2 | | 1150 | 1325 | 1,600,000 | |
| No.3 | | 660 | 760 | 1,400,000 | |
| **Mixed Maple** | | | | | |
| Select Structural | 2x4 | 1725 | 1985 | 1,300,000 | NELMA |
| No.1 | | 1250 | 1440 | 1,200,000 | |
| No.2 | | 1210 | 1390 | 1,100,000 | |
| No.3 | | 690 | 795 | 1,000.000 | |
| Stud | | 695 | Boo | 1,000,000 | |
| Construction | | 920 | 1060 | 1,100,000 | |
| Standard | | 520 | 595 | 1,000,000 | |
| Utility | | 260 | 300 | 900,000 | |
| Select Structural | 2x6 | 1495 | 1720 | 1,300,000 | |
| No.1 | | 1085 | 1245 | 1,200,000 | |
| No.2 | | 1045 | 1205 | 1,100,000 | |
| No.3 | | 600 | 690 | 1,000,000 | |
| Stud | | 635 | 725 | 1,000,000 | |
| Select Structural | 2x8 | 1380 | 1585 | 1,300,000 | |
| No.1 | | 1000 | 1150 | 1,200,000 | |
| No.2 | | 965 | 1110 | 1,100,000 | |
| No.3 | | 550 | 635 | 1,000,000 | |
| Select Structural | 2x10 | 1265 | 1455 | 1,300,000 | |
| No.1 | | 915 | 1055 | 1,200,000 | |
| No.2 | | 885 | 1020 | 1,100,000 | |
| No.3 | | 505 | 580 | 1,000,000 | |
| Select Structural | 2x12 | 1150 | 1325 | 1,300,000 | |
| No.1 | | 835 | 960 | 1,200,000 | |
| No.2 | | 805 | 925 | 1,100,000 | |
| No.3 | | 460 | 530 | 1,000,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Mixed Oak** | | | | | |
| Select Structural | 2x4 | 1985 | 2280 | 1,100,000 | NELMA |
| No.1 | | 1425 | 1635 | 1,000,000 | |
| No.2 | | 1380 | 1585 | 900,000 | |
| No.3 | | 820 | 940 | 800,000 | |
| Stud | | 790 | 910 | 800,000 | |
| Construction | | 1065 | 1225 | 900,000 | |
| Standard | | 605 | 695 | 800,000 | |
| Utility | | 290 | 330 | 800,000 | |
| Select Structural | 2x6 | 1720 | 1975 | 1,100,000 | |
| No.1 | | 1235 | 1420 | 1,000,000 | |
| No.2 | | 1195 | 1375 | 900,000 | |
| No.3 | | 710 | 815 | 800,000 | |
| Stud | | 720 | 825 | 800,000 | |
| Select Structural | 2x8 | 1585 | 1825 | 1,100,000 | |
| No.1 | | 1140 | 1310 | 1,000,000 | |
| No.2 | | 1105 | 1270 | 900,000 | |
| No.3 | | 655 | 755 | 800,000 | |
| Select Structural | 2x10 | 1455 | 1675 | 1,100,000 | |
| No.1 | | 1045 | 1200 | 1,000,000 | |
| No.2 | | 1010 | 1165 | 900,000 | |
| No.3 | | 600 | 690 | 800,000 | |
| Select Structural | 2x12 | 1325 | 1520 | 1,100,000 | |
| No.1 | | 950 | 1090 | 1,000,000 | |
| No.2 | | 920 | 1060 | 900,000 | |
| No.3 | | 545 | 630 | 800,000 | |
| **Mixed Southern Pine** | | | | | |
| Select Structural | 2x4 | 2360 | 2710 | 1,600,000 | SPIB |
| No.1 | | 1670 | 1920 | 1,500,000 | |
| No.2 | | 1500 | 1720 | 1,400,000 | |
| No.3 | | 865 | 990 | 1,200,000 | |
| Stud | | 890 | 1020 | 1,200,000 | |
| Construction | | 1150 | 1320 | 1,300,000 | |
| Standard | | 635 | 725 | 1,200,000 | |
| Utility | | 315 | 365 | 1,100,000 | |
| Select Structural | 2x6 | 2130 | 2450 | 1,600,000 | |
| No.1 | | 1490 | 1720 | 1,500,000 | |
| No.2 | | 1320 | 1520 | 1,400,000 | |
| No.3 | | 775 | 895 | 1,200,000 | |
| Stud | | 775 | 895 | 1,200,000 | |
| Select Structural | 2x8 | 2010 | 2310 | 1,600,000 | |
| No.1 | | 1380 | 1590 | 1,500,000 | |
| No.2 | | 1210 | 1390 | 1,400,000 | |
| No.3 | | 720 | 825 | 1,200,000 | |
| Select Structural | 2x10 | 1730 | 1980 | 1,600,000 | |
| No.1 | | 1210 | 1390 | 1,500,000 | |
| No.2 | | 1060 | 1220 | 1,400,000 | |
| No.3 | | 605 | 695 | 1,200,000 | |
| Select Structural | 2x12 | 1610 | 1850 | 1,600,000 | |
| No.1 | | 1120 | 1290 | 1,500,000 | |
| No.2 | | 1010 | 1160 | 1,400,000 | |
| No.3 | | 575 | 660 | 1,200,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Northern Red Oak** | | | | | |
| Select Structural | 2x4 | 2415 | 2775 | 1,400,000 | NELMA |
| No.1 | | 1725 | 1985 | 1,400,000 | |
| No.2 | | 1680 | 1935 | 1,300,000 | |
| No.3 | | 950 | 1090 | 1,200,000 | |
| Stud | | 950 | 1090 | 1,200,000 | |
| Construction | | 1265 | 1455 | 1,200,000 | |
| Standard | | 720 | 825 | 1,100,000 | |
| Utility | | 345 | 395 | 1,000,000 | |
| Select Structural | 2x6 | 2095 | 2405 | 1,400,000 | |
| No.1 | | 1495 | 1720 | 1,400,000 | |
| No.2 | | 1460 | 1675 | 1,300,000 | |
| No.3 | | 820 | 945 | 1,200,000 | |
| Stud | | 865 | 990 | 1,200,000 | |
| Select Structural | 2x8 | 1930 | 2220 | 1,400,000 | |
| No.1 | | 1380 | 1585 | 1,400,000 | |
| No.2 | | 1345 | 1545 | 1,300,000 | |
| No.3 | | 760 | 875 | 1,200,000 | |
| Select Structural | 2x10 | 1770 | 2035 | 1,400,000 | |
| No.1 | | 1265 | 1455 | 1,400,000 | |
| No.2 | | 1235 | 1420 | 1,300,000 | |
| No.3 | | 695 | 800 | 1,200,000 | |
| Select Structural | 2x12 | 1610 | 1850 | 1,400,000 | |
| No.1 | | 1150 | 1325 | 1,400,000 | |
| No.2 | | 1120 | 1290 | 1,300,000 | |
| No.3 | | 635 | 725 | 1,200,000 | |
| **Northern Species** | | | | | |
| Select Structural | 2x4 | 1640 | 1885 | 1,100,000 | NLGA |
| No.1 /No.2 | | 990 | 1140 | 1,100,000 | |
| No.3 | | 605 | 695 | 1,000,000 | |
| Stud | | 570 | 655 | 1,000,000 | |
| Construction | | 775 | 895 | 1,000,000 | |
| Standard | | 430 | 495 | 900,000 | |
| Utility | | 200 | 230 | 900,000 | |
| Select Structural | 2x6 | 1420 | 1635 | 1,100,000 | |
| No. 1 / No.2 | | 860 | 990 | 1,100,000 | |
| No.3 | | 525 | 600 | 1,000,000 | |
| Stud | | 520 | 595 | 1,000,000 | |
| Select Structural | 2x8 | 1310 | 1510 | 1,100,000 | |
| No.1/No.2 | | 795 | 915 | 1,100,000 | |
| No.3 | | 485 | 555 | 1,000,000 | |
| Select Structural | 2x10 | 1200 | 1380 | 1,100,000 | |
| No.1 /No.2 | | 725 | 835 | 1,100,000 | |
| No.3 | | 445 | 510 | 1,000,000 | |
| Select Structural | 2x12 | 1095 | 1255 | 1,100,000 | |
| No.1 /No.2 | | 660 | 760 | 1,100,000 | |
| No.3 | | 405 | 465 | 1,000,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Northern White Cedar** | | | | | |
| Select Structural | 2x4 | 1335 | 1535 | 800,000 | NELMA |
| No.1 | | 990 | 1140 | 700,000 | |
| No.2 | | 950 | 1090 | 700,000 | |
| No.3 | | 560 | 645 | 600,000 | |
| Stud | | 540 | 620 | 600,000 | |
| Construction | | 720 | 825 | 700,000 | |
| Standard | | 405 | 465 | 600,000 | |
| Utility | | 200 | 230 | 600,000 | |
| Select Structural | 2x6 | 1160 | 1330 | 800,000 | |
| No.1 | | 860 | 990 | 700,000 | |
| No.2 | | 820 | 945 | 700,000 | |
| No.3 | | 485 | 560 | 600,000 | |
| Stud | | 490 | 560 | 600,000 | |
| Select Structural | 2x8 | 1070 | 1230 | 800,000 | |
| No.1 | | 795 | 915 | 700,000 | |
| No.2 | | 760 | 875 | 700,000 | |
| No.3 | | 450 | 515 | 600,000 | |
| Select Structural | 2x10 | 980 | 1125 | 800,000 | |
| No.1 | | 725 | 835 | 700,000 | |
| No.2 | | 695 | 800 | 700,000 | |
| No.3 | | 410 | 475 | 600,000 | |
| Select Structural | 2x12 | 890 | 1025 | 800,000 | |
| No.1 | | 660 | 760 | 700,000 | |
| No.2 | | 635 | 725 | 700,000 | |
| No.3 | | 375 | 430 | 600,000 | |
| **Red Maple** | | | | | |
| Select Structural | 2x4 | 2245 | 2580 | 1,700,000 | NELMA |
| No.1 | | 1595 | 1835 | 1,600,000 | |
| No.2 | | 1555 | 1785 | 1,500,000 | |
| No.3 | | 905 | 1040 | 1,300,000 | |
| Stud | | 885 | 1020 | 1,300,000 | |
| Construction | | 1210 | 1390 | 1,400,000 | |
| Standard | | 660 | 760 | 1,300,000 | |
| Utility | | 315 | 365 | 1,200,000 | |
| Select Structural | 2x6 | 1945 | 2235 | 1,700,000 | |
| No.1 | | 1385 | 1590 | 1,600,000 | |
| No.2 | | 1345 | 1545 | 1,500,000 | |
| No.3 | | 785 | 905 | 1,300,000 | |
| Stud | | 805 | 925 | 1,300,000 | |
| Select Structural | 2x8 | 1795 | 2065 | 1,700,000 | |
| No.1 | | 1275 | 1470 | 1,600,000 | |
| No.2 | | 1240 | 1430 | 1,500,000 | |
| No.3 | | 725 | 835 | 1,300,000 | |
| Select Structural | 2x10 | 1645 | 1890 | 1,700,000 | |
| No.1 | | 1170 | 1345 | 1,600,000 | |
| No.2 | | 1140 | 1310 | 1,500,000 | |
| No.3 | | 665 | 765 | 1,300,000 | |
| Select Structural | 2x12 | 1495 | 1720 | 1,700,000 | |
| No.1 | | 1065 | 1225 | 1,600,000 | |
| No.2 | | 1035 | 1190 | 1,500,000 | |
| No.3 | | 605 | 695 | 1,300,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Red Oak** | | | | | |
| Select Structural | 2x4 | 1985 | 2280 | 1,400,000 | NELMA |
| No.1 | | 1425 | 1635 | 1,300,000 | |
| No.2 | | 1380 | 1585 | 1,200,000 | |
| No.3 | | 820 | 940 | 1,100,000 | |
| Stud | | 790 | 910 | 1,100,000 | |
| Construction | | 1065 | 1225 | 1,200,000 | |
| Standard | | 605 | 695 | 1,100,000 | |
| Utility | | 290 | 330 | 1,000,000 | |
| Select Structural | 2x6 | 1720 | 1975 | 1,400,000 | |
| No.1 | | 1235 | 1420 | 1,300,000 | |
| No.2 | | 1195 | 1375 | 1,200,000 | |
| No.3 | | 710 | 815 | 1,100,000 | |
| Stud | | 720 | 825 | 1,100,000 | |
| Select Structural | 2x8 | 1585 | 1825 | 1,400,000 | |
| No.1 | | 1140 | 1310 | 1,300,000 | |
| No.2 | | 1105 | 1270 | 1,200,000 | |
| No.3 | | 655 | 755 | 1,100,000 | |
| Select Structural | 2x10 | 1455 | 1675 | 1,400,000 | |
| No.1 | | 1045 | 1200 | 1,300,000 | |
| No.2 | | 1010 | 1165 | 1,200,000 | |
| No.3 | | 600 | 690 | 1,100,000 | |
| Select Structural | 2x12 | 1325 | 1520 | 1,400,000 | |
| No.1 | | 950 | 1090 | 1,300,000 | |
| No.2 | | 920 | 1060 | 1,200,000 | |
| No.3 | | 545 | 630 | 1,100,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Redwood** | | | | | |
| Clear Structural | 2x4 | 3020 | 3470 | 1,400,000 | |
| Select Structural | | 2330 | 2680 | 1,400,000 | |
| Select Structural, open grain | | 1900 | 2180 | 1,100,000 | |
| No.1 | | 1680 | 1935 | 1,300,000 | |
| No.1, open grain | | 1335 | 1535 | 1,100,000 | |
| No.2 | | 1595 | 1835 | 1,200,000 | |
| No.2, open grain | | 1250 | 1440 | 1,000,000 | |
| No.3 | | 905 | 1040 | 1,100,000 | |
| No.3, open grain | | 735 | 845 | 900,000 | |
| Stud | | 725 | 835 | 900,000 | |
| Construction | | 950 | 1090 | 900,000 | |
| Standard | | 520 | 595 | 900,000 | |
| Utility | | 260 | 300 | 800,000 | |
| Clear Structural | 2x6 | 2615 | 3010 | 1,400,000 | |
| Select Structural | | 2020 | 2320 | 1,400,000 | |
| Select Structural, open grain | | 1645 | 1890 | 1,100,000 | |
| No.1 | | 1460 | 1675 | 1,300,000 | |
| No.1, open grain | | 1160 | 1330 | 1,100,000 | |
| No.2 | | 1385 | 1590 | 1,200,000 | |
| No.2, open grain | | 1085 | 1245 | 1,000,000 | |
| No.3 | | 785 | 905 | 1,100,000 | |
| No.3, open grain | | 635 | 730 | 900,000 | |
| Stud | | 660 | 760 | 900,000 | |
| Clear Structural | 2x8 | 2415 | 2775 | 1,400,000 | |
| Select Structural | | 1865 | 2140 | 1,400,000 | RIS |
| Select Structural, open grain | | 1520 | 1745 | 1,100,000 | |
| No.1 | | 1345 | 1545 | 1,300,000 | |
| No.1, open grain | | 1070 | 1230 | 1,100,000 | |
| No.2 | | 1275 | 1470 | 1,200,000 | |
| No.2, open grain | | 1000 | 1150 | 1,000,000 | |
| No.3 | | 725 | 835 | 1,100,000 | |
| No.3, open grain | | 585 | 675 | 900,000 | |
| Clear Structural | 2x10 | 2215 | 2545 | 1,400,000 | |
| Select Structural | | 1710 | 1965 | 1,400,000 | |
| Select Structural, open grain | | 1390 | 1600 | 1,100,000 | |
| No.1 | | 1235 | 1420 | 1,300,000 | |
| No.1, open grain | | 980 | 1125 | 1,100,000 | |
| No.2 | | 1170 | 1345 | 1,200,000 | |
| No.2, open grain | | 915 | 1055 | 1,000,000 | |
| No.3 | | 665 | 765 | 1,100,000 | |
| No.3, open grain | | 540 | 620 | 900,000 | |
| Clear Structural | 2x12 | 2015 | 2315 | 1,400,000 | |
| Select Structural | | 1555 | 1785 | 1,400,000 | |
| Select Structural, open grain | | 1265 | 1455 | 1,100,000 | |
| No.1 | | 1120 | 1290 | 1,300,000 | |
| No.1, open grain | | 890 | 1025 | 1,100,000 | |
| No.2 | | 1065 | 1225 | 1,200,000 | |
| No.2, open grain | | 835 | 960 | 1,000,000 | |
| No.3 | | 605 | 695 | 1,100,000 | |
| No.3, open grain | | 490 | 560 | 900,000 | |

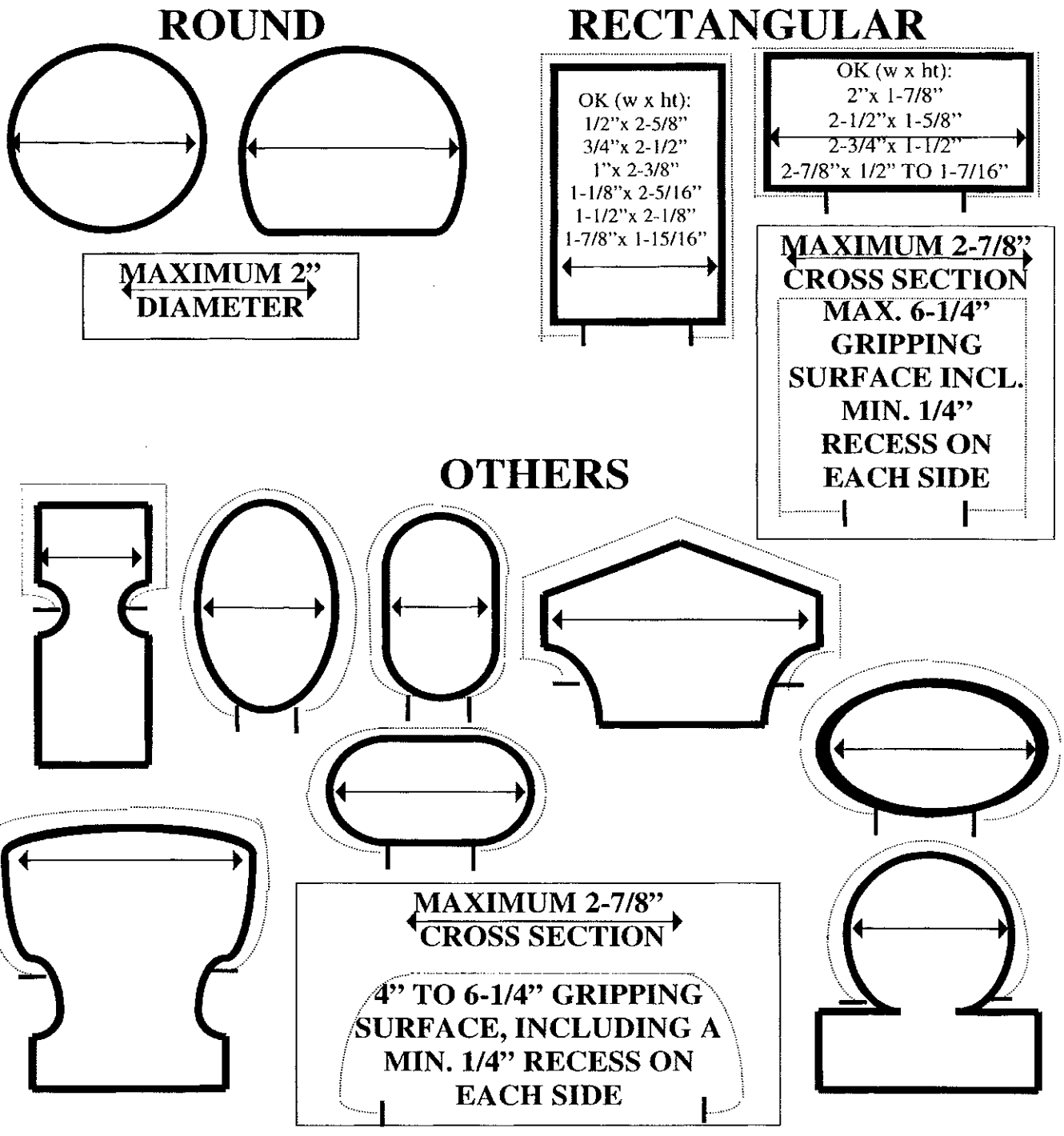
| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Southern Pine** | | | | | |
| Dense Select Structural | 2x4 | 3510 | 4030 | 1,900,000 | SPIB |
| Select Structural | | 3280 | 3770 | 1,800,000 | |
| Non–Dense Select Structural | | 3050 | 3500 | 1,700,000 | |
| No.1 Dense | | 2300 | 2650 | 1,800,000 | |
| No.1 | | 2130 | 2450 | 1,700,000 | |
| No.1 Non–Dense | | 1950 | 2250 | 1,600,000 | |
| No.2 Dense | | 1960 | 2250 | 1,700,000 | |
| No.2 | | 1720 | 1980 | 1,600,000 | |
| No.2 Non–Dense | | 1550 | 1790 | 1,400,000 | |
| No.3 | | 980 | 1120 | 1,400,000 | |
| Stud | | 1010 | 1160 | 1,400,000 | |
| Construction | | 1270 | 1450 | 1,500,000 | |
| Standard | | 720 | 825 | 1,300,000 | |
| Utility | | 345 | 395 | 1,300,000 | |
| Dense Select Structural | 2x6 | 3100 | 3570 | 1,900,000 | |
| Select Structural | | 2930 | 3370 | 1,800,000 | |
| Non–Dense Select Structural | | 2700 | 3110 | 1,700,000 | |
| No.1 Dense | | 2010 | 2310 | 1,800,000 | |
| No.1 | | 1900 | 2180 | 1,700,000 | |
| No.1 Non–Dense | | 1720 | 1980 | 1,600,000 | |
| No.2 Dense | | 1670 | 1920 | 1,700,000 | |
| No.2 | | 1440 | 1650 | 1,600,000 | |
| No.2 Non–Dense | | 1320 | T520 | 1,400,000 | |
| No.3 | | 865 | 990 | 1,400,000 | |
| Stud | | 890 | 1020 | 1,400,000 | |
| Dense Select Structural | 2x8 | 2820 | 3240 | 1,900,000 | |
| Select Structural | | 2650 | 3040 | 1,800,000 | |
| Non–Dense Select Structural | | 2420 | 2780 | 1,700,000 | |
| No.1 Dense | | 1900 | 2180 | 1,800,000 | |
| No.1 | | 1730 | 1980 | 1,700,000 | |
| No.1 Non–Dense | | 1550 | 1790 | 1,600,000 | |
| No.2 Dense | | 1610 | 1850 | 1,700,000 | |
| No.2 | | 1380 | 1590 | 1,600,000 | |
| No.2 Non–Dense | | 1260 | 1450 | 1,400,000 | |
| No.3 | | 805 | 925 | 1,400,000 | |
| Dense Select Structural | 2x10 | 2470 | 2840 | 1,900,000 | |
| Select Structural | | 2360 | 2710 | 1,800,000 | |
| Non–Dense Select Structural | | 2130 | 2450 | 1,700,000 | |
| No.1 Dense | | 1670 | 1920 | 1,800,000 | |
| No.1 | | 1500 | 1720 | 1,700,000 | |
| No.1 Non–Dense | | 1380 | 1590 | 1,600,000 | |
| No.2 Dense | | 1380 | 1590 | 1,700,000 | |
| No.2 | | 1210 | 1390 | 1,600,000 | |
| No.2 Non–Dense | | 1090 | 1260 | 1,400,000 | |
| No.3 | | 690 | 795 | 1,400,000 | |
| Dense Select Structural | 2x12 | 2360 | 2710 | 1,900,000 | |
| Select Structural | | 2190 | 2510 | 1,800,000 | |
| Non–Dense Select Structural | | 2010 | 2310 | 1,700,000 | |
| No.1 Dense | | 1550 | 1790 | 1,800,000 | |
| No.1 | | 1440 | 1650 | 1,700,000 | |
| No.1 Non–Dense | | 1320 | 1520 | 1,600,000 | |
| No.2 Dense | | 1320 | 1520 | 1,700,000 | |
| No.2 | | 1120 | 1290 | 1,600,000 | |
| No.2 Non–Dense | | 1040 | 1190 | 1,400,000 | |
| No.3 | | 660 | 760 | 1,400,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Spruce–Pine–Fir** | | | | | |
| Select Structural | 2x4 | 2155 | 2480 | 1,500,000 | NLGA |
| No.1 /No.2 | | 1510 | 1735 | 1,400,000 | |
| No.3 | | 865 | 990 | 1,200,000 | |
| Stud | | 855 | 980 | 1,200,000 | |
| Construction | | 1120 | 1290 | 1,300,000 | |
| Standard | | 635 | 725 | 1,200,000 | |
| Utility | | 290 | 330 | 1,100,000 | |
| Select Structural | 2x6 | 1870 | 2150 | 1,500,000 | |
| No.1 /No.2 | | 1310 | 1505 | 1,400,000 | |
| No.3 | | 750 | 860 | 1,200,000 | |
| Stud | | 775 | 895 | 1,200,000 | |
| Select Structural | 2x8 | 1725 | 1985 | 1,500,000 | |
| No. 1 / No.2 | | 1210 | 1390 | 1,400,000 | |
| No.3 | | 690 | 795 | 1,200,000 | |
| Select Structural | 2x10 | 1580 | 1820 | 1,500,000 | |
| No.1/No.2 | | 1105 | 1275 | 1,400,000 | |
| No.3 | | 635 | 725 | 1,200,000 | |
| Select Structural | 2x12 | 1440 | 1655 | 1,500,000 | |
| No.1 /No.2 | | 1005 | 1155 | 1,400,000 | |
| No.3 | | 575 | 660 | 1,200,000 | |
| **Spruce–Pine–Fir (South)** | | | | | |
| Select Structural | 2x4 | 2245 | 2580 | 1,300,000 | NELMA<br>NSLB<br>WCLIB<br>WWPA |
| No.1 | | 1465 | 1685 | 1,200,000 | |
| No.2 | | 1295 | 1490 | 1,100,000 | |
| No.3 | | 735 | 845 | 1,000,000 | |
| Stud | | 725 | 835 | 1,000,000 | |
| Construction | | 980 | 1125 | 1,000,000 | |
| Standard | | 545 | 630 | 900,000 | |
| Utility | | 260 | 300 | 900,000 | |
| Select Structural | 2x6 | 1945 | 2235 | 1,300,000 | |
| No.1 | | 1270 | 1460 | 1,200,000 | |
| No.2 | | 1120 | 1290 | 1,100,000 | |
| No.3 | | 635 | 730 | 1000,000 | |
| Stud | | 660 | 760 | 1,000,000 | |
| Select Structural | 2x8 | 1795 | 2065 | 1,300,000 | |
| No.1 | | 1175 | 1350 | 1,200:000 | |
| No.2 | | 1035 | 1190 | 1,100,000 | |
| No.3 | | 585 | 675 | 1,000,000 | |
| Select Structural | 2x10 | 1645 | 1890 | 1,300,000 | |
| No.1 | | 1075 | 1235 | 1,200,000 | |
| No.2 | | 950 | 1090 | 1,100,000 | |
| No.3 | | 540 | 620 | 1,000,000 | |
| Select Structural | 2x12 | 1495 | 1720 | 1,300,000 | |
| No.1 | | 980 | 1125 | 1,200,000 | |
| No.2 | | 865 | 990 | 1,100,000 | |
| No.3 | | 490 | 560 | 1,000,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **Western Cedars** | | | | | |
| Select Structural | 2x4 | 1725 | 1985 | 1,100,000 | WCLIB<br>WWPA |
| No.1 | | 1250 | 1440 | 1,000,000 | |
| No.2 | | 1210 | 1390 | 1,000,000 | |
| No.3 | | 690 | 795 | 900,000 | |
| Stud | | 695 | 800 | 900,000 | |
| Construction | | 920 | 1060 | 900,000 | |
| Standard | | 520 | 595 | 800,000 | |
| Utility | | 260 | 300 | 800,000 | |
| Select Structural | 2x6 | 1495 | 1720 | 1,100,000 | |
| No.1 | | 1085 | 1245 | 1,000,000 | |
| No.2 | | 1045 | 1205 | 1,000,000 | |
| No.3 | | 600 | 690 | 900,000 | |
| Stud | | 635 | 725 | 900,000 | |
| Select Structural | 2x8 | 1380 | 1585 | 1,100,000 | |
| No.1 | | 1000 | 1150 | 1,000,000 | |
| No.2 | | 965 | 1110 | 1,000,000 | |
| No.3 | | 550 | 635 | 900,000 | |
| Select Structural | 2x10 | 1265 | 1455 | 1,100,000 | |
| No.1 | | 915 | 1055 | 1,000,000 | |
| No.2 | | 885 | 1020 | 1,000,000 | |
| No.3 | | 505 | 580 | 900,000 | |
| Select Structural | 2x12 | 1150 | 1325 | 1,100,000 | |
| No.1 | | 835 | 960 | 1,000,000 | |
| No.2 | | 805 | 925 | 1,000,000 | |
| No.3 | | 460 | 530 | 900,000 | |
| **Western Woods** | | | | | |
| Select Structural | 2x4 | 1510 | 1735 | 1,200,000 | WCLIB<br>WWPA |
| No.1 | | 1120 | 1290 | 1,100,000 | |
| No.2 | | 1120 | 1290 | 1,000,000 | |
| No.3 | | 645 | 745 | 900,000 | |
| Stud | | 635 | 725 | 900,000 | |
| Construction | | 835 | 960 | 1,000,000 | |
| Standard | | 460 | 530 | 900,000 | |
| Utility | | 230 | 265 | 800,000 | |
| Select Structural | 2x6 | 1310 | 1505 | 1,200,000 | |
| No.1 | | 970 | 1120 | 1,100,000 | |
| No.2 | | 970 | 1120 | 1,000,000 | |
| No.3 | | 560 | 645 | 900,000 | |
| Stud | | 575 | 660 | 900,000 | |
| Select Structural | 2x8 | 1210 | 1390 | 1,200,000 | |
| No.1 | | 895 | 1030 | 1,100,000 | |
| No.2 | | 895 | 1030 | 1,000,000 | |
| No.3 | | 520 | 595 | 900,000 | |
| Select Structural | 2x10 | 110 | 1275 | 1,200,000 | |
| No.1 | | 820 | 945 | 1,100,000 | |
| No.2 | | 820 | 945 | 1,000,000 | |
| No.3 | | 475 | 545 | 900,000 | |
| Select Structural | 2x12 | 1005 | 1155 | 1,200,000 | |
| No.1 | | 750 | 860 | 1,100,000 | |
| No.2 | | 750 | 860 | 1,000,000 | |
| No.3 | | 430 | 495 | 900,000 | |

| Species and Grade | Size | Design Value in Bending, "Fb" | | Modulus of Elasticity "E" | Grading Rules Agency |
|---|---|---|---|---|---|
| | | Normal Duration | Snow Loading | | |
| **White Oak** | | | | | |
| Select Structural | 2x4 | 2070 | 2380 | 1,100,000 | NELMA |
| No.1 | | 1510 | 1735 | 1,000,000 | |
| No.2 | | 1465 | 1685 | 900,000 | |
| No.3 | | 820 | 940 | 800,000 | |
| Stud | | 820 | 945 | 800,000 | |
| Construction | | 1095 | 1255 | 900,000 | |
| Standard | | 605 | 695 | 800,000 | |
| Utility | | 290 | 330 | 800,000 | |
| Select Structural | 2x6 | 1795 | 2065 | 1,100,000 | |
| No.1 | | 1310 | 1505 | 1,000,000 | |
| No.2 | | 1270 | 1460 | 900,000 | |
| No.3 | | 710 | 815 | 800,000 | |
| Stud | | 750 | 860 | 800,000 | |
| Select Structural | 2x8 | 1655 | 1905 | 1,100,000 | |
| No.1 | | 1210 | 1390 | 1,000,000 | |
| No.2 | | 1175 | 1350 | 900,000 | |
| No.3 | | 655 | 755 | 800,000 | |
| Select Structural | 2x10 | 1520 | 1745 | 1,100,000 | |
| No.1 | | 1105 | 1275 | 1,000,000 | |
| No.2 | | 1075 | 1235 | 900,000 | |
| No.3 | | 600 | 690 | 800,000 | |
| Select Structural | 2x12 | 1380 | 1585 | 1,100,000 | |
| No.1 | | 1005 | 1155 | 1,000,000 | |
| No.2 | | 980 | 1125 | 900,000 | |
| No.3 | | 545 | 630 | 800,000 | |
| **Yellow Poplar** | | | | | |
| Select Structural | 2x4 | 1725 | 1985 | 1,500,000 | NSLB |
| No.1 | | 1250 | 1440 | 1,400,000 | |
| No.2 | | 1210 | 1390 | 1,300,000 | |
| No.3 | | 690 | 795 | 1,200,000 | |
| Stud | | 695 | 800 | 1,200,000 | |
| Construction | | 920 | 1060 | 1,300,000 | |
| Standard | | 520 | 595 | 1,100,000 | |
| Utility | | 230 | 265 | 1,100,000 | |
| Select Structural | 2x6 | 1495 | 1720 | 1,500,000 | |
| No.1 | | 1055 | 1245 | 1,400,000 | |
| No.2 | | 1045 | 1205 | 1,300,000 | |
| No.3 | | 600 | 690 | 1,200,000 | |
| Stud | | 635 | 725 | 1,200,000 | |
| Select Structural | 2x8 | 1380 | 1585 | 1,500,000 | |
| No.1 | | 1000 | 1150 | 1,400,000 | |
| No.2 | | 965 | 1110 | 1,300,000 | |
| No.3 | | 550 | 635 | 1,200,000 | |
| Select Structural | 2x10 | 1265 | 1455 | 1,500,000 | |
| No.1 | | 915 | 1055 | 1,400,000 | |
| No.2 | | 885 | 1020 | 1,300,000 | |
| No.3 | | 505 | 580 | 1,200,000 | |
| Select Structural | 2x12 | 1150 | 1325 | 1,500,000 | |
| No.1 | | 835 | 960 | 1,400,000 | |
| No.2 | | 805 | 925 | 1,300,000 | |
| No.3 | | 460 | 530 | 1,200,000 | |

# 21.04(2)(a)5.
# HANDRAIL SHAPES



## EROSION CONTROL PROCEDURES

## EXAMPLES, ILLUSTRATIONS AND GUIDELINES

The following examples and illustrations of some erosion control procedures are provided for your information. Many of these examples can be found in the "Wisconsin Construction Site Best Management Practices Handbook", developed by the Wisconsin department of natural resources. Note: The Handbook is available from Document sales, 202 South Thornton Avenue, P.O. Box 7840, Madison, WI 53707–8480; phone (608) 266–3358.

**Figures E–1 to E–11**, depict the materials and installation of some erosion control procedures.

Also included in the appendix are examples of plot plans depicting the best management practices that will help meet the requirements of the performance standards in this code.
**Figure E – 12** is an example of a site with slopes of 12 % or less and also simple slopes, i.e. all slopes occurring in one general direction. Downslope measures are required, to reduce maintenance of these measures, the upslope diversion is recommended.
**Figure E – 13** is an example of a site with complex slopes (slopes occurring in more than one direction). This site also has an area where slopes that are 12–20% are going to be disturbed. The location of the erosion control procedures are clearly indicated on the plot plan, including narratives that indicated methods of permanent stabilization.
**Figure E – 14** is an example of a large lot, greater than 5 acres, with slopes greater than 12% and where the area of land disturbing activity is indicated. This plan indicates the use of vegetative barriers.

**Figure E – 15** explains how to determine and calculate % slopes.

Guidelines for timing the implementation of the erosion control practices and procedures in order to stabilize areas disturbed during construction of one and 2–family dwellings are included in this appendix. Dormant seeding, the guidelines for the use of vegetative buffers and the recommended maintenance for erosion control practices are also included.

For sites using either straw bales or silt fences as a perimeter control, **Table E–1** is included as a guide for determining the distance between parallel fences constructed on various slopes. Perimeter measures should be installed at right angles to the direction of flow. Drainage area is to be no more than 1/4 acres (approx. 10,000 square feet) per 100 feet of perimeter control.

**TABLE E–1**
**DISTANCE BETWEEN PARALLEL**
**STRAW BALES OR SILT FENCES**

| Slope Percent | Slope Distance (feet) |
|---|---|
| < 2% | 100 feet |
| 2 to 5% | 75 feet |
| 5 to 10% | 50 feet |
| 10 to 20% | 25 feet |
| > 20% | 15 feet |

## VEGETATIVE BARRIERS

Vegetative barriers may be used as a perimeter measure if disturbed areas above consist of slopes no greater than 6% and barriers are on a grade no steeper than 5%. Vegetative barriers are to be a minimum of 10' wide for every 50 feet of open ground draining to them. These barriers must be maintained, i.e. not driven on or destroyed. If the barriers become covered with silt or otherwise destroyed, additional perimeter measures may be required.

## TEMPORARY STABILIZATION OR MULCH CROP

**It is much easier to control erosion than to control sediment.** Temporary stabilization helps to minimize erosion and therefore the need for long term maintenance of silt fences and straw bales. Annual rye grass may be planted as a temporary cover between April 1 and September 15. If seeding is done in the spring or late summer seeding dates and slopes are 6% or less, mulch may not be necessary.

Winter rye may be planted between July 15 and October 15. These seedings should be mulched.

## LATE SEASON CONSTRUCTION MULCHING/DORMANT SEEDING

If ground is broken after September 15, mulch should be applied as soon as a rough grade is established, unless final grade and landscaping is to be completed before the next growing season. Mulch will help to reduce the raindrop impact. Seeding should not be done between September 15 and November 1 as the weather is warm enough for the seed to germinate but it will not have an opportunity to establish a root system strong enough to survive the winter. A dormant seeding may be done OVER the mulch after November 1. These seedings are risky. A split application of seed may also be made, using half in November and balance early in spring.

## WINTER CONSTRUCTION

In areas with course soils, (sands) if excavation is possible most likely a trencher can be used to install the necessary silt fence. If at all possible leave the perimeter of the site undisturbed (this is assuming the site had vegetation present prior to frost); this may be the easiest erosion control for flat sites (6% or less).

In areas that have heavy soils, (clays) close attention should be paid to the try to get perimeter measures installed prior to frost penetrating greater than 6". If ground is solidly frozen, perimeter measures that need to be trenched may have to wait to be installed when the frost first starts to come out in the spring. This does not eliminate the need to keep sediment from leaving the site. Alternate methods for controlling erosion should be considered such as the use of soil stabilizers.

# MAINTENANCE OF THE MOST COMMONLY USED EROSION CONTROL PROCEDURES

**SILT FENCES**
Repair or replacement should be done within 24 hours if fencing is torn, sagging, overtopped, blown over (laying down), shows a lack of integrity, or in any way is not functioning as designed. Sediment deposits should be removed after each storm event. Sediment deposits shall be removed when deposits reach 0.5 the above ground height of the fence. Silt fence should be removed after upland areas have been stabilized. Any sediment deposits remaining in place after the silt fence is no longer required should be dressed to conform to the existing grade, prepared and stabilized.

**STRAWBALES**
Replacement of broken or torn bales should be done within 24 hours. Sediment deposits should be removed when deposits reach 0.5 the height of the bales. Strawbales should be removed after upland areas have been stabilized. Any sediment deposits remaining in place after the strawbale barrier is no longer required should be dressed to conform to the existing grade, prepared and stabilized.

**MULCHING**
Additional mulch or matting should be applied when rills develop (rill – small, eroded ditch measuring 1" or less width).

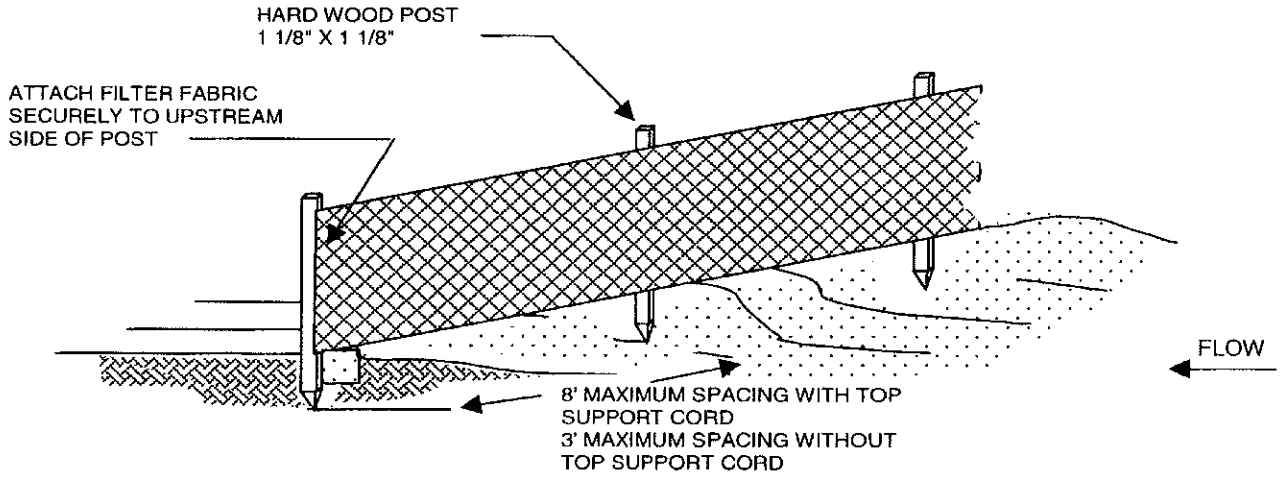
**TEMPORARY DIVERSION**
Any breaks or eroded areas of a diversion should be repaired within 24 hours.

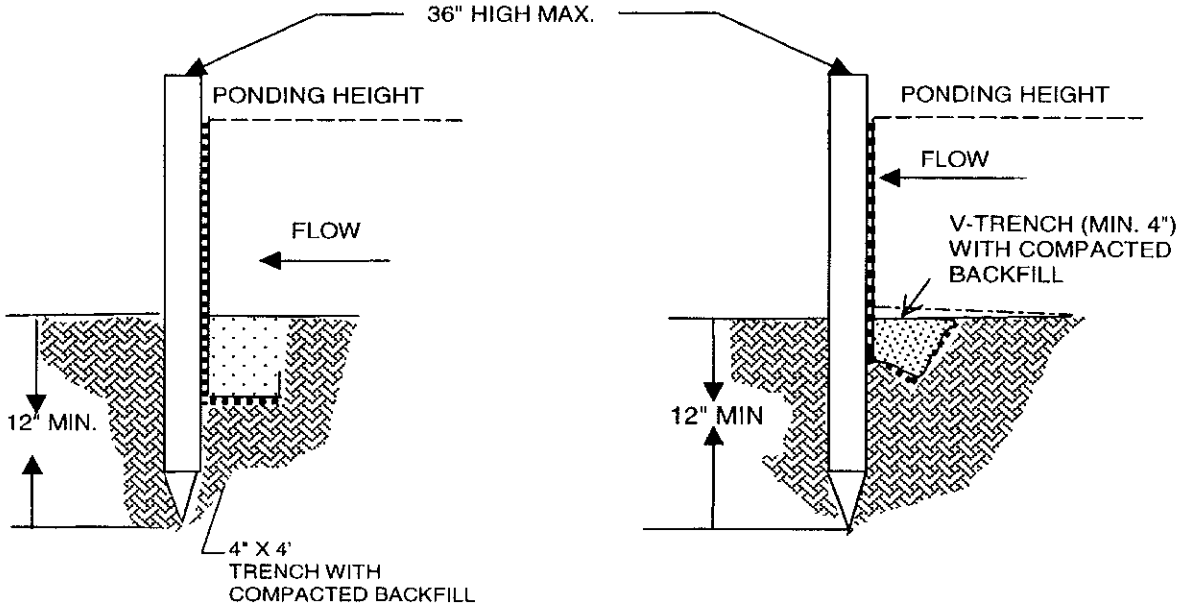
**SEDIMENT TRAP**
Any structural deficiencies should be repaired within 24 hours. Sediment should be removed when it reaches half of the outlet height of trap.

**SODDING**
Repair or replacement of sod that has been destroyed in an area of channelized flow should be done within 24 hours after the rain event.

**INLET PROTECTION BARRIERS**
Sediment deposits should be removed when deposits reach 0.5 the height of the fence. Repair or replacement should be made to damged barriers within 24 hours.

**TEMPORARY GRAVEL CONSTRUCTION ENTRANCE**
Rock should be maintained to meet the design criteria of 2–3" aggregate stone; 12 feet wide and 50 feet long or the distance to the foundation, whichever is less; and maintained at a depth of 6". Filter fabric (geotextile) should be used as a separation barrier between the rock and soil if soils are mainly clay or silt.




**NOTES:**

1. SILT FENCE SHALL BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.

2. THE ENDS OF THE FENCE SHALL BE TURNED UPSLOPE TO PREVENT WATER FROM RUNNING AROUND THE ENDS OF THE FENCE.

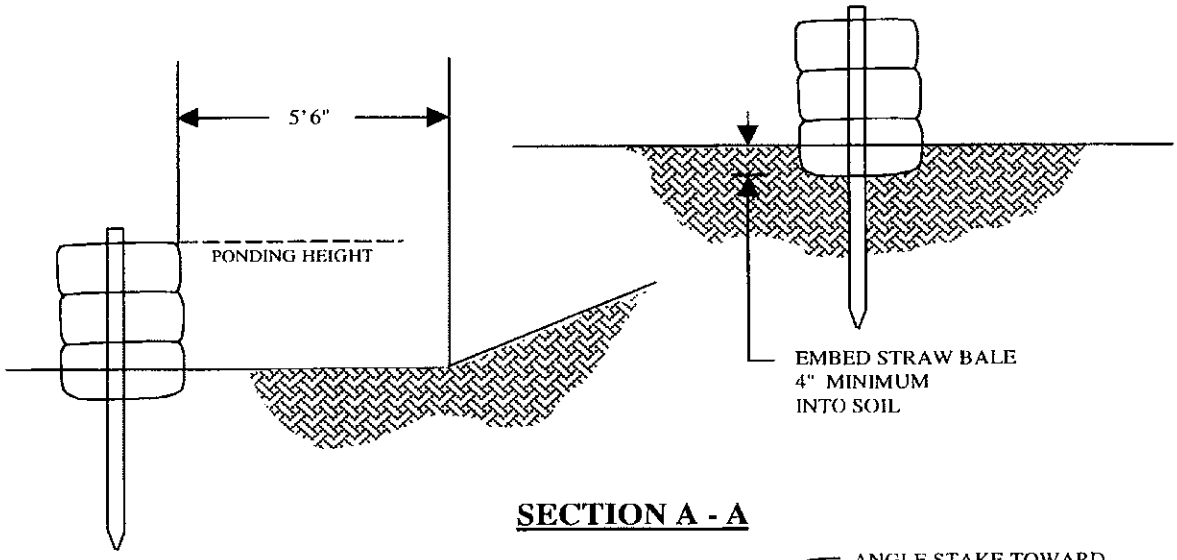
3. INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY (9" MAXIMUM RECOMMENDED STORAGE HEIGHT)

4. REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.

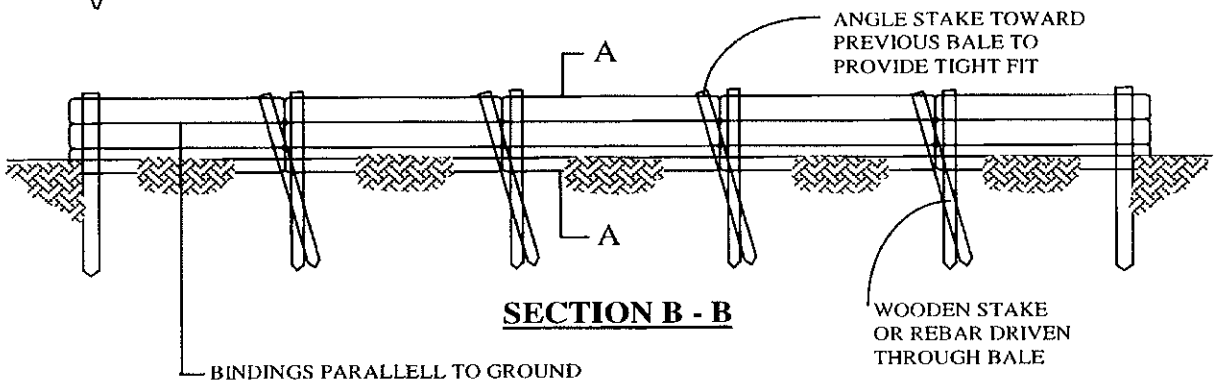
NOT TO SCALE

**FIG. E - 1**

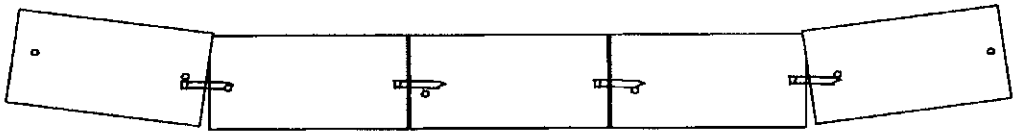
SILT FENCE




**SECTION A - A**




**SECTION B - B**



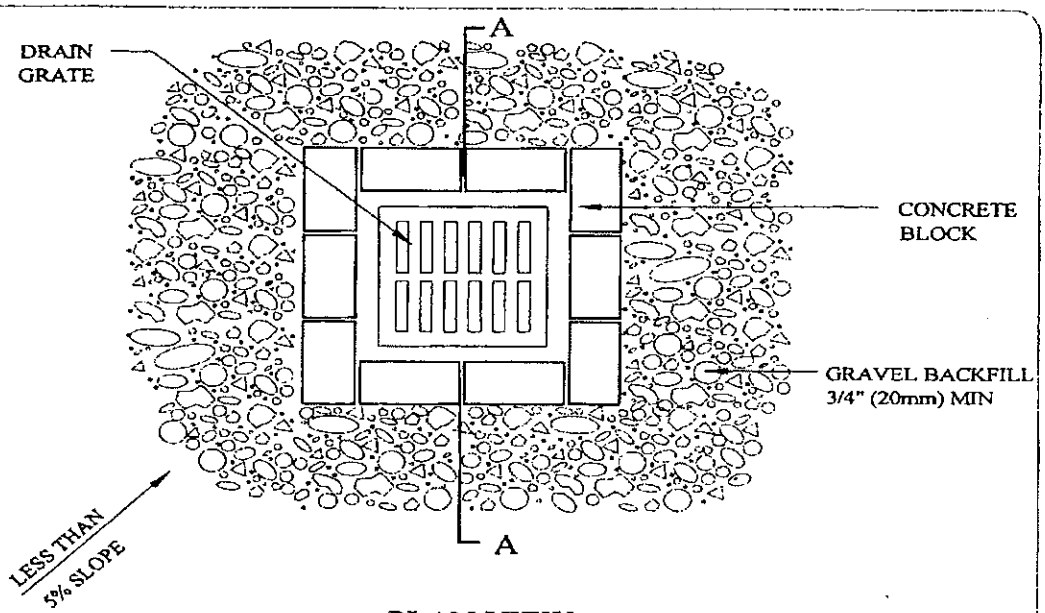
**PLAN**

NOTES:

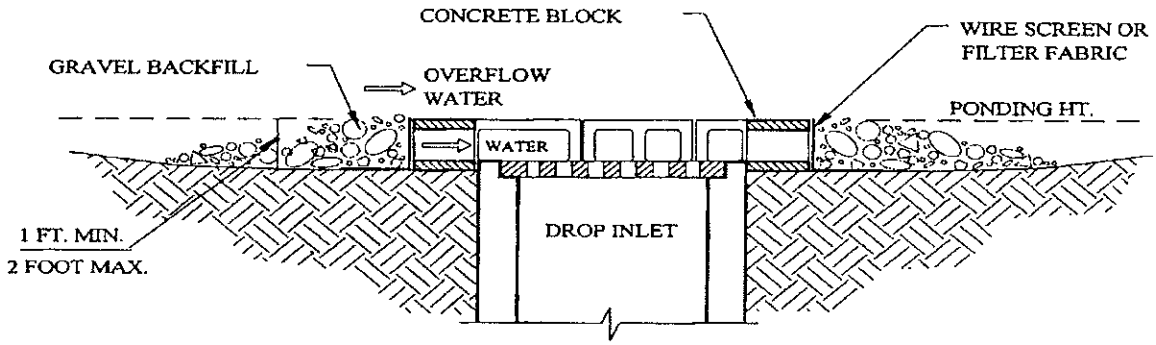
1. THE STRAW BALES SHALL BE PLACED ON SLOPE CONTOUR WITH ENDS OF STRAW BALE FENCE TURNED UPSLOPE TO PREVENT FLANKING
2. BALES TO BE PLACED SO THAT BINDINGS ARE ORIENTED AROUND THE SIDES RATHER THAN ALONG THE TOPS AND BOTTOMS OF THE BALES.
3. BALES TO BE PLACED IN A ROW WITH THE ENDS TIGHTLY ABUTTING.
4. KEY IN BALES 4" INTO SOIL TO PREVENT EROSION OR FLOW UNDER BALES

**FIG. E - 2**

STRAW BALE FENCE




PLAN VIEW



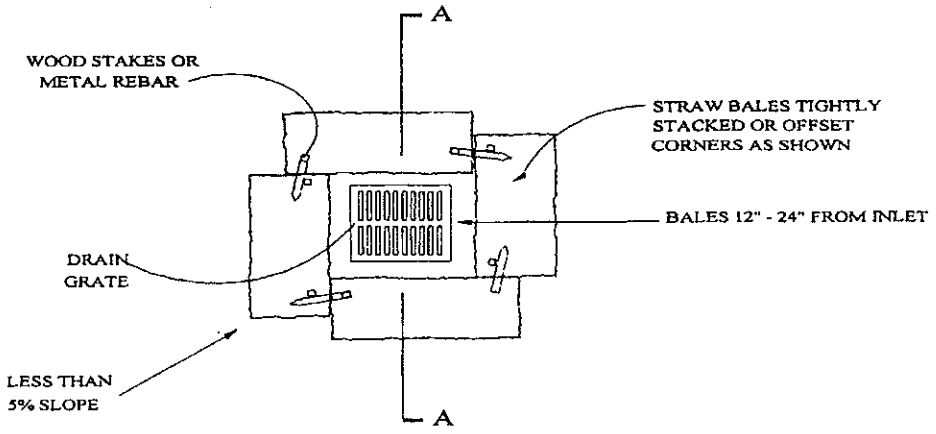

SECTION A - A

NOTES:

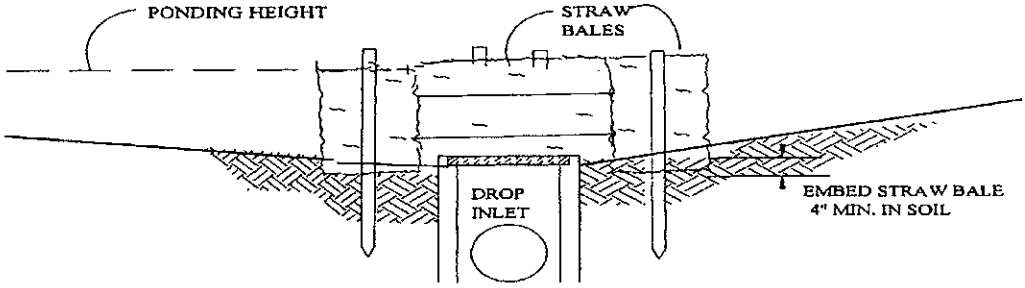
1. DROP INLET SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%)
2. EXCAVATE A BASIN OF SUFFICIENT SIZE ADJACENT TO THE DROP INLET.
3. THE TOP OF THE STRUCTURE (PONDING HEIGHT) MUST BE WELL BELOW THE GROUND ELEVATION DOWNSLOPE TO PREVENT RUNOFF FROM BYPASSING THE INLET. A TEMPORARY DIKE MAY BE NECESSARY ON THE DOWNSLOPE SIDE OF THE STRUCTURE.

**FIG. E - 3**
BLOCK AND GRAVEL
DROP INLET
SEDIMENT BARRIER

(MAY BE USED ON PAVED SURFACES)




PLAN VIEW




SECTION A-A

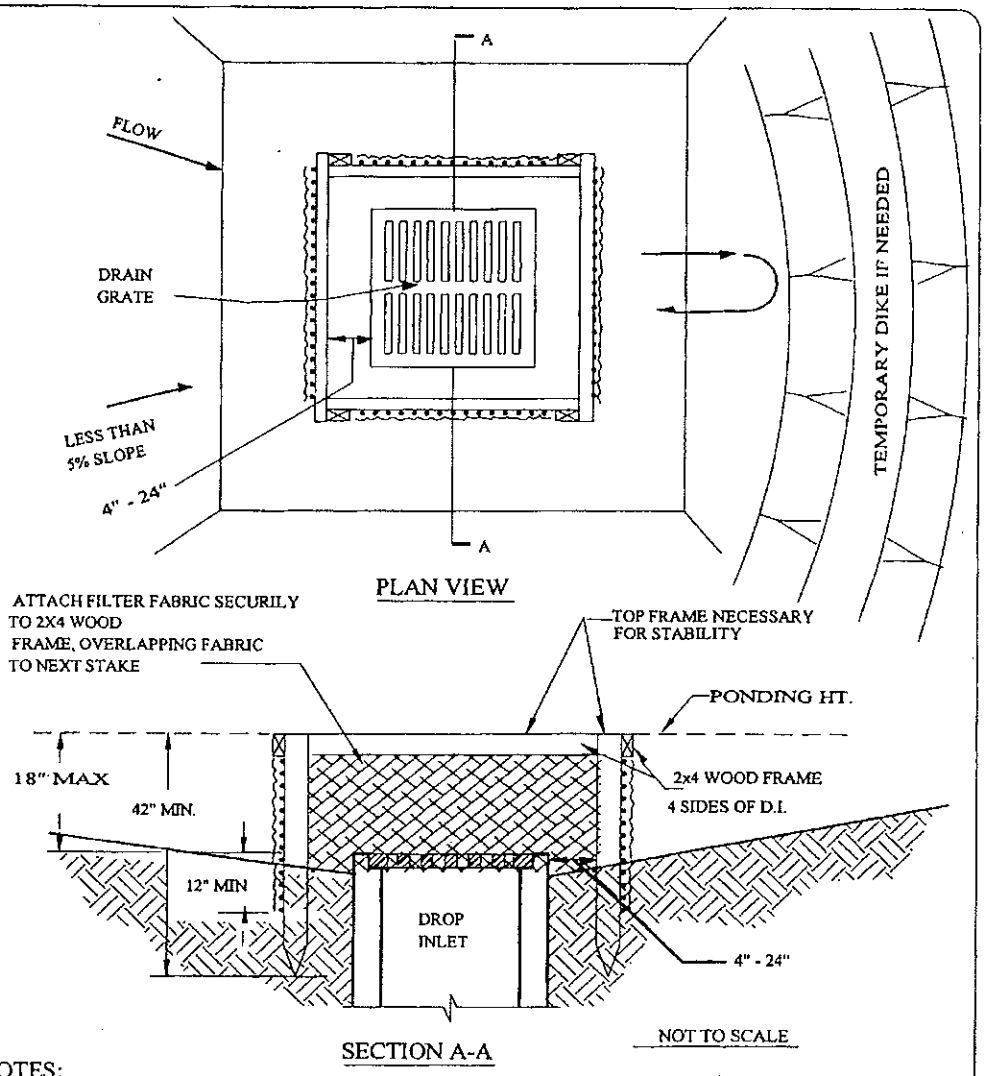
NOTES:

1. DROP INLET SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%)

2. EMBED THE BALES 4" INTO THE SOIL AND OFFSET CORNERS OR PLACE BALES WITH ENDS TIGHTLY ABUTING.

3. THE TOP OF THE STRUCTURE (PONDING HEIGHT) MUST BE WELL BELOW THE GROUND ELEVATION DOWNSLOPE TO PREVENT RUNOFF FROM BYPASSING THE INLET. EXCAVATION OF A BASIN ADJACENT TO THE DROP INLET OR A TEMPORARY DIKE ON THE DOWNSLOPE OF THE STRUCTURE MAY BE NECESSARY.

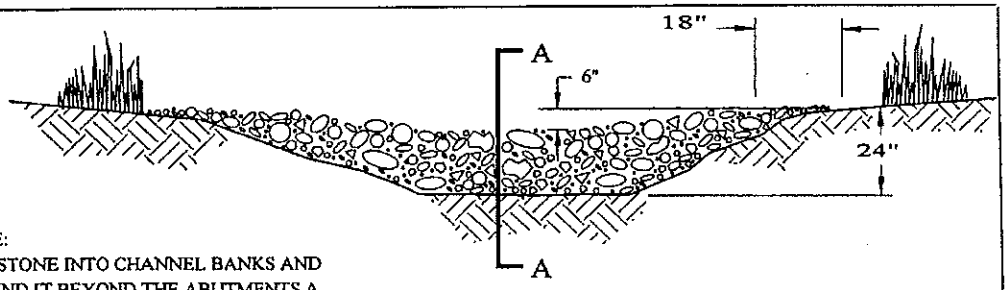
**FIG. E - 4**
STRAW BALE DROP INLET SEDIMENT BARRIER
(FOR USE ON UNPAVED SURFACES)




NOTES:

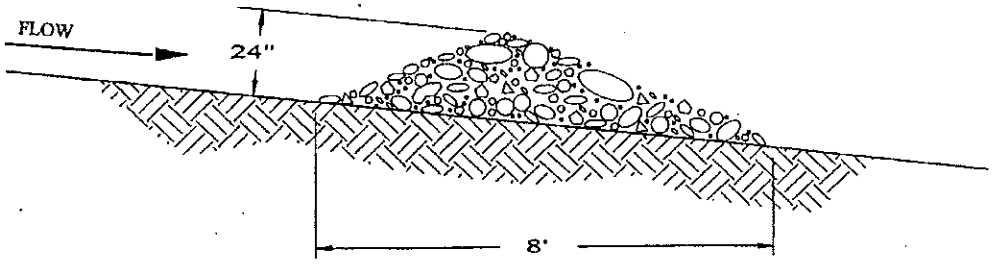
1. DROP INLET SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%)
2. USE 2"X4" WOOD OR EQUIVALENT METAL STAKES, 42" MINIMUM LENGTH.
3. INSTALL 2"X4" WOOD TOP FRAME TO INSURE STABILITY.
4. THE TOP OF THE FRAME (PONDING HEIGHT) MUST BE WELL BELOW THE GROUND ELEVATION DOWNSLOPE TO PREVENT RUNOFF FROM BY-PASSING THE INLET. A TEMPORARY DIKE MAY BE NECESSARY ON THE DOWNSLOPE SIDE OF THE STRUCTURE.

**FIG. E - 5**
DROP INLET
SEDIMENT BARRIER
SILT FENCE
(FOR USE ON UNPAVED SURFACES)



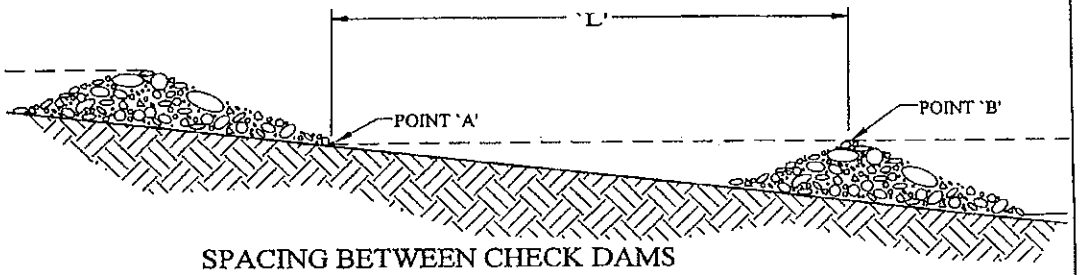

NOTE:
KEY STONE INTO CHANNEL BANKS AND EXTEND IT BEYOND THE ABUTMENTS A MINIMUM OF 18" TO PREVENT FLOW AROUND DAM.

VIEW LOOKING UPSTREAM




SECTION A - A

'L' = THE DISTANCE SUCH THAT POINTS 'A' AND 'B' ARE OF EQUAL ELEVATION.




SPACING BETWEEN CHECK DAMS

NOT TO SCALE

**NOTES**

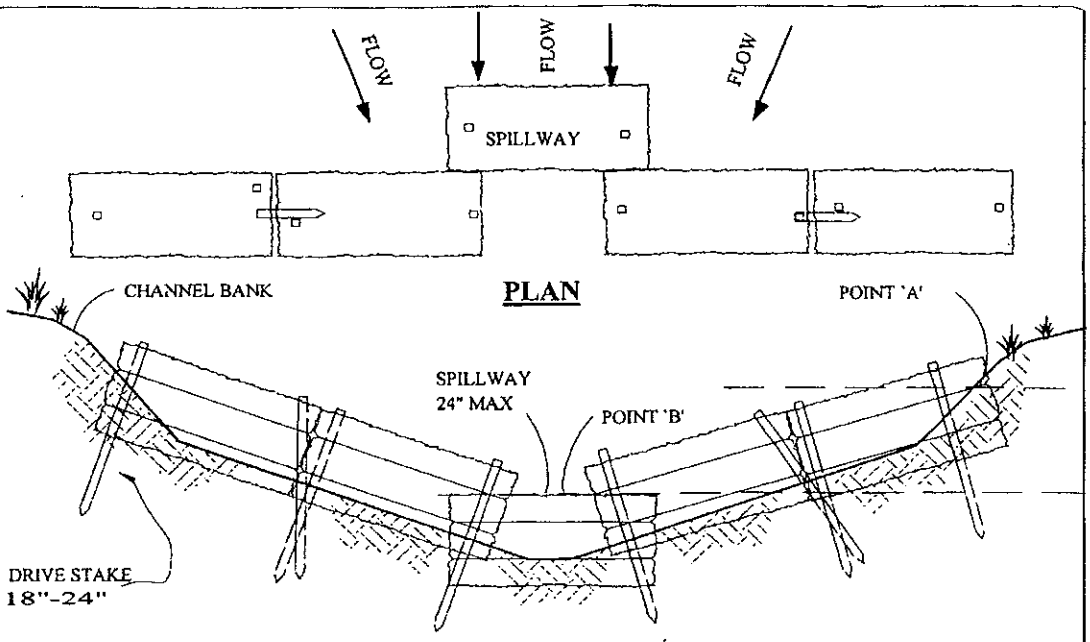
**CHECK DAMS ARE TO BE USED AS TEMPORARY GRADE STABILIZATION STURCTURES UNTIL THE DRAINGEWAY IS PERMANENTLY STABILIZED**

**CHECK DAMS MAY NOT BE USED IN A PERENNIAL STREAM**

1. DRAINAGE AREA ABOVE CHECK DAM SHALL BE LESS THAN 2 ACRES
2. THE MAXIMUM HEIGHT OF THE CHECK DAM CENTER SHALL BE 2 FT.
3. THE CENTER OF THE CHECK DAM SHALL BE 6 IN. LOWER THAN THE OUTER EDGES
4. ROCK DAMS SHALL BE CONSTRUCTED OF 2-15 IN. ROCK

'L' = THE DISTANCE SUCH THAT POINTS 'A' AND

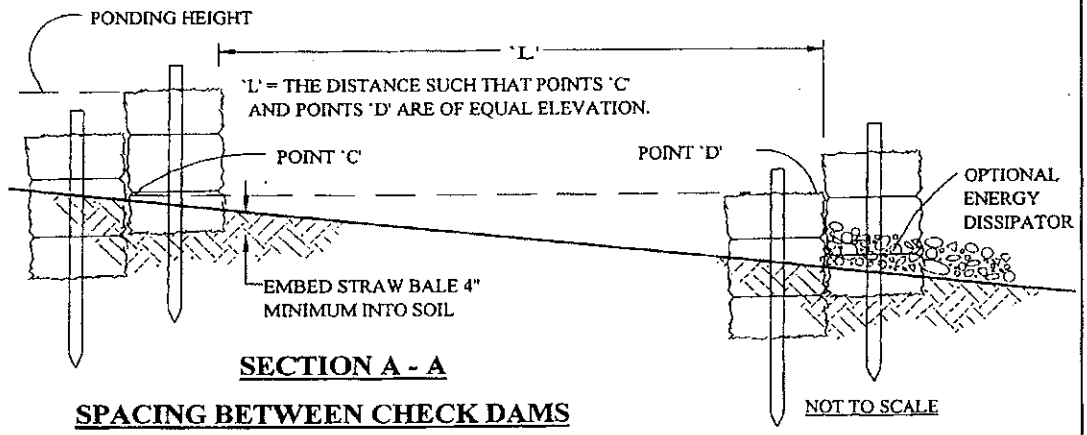
**FIG. E - 6**
ROCK
CHECK DAM




**PLAN**




**VIEW LOOKING UPSTREAM**




**SECTION A - A**

**SPACING BETWEEN CHECK DAMS**

NOT TO SCALE

**NOTES:**

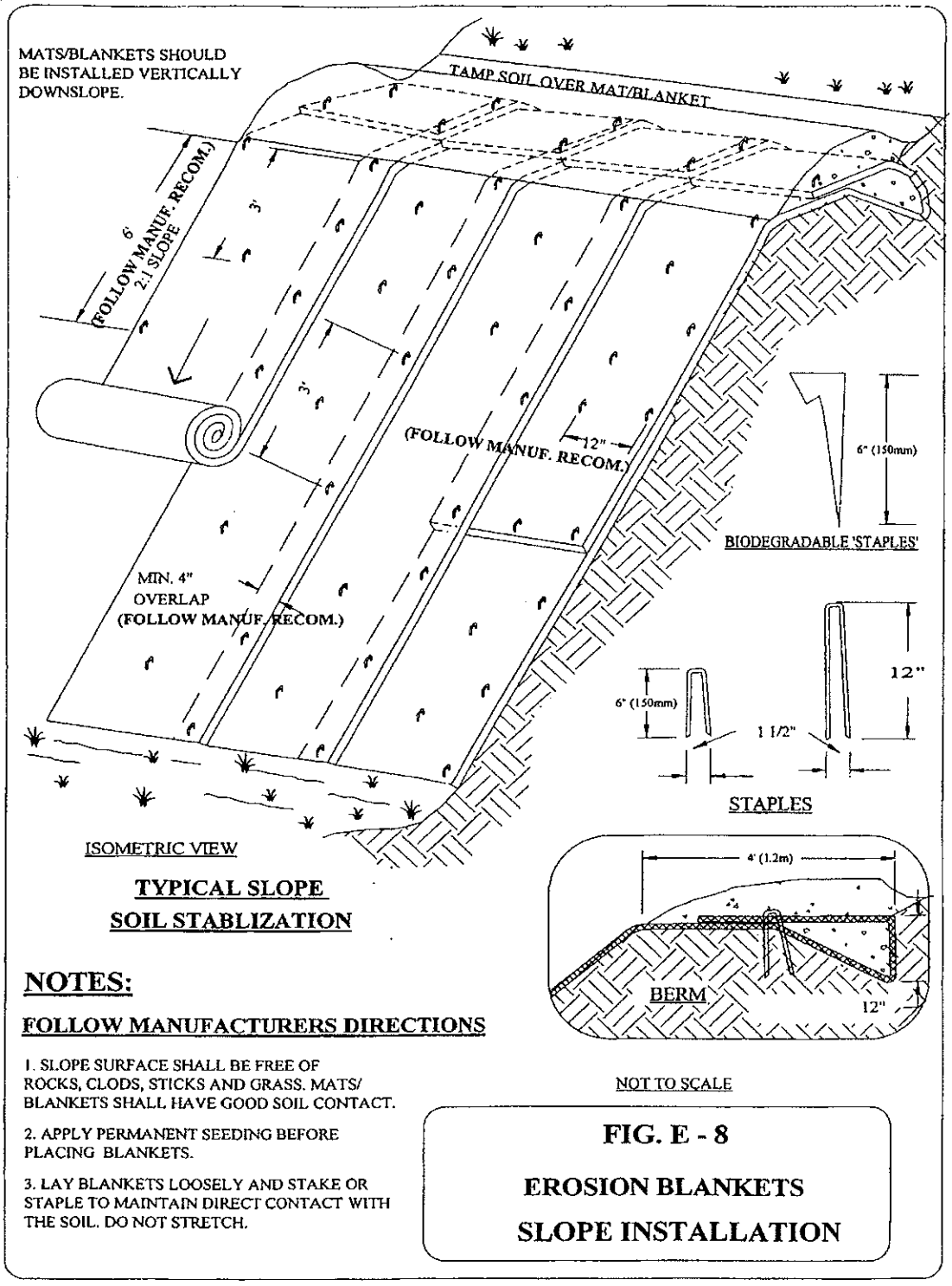
**CHECK DAMS ARE TO BE USED AS TEMPORARY GRADE STABILIZATION STRUCTURES UNTIL THE DRAINAGEWAY IS PERMANENTLY STABILIZED.**

**CHECK DAMS MAY NOT BE USED IN A PERENNIAL STREAM**

1. EMBED BALES 4" INTO THE SOIL AND 'KEY' BALES INTO THE CHANNEL BANKS
2. POINT 'A' MUST BE HIGHER THAN POINT 'B'. (SPILLWAY HEIGHT)
3. PLACE BALES PERPENDICULAR TO THE FLOW WITH ENDS TIGHTLY ABUTTING.
4. SPILLWAY HEIGHT SHALL NOT EXCEED 24".
5. INSPECT AFTER EACH SIGNIFICANT STORM, MAINTAIN AND REPAIR PROMPTLY.

**FIG. E - 7**

STRAW BALE
CHECK DAM




**TYPICAL SLOPE**
**SOIL STABLIZATION**

## NOTES:

**FOLLOW MANUFACTURERS DIRECTIONS**

1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. MATS/ BLANKETS SHALL HAVE GOOD SOIL CONTACT.

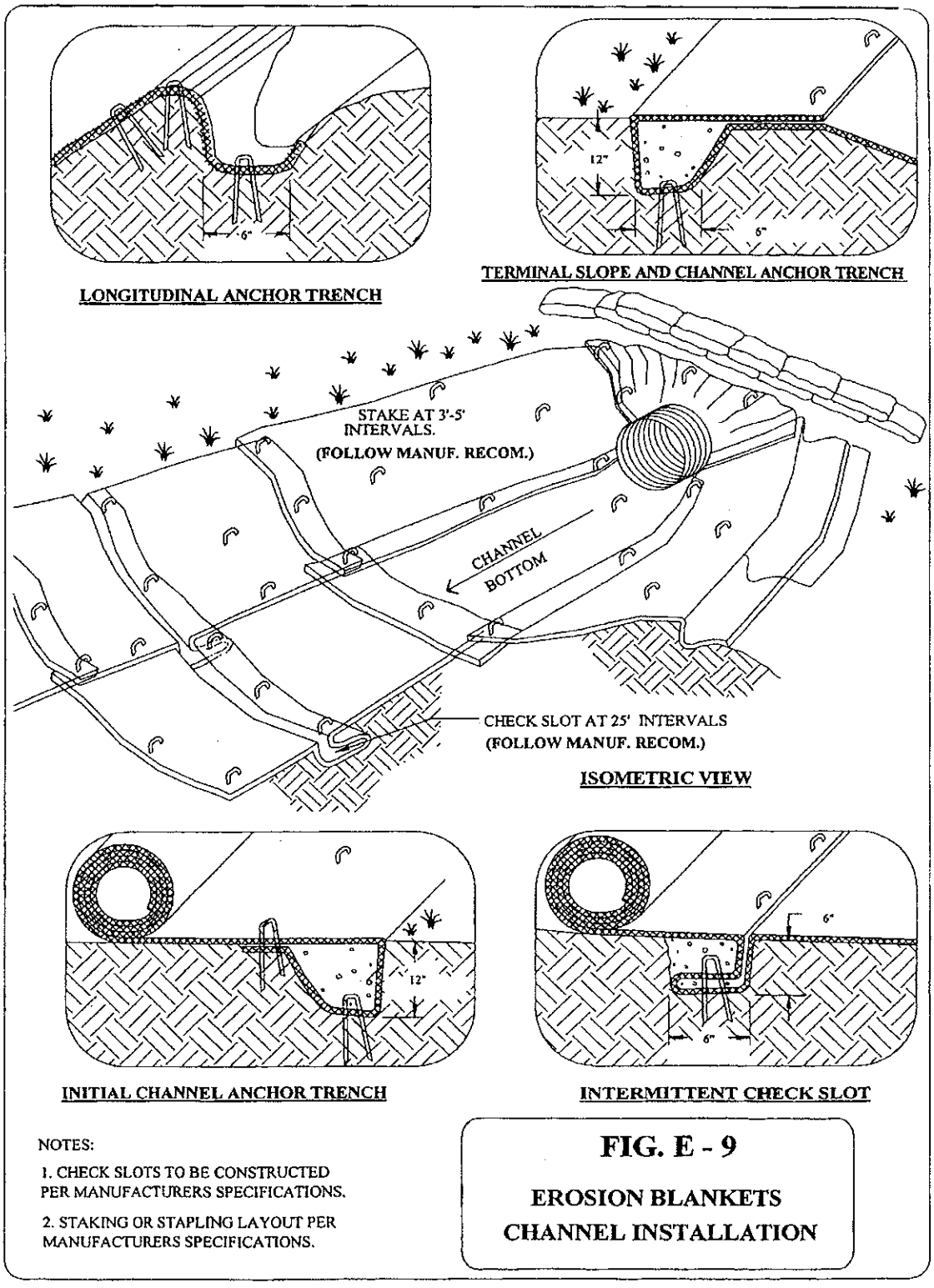
2. APPLY PERMANENT SEEDING BEFORE PLACING BLANKETS.

3. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.

**FIG. E - 8**

**EROSION BLANKETS**

**SLOPE INSTALLATION**

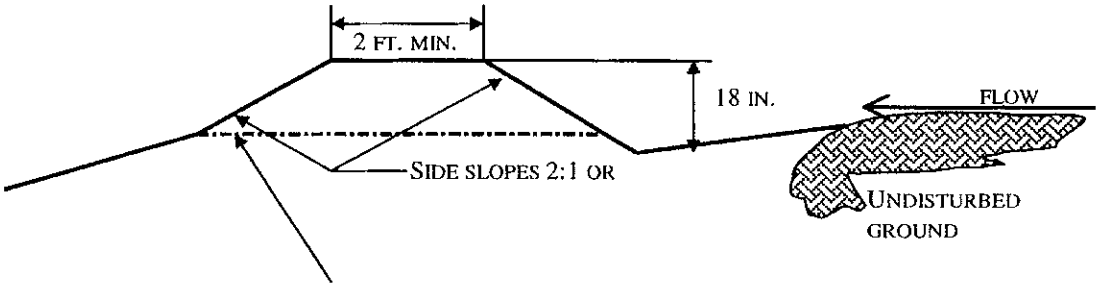



NOTES:

1. CHECK SLOTS TO BE CONSTRUCTED PER MANUFACTURERS SPECIFICATIONS.
2. STAKING OR STAPLING LAYOUT PER MANUFACTURERS SPECIFICATIONS.

**FIG. E - 9**

**EROSION BLANKETS**
**CHANNEL INSTALLATION**




## PURPOSE

To divert runoff around disturbed areas to a location where the clean water can be discharged to existing vegetation in such a way as to prevent any negative offsite impacts.

## CONDITIONS WHERE PRACTICE APPLIES

1. Where drainage areas do not exceed 3 acres.
2. Upslope of disturbed areas where erosion is likely to occur.
3. Upslope of soil piles.
4. Above steep cut or fill slopes.

## STABILIZATION

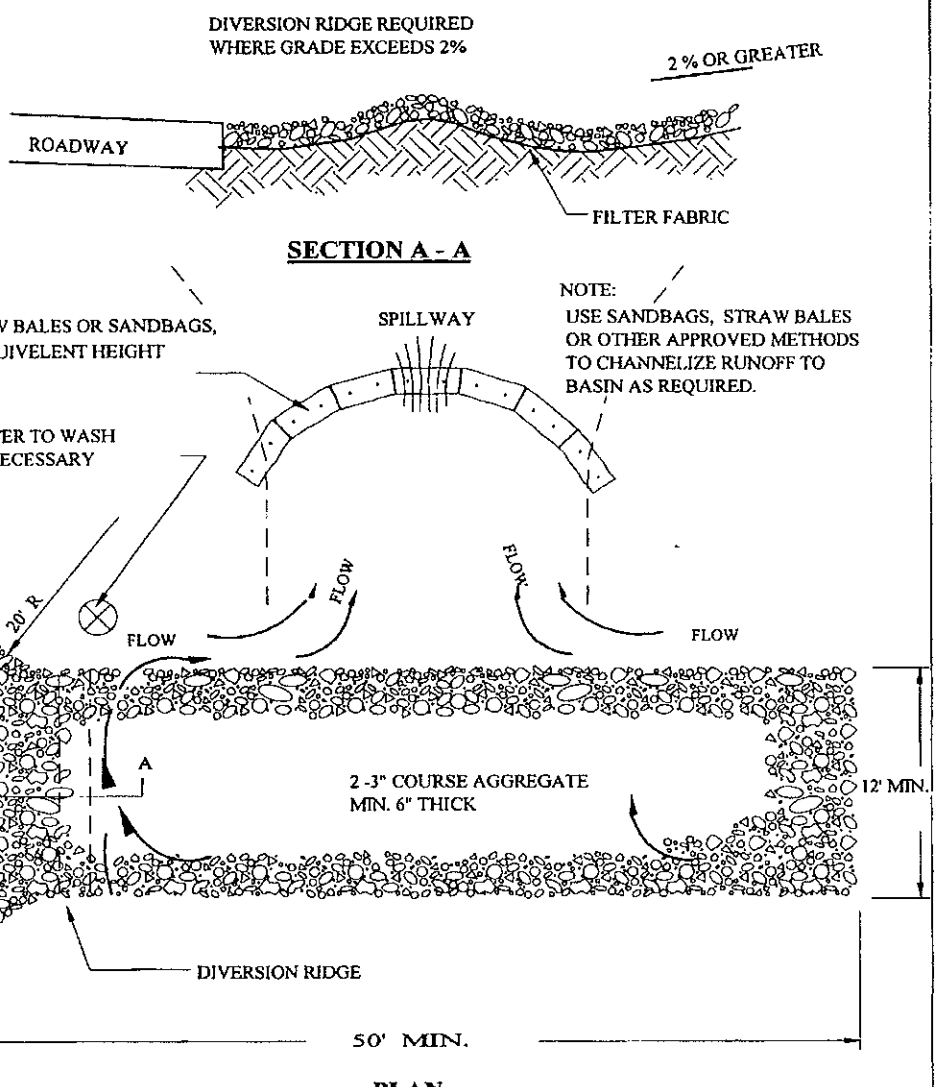
Diversions side slopes, ridge, downslope side of the berm and channel should be stabilized within 7 days of final grading by:

1. Sodding;
2. seeding and mulching in combination with filter fabric barriers or straw bale barriers;
3. covering with suitable geotextile;
4. covering with 6 mil polyethylene sheeting.

(vegetation should be used as the stabilization method if diversion is to be in place 30 days or longer)

**FIG. E – 10**

**TEMPORARY DIVERSION**




**NOTES:**

IF SOILS ARE MAINLY COMPOSED OF CLAYS OR SILTS, USE OF A FILTER FABRIC AS A SEPARATION BARRIER BETWEEN THE ROCK AND SOIL IS RECOMMENDED.

1. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHT-OF-WAYS. THIS MAY REQUIRE TOP DRESSING, REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT.

2. WHEN NECESSARY, WHEELS SHALL BE CLEANED PRIOR TO ENTRANCE ONTO PUBLIC RIGHT-OF-WAY.

3. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABLIZED WITH CRUSHED STONE THAT DRAINS INTO AN APPROVED SEDIMENT TRAP OR SEDIMENT BASIN.

**FIG. E - 11**
TEMPORARY
**GRAVEL CONSTRUCTION ENTRANCE/EXIT**

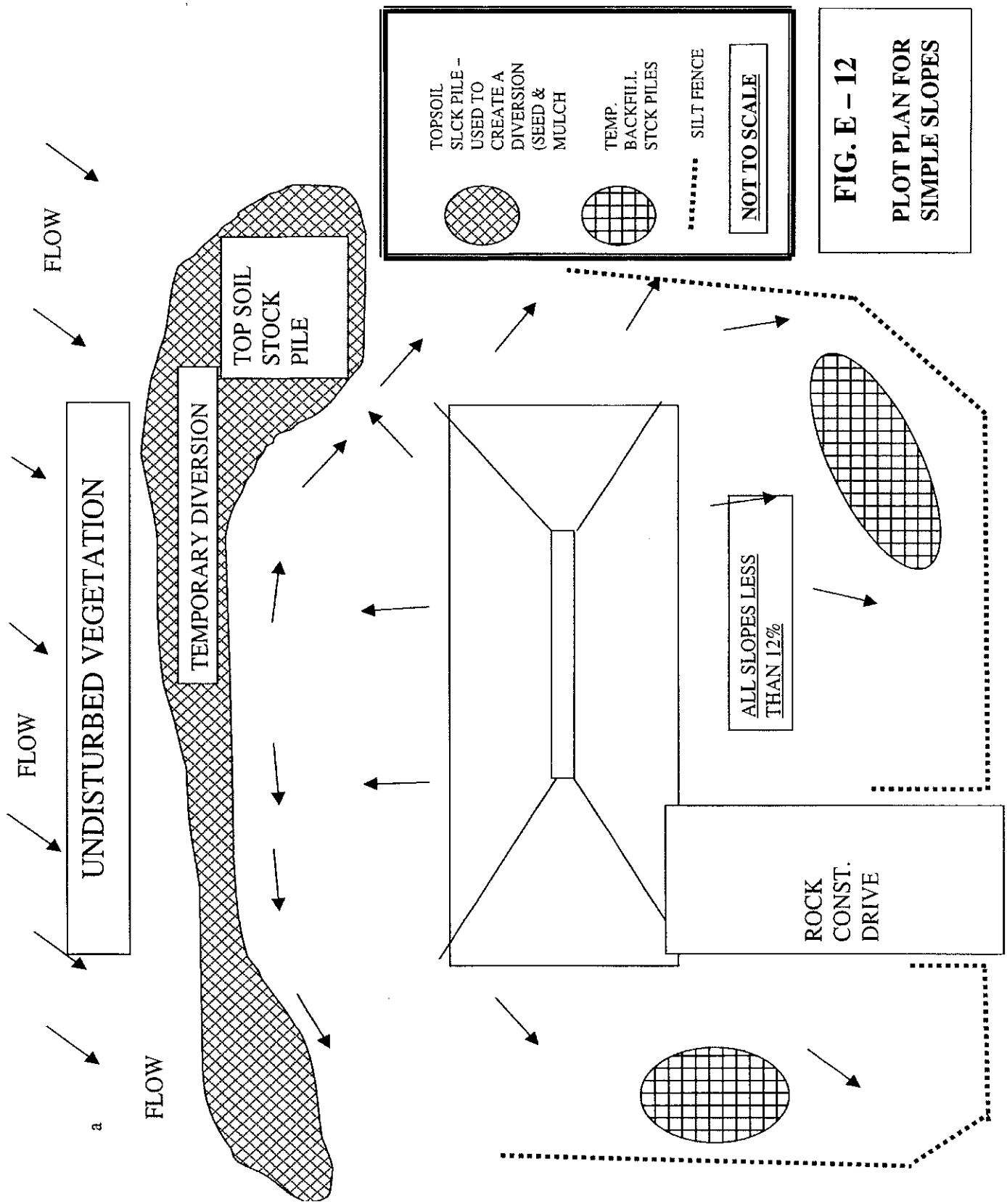



**FIG. E – 12**

**PLOT PLAN FOR SIMPLE SLOPES**

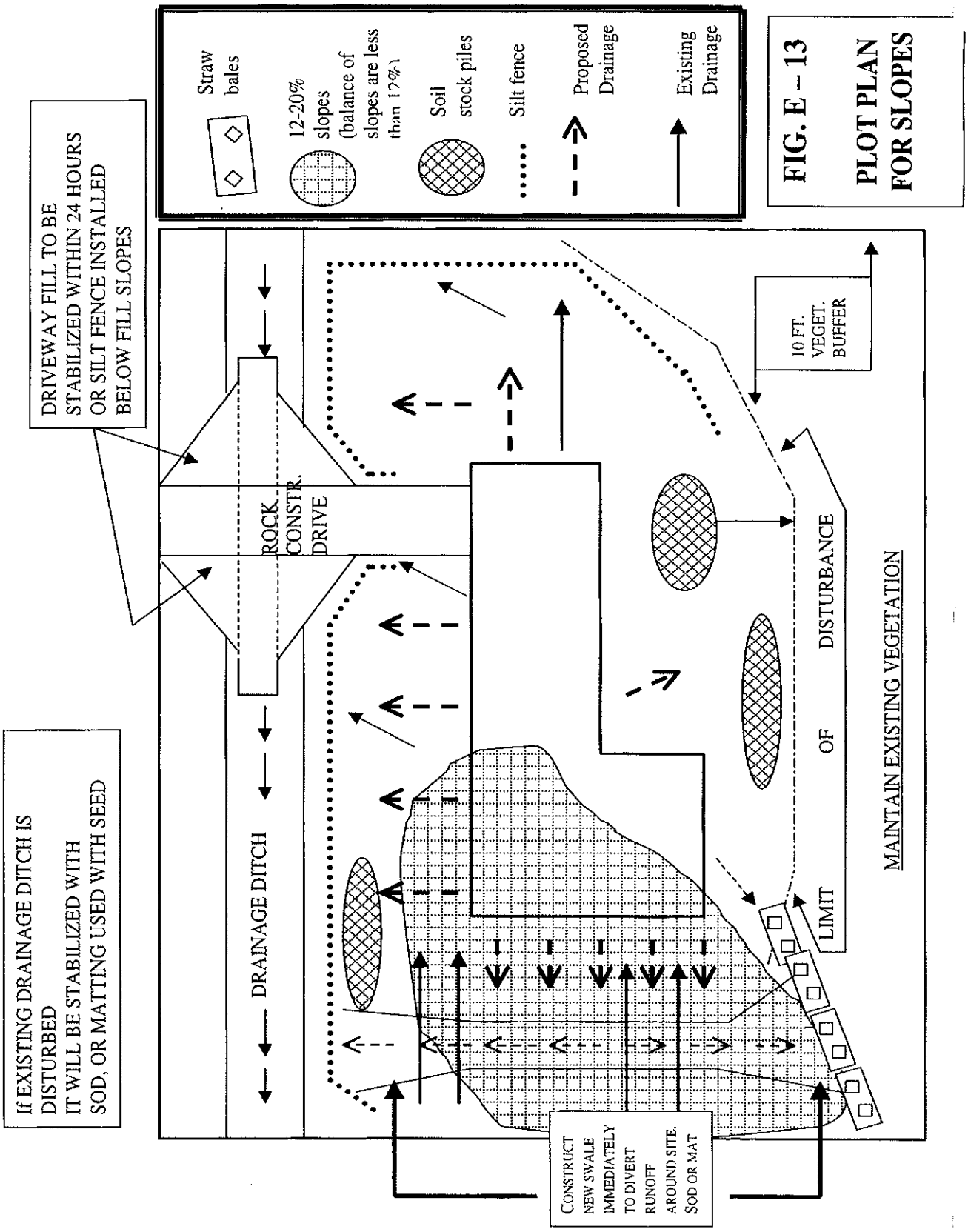
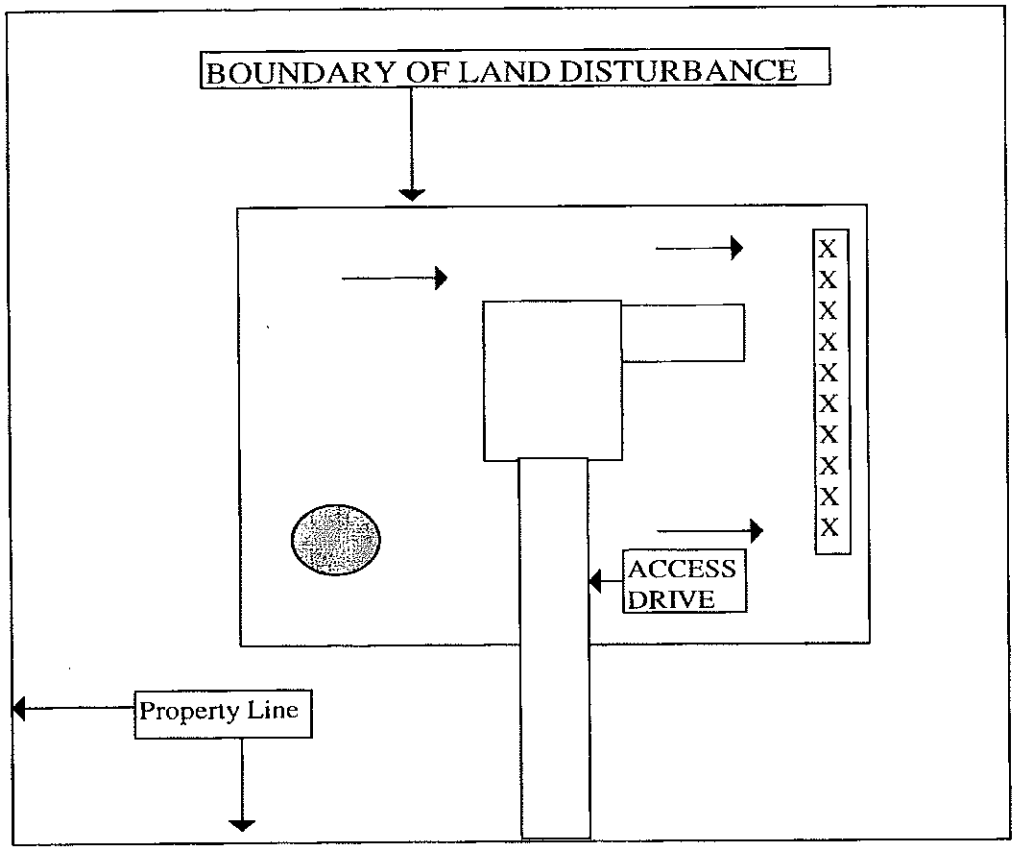
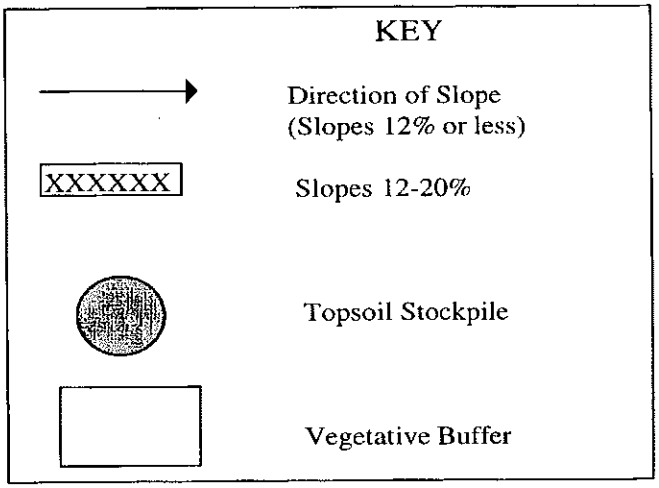



**FIG. E – 13**

**PLOT PLAN FOR SLOPES**




**NOTES:**

1. INDICATES BOUNDARY OF LAND DISTURBING ACTIVITY
2. INDICATE SLOPES IN DISTURBED AREAS BY RANGES:
   12% OR LESS
   12-20%
   20% OR STEEPER

**FIG. E – 14**

EROSION CONTROL PLAN FOR LARGE LOT

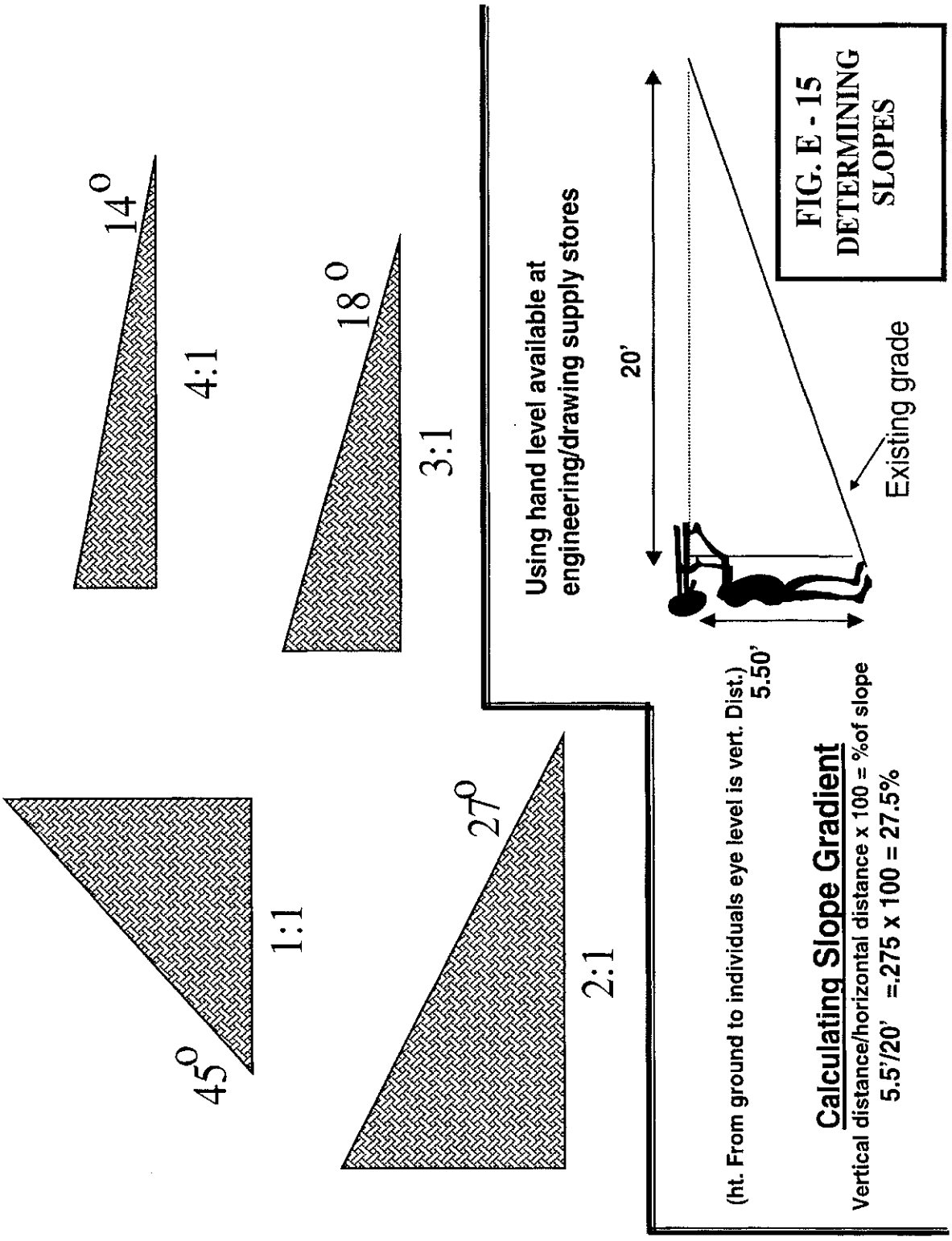



**FIG. E - 15**
**DETERMINING SLOPES**

s. Comm 21.16

**Frost Protected Shallow Footings**

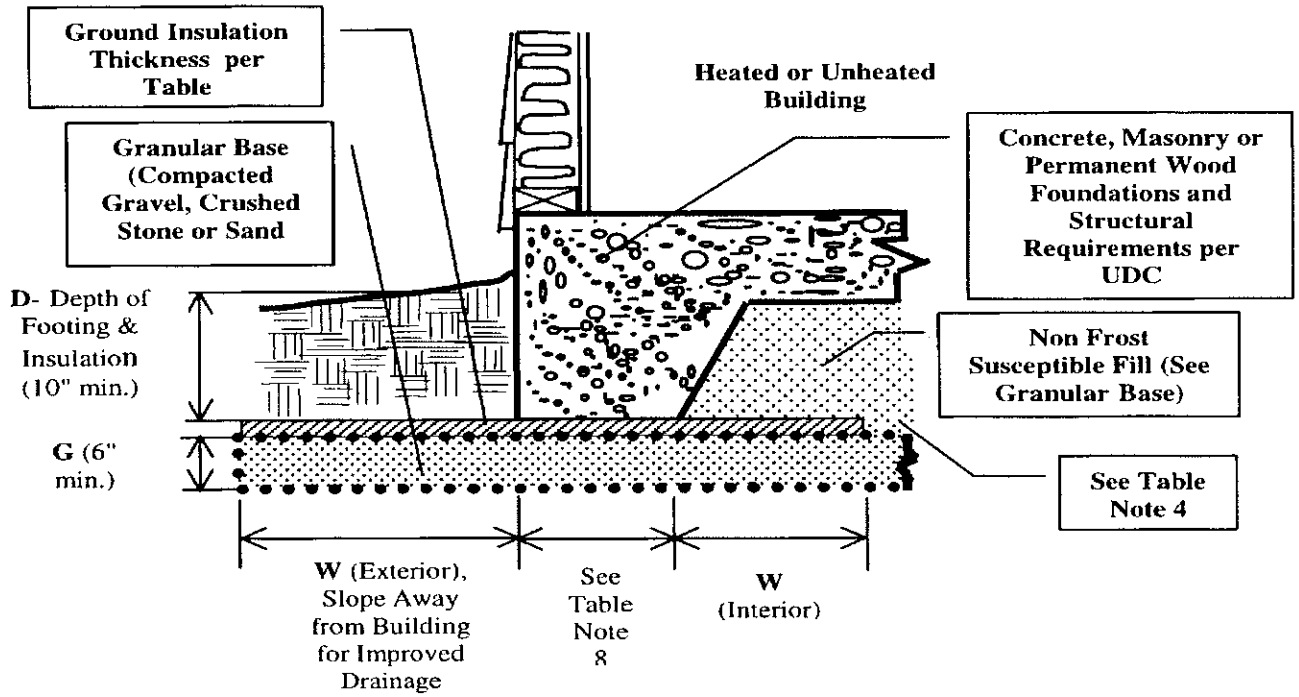
In lieu of frost walls, the following is an acceptable method.

**Minimum Ground Insulation Requirements (1)**

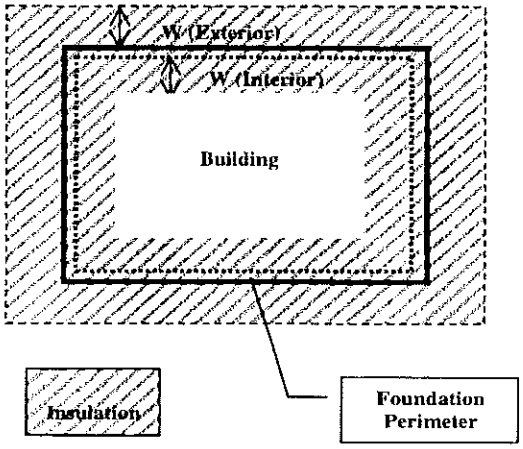
| | | Mean Annual Temperature (2,6) | | | Minimum Footing Depth (7,8) | |
|---|---|---|---|---|---|---|
| **Air Freezing Index (F–days) (3)** | **W–Insulation Width from Edge of Footing (4,5)** | **38** | **40** | **≥41** | **D– Concrete Depth** | **G– Granular Base Thickness** |
| 2250 or less | 63″ | NA | NA | 2.5″ | 10″ | 6″ |
| 2251–3000 | 79″ | 4″ | 3.5″ | 3.5″ | 10″ | 6″ |
| 3001–3750 | 91″ | 5″ | NA | NA | 10″ | 6″ |

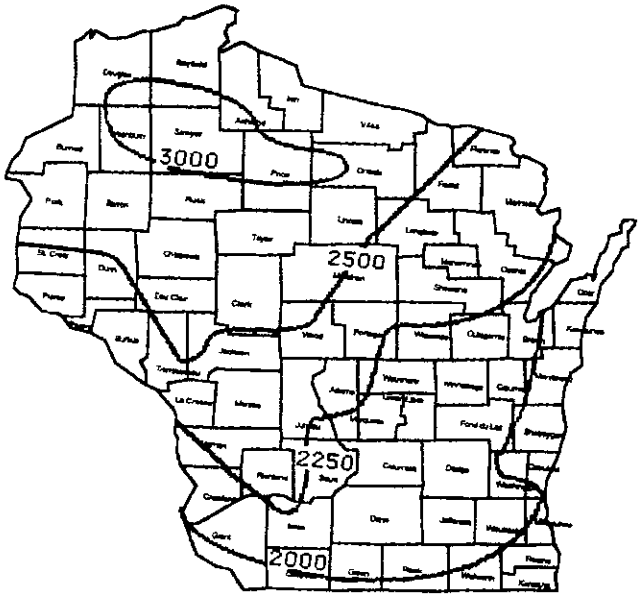
Notes:

1. Also see s. Comm 22.26 for additional slab–edge insulation requirements.
2. Units are degrees Fahrenheit. See estimate provided on Mean Annual Temperature contour Map.
3. Air freezing index shall be based on maximum year expected for a 100 year return period. See estimate provided on AFI Contour Map.
4. Ground insulation to the building interior can be extended beneath the entire slab where it is desired to protect the entire slab from frost heave action.
5. Ground insulation to the building interior can be in one horizontal plane (as shown in the detail) and covered with non frost–susceptible fill or the insulation maybe placed directly beneath the slab.
6. Insulation thickness recommendations are for extruded polystyrene (XPS) insulation.
7. The minimum depth of concrete footing and horizontal insulation is 10". A 6" drainage layer is required under the insulation.
8. Insulation placed directly beneath the footing shall be Type IV or Type VI XPS in accordance with ASTM C578. Maximum deadload placed on the Type IV insulation shall be 1200 pounds/square foot. Maximum deadload placed on the Type IV insulation shall be 1200 pounds/square foot. Maximum deadload placed on Type VI shall be 1900 psf.

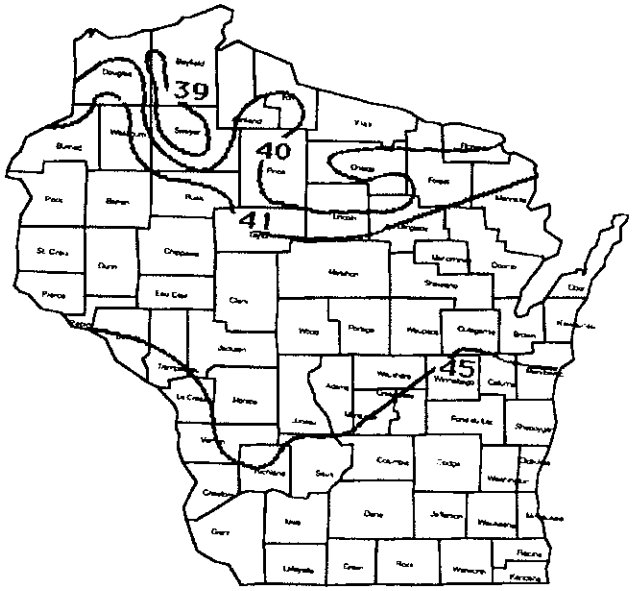


**Plan View**




**Air-Freeze Index Contour Map**




**Mean Annual Temperature Contour Map**

# UDC Energy Worksheet

The UDC Energy Worksheet is required to be submitted with building plans for plan review prior to issuance of a building permit. Following is a sample dwelling and completed Energy Worksheet and a blank worksheet after that. **The sample completed worksheet has been completed for both the Prescriptive Package and System Design Methods for demonstration purposes. Normally only one method is required to be completed for showing code compliance.**

**Sample dwelling**: Non-Electrically heated single-family dwelling located in Dane County (Zone 3). Has 1,500 square feet and 186 linear feet of perimeter building thermal envelope. Garage is not heated. Estimated infiltration rate is .3 air changes per hour. There will be 170 cfm of installed exhaust ventilation.

**Gross Above-Foundation Walls:**

Wall = 8.09' (97"-1/8") x 186 linear feet = 1,504 square feet

Box sill = 0.81 feet (9-3/4 inches deep: sill, header, subfloor) x 186 linear feet = 151 square feet

| | |
|---|---|
| Wood 1 x 8-inch drop siding | R = 0.79 |
| **1-inch extruded polystyrene sheathing** | **R = 5** |
| **R13 batt insulation** | **R = 13** |
| 2 x 4 framing, 16 inches O.C. | R = 4.4 |
| 1/2-inch drywall finish | R = 0.56 |

**Door area** = 38 sq ft

| | |
|---|---|
| **Insulated steel doors** | **U = 0.35** |

**Windows:**

Above-Foundation Windows - 150 sq ft

| | |
|---|---|
| **Wood, low-E, argon-filled, double-pane with 1/2" air space, rated by NFRC** | **U = 0.35** |

Foundation wall window area = 20 square feet

| | |
|---|---|
| **Operable metal w/o thermal break, double pane** | **U = 0.87** |

**Foundation** - 8 ft high, 1 ft exposed

| | |
|---|---|
| 8-inch poured concrete | R = 0.8 |
| **1-inch extruded polystyrene for full height** | **R = 5** |

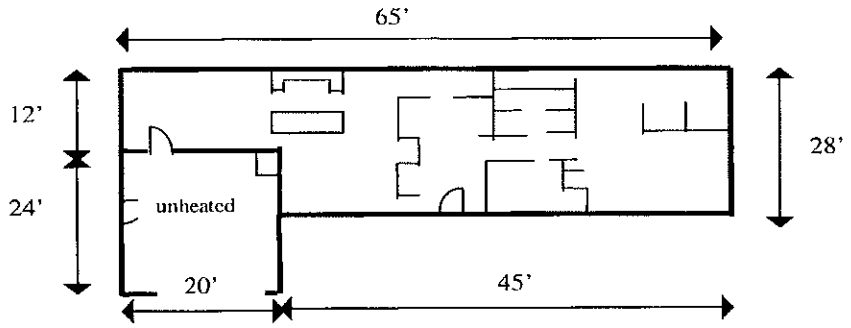
**Ceiling** - 1,500 square feet, standard roof trusses (no raised heel)

| | |
|---|---|
| 2 x 4 trusses, 24 inches O.C. | R = 4.4 |
| Blown fiberglass insulation | R/inch = 2.5 |
| **Insulation in cavity, 16 inches** | **R = 40** |
| Insulation over framing, 12.5 inches | R = 31.25 |
| 5/8-inch drywall finish | R = 0.56 |

**Heating Plant**

| | |
|---|---|
| **Gas-Fired Hot Air, 90% AFUE** | **High Efficiency** |

tk\h:\udc\gentech



**Submit completed worksheet pages 3-6 with dwelling plans to local enforcing municipality.**

Project Address: ***Sample - Zone 3***

Builder: _____ Owner: _____

Worksheet Completed By: _____ Date: _____

Does dwelling unit have three kilowatts or more input capacity of permanently installed electrical space heating equipment?

☐ YES (see below) ☒ NO

You will need to apply the stricter standards shown for electrically-heated homes if you answered "YES" to the above question.

**A. Area Calculations**

Enter appropriate dimensions to obtain area values. Some calculations will not be necessary depending on home design or calculation method. These calculated areas are referenced elsewhere on this worksheet, for example, "(A.1.)".

| | |
|---|---|
| 1. Window, Skylight & Patio Door Area (overall unit area)<br>a. In Above- Foundation Walls: ***150*** sq. ft.<br>b. In Foundation Walls: ***20*** sq. ft.<br>c. Total (a. + b.) = ***170*** | 2. Opaque Door Area<br>a. In Above- Foundation Walls: ***38*** sq. ft.<br>b. In Foundation Walls: ***0*** sq. ft.<br>c. Total (a. + b.) = ***38*** |
| 3. Gross Exposed Basement Wall Area<br>***1' x 186'***<br>***186*** sq. ft. | 4. Basement Wall Area Below Grade<br>***7' x 186'***<br>***1302*** sq. ft. |
| 5. Opaque [1] Basement Wall Area (A.3. + A.4. - A.1.b.- A.2.b.)<br>***186 + 1302 - 20 - 0***<br>***1468*** sq. ft.<br>If the exposed area of A.3.is greater than the below grade area of A.4., add A.5. to A.7 and cross out the number in this cell. | 6. Gross Heated Above-Foundation Wall Area, **including boxsill**<br>***1504 + 151***<br>***1655*** sq. ft. |
| 7. Above Foundation Code Wall Area (A.6. + A1.b. + A.2.b.)<br>***1655 + 20 + 0***<br>***1675*** sq. ft. | 8. Opaque [1] Above-Foundation Wall Area (A.6. - A1.a. - A.2.a.)<br>***1655 - 150 - 38***<br>***1467*** sq. ft. |
| 9. Floor Area Over Interior Unconditioned Spaces Less Than 50°<br>***0*** sq. ft. | 10. Insulated Roof Or Ceiling (less skylights)<br>***28 x 45 = 1260***<br>***12 x 20 = 240***<br>***1500*** sq. ft. |
| 11. Exterior Floor Area (Overhangs)<br>***0*** sq. ft. | 12. Crawl Space Wall Area<br>***0*** sq. ft. |
| 13. Slab On Grade (above or less than 12 inches below grade)<br>***0*** lineal feet of slab perimeter | 14. Total Heated Envelope Area (A.5 + A.7 + A.9 + A.10 +A.11 + A.12 +(A.13. X 2'))<br>***1468 + 1675 + 0 + 1500 + 0 + 0 + 0***<br>***4643*** sq. ft. |
| 15. Percent Glazing (for Prescriptive Package Method, Section B, only) (A.1.c. ÷ A.7. X 100%)<br>***170 ÷ 1675 x 100%***<br>***10.2*** % | 16. Windows Description - Above-Foundation Windows:<br>Frame type: ☒ Wood or Wood Clad ☐ Vinyl ☐ Metal<br>Glazing type: ☒ Dual ☐ Triple ☐ Dual w/storm panel<br>Dual-Glazing Air Space: ☐ 1/4' ☐ 3/8" ☒ 1/2" or more<br>Features: ☒ Low-E ☒ Argon-filled ☐ Suspended film<br>Foundation Windows: ☐ Vinyl ☒ Metal |

**B. Prescriptive Package Method (Skip this section if using the System Design Method of Sections C-F)**
The prescriptive package method is the simplest method for determining compliance with the UDC insulation and window requirements. To use the prescriptive package method, enter your actual design values in the "Actual " row below. **For a component, with two or more areas of different insulation levels, such as windows,** either use the least insulating value for both areas or use the Weighted Average tables below. Multiply your % glazing by the glazing U-value to obtain your "Glazing Factor". Find the Prescriptive Table that applies to your space heating fuel and sheathing type. Select a package from the table that most closely matches the construction indicated on your plans. **Do not exceed the package U-values or glazing factor or fall below the package R-values with your design.** Transfer the R-Values and U-values to the blank table below in the "Allowed" row. Then proceed to Section F. See page 2 for detailed instructions for this section.

| | Package # | % glazing | U glazing | Glazing Factor (% glazing × U glazing) | R wall | R ceiling | R Bsmt, Crawl Space, Slab or Floor | U door | U overall | Equip. Eff. |
|---|---|---|---|---|---|---|---|---|---|---|
| Actual | ------ | *10.2* % (A.15) | *0.41* | *0.042* | *R13 + 5* | *R40* | *R5* | *0.35* | ---------- | *High* |
| Allowed | *45* | ---------- | ---------- | *0.0504* Max | *R18, I* Min | *R40* Min | *R5* Min | *0.35* Max | *0.086* | *High* |

**(Please go to Section F.)**

**Optional R-Value/U-Value Weighted Average Table** for Component: ***Windows***

| Component Construction Description | R Value | U-Value (1÷R Value) | Area (sq ft) | U-Value × Area (UA) |
|---|---|---|---|---|
| ***Basement windows*** | | ***0.87*** | ***20*** | ***17.4*** |
| ***Above-foundation windows*** | | ***0.35*** | ***150*** | ***52.5*** |
| | | | Total Area = ***170*** | Total UA = ***69.9*** |

***69.9*** (Total UA) ÷ ***170*** (Total Area) = ***0.41*** (Weighted Average U-Value (for windows or doors))

_____ (Total Area) ÷ _____ (Total UA) = _____ (Weighted Average R-Value (for all other components))

**Optional R-Value/U-Value Weighted Average Table** for Component:

| Component Construction Description | R Value | U-Value (1÷R Value) | Area (sq ft) | U-Value × Area (UA) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | Total Area = | Total UA = |

_____ (Total UA) ÷ _____ (Total Area) = _____ (Weighted Average U-Value (for windows or doors))

_____ (Total Area) ÷ _____ (Total UA) = _____ (Weighted Average R-Value (for all other components))

***Because the sample house fit a Package, you would normally skip ahead to Section F. For demonstration purposes here, the System Design Method is also completed.***

**C. Code-Allowed Heat Loss For System Design Method**
Enter area values from Section A as notated and temperature differences per footnote 2 into this table and then multiply across by the electric or non-electric code-required U-value. Total the right column to find the total allowed heat loss factor.

| Component | Area From Sect A. | × Required U-Value | | = Heat Loss UA |
|---|---|---|---|---|
| | | ☒ NON-ELEC | ☐ ELECTRIC | |
| 1. Opaque Basement Wall [2] | ***1468*** (A.5.) | 0.077 [3] | 0.077 [3] | ***113*** |
| 2. Above Foundation Code Wall | ***1675*** (A.7.) | 0.110 | 0.080 | ***184*** |
| 3. Floor Over Interior Unconditioned Space | (A.9.) | 0.050 | 0.050 | |
| 4. Roof or Ceiling | ***1500*** (A.10.) | 0.026 | 0.020 | ***39*** |
| 5. Floor Over Exterior | (A.11.) | 0.033 | 0.033 | |
| 6. Crawl Space Wall | (A.12.) | 0.060 | 0.060 | |
| 7. Slab On Grade ☐ Unheated ☐ Heated [3] | (A.13.) Lin. ft. | 0.72 'F' 0.70 'F' | 0.68 'F' 0.68' F' | |
| 8. Subtotal | | | | ***336*** |
| 9. Credit for High Efficiency Heating Plant: 1.18 for furnace or boiler >90% AFUE; 1.15 for heat pump> 7.8 HPSF, Otherwise use 1.0 | | | | × ***1.18*** |
| **10. Total Code-Allowed Heat Loss Factor** | | | | ***396.5*** |

**D. System Design Method - Actual 'U' Values Of Your Home's Components**

**D.1. Above-Foundation Components** - If applicable, check the appropriate typical component constructions listed below, and use the pre-calculated U values. If your wall construction is not listed, you may obtain a pre-calculated U value from the default U-Value tables in the UDC Appendix. (Note that the default Table 2 Wood Frame U-values assume no insulating sheathing which penalizes you if your wall does have insulating sheathing, then you may need to use the Manual Calculation section below.) If you are using exterior metal framing, then you must use the Metal-Frame Wall U-Values of the UDC Appendix. If your component construction is not listed here or in the default tables, you need to use the Manual Calculation section below to manually enter R-values for the different layers of building materials from the Typical Thermal Properties of Building Materials Table of the UDC Appendix, ASHRAE Fundamentals Manual or manufacturer's specifications. Total them across and then obtain the U-value by taking the reciprocal (1/R) of the total R-value.

| | | |
|---|---|---|
| **Above-Foundation Walls** | ☐ 2X4, 16" O.C., R-13 batt, R-1 board: U - .079<br>☐ 2X6, 16" O.C., R-19 batt, R-1 board: U - .059 | ☐ 2X4, 16" O.C., R-13 batt, R-5 board: U - .061<br>☐ 2X6, 16" O.C., R-19 batt, R-5 board: U - .049 |
| ☐ Other - describe: | | U - from Default Table |
| **Roof or Ceiling** | ☐ 2X4 truss, 24" O.C., with R-38 insulation: U - .030<br>☐ 2X12 cathedral ceiling, 16" O.C., with R-38 insulation U - .027 | ☐ 2X4 truss, 24" O.C., with R-52 insulation: U - .025 |
| ☒ Other - describe: ***R40 with regular trusses*** | | U - ***0.029*** from Default Table ***1*** |
| **Floor Over Exterior or Unconditioned Space** | ☐ 2X10 joists, 16" O.C., R-19 batt: U - .047 | |
| ☐ Other - describe: | | U - from Default Table |

**Optional Manual U-Value Calculation (if assembly not listed above)**

| Component Name | Cavity Or Solid If Applicable | Ext. Air Film* | Ext. Finish | Insulation Over Framing | Shea-thing | Framing Or Solid | Insulation Within Cavity | Inter-ior Finish | Int. Air Film* | Total R-Value | U-Value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Above Foundation Wall*** | Cavity | *.17* | *0.79* | *5.0* | | ---------- | *13* | *0.56* | *.68* | *20.2* | *.050* |
| | Solid | *.17* | *0.79* | *5.0* | | *4.4* | ---------- | *0.56* | *.68* | *11.6* | *.086* |
| | Cavity | | | | | ---------- | | | | | |
| | Solid | | | | | | ---------- | | | | |

*** Air Film R-Values**

| Location | Heat Flow Direction | | |
|---|---|---|---|
| | Upwards | Horizontal | Downwards |
| **Exterior** | .17 | .17 | .17 |
| **Interior** | .61 | .68 | .92 |

**D.2. Foundation And Slab-On-Grade Components** - Check appropriate boxes for planned type of construction to determine pre-calculated overall 'U-value' including air films, wall, insulation, soil and cavity/solid differences. Slab on grade F-values are per lineal foot of slab perimeter.

| Component Type | U-Value | |
|---|---|---|
| **Foundation Wall** | **Basement** | **Crawl Space** |
| ☐ Masonry or concrete wall without insulation | 0.360 | 0.477 |
| ☒ Masonry or concrete wall with R-5 insulation board for full height | (0.115) | 0.136 |
| ☐ Masonry or concrete wall with R-10 insulation board or R-11 insulation batt and 2X4's for full height | 0.072 | 0.081 |
| ☐ Permanent wood foundation with R-19 batt for full height | 0.054 | 0.059 |
| ☐ Basement or crawl space floor without insulation | 0.025 | 0.025 |
| ☐ Basement floor with R-5 insulation | 0.022 | 0.022 |
| **Slab-On-Grade (or within 12" of grade)** | **F-Value** | |
| ☐ Slab-on-grade without insulation | 1.04 | |
| ☐ Slab-on-grade with R-5 insulation for 48" total horizontal and vertical application | 0.74 | |
| ☐ Slab-on-grade with R-10 insulation board for 48" total application | 0.68 | |

**D.3. Windows And Doors** - Use manufacturer's specifications for window and glazed door values, if they were determined per NFRC Std 100, to enter into Table E. Otherwise see default tables of UDC s. Comm 22.05 for U-values.

**E. System Design Method - Calculated Envelope Heat Loss Factor Of Your Home**

Enter values into table from elsewhere on this worksheet and multiply across to find the actual heat loss factor of each component. If using pre-calculated component U-values, **do not calculate separate cavity and solid figures or apply wood frame factors.** Total component heat loss factors in right column to find total envelope heat loss factors.

| Component | Cavity Or Solid If Applicable | Area From Sect. A | × Wood Frame Factor** | × Actual 'U' Value From Sect. D | = Heat Loss Factor (UA) |
|---|---|---|---|---|---|
| Above-Foundation Windows | ---------- | *150* (A.1.a.) | ---------- | *0.35* | *52.5* |
| Foundation Windows | ---------- | *20* (A.1.b) | ---------- | *0.87* | *17.4* |
| Doors | ---------- | *38* (A.2.c) | ---------- | *0.35* | *13.3* |
| Opaque Basement Wall | ---------- | *1468* (A.5.) | ---------- | *0.115* | *168.8* |
| Opaque Above-Foundation Wall | Cavity | | *.75* | *.050* | *55* |
| | Solid | *1467* (A.8.) | *.25* | *.086* | *31.5* |
| Floor Over Unconditioned Spaces | Cavity | | | | |
| | Solid | (A.9.) | | | |
| Roof or Ceiling | Cavity | | | | |
| | Solid | *1500* (A.10.) | | *0.029* | *43.5* |
| Floor Over Exterior | Cavity | | | | |
| | Solid | (A.11.) | | | |
| Crawl Space Wall | ---------- | (A.12.) | ---------- | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Slab On Grade | ---------- | (A.13.)Lin. ft. | ---------- | F-Value | |
| **Total Calculated Envelope Heat Loss Factor**- Not to exceed Total Code Allowed Heat Loss Factor of line 10 of Section C. (Enter here: *396.5* )by more than 1% | | | | | *382* |

** Adjustment Factors For Wood-Framed Components - Do not apply if your are using a pre-calculated or default U-Value.

| Spacing Of Framing Members | Stud Walls | | Joists/Rafters | |
|---|---|---|---|---|
| | Cavity | Solid | Cavity | Solid |
| 12" | .70 | .30 | .86 | .14 |
| 16" | .75 | .25 | .90 | .10 |
| 24" | .78 | .22 | .93 | .07 |

**F. Heat Loss Factor Due to Air Infiltration (for heating equipment sizing)**

Enter appropriate values. A maximum infiltration air change rate of 0.5 per hour is allowed in addition to ventilation losses.

| Floor Level | Area (sq ft) | × Height (ft) | Fan Capacity (cfm) | × Constant | × Air Changes Per Hour | = Heat Loss Factor(UA) |
|---|---|---|---|---|---|---|
| Basement | *1500* | *8* | ---------- | .018 | *0.3* | *64.8* |
| Level 1 | *1500* | *8* | ---------- | .018 | *0.3* | *64.8* |
| Level 2 | | | ---------- | .018 | | |
| Level 3 | | | ---------- | .018 | | |
| Ventilation | ---------- | ---------- | *170* | .432 | ---------- | *73.4* |
| **Total Infiltration & Ventilation Heat Loss Factor** | | | | | | *203* |

**G. Heating Equipment Sizing**

Enter appropriate value to determine the maximum and minimum allowable heating equipment capacity in BTUs/HR. A more detailed calculation may be submitted to the local code official. [4]

| | | | | |
|---|---|---|---|---|
| **Prescriptive Package Method:** | *0.086* **U overall** from selected Prescriptive Package of Section B | × | *4643* Total Envelope Area (A.14.) | = *399.3* |
| **OR System Design Method**: Calculated Heat Loss Factor from Sect. E. | | | | |
| Infiltration & Ventilation Heat Loss Factor (from Sect. F.) | | | | + *203* |
| Total Heat Loss Factor (UA) | | | | = *602.3* |
| Temperature Difference from Zone Table on page 1 | | | | × *85* |
| **Minimum Heating Equipment Output** | | | | = *51,196* |
| Allowable Heating Equipment Size Margin Multiplier | | | | × 1.15 |
| **Maximum Allowable Heating Equipment Output** [5] | | | | = *58,875* |
| Planned Furnace Output Or Boiler IBR Rating | | | | *60,000* |
| Make & Model if High Efficiency Credit has been taken: *Acme XLH60K* | | | | |

## Prescriptive Package Tables (Corrected)

(See notes on page 2 of Energy Worksheet; I = insulating sheathing, RT = raised heel roof truss)

**Table B-1 Prescriptive packages, Non-electric Heat, Structural Sheathing only**

| Package | Glazing Factor | R wall | R ceiling | R basement | U door | U overall | HVAC Equipment Efficiency |
|---|---|---|---|---|---|---|---|
| 1 | 0.0370 | R21 | R42 | R7 | 0.35 | 0.073 | Normal |
| 2 | 0.0264 | R21 | R51, RT | R5 | 0.35 | 0.073 | Normal |
| 3 | 0.0333 | R15 | R42 | R10 | 0.35 | 0.073 | Normal |
| 4 | 0.0440 | R19 | R33 | R10 | 0.35 | 0.073 | Normal |
| 5 | 0.0330 | R13 | R42 | R11 | 0.35 | 0.073 | Normal |
| 6 | 0.0480 | R19 | R33 | R11 | 0.35 | 0.073 | Normal |
| 7 | 0.0600 | R21 | R47 | R11 | 0.35 | 0.073 | Normal |
| 8 | 0.0407 | R13 | R44 | R13 | 0.35 | 0.073 | Normal |
| 9 | 0.0600 | R19 | R42 | R13 | 0.35 | 0.073 | Normal |
| 10 | 0.0680 | R21 | R38, RT | R13 | 0.35 | 0.073 | Normal |
| 11 | 0.0296 | R13 | R49 | R5 | 0.35 | 0.086 | High |
| 12 | 0.0440 | R19 | R30 | R5 | 0.35 | 0.086 | High |
| 13 | 0.0520 | R21 | R33 | R5 | 0.35 | 0.086 | High |
| 14 | 0.0720 | R13 | R47 | R10 | 0.35 | 0.086 | High |
| 15 | 0.0784 | R19 | R38 | R10 | 0.47 | 0.086 | High |
| 16 | 0.0640 | R13 | R33 | R11 | 0.47 | 0.086 | High |
| 17 | 0.0896 | R19 | R49 | R11 | 0.35 | 0.086 | High |
| 18 | 0.0896 | R21 | R34 | R11 | 0.35 | 0.086 | High |
| 19 | 0.0920 | R19 | R34 | R11 | 0.47 | 0.086 | High |
| 20 | 0.0840 | R13 | R49 | R13 | 0.35 | 0.086 | High |
| 21 | 0.0840 | R19 | R30 | R13 | 0.47 | 0.086 | High |
| 22 | 0.0896 | R21 | R31 | R13 | 0.47 | 0.086 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R crawl** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 23 | 0.0520 | R19 | R34 | R19 | 0.47 | 0.070 | Normal |
| 24 | 0.0672 | R13 | R36 | R19 | 0.47 | 0.083 | High |
| 25 | 0.0720 | R13 | R33 | R19 | 0.47 | 0.083 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 26 | 0.0560 | R21 | R36 | R5 | 0.47 | 0.103 | Normal |
| 27 | 0.0728 | R13 | R36 | R5 | 0.47 | 0.121 | High |
| 28 | 0.0760 | R13 | R34 | R5 | 0.47 | 0.121 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R heated-slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 29 | 0.0560 | R21 | R47 | R5 | 0.47 | 0.101 | Normal |
| 30 | 0.0728 | R13 | R42 | R5 | 0.47 | 0.120 | High |
| 31 | 0.0760 | R13 | R38 | R5 | 0.47 | 0.120 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R floor** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 32 | 0.0480 | R19 | R47 | R19 | 0.35 | 0.065 | Normal |
| 33 | 0.0728 | R19 | R36 | R19 | 0.47 | 0.077 | High |
| 34 | 0.0560 | R13 | R34 | R19 | 0.47 | 0.077 | High |

**Table B-2 Prescriptive packages, Non-electric Heat, Insulating Sheathing**

| Package | Glazing Factor | R wall | R ceiling | R basement | U door | U overall | HVAC Equipment Efficiency |
|---|---|---|---|---|---|---|---|
| 35 | 0.0370 | R20, I | R42 | R7 | 0.35 | 0.073 | Normal |
| 36 | 0.0363 | R28, I | R38, RT | R5 | 0.35 | 0.073 | Normal |
| 37 | 0.0552 | R18, I | R44 | R10 | 0.35 | 0.073 | Normal |
| 38 | 0.0560 | R20, I | R47 | R10 | 0.35 | 0.073 | Normal |
| 39 | 0.0560 | R23, I | R34 | R10 | 0.35 | 0.073 | Normal |
| 40 | 0.0560 | R18, I | R47 | R11 | 0.35 | 0.073 | Normal |
| 41 | 0.0616 | R23, I | R42 | R11 | 0.35 | 0.073 | Normal |
| 42 | 0.0546 | R18, I | R44 | R11 | 0.35 | 0.073 | Normal |
| 43 | 0.0672 | R23, I | R40 | R13 | 0.35 | 0.073 | Normal |
| 44 | 0.0720 | R25, I | R36 | R13 | 0.35 | 0.073 | Normal |
| 45 | 0.0504 | R18, I | R40 | R5 | 0.35 | 0.086 | High |
| 46 | 0.0560 | R19, I | R47 | R5 | 0.35 | 0.086 | High |
| 47 | 0.0560 | R23, I | R38 | R5 | 0.47 | 0.086 | High |
| 48 | 0.0600 | R25, I | R38 | R5 | 0.47 | 0.086 | High |
| 49 | 0.0680 | R26, I | R42 | R5 | 0.35 | 0.086 | High |
| 50 | 0.0680 | R28, I | R47 | R5 | 0.47 | 0.086 | High |
| 51 | 0.0672 | R26, I | R47 | R5 | 0.35 | 0.086 | High |
| 52 | 0.0672 | R28, I | R38 | R5 | 0.35 | 0.086 | High |
| 53 | 0.0720 | R20, I | R42 | R7 | 0.47 | 0.086 | High |
| 54 | 0.0855 | R18, I | R36 | R11 | 0.35 | 0.086 | High |

# Wisconsin Uniform Dwelling Code
# Energy Worksheet

**Instructions:** This worksheet is a Safety & Buildings Division (S&BD)-approved method of manually showing compliance with the energy conservation and heating equipment sizing requirements of the Uniform Dwelling Code (UDC), for new dwelling permits **submitted on or after February 1, 1999**. It may be necessary for the user to purchase a copy of the UDC from State Document Sales, (608)266-3358. Additional information is printed in the UDC Commentary, which is available for a fee, as are blank copies of this form, from S&BD at POB 2509, Madison, WI 53701, Tel. 608-267-4405. **Earlier editions of this worksheet may NOT be used.** Numbers in brackets, [1], refer to the footnotes printed on page 2.

You may also submit completed worksheets from the computer program WIS*check*, which is available for free download from http://www.energycodes.org/ on the Internet.

A required U-value is the **maximum** acceptable heat transmittance for an element. A required insulation R-value is the **minimum** acceptable level of resistance to heat transmittance. (U-values and R-values are reciprocals of each other.) If a component includes two or more areas of different insulation levels, either use the less insulating value for both areas, or use the Optional Weighted Average table in the **Prescriptive Package Method** section or enter separate areas and insulation values in the **System Design Method**. All "U" values must be carried to four places after the decimal point, rounded to three places. Other values may be rounded to the whole number.

**Window and door U-values** must be tested and documented by the manufacturer in accordance with the National Fenestration Rating Council (NFRC) test procedures or be taken from the glazing U-value table in s. Comm 22.05. Center-of-glass U-values cannot be used. 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.

The code gives credit for **high-efficiency heating equipment**. "High-Efficiency" means a furnace with an AFUE of 90% or more, or a heat pump with an HSPF of 7.8 or more without the use of electric resistance backup heat of greater than 3 kilowatts. If you plan to install more than one piece of heating equipment, the equipment with the lowest efficiency must exceed the efficiency required by the selected package.

**Choice of Method:** You have the choice of using the Prescriptive Package Method or the System Design Method to show code compliance. For the simpler **Prescriptive Package Method** , which is recommended for standard designs, complete Sections **A., B., F., and G.** Instructions are on page 2. You will be first calculating component areas, then comparing your planned insulation levels to the required insulation levels of the Prescriptive Packages. You will then calculate infiltration and ventilation heat losses to size your heating equipment. If you cannot comply with one of the prescriptive packages, you may be able to show compliance by the System Design Method.

For the **System Design Method**, which is recommended for alternative designs in which more insulation is installed in one component to offset less in another, complete **Sections A., C., D., E., F. and G.** You will be first calculating component areas, then a code-allowed heat loss factor, then component U- and R-values and then your calculated heat loss factor which you will compare to the code-allowed heat loss factor. You will then calculate infiltration and ventilation heat losses to size your heating equipment.

The **County Zone Table** below is use for determining the temperature difference for sizing your heating plant in Section G. You may submit to your local code official more exact calculations to size your heating equipment.

| Zone 1 - 95 degrees | Zone 2 - 90 degrees | Zone 3 - 85 degrees | Zone 4 - 80 degrees |
|---|---|---|---|
| Ashland, Barron, Bayfield, Burnett, Chippewa, Douglas, Dunn, Florence, Forest, Iron, Lincoln, Oneida, Pierce, Polk, Price, Rusk, Saint Croix, Sawyer, Taylor, Vilas, Washburn | Adams, Buffalo, Clark, Eau Claire, Jackson, Juneau, LaCrosse, Langlade, Marathon, Marinette, Menominee, Monroe, Portage, Shawano, Oconto, Pepin, Trempeleau, Vernon, Waupaca, Wood | Brown, Calumet, Columbia, Crawford, Dane, Dodge, Door, Fond du Lac, Grant, Green, Green Lake, Iowa, Kewaunee, LaFayette, Manitowoc, Marquette, Outagamie, Richland, Sauk, Sheboygan, Waushara, Winnebago | Jefferson, Kenosha, Milwaukee, Ozaukee, Racine, Rock, Walworth, Washington, Waukesha |

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## Detailed Instructions for Section B. Prescriptive Package Method:

**R-value requirements** are for insulation only and do not include structural components.

**For a component with two or more areas of different insulation levels**, either use the least insulating value for both areas or use the Weighted Average tables on page 4.

**Wall R-values** represent the sum of the wall cavity insulation plus insulating sheathing, if used. Do not include exterior siding, structural sheathing or interior drywall. For example, an R-20 requirement could be met *EITHER* by R-15 cavity insulation plus R-5 sheathing *OR* R-13 cavity insulation plus R-7 sheathing. Note that there are separate tables for walls with structural sheathing only and for walls with insulating sheathing. To use a table for insulating sheathing, the sheathing used must be at least R-4, except that at least R-2 insulation may be provided over corner bracing. Table wall R-Values apply to wood-frame or mass (concrete, masonry, log) wall assemblies, but not to metal-frame construction. If metal frame is planned, use the adjusted R-Values from the Metal-Frame Wall Tables of the UDC Appendix. Table wall values apply to boxsills.

**Ceiling R-values** represent the sum of the cavity insulation plus insulating sheathing, if used. For ventilated ceilings, any insulating sheathing must be placed between the conditioned space and the ventilated portion of the roof. Ceiling R-values with **"RT"** indicates that a raised-heel truss or oversized truss construction must be used so that the insulation achieves the full insulation thickness over the exterior walls.

**Floor requirements** apply to floors over unconditioned spaces (such as un-insulated crawlspaces, basements and garages). Floors over outside air shall have a Uoverall = 0.033 or R-30 added insulation.

**"Heated-Slab"** requirements apply to slabs that contain heat ducts or pipes. All slab insulation must extend at least 48 inches either 1) down from the top of the slab, or 2) down from the top of the slab to the bottom of the slab and then horizontally underneath the slab, or 3) down from the top of the slab to the bottom of the slab and then horizontally away from the slab, with pavement or at least 10 inches of soil covering the horizontal insulation.

**Walls of basements** below un-insulated floors must be insulated from the top of the basement wall to the level of the basement floor. Conditioned basement windows and glass doors must be included with the other glazing. Exterior basement doors must meet the door U-value requirements. If more than 50% of the basement is exposed, then all of the basement walls must instead meet the above-foundation wall requirements.

**Crawl space wall R-value requirements** are for walls of unventilated crawlspaces. The crawlspace wall insulation must extend from the top of the wall (including the sill plate) to at least 12 inches below the outside finished grade. If the distance from the outside finished grade to the top of the footing is less than 12 inches, the insulation must extend a total vertical plus horizontal distance of 24 inches from the outside finished grade.

---

**Footnotes for worksheet:**

[1] Opaque wall area is wall area minus opening areas of doors and windows.

[2] These below-grade U-values have the insulating value of the soil added to the code-required U-values which apply to the building materials only. See Sect. D.2. for typical insulated component U-values.

[3] These slab-on-grade F-values are derived from the code-required U-values and include the heat loss through the edge and body of the slab. See Sect. D.2. Temperature difference is the same as for above-grade spaces.

[4] For building additions, show that the existing heating equipment, if used to heat the addition, is large enough. To do so, you must calculate the heat loss of the whole building.

[5] If desired manufacturer does not have a furnace of this size, then a designer may select the manufacturer's next larger size.

**Submit completed worksheet pages 3-6 with dwelling plans to local enforcing municipality.**

Project Address: _____

Builder: _____ Owner: _____

Worksheet Completed By: _____ Date: _____

Does dwelling unit have three kilowatts or more input capacity of permanently installed electrical space heating equipment?

☐ YES (see below) ☐ NO

You will need to apply the stricter standards shown for electrically-heated homes if you answered "YES" to the above question.

**A. Area Calculations**

Enter appropriate dimensions to obtain area values. Some calculations will not be necessary depending on home design or calculation method. These calculated areas are referenced elsewhere on this worksheet, for example, "(A.1.)".

| | |
|---|---|
| 1. Window, Skylight & Patio Door Area (overall unit area)<br>a. In Above-Foundation Walls b. In Foundation Walls<br>_____ sq. ft. _____ sq. ft.<br>c. Total (a. + b.) = _____ | 2. Opaque Door Area<br>a. In Above- Foundation Walls b. In Foundation Walls<br>_____ sq. ft. _____ sq. ft.<br>c. Total (a. + b.) = _____ |
| 3. Gross Exposed Basement Wall Area<br>_____ sq. ft. | 4. Basement Wall Area Below Grade<br>_____ sq. ft. |
| 5. Opaque [1] Basement Wall Area (A.3. + A.4. - A.1.b.- A.2.b.)<br>_____ sq. ft.<br>If the exposed area of A.3.is greater than the below grade area of A.4., add A.5. to A.7 and cross out the number in this cell. | 6. Gross Heated Above-Foundation Wall Area, **including boxsill**<br>_____ sq. ft. |
| 7. Above Foundation Code Wall Area (A.6. + A1.b. + A.2.b.)<br>_____ sq. ft. | 8. Opaque [1] Above-Foundation Wall Area (A.6. - A1.a. - A.2.a.)<br>_____ sq. ft. |
| 9. Floor Area Over Interior Unconditioned Spaces Less Than 50°<br>_____ sq. ft. | 10. Insulated Roof Or Ceiling (less skylights)<br>_____ sq. ft. |
| 11. Exterior Floor Area (Overhangs)<br>_____ sq. ft. | 12. Crawl Space Wall Area<br>_____ sq. ft. |
| 13. Slab On Grade (above or less than 12 inches below grade)<br>_____ lineal feet of slab perimeter | 14. Total Heated Envelope Area (A.5 + A.7 + A.9 + A.10 +A.11 + A.12 +(A.13. × 2'))<br>_____ sq. ft. |
| 15. Percent Glazing (for Prescriptive Package Method, Section B, only) (A.1.c. ÷ A.7. × 100%)<br>_____ % | 16. Windows Description - Above-Foundation Windows:<br>Frame type: ☐ Wood or Wood Clad ☐ Vinyl ☐ Metal<br>Glazing type: ☐ Dual ☐ Triple ☐ Dual w/storm panel<br>Dual-Glazing Air Space: ☐ 1/4' ☐ 3/8" ☐ 1/2" or more<br>Features: ☐ Low-E ☐ Argon-filled ☐ Suspended film<br>Foundation Windows: ☐ Vinyl ☐ Metal |

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**B. Prescriptive Package Method (Skip this section if using the System Design Method of Sections C-F)**
The prescriptive package method is the simplest method for determining compliance with the UDC insulation and window requirements. To use the prescriptive package method, enter your actual design values in the "Actual " row below. **For a component, with two or more areas of different insulation levels, such as windows,** either use the least insulating value for both areas or use the Weighted Average tables below. Multiply your % glazing by the glazing U-value to obtain your "Glazing Factor". Find the Prescriptive Table that applies to your space heating fuel and sheathing type. Select a package from the table that most closely matches the construction indicated on your plans. **Do not exceed the package U-values or glazing factor or fall below the package R-values with your design.** Transfer the R-Values and U-values to the blank table below in the "Allowed" row. Then proceed to Section F. See page 2 for detailed instructions for this section.

| | Package # | % glazing | U glazing | Glazing Factor (% glazing × U glazing) | R wall | R ceiling | R Bsmt, Crawl Space, Slab or Floor | U door | U overall | Equip. Eff. |
|---|---|---|---|---|---|---|---|---|---|---|
| **Actual** | ------ | % (A.15) | | | | | | | ---------- | |
| **Allowed** | | ---------- | ---------- | Max | Min | Min | Min | Max | | |

**(Please go to Section F.)**

**Optional R-Value/U-Value Weighted Average Table** for Component:

| Component Construction Description | R Value | U-Value (1÷R Value) | Area (sq ft) | U-Value × Area (UA) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | Total Area = | Total UA = |

(Total UA) ÷ (Total Area) = (Weighted Average U-Value (for windows or doors))

(Total Area) ÷ (Total UA) = (Weighted Average R-Value (for all other components))

**Optional R-Value/U-Value Weighted Average Table** for Component:

| Component Construction Description | R Value | U-Value (1÷R Value) | Area (sq ft) | U-Value × Area (UA) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | Total Area = | Total UA = |

(Total UA) ÷ (Total Area) = (Weighted Average U-Value (for windows or doors))

(Total Area) ÷ (Total UA) = (Weighted Average R-Value (for all other components))

**C. Code-Allowed Heat Loss For System Design Method**
Enter area values from Section A as notated and temperature differences per footnote 2 into this table and then multiply across by the electric or non-electric code-required U-value. Total the right column to find the total allowed heat loss factor.

| Component | Area From Sect A. | × Required U-Value | | = Heat Loss UA |
|---|---|---|---|---|
| | | ☐ NON-ELEC | ☐ ELECTRIC | |
| 1. Opaque Basement Wall [2] | (A.5.) | 0.077 [3] | 0.077 [3] | |
| 2. Above Foundation Code Wall | (A.7.) | 0.110 | 0.080 | |
| 3. Floor Over Interior Unconditioned Space | (A.9.) | 0.050 | 0.050 | |
| 4. Roof or Ceiling | (A.10.) | 0.026 | 0.020 | |
| 5. Floor Over Exterior | (A.11.) | 0.033 | 0.033 | |
| 6. Crawl Space Wall | (A.12.) | 0.060 | 0.060 | |
| 7. Slab On Grade ☐ Unheated ☐ Heated [3] | (A.13.) Lin. ft. | 0.72 'F' 0.70 'F' | 0.68 'F' 0.68' F' | |
| 8. Subtotal | | | | |
| 9. Credit for High Efficiency Heating Plant: 1.18 for furnace or boiler >90% AFUE; 1.15 for heat pump> 7.8 HPSF, Otherwise use 1.0 | | | | × |
| **10.** | | **Total Code-Allowed Heat Loss Factor** | | |

**D. System Design Method - Actual 'U' Values Of Your Home's Components**

**D.1. Above-Foundation Components** - If applicable, check the appropriate typical component constructions listed below, and use the pre-calculated U values. If your wall construction is not listed, you may obtain a pre-calculated U value from the default U-Value tables in the UDC Appendix. (Note that the default Table 2 Wood Frame U-values assume no insulating sheathing which penalizes you if your wall does have insulating sheathing, then you may need to use the Manual Calculation section below.) If you are using exterior metal framing, then you must use the Metal-Frame Wall U-Values of the UDC Appendix. If your component construction is not listed here or in the default tables, you need to use the Manual Calculation section below to manually enter R-values for the different layers of building materials from the Typical Thermal Properties of Building Materials Table of the UDC Appendix, ASHRAE Fundamentals Manual or manufacturer's specifications. Total them across and then obtain the U-value by taking the reciprocal (1/R) of the total R-value.

| | | |
|---|---|---|
| **Above-Foundation Walls** | ☐ 2X4, 16" O.C., R-13 batt, R-1 board: U - .079<br>☐ 2X6, 16" O.C., R-19 batt, R-1 board: U - .059 | ☐ 2X4, 16" O.C., R-13 batt, R-5 board: U - .061<br>☐ 2X6, 16" O.C., R-19 batt, R-5 board: U - .049 |
| ☐ Other - describe: | | U - from Default Table |
| **Roof or Ceiling** | ☐ 2X4 truss, 24" O.C., with R-38 insulation: U - .030<br>☐ 2X12 cathedral ceiling, 16" O.C., with R-38 insulation U - .027 | ☐ 2X4 truss, 24" O.C., with R-52 insulation: U - .025 |
| ☐ Other - describe: | | U - from Default Table |
| **Floor Over Exterior or Unconditioned Space** | ☐ 2X10 joists, 16" O.C., R-19 batt: U - .047 | |
| ☐ Other - describe: | | U - from Default Table |

**Manual U-Value Calculation (if assembly not listed above)**

| Component Name | Cavity Or Solid If Applicable | Ext. Air Film* | Ext. Finish | Insulation Over Framing | Shea-thing | Framing Or Solid | Insulation Within Cavity | Inter-ior Finish | Int. Air Film* | Total R-Value | U-Value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cavity | | | | | ---------- | | | | | |
| | Solid | | | | | | ---------- | | | | |
| | Cavity | | | | | ---------- | | | | | |
| | Solid | | | | | | ---------- | | | | |

*** Air Film R-Values**

| Location | Heat Flow Direction | | |
|---|---|---|---|
| | Upwards | Horizontal | Downwards |
| **Exterior** | .17 | .17 | .17 |
| **Interior** | .61 | .68 | .92 |

**D.2. Foundation And Slab-On-Grade Components** - Check appropriate boxes for planned type of construction to determine pre-calculated overall 'U-value' including air films, wall, insulation, soil and cavity/solid differences. Slab on grade F-values are per lineal foot of slab perimeter.

| Component Type | U-Value | |
|---|---|---|
| **Foundation Wall** | **Basement** | **Crawl Space** |
| ☐ Masonry or concrete wall without insulation | 0.360 | 0.477 |
| ☐ Masonry or concrete wall with R-5 insulation board for full height | 0.115 | 0.136 |
| ☐ Masonry or concrete wall with R-10 insulation board or R-11 insulation batt and 2X4's for full height | 0.072 | 0.081 |
| ☐ Permanent wood foundation with R-19 batt for full height | 0.054 | 0.059 |
| ☐ Basement or crawl space floor without insulation | 0.025 | 0.025 |
| ☐ Basement floor with R-5 insulation | 0.022 | 0.022 |
| **Slab-On-Grade (or within 12 " of grade)** | **F-Value** | |
| ☐ Slab-on-grade without insulation | 1.04 | |
| ☐ Slab-on-grade with R-5 insulation for 48" total horizontal and vertical application | 0.74 | |
| ☐ Slab-on-grade with R-10 insulation board for 48" total application | 0.68 | |

**D.3. Windows And Doors** - Use manufacturer's specifications for window and glazed door values, if they were determined per NFRC Std 100, to enter into Table E. Otherwise see default tables of UDC s. Comm 22.05 for U-values.

SBD-5518 (R. 12/98) Corr

**E. System Design Method - Calculated Envelope Heat Loss Factor Of Your Home**

Enter values into table from elsewhere on this worksheet and multiply across to find the actual heat loss factor of each component. If using pre-calculated component U-values, **do not calculate separate cavity and solid figures or apply wood frame factors.** Total component heat loss factors in right column to find total envelope heat loss factors.

| Component | Cavity Or Solid If Applicable | Area From Sect. A | × Wood Frame Factor** | × Actual 'U' Value From Sect. D | = Heat Loss Factor (UA) |
|---|---|---|---|---|---|
| Above-Foundation Windows | ---------- | (A.1.a.) | ---------- | | |
| Foundation Windows | ---------- | (A.1.b) | ---------- | | |
| Doors | ---------- | (A.2.c) | ---------- | | |
| Opaque Basement Wall | ---------- | (A.5.) | ---------- | | |
| Opaque Above-Foundation Wall | Cavity | | | | |
| | Solid | (A.8.) | | | |
| Floor Over Unconditioned Spaces | Cavity | | | | |
| | Solid | (A.9.) | | | |
| Roof or Ceiling | Cavity | | | | |
| | Solid | (A.10.) | | | |
| Floor Over Exterior | Cavity | | | | |
| | Solid | (A.11.) | | | |
| Crawl Space Wall | ---------- | (A.12.) | ---------- | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Slab On Grade | ---------- | (A.13.)Lin. ft. | ---------- | F-Value | |
| **Total Calculated Envelope Heat Loss Factor-** Not to exceed Total Code Allowed Heat Loss Factor of line 10 of Section C. (Enter here: )by more than 1% | | | | | |

** Adjustment Factors For Wood-Framed Components - Do not apply if your are using a pre-calculated or default U-Value.

| Spacing Of Framing Members | Stud Walls | | Joists/Rafters | |
|---|---|---|---|---|
| | Cavity | Solid | Cavity | Solid |
| 12" | .70 | .30 | .86 | .14 |
| 16" | .75 | .25 | .90 | .10 |
| 24" | .78 | .22 | .93 | .07 |

**F. Heat Loss Factor Due to Air Infiltration (for heating equipment sizing)**

Enter appropriate values. A maximum infiltration air change rate of 0.5 per hour is allowed in addition to ventilation losses.

| Floor Level | Area (sq ft) | × Height (ft) | Fan Capacity (cfm) | × Constant | × Air Changes Per Hour | = Heat Loss Factor(UA) |
|---|---|---|---|---|---|---|
| Basement | | | --------- | .018 | | |
| Level 1 | | | --------- | .018 | | |
| Level 2 | | | --------- | .018 | | |
| Level 3 | | | --------- | .018 | | |
| Ventilation | ---------- | ---------- | | .432 | ---------- | |
| **Total Infiltration & Ventilation Heat Loss Factor** | | | | | | |

**G. Heating Equipment Sizing**

Enter appropriate value to determine the maximum and minimum allowable heating equipment capacity in BTUs/HR. A more detailed calculation may be submitted to the local code official. [4]

| | |
|---|---|
| **Prescriptive Package Method:** U overall from selected Prescriptive Package of Section B × Total Envelope Area (A.14.) = | |
| **OR System Design Method**: Calculated Heat Loss Factor from Sect. E. | |
| Infiltration & Ventilation Heat Loss Factor (from Sect. F.) | + |
| Total Heat Loss Factor (UA) | = |
| Temperature Difference from **County Zone Table** on page 1 | × |
| **Minimum Heating Equipment Output** | = |
| Allowable Heating Equipment Size Margin Multiplier | × 1.15 |
| **Maximum Allowable Heating Equipment Output** [5] | = |
| Planned Furnace Output Or Boiler IBR Rating | |
| Make & Model if High Efficiency Credit has been taken: | |

## Prescriptive Package Tables (Corrected)

(See notes on page 2 of Energy Worksheet: I = insulating sheathing, RT = raised heel roof truss)

**Table B-1 Prescriptive packages, Non-electric Heat, Structural Sheathing only**

| Package | Glazing Factor | R wall | R ceiling | R basement | U door | U overall | HVAC Equipment Efficiency |
|---|---|---|---|---|---|---|---|
| 1 | 0.0370 | R21 | R42 | R7 | 0.35 | 0.073 | Normal |
| 2 | 0.0264 | R21 | R51, RT | R5 | 0.35 | 0.073 | Normal |
| 3 | 0.0333 | R15 | R42 | R10 | 0.35 | 0.073 | Normal |
| 4 | 0.0440 | R19 | R33 | R10 | 0.35 | 0.073 | Normal |
| 5 | 0.0330 | R13 | R42 | R11 | 0.35 | 0.073 | Normal |
| 6 | 0.0480 | R19 | R33 | R11 | 0.35 | 0.073 | Normal |
| 7 | 0.0600 | R21 | R47 | R11 | 0.35 | 0.073 | Normal |
| 8 | 0.0407 | R13 | R44 | R13 | 0.35 | 0.073 | Normal |
| 9 | 0.0600 | R19 | R42 | R13 | 0.35 | 0.073 | Normal |
| 10 | 0.0680 | R21 | R38, RT | R13 | 0.35 | 0.073 | Normal |
| 11 | 0.0296 | R13 | R49 | R5 | 0.35 | 0.086 | High |
| 12 | 0.0440 | R19 | R30 | R5 | 0.35 | 0.086 | High |
| 13 | 0.0520 | R21 | R33 | R5 | 0.35 | 0.086 | High |
| 14 | 0.0720 | R13 | R47 | R10 | 0.35 | 0.086 | High |
| 15 | 0.0784 | R19 | R38 | R10 | 0.47 | 0.086 | High |
| 16 | 0.0640 | R13 | R33 | R11 | 0.47 | 0.086 | High |
| 17 | 0.0896 | R19 | R49 | R11 | 0.35 | 0.086 | High |
| 18 | 0.0896 | R21 | R34 | R11 | 0.35 | 0.086 | High |
| 19 | 0.0920 | R19 | R34 | R11 | 0.47 | 0.086 | High |
| 20 | 0.0840 | R13 | R49 | R13 | 0.35 | 0.086 | High |
| 21 | 0.0840 | R19 | R30 | R13 | 0.47 | 0.086 | High |
| 22 | 0.0896 | R21 | R31 | R13 | 0.47 | 0.086 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R crawl** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 23 | 0.0520 | R19 | R34 | R19 | 0.47 | 0.070 | Normal |
| 24 | 0.0672 | R13 | R36 | R19 | 0.47 | 0.083 | High |
| 25 | 0.0720 | R13 | R33 | R19 | 0.47 | 0.083 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 26 | 0.0560 | R21 | R36 | R5 | 0.47 | 0.103 | Normal |
| 27 | 0.0728 | R13 | R36 | R5 | 0.47 | 0.121 | High |
| 28 | 0.0760 | R13 | R34 | R5 | 0.47 | 0.121 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R heated-slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 29 | 0.0560 | R21 | R47 | R5 | 0.47 | 0.101 | Normal |
| 30 | 0.0728 | R13 | R42 | R5 | 0.47 | 0.120 | High |
| 31 | 0.0760 | R13 | R38 | R5 | 0.47 | 0.120 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R floor** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 32 | 0.0480 | R19 | R47 | R19 | 0.35 | 0.065 | Normal |
| 33 | 0.0728 | R19 | R36 | R19 | 0.47 | 0.077 | High |
| 34 | 0.0560 | R13 | R34 | R19 | 0.47 | 0.077 | High |

**Table B-2 Prescriptive packages, Non-electric Heat, Insulating Sheathing**

| Package | Glazing Factor | R wall | R ceiling | R basement | U door | U overall | HVAC Equipment Efficiency |
|---|---|---|---|---|---|---|---|
| 35 | 0.0370 | R20, I | R42 | R7 | 0.35 | 0.073 | Normal |
| 36 | 0.0363 | R28, I | R38, RT | R5 | 0.35 | 0.073 | Normal |
| 37 | 0.0552 | R18, I | R44 | R10 | 0.35 | 0.073 | Normal |
| 38 | 0.0560 | R20, I | R47 | R10 | 0.35 | 0.073 | Normal |
| 39 | 0.0560 | R23, I | R34 | R10 | 0.35 | 0.073 | Normal |
| 40 | 0.0560 | R18, I | R47 | R11 | 0.35 | 0.073 | Normal |
| 41 | 0.0616 | R23, I | R42 | R11 | 0.35 | 0.073 | Normal |
| 42 | 0.0546 | R18, I | R44 | R11 | 0.35 | 0.073 | Normal |
| 43 | 0.0672 | R23, I | R40 | R13 | 0.35 | 0.073 | Normal |
| 44 | 0.0720 | R25, I | R36 | R13 | 0.35 | 0.073 | Normal |
| 45 | 0.0504 | R18, I | R40 | R5 | 0.35 | 0.086 | High |
| 46 | 0.0560 | R19, I | R47 | R5 | 0.35 | 0.086 | High |
| 47 | 0.0560 | R23, I | R38 | R5 | 0.47 | 0.086 | High |
| 48 | 0.0600 | R25, I | R38 | R5 | 0.47 | 0.086 | High |
| 49 | 0.0680 | R26, I | R42 | R5 | 0.35 | 0.086 | High |
| 50 | 0.0680 | R28, I | R47 | R5 | 0.47 | 0.086 | High |
| 51 | 0.0672 | R26, I | R47 | R5 | 0.35 | 0.086 | High |
| 52 | 0.0672 | R28, I | R38 | R5 | 0.35 | 0.086 | High |
| 53 | 0.0720 | R20, I | R42 | R7 | 0.47 | 0.086 | High |
| 54 | 0.0855 | R18, I | R36 | R11 | 0.35 | 0.086 | High |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 55 | 0.0896 | R23, I | R33 | R11 | 0.47 | 0.086 | High |
| 56 | 0.0861 | R18, I | R36 | R13 | 0.47 | 0.086 | High |
| 57 | 0.1000 | R23, I | R33 | R13 | 0.47 | 0.086 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R crawl** | **U door** | **U overall** | **HVAC Equipment Efficiency.** |
| 58 | 0.0546 | R18, I | R38 | R19 | 0.47 | 0.070 | Normal |
| 59 | 0.0784 | R15, I | R30 | R19 | 0.47 | 0.083 | High |
| 60 | 0.0880 | R15, I | R38 | R19 | 0.47 | 0.083 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 61 | 0.0640 | R23, I | R36 | R5 | 0.47 | 0.103 | Normal |
| 62 | 0.0896 | R15, I | R36 | R5 | 0.47 | 0.121 | High |
| 63 | 0.0960 | R15, I | R38 | R5 | 0.47 | 0.121 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R heated-slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 64 | 0.0640 | R23, I | R34 | R5 | 0.47 | 0.101 | Normal |
| 65 | 0.0840 | R15, I | R31 | R5 | 0.47 | 0.121 | High |
| 66 | 0.0920 | R15, I | R33 | R5 | 0.47 | 0.121 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R floor** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| 67 | 0.0480 | R20, I | R44 | R19 | 0.35 | 0.065 | Normal |
| 68 | 0.0728 | R20, I | R36 | R19 | 0.47 | 0.077 | High |
| 69 | 0.0560 | R14, I | R38 | R19 | 0.47 | 0.078 | High |

**Table B-3 Prescriptive packages, Electric Heat, Structural Sheathing Only**

| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R basement** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
|---|---|---|---|---|---|---|---|
| E 70 | 0.0396 | R21 | R37, RT | R19 | 0.35 | 0.059 | Normal |
| E 71 | 0.0429 | R21 | R42, RT | R19 | 0.35 | 0.059 | Normal |
| E 72 | 0.0520 | R21 | R49 | R13 | 0.35 | 0.068 | High |
| E 73 | 0.0640 | R19 | R42, RT | R19 | 0.35 | 0.068 | High |
| E 74 | 0.0693 | R21 | R49, RT | R19 | 0.47 | 0.068 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R crawl** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| E 75 | 0.0429 | R21 | R54, RT | R30 | 0.35 | 0.054 | Normal |
| E 76 | 0.0480 | R21 | R45, RT | R19 | 0.35 | 0.062 | High |
| E 77 | 0.0627 | R21 | R54, RT | R30 | 0.47 | 0.062 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| E 78 | 0.0396 | R26 | R51, RT | R10 | 0.35 | 0.083 | Normal |
| E 79 | 0.0480 | R21 | R49 | R7 | 0.35 | 0.095 | High |
| E 80 | 0.0528 | R21 | R49, RT | R5 | 0.35 | 0.095 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R floor** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| E 81 | 0.0363 | R21 | R54, RT | R30 | 0.35 | 0.052 | Normal |
| E 82 | 0.0520 | R21 | R49 | R30 | 0.35 | 0.060 | High |
| E 83 | 0.0528 | R21 | R44, RT | R30 | 0.47 | 0.060 | High |

**Table B-4 Prescriptive packages, Electric Heat, Insulating Sheathing**

| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R basement** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
|---|---|---|---|---|---|---|---|
| E 84 | 0.0480 | R25, I | R48, RT | R16 | 0.35 | 0.059 | Normal |
| E 85 | 0.0495 | R25, I | R48, RT | R16 | 0.35 | 0.059 | Normal |
| E 86 | 0.0462 | R28, I | R40 | R16 | 0.35 | 0.059 | Normal |
| E 87 | 0.0429 | R25, I | R36 | R18 | 0.35 | 0.059 | Normal |
| E 88 | 0.0528 | R23, I | R58, RT | R18 | 0.35 | 0.059 | Normal |
| E 89 | 0.0462 | R25, I | R42 | R18 | 0.35 | 0.059 | Normal |
| E 90 | 0.0560 | R25, I | R46, RT | R10 | 0.35 | 0.068 | High |
| E 91 | 0.0640 | R23, I | R48, RT | R13 | 0.35 | 0.068 | High |
| E 92 | 0.0600 | R25, I | R42 | R13 | 0.35 | 0.068 | High |
| E 93 | 0.0600 | R23, I | R37 | R18 | 0.47 | 0.068 | High |
| E 94 | 0.0759 | R25, I | R46, RT | R18 | 0.47 | 0.068 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R crawl** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| E 95 | 0.0429 | R25, I | R48, RT | R23 | 0.35 | 0.054 | Normal |
| E 96 | 0.0520 | R23, I | R38 | R23 | 0.35 | 0.062 | High |
| E 97 | 0.0561 | R25, I | R44 | R23 | 0.47 | 0.062 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R slab** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| E 98 | 0.0396 | R25, I | R48, RT | R10 | 0.35 | 0.083 | Normal |
| E 99 | 0.0560 | R23, I | R44 | R7 | 0.35 | 0.095 | High |
| E 100 | 0.0594 | R25, I | R46, RT | R5 | 0.47 | 0.095 | High |
| **Package** | **Glazing Factor** | **R wall** | **R ceiling** | **R floor** | **U door** | **U overall** | **HVAC Equipment Efficiency** |
| E 101 | 0.0429 | R25, I | R46, RT | R30 | 0.35 | 0.052 | Normal |
| E 102 | 0.0560 | R23, I | R44 | R30 | 0.35 | 0.060 | High |
| E 103 | 0.0627 | R25, I | R44, RT | R30 | 0.47 | 0.060 | High |

# Default Assembly R and U Value Tables

(All U–values include framing factors, finish materials and air films.)

Table 1. Ceiling U–Values[a]

| Insulation R–Value | Standard Truss U–Value | Raised Truss[b] U–Value | Insulation R–Value | Standard Truss U–Value | Raised Truss[b] U–Value |
|---|---|---|---|---|---|
| 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–2 sheathing is reported as R–21 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 a raised truss, the insulation must achieve its full insulation thickness over the exterior walls.

Table 2. Wood–Frame Wall U–Values[a,b]

| 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 |
| 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) U–values in this Table were developed for wood–frame walls, but the 16–in. O.C. Wall U–Value column can also be used for above–grade concrete, masonry, and log walls. Mass wall R–value to U–value conversion tables are planned for future versions of the MECcheck Manual. TM

(c) Wall R–values are the sum of the cavity insulation plus insulating sheathing (if used).

Table 3. 16–in. O.C. Metal–Frame Wall U–Values and Equivalent Prescriptive Package Wall R–Values (Use the U–values below for the System Design Method of the Energy Worksheet. Use the equivalent R–value below to choose an Energy Worksheet Prescriptive Package with a wall R–value that is less than or equal to it. If you have an equivalent R–value without an "I" listed after it, then you must use a Package wall R–value without an "I" designation.)

| Cavity R–Value | Insulating Sheathing R–Value | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | R–0 | R–1 | R–2 | R–3 | R–4 | R–5 | R–6 | R–7 | R–8 | R–9 | R–10 |
| R–0 | U–0.270 | U–0.258 | U–0.205 | U–0.170 | U–0.146 | U–0.127 | U–0.113 | U–0.101 | U–0.092 | U–0.084 | U–0.078 |
| R–11 | U–0.120 | U–0.118 | U–0.106 | U–0.096 | U–0.087 | U–0.080 | U–0.074 R15 | U–0.069 R15I | U–0.065 R16I | U–0.061 R18I | U–0.057 R20I |
| R–13 | U–0.114 | U–0.111 | U–0.100 | U–0.091 | U–0.084 | U–0.077 R15 | U–0.072 R15 | U–0.067 R15I | U–0.063 R17I | U–0.059 R19I | U–0.056 R22I |
| R–15 | U–0.109 | U–0.107 | U–0.096 | U–0.088 | U–0.081 | U–0.075 R15 | U–0.070 R15 | U–0.065 R16I | U–0.061 R18I | U–0.058 R19I | U–0.054 R22I |
| R–19 | U–0.101 | U–0.099 | U–0.090 | U–0.083 | U–0.077 R15 | U–0.071 R15 | U–0.066 R15I | U–0.062 R17I | U–0.059 R19I | U–0.055 R20I | U–0.052 R22I |
| R–21 | U–0.098 | U–0.096 | U–0.088 | U–0.081 R13 | U–0.075 R15 | U–0.070 R15 | U–0.065 R16I | U–0.061 R18I | U–0.058 R19I | U–0.054 R20I | U–0.052 R22I |
| R–25 | U–0.094 | U–0.093 | U–0.085 | U–0.078 R13 | U–0.073 R15 | U–0.068 R15I | U–0.063 R17I | U–0.060 R19I | U–0.056 R20I | U–0.053 R20I | U–0.051 R23I |

Table 4. 24–in. O.C. Metal–Frame Wall U–Values and Equivalent Prescriptive Package Wall R–Values (Use the U–values below for the System Design Method of the Energy Worksheet. Use the equivalent R–value below to choose an Energy Worksheet Prescriptive Package with a wall R–value that is less than or equal to it. If you have an equivalent R–value without an "I" listed after it, then you must use a Package wall R–value without an "I" designation.)

| Cavity R–Value | Insulating Sheathing R–Value | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | R–0 | R–1 | R–2 | R–3 | R–4 | R–5 | R–6 | R–7 | R–8 | R–9 | R–10 |
| R–0 | U–0.270 | U–0.258 | U–0.205 | U–0.170 | U–0.146 | U–0.127 | U–0.113 | U–0.101 | U–0.092 | U–0.084 | U–0.078 R13 |
| R–11 | U–0.106 | U–0.104 | U–0.095 | U–0.086 | U–0.080 R13 | U–0.074 R15 | U–0.069 R15I | U–0.064 R17I | U–0.060 R18I | U–0.057 R20I | U–0.054 R20I |
| R–13 | U–0.100 | U–0.098 | U–0.090 | U–0.082 R13 | U–0.076 R15 | U–0.071 R15 | U–0.066 R15I | U–0.062 R17I | U–0.058 R19I | U–0.055 R20I | U–0.052 R22I |
| R–15 | U–0.094 | U–0.093 | U–0.085 | U–0.078 R13 | U–0.073 R15 | U–0.068 R15I | U–0.063 R17I | U–0.060 R19I | U–0.056 R20I | U–0.053 R20I | U–0.051 R23I |
| R–19 | U–0.088 | U–0.086 | U–0.080 R13 | U–0.074 R15 | U–0.069 R15I | U–0.064 R17I | U–0.060 R19I | U–0.057 R20I | U–0.054 R20I | U–0.051 R23I | U–0.049 R24I |
| R–21 | U–0.085 | U–0.084 | U–0.077 R15 | U–0.072 R15 | U–0.067 R15I | U–0.063 R17I | U–0.059 R19I | U–0.056 R20I | U–0.053 R20I | U–0.050 R23I | U–0.048 R24I |
| R–25 | U–0.081 R13 | U–0.080 R13 | U–0.074 R15 | U–0.069 R15 | U–0.064 R17I | U–0.060 R19I | U–0.057 R20I | U–0.054 R20I | U–0.051 R23I | U–0.049 R23I | U–0.046 R24I |

Table 5. 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 6. Basement U–Values[a]

| 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 10 ft below ground level or to the floor of the basement, whichever is less.

Table 7. Slab F–Values

| Perimeter Insulation R–Value | Slab F–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 8. Crawl Space Wall U–Values

| Insulation R–Value | Crawl Space Wall U–Value |
|---|---|
| R–0 | 0.477 |
| R–1 | 0.313 |
| R–2 | 0.235 |
| R–3 | 0.189 |
| R–4 | 0.158 |
| R–5 | 0.136 |
| R–6 | 0.120 |
| R–7 | 0.107 |
| R–8 | 0.096 |
| R–9 | 0.088 |
| R–10 | 0.081 |
| R–11 | 0.075 |
| R–12 | 0.069 |
| R–13 | 0.065 |
| R–14 | 0.061 |
| R–15 | 0.057 |
| R–16 | 0.054 |
| R–17 | 0.051 |
| R–18 | 0.049 |
| R–19 | 0.047 |
| R–20 | 0.045 |

Table 9. U–Values for Windows, Glazed Doors, and Skylights[a]

| **Frame/Glazing Features** | **Single Pane** | **Double Pane** |
|---|---|---|
| Metal Without Thermal Break | | |
| Operable | 1.27 | 0.87 |
| Fixed | 1.13 | 0.69 |
| Garden Window | 2.60 | 1.81 |
| Curtain Wall | 1.22 | 0.79 |
| Door | 1.26 | 0.80 |
| Skylight | 1.98 | 1.31 |
| Site–Assembled Skylight | 1.36 | 0.82 |
| Metal With Thermal Break | | |
| Operable | 1.08 | 0.65 |
| Fixed | 1.07 | 0.63 |
| Curtain Wall | 1.11 | 0.68 |
| Door | 1.10 | 0.66 |
| Skylight | 1.89 | 1.11 |
| Site–Assembled Skylight | 1.25 | 0.70 |
| Reinforced Vinyl or Metal–Clad Wood | | |
| Operable | 0.90 | 0.57 |
| Fixed | 0.98 | 0.56 |
| Door | 0.99 | 0.57 |
| Skylight | 1.75 | 1.05 |
| Wood/Vinyl/Fiberglass | | |
| Operable | 0.89 | 0.55 |
| Fixed | 0.98 | 0.56 |
| Garden Window | 2.31 | 1.61 |
| Door | 0.98 | 0.56 |
| Skylight | 1.47 | 0.84 |
| Glass Block Assemblies | 0.60 | |

(a) The U–values in these tables can be used in the absence of test U–values. The product cannot receive credit for a feature that cannot be clearly detected. Where a composite of materials from two different product types is used, the product must be assigned the higher U–value.

Table 10. U–Value Table for Non–Glazed Doors[a]

| **Steel Doors** | | |
|---|---|---|
| Without Foam Core | 0.60 | |
| With Foam Core | 0.35 | |
| **Wood Doors** | **Without Storm** | **With Storm** |
| Panel With 7/16–in. Panels | 0.54 | 0.36 |
| Hollow Core Flush | 0.46 | 0.32 |
| Panel With 1–1/8–in. Panels | 0.39 | 0.28 |
| Solid Core Flush | 0.40 | 0.26 |

(a) The U–values in these tables can be used in the absence of test U–values. The product cannot receive credit for a feature that cannot be clearly detected. Where a composite of materials from two different product types is used, the product must be assigned the higher U–value.

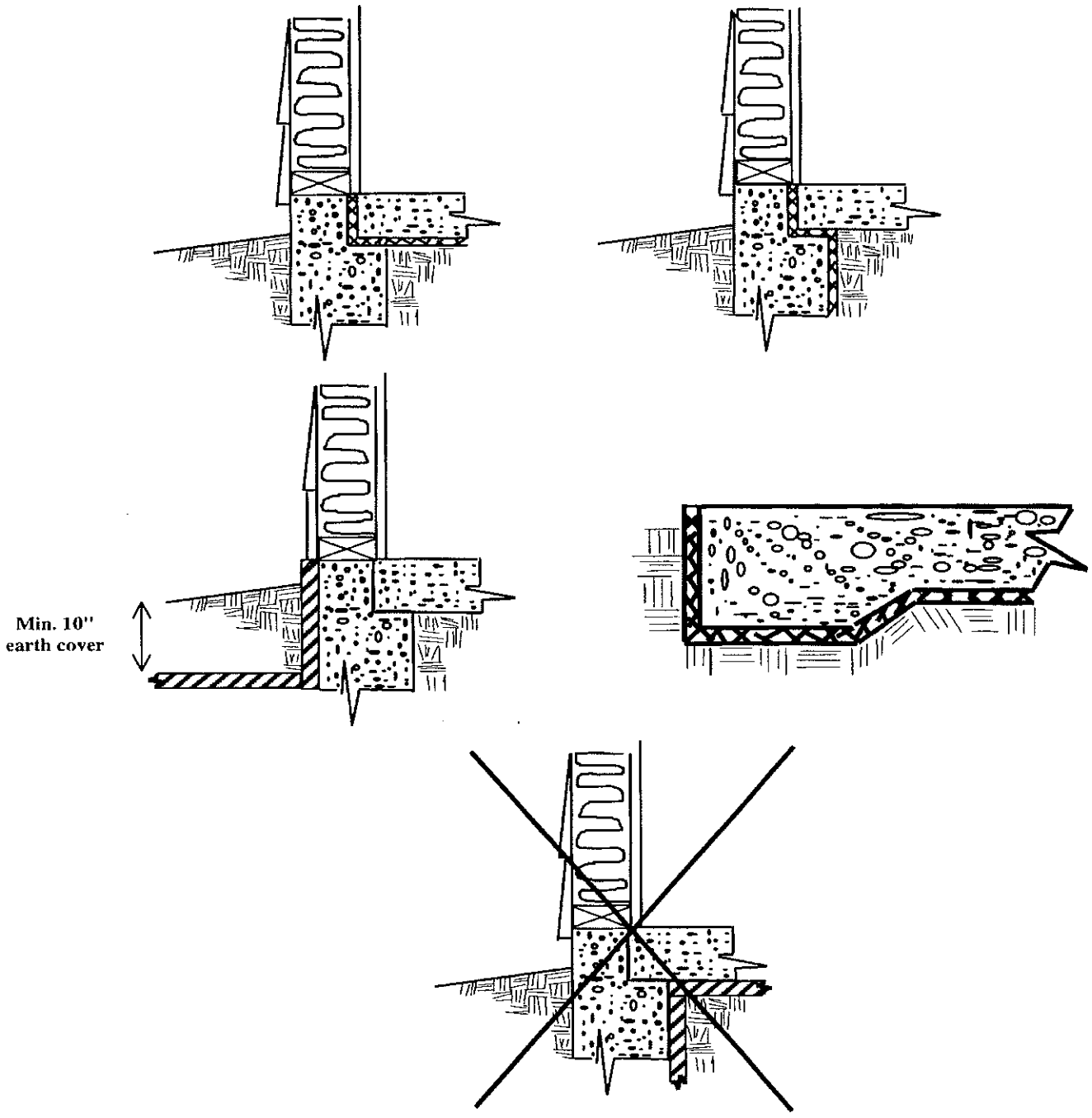
## Typical Thermal Properties of Building Materials—Design Values[a]

| Description | Density, lb/ft$^3$ | Resistance (R) Per Inch Thickness °F . ft$^2$ . h | Resistance (R) For Thickness Listed |
|---|---|---|---|
| **SHEATHING** | | | |
| Gypsum or plaster board ..... 1/2". | 50 | — | 0.45 |
| Gypsum or plaster board ..... 5/8". | 50 | — | 0.56 |
| Plywood (Douglas Fir) ..... 1/2". | 34 | — | 0.62 |
| Plywood (Douglas Fir) ..... 5/8". | 34 | — | 0.77 |
| Plywood or wood panels ..... 3/4". | 34 | — | 0.93 |
| Vegetable fiber board | | | |
| Sheathing, regular density ..... 1/2". | 18 | — | 1.32 |
| Hardboard | | | |
| Medium density ..... | 50 | 1.37 | — |
| Particleboard | | | |
| Medium density ..... | 50 | 1.06 | — |
| **FINISH FLOORING MATERIALS** | | | |
| Carpet and rubber pad | — | — | 1.23 |
| **INSULATING MATERIALS** | | | |
| *Blanket and Batt* | | | |
| Mineral fiber, fibrous form processed from rock, slag, or glass | | | |
| approx. 3–4 in. ..... | 0.4–2.0 | — | 11 |
| approx. 3.5 in ..... | 0.4–2.0 | — | 13 |
| approx. 3.5 in ..... | 1.2–1.6 | — | 15 |
| approx. 5.5–6.5 in. ..... | 0.4–2.0 | — | 19 |
| approx. 5.5 in. ..... | 0.6–1.0 | — | 21 |
| approx. 6–7.5 in. ..... | 0.4–2.0 | — | 22 |
| approx. 8.25–10 in. ..... | 0.4–2.0 | — | 30 |
| approx. 10–13 in. ..... | 0.4–2.0 | — | 38 |
| *Board and Slabs* | | | |
| Glass fiber, organic bonded | 4.0–9.0 | 4.00 | — |
| Expanded polystyrene, extruded (smooth skin surface) | 1.8–3.5 | 5.00 | — |
| Expanded polystyrene, molded beads | 1.0 | 3.85 | — |
| | 1.25 | 4.00 | — |
| | 1.5 | 4.17 | — |
| | 1.75 | 4.17 | — |
| | 2.0 | 4.35 | — |
| Cellular polyurethane/polyisocyanurate | 1.5 | 6.25–5.56 | — |
| Cellular polyisocyanurate (CFC–11 exp.) (gas–impermeable facers) | 2.0 | 7.04 | — |
| Mineral fiberboard, wet felted | | | |
| Acoustical tile ..... | 18.0 | 2.86 | — |
| *Loose Fill* | | | |
| Cellulosic insulation (milled paper or wood pulp) | 2.3–3.2 | 3.70–3.13 | — |
| Perlite, expanded | 2.0–4.1 | 3.7–3.3 | — |
| | 4.1–7.4 | 3.3–2.8 | — |
| | 7.4–11.0 | 2.8–2.4 | — |
| Mineral fiber (rock, slag, or glass) | | | |
| approx. 3.75–5 in. ..... | 0.6–2.0 | — | 11.0 |
| approx. 6.5–8.75 in. ..... | 0.6–2.0 | — | 19.0 |
| approx. 7.5–10 in. ..... | 0.6–2.0 | — | 22.0 |
| approx. 10.25–13.75 in. ..... | 0.6–2.0 | — | 30.0 |
| Mineral fiber (rock, slag, or glass) | | | |
| approx. 3.5 in. (closed sidewall application) ..... | 2.0–3.5 | — | 12.0–14.0 |
| Vermiculite, exfoliated | 7.0–8.2 | 2.13 | — |
| | 4.0–6.0 | 2.27 | — |
| *Spray Applied* | | | |
| Polyurethane foam | 1.5–2.5 | 6.25–5.56 | — |
| Ureaformaldehyde foam | 0.7–1.6 | 4.55–3.57 | — |
| Cellulosic fiber | 3.5–6.0 | 3.45–2.94 | — |
| Glass fiber | 3.5–4.5 | 3.85–3.70 | — |

| | | | |
|---|---|---|---|
| **ROOFING** | | | |
| Asphalt shingles | 70 | — | 0.44 |
| **PLASTERING MATERIALS** | | | |
| Cement plaster, sand aggregate | 116 | 0.20 | — |
| 0.75 in. | — | — | 0.15 |
| **MASONRY MATERIALS** | | | |
| *Masonry Units* | | | |
| Brick, fired clay | 150 | 0.12–0.10 | — |
| Concrete blocks | | | |
| Normal weight aggregate (sand and gravel) | | | |
| 8 in., 33–36 lb, 126–136 lb/ft$^3$ concrete, 2 or 3 cores | — | — | 1.11–0.97 |
| Same with perlite filled cores | — | — | 2.0 |
| Same with vermiculite filled cores | — | — | 1.92–1.37 |
| 12 in., 50 lb, 125 lb/ft$^3$ concrete, 2 cores | — | — | 1.23 |
| *Concretes* | | | |
| Sand and gravel or stone aggregate concretes | 150 | 0.10 | — |
| **SIDING MATERIALS (on flat surface)** | | | |
| *Siding* | | | |
| Asphalt roll siding | — | — | 0.15 |
| Hardboard siding, 7/16" | — | — | 0.67 |
| Wood, drop, 1 by 8 in. | — | — | 0.79 |
| Aluminum, steel, or vinyl, over sheathing | | | |
| Hollow–backed | — | — | 0.61 |
| Insulating–board backed nominal 3/8" | — | — | 1.82 |
| Insulating–board backed nominal 3/8", foil backed | — | — | 2.96 |
| **WOOD** | | | |
| Maples, oak and similar materials | 45 | 0.91 | |
| Fir, pine and similar materials | 32 | 1.25 | |
| 3/4" | 32 | 0.94 | |
| 1–1/2" | 32 | 1.9 | |
| 3–1/2" | 32 | 4.4 | |
| 5–1/2" | 32 | 6.9 | |
| 7–1/4" | 32 | 9.1 | |
| 9–1/4" | 32 | 11.6 | |
| 11–1/4" | 32 | 14.1 | |

[a]Values are for a mean temperature of 75°F. Representative values for dry materials are intended as design (not specification) values for materials in normal use. Thermal values of insulating materials may differ from design values depending on their in–situ properties (e.g., density and moisture content, orientation, etc.) and variability experienced during manufacture. For properties of a particular product, use the value supplied by the manufacturer or by unbiased tests in accordance with s. Comm 22.31.

## s. Comm 22.26
## Slab-On-Grade Insulation Details




Insulation shall extend vertically and horizontally for a total of 48". In all cases the insulation shall insulate to the top edge of the floor perimeter. The last diagram is not an acceptable method.

# INDEX

**See also first page of each chapter for listing of section headings.**

**Comm Section #(s)**