# *REVIEW MATERIALS*

## *Course 16188*

# *Construction Standards & Energy Conservation*

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**This Course has been approved by the Wisconsin Department of Safety and Professional Services for the following Certifications, Registrations or License.**

**Course Expires: October 13, 2029**

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**Course: 16188 CONSTRUCTION STANDARDS & ENERGY CONSERVATION**

**This course is valid for these credentials:**

| Credential Description | Cred Code | Credit Hours |
|---|---|---|
| Dwelling Contractor Qualifier | DCQ | 12.0 |
| UDC-Construction Inspector | UCI | 12.0 |

# Construction Standards & Energy Conservation
# Wisconsin Department of Safety and Professional Services
# Course Identification Number: 16188
# Expiration Date: October 13, 2029
# Education Credit: 12 Hours

## Course Provider

**USCONTRACTORLICENSE LLC dba Kevin Wunderlin**
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## Course Type: Dwelling Contractor Qualifier Certification
## UDC Construction Inspector Certification

## Construction Standards

This course (12 hours of continuing education) is designed to familiarize Contractors and Inspectors with information on the updated construction codes required for building a home, according to the Uniform Dwelling Code (UDC).

Topics covered under SPS 321 (Construction Standards) include Design Criteria, Excavations, Footings, Foundations, Floors, Walls, Roof and Ceilings, Fireplace Requirements, Construction in Floodplains and Installation of Manufactured Homes.

This course is a distance learning or e-learning course, which allows the attendee to complete the course on their time schedule.

**EXAM**

**360 questions** related to the Reference Materials are used to test the attendee on their comprehension of the materials. A 70% score will need to be attained in order to pass this course.

**The course attendee will receive the materials by one of the following delivery methods:**

**Online:** The attendee will receive an email with the instructions and a link to the online course. The Reference/Instructional Materials and Exam will be available after registration is complete. The exam can be completed from the computer screen by use of "radio buttons". Answers are automatically saved. Reentry is done by the use of a personalized "resume code". Once the exam has been completed it is submitted. Grading will be done automatically by the computer program. The score and correct and incorrect answers are shown immediately.

**Email:** All materials are sent via email in PDF form to the attendees email address. The PDF documents can be saved to a file on the computer or they can be printed out. A bubble answer sheet needs to be printed; filled in and returned to us for grading.

**Printed:** The Instructional/Reference Materials and Exam is sent in booklet form to the attendees' home or office. The bubble answer sheet is completed and returned to us for grading.

**Outline of Course**
SPS 321.01 Scope.

**Subchapter II — Design Criteria**
SPS 321.02 Loads and materials.
SPS 321.03 Exits.
SPS 321.035 Interior circulation.
SPS 321.04 Stairways and elevated areas.
SPS 321.042 Ladders.
SPS 321.045 Ramps.
SPS 321.05 Natural light and natural ventilation.
SPS 321.06 Ceiling height.
SPS 321.07 Attic and crawl space access.
SPS 321.08 Fire separation and dwelling unit separation.
SPS 321.085 Fireblocking.
SPS 321.09 Smoke detectors.
SPS 321.095 Automatic fire sprinklers.
SPS 321.10 Protection against decay and termites.
SPS 321.11 Foam plastic.
SPS 321.115 Installation of elevators or dumbwaiters.

**Subchapter III — Excavations**
SPS 321.12 Grade.
SPS 321.125 Erosion control and sediment control.
SPS 321.126 Storm water management.
SPS 321.13 Excavations adjacent to adjoining property.
SPS 321.14 Excavations for footings and foundations.

**Subchapter IV — Footings**
SPS 321.15 Footings.
SPS 321.16 Frost protection.
SPS 321.17 Drain tiles.

**Subchapter V — Foundations**
SPS 321.18 Foundations.

**Subchapter VI — Floors**
SPS 321.19 Floor design.
SPS 321.20 Concrete floors.
SPS 321.203 Garage floors.
SPS 321.205 Wood floors in contact with the ground.
SPS 321.21 Precast concrete floors.
SPS 321.22 Wood frame floors.
SPS 321.225 Decks.

**Subchapter VII — Walls**
SPS 321.23 Wall design.
SPS 321.24 Exterior covering.
SPS 321.25 Wood frame walls.
SPS 321.26 Masonry walls.

**Subchapter VIII — Roof and Ceilings**
SPS 321.27 Roof design.
SPS 321.28 Weather protection for roofs.

**Subchapter IX — Fireplace Requirements**
SPS 321.29 Masonry fireplaces.
SPS 321.30 Masonry chimneys.
SPS 321.32 Factory−built fireplaces.

**Subchapter X — Construction in Floodplains**
SPS 321.33 Construction in floodplains.
SPS 321.34 Construction in coastal floodplains.

**Subchapter XI — Installation of Manufactured Homes**
SPS 321.40 Installation standards

## Energy Conservation

Topics covered under SPS 322 (Energy Conservation) include Scope, Application, Definitions, Insulation Materials and Installation, Dwelling Thermal Envelope, Systems and Simulated Performance Alternative.

**Subchapter I — Scope and Application**
SPS 322.01 Scope.
SPS 322.02 Application.

**Subchapter II — Definitions**
SPS 322.10 Definitions.

**Subchapter III — Insulation Materials and Installation**
SPS 322.20 Basic requirements.
SPS 322.21 Protection of insulation.

**Subchapter IV — Dwelling Thermal Envelope**
SPS 322.30 General design requirements.
SPS 322.31 Prescriptive insulation and fenestration criteria.
SPS 322.32 Specific insulation requirements.
SPS 322.33 Slab floors.
SPS 322.34 Crawl spaces.
SPS 322.35 Thermally isolated sunrooms.
SPS 322.36 Fenestration.
SPS 322.37 Air leakage.
SPS 322.38 Vapor retarders.
SPS 322.39 Ventilation and moisture control.

**Subchapter V — Systems**
SPS 322.40 Indoor temperatures and equipment sizing.
SPS 322.41 Temperature control.
SPS 322.42 Duct systems.
SPS 322.43 Duct and plenum sealing.
SPS 322.44 Pipe insulation.
SPS 322.45 Air conditioner and heat pump efficiencies.
SPS 322.46 Replacement furnace and boiler efficiencies.

**Subchapter VI — Simulated Performance Alternative**
SPS 322.50 General.
SPS 322.51 Performance−based compliance.
SPS 322.52 Documentation.
SPS 322.53 Calculation procedure.

# Chapter SPS 321

# CONSTRUCTION STANDARDS



**Note:** Chapter Ind 21 was renumbered to be chapter ILHR 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. Chapter Comm 21 was reprinted to correct the Table of Contents, Register October 2009 No. 646. Chapter Comm 21 was renumbered chapter SPS 321 under s. 13.92 (4) (b) 1., Stats., Register December 2011 No. 672.

## Subchapter I — Scope

**SPS 321.01 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

**SPS 321.02 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. The construction of buildings and structures shall result in a system that provides a complete load path capable of transferring all loads from point of origin through the load–resisting elements to the foundation.

(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 321.02. The design load shall be applied uniformly over the component area.

**Table 321.02–1**

| 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.* Dwellings shall be designed and constructed to withstand either a horizontal and uplift pressure of 20 pounds per square foot acting over the surface area or the wind loads determined in accordance with ASCE 7–05, *Minimum Design Loads for Buildings and Other Structures*.

**Note:** ASCE 7–05 allows for substantial reduction from 20 psf as applied to the surface area.

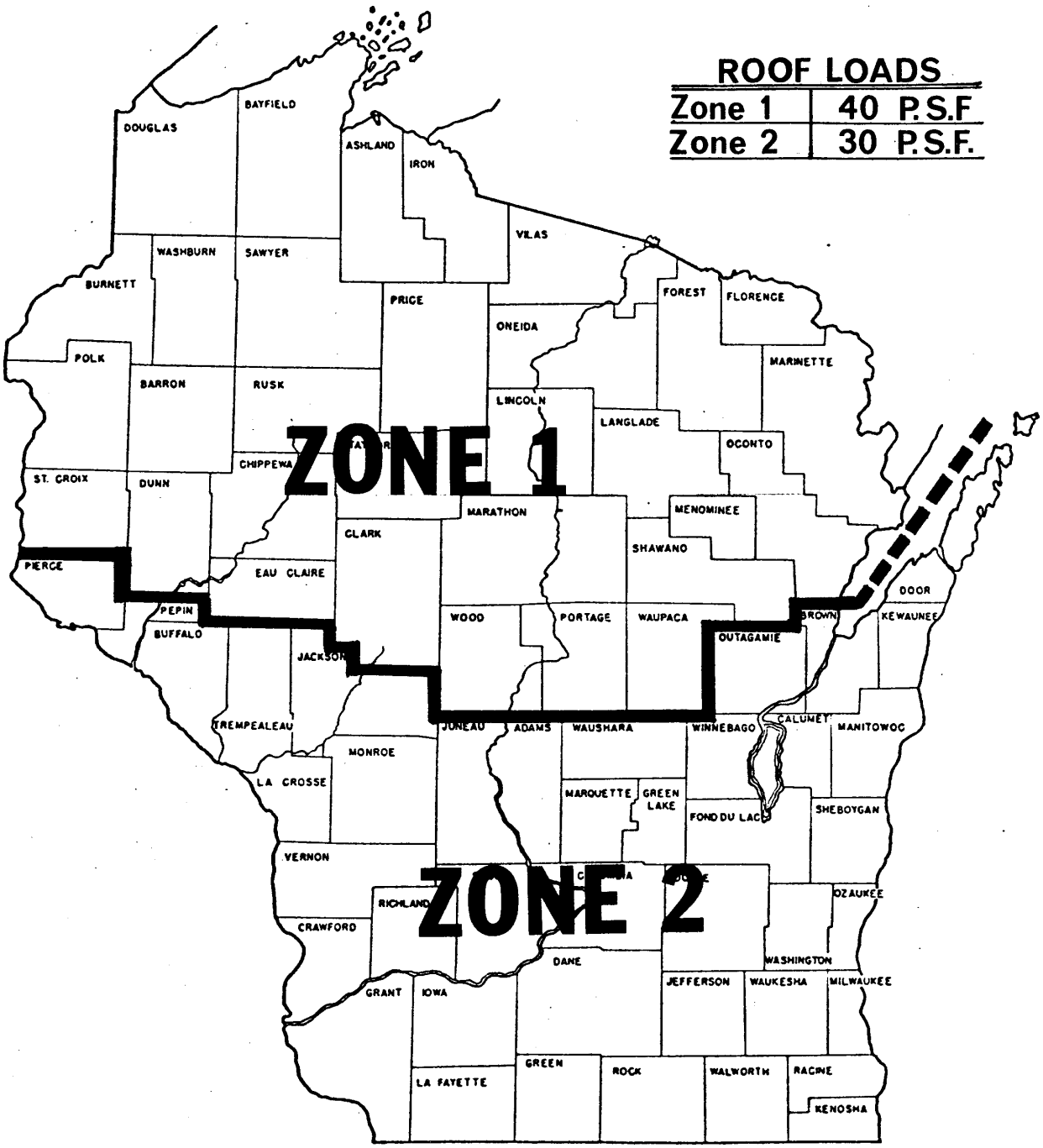
**(2)** METHODS OF DESIGN. All dwellings shall be designed by the method of structural analysis or the method of accepted practice specified in each part of this code.

**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 STANDARDS. (a) *General.* Design, construction, installation, practice and structural analysis shall conform to the following nationally recognized standards.

(b) *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 321.02**
**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 ch. SPS 325 Appendix A or approved by the department may be used in lieu of designing by structural analysis.

3. Sawn lumber that is not graded in accordance with the standards under subd. 1., shall use the NDS published allowable design stresses for the lumber species using grade number 3 when used for studs, stringers, rafters or joists and may use grade number 1 when used for beams, posts or timbers.

(c) *Structural steel.* The design, fabrication, and erection of structural steel for buildings shall conform to Specification for Structural Steel Buildings and the provisions of the accompanying commentary as adopted under Table 320.24–3.

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

1. ACI Standard 318, Building Code Requirements for Structural Concrete.

2. ACI Standard 332, Residential Code Requirements for Structural Concrete.

**Note:** Concrete construction in one– and two–family dwellings should meet the standards established in ACI 332. Construction means, materials, or methods not addressed in ACI 332 should meet the standards established in ACI 318.

(e) *Masonry.* The design and construction of masonry shall conform to the following standards:

1. ACI 530, Building Code Requirements for Masonry Structures.

2. ACI 530.1, Specification for Masonry Structures.

(f) *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.

(g) *Whole logs.* Dwellings constructed of whole logs shall conform to ICC 400, Standard on the Design and Construction of Log Structures.

**Note:** This standard requires the minimum log diameter to be 8 inches.

(h) *Fasteners.* 1. All building components shall be fastened to withstand the dead load, live load, snow load, and wind load.

2. Fasteners shall comply with the schedule listed in Table 321.02–2.

**Note:** Other fastening methods may be allowed if engineered under s. SPS 321.02 (3).

**Table 321.02–2**
**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 | 3–8d |
| Joist to sill or girder, toe nail | 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 | 2–16d at 16″ o.c. |
| Top or sole plate to stud, end nail | 2–16d |
| Stud to sole plate, toe nail | 3–8d or 2–16d |
| Doubled studs, face nail | 10d at 24″ o.c. |
| Doubled top plates, face nail | 10d at 24″ o.c. |
| Doubled top plates, minimum 24–inch offset of end joints, face nail in lapped area | 8–16d |
| Top plates, laps and intersections, face nail | 2–10d |
| 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, 1¾″ |
| Built–up corner studs | 10d at 24″ o.c. |

| Description of Building Materials/Connection | Number and Type of Fastener[1 2 3] |
|---|---|
| **Roof/Ceiling Framing** | |
| Ceiling joists to plate, toe nail | 3–8d |
| Ceiling joist, laps over partitions, face nail | 3–10d |
| Ceiling joist to parallel rafters, face nail | 3–16d |
| Rafter to plate, toe nail (maximum 6 rafter span, engineered connector for longer) | 2–16d |
| 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, 1¾″ |
| Wider than 1″ x 6″ subfloor toe to each joist, face nail | 3–8d or 4 staples 1¾″ |
| 2″ subfloor to joist or girder, blind and face nail | 2–16d |
| 1″ x 6″ roof or wall sheathing to each bearing, face nail | 2–8d or 2 staples, 1¾″ |
| 1″ x 8″ roof or wall sheathing to each bearing, face nail | 2–8d or 3 staples, 1¾″ |
| Wider than 1″ x 8″ roof sheathing to each bearing, face nail | 3–8d or 4 staples, 1¾″ |
| 2″planks | 2–16d at each bearing |

**Panel Sheathing**

| Material | Fastener | Spacing of Fastener | |
|---|---|---|---|
| | | Edges | Intermediate Supports |
| **Engineered wood panel for subfloor and roof sheathing and wall corner wind bracing to framing** | | | |
| 5/16″ to ½″ | 6d common or deformed nail or staple, 1½″ | 6″ | 12″ [4] |
| 5/8″ to ¾″ | 8d smooth or common, 6d deformed nail, or staple, 14 ga. 1¾″ | 6″ | 12″ [4] |
| 7/8″ to 1″ | 8d common or deformed nail | 6″ | 12″ |
| 1 1/8″ to 1¼″ | 10d smooth or common, or 8d deformed nail | 6″ | 12″ |
| **Combination subfloor/ underlayment to framing** | | | |
| ¾″ or less | 6d deformed or 8d smooth or common nail | 6″ | 12″ |
| 7/8″ to 1″ | 8d smooth, common or deformed nail | 6″ | 12″ |
| 1 1/8″ to 1 ¼″ | 10d smooth or common or 8d deformed nail | 6″ | 12″ |
| **Wood panel siding to framing** | | | |
| ½″ or less | 6d corrosion–resistant siding and casing nails | 6″ | 12″ |
| 5/8″ | 8d corrosion–resistant siding and casing nails | 6″ | 12″ |
| ½″ structural cellulosic fiberboard sheathing | 1½″ galvanized roofing nail; 8d common nail; staple 16 ga., 1½″ long | 3″ | 6″ |
| 25/32″ structural cellulosic fiberboard sheathing | 1¾″ galvanized roofing nail; 8d common nail; staple 16 ga., 1¾″ long | 3″ | 6″ |
| ½″ gypsum sheathing[5] | 1½″ galvanized roofing nail; 6d common nail; staple galvanized 1½″ long; 1¼″ screws, Type W or S | 4″ | 8″ |
| 5/8″ gypsum sheathing[5] | 1¾″ galvanized roofing nail; 8d common nail; staple galvanized 1 5/8″ long; 1 5/8″ screws, Type W or S | 7″ | 7″ |

[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″ o.d. crown width.
[4] Staples shall be spaced at not more than 10″ o.c. at intermediate supports for floors.

[5] Apply vertically 4′ x 8′ or 4′ x 9′ panels.

**(4)** ALTERNATE MATERIALS AND STANDARDS. No part of this code is intended to prohibit or discourage use of alternate, equivalent materials or standards; or the construction of innovative dwellings such as a dwelling built below ground, a geodesic dome, a concrete house, a fiberglass house, or any other nonconventional structure.

**Note:** Examples of materials addressed by this subsection include structural insulated panels that are used in accordance with the manufacturer's instructions or structural analysis, and cold–formed steel framing complying with AISI S230 *Standard for Cold–Formed Steel Framing — Prescriptive Method for One and Two Family Dwellings*.

**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; CR 02–077: am. (1) (intro.) and (d) Register May 2003 No. 569, eff. 8–1–03; corrections in (3) (b) and (d) made under s. 13.93 (2m) (b) 7., Stats., Register May 2003 No. 569; CR 08–043: r. (1) (c) 2. and 3., renum. (1) (c) 1., (3) (a) to (e) and (intro.) to be (1) (c), (3) (b) to (f) and (3) (a) and am. (3) (a) and (e), am. (3) (title), cr. (3) (b) 3., (e) 1., 2. and (g), am. (3) (e) Register March 2009 No. 639, eff. 4–1–09; correction in (1) (b) 1., (3) (c) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; EmR1403: emerg. am. (1) (c), eff. 4–1–14; CR 14–015: am. (1) (c) Register August 2014 No. 704, eff. 9–1–14; CR 15–041: renum. Table 321.02 to Table 321.02–1 and (1) (d) to (3) (h) 1. and am., am. (3) (c), (d) 1., 2., consol. (3) (g) (intro.) and 2. and renum. to (3) (g) and am., r. (3) (g) 1., cr. (3) (h) 2., Table 321.02–2 renum. from SPS 320 to 325 Appendix and am., (4) renum from SPS 320.02 (5) and am. Register December 2015 No. 720, eff. 1–1–16; correction in (3) (b) 2. under s. 13.92 (4) (b) 7., Stats., Register December 2015 No. 720.

**SPS 321.03 Exits.** Exits, doors and hallways shall be constructed as specified in this section.

**(1)** EXITS FROM THE FIRST FLOOR. (a) Except as allowed under par. (h), every dwelling unit shall be provided with at least 2 exit doors accessible from the first floor.

(b) At least one of the exits shall discharge to grade and may not go through a garage. This exit may include interior or exterior stairs.

**Note:** Under this paragraph, only one of the two exit doors that are addressed in par. (a) is required to exit directly to grade.

(c) Any exit that does not comply with par. (b) may discharge to an outside balcony that complies with sub. (8).

(d) Any exit that does not comply with par. (b) 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) Except as allowed under pars. (f) and (h), the 2 required exit doors shall be separated by at least the greater of the following distances:

1. One–third the length of the longest diagonal of the floor in plan view, exclusive of an attached garage.

2. 20 feet.

**Note:** See ch. SPS 325 Appendix A for examples of exit separation design.

(f) 1. First floor levels that do not meet the separation requirements under par. (e), shall have at least one egress window complying with sub. (6) on that floor level.

2. An egress window to comply with subd. 1. shall be separated from at least one door on the first floor by one of the distances under par. (e).

3. If first floor levels that do not meet the separation requirements under par. (e) contain one or more sleeping rooms, each sleeping room shall have at least one egress window complying with sub. (6).

(g) 1. The exit separation distance required under par. (e) shall be calculated or measured as a straight line from the midpoint of one doorway to the midpoint of the other doorway.

2. For exiting through an attached garage, the separation distance shall be measured using the door connecting the garage and the dwelling. Distance within the garage shall be ignored.

(h) 1. Dwellings consisting of no more than a first floor with a maximum floor area of 400 square feet and a loft area not exceeding half of the first floor area, shall be provided with at least one exit door leading directly to the exterior and at least one egress window that complies with sub. (6).

2. a. Dwellings that meet the size restrictions under subd. 1., are not required to meet the exit separation requirements under par. (e) or (f).

b. If a dwelling that meets the size restrictions under subd. 1., has more than one room on the first floor, the door and the egress window shall be located in different rooms.

3. One of the exit doors required in par. (a) may be omitted for a dwelling unit that has one or more egress windows on the first floor. If there are bedrooms, each must have a window that complies with sub. (6).

**(2)** EXITS FROM THE SECOND FLOOR. (a) At least 2 exits shall be provided from the second floor. At least 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 that discharges to grade, or to a balcony which complies with sub. (8), or to a deck that complies with s. SPS 321.225 and that is no more than 15 feet above the grade below.

(b) Windows that comply with sub. (6) may be provided in each second floor bedroom — or in another location on the second floor if there are no bedrooms on that floor — in lieu of the second exit from that floor.

(c) Where the second floor of a building is the lowest floor level in a dwelling unit, as in an up–and–down duplex, no exit from the unit may go through another dwelling unit or other party's occupancy on the first floor.

**(3)** EXITS ABOVE THE SECOND FLOOR. (a) Except as provided under pars. (b) and (c), each habitable floor above the second floor shall be provided with at least 2 exits that meet all of the following requirements:

1. The exits shall be stairways or ramps that lead to the second floor or discharge to grade.

2. The exits shall be located such that an exit is accessible to the second floor if another exit is blocked.

(b) A second stairway or ramp exit is not required for habitable areas on a third floor that meet all of the following requirements:

1. The habitable area consists of a single room.

**Note:** Non–habitable areas, such as closets and bathrooms may be partitioned off.

2. The room is not used for sleeping.

3. The habitable area has a floor area of 400 square feet or less.

4. There is at least one egress window meeting the requirements of sub. (6) in the habitable area.

(c) A second stairway or ramp exit is not required for habitable areas on a third floor that meet all of the following requirements:

1. The dwelling is fully sprinklered in accordance with NFPA 13R or NFPA 13D.

2. If a required exit includes an attached garage, the garage shall be sprinklered.

**(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.* Except as provided in par. (b), 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 ½–inch or greater or rounding down fractions of inches if they are less than ½–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 stair used for the sole purpose of reaching the top of the platform or fixture is exempt from the requirements of s. SPS 321.04.

(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 at least equal to the width of the window.

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 stair to aid egress. Stairs used to comply with this section are exempt from the requirements of s. SPS 321.04.

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

b. Ladder rungs shall have a minimum inside width of at least 12 inches and shall project at least 3 inches from the wall behind the ladder.

c. Ladder rungs shall be able to support a concentrated load of 200 pounds.

d. Ladder rungs shall have a maximum rise of 12 inches between rungs and shall extend to within 12 inches of exterior grade.

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

(f) An egress window under a deck or porch shall discharge through a clear path of at least 36 inches in height and 36 inches in width, and no more than 15 feet in length, to a yard or open space.

**Note:** Under this paragraph, there is no maximum height above grade for an egress window. Similarly, egress windows are not prohibited from discharging to a roof, regardless of the slope of the roof.

**(7)** DOORS USED FOR EXITING. (a) Doors used for exiting from a dwelling shall meet the following dimensions:

1. At least one exit door shall be a swing–type door at least 80 inches high by 36 inches wide.

2. Except as allowed under subds. 3. and 4., other required exit doors shall be at least 76 inches high by 32 inches wide.

3. Where double doors are used as a required exit, each door leaf shall provide a clear opening at least 30 inches wide and be at least 76 inches high.

4. Where sliding doors are used as a required exit, the clear opening shall be at least 29 inches wide and be at least 76 inches high.

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

**(8)** BALCONIES. (a) Balconies shall be made of concrete, metal or wood which is treated, protected or naturally decay–resistive in accordance with s. SPS 321.10.

(b) Balconies shall be provided with guards in accordance with s. SPS 321.04 (3).

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

1. The balcony guard 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 guard and its supports may infringe on the dimensions of the required area no more than 4.5 inches.

**(9)** 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.

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

**(11)** EXITS TO COURTYARDS. No exit may discharge to a courtyard having a perimeter that is entirely enclosed by exterior building walls or other obstructions that prevent pedestrian passage.

**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; reprinted to correct printing error in (6) (e) 2., Register September 2001 No. 549; CR 02–077: am. (1) (a), (5) (a) (intro.) and (10) (b), r. and recr. (1) (e), cr. (1) (f) to (h), Register May 2003 No. 569, eff. 8–1–03; CR 03–097: am. (1) (h) 1., Register November 2004 No. 587, eff. 1–1–05; CR 08–043: am. (title) and (1) (b), r. and recr. (3) and (7), renum. (6) (e) 5. and (10) to (12) to be (6) (e) 5. a. and (8) to (10), cr. (6) (e) 5. b. to d., r. (8) and (9) Register March 2009 No. 639, eff. 4–1–09; correction in (2) (a) made under s. 13.92 (4) (b) 7., Stats., Register March 2009 No. 639; CR 09–104: am. (1) (c) Register December 2010 No. 660, eff. 1–1–11; correction in (6) (d) 5., (e) 4., (8) (a), (b) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; CR 15–041: am. (1) (c), (d), cr. (1) (h) 3., am. (2) (a) to (c), (6) (d) 5., (e) 4., 5. a., cr. (6) (f), am. (7) (a) 4., (8) (b), (c) 1., 3., cr. (11) Register December 2015 No. 720, eff. 1–1–16.

**SPS 321.035 Interior circulation. (1)** DOORS AND OPENINGS. All doors and openings to the following areas shall be at least 80 inches high and provide either a net clear opening width of 30 inches or be a 32–inch door:

(a) Except as provided under pars. (b) and (c), all entrances into common use areas.

(b) At least 50% of the bedrooms.

(c) 1. At least one full bathroom, including doors or openings to a sink, toilet and tub or shower. If this bathroom is accessible only through a bedroom, the bedroom door shall meet the minimum width requirements of this section.

2. If one or more full bathrooms are provided on the first floor, the bathroom meeting the requirements under this section shall be on the first floor.

**Note:** This section does not require a full bathroom on the first floor.

**(2)** HALLWAYS. (a) Except as allowed under par. (b), the clear width of hallways shall be at least 36 inches.

(b) The following are allowed to infringe on the required clear width of a hallway:

1. Door hardware and finish trim.

2. Handrails may infringe into the minimum width of a hallway up to 4½ inches on each side.

3. Heating registers may infringe into the minimum width of a hallway up to 4½ inches and no part of the register may be more than 38 inches above the floor.

4. Ducts, pipes, light fixtures, structural features, and corner treatments that are within 84 inches of the floor may infringe into the minimum width of a hallway by a maximum of 4½ inches on each side.

5. Unlimited infringements are allowed in a hallway more than 84 inches above the floor.

**(3)** KITCHENS. (a) There shall be at least 30 inches of clearance between a wall, a permanently−installed kitchen island, permanently−installed kitchen cabinets and the following kitchen appliances, if provided:

1. A range, cook top or oven.

2. A sink, refrigerator or freezer.

(b) Measurements shall be taken from the face of the wall, island, cabinet or appliance, ignoring knobs and handles.

**Note:** See ICC/ANSI A117.1 chapter 10 for more guidelines relating to doors and accessible routes. Under that standard, doors must be at least 80−inches in height and provide a minimum net clear opening of 31¾−inches in width in order to provide accessibility for people with disabilities.

**History:** CR 08−043: cr. Register March 2009 No. 639, eff. 4−1−09.

## SPS 321.04 Stairways and elevated areas.

**(1)** SCOPE. (a) *General.* Except as provided under par. (b), the following stairways shall conform to the requirements of this section.

1. Every interior and exterior stairway attached to, or supported by any part of the structure covered under this code.

2. Tub access stairs, unless they are an integral part of an approved plumbing product.

(b) *Exceptions.* The following stairways are not required to comply with the requirements of this section:

1. Stairways leading to non−habitable attics or crawl spaces.

2. Non−required stairways connecting the basement directly to the exterior of the structure without communicating with any other part of the structure.

**(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. The minimum clear width at and below the handrail, including at treads and landings, may not be less than 31.5 inches where a handrail is installed on one side, and 27 inches where handrails are provided on both sides.

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. a. Except for spiral staircases under subd. 2., risers may not exceed 8 inches in height measured vertically from tread to tread.

b. At the top and bottom of a flight, measurement shall be taken from the top of the nosing to the finished floor surface unless the finished surface is carpeting, in which case measurement shall be made to the hard surface below the carpeting.

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 outer edge of the center column.

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 of the tread or inside face of spindles or balusters.

c. Winder treads may not be used on a straight stairway.

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 is at least 9 inches, when measured at a distance of 12 inches from the narrow end of the tread or from the inside face of the wall.

b. There may be more than one individual winder tread in a stairway.

c. Winder treads may not be used on a straight stairway.

(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, the greatest tread depth may not exceed the smallest tread depth by more than $^3/_8$ inch and the greatest riser height may not exceed the smallest riser height by more than $^3/_8$ 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).

(f) *Open risers.* Stairways with open risers shall be constructed to prevent the through−passage of a sphere with a diameter of 4 inches or larger between any 2 adjacent treads.

(g) *Walking surface.* The walking surface of stair treads and landings shall be a planar surface that is free of lips or protrusions that could present a tripping hazard.

**(3)** HANDRAILS AND GUARDS. (a) *General.* 1. A flight of stairs with more than 3 risers shall be provided with at least one handrail for the full length of the flight.

2. Guards 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.

**Note:** A handrail provided at 30 to 38 inches above the tread nosing meets the height requirement for a guard on a stairway.

3. a. Except as provided in subd. 3. b., guards shall be constructed to prevent the through−passage of a sphere with a diameter of 4 3/8 inches, when applying a force of 4 pounds.

b. The triangular area formed by the tread, riser and bottom rail shall have an opening size that prevents the through−passage of a sphere with a diameter of 6 inches, when applying a force of 4 pounds.

c. Rope, cable, or similar materials used in guard infill shall be strung with maximum openings of 3 1/2 inches with vertical supports a maximum of 4 feet apart.

**Note:** In some cases, the vertical supports could be simple cable stays that offer vertical support to the rope or cable span. Structural posts must be supplied to provide the rail with the minimum 200 pound load resistance, as well as to resist the tensile loads exerted by the tightened rope or cable.

4. a. Handrails and guards shall be designed and constructed to withstand a 200 pound load applied in any direction.

b. Handrail or guard infill components, balusters and panel fillers shall withstand a horizontally applied perpendicular load of 50 pounds on any one−foot−square area.

c. Glazing used in handrail or guard assemblies shall be safety glazing.

5. Exterior handrails and guards shall be constructed of metal, decay resistant or pressure−treated wood, or shall be protected from the weather.

(b) *Handrails.* 1. 'Height.' a. Handrails shall be located at least 30 inches, but no more than 38 inches above the nosing of the treads, except as provided in subds. 1. b. to d. 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 tread.

b. A volute, turnout, or starting easing that does not comply with subd. 1. a. may extend over the lowest tread.

c. Transition fittings on handrails may extend above the 38–inch height limit.

d. Where handrail fittings or bendings are used to provide a continuous transition between flights, or at winder treads, or from a handrail to a guard, or at the start of a flight, the height at the fittings or bendings may exceed 38 inches.

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

3. 'Winders.' a. Except as provided under subd. 3. b., the required handrail on winder stairs shall be placed on the side where the treads are wider.

b. Where all winder treads in a flight have a depth of at least 9 inches from nosing to nosing measured at a point 12 inches from the narrow end of the tread, the required handrail may be located on either side of the stairway.

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 ch. SPS 325 Appendix A 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) *Guards.* 1. 'Application.' a. 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 guards.

b. The requirements under subd. 1. a. apply where insect screens are the only means of enclosure or protection for a surface that is more than 24 inches above grade or a floor.

c. For exterior applications, the 24 inch vertical measurement shall be taken from the lowest point within 3 feet horizontally from the edge of the deck, landing, porch or similar structure.

d. This paragraph does not apply to window wells, egress wells, and retaining walls.

2. 'Height.' Guards shall extend to at least 36 inches above the floor or to the underside of a stair handrail complying with s. SPS 321.04 (3) (b). Measurement shall be taken from the hard structural surface beneath any finish material to the top of the guard.

3. 'Opening size.' Guards shall be constructed to prevent the through–passage of a sphere with a diameter of 4 3/8 inches, when applying a force of 4 pounds.

**(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 treads 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 except as provided in par. (d). The landing shall be at least as wide as the treads and shall measure at least 3 feet in the direction of travel.

(c) *Doors at landings.* Except as provided in subds. 1. to 3. and par. (d), level landings shall be provided on each side of any door located at the top or base of a stair, regardless of the direction of swing. In the following exceptions, a stairway between a dwelling and an attached garage, carport or porch is considered to be an interior stair:

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 or an in–swinging glass door and the top of an exterior stairway of 3 or fewer risers.

(d) *Exterior landings.* 1. The exterior landing, platform, or sidewalk at an exterior doorway shall be located a maximum of 8 inches below the interior floor elevation, be sloped away from the doorway at a minimal rate that ensures drainage, and have a length of at least 36 inches in the direction of travel out of the dwelling.

2. The landing at the base of an exterior stair shall be sloped away from the stair at a minimal rate that ensures drainage.

**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; CR 02–077: am. (2) (b) 1., (e) 1. and (3) (a), cr. (2) (f) and (3) (c) 3., r. and recr. (3) (b) 3., renum. (4) (c) to be (4) (c) 1. (intro.), a. to c. and 2. and am. (4) (c) 1. (intro.) and 2. Register May 2003, No. 569, eff. 8–1–03; CR 03–097: am. (2) (f), (3) (a) 3., and (c) 3. Register November 2004 No. 587, eff. 1–1–05; CR 08–043: r. and recr. (1), am. (2) (c) 2., 3. b. and (e) 1., cr. (2) (c) 3. c., 4. c., (g), (3) (a) 3. c., 4. b., c., (c) 1. b. and c., renum. (3) (a) 4. and (c) 1. to be (3) (a) 4. a. and (c) 1. a. Register March 2009 No. 639, eff. 4–1–09; CR 15–041: am. (1) (a) 2., (2) (a) 1., (c) 4. a., b., (3) (title), (a) 1. to 5., renum. (3) (b) 1. to (3) (b) 1. a. and am., cr. (3) (b) 1. b. to d., am. (3) (b) 3. a., b., (c) (title), 1. a., cr. (3) (c) 1. d., am. (3) (c) 2., 3., (4) (a) 2., (b), renum. (4) (c) 1. to (c) and am. (intro.) and 3., renum. (4) (c) 2. to (4) (d) 1. and am., cr. (4) (d) (title), 2. Register December 2015 No. 720, eff. 1–1–16; CR 15–041: am. (4) (c) 3. (omitted Register December 2015 No. 720) Register January 2016 No. 721.

**SPS 321.042 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 321.042. Treads less than 9 inches in width shall have open risers. All treads shall be uniform in dimension.

**Table 321.042**

| 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 321.042.

**(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 1½ 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; correction in (2) (a), (3) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

**SPS 321.045 Ramps. (1)** GENERAL. Every exterior or interior ramp which leads to or from an exit shall comply with the requirements of this section.

**Note:** See ICC/ANSI A117.1 chapter 5 for more guidelines relating to the design and construction of an accessible ramp. Under that standard, ramps along an accessible route for people with disabilities should have a slope of not more than 1–foot of rise in 12–feet of run and should have handrails on both sides of the ramp.

**(2)** 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.

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

**(4)** 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) 1. 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 4 3/8 inches when applying a force of 4 pounds, except as provided in subd. 2.

2. This paragraph does not apply to ramps having a walking surface that is less than 24 inches above adjacent grade, if a toe–kick or side rail is provided to 4 inches above the walking surface, and a mid–rail is provided between the toe–kick or side rail and the handrail.

(d) The clear space between the handrail and any adjoining wall shall be at least 1½ inches.

**(5)** 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; CR 03–097: am. (3) (c) Register November 2004 No. 587, eff. 1–1–05; CR 08–043: renum. (intro.) and (1) to (4) to be (1) to (5) and am. (1) Register March 2009 No. 639, eff. 4–1–09; CR 15–041: renum. (4) (c) to (4) (c) 1. and am., cr. (4) (c) 2. Register December 2015 No. 720, eff. 1–1–16.

**SPS 321.05 Natural light and natural ventilation. (1)** NATURAL LIGHT. Each habitable room 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, ground floors or above garages do not require 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.

**(1m)** NET FLOOR AREA. For the purposes of subs. (1) and (2), "net floor area" does not include any area with a ceiling height of less than 5 feet.

**(2)** VENTILATION. (a) *Natural ventilation.* 1. Natural ventilation shall be provided to each habitable room 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, except as provided in subd. 2. 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.

2. Any area with a ceiling height of less than 5 feet may be excluded from the net floor area.

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

**(3)** SAFETY GLASS. (am) Except as provided in par. (bm), glazing shall consist of safety glass meeting the requirements of either 16 CFR Part 1201 or ANSI Z97.1 when installed in any of the following locations:

1. In any sidelight or glazing adjacent to a door, that meets all of the following:

a. The nearest point of the glazing is within 2 feet of the door when the door is in the closed position.

b. The nearest point of the glazing is within 5 feet of the floor.

c. The plane of the glazing is within 30 degrees of the plane of the door when the door is in the closed position.

2. In any wall where the glazing is within 5 feet vertically of the lowest drain inlet and within 3 feet horizontally of the nearest

part of the inner rim of a bathtub, hot tub, shower, spa or whirlpool appliance.

3. 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.

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

5. In guard assemblies.

(bm) Safety glass is not required where glazing meets any of the following:

1. The size of an individual pane of glass is 8 inches or less in the least dimension.

2. The safety glass is required by sub. (3) (am) 1. and the only door within 2 feet of the glazing is the fixed panel of a patio door.

3. The safety glass is required by sub. (3) (am) 1. and there is an intervening wall or other permanent barrier between the door and the glazing.

**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.

**Note:** Glass blocks are considered to be masonry products and are regulated under the ACI 530 standard adopted under s. SPS 320.24. They are not required to be safety glazing.

**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; CR 02–077: am. (1) (a) and (5) (b) Register May 2003 No. 569, eff. 8–1–03; CR 08–043: am. (title), r. (3) and (4), renum. (5) to be (3) and am. (3) (intro.), r. and recr. (3) (a) and (b) Register March 2009 No. 639, eff. 4–1–09; CR 15–041: am. (1) (intro.), cr. (1m), renum. (2) (a) to (2) (a) 1. and am., cr. (2) (a) 2., renum. (3) (intro.) and (a) to (d) to (3) (am) (intro.) and 1. to 4. and am. (am) (intro.), 1. (intro.), a., cr. (3) (am) 5., renum. (3) (e) to (3) (bm) (intro.) and am., cr. (3) (bm) 1. to 3. Register December 2015 No. 720, eff. 1–1–16; CR 15–089: am. (1) (a) Register May 2016 No. 725, eff. 6–1–16.

**SPS 321.06 Ceiling height.** All habitable rooms, kitchens, hallways, bathrooms and corridors shall have a ceiling height of at least 7 feet, except as follows:

**(1)** (a) 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. Any area with a ceiling height of less than 5 feet may be ignored in this calculation.

(b) The 50% limit in par. (a) does not apply to subs. (3) to (6).

**(2)** Beams and girders or other projections may project to no more than 8 inches below the required ceiling height.

**(3)** The ceiling height extending back from the front edge of a water closet may slope to below 7 feet, but may not go below 5 feet until beyond the back of the water closet.

**(4)** The ceiling height extending back from the front edge of a lavatory may be less than 7 feet, but may not go below 5 feet until beyond the back of the lavatory.

**(5)** A ceiling height of less than 7 feet may be provided between the rear rim of a bathtub and a wall of the room abutting that rim, or between the side rim and a room wall abutting that rim.

**(6)** A ceiling height of less than 7 feet may be provided between the rear wall of a shower stall and a wall of the room abutting that rear wall, or between the side wall of a shower and a room wall abutting that side wall.

**Note:** Section SPS 384.20 (5) (o) 4. establishes minimum horizontal clearances for water closets, and reads as follows: "A water closet may not be located closer than 15 inches from its center to any side wall, partition, vanity, or other obstruction, nor closer than 30 inches center to center, between water closets. There shall be at least 24 inches clearance in front of a water closet to any wall, fixture or door."

**Note:** See ch. SPS 384 Appendix for further explanatory material.

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. Register, February, 1985, No. 350, eff. 3–1–85; CR 15–041: renum. 321.06 to 321.06 (intro.), (1) (a), and (2) and am., cr. (1) (b), (3) to (6) Register December 2015 No. 720, eff. 1–1–16.

**SPS 321.07 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. SPS 382 to 387, Plumbing Code or ch. SPS 316, 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.

**SPS 321.08 Fire separation and dwelling unit separation. (1)** FIRE SEPARATION. Dwelling units shall be separated from garage spaces, accessory buildings, property lines and other dwelling units in accordance with Table 321.08 and the following requirements:

**Table 321.08**

| 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>1/3–hour door or window[3] |
| 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 |
| Zero Lot Line | None | Follow sub. (2) (d) 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 ¾ 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 ¾–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 ½–inch gypsum drywall shall be used on each side of the separation wall or ceiling.

c. Two layers of ½–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.

(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.* 1. 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.

2. Only glazing allowed by the door's listing may be installed in any door required under this section.

(d) *Other openings.* 1. Access openings in fire separation walls or ceilings shall be protected in one of the following ways:

a. The opening is protected with a material that has a finish rating of at least 20 minutes.

b. The opening is protected in the same way as the wall or ceiling where the opening is located.

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)** DWELLING UNIT SEPARATION. (a) *General.* In 2−family dwellings, dwelling units shall be separated from each other and from shared tenant spaces including attics, basements, garages, vestibules and corridors.

(b) *Attic separation.* Dwelling units with attic space that extends over both units shall be separated in accordance with one of the following:

1. 'Complete separation.' The units shall be provided with wall construction under par. (d) that extends all the way to the underside of the roof deck.

2. 'Vertical and horizontal separation.' a. The units shall be provided with wall construction under par. (d) that extends to the dwelling unit ceiling and ceiling construction under par. (e).

b. Dwelling units using this method of separation shall provide attic draft stopping under par. (f) that extends all the way to the underside of the roof deck above and in line with the separation wall.

(c) *Doors.* Any door installed in the dwelling 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.

(d) *Walls.* Walls in the dwelling unit separation shall be protected by not less than one layer of $^5/_8$−inch Type X gypsum wallboard or 2 layers of ½−inch gypsum wallboard or equivalent on each side of the wall with joints in compliance with sub. (1) (a) 2.

(e) *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.

(f) *Draft stopping for concealed roof spaces and attics.* 1. Attic areas, mansards, overhangs and other concealed roof spaces shall be draft stopped above and in line with the separation wall.

2. Acceptable draft stopping materials include:

a. $^3/_8$−inch wood structural panel.

b. ½−inch gypsum board.

**(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.

(c) *Plastic Piping.* Penetrations of a required separation by plastic pipe shall be protected by a penetration firestop system approved by the department and installed as tested in accordance with ASTM E 814 or UL 1479, with a minimum positive pressure differential of 0.01 inch of water (3 pa), and shall have an F rating of not less than the required fire−resistance rating of the assembly penetrated.

**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; CR 02−077: am. (1) (a) 1. and (2) (a) to (c) Register May 2003 No. 569, eff. 8−1−03; CR 08−043: am. (1) (intro.) and Table, r. (1) (a) 4. and (2) (e), renum. (1) (c), (2) (b), (c) and (d) to be (1) (c) 1., (2) (c), (d) and (e) and am. (2) (d), cr. (1) (c) 2., (2) (b) and (f), r. and recr. (1) (d) 1. and (2) (a) Register March 2009 No. 639, eff. 4−1−09; correction in Table 21.08 made under s. 13.92 (4) (b) 7., Stats., Register March 2009 No. 639; correction in (1) (intro.) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; CR 15−041: am. Table 321.08, cr. (3) (c) Register December 2015 No. 720, eff. 1−1−16.

**SPS 321.085 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 including the attachment between a carport and a dwelling.

(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 ¾−inch nominal plywood or wood structural panel with any joints backed with the same material.

(d) One thickness of ½−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 ½ 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; CR 02−077: am. (1) (b) Register May 2003 No. 569, eff. 8−1−03.

**SPS 321.09 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, within 21 feet of the centerline of the door opening to any sleeping room and in an exit path from any sleeping room.

(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 that the manufacturer of a modular home shall install a functional smoke detector on each floor level except the attic or storage area of each dwelling unit.

**(2)** (a) Except for dwellings with no electrical service, 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.

**Note:** Wireless interconnectivity is permitted under this paragraph.

(b) Dwellings with no electrical service shall be provided with battery−powered smoke detectors in the locations under sub. (1). Interconnection and battery−backup are not required in these dwellings.

**(3)** For family living units with one or more communicating split levels or open adjacent levels with less than 5 feet of 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.

**(6)** In basements where two required exits are separated by a continuous wall, a smoke detector shall be placed on each side of the wall within 21 feet of each exit.

**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; CR 08−043: am. (1) (b) and (3), renum. (2) to be (2) (a) and am., cr. (2) (b) and (6) Register March 2009 No. 639, eff. 4−1−09.

**SPS 321.095 Automatic fire sprinklers. (1)** Except as provided in subs. (2) and (3), the design, installation, testing and maintenance of automatic fire sprinklers shall conform to NFPA 13D.

**(2)** (a) The requirements of NFPA 13D sections 6.3 (4), 8.1.3 and 8.6 are not included as part of this code.

(b) Fire department connections are prohibited in multipurpose piping systems.

**(3)** (a) Limited area automatic fire sprinkler systems are allowed in dwellings.

(b) 1. A limited area automatic fire sprinkler system shall add the following wording to the warning sign required in 6.3(5) of NFPA 13D: "The number and location of sprinklers in this system does not conform to NFPA 13D."

2. An automatic fire sprinkler system providing fire protection throughout the dwelling in accordance with NFPA 13D shall add the following wording to the warning sign required in 6.3(5) of NFPA 13D: "The number and location of sprinklers in this system conform with NFPA 13D."

**Note:** Multipurpose piping systems need to conform to provisions of the Plumbing Code, chs. SPS 381 to 387. These systems attach fire sprinkler heads to the dwelling's potable water piping system.

**Note:** Chapter 145 of the Statutes requires automatic fire sprinkler systems on dedicated water supply systems, to be installed by a licensed sprinkler fitter.

**History:** CR 08−043: cr. Register March 2009 No. 639, eff. 4−1−09; CR 10−103: r. and recr. Register August 2011 No. 668, eff. 9−1−11.

**SPS 321.097 Carbon monoxide alarms. (1)** DEFINITIONS. In this section:

(a) "Fuel−burning appliance" has the meaning given in s. 101.647 (1) (b), Stats. Fuel−burning appliances include stoves, ovens, grills, clothes dryers, furnaces, boilers, water heaters, fireplaces and heaters.

**Note:** Section 101.647 (1) (b), Stats., reads: "Fuel−burning appliance" means a device that is installed in a dwelling, that burns fossil fuel or carbon−based fuel, and that produces carbon monoxide as a combustion by−product.

(b) "Tourist rooming house" has the meaning given in s. ATCP 72.03 (20).

**Note:** Section ATCP 72.03 (20) reads: "Tourist rooming house" means all lodging places and tourist cabins and cottages, other than hotels and motels, in which sleeping accommodations are offered for pay to tourists or transients. It does not include private boarding or rooming houses not accommodating tourists or transients, or bed and breakfast establishments regulated under ch. ATCP 73.

**(2)** NEW CONSTRUCTION. (a) *General.* Except as provided in sub. (4), listed and labeled carbon monoxide alarms shall be installed and maintained in accordance with s. 101.647 (2) to (6), Stats., in one and 2−family dwellings, for which building permit applications were made or construction commenced on or after February 1, 2011.

**Note:** Section 101.647 (2) to (6), Stats., reads:

**(2)** INSTALLATION AND SAFETY CERTIFICATION. The owner of a dwelling shall install any carbon monoxide detector required under this section according to the directions and specifications of the manufacturer of the carbon monoxide detector. A carbon monoxide detector required under this section shall bear an Underwriters Laboratories, Inc., listing mark and may be a device that is combined with a smoke detector.

**(3)** REQUIREMENTS. (a) The owner of a dwelling shall install a functional carbon monoxide detector in the basement of the dwelling and on each floor level except the attic, garage, or storage area of each dwelling unit. A carbon monoxide detector wired to the dwelling's electrical wiring system shall have a backup battery power supply. Except as provided under par. (b), the occupant of the dwelling unit shall maintain any carbon monoxide detector in that unit. This paragraph does not apply to the owner of a dwelling that has no attached garage, no fireplace, and no fuel−burning appliance.

(am) 1. If the building permit for the initial construction of a dwelling was issued on or after February 1, 2011, and the electrical service for the dwelling is provided by a public utility, as defined in s. 196.01 (5), the owner of the dwelling shall install each carbon monoxide detector required under par. (a) so that it is powered by the dwelling's electrical wiring system, except as provided under subd. 2.

2. The requirement that each carbon monoxide detector be installed in the manner provided under subd. 1. does not apply to a dwelling if the dwelling, when initially constructed, had no attached garage, no fireplace, and no fuel−burning appliance.

(b) If any occupant who is not the owner of a dwelling, or any person authorized by state law or by city, village, town, or county ordinance or resolution to exercise powers or duties involving inspection of real or personal property, gives written notice to the owner that the carbon monoxide detector is not functional, the owner shall provide, within 5 days after receipt of that notice, any maintenance necessary to make that carbon monoxide detector functional.

**(4)** INSPECTION. The department or person authorized by state law or by city, village, town, or county ordinance or resolution to exercise powers or duties involving inspection of real or personal property may inspect new dwellings and, at the request of the owner or renter, may inspect the interior of a dwelling unit in a dwelling to ensure compliance with this section.

**(5)** LIABILITY EXEMPTION. The owner of a dwelling is not liable for damages resulting from any of the following:

(a) A false alarm from a carbon monoxide detector if the carbon monoxide detector was reasonably maintained by the owner of the dwelling.

(b) The failure of a carbon monoxide detector to operate properly if that failure was the result of tampering with, or removal or destruction of, the carbon monoxide detector by a person other than the owner of the dwelling or the result of a faulty detector that was reasonably maintained by the owner of the dwelling.

**(6)** TAMPERING PROHIBITED. No person may tamper with, remove, destroy, disconnect, or remove batteries from an installed carbon monoxide detector, except in the course of inspection, maintenance, or replacement of the detector.

(b) *Location.* 1. On floor levels that contain one or more sleeping areas, a carbon monoxide alarm shall be installed outside of the sleeping area, within 21 feet of the centerline of the door opening to any sleeping area and in an exit path from any sleeping area.

2. On floor levels that do not contain a sleeping area, a carbon monoxide alarm shall be installed in a common area on each floor level.

(c) *Electrical service and interconnection.* 1. Except as provided in subd. 2., carbon monoxide alarms shall be continuously powered by the house electrical service, shall have a backup power supply and shall be interconnected so that activation of one alarm will cause activation of all alarms.

2. Dwellings with no electrical service shall be provided with battery−powered carbon monoxide alarms in the locations under par. (b). Interconnection is not required in these dwellings.

(d) *Standards.* The devices shall conform with one of the following standards:

1. Carbon monoxide alarms shall be listed and labeled identifying conformance with UL 2034.

**Note:** Pursuant to this subdivision, carbon monoxide alarms need to be acceptable under the 2005 edition of the UL 2034 standard, *Single and Multiple State Carbon Monoxide Alarms*.

2. Carbon monoxide detectors and sensors as part of a gas detection or emergency signaling system shall be listed and labeled identifying conformance with UL 2075.

**Note: Note:** Pursuant to this subdivision, carbon monoxide detectors and sensors need to be acceptable under the 2007 edition of the UL 2075 standard, *Gas and Vapor Protectors and Sensors*.

**(3)** EXISTING DWELLINGS. Except as provided in sub. (4), listed and labeled carbon monoxide alarms shall be installed and maintained in accordance with s. 101.647 (2) to (6), Stats., in one and 2–family dwellings, for which building permit applications were made or initial construction commenced on or after June 1, 1980, and before February 1, 2011.

**Note:** See statutory reprint under s. SPS 321.097 (2) (a).

**(4)** TOURIST ROOMING HOUSES. (a) Listed and labeled carbon monoxide alarms with battery secondary power supplies shall be installed and maintained in dwellings to be utilized as licensed tourist rooming houses and that contain fuel–burning appliances in accordance with s. 101.149 (2) and (3), Stats.

**Note:** Section 101.149 (2) and (3), Stats., reads:

**(2)** INSTALLATION REQUIREMENTS. (a) Except as provided in par. (b), the owner of a residential building shall install a carbon monoxide detector in all of the following places not later than the date specified under par. (c):

1. In the basement of the building if the basement has a fuel–burning appliance.

2. Within 15 feet of each sleeping area of a unit that has a fuel–burning appliance.

3. Within 15 feet of each sleeping area of a unit that is immediately adjacent to a unit that has a fuel–burning appliance.

4. In each room that has a fuel–burning appliance and that is not used as a sleeping area. A carbon monoxide detector shall be installed under this subdivision not more than 75 feet from the fuel–burning appliance.

5. In each hallway leading from a unit that has a fuel–burning appliance, in a location that is within 75 feet from the unit, except that, if there is no electrical outlet within this distance, the owner shall place the carbon monoxide detector at the closest available electrical outlet in the hallway.

(b) If a unit is not part of a multiunit building, the owner of the residential building need not install more than one carbon monoxide detector in the unit.

(c) 1. Except as provided under subd. 2., the owner of a residential building shall comply with the requirements of this subsection before the building is occupied.

2. The owner of a residential building shall comply with the requirements of this subsection not later than April 1, 2010, if construction of the building was initiated before October 1, 2008, or if the department approved the plans for the construction of the building under s. 101.12, Stats., before October 1, 2008.

(d) Any carbon monoxide detector that bears an Underwriters Laboratories, Inc., listing mark or similar mark from an independent product safety certification organization satisfies the requirements of this subsection.

(e) The owner shall install every carbon monoxide detector required by this subsection according to the directions and specifications of the manufacturer of the carbon monoxide detector.

**(3)** MAINTENANCE REQUIREMENTS. (a) The owner of a residential building shall reasonably maintain every carbon monoxide detector in the residential building in the manner specified in the instructions for the carbon monoxide detector.

(b) An occupant of a unit in a residential building may give the owner of the residential building written notice that a carbon monoxide detector in the residential building is not functional or has been removed by a person other than the occupant. The owner of the residential building shall repair or replace the nonfunctional or missing carbon monoxide detector within 5 days after receipt of the notice.

(c) The owner of a residential building is not liable for damages resulting from any of the following:

1. A false alarm from a carbon monoxide detector if the carbon monoxide detector was reasonably maintained by the owner of the residential building.

2. The failure of a carbon monoxide detector to operate properly if that failure was the result of tampering with, or removal or destruction of, the carbon monoxide detector by a person other than the owner or the result of a faulty alarm that was reasonably maintained by the owner as required under par. (a).

(b) Carbon monoxide alarms shall be wired to the dwelling's electrical service.

(c) Carbon monoxide alarms within a dwelling unit shall be interconnected so that activation of one alarm will cause activation of all alarms within the dwelling unit.

(d) The devices shall conform with one of the following standards:

1. Carbon monoxide alarms shall be listed and labeled identifying conformance with UL 2034.

**Note:** Pursuant to this subdivision, carbon monoxide alarms need to be acceptable under the 2005 edition of the UL 2034 standard, *Single and Multiple State Carbon Monoxide Alarms*.

2. Carbon monoxide detectors and sensors as part of a gas detection or emergency signaling system shall be listed and labeled identifying conformance with UL 2075.

**Note:** Pursuant to this subdivision, carbon monoxide detectors and sensors need to be acceptable under the 2007 edition of the UL 2075 standard, *Gas and Vapor Protectors and Sensors*.

(e) The installation of carbon monoxide alarms or detectors in adjacent units required under s. 101.149 (2) (a) 3., Stats., shall apply to those units located on the same floor level.

(f) 1. For the purposes of s. 101.149 (2) (a) 4., Stats., "room" means an enclosed area affording space for any other human activity besides just servicing mechanical equipment, including fuel–burning appliances.

2. For the purposes of s. 101.149 (2) (a) 4., Stats., where a fuel–burning appliance is located within a closet or enclosed space not affording space for any other human activity within a dwelling unit or sleeping unit, a carbon monoxide alarm or detector shall be located within 75 feet of that closet or space.

(g) Pursuant to s. 101.149 (6) (b), Stats., the department may issue orders for a violation of the provisions of this subsection.

(h) Violation of the provisions of this subsection shall be subject to the penalties provided under s. 101.149 (8), Stats.

**Note:** Section 101.149 (8), Stats., reads:

**(8)** PENALTIES. (a) If the department of safety and professional services or the department of agriculture, trade and consumer protection determines after an inspection of a building under this section or s. 97.625 (1g) that the owner of the building has violated sub. (2) or (3), the respective department shall issue an order requiring the person to correct the violation within 5 days or within such shorter period as the respective department determines is necessary to protect public health and safety. If the person does not correct the violation within the time required, he or she shall forfeit $50 for each day of violation occurring after the date on which the respective department finds that the violation was not corrected.

(b) If a person is charged with more than one violation of sub. (2) or (3) arising out of an inspection of a building owned by that person, those violations shall be counted as a single violation for the purpose of determining the amount of a forfeiture under par. (a).

(c) Whoever violates sub. (4) is subject to the following penalties:

1. For a first offense, the person may be fined not more than $10,000 or imprisoned for not more than 9 months, or both.

2. For a 2nd or subsequent offense, the person is guilty of a Class I felony.

**History:** EmR0826: emerg. cr. eff. 10–1–08; CR 08–085: cr. Register May 2009 No. 641, eff. 6–1–09; renumbered under s. 13.92 (4) (b) 1. and corrections in (1) (b) 2. and (6) made under s. 13.92 (4) (b) 7., Stats., Register May 2009 No. 641; CR 10–089: renum. (1) (a), (2), (3), (5), (6), (7) to be (4) (a), (b), (c), (e), (g), (h) and am. (4) (g) and (h), r. (1) (b), (4), cr. (1), (2), (3), (4) (title), (d), (f) Register January 2011 No. 661, eff. 2–1–11; **correction in (1) (b) made under s. 13.92 (4) (b) 7., Stats., Register February 2017 No. 734**.

## SPS 321.10 Protection against decay and termites.

**(1)** Wood used in any of the applications under this section shall meet all of the following requirements:

(a) The wood shall be labeled and pressure treated with preservative in accordance with an AWPA standard or shall be naturally durable and decay–resistant 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) Resting directly upon or embedded in earth.

(b) Floor joists or sleepers that meet all of the following conditions:

1. The joists or sleepers are protected from the weather.

2. The joists or sleepers are within 18 inches above a lower floor surface, deck or soil.

3. There is no vapor retarder that meets the requirements under s. SPS 322.38 (1) (a) between the joists or sleepers and the soil below.

**Note:** This situation could occur with a floor over a crawl space or when a floor is added over a patio deck or a garage slab.

(c) Floor joists exterior to the dwelling that are within 18 inches above exterior grade, unless protected with a moisture barrier.

**Note:** Acceptable moisture barriers for this application include ¾–inch exterior preservative–treated plywood, or ice dam protection material listed as meeting the requirements of ASTM D 1970 or vapor retarder material, provided they are protected from physical and UV light damage.

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

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

(f) 1. Siding and sheathing in contact with concrete, masonry or earth and within 6 inches above final exterior grade.

2. Siding and sheathing in contact with concrete or masonry and within 2 inches above an impervious surface.

(g) Ends of wood structural members and their shims resting on or supported in masonry or concrete walls and having clearances of less than ½ inch on the top, sides and ends.

(h) Bottom plates or sole plates of walls that rest on concrete or masonry and that are below exterior grade or less than 8 inches above final exterior grade.

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

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

(k) Permanent wood foundations.

**(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)** 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.

**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.

**(5)** FASTENERS. (a) Fasteners for pressure−preservative treated wood and fire−retardant−treated wood shall meet one of the following requirements:

1. The fastener is a steel bolt with a diameter of 0.5 inch or greater.

2. The fastener is made of stainless steel.

3. The fastener is made of hot−dipped, zinc−galvanized steel with the coating weight and thickness labeled as complying with ASTM A 153.

4. The fastener is made of steel with a mechanically−deposited zinc coating labeled as complying with ASTM B 695, Class 55 or greater.

5. The fastener has coating types and weights in accordance with the fastener manufacturer's recommendations. In the absence of the manufacturer's recommendations subd. 1., 2., 3., or 4. shall apply.

**Note:** "Zinc plated," "zinc coated," "chrome plated," etc., fasteners do not necessarily comply with either of these standards.

(b) When a fastener is used with a hanger or other metal fixture, the fastener shall be of the same material as the hanger or metal fixture.

**Note:** When separate pieces are in close contact, zinc corrodes rapidly in the presence of plain steel. Zinc corrodes much more rapidly in the presence of stainless steel.

(c) For the purposes of this section, a fastener includes nails, screws and bolts, along with nuts and washers.

**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; CR 02−077: am. (4) (a) Register May 2003 No. 569, eff. 8−1−03; CR 08−043: am. (1), (2) (a) and (i), r. and recr. (2) (b) and (h), r. (2) (g) and (4) (b), renum. (2) (c) to (f) and (4) (a) to be (2) (d) to (g) and (4) and am. (2) (e), (f) 1. and (g), cr. (2) (c), (k) and (5) Register March 2009 No. 639, eff. 4−1−09; correction in (2) (a) 3. made under s. 13.92 (4) (b) 7., Stats., Register March 2009 No. 639; correction in (2) (b) 3. made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; CR 15−041: renum. (2) (f) to (2) (f) 1., cr. (2) (f) 2. Register December 2015 No. 720, eff. 1−1−16.

**SPS 321.11 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. ½−inch gypsum wallboard.

2. ½−inch nominal wood structural panel.

3. ¾−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. SPS 320.18. Approval will be based on tests that evaluate materials or products representative of actual end−use applications.

**Note:** See s. SPS 322.21 (3) for requirements for protecting foam plastic on the exterior of a dwelling.

**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; correction in (2) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

**SPS 321.115 Installation of elevators or dumbwaiters.** Elevators or dumbwaiters serving dwelling units shall comply with the requirements under ch. SPS 318.

**History:** CR 08−030: cr. Register December 2008 No. 636, eff. 1−1−09; correction made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

## Subchapter III — Excavations

**SPS 321.12 Drainage. (1)** GRADE. The finished grade of the soil shall slope away from the dwelling at a rate of at least 1/2 inch per foot for at least 10 feet, except as provided in subs. (2) and (3).

**(2)** OTHER SURFACES. Where the finished surface is impervious, it shall slope away from the dwelling for at least 10 feet at a rate that ensures equivalent drainage.

**(3)** OBSTRUCTIONS. Where lot lines, walls, slopes, or other barriers prevent having the 10−foot distance in sub. (2), swales or other means shall be provided to ensure equivalent drainage away from the dwelling.

**History:** Cr. Register, November, 1979, No. 287, eff. 6−1−80; CR 02−077: am. Register May 2003 No. 569, eff. 8−1−03; CR 15−041: renum. 321.12 to 321.12 (1) and am., cr. 321.12 (title), (2), (3) Register December 2015 No. 720, eff. 1−1−16.

**SPS 321.125 Erosion control and sediment control. (1)** GENERAL. (a) Where land disturbing construction activity is to occur erosion and sediment control practices shall be employed, as necessary, and maintained to prevent or reduce the potential deposition of soil or sediment to all of the following:

1. The waters of the state.

2. Adjacent properties.

**Note:** Authority over erosion and sediment control at construction sites having a land−disturbance area of one acre or more was transferred to the Department of Natural Resources (DNR) under 2013 Wis. Act 20, sections 1712 and 2088. Consequently, the Department of Safety and Professional Services no longer applies the requirements in this section to those sites. Information regarding the DNR permit requirements and standards may be available at http://dnr.wi.gov/topic/stormwater/construction.

(b) Land disturbing construction activities, except those activities necessary to implement erosion or sediment control practices, may not begin until the sediment control practices are in place for each area to be disturbed in accordance with the approved plan.

(c) Erosion and sediment control practices shall be maintained until the disturbed areas are stabilized. A disturbed area shall be considered stabilized by vegetation when a perennial cover has been established with a density of at least 70%.

(d) Erosion and sediment control practices shall either be approved by the department or listed by the department of natural resources in accordance with the process under s. NR 151.32 (2).

**Note:** Listed practices can be found through the Division of Industry Services website at http://dsps.wi.gov/programs/industry−services or by contacting the Division at telephone (608) 266−3151 or (877) 617−1565 or 411 (Telecommunications Relay).

**(2)** MANDATED PRACTICES. Specific practices at each site where land disturbing construction activity is to occur shall be utilized to prevent or reduce all of the following:

(a) The deposition of soil from being tracked onto streets by vehicles.

(b) The discharge of sediment from disturbed areas into on−site storm water inlets.

(c) The discharge of sediment from disturbed areas into abutting waters of the state.

(d) The discharge of sediment from drainage ways that flow off the site.

(e) The discharge of sediment by dewatering activities.

(f) The discharge of sediment eroding from soil stockpiles existing for more than 7 days.

**(3)** CONTROL STANDARDS. Including the practices under sub. (2), additional erosion and sediment control practices shall be employed, as necessary, to accomplish one of the following:

(a) A potential annual cumulative soil loss rate of not more than one of the following:

1. Five tons per acre per year where sand, loamy sand, sandy loam, loam, sandy clay loam, clay loam, sandy clay, silty clay or clay textures are exposed.

2. Seven and 1/2 tons per acre per year where silt, silty clay loam, or silt loam textures are exposed.

(c) A reduction of at least 40% of the potential sediment load in storm water runoff from the site on an average annual basis as compared with no sediment or erosion controls for the site where less than one acre of land disturbing construction activity is to occur.

**Note:** See ch. SPS 325 Appendix A for further explanatory material regarding compliance solutions for 80 and 40% reductions.

**(4)** SOIL LOSS ANALYSIS. Potential soil loss shall be determined using an engineer analytical modeling acceptable to the department.

**Note:** The Revised Universal Soil Loss Equation II is an example of an acceptable model to determine soil loss.

**(5)** MONITORING. (a) The owner or owner's agent shall check the erosion and sediment control practices for maintenance needs at all the following intervals until the site is stabilized:

1. At least weekly.

2. Within 24 hours after a rainfall event of 0.5 inches or greater. A rainfall event shall be considered to be the total amount of rainfall recorded in any continuous 24 hour period.

3. At all intervals cited on the erosion and sediment control plan.

(b) The owner or owner's agent shall maintain a monitoring record when the land disturbing construction activity involves one or more acres.

(c) The monitoring record shall contain at least the following information:

1. The condition of the erosion and sediment control practices at the intervals specified under par. (a).

2. A description of the maintenance conducted to repair or replace erosion and sediment control practices.

**(6)** MAINTENANCE. (a) 1. Except as provided in subd. 3., off−site sediment deposition resulting from the failure of an erosion or sediment control practice shall be cleaned up by the end of the next day.

**Note:** Contact the Department of Natural Resources before attempting to clean up any sediment deposited or discharged into the waters of the state.

2. Except as provided in subd. 3., off−site soil deposition, resulting from construction activity, that creates a nuisance shall be cleaned up by the end of the work day.

3. A municipality may enact more stringent requirements regarding cleanup of soil or sediment deposition onto public ways.

(b) 1. Except as required in subd. 2., the owner or owner's agent shall complete repair or replacement of erosion and sediment control practices as necessary within 48 hours of an interval specified under sub. (5).

2. When the failure of erosion or sediment control practices results in an immediate threat of sediment entering public sewers or the waters of the state, procedures shall be implemented immediately to repair or replace the practices.

**Note:** See ch. SPS 325 Appendix A for further explanatory material.

**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; CR 02−077: cr. (4) Register May 2003 No. 569, eff. 8−1−03; CR 05−113: r. and recr. Register December 2006 No. 612, eff. 4−1−07; CR 15−041: am. (3) (a) 2., r. (3) (b) Register December 2015 No. 720, eff. 1−1−16.

**SPS 321.13 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.

**SPS 321.14 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

**SPS 321.15 Footings. (1)** GENERAL. (a) The dwelling and attached structures, such as decks and garages, shall be supported on a structural system designed to transmit and safely distribute the loads to the soil.

(b) 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.

(c) Footings shall be sized to not exceed the allowable material stresses.

(d) The bearing area shall be at least equal to the area required to transfer the loads to the supporting soil without exceeding the bearing capacity of the soil.

(e) 1. Structures supported on floating slabs or similar shallow foundations 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, except as provided in subd. 2. This isolation shall extend for the full height of the structure.

2. Exterior ramps are not required to comply with subd. 1.

**(2)** 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 that are unable to support themselves at a 90 degree angle for the full depth of the footing.

(b) *Column or pier footing.* 1. The minimum width and length of column or pier footings shall measure at least 2 feet by 2 feet.

2. The minimum depth of column or pier footings shall measure at least 12 inches nominal.

(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.

(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.

**(3)** 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; CR 08–043: renum. (intro.), (1) and (2) to be (1), (2) and (3) and am. (1), (2) (b) and (e), cr. (1) (e) Register March 2009 No. 639, eff. 4–1–09; CR 15–041: renum. (1) (e) to (1) (e) 1. and am., cr. (1) (e) 2. Register December 2015 No. 720, eff. 1–1–16.

**SPS 321.16 Frost protection. (1)** GENERAL. (a) Footings and foundations, including those for landings and stoops, shall be placed below the frost penetration level or at least 48 inches below adjacent grade, whichever is deeper, except as allowed under sub. (2).

(b) Footings may not be placed on frozen material.

**(2)** EXCEPTIONS. (a) Frost protected shallow foundations shall be designed in accordance with ASCE–32 as adopted in Table 320.24–5.

(b) Portions of footings or foundations located directly under window areaways do not require frost protection provided the rest of the foundation is protected in accordance with this section.

(c) Footings and foundations may bear directly on bedrock less than 48 inches below adjacent grade provided all of the following conditions are met.

1. The rock shall be cleaned of all earth prior to placement.

2. All clay in crevices of the rock shall be removed to the level of frost penetration or to 1.5 times the width of the rock crevice, whichever is less.

3. Provisions shall be taken to prevent water from collecting anywhere along the foundation.

(d) Subsection (1) (a) does not apply to the footing for a ramp and its handrail posts unless the ramp abuts a frost–protected stoop or landing, in which case only the footing for that abutting end of the ramp is required to have the frost protection under sub. (1) (a), such as by bearing onto the stoop or landing, so that a tripping hazard is not created.

**Note:** See ch. SPS 325 Appendix A for further information.

**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; CR 08–043: r. and recr. Register March 2009 No. 639, eff. 4–1–09; correction in (2) (a) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; CR 15–041: am. (1) (a), cr. (2) (d) Register December 2015 No. 720, eff. 1–1–16.

**SPS 321.17 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 all of the following:

a. The drain tile or pipe installed inside and outside the foundation, except as allowed under s. SPS 321.17 (3) (d) 1. b.

b. Bleeders connecting the inside tile or pipe to the outside tile or pipe.

c. The sump pit or crock.

d. The discharge piping.

e. A pump or other means of discharging water to 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 or registered UDC inspection agency, a partial drain tile or pipe system may be installed.

2. For the purposes of this section, a partial drain tile or pipe system includes a means of discharging water from the tile or pipe and may include any of the other elements under par. (a) 2.

**Note:** Means of discharging water include a sump pit, a crock or natural means of drainage to daylight.

**(2)** OPTIONAL SYSTEMS. (a) *New construction.* 1. For new dwelling construction, a municipality or registered UDC inspection agency 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 or registered UDC inspection agency 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. a. Except as allowed under subd. 1. b., the top of the tile or pipe shall be at or below the top of the footing.

b. Where the top of the footing is more than 4 inches below the bottom of the floor slab, tile or pipe is required on the interior of the foundation only and it shall be placed directly under the floor.

**Note:** This situation will commonly occur with a walk−out basement.

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

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

4. 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.

5. 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 ¾−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.

6. a. 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.

b. Bleeder tiles or pipes shall have a minimum interior diameter of 3 inches.

c. Direct connection of the bleeders is not required if the intersection of the bleeder with the tile or pipe is covered with a membrane or fabric that prevents soil and fines from entering the system.

7. 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. SPS 382 to 387.

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

**SPS 382.36 (8)** SUMPS AND PUMPS. (a) *Sumps.* 1. 'General.' All storm building subdrains shall discharge into a sump, the contents of which shall be automatically lifted and discharged, dispersed or used in accordance with sub. (4).

2. 'Construction and installation'. a. Except as provided in subd. 2. c. and d., an interior sump shall have a rim extending at least one inch above the floor immediately adjacent to the sump.

b. A sump shall have a removable cover of sufficient strength for anticipated loads.

c. Where a sump is installed in an exterior meter pit or elevator pit, the rim may be level with the floor.

d. When a sump is provided with an airtight, solid cover.

3. 'Location'. All sumps installed for the purpose of receiving clearwater, groundwater or stormwater shall be separated from water wells by the applicable separation distances contained in chs. NR 811 and 812, or as otherwise permitted by the department of natural resources.

**Note:** See Appendix A−382.30 (11) (d) for material reprinted from s. NR 812.08.

4. 'Size'. Except as recommended by the pump manufacturer, the size of each sump shall be no smaller than 16 inches in diameter at the top, 14 inches in diameter at the bottom, and 22 inches in depth.

(b) *Pumps.* 1. 'Size.' The pump shall be of a capacity appropriate for the anticipated use.

2. 'Discharge piping.' a. Where a pump discharges into a storm drain system, a check valve shall be installed.

b. The minimum diameter discharge piping shall be based on the design flow rate of the pump and a minimum velocity of one foot/second.

**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; CR 03−097: am. (1) (b) 1., (2) (a) 1., and (3) (a) Register November 2004 No. 587, eff. 1−1−05; CR 08−043: am. (1) (a) 2. and (b) 2., renum. (3) (d) 1. to 4., 5. and 6. to be (3) (d) 2. to 5., 6. a. and 7., cr. (3) (d) 1., 6. b. and c. Register March 2009 No. 639, eff. 4−1−09; correction in (1) (a) 2. a., (3) (e) 3. made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

## Subchapter V — Foundations

**SPS 321.18 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:

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.

d. Alternate foundation anchorage, designed and spaced in accordance with structural analysis and as required to provide equivalent anchorage to the requirements of subd. 3. a., is allowable.

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) *Floor framing.* 1. Floor framing shall be fastened to the sill plate by one of the following methods:

a. Mechanical fasteners used in accordance with the manufacturer's testing and listing.

b. In accordance with structural analysis.

c. In accordance with the fastener table printed in ch. SPS 325 Appendix A.

**Note:** Per s. SPS 321.22 (1), sill plates are not required on foundation walls of poured concrete or on masonry walls with mortar− or grout−filled cores or on masonry walls with a solid block top course.

2. a. Where the floor framing is parallel to the foundation wall, solid blocking or bridging shall be installed in at least the

first adjacent joist space at a spacing of no more than 32 inches on center.

b. Blocking and bridging shall be the same depth as the joist.

c. Fastening of the blocking or bridging shall be in accordance with structural analysis or the fastener schedule in Table 321.02–2.

**Note:** The floor–framing elements required in this section are intended to provide lateral support to the top of the foundation wall. See s. SPS 321.22 (9) for further requirements relating to floor framing, including for bridging of floor framing to provide restraint against rotation or lateral displacement of the floor framing.

(e) *Soil lateral load.* Unless designed through structural analysis, soil lateral loads shall be determined from Table 321.18–A.

**Table 321.18–A**
**SOIL LATERAL LOAD**

| Description of Backfill Material[e] | 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 | 60[d] |
| 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]Soil classes are in accordance with the Unified Soil Classification System, ASTM D2487, and design lateral loads are for moist soil conditions without hydrostatic pressure.

**(2)** CONCRETE FOUNDATION WALLS. (a) *General structural requirements.* Except as provided in par. (b), unless designed through structural analysis, the minimum thickness of concrete foundation walls shall be determined from Table 321.18–B, but in no case shall the thickness of the foundation wall be less than the thickness of the wall it supports.

(b) *Equalized loading.* 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.

**Note:** See s. SPS 321.15 (1) (c) for trench footing requirements.

**Table 321.18–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.* 1. Except as allowed under subd. 3., masonry block foundation walls shall be coated with a layer of minimum $^3/_8$–inch thick type M or S portland cement mortar parging on the exterior of the wall from footing to finished grade.

2. Masonry foundation walls shall be damp–proofed by applying to the exterior surface of the portland cement parging from footing to finished grade, a continuous coating of one of the following:

a. A bituminous coating applied in accordance with the manufacturer's instructions.

b. Acrylic–modified cement applied at a minimum rate of 3 pounds per square yard.

c. A layer of minimum $^1/_8$–inch thick structural surface bonding material labeled as complying with ASTM C887.

**Note:** The ASTM C887 standard is entitled, "Standard Specification for Packaged, Dry, Combined Materials for Surface Bonding Mortar."

d. A waterproofing treatment applied in accordance with the manufacturer's instructions.

3. a. Parging of masonry block foundation walls is not required where a dampproofing material is sufficiently flexible to be listed or designed for direct application to masonry block.

b. Parging of masonry block foundation walls is not required where a layer of minimum ¼–inch thick structural surface bonding material labeled as complying with ASTM C887 is used for dampproofing.

(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 321.18–C, but in no case shall the thickness be less than the thickness of the wall it supports.

2. Reinforced masonry walls shall be reinforced in accordance with the requirements of Tables 321.18–D, 321.18–E or 321.18–F. Vertical reinforcement shall be provided on each side of any opening and at intervals indicated in the appropriate table.

## Table 321.18–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, GC, SM, SM–SC and ML soils 45 | SC, MH, ML–CL and inorganic CL 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, see s. SPS 321.18 (1) (e). 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 321.18–D, 321.18–E or 321.18–F is required.
[d] Mortar shall be Type M or S and masonry shall be laid in running bond.

## Table 321.18–D[b,c,d]

**8, 10 OR 12 IN. REINFORCED MASONRY FOUNDATION WALLS WHERE d ≥ 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. SPS 321.18 (1) (e). 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. SPS 321.18 (3) (b).
[c] For alternative reinforcement, see s. SPS 321.18 (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 321.18–E[b,c,d]

**10 OR 12 IN. REINFORCED MASONRY FOUNDATION WALLS WHERE d ≥ 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. SPS 321.18 (1) (e). 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. SPS 321.18 (3) (b).
[c] For alternative reinforcement, see s. SPS 321.18 (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 321.18–F[b,c,d]

**12 IN. REINFORCED MASONRY FOUNDATION WALLS WHERE d ≥ 8.75 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 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 40″ 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. SPS 321.18 (1) (e). 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. SPS 321.18 (3) (b).
[c] For alternative reinforcement, see s. SPS 321.18 (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 321.18−D, 321.18−E and 321.18−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 321.18−D, 321.18−E and 321.18−F only if the design is based on structural analysis.

**(4)** WOOD FOUNDATIONS. Wood foundations shall be designed and constructed in accordance with the wood−foundation standard adopted in Table 320.24−6m.

**Note:** The department will accept Permanent Wood Foundations Design and Construction Guide published by the Southern Forest Products Association through the Southern Pine Council, as complying with this standard. The Design and Construction Guide requires a 3.5 inch thick floor slab if a poured concrete floor slab is used.

**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, Register March 2001 No. 543, eff. 4−1−01; CR 02−077: r. (1) (c) 1., renum. (1) (d) to be (1) (e), cr. (1) (d), am. (4) (intro.), (b) and Tables 21.18−A, C and F Register May 2003 No. 569, eff. 8−1−03; CR 08−043: am. (1) (d) 2. b. and Tables 21.18−C to F, cr. (2) (a) (title) and (b) (title), r. and recr. (3) (a) and (4) Register March 2009 No. 639, eff. 4−1−09; correction in (1) (e), (2) (a), (3) (b) 1., 2., 5., 6., (4), Table 321.18−C to −F made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; CR 15−041: am. (1) (c) 3. a., cr. (1) (c) 3. d., am. (1) (d) 2. c., (4) Register December 2015 No. 720, eff. 1−1−16; CR 15−043: am. (1) (d) 1. c. Register December 2015 No. 720, eff. 1−1−16; correction under s. 13.92 (4) (b) 7. Register December 2015 No. 720.

## Subchapter VI — Floors

**SPS 321.19 Floor design.** Floors shall support all dead loads plus the minimum unit live loads as set forth in s. SPS 321.02. 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. SPS 321.20 or 321.205.

**History:** Cr. Register, November, 1979, No. 287, eff. 6−1−80; r. and recr., Register, March, 1992, No. 435, eff. 4−1−92; correction made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

**SPS 321.20 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. SPS 321.17 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; correction in (3) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

**SPS 321.203 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 be sloped such that water is removed in accordance with one of the following:

(a) Water drains toward the overhead door or to exterior grade such that no damage will be caused to any structural member or wall covering of the garage or the dwelling.

(b) Water drains into an interior floor drain that complies with the requirements of ch. SPS 382.

**Note:** See s. SPS 382.34 for floor drain requirements.

**History:** Cr. Register, November, 1995, No. 479, eff. 12−1−95; CR 02−077: r. and recr. (2) Register May 2003 No. 569, eff. 8−1−03; correction in (2) (b) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

**SPS 321.205 Wood floors in contact with the ground.** Wood floors in contact with the ground shall comply with the requirements under s. SPS 321.18 (4).

**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; CR 02−077: r. and recr. Register May 2003 No. 569, eff. 8−1−03; correction made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

**SPS 321.21 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.

**SPS 321.22 Wood frame floors.** Unless designed through structural analysis, wood frame floors shall comply with the following requirements:

**(1)** FLOOR JOISTS. (a) *General.* 1. Floor joists shall comply with the structural requirements and live load determination under s. SPS 321.02.

**Note:** See ch. SPS 325 Appendix A for design information.

2. Where the joists of a floor system are parallel to, and located between bearing walls above and below, the joists shall be doubled.

(b) *Floor joists on concrete walls.* Where a sill plate is provided for floor joists on poured concrete, the sill plates shall be fastened to the foundation.

**Note:** Section SPS 321.18 (1) (d) requires the floor joists to also be fastened to the sill plate.

(c) *Floor joists on masonry walls with a solid top course.* Where a sill plate is provided for floor joists on solid block top course masonry, the sill plate shall be fastened to the foundation.

(d) *Floor joists on masonry walls with open top course.* 1. Where the masonry wall has an open top course, a sill plate at least as wide as the foundation wall shall be fastened to the foundation.

2. Where anchor bolts are used on masonry walls with an open top course, the minimum width of an individual piece making up the sill plate shall be at least 5.5 inches.

**Note:** A sill plate can be made of multiple pieces to achieve the full width.

**(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. (a) Girders and beams shall be selected from Table 321.22−A1 or Table 321.22−A2 or shall be designed through structural analysis.

(b) 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.

(c) 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.

(d) Lateral restraint for all wood beams shall be provided at all columns using a saddle or other approved connection where the beam meets one of the following conditions:

1. The beam is not restrained at both ends.

2. The beam is more than 11.25 inches deep using actual measurement.

**Note:** A saddle supports the beam on the bottom and allows for the through–connection of fasteners into the side of the beam.

**(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 1½–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 ¼ 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 or another hole. In no case shall the distance between adjacent holes be less than the diameter of the larger hole.

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) *General*. Except as provided in pars. (b) and (c), a floor joist overhang shall be cantilevered beyond the outer edge of the supporting wall below it by no more than the actual depth of the joist or shall be designed through structural analysis in accordance with s. SPS 321.02 (3).

(b) *Joist overhangs parallel to the main floor framing system.* Joist overhangs that are extensions of, and parallel to, the main floor framing system may extend beyond the depth of the joist without structural analysis provided they meet all of the following conditions:

1. The overhang is cantilevered no more than 2 feet beyond the outer edge of the supporting wall below it.

2. a. The overhang supports a uniform load limited to the weight of the bearing wall and the tributary roof area above it.

b. The tributary length of the roof area, excluding the eave overhang, is no more than 2 feet greater than the actual length of the joist directly below.

c. The eave overhang is no more than 2 feet.

**Note:** The tributary length is usually half the span of the joist or rafter.

3. The joist overhang does not support any concentrated loads. For the purposes of this subsection, a framed opening in the wall with a rough opening of 4 feet or less shall be considered uniform loading.

4. a. The cantilevered joist is doubled at the supporting wall.

b. The doubled joist length extends inward beyond the inner edge of the supporting wall by the same distance as the cantilever.

c. The added joist member is secured to the main joist as stated in the nailing schedule in ch. SPS 325 Appendix A, under the heading for "floor framing, built–up girder and beams, top loaded".

(c) *Joist overhangs perpendicular to the main floor framing system.* Joist overhangs that are perpendicular to the main floor framing system, or lookout joists, may extend beyond the depth of the joist without structural analysis provided they meet all of the following conditions:

1. The joist overhang is cantilevered no more than 2 feet beyond the outer edge of the supporting wall below it.

2. a. A double floor joist is used to support the lookout joist.

b. The double floor joist is located a distance of at least 2 times the cantilever length inward from the outer edge of the supporting wall below.

c. The lookout joists are fastened to the double joist with metal hangers.

3. The joist overhang supports no more than either a non–bearing wall or a wall that supports only a roof which spans no more than the floor overhang cantilever length plus the eave overhang.

(d) All overhangs longer than the depth of the supporting joist that do not meet all of the conditions under par. (b) or (c) shall be designed through structural analysis.

**(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 321.22–A1

### MINIMUM SIZES FOR BEAMS AND GIRDERS OF STEEL OR WOOD

| | One Floor Only | | Roof/Ceiling and One Floor | | | | Roof/Ceiling+ One Floor/Ceiling + One Floor | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Column Spacing | Wood Beams[1] (in., nominal) | A 36 Steel Beams[2] | Wood Beams[1,3] (in., nominal) Zone 2 | Zone 1 | A 36 Steel Beams[2] Zone 2 | Zone 1 | Wood Beams[1,3] (in., nominal) Zone 2 | Zone 1 | A 36 Steel Beams[2] 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 3½–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 321.22–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 A321.

[3]The 2–inch members shall be laid on edge and fastened together with a double row of common nails not less than 3½–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 SHATHING, BOARDS AND PLANKS. (a) *Plywood sheathing.* Plywood sheathing used for floors shall be limited to the allowable loads and spans shown in Table 321.22–B.

(c) *Combination subfloor–underlayment.* Combination subfloor–underlayment shall be installed in accordance with Table 321.22–D.

(d) *Floor boards.* Where wood boards are used for floor sheathing, the boards shall comply with the minimum thicknesses shown in Table 321.22–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.

**Note:** This 4:1 ratio means bridging is required for wood–framed floors having nominal 2X10 or deeper solid–sawn–lumber joists, to provide restraint against rotation or lateral displacement.

(b) *Engineered products.* Bridging shall be provided for engineered framing products in accordance with the manufacturer's recommendations.

**Note:** See s. SPS 321.18 (1) (d) for further requirements relating to floor framing, including for bridging or blocking of floor framing to provide lateral support to the top of foundation walls.

**(10)** SILL PLATES. All of the following requirements apply to a sawn–lumber sill plate with uniform loading that is partially extended beyond the load–bearing surface of a foundation wall in order to put the exterior surface of an upper–lying wall flush with or beyond the exterior surface of insulation that is placed on the outside of the foundation wall:

(a) The center of any anchor bolt shall be set back from the side edge of the sill plate by a distance of at least 4 times the diameter of the bolt.

(b) The thickness of the concrete or mortar cover around any anchor bolt shall comply with ACI 318 section 7.7.

**Note:** Under ACI 318 section 7.7, the minimum cover for a 5/8–inch–diameter or smaller bolt is 1 1/2 inches.

(c) With wood floor joists that are parallel to the foundation wall, the sill plate may not extend beyond the load–bearing surface of the wall by more than one–half of the nominal thickness of the joist that bears on the sill plate.

**Note:** As used throughout this chapter and in the standards that the chapter incorporates by reference, the shorter side of the cross–sectional area of a wood member is the thickness of the member. The longer side of the cross–sectional area is the depth, when the longer side is vertical; and it is the width when the longer side is horizontal.

**Note:** Under sub. (6), wood floor joists that are perpendicular to the foundation wall can extend beyond the foundation wall by a distance of up to the depth of the joist.

**Note:** Subsection (1) (d) requires a full–width sill plate for floor joists over open–core masonry units.

### Table 321.22–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 ¼–inch minimum thickness underlayment or 1½ 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 1½ inches lightweight concrete.

[5]May be 24 inches if 25/32–inch wood strip flooring is installed at right angles to joists.

### Table 321.22–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 ¼–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 321.22–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; CR 02–077: am. (5) (b) 1., r. and recr. (6) Register May 2003 No. 569, eff. 8–1–03; CR 08–043: r. and recr. (1), r. (1m), (8) (b) and Table 21.22–C, renum. (3) (intro.), (a) and (b) to be (3) (a), (b) and (c), cr. (3) (d) Register March 2009 No. 639, eff. 4–1–09; correction in (1) (a) 1., (3) (a), (6) (a), (8) (a), (c), (d), Table 321.22–A2 made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; CR 15–041: cr. (10) Register December 2015 No. 720, eff. 1–1–16; CR 15–043: am. (6) (b) 4. c. Register December 2015 No. 720, eff. 1–1–16.

**SPS 321.225 Decks. (1)** Decks attached to dwellings and any detached decks that serve an exit shall comply with the applicable provisions of subchs. II to X of ch. SPS 321, including all of the following:

(a) Excavation requirements under s. SPS 321.14;

(b) Footing requirements under s. SPS 321.15 (2) (f);

(c) Frost penetration requirements under s. SPS 321.16;

(d) Load requirements under s. SPS 321.02;

(e) Stair, handrail and guard requirements of s. SPS 321.04.

(f) Decay protection requirements of s. SPS 321.10.

**(2)** A deck that complies with the standards in ch. SPS 325 Appendix B, and ch. SPS 325 Appendix C, if applicable, shall be considered as complying with sub. (1).

**History:** Cr. Register, March, 1992, No. 435, eff. 4–1–92; correction in (1) to (6) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; CR 15–043: Renum. to (1) and am., cr. (2) Register December 2015 No. 720, eff. 1–1–16.

## Subchapter VII — Walls

**SPS 321.23 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.

**SPS 321.24 Exterior covering. (1)** GENERAL. The exterior walls shall be covered with a permanent weather resistant finish.

**(2)** DURING CONSTRUCTION. During construction, wall cavity insulation may not be installed until a water–resistant covering is in place over the wall cavity and windows, doors and a roof with at least underlayment are installed.

**Note:** An example of acceptable water–resistant covering for a wall is foam sheathing with permanently taped joints.

**(3)** FLASHING. (a) Corrosion–resistant flashing shall be installed in the exterior wall to prevent water from entering the wall cavity or coming in contact with the structural framing components.

(b) The flashing shall extend to the surface of the exterior wall finish and prevent water from reentering the exterior wall.

(c) 1. Any joints between 2 pieces of flashing that form a vertical joint shall be lapped a minimum of 6 inches and sealed.

2. Any joints between 2 pieces of flashing that form a horizontal joint shall be lapped a minimum of 2 inches and sealed unless otherwise specified by the flashing manufacturer.

3. Sealants used for flashing shall be exterior grade and shall be compatible with the materials being sealed.

(d) Flashing shall be provided at all of the following locations:

1. At the top of all exterior door and window openings, unless using self–flashing windows that provide at least one inch of flashing around the opening, including the corners.

2. At the intersection of chimneys or other masonry construction with frame walls.

3. Under and at the ends of masonry, wood or metal copings and sills.

4. Continuously above all projecting wood trim.

5. Where porches, decks or stairs attach to a wall or floor assembly of wood frame construction.

6. At wall and roof intersections.

7. At built–in gutters.

8. Along the bottom of door openings that are elevated above–grade.

**Note:** Flashing placed along the bottom of a door opening that is elevated above–grade can subsequently accommodate adding a deck outside the door.

(e) For a roof that intersects with an upper–lying head wall and rake wall, such as where a dormer is provided, the vertical metal flashing along the rake wall shall extend down the roof at least one–half inch past the vertical flashing on the head wall.

**Note:** A head wall as addressed in this paragraph intersects a sloping roof at a horizontal line along the top of a roof segment. A rake wall intersects a sloping roof along the side of a roof segment.

(f) For a roof eave that intersects with a sidewall, the end of the roof flashing shall be installed so that it diverts water away from the sidewall and onto the roof or into the gutter.

**Note:** See s. SPS 321.26 (5) for additional flashing requirements with masonry cavity walls and s. SPS 321.28 (7) for additional flashing requirements with roofing.

**Note:** See s. SPS 321.26 (8) for further requirements relating to flashing for masonry.

**(4)** WATER–RESISTIVE BARRIER REQUIREMENTS. (a) *General.* 1. Exterior walls of wood or metal frame construction shall be provided with a water–resistive barrier from the highest point to the bottom of the permanent weather–resistant covering.

**Note:** Acceptable water–resistive barrier materials include polymeric–based house wraps and spray–applied water–resistive barriers installed per the manufacturer's instructions, #15 or greater asphalt–saturated felts that comply with ASTM D 226 for type I felt and extruded foam sheathing with permanently taped joints. Duct tape or similar will not result in a permanently taped joint.

2. Structural products with an integral water–resistive barrier may be approved by the department as a complete assembly.

(b) *Material compatibility.* The water–resistive barrier material shall be compatible with the other materials in the wall with which it will come into contact.

**Note:** Spray–applied water–resistive barriers may not be compatible with foam plastic insulation.

(c) *Performance requirements.* 1. Polymer–based house wraps shall meet all of the following requirements:

a. A water vapor permeability rating of 5 perms or higher when tested in accordance with ASTM E96.

b. An acceptable water–resistance rating determined in accordance with ASTM D779, AATCC 127 or CCMC 07102.

**Note:** Asphalt–saturated felt or "tar paper" is not a polymeric–based house wrap.

**Note:** For more information on the water–resistance tests and their results, see the International Code Council Evaluation Services Acceptance Criteria AC 38.

2. Spray–applied water–resistive barriers shall be approved under the International Code Council Evaluation Services.

**Note:** For approval criteria, see ICC–ES acceptance criteria AC 212 or successor document.

(d) *Application.* 1. Horizontal seams in sheet or strip material shall be overlapped such that the upper layer extends over the lower layer at least 2 inches.

2. Vertical seams in sheet or strip materials shall be overlapped at least 6 inches.

3. Any rips, tears or voids shall be patched in accordance with subds. 1. and 2.

(e) *Penetrations.* 1. Penetrations caused by fasteners of the water–resistive barrier or the weather–resistant exterior covering do not require sealing.

2. Penetrations of 5 square inches or less with an annular space of no more than ½ inch shall be sealed with caulk or similar material.

3. Penetrations of greater than 5 square inches shall be flashed in accordance with sub. (3).

**History:** Cr. Register, November, 1979, No. 287, eff. 6–1–80; r. and recr. Register, March, 2001, No. 543, eff. 4–1–01; CR 02–077: cr. (3) Register May 2003 No. 569, eff. 8–1–03; CR 08–043: am. (2), renum. (3) (c) to be (3) (d), cr. (3) (c) and (4) Register March 2009 No. 639, eff. 4–1–09; CR 15–041: cr. (3) (e), (f) Register December 2015 No. 720, eff. 1–1–16; CR 15–043: cr. (3) (d) 8. Register December 2015 No. 720, eff. 1–1–16.

**SPS 321.25 Wood frame walls.** Unless designed through structural analysis, wood frame walls shall comply with the following requirements.

**(1)** STUD CONFIGURATION. Wood studs shall comply with the size and spacing requirements indicated in Table 321.25–A. Studs in the exterior walls shall be placed with the wide faces perpendicular to the plane of the wall.

**Note:** See ch. SPS 325 Appendix A for acceptable nailing schedule.

**Note:** See s. SPS 321.10 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. SPS 321.02.

(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.

**(2m)** BOTTOM PLATES. (a) *Masonry foundation walls with open top course.* 1. Where a masonry foundation wall has an open top course, a bottom plate at least as wide as the foundation wall shall be fastened to the foundation.

2. Where anchor bolts are used on a masonry foundation wall with an open top course, the minimum width of an individual piece making up the bottom plate shall be at least 5 1/2 inches.

**Note:** A sill plate can be made of multiple pieces to achieve the full width.

(b) *Extension beyond the bearing surface.* All of the following requirements apply to a sawn–lumber sill plate with uniform loading that is partially extended beyond the load–bearing surface of a foundation wall in order to put the exterior surface of an upper–lying wall flush with or beyond the exterior surface of insulation which is placed on the outside of the foundation wall:

1. The center of any anchor bolt shall be set back from the side edge of the sill plate by a distance of at least 4 times the diameter of the bolt.

2. The thickness of the concrete or mortar cover around any anchor bolt shall comply with ACI 318 section 7.7.

**Note:** Under ACI 318 section 7.7, the minimum cover for a 5/8–inch–diameter or smaller bolt is 1 1/2 inches.

3. Where a stud wall bears directly on a double bottom plate, the plate may not extend more than 1 1/2 inches beyond the load–bearing surface of the foundation wall.

4. Where a stud wall bears directly on a single bottom plate, the plate may not extend more than 1 inch beyond the load–bearing surface of the foundation wall.

**(3)** WALL OPENINGS. (am) *Headers.* Where doors or windows occur, headers shall be used to carry the load across the opening.

(bm) *Header size.* The size of headers shall be determined in accordance with the spans and loading conditions listed in Tables 321.25–B, 321.25–C and 321.25–D. Headers for longer spans shall be designed by an engineering method under s. SPS 321.02.

(cm) *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.

**(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. All columns shall be positively attached to the beams they support using clips, straps or saddles.

5. 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.

**Table 321.25–A**

**SIZE, HEIGHT AND SPACING OF WOOD STUDS[a, c]**

| Nominal Stud Size (inches) | Bearing and Exterior Nonbearing Walls | | | | | Interior Nonbearing Walls | |
|---|---|---|---|---|---|---|---|
| | Maximum Laterally Unsupported Stud Height[a] (feet) | Maximum Spacing When Supporting Roof and Ceiling Only (inches) | Maximum Spacing When Supporting One Floor, Roof and Ceiling (inches) | Maximum Spacing When Supporting Two Floors, Roof and Ceiling (inches) | Maximum Spacing When Supporting One Floor Only (inches) | Maximum Laterally Unsupported Stud Height[a] (feet) | Maximum Spacing (inches) |
| | |  |  |  |  | | |
| 2 x 3[b] | – | – | – | – | – | 10 | 16 |
| 2 x 4 | 10 | 24 | 16 | – | 24 | 14 | 24 |
| 3 x 4 | 10 | 24 | 24 | 16 | 24 | 14 | 24 |
| 2 x 5 | 10 | 24 | 24 | – | 24 | 16 | 24 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 x 6 | 12[d] | 24 | 24 | 16 | 24 | 20 | 24 |

[a]Listed heights are distances between points of lateral support placed perpendicular to the plane of the wall. Increases in unsupported height are permitted where justified by analysis. Studs shall be stud grade or better, except that utility grade may be used when spaced not more than 16 inches on center, supports no more than a roof and ceiling and does not exceed 8 feet in height for exterior walls or 10 feet in height for interior nonload−bearing walls.

[b]May not be used in exterior walls.

cAll spacing dimensions are to the center of the studs.

[d]Use of stud heights that range from over 10 feet to 12 feet for bearing and exterior nonbearing walls is prohibited unless supported by structural analysis. The allowable deflection may not exceed whichever of the following are applicable:

Interior walls and partitions — span height/180.
Exterior walls with plaster or stucco finish — span height/360.
Exterior walls with other brittle finishes — span height/240.
Exterior walls with flexible finishes — span height/120.
Exterior walls with interior gypsum wallboard finish — span height/180.
Any manufacturer−specified limits for any included windows or doors.

**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.

2. Columns made solely of steel pipe stock shall follow Table 321.25−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 321.25−F or the size shall be determined through structural analysis or load testing.

**Table 321.25−B**

**ALLOWABLE SPANS (FEET) FOR HEADERS SUPPORTING ROOF/CEILING ASSEMBLIES***

| | 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** | |
| | **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 321.25−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 321.25−D**

**ALLOWABLE SPANS (FEET) FOR HEADERS SUPPORTING ONE FLOOR AND ROOF/CEILING ASSEMBLY***

| | 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** | |
| | **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 321.25−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 321.25–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 321.25–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.

**(7)** FOUNDATION CRIPPLE WALLS. (a) Foundation cripple walls shall be framed with studs at least as large as the studs above.

(b) When more than 4 feet in height, cripple walls shall be framed with studs needed for an additional floor level.

(c) Cripple walls with a stud height of less than 14 inches shall be sheathed on at least one side for its entire length with a wood structural panel that is fastened to both the top and bottom plates or the cripple walls shall be constructed of solid blocking.

(d) Cripple walls with a stud height of 14 inches or greater shall be braced in accordance with sub. (8).

(e) Cripple walls shall be fully supported by a continuous foundation.

**(8)** WALL BRACING. (a) *General.* Dwellings using wood–framed walls shall be braced in accordance with this section. Where a building, or a portion thereof, does not comply with one or more of the bracing requirements in this section, those portions shall be designed and constructed in accordance with accepted engineering practice.

**Note:** Acceptable engineering wall bracing practices include any of the following:

1. The provisions under section R602.10 or R602.12 of the International Residential Code (IRC) – 2012.

2. Design in accordance with the engineering basis of the 2012 IRC bracing provisions, such as described in Crandell, J. and Martin, Z., "The Story Behind the *2009 IRC* Wall Bracing Provisions (Part 2: New Wind Bracing Requirements)," *Wood Design Focus*, Forest Products Society, Peachtree Corners, GA, Spring 2009.

3. Installation instructions from the manufacturer of the bracing product that are compliant with s. SPS 321.02.

**Note:** For a walk–out basement where some of the walls are concrete and other walls or portions thereof are wood–framed, the Department considers a minimum 8–inch–nominal–thickness poured–in–place concrete basement wall as being equivalent in lateral load and shear resistance to any of the allowable wood–framed wall bracing materials. To determine the required bracing for a walk–out basement, first draw a rectangle around the entire floor plan and projections as if all of the walls are wood–framed. Determine the required bracing amounts per the chosen bracing material and method and then locate the bracing to meet the requirements of Figure 321.25–C. Any required braced wall panel locations that occur on a wall or portion of a wall that is actually of poured–in–place concrete construction is considered equivalent, and that amount of bracing will count towards the minimum required amount and will not need to be provided in another location on that rectangle side.

(b) *Bracing Materials and Methods.* Wall bracing shall consist of the materials and methods listed in Table 321.25–G or approved alternatives capable of providing the required wind load resistance as determined in accordance with s. SPS 321.02 (1) (c).

## Table 321.25–G

**BRACING METHODS[a, f]**

| Material | Minimum Brace Material Thickness or Size | Maximum Nominal Wall Height[b] | Minimum Braced Wall Panel Width or Brace Angle | Connection Criteria | |
|---|---|---|---|---|---|
| | | | | Minimum Fasteners | Maximum Spacing |
| Intermittent Bracing Methods | | | | | |
| LIB[c]<br>Let–in bracing | 1x4 wood brace<br>(or approved metal brace installed per manufacturer instructions) | 10’ | 45° angle and maximum 16” o.c. stud spacing[b] | 2–8d common nails or 3–8d box nails (2 3/8” long x 0.113” diameter) | Per stud and top and bottom plates[e] |
| DWB<br>Diagonal wood boards | ¾” (1” nominal) for maximum 24” o.c. stud spacing | 10’ | 48” | 2–8d box nails (2 3/8” long x 0.113” diameter) or 2 – 1 3/4” long 16–gage staples | Per stud and top and bottom plates[e] |
| WSP<br>Wood structural panel | 3/8” for maximum 16”o.c. stud spacing;<br>7/16” for maximum 24” o.c. stud spacing | 10’ | 48” | 6d common nail or 8d box nail (2 3/8” long x 0.113” diameter); or 7/16”– or 1/2”–crown 16–gage staples, 1 1/4” long | 6” edges, 12” field (nails)<br>3” edges, 6” field (staples) |
| SFB<br>Structural fiber-board sheathing | ½” for maximum 16” o.c. stud spacing | 10’ | 48” | 1 1/2” long x 0.120” diameter galvanized roofing nails or 1”–crown 16–gage staples, 1 1/4” long | 3” edges, 6” field |
| GB<br>Gypsum board (installed on both sides of wall) | ½” for maximum 24” o.c. stud spacing | 10’ | 96” | 5d cooler nails, or #6 screws | 7” edges, 7” field (including top and bottom plates) |
| Continuous Sheathed Bracing Methods | | | | | |
| CS–WSP[d]<br>Continuous sheathed WSP | 3/8” for maximum 16”o.c. stud spacing;<br>7/16” for maximum 24” o.c. stud spacing | 12’ | Refer to Table 321.25–H | Same as WSP | Same as WSP |
| CS–SFB[d]<br>Continuous sheathed SFB | ½” for maximum 16” o.c. stud spacing | | | Same as SFB | Same as SFB |
| Narrow Panel Bracing | | | | | |
| PF<br>Portal frame | 7/16” | 12’ | Refer to Figure 321.25–A | Refer to Figure 321.25–A | Refer to Figure 321.25–A |

[a]The interior side of all exterior walls shall be sheathed with minimum ½–inch gypsum wallboard unless otherwise permitted to be excluded by this subsection. All edges of panel–type wall bracing, except horizontal joints in GB bracing, shall be attached to framing or blocking.

[b]The actual measured wall height shall include stud height and thickness of top and bottom plates. The actual wall height shall be permitted to exceed the listed nominal values by not more than 4½ inches. Tabulated bracing amounts in s. SPS 321.25 (8) (c) are based on a 10–foot nominal wall height for all bracing methods and shall be permitted to be adjusted to other nominal wall heights not exceeding 12 feet in accordance with footnotes to Table 321.25–I or Table 321.25–J.

[c]LIB is not permitted for walls supporting a roof and two floors. Two LIB braces installed at a 60° angle from horizontal shall be permitted to be substituted for each 45° angle LIB brace.

[d]Bracing with CS–WSP and CS–SFB shall have sheathing installed on all sheathable surfaces above, below, and between wall openings.

[d]Shall be attached to the top and bottom plates and any intermediate studs, in one continuous length.

[e]Each braced panel may contain no more than one hole, having a maximum dimension of no more than ten percent of the least dimension of the panel, and confined to the middle three–fourths of the panel.

## Table 321.25–H[a, b]

**MINIMUM WIDTHS OF CS–WSP AND CS–SFB BRACED WALL PANELS**

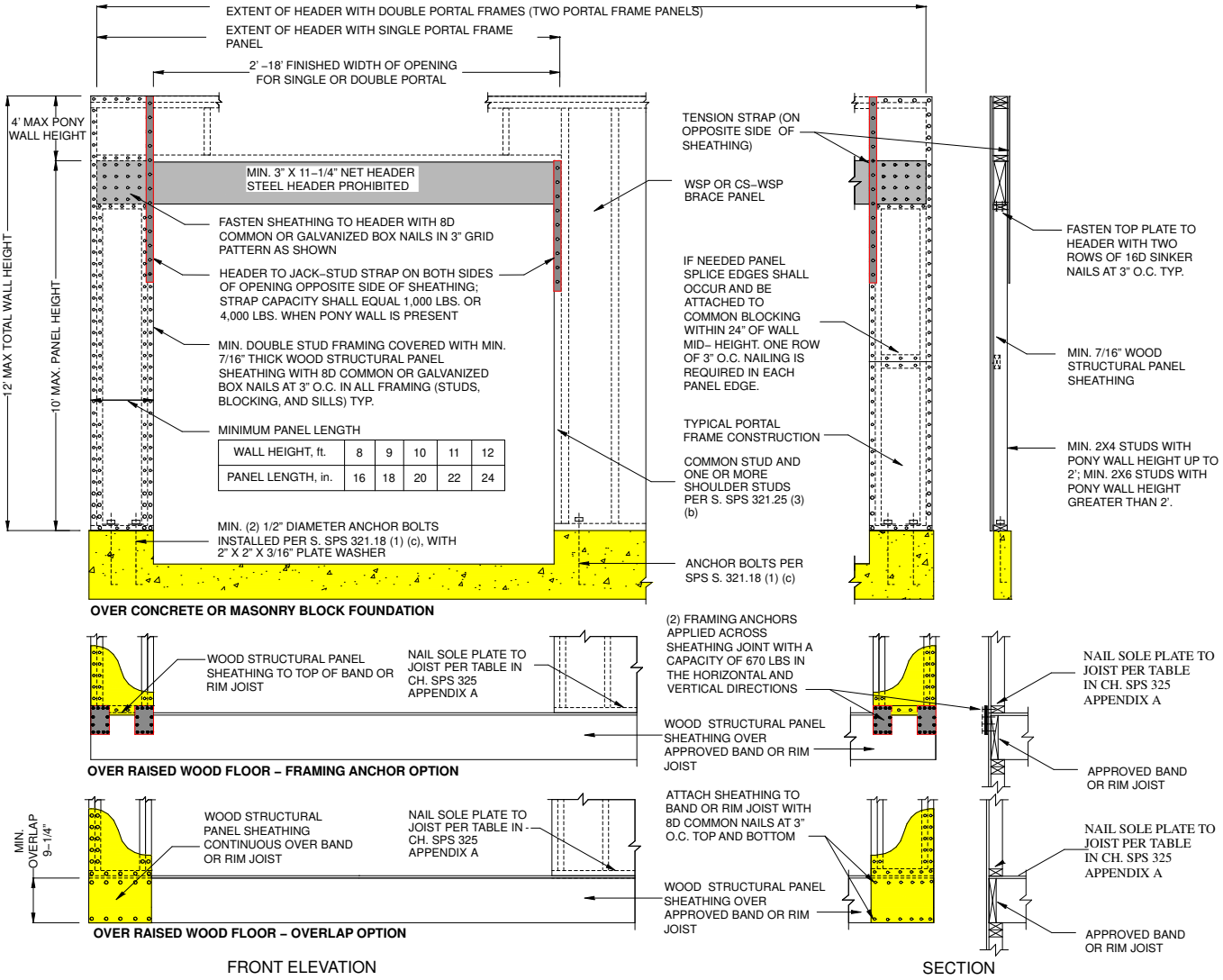
| Maximum Opening Height Adjacent to Braced Wall Panel | Minimum Width of Full–Height Braced Wall Panel (inches) | | | |
|---|---|---|---|---|
| | 8’ Tall Wall | 9’ Tall Wall | 10’ Tall Wall | 12’ Tall Wall |
| 5’– 4” | 24 | 27 | 30 | 36 |
| 6’– 8” | 32 | 30 | 30 | 36 |
| 8’ | 48 | 41 | 38 | 36 |
| 9’ | – | 54 | 46 | 41 |
| 10’ | – | – | 60 | 48 |
| 12’ | – | – | – | 72 |

[a]Sheathing shall extend from the top of the top plate to the bottom of the bottom plate and may be multiple sheets. All joints shall be blocked.

[b]Interpolation is permitted.

**Figure 321.25–A**

**METHOD PF – PORTAL FRAME BRACE CONSTRUCTION**




**Note:** Steel headers are permitted if designed by structural analysis.

**Note:** As shown in the above cross–section, 1/2–inch gypsum wallboard is not required on the interior side of the wall.

(c) *Bracing amount.* Bracing methods and materials complying with Table 321.25–G shall be applied to walls in accordance with all of the following requirements:

1. For the purpose of determining bracing amounts, the outermost extents of the building plan at each floor level shall be circumscribed with a rectangle to define the overall length of each building side as shown in Figure 321.25–B.

2. In no case may the amount of bracing be less than two braced wall panels on walls parallel to each rectangle side for each floor level of the building.

3. Where used, the number of intermittent brace panels applied to walls parallel to each rectangle side shall comply with Table 321.25–I.

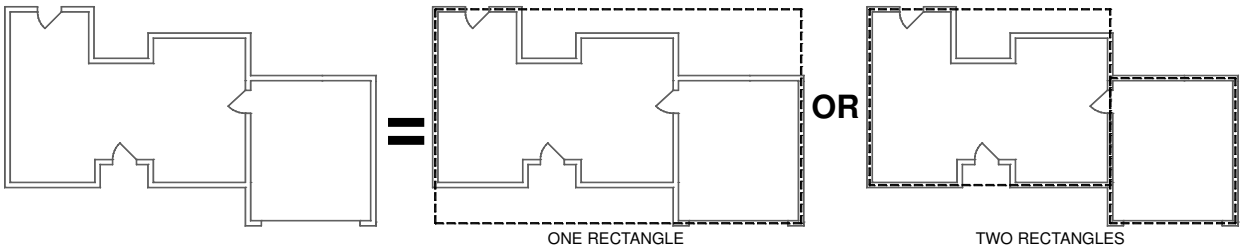
4. Where used, the total length of continuous sheathed brace panels applied to walls parallel to each building side shall comply with Table 321.25–J.

5. The location of brace panels applied to walls parallel to each building side shall comply with Figure 321.25–C.

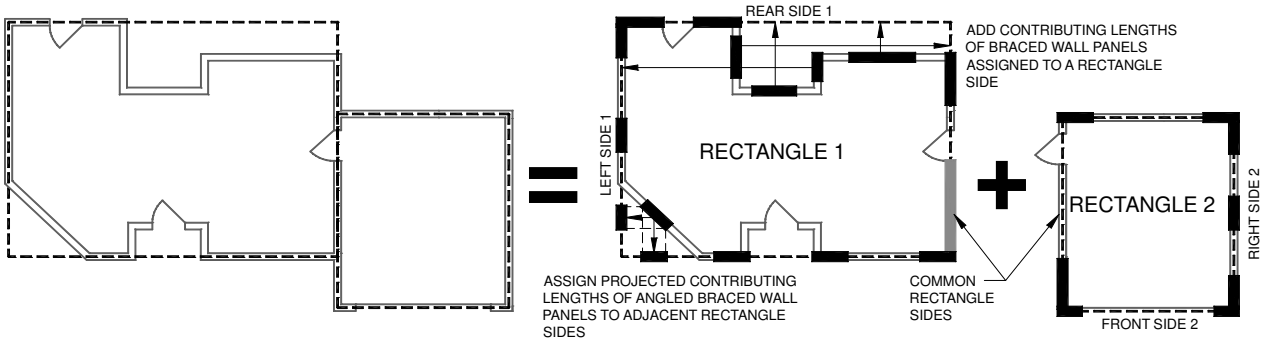
6. Balloon–frame walls may be no longer than 21 feet and shall have a maximum height of two floors unless constructed in accordance with an approved design. Wall framing shall be continuous from the lowest floor to the wall top plate at the roof. All edges of sheathing shall be supported on and fastened to blocking or framing. Braced wall panels may not be required on the balloon–frame wall portion provided the bracing amount and brace spacing requirement are satisfied for the building side. Where brace panels are located on the balloon–frame wall portion, they shall have a height–to–width ratio of not more than 2.5:1.

7. For a gable end wall, if the brace–panel height does not exceed 12 feet at the highest portion and if the 12½–foot and 21–foot spacing requirements in Figure 321.25–C are met, the wall is adequately braced. Where a brace panel exceeds 12 feet in height, it shall have a height–to–width ratio of not more than 2.5:1, and comply with Figure 21.25–C.

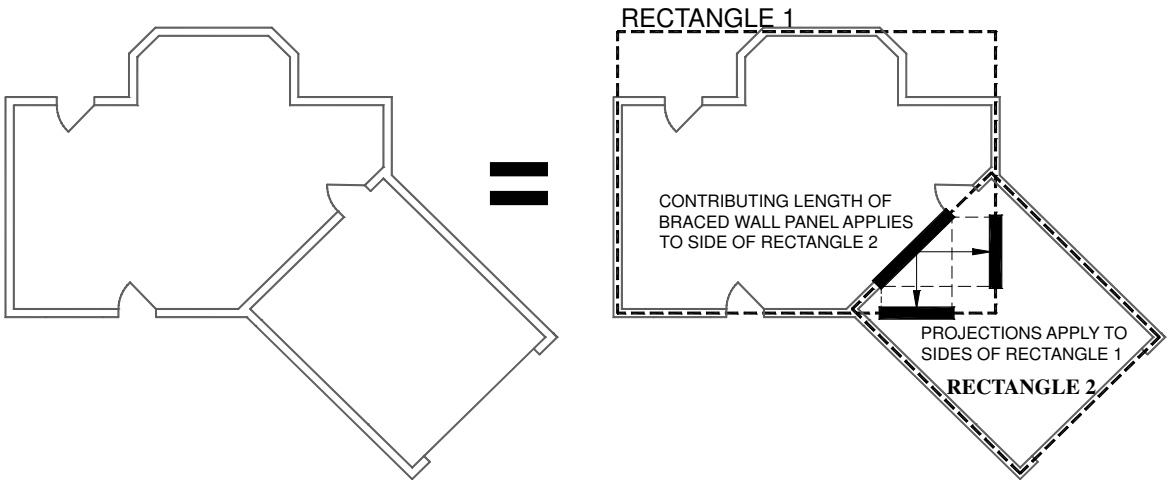
**FIGURE 321.25–B**
**DEFINING BUILDING SIDES AND LENGTHS WITH ONE OR MORE CIRCUMSCRIBED RECTANGLES[a,b,c]**




**(1) Basic floor plan**




**(2) Angled–building–side plan[d]**




**(3) Angled floor plan[e]**

[a]Each floor plan level shall be circumscribed with one or more rectangles around the entire floor plan at the floor level under consideration as shown. When multiple rectangles are used, each side shall be braced as though it were a separate building and the bracing amount added together along the common wall where adjacent rectangles overlap or abut.

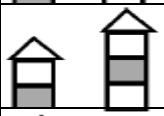
[b]Rectangles shall surround all enclosed plan offsets and projections. Chimneys, partial height projections, and open structures, such as carports and decks, shall be excluded from the rectangle.

[c]Each rectangle shall have a maximum rectangle length–to–width ratio of 3:1.

[d]Projected contributing lengths of angled braced wall panels shall be assigned to the closest rectangle sides, as shown for the angled corner in the angled–building–side–plan shown above.

[e]Braced wall panels located on a common wall where angled rectangles intersect, as shown in Figure 321.25–B(3), shall have their contributing length applied towards the required length of bracing for the parallel rectangle side and its projected contributing lengths towards the adjacent angled rectangle sides. Where the common side of rectangle 2 as shown in Figure 321.25–B(3) has no physical wall, the portion shall be designed in accordance with s. SPS 321.25 (8) (a).

**TABLE 321.25–I**
**REQUIRED NUMBER OF INTERMITTENT BRACED WALL PANELS ON WALLS PARALLEL TO EACH RECTANGLE SIDE AT EACH FLOOR LEVEL[a,b,c,d,e,f, h, j]**

| Wall Supporting: | | Required Number of Brace Panels on a Building Side Length of Perpendicular Side (feet)[g] | | |
|---|---|---|---|---|
| | | ≤25 | ≤50 | ≤75 |
| Roof and ceiling only |  | 1[i] | 2 | 3 |
| One floor, roof and ceiling |  | 2 | 4 | 6 |
| Two floors, roof and ceiling |  | 3 | 6 | 9 |

[a]Interpolation is permitted. Extrapolation to buildings larger than addressed in this table is prohibited.

[b]This table applies to wind exposure category B. For wind exposure category C or D, multiply the number of braced wall panels required by 1.3 or 1.6, respectively.

Wind exposure category B is comprised of urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single–family dwellings or larger. Exposure B shall be assumed unless the site meets the definition of another type exposure.

Wind exposure category C is comprised of flat, open country and grasslands with scattered obstructions, including surface undulations or other irregularities, having heights generally less than 30 feet extending more than 1,500 feet from the building site in any quadrant. This exposure also applies to any building located within Exposure B type terrain where the building is directly adjacent to open areas of Exposure C type terrain in any quadrant for a distance of more than 600 feet.

Wind exposure category D is comprised of flat, unobstructed areas exposed to wind flowing over open water for a distance of at least 1 mile. This exposure applies only to those buildings and other structures exposed to the wind coming from over the water. Exposure D extends inland from the shoreline a distance of 1,500 feet or 10 times the height of the building or structure, whichever is greater.

[c]Tabulated values are based on a nominal wall height of 10 feet. For nominal wall heights other than 10 feet and not more than 12 feet, multiply the required number of brace panels by the following factors: 0.9 for 8 feet, 0.95 for 9 feet, 1.15 for 11 feet, or 1.3 for 12 feet.

[d]Tabulated values are based on a roof with a top–of–wall–to–ridge height of 10 feet. For top–of–wall–to–ridge heights other than 10 feet, multiply the required number of brace panels by the following factors for each floor level support condition:

Roof only – 0.7 for 5 feet, 1.3 for 15 feet, or 1.6 for 20 feet

Roof + 1 Floor – 0.85 for 5 feet, 1.15 for 15 feet, or 1.3 for 20 feet

Roof + 2 Floors – 0.9 for 5 feet or 1.1 for 15 feet.

[e]Where minimum 1/2–inch gypsum wallboard is not included on the interior side of the wall, multiply the number of braced wall panels by 1.7 for LIB bracing or 1.4 for all other bracing methods, except this increase is not required for the portal frame method.

[f]Adjustments in footnotes b to e apply cumulatively. Fractions of panels shall be rounded to the nearest one–half braced wall panel.

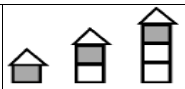
[g]Perpendicular sides to the front and rear sides are the left and right sides. Perpendicular sides to the left and right sides are the front and rear sides. See Figure 321.25–B.

[h]The following braced wall panel conditions shall be permitted to be counted as one–half a braced wall panel toward meeting the required number of panels: (1) one 60 degree LIB; (2) one 48" GB or one 96" GB with gypsum wallboard on one side; (3) one 36" WSP or SFB braced wall panel for wall heights not more than 9 feet; (4) a 48" WSP or SFB braced wall panel where there is no more than one unblocked horizontal joint; or (5) one PF brace panel complying with Figure 321.25–A.

[i]This value of less than 2 serves only as the beginning value for calculation purposes. The resulting value shall be 2 or greater, to be consistent with subd. 2.

[j]Any floor, habitable or otherwise, that is contained wholly within the roof rafters or roof trusses is exempt from being considered a floor for purposes of determining wall bracing if the top–of–wall–to–ridge height does not exceed 20 feet and if no opening in the roof exceeds 48 inches in height.

**Table 321.25–J**
**REQUIRED LENGTH OF CONTINUOUS BRACING ON WALLS PARALLEL TO EACH RECTANGLE SIDE AT EACH FLOOR LEVEL[a,b,c,d,e,g,h, j]**

| Top–of–Wall–to–Ridge Height (feet) | Wall Supporting: | | Total Required Length (feet) of Full–Height Bracing on Any Side of Rectangle | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Length of Perpendicular Side (feet)[f] | | | | | | | |
| | | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
| 10 | Roof and ceiling only |  | 2.0 [i] | 3.5 [i] | 5.0 | 6.0 | 7.5 | 9.0 | 10.5 | 12.0 |
| | One floor, roof and ceiling |  | 3.5 [i] | 6.5 | 9.0 | 12.0 | 14.5 | 17.0 | 19.8 | 22.6 |
| | Two floors, roof and ceiling |  | 5.0 | 9.5 | 13.5 | 17.5 | 21.5 | 25.5 | 29.2 | 33.4 |
| 15 | Roof and ceiling only |  | 2.6 [i] | 4.6 | 6.5 | 7.8 | 9.8 | 11.7 | 13.7 | 15.7 |
| | One floor, roof and ceiling |  | 4.0 | 7.5 | 10.4 | 13.8 | 16.7 | 19.6 | 22.9 | 26.2 |
| | Two floors, roof and ceiling |  | 5.5 | 10.5 | 14.9 | 19.3 | 23.7 | 27.5 | 32.1 | 36.7 |
| 20 | Roof and ceiling only |  | 2.9 [i] | 5.2 | 7.3 | 8.8 | 11.1 | 13.2 | 15.4 | 17.6 |
| | One floor, roof and ceiling |  | 4.5 | 8.5 | 11.8 | 15.6 | 18.9 | 22.1 | 25.8 | 29.5 |
| | Two floors, roof and ceiling |  | 6.2 | 11.9 | 16.8 | 21.8 | 27.3 | 31.1 | 36.3 | 41.5 |

[a]Interpolation is permitted. Extrapolation to buildings larger than addressed in this table is prohibited.

[b]This table applies to wind exposure category B. For wind exposure category C or D, multiply the required length of wall bracing by 1.3 or 1.6, respectively. Wind exposure categories are as defined in Table 321.25–I footnote b.

[c]Tabulated values are based on a nominal wall height of 10 feet. For nominal wall heights other than 10 feet, multiply the required length of bracing by the following factors: 0.90 for 8 feet, 0.95 for 9 feet, 1.05 for 11 feet, or 1.10 for 12 feet.

[d]Where minimum ½–inch gypsum wallboard interior finish is not provided, the required bracing amount for the affected rectangle side shall be multiplied by 1.4, except this increase is not required for the portal frame method.

[e]Adjustments in footnotes b to d apply cumulatively.

[f]Perpendicular sides to the front and rear sides are the left and right sides. Perpendicular sides to the left and right sides are the front and rear sides. See Figure 321.25–B.

[g]Continuous sheathing shall be applied to all surfaces of the wall, including areas between brace panels and above and below wall openings.

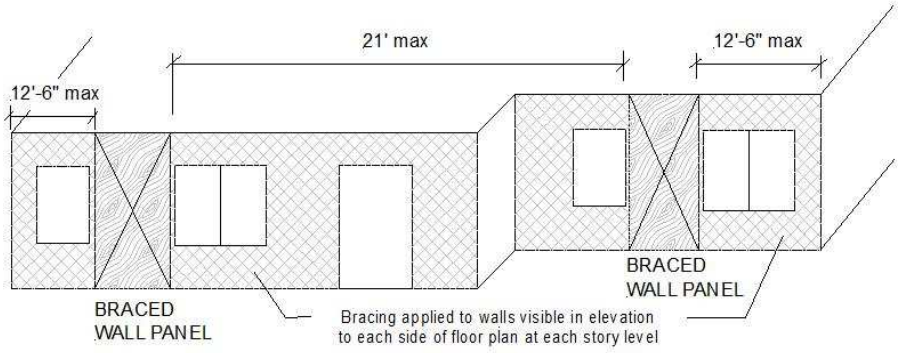
[h]When used on a wall line with continuous sheathing, each portal frame panel is counted for its actual length in contributing toward the length of continuous sheathing used on other portions of the same wall line, such as the building side at a given story level.

[i]Any value of less than 4.0 in this table serves only as the beginning value for calculation purposes. The resulting value shall be 4.0 or greater, to be consistent with Table 321.25–H and subd. 2.

[j]Any floor, habitable or otherwise, that is contained wholly within the roof rafters or roof trusses is exempt from being considered a floor for purposes of determining wall bracing if the top–of–wall–to–ridge height does not exceed 20 feet and if no opening in the roof exceeds 48 inches in height.

**Figure 321.25–C**

**LOCATION OF BRACED WALL PANELS ALONG A BUILDING SIDE[a]**




[a]A braced wall panel can be anything from one–half to one brace panel.

(d) *Braced wall panel support.* Braced wall panels shall be supported on floor framing or foundations as follows:

1. Where joists are perpendicular to braced wall lines above or below, blocking shall be provided between the joists at braced wall panel locations to permit fastening of wall plates in accordance with the fastener table in the ch. SPS 325 Appendix A.

2. Where joists are parallel to braced wall lines above or below, a rim joist or other parallel framing member shall be provided at the wall to permit fastening of wall plates in accordance with the fastener table in the ch. SPS 325 Appendix A.

3. Braced wall panels shall be permitted to be supported on cantilevered floor joists meeting the cantilever limits of s. SPS 321.22 (6) provided joists are blocked at the nearest bearing wall location, except such blocking is not required for cantilevers not exceeding 24 inches where a full height rim joist is provided.

**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; CR 02–077: r. (3) (c) Register May 2003 No. 569, eff. 8–1–03; CR 08–043: am. (1) (title), r. (1) (b), renum. (1) (a) and (6) (a) 4. to be (1) and (6) (a) 5., r. and recr. Table 21.25–A, cr. (6) (a) 4., (7), (8) and (9) Register March 2009 No. 639, eff. 4–1–09; correction in Figure 21.25–E made under s. 13.92 (4) (b) 7., Stats., Register March 2009 No. 639; CR 09–104: am. 21.25 (8) (e) 2., Table 21.25–H, (9) (b) 3., Table 21.25–J, Figure 21.25–G (c), (9) (c) 4. Register December 2010 No. 660, eff. 1–1–11; correction in (1), (2) (b) 3., (3) (a), (6) (c) 2., (d), (8) (c) 1. d., 2. c., (d), (e) 2., 3., (f) 2., (g) 3., (h) 2. b., (9) (b) 1., 2. b., d., 4. b., c., i., (c) 2. (intro.), b., c., d., 3., 4., 5. a., c., d., g., h., i., Table 321.25–H, Figure 321.25–F, –H to –K made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; EmR1403: emerg. am. Table 321.25–A, (7) (d), r. and recr. (8) (b), (c), Tables 321.25–G to 321.25–J, Figures 321.25–A to 321.25–C, r. (8) (d) to (f), renum. (8) (g) (title), (intro.), 1. to 3. to (8) (d) (title), (intro.), 1. to 3., r. (8) (g) 4., (h), (9), Tables 321.25–K, 321.25–L, Figures 321.25–D to 321.25–K, eff. 4–1–14; CR 14–015: am. Table 321.25–A, (7) (d), r. and recr. (8) (b), (c), Tables 321.25–G to 321.25–J, Figures 321.25–A to 321.25–C, r. (8) (d) to (f), renum. (8) (g) (title), (intro.), 1. to 3. to (8) (d) (title), (intro.), 1. to 3., r. (8) (g) 4., (h), (9), Tables 321.25–K, 321.25–L, Figures 321.25–D to 321.25–K Register August 2014 No. 704, eff. 9–1–14; CR 15–041: cr. (2m), renum. (3) (intro.), (a), (b) to (3) (am), (bm), (cm), cr. (3) (am) (title), am Table I (title), Table J (title) Register December 2015 No. 720, eff. 1–1–16; CR 15–043: am. (8) (d) 1., 2. Register December 2015 No. 720, eff. 1–1–16.

**SPS 321.26 Masonry walls.** Masonry walls shall be constructed in accordance with the requirements of this section.

**(1)** COLD WEATHER WORK. When ambient air temperature is below 40°F, the cold weather construction procedures under ACI 530.1 shall be followed.

**Note:** The requirements for cold weather work are in sections 1.8 and 1.8C of the 2005 edition of the ACI standard.

**(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. (a) *Mortar specifications.* The type of mortar shall be determined from Table 321.26–A. The mortar shall conform to the requirements of ASTM C–270.

(b) *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 mortar specifications. Only mineral oxide may be used as mortar color and shall not exceed 10% by weight of the cement.

(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 2½ hours after mixing.

**Note:** To ensure proper mortar mixing, machine mixing is recommended.

**Table 321.26–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 |

(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) *Corbels.* Corbels shall be constructed in accordance with ACI 530.

(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 1¼ inches, unless at least $^2/_3$ the mass of the wythe of masonry involved is located directly over the load–carrying member.

**(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 321.26–C.

**Table 321.26–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 $^1/_2$″ or Equivalent Reinforcing Bars[2] |
|---|---|---|---|---|
| L 3 x 3 x $^1/_4$ | 6′ – 0″ | 3′ – 6″ | 3′ – 0″ | 1 |
| L 4 x 3 x $^1/_4$ | 8′ – 0″ | 5′ – 0″ | 3′ – 0″ | 1 |
| L 6 x 3$^1/_2$ x $^1/_4$ | 14′ – 0″ | 8′ – 0″ | 3′ – 6″ | 2 |
| 2 – L 6 x 3$^1/_4$ x $^1/_4$ | 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. A minimum one–inch air space shall be provided between the veneer and the sheathing unless a manufactured offset material is used.

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 2 feet.

5. Ventilation openings shall be provided at the top of the wall.

**Note:** The ventilation opening could be other than a weep hole.

6. Studs and sheathing behind masonry veneer shall be covered with material used to construct the water–resistive barrier as required under s. SPS 321.24 (4).

**Note:** Acceptable water–resistive barrier materials include polymeric–based house wraps and #15 or greater asphalt–saturated felts that comply with ASTM D 226 for type I felt.

7. Masonry or brick veneer shall be above final exterior grade unless there is through–wall flashing at grade or within 2 courses above grade.

(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.

(c) *Veneer attachment.* Veneers shall be anchored or adhered in accordance with ACI 530 and ACI 530.1.

**(8)** FLASHING. (a) *General.* 1. Flashing shall be installed in accordance with this section to drain any water outward away from structural members, sheathing and insulation.

2. Open joints or weep holes shall be provided in the facing immediately above the flashing at a horizontal spacing not exceeding 2 feet.

3. Flashing that will be exposed to ultraviolet light shall consist of materials which are durable and permanently UV–resistant, such as sheet metal or heavy–gauge PVC.

**Note:** Materials including house wrap, asphalt–impregnated building paper, plastic sheeting, peel–and–stick rubberized sheet material, and light–gauge PVC are not acceptable as meeting this requirement.

(b) *Location.* 1. 'Lintels and chimneys.' In exterior hollow masonry walls, flashing shall be installed at the backsides of chimneys and at the bottom of the cavity formed by openings such as lintels over doors and windows.

2. 'Veneer.' Flashing shall be installed at the bottom of veneer and shall extend over the top of the foundation and up at least 8 inches and be embedded in the backing course.

(c) *Weep holes.* 1. Weep holes may not be placed below final grade.

2. Rope or similar material used to form a weep hole shall be removed as soon as the mortar sets.

3. Weep holes shall be $^3/_8$–inch minimum diameter.

**Note:** See s. SPS 321.24 (3) for further requirements relating to flashing for masonry.

**(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 2½ 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 ½–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 4½ 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 321.26.

**Table 321.26**

**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. Joints in masonry construction shall be constructed in accordance with ACI 530.1.

**(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; CR 02–077: am. (7) (a) 4. Register May 2003 No. 569, eff. 8–1–03; CR 08–043: r. and recr. (1), (5) (a), (8) and (12), renum. (3) (intro.) and (a) to be (3) (a) and (b) and am. (3) (a), am. (4) (b) and (7) (a) 2., r. (5) (c), Tables 21.26–B and B1, cr. (7) (a) 5. to 7. and (c) Register March 2009 No. 639, eff. 4–1–09; CR 09–104: am. (8) (a) 3. Register December 2010 No. 660, eff. 1–1–11; correction in (9) (c) made under s. 13.92 (4) (b) 7., Stats., Register January 2011 No. 661; correction in (3) (a), (6) (b), (7) (a) 6., (11) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

## Subchapter VIII — Roof and Ceilings

**SPS 321.27 Roof design and framing. (1)** STRUCTURAL DESIGN. (a) *General.* Roof and roof–ceiling assemblies shall support all dead loads plus the minimum live loads under par. (c) and s. SPS 321.02.

(b) *Applicability of tables.* The joist and rafter tables in ch. SPS 325 Appendix A are valid for roofs with a minimum slope of 3 in 12. Lesser slopes require engineering analysis or shall be provided with a ridge beam.

(c) *Sloped roof snow loads.* Snow loads specified in s. SPS 321.02 (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.

**Note:** A roof pitch of 7 in 12 is equal to 30°.

**(2)** LATERAL RESTRAINT OF WALLS. Provisions shall be taken to absorb the horizontal thrust produced by a sloping roof through the use of wall ties, ceiling joists, beams at the ridge or at the wall or a system designed through structural analysis.

**(3)** UPLIFT AND SUCTION FORCES. (a) *General.* 1. Roofs shall withstand a pressure of at least 20 pounds per square foot acting upward normal to the roof surface.

2. 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.

(b) *Anchorage.* 1. 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.

2. 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 ch. SPS 325 Appendix A.

**(4)** ROOF RAFTERS. (a) *General.* 1. Rafters shall be notched to fit the exterior wall plate and fastened to the wall.

2. Collar ties shall be installed on the upper third of every third pair of abutting roof rafters or every 48 inches, whichever is less.

**Note:** Collar ties are intended to provide stability to the roof at the ridge. Lateral restraint for the walls must be provided in accordance with sub. (2).

(b) *Ridge boards.* 1. Where rafters meet to form a ridge, the rafters shall be attached to a ridge board.

2. The ridge board shall have a depth at least equal to the length of the cut end of the rafter abutting it.

3. Where all rafters are placed directly opposite each other or are offset at the ridge board by less than the thickness of the rafter, the ridge board shall have a nominal thickness of at least 1 inch.

4. Where one or more rafters are offset at the ridge board by more than the thickness of the rafter, the ridge board shall have a nominal thickness of at least 2 inches.

(c) *Ridge beams.* Rafters shall be attached to ridge beams using engineered clips, straps or hangers or the connection shall be designed through structural analysis.

(d) *Bearing.* The required bearing for wood rafters shall be in accordance with the NDS adopted in Table 320.24–6m, except 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.

(e) *Ladders.* 1. Overhangs at gable end walls of more than 12 inches shall be provided with ladders which extend into the structure a distance no less than the length of the overhang.

2. The ladders shall be fastened at the wall.

3. The interior end of each ladder shall be attached to a rafter or truss with a hanger.

**Note:** For the purposes of this section, a ladder is defined as a perpendicular projection extending beyond the face of the wall below.

**(5)** CEILING JOISTS. (a) Ceiling joists shall be nailed to exterior walls and to the ends of rafters.

(b) Ends of ceiling joists shall be lapped at least 3 inches and be fastened either with 3–16d nails or in accordance with the floor joist requirements under s. SPS 321.22 (4) (a) 1. d.

**Note:** See the fastener table in the ch. SPS 325 Appendix A for a nailing schedule for ceiling joists.

(c) Where ceiling joists are placed at right angles to the rafters, the lookout joist or ties shall be fastened to the parallel ceiling joists or rafters using engineered clips, straps or hangers or the connection shall be designed through structural analysis.

**(6)** VALLEY AND HIP RAFTERS. (a) *Valley rafters.* 1. 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.

2. Where ridges are provided at different elevations, vertical support shall be provided for the interior end of the lower ridge board or ridge beam.

(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 than required to permit full contact with the jack rafter.

**(7)** ROOF TRUSSES. (a) Metal plate connected wood roof trusses shall be designed in accordance with TPI 1 and the NDS adopted under s. SPS 320.24.

(b) Truss members shall not be cut, bored or notched, except as allowed under sub. (8) (d).

(c) If connection is provided to stabilize a non–load bearing wall, a slotted expansion joint or clip shall be used.

**(8)** NOTCHING AND BORING. (a) *General.* 1. Notching and boring of beams or girders is prohibited unless determined through structural analysis.

2. Notching and boring of ceiling joists and rafters shall comply with pars. (b) and (c).

(b) *Notching.* 1. Notches located in the top or bottom of ceiling joists and rafters are prohibited from all of the following:

a. Having a depth exceeding $^1/_6$ the depth of the member.

b. Having a length exceeding $^1/_3$ the depth of the member.

c. Being located in the middle $^1/_3$ of the span of the member.

2. Where ceiling joists or rafters are notched at the ends, the notch may not exceed ¼ the depth of the member.

3. Bird mouth cuts may not exceed $^1/_3$ the depth of the rafter unless the seat cut bears fully on the wall plate.

(c) *Boring.* 1. Holes bored within 2 inches of the top or bottom of ceiling joists or rafters may not be located in the middle $^1/_3$ of the span of the member.

2. The diameter of a hole may not exceed $^1/_3$ the depth of the member.

3. A hole may not be bored within 2 inches of a notch or another hole.

4. The distance between adjacent holes may not be less than the diameter of the larger hole.

(d) *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.

**(9)** ROOF SHEATHING, BOARDS AND PLANKING. (a) *Structural sheathing.* The allowable loads and spans for structural sheathing shall be in accordance with the grade stamp on the panel.

(b) *Roof boards.* 1. Where the rafter spacing is 24 inches on center or less, roof boards may be used that have a minimum thickness of $^5/_8$–inch for solid sheathing and $^3/_4$–inch for spaced sheathing.

2. Where the rafter spacing is greater than 24 inches on center, roof boards shall be tongue and groove, at least 1.5 inches thick.

(c) *Roof planks.* 1. Roof planks shall be tongue and groove or splined and at least 2 inches, nominal, in thickness.

2. Planks shall terminate over beams unless the joints are end matched.

3. The planks shall be laid so that no continuous line of joints will occur except at points of support.

4. Planks shall be nailed or fastened to each beam.

**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; CR 02–077: r. and recr. (3) (b) Register May 2003 No. 569, eff. 8–1–03; CR 08–043: r. and recr. Register March 2009 No. 639, eff. 4–1–09; correction in (1) (a), (c), (4) (d), (5) (b), (7) (a) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; CR 15–041: am. (4) (d) Register December 2015 No. 720, eff. 1–1–16.

**SPS 321.28 Weather protection for roofs. (1)** GENERAL. (a) All roofs shall be designed and constructed to assure drainage of water.

(b) All fasteners shall be corrosion resistant.

**(2)** UNDERLAYMENT FOR SHINGLES. 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.

**(3)** ASPHALT SHINGLES. (a) *General.* 1. 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 results of testing conducted in accordance with an approved test method for verifying compliance with the sealant uplift resistance required in this paragraph. Information on the applicable test method may be obtained from the department.

2. 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 par. (c).

3. Shingles shall be installed in accordance with the manufacturer's recommendations.

4. Shingles shall have at least 4 fasteners per strip shingle or 2 fasteners per interlocking shingle, unless the manufacturer has other specifications.

5. Shingle head lap shall be at least 2 inches, unless the manufacturer has other specifications.

6. All fasteners for shingles shall be corrosion–resistant.

**Note:** See s. SPS 320.07 (62) for definitions of shingle terms.

**Note:** Section SPS 320.04 (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.

(c) *Fiberglass shingles.* 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.

**(4)** ICE DAM PROTECTION. (a) Shingled or shake roofs that extend over a heated area of a dwelling or attached garage and that have a slope of 4:12 or less shall be provided with ice dam protection in the form of sheet metal or a product labeled as meeting the requirements of ASTM D 1970.

(b) The ice dam protection shall extend at least 30 inches up the roof slope from the roof edge and at least 12 inches up the roof slope beyond the inner face of the exterior wall.

**(5)** OTHER ROOF COVERINGS. All roof coverings not otherwise addressed in this section shall be installed in accordance with the manufacturer's instructions or a national standard recognized by the department.

**(6)** REROOFING. New roof coverings may not be installed over existing roof coverings where any of the following conditions exist:

(a) The existing roof or roof covering is water−soaked or has deteriorated such that it is inadequate as a base for additional roofing.

(b) The existing roof is wood shake, slate, clay, cement or asbestos−cement tile.

(c) The existing roof has 2 or more applications of any type of permanent roof covering.

**(7)** FLASHING. (a) *General.* Flashing shall be installed at the junction of chimneys and roofs, in all valleys, and around all roof openings.

(b) *Flashing of open valleys.* 1. Open valleys shall be flashed with at least No. 28 gauge 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 number 15 roofing underlayment.

2. Flashing sections shall be overlapped by at least 4 inches.

(c) *Flashing of closed valleys.* Where shingles are laced or woven over the valley, the valley shall be flashed with one of the following:

1. At least one layer of 50−pound roofing, at least 20 inches wide, over a layer of number 15 roofing underlayment.

2. A product labeled as meeting the requirements of ASTM D1970.

(d) *Chimney flashing.* 1. Chimneys shall be flashed and counter−flashed to a height of at least 6 inches.

2. Chimney crickets or saddles shall be installed where the upper side of a chimney is more than 30 inches wide on a sloping roof.

3. The intersection of the cricket and the chimney shall be flashed and counter−flashed to a height of at least 6 inches.

**History:** Cr. Register, November, 1979, No. 287, eff. 6−1−80; am. (7) (a), r. and recr. Table 321.28−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; CR 02−077: r. and recr. (1) (a), renum. (6) (intro) to (c) to be (6) (a) to (d) and am. (6) (a) to (c) Register May 2003 No. 569, eff. 8−1−03; CR 08−043: r. and recr. Register March 2009 No. 639, eff. 4−1−09; CR 15−041: am. (3) (a) 2., cr. (3) (a) 6., r. (3) (b), renum. (7) (c) to (7) (c) (intro.) and 1. and am., cr. (7) (c) 2. Register December 2015 No. 720, eff. 1−1−16; correction in (3) (a) 2. under s. 13.92 (4) (b) 7., Stats., Register December 2015 No. 720.

## Subchapter IX — Fireplace Requirements

**SPS 321.29 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 321.29.

**Table 321.29**
**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 ¼−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. SPS 323.06 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 321.29−1.

**Table 321.29−1**
**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. SPS 321.30 (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. SPS 321.30 (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; correction in (1), (5m), (6) (d), (9) (a), (12) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

**SPS 321.30 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 bed of refractory mortar or refractory cement.

(c) Variations in inside and outside dimensions shall not exceed ¼ inch for clay flue liners.

(d) There shall be a minimum clearance of ½–inch and a maximum clearance of 1–inch between the flue liner and the chimney walls.

(e) Unless serving a masonry fireplace under s. SPS 321.29, 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 ¼–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; CR 02–077: am. (7) (b) and (d) Register May 2003 No. 569, eff. 8–1–03; correction in (7) (e) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

**SPS 321.32 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. SPS 321.29 (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; correction in (3) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

## Subchapter X — Construction in Floodplains

**SPS 321.33 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.

### SPS 321.34 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. SPS 321.33.

**(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; correction in (1) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

## Subchapter XI — Installation of Manufactured Homes

### SPS 321.40 Installation standards.

**(1)** PRODUCED ON OR AFTER APRIL 1, 2007. (a) *Adoption of standards.* The federal *Model Manufactured Home Installation Standards*, 24 CFR part 3285, as in effect on December 1, 2014, is hereby incorporated by reference into this chapter.

**Note:** A copy of this edition of 24 CFR 3285 is on file in the offices of the Department and the Legislative Reference Bureau. Copies of 24 CFR 3285 are available at http://www.gpo.gov/fdsys/granule/CFR-2013-title24-vol5/CFR-2013-title24-vol5-part3285.

**Note:** Section 24 CFR 3285.1(a)(1) reads as follows: "States that choose to operate an installation program for manufactured homes in lieu of the federal program must implement installation standards that provide protection to its residents that equals or exceeds the protection provided by these Model Installation Standards."

(b) *Compliance.* A manufactured home produced on or after April 1, 2007, shall be installed in accordance with 24 CFR part 3285 except as otherwise provided by this subsection.

**Note:** As provided under 24 CFR 3285.1(a)(intro.), "The manufacturer's installation instructions, including specific methods for performing a specific operation or assembly, will be deemed to comply with these Model Installation Standards, provided they meet or exceed the minimum requirements of these Model Installation Standards and do not take the home out of compliance with the Manufactured Home Construction and Safety Standards (24 CFR part 3280)."

(c) *Additional definitions.* These are department definitions in addition to the definitions in 24 CFR 3285.5:

1. "Department" means the department of safety and professional services.

2. "HUD" means the federal department of housing and urban development.

3. "Manufactured home section" means a portion of a manufactured home which when installed does not provide all the facilities for year–round residential occupancy.

4. "Manufactured home unit" means a complete manufactured home which when installed provides all the facilities for year–round residential occupancy.

(d) *Substituted definitions.* Substitute the following definitions and informational note for the corresponding definitions in 24 CRF 3285.5:

1. "Approved" means acceptable to the department.

2. "Base flood elevation" means the elevation of the base flood, including wave height, relative to the datum specified on a county's flood hazard map.

3. "Flood hazard area" means the greater of either of the following:

a. The special flood hazard area shown on the flood insurance rate map.

b. The area subject to flooding during the design flood and shown on a county's flood hazard map, or otherwise legally designated.

4. "Flood hazard map" means a map delineating the flood hazard area and adopted by a county.

5. "Local authority having jurisdiction (LAHJ)" means the department; except where it is used in conjunction with "flood hazard map," in which case it means the county.

6. "Manufactured home" has the meaning given in s. 101.91 (2), Stats.

**Note:** Section 101.91 (2) of the Statutes is reprinted in a Note under s. SPS 320.07 (52m).

(e) *Fire separation.* Substitute the following wording for the requirements in 24 CFR 3285.101: Fire separation distances shall be provided in accordance with the distances specified in s. SPS 326.12.

(f) *Flood hazard.* Substitute the following wording and informational note for the requirements in 24 CFR 3285.102(c): Prior to the initial installation of a new manufactured home, the owner or permit applicant is responsible to determine whether the home site lies wholly or partly within a special flood hazard area as shown on the county's flood insurance rate map, flood boundary and floodway map, or flood hazard boundary map. If so located, the map and supporting studies adopted by the county may be used to determine the flood hazard zone and base flood elevation at the site.

**Note:** The department of natural resources and the federal emergency management agency may also have regulations that apply to construction in flood hazard areas.

(g) *Wind loads.* This is a department informational note to be used under 24 CFR 3285.103(a):

**Note:** The HUD–required wind loads for Wisconsin, Zone 1, are not less than 15 psf horizontal and not less than 9 psf uplift.

(h) *Roof loads.* This is a department informational note to be used under 24 CFR 3285.103(b):

**Note:** See ch. SPS 325 Appendix A for a reprint of HUD's roof–load zone map.

(i) *Thermal zone.* This is a department informational note to be used under 24 CFR 3285.103(c):

**Note:** The HUD–required thermal zone for Wisconsin is Zone 3, for an overall maximum coefficient of heat transmission not to exceed 0.079 Btu/(hr.)(sq. ft.)(°F).

(j) *Soil test.* This is a department requirement in addition to the requirements in 24 CFR 3285.202(a): Where a community–wide soil test does not exist and a soil test is required by this chapter, such as for a proposed frost–free–foundation design, the test shall be conducted to determine the soils in the entire community rather than at an individual site.

(k) *Footings and foundations.* This is a department requirement in addition to the requirements in 24 CFR 3285.301: Footings and foundations may be designed in accordance with subchs. IV and V, which include a frost depth of at least 48 inches.

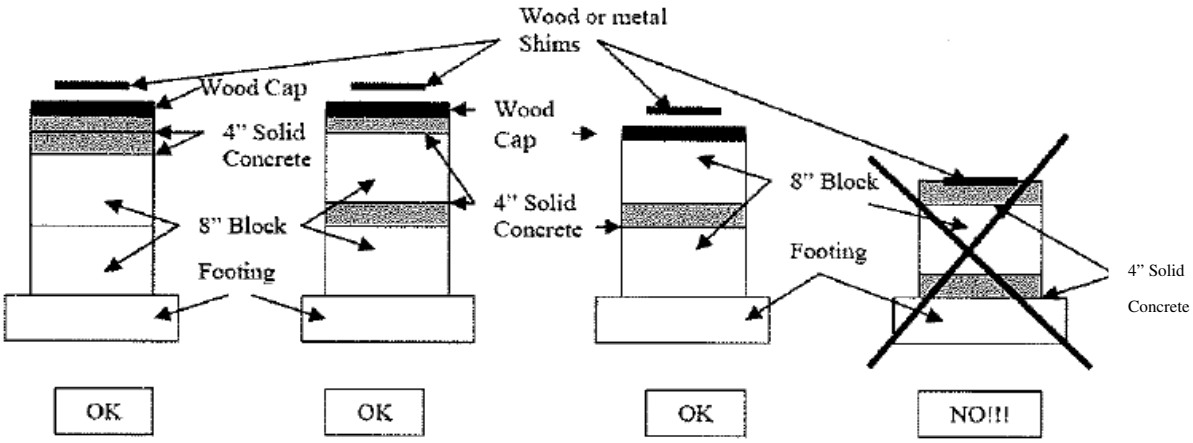
(L) *Caps.* Substitute the following wording for the requirements in 24 CFR 3285.304(b)(2): A combination of up to two 4–inch–thick solid–concrete blocks and no more than one 2–inch–thick piece of hardwood lumber shall be permitted as cap material. Lumber used as cap and gap filler material may be of 2–inch nominal lumber at least equal to No. 2 spruce/pine/fir having a minimum fiber bending stress rating of 1200 psi. All lumber used as cap and gap filler shall be the same species of wood. Lumber used to fill a gap in the pier may only be placed at the top of the pier.

(m) *Gaps.* This is a department informational note to be used under 24 CFR 3285.304(c)(1):

**Note:** See lumber specifications under par. (L).

(n) *Additional blocking.* Substitute the following wording for the requirements in 24 CFR 3285.304(c)(3): If a pier is provided with a cap block of 4–inch concrete or 2–inch lumber, another 4–inch concrete block may be placed anywhere in the pier but may not be placed directly upon the footing.

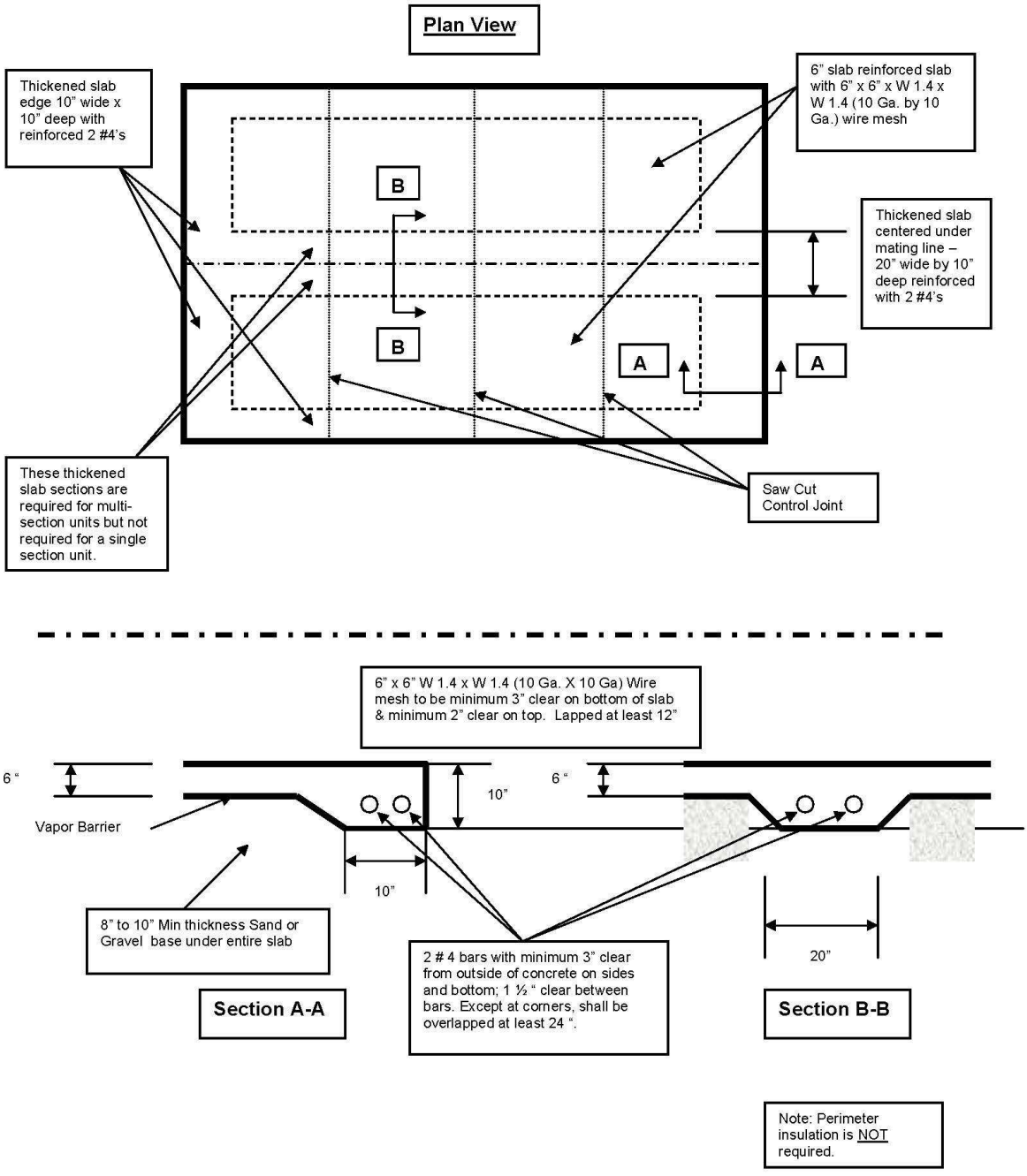
(o) *Illustration.* This is a department figure to be used under 24 CFR 3285.304:




(p) *Footings and foundations.* This is a department requirement in addition to the requirements in 24 CFR 3285.312: Footings and foundations may be designed in accordance with any of the following:

1. Subchs. IV and V.
2. The department–approved slab design that is shown in the figure and limitations at the end of this paragraph.
3. Other proprietary designs approved by the department.

**Acceptable slab on grade for pier supported manufactured home produced on or after April 1, 2007 [per SPS 321.40 (1)]**




Limitations:

1. Minimum 3,000 psi concrete. [24 CFR 3285.312(a)(1)(ii)]
2. Rebar and mesh at least grade 40.
3. Soil bearing capacity at least 2,000 psf. [SPS 321.40 (2) (b) 2.]
4. Placed on undisturbed soil. May not be placed on unprepared fill material, organic soil, alluvial soil, mud, or frozen soil. [SPS 321.40 (2) (b) 1. and 24 CFR 3285.312(a)]

5. 8 to 10" of clean, graded sand, gravel, or crushed stone base in clay soils. [SPS 321.20 (2) with added thickness to resist frost.] Compaction of sand, etc., should be 95% of modified Proctor.

6. 6 mil vapor retarder overlapped 12 inches and sealed. [24 CFR 3285.204]

7. Maximum pier spacing of 7 feet with max. load per pier of 5,300 lbs. when placed on 6" thick slab. [SPS 321.40 (2) (b) 10. and 24 CFR 3285.310]

8. Maximum load per pier of 11,900 lbs. at mating line when centered on the 20" W. X 10" D. thickened slab, Section B–B, reinforced with 2 – #4 bars. Individual pier footings at mating line meeting sizing requirements in 24 CFR 3285 Table to 3285.312 may be used in lieu of continuous thickened slab. [24 CFR 3285.312(c)]

9. Site shall drain away from the home per SPS 321.12. Ensure drainage of sand fill zone so that any clay does not cause water to pool under the slab.

10. The water table may not be above the frost penetration depth, i.e. at least 4 feet below grade. [SPS 321.16 (1) (a)]

11. Saw cut joints in slab so that sections are approximately square. (Example: 16' by 76' slab = 4 segments.)

(q) *Anchors and tie–down straps.* This is a department requirement in addition to the requirements in 24 CFR 3285.402(b)(1) and (2): Ground anchors and tie–down straps may be of painted steel to provide the weather–deterioration protection required by this section.

(r) *Severe climate.* Substitute the following wording for the requirements in 24 CFR 3285.404: In frost–susceptible soil locations, ground–anchor augers shall be installed to the design depth of the anchor but not less than 30 inches, unless the foundation system is frost–protected to prevent the effects of frost heave, in accordance with acceptable engineering practice and ss. 24 CFR 3280.306 and 3285.312.

(s) *Ventilation openings.* Substitute the following wording for the requirements in 24 CFR 3285.505(d): Ventilation openings shall be covered for their full height and width with a perforated corrosion– and weather–resistant covering that is designed to prevent entry of rodents.

(t) *Plumbing.* This is a department informational note to be used under 24 CFR 3285.601:

**Note:** The Department's rules relating to registration and licensing of plumbers are in ch. SPS 305. The Department's rules relating to pipe supports; pitch of sanitary drainage piping, storm water or clear water piping, and water supply piping; and plumbing specific to manufactured homes and manufactured home communities are in chapter SPS 382.

(u) *Access for a transporter.* Substitute the following wording for the recommended requirements in 24 CFR 3285.902(a): Before attempting to move a home, ensure that the transportation equipment and home can be routed to the installation site and that all special transportation permits required by the department of transportation have been obtained.

(v) *Drainage structures.* Substitute the following wording for the recommended requirements in 24 CFR 3285.902(b): The use of ditches and culverts to drain surface runoff is subject to local and state regulations and shall be included and considered in the overall site preparation.

(w) *Local permits.* Substitute the following wording and informational note for the recommended requirements in 24 CFR 3285.903(a): All locally required permits shall be obtained and all corresponding fees shall be paid.

**Note:** See s. SPS 320.08 for the Department's requirements for obtaining a Wisconsin uniform building permit prior to each installation.

(x) *Local plan approval.* Substitute the following wording for the recommended requirements in 24 CFR 3285.903(b): Prior to alteration of a home's pier blocking, the local municipality shall be contacted to determine if plan approval and permits are required.

(y) *Accessory buildings and structures.* Substitute the following wording for the recommended requirements in 24 CFR 3285.903(c): Each accessory building and structure is designed to support all of its own live and dead loads, unless the structure, including any attached garage, carport, deck, or porch, is attached to the manufactured home and is otherwise included in the installation instructions.

(z) *Contacting the utility providers.* Substitute the following wording for the recommended requirements in 24 CFR 3285.904(a): The utility providers shall be consulted before connecting the manufactured home to any utilities.

(za) *Conversion of gas appliances.* Substitute the following wording for the recommended requirements in 24 CFR 3285.904(d)(1): A service person acceptable to the utility provider shall convert the appliance from one type of gas to another, following instructions by the manufacturer of each appliance.

(zb) *Gas appliance startup procedures.* Substitute the following wording for the recommended requirements in 24 CFR 3285.904(d)(4)(intro.): When required by the utility provider, the installer shall perform the following procedures:

(zc) *Heating oil systems.* This is a department informational note to be used under 24 CFR 3285.905:

**Note:** See ch. ATCP 93 for additional requirements relating to installation of heating oil systems.

**(2)** PRODUCED BEFORE APRIL 1, 2007. (a) Except as provided in par. (b), the installation of a manufactured home produced before April 1, 2007 shall be installed in conformance with the requirements in effect at the time the manufactured home was produced.

(b) The installation of a manufactured home produced before April 1, 2007 to be installed on piers shall conform to at least all of the following requirements:

1. No footing may be placed upon unprepared fill material, topsoil, alluvial soil or mud. All organic matter shall be removed from the area that will be beneath any footing.

2. The soil bearing capacity shall be determined through test by a pocket penetrometer or other means of analysis. If the soil bearing capacity under each intended pier location is less than 2000 pounds per square foot, piers shall be located in accordance with the manufacturer's instructions.

3. The home site shall be graded to permit water to drain from under the home and away from the home for a minimum of 5 feet from the home.

4. Every pier shall be supported by a footing. Each footing shall be no less than a nominal 16 inches by 16 inches.

5. Each footing shall consist of one of the following:

a. One nominal 4–inch by 16–inch by 16–inch solid concrete block or 2 nominal 4–inch by 8–inch by 16–inch solid concrete blocks. If a single block pier and 2 footing blocks are used, the 2 footing blocks shall be positioned with the joint parallel to the main frame. If a double block pier and 2 footing blocks are used, the 2 footing blocks shall be positioned with the joint either parallel or perpendicular to the main frame.

b. A 16–inch by 16–inch pad constructed of acrylonitrile–butadiene–styrene (ABS) having a rated load bearing capacity of not less than 6000 pounds.

c. An 18–inch diameter hole bored to below the frost line or to unfractured bedrock and filled with poured concrete.

d. Any other materials and systems approved in advance by the department.

6. Piers shall be constructed of concrete blocks, manufactured steel stands or manufactured concrete stands. Manufactured stands shall be labeled for use as piers for manufactured homes.

7. Piers constructed of single stacked concrete blocks shall be limited to a height of 36 inches. Piers constructed of concrete blocks and exceeding 36 inches but less than 80 inches shall be constructed using double stacked blocks with each layer opposing the direction of the layer underneath it. Piers constructed of concrete blocks and exceeding 80 inches shall be constructed using double blocks laid in concrete mortar with each layer opposing the direction of the layer underneath it and with each core filled with concrete and a ½–inch steel reinforcing rod.

8. All concrete blocks shall be 2–core design, construction grade blocks having nominal dimensions of at least 8 inches by 8 inches by 16 inches. All concrete blocks shall be placed with the cores open vertically. The concrete block nearest the main frame of the manufactured home shall be perpendicular to the linear direction of the frame. None of these concrete blocks may contact the main frame of the home.

9. Alternative materials may be used for pier installations provided they are approved in advance by the department.

10. Piers shall be placed under the main frame of the chassis at intervals of not more than 7 feet on–center and no more than 3 feet from the exterior side of each end wall. The 7–foot spacing requirement may be varied as permitted by footing, spacing and soil capacity tables provided by the home manufacturer.

11. Piers shall be placed under the bearing points of clear–span openings of 4 feet or more in center mating walls.

12. Piers shall be plumb and centered under the contact area at the point of support.

13. a. Each pier shall be capped with a solid concrete block at least 4 inches thick or a solid wood block having a nominal thickness of at least 2 inches.

b. The cap shall be the same width and length as the top of the pier.

c. The cap shall consist of no more than 2 pieces.

d. Two–piece caps shall be positioned with the joint perpendicular to the main frame.

14. Where shims are utilized, wood shims shall be installed between the pier cap and the frame. Shims shall be driven from opposing sides and shall be no less than 4 inches by 8 inches.

15. Wood caps and shims shall be at least equal to No. 2 spruce pine fir having a minimum fiber bending stress rating of 1200 psi. All wood caps shall be the same species of wood, and all shims shall be the same species of wood.

16. The combination of a nominal 2–inch solid concrete block or a nominal 2–inch wood cap plus shims shall not exceed 3 ½ inches.

17. A minimum clearance of 12 inches shall be maintained beneath the lowest point of the main frame in the area of any utility connection. A minimum clearance of 12 inches shall also be maintained under the home for at least 75% of the home. The remainder of the home may be less than 12 inches above the ground but may not touch the ground.

**History:** CR 05–113: cr. Register December 2006 No. 612, eff. 4–1–07; CR 08–043: am. (2) (b) 13. Register March 2009 No. 639, eff. 4–1–09; CR 14–017: r. and recr. (1), cr. (2) (title), am. (2) (b) 8. Register August 2014 No. 704, eff. 9–1–14; correction in numbering in (1) (za) to (zc) made under s. 13.92 (4) (b) 1., Stats., Register August 2014 No. 704; correction in (1) (p) (intro.) made under s. 13.92 (4) (b) 7., Stats., Register August 2014 No. 704; corrections in (1) (g) to (i) made under s. 35.17, Stats., Register August 2014 No. 704; CR 15–034: am. (1) (a) Register December 2015 No. 720, eff. 1–1–16.

# Chapter SPS 322

# 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. Chapter Comm 22 as it existed on March 31, 2009, was repealed and a new chapter Comm 22 was created effective April 1, 2009. Chapter Comm 22 was renumbered chapter SPS 322 under s. 13.92 (4) (b) 1., Stats., Register December 2011 No. 672.

## Subchapter I — Scope and Application

**SPS 322.01 Scope. (1)** This chapter applies to all one– and 2–family dwellings covered by this code that use any amount of non–renewable energy for heat generation.

**Note:** Non–renewable energy sources used for heat distribution only will not require compliance with this chapter.

**Note:** Although the actual source of heat delivered by a heat pump is renewable, a dwelling using a heat pump is not exempt from the requirements of this chapter due to the required input of electricity to run the pump and compressor.

**(2)** The equipment efficiency standards in this chapter apply to all one– and 2–family dwellings covered by this code that use the respective equipment.

**(3)** (a) The vapor retarder requirements under s. SPS 322.38 and the moisture control and ventilation requirements under s. SPS 322.39 apply to any dwelling with insulation installed, whether or not the insulation is required under this code.

(b) The vapor retarder requirements under s. SPS 322.38 do not apply to an unheated space, such as an attached, unheated garage.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09; correction in (3) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; CR 15–041: renum. (3) to (3) (a), cr. (3) (b) Register December 2015 No. 720, eff. 1–1–16.

**SPS 322.02 Application. (1)** This chapter is not intended to conflict with any safety or health requirements. Where a conflict occurs, the safety and health requirements shall govern.

**(2)** This chapter allows the designer the option of using various methods to demonstrate compliance with 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. Unless specifically exempted, all requirements of this chapter apply regardless of the method used.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09.

## Subchapter II — Definitions

**SPS 322.10 Definitions. (1)** "Air–impermeable" means having an air permeance less than or equal to 0.02 L/s–$m^2$ at a pressure differential of 75 pascals when tested according to ASTM E 2178 or ASTM E 283.

**(2)** "Conditioned floor area" means the sum of areas of all floors in conditioned space in the structure, including basements, cellars, and intermediate floored levels measured from the exterior faces of exterior walls or from the center line of interior walls, excluding covered walkways, open roofed–over areas, porches, exterior terraces or steps, chimneys, roof overhangs and similar features.

**(3)** "Conditioned space" means space within the dwelling thermal envelope which is provided with heated air or surfaces to provide a heated space capable of maintaining the temperature of the space to at least 50°F at design conditions.

**(4)** "Crawl space wall" means the opaque portion of a wall which encloses a crawl space and is partially or totally below grade.

**(5)** "Dwelling thermal envelope" means the elements of a dwelling with enclosed conditioned space through which thermal energy may be transferred to or from unconditioned space or the exterior.

**(6)** "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. Any skylight shaft walls that are 12 inches or more in depth, measured from the ceiling plane to the roof deck, are considered in the area of exterior walls and are not considered part of the roof assembly.

**(7)** "Heated slab" means a floor slab in which an uninsulated heating element, uninsulated hydronic tubing or uninsulated hot air distribution system is in contact with the slab or placed within the slab or the subgrade.

**(8)** "HVAC" means heating, ventilating and air conditioning.

**(9)** "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.

**(10)** "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.

**(11)** "IC−rated" means an electrical fixture 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.

**(12)** "Mass wall" means a wall of concrete block, concrete, insulated concrete forms, masonry cavity, brick other than brick veneer, earth and solid timber or logs.

**(13)** "Opaque areas" means all exposed areas of a dwelling envelope which enclose conditioned space except openings for windows, skylights, doors and dwelling service systems.

**(14)** "Proposed design" means a description of the proposed dwelling used to estimate annual energy use for determining compliance based on total building performance.

**(15)** "Renewable energy sources" means sources of energy, excluding minerals and petroleum products, derived from incoming solar radiation, trees and other plants, wind, waves and tides, lake or pond thermal differences and from the internal heat of the earth.

**(16)** "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 space. Any skylight shaft walls less than 12 inches in depth, as measured from the ceiling plane to the roof deck, are considered in the roof assembly and are not considered in the area of exterior walls.

**(17)** "Sun room" means a one−story structure attached to a dwelling with a glazing area in excess of 40% of the gross area of the structure's exterior walls and roof and with any screened areas capable of being covered or replaced with glazing during the heating season.

**Note:** A thermally isolated sun room does not count in the calculation of amount of glazing.

**(18)** "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, water heating, or illumination.

**(19)** "Thermal resistance" or "R−value" means a measure of the ability to retard the flow of heat. The R−value is the reciprocal of thermal transmittance or U−factor 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.

**(20)** "Thermal transmittance" or "U−factor" means the time rate of heat flow through a body or assembly which is located between 2 different environments, expressed in Btu/h • ft.$^2$ • °F. The U−factor 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−factor 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.

**(21)** "Thermally isolated" means physically and thermally separated with separate zone or separate equipment controls for space heating.

**(22)** "Thermostat" means an automatic control device actuated by temperature and designed to be responsive to temperature.

**(23)** "Ventilation" means the process of supplying or removing air by natural or mechanical means to or from any space. The air may or may not have been conditioned.

**(24)** "Zone" means a space or group of spaces within a dwelling with heating requirements sufficiently similar so that comfort conditions can be maintained throughout by a single controlling device.

**History:** CR 08−043: cr. Register March 2009 No. 639, eff. 4−1−09; CR 09−104: am. (17) Register December 2010 No. 660, eff. 1−1−11.

## Subchapter III — Insulation Materials and Installation

**SPS 322.20 Basic requirements. (1)** GENERAL. When available, information and values on thermal properties, performance of building envelope sections and components, and heat transfer shall be obtained from the ASHRAE Handbook of Fundamentals.

**(2)** COMPUTATION OF R−VALUES. (a) Insulation material used in layers, such as framing cavity insulation and insulating sheathing, shall be summed to compute the component R−value.

(b) The manufacturer's settled R−value shall be used for blown insulation.

(c) Computed R−values may not include values for air films or for building materials other than insulation materials.

**Note:** The REScheck program will automatically account for air films and other building materials.

**(3)** LABORATORY OR FIELD TEST MEASUREMENTS. (a) *General dwelling thermal envelope materials.* When information specified under sub. (1) is not available, or when a different value is claimed, supporting data shall be obtained using one of the following test methods:

1. ASTM C177, Standard test method for steady state heat flux measurements and thermal transmission properties by means of the guarded−hot−plate apparatus.

2. ASTM C335, Standard test method for steady state heat transfer properties of pipe insulation.

3. ASTM C518, Standard test method for steady state thermal transmission properties by means of the heat flow meter apparatus.

4. ASTM C1363, Standard test method for the thermal performance of building materials and envelope assemblies by means of a hot box apparatus.

(b) *Foam plastic insulation.* 1. When information specified under sub. (1) is not available, or when a different value is claimed, foam plastic insulation that uses a gas other than air as the insulating medium shall use laboratory or field tests conducted on representative samples that have been aged for the equivalent of 5 years or until the R−value has stabilized.

2. The tests shall be conducted by an independent third party using the standards listed under par. (a) and shall be submitted for department review and approval in accordance with s. SPS 320.18.

(c) *Concrete masonry units.* Systems using integrally−insulated concrete masonry units shall be evaluated for thermal performance in accordance with one of the following:

1. Default values as approved by the department with no extrapolations or interpolations.

2. Laboratory or field test measurements specified under par. (a).

3. The material approval process specified in s. SPS 320.18.

**(4)** GENERAL INSTALLATION. (a) Materials, equipment and systems shall be identified in a manner that will allow a determination of their compliance with the applicable provisions of this code.

(b) All insulation materials, caulking and weatherstripping, fenestration assemblies, mechanical equipment and systems components, and water−heating equipment and system components shall be installed in accordance with the manufacturer's installation instructions.

(c) Manufacturer's installation instructions shall be available on the job site at the time of inspection.

(d) 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.

**(5)** IDENTIFICATION. (a) 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) 1. The thickness of blown−in roof and ceiling insulation shall be identified by thickness markings that are labeled in inches and installed at least one for every 300 square feet through the attic space.

2. 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.

3. Each marker shall face the attic access.

4. The thickness of installed insulation shall meet or exceed the minimum initial installed thickness shown by the marker.

**(6)** CERTIFICATE. (a) A permanent certificate shall be posted on or immediately adjacent to the electrical distribution panel.

(b) The certificate shall be completed by the owner, builder or insulation installer.

(c) The certificate shall list at least the following information:

1. The predominant R−values of insulation installed in or on ceilings or roofs, walls, foundation walls, slabs and any heating ducts that are outside the thermal envelope.

2. The U−factors of all windows, skylights and doors.

(d) If using the REScheck or REM/Rate software programs, the certificate shall be printed from that program.

**History:** CR 08−043: cr. Register March 2009 No. 639, eff. 4−1−09; correction in (3) (a) made under s. 13.92 (4) (b) 1., Stats., Register March 2009 No. 639; correction in (3) (b) 2., (c) 3. made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

**SPS 322.21 Protection of insulation. (1)** BLANKET INSULATION. Insulating blankets or batts shall be held in place with a covering or other means of mechanical or adhesive fastening.

**Note:** If the insulation is on a below−grade wall, s. SPS 322.38 (4) may prohibit the use of vapor retarder material used as the covering.

**(2)** WIND WASH PROTECTION. (a) Except as provided under s. SPS 322.39 (4) for cathedral ceilings, all air−permeable insulation materials installed in any position other than horizontal, shall be covered on the cold−in−winter side with a permanently attached material of low air permeability to maintain the R−value of the insulation.

**Note:** Suitable materials for this purpose include house wrap permanently attached with batten strips, asphalt−impregnated felt or tar paper, plywood, oriented strand board or OSB, siding material, rigid insulation sheathing, etc.

(b) If non−rigid sheet material is used, it shall be water vapor permeable.

**Note:** Water vapor permeable materials for this purpose include house wrap permanently attached with batten strips and asphalt−impregnated felt or tar paper.

**(3)** FOAM PLASTIC INSULATION. (a) Exterior foam plastic insulation shall be protected from physical damage and damage from ultraviolet light with a permanent, opaque, weather−resistant covering or coating.

(b) The protective covering shall cover the exposed exterior insulation and extend a minimum of 2 inches below grade, except the covering is not required below a brick ledge.

**Note:** For interior applications, a thermal barrier may be required under s. SPS 321.11.

**History:** CR 08−043: cr. Register March 2009 No. 639, eff. 4−1−09; correction in (2) (a) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; CR 15−041: am. (3) (b) Register December 2015 No. 720, eff. 1−1−16.

## Subchapter IV — Dwelling Thermal Envelope

**SPS 322.30 General design requirements. (1)** GENERAL. Dwelling thermal envelope insulation amounts and details shall be determined using one of the methods described in this subchapter.

**(2)** INFILTRATION. (a) Infiltration for heating design loads shall be calculated based on a maximum of 0.5 air change per hour in the heated space.

(b) 1. If the proposed design takes credit for a reduced air change per hour level, documentation of the measures providing the reduction or the results of a post−construction blower door test conducted in accordance ASTM E 779 shall be provided to the department.

2. The minimum air change per hour rate may not be less than 0.2, unless mechanical ventilation is provided.

**(3)** BASEMENTS AND CRAWL SPACES. Where basement and crawl space walls are part of the dwelling thermal envelope, their R−values and U−factors shall be based on the wall components. Adjacent soil may not be considered in the determination.

**(4)** GARAGES. (a) Except as provided under par. (b), a garage may not be provided with any supplemental heat unless all of the following conditions are met:

**Note:** Because of the scope of this chapter, the requirements under this subsection apply only to heat generated from non−renewable sources.

1. The dwelling shall be thermally isolated from the garage.

2. The garage floor, ceiling and walls shall be provided with a vapor retarder in accordance with s. SPS 322.38.

3. All building elements shall meet the requirements of s. SPS 322.31.

(b) The thermal envelope requirements under par. (a) are not required if all of the following conditions are met:

1. The thermostat is permanently limited to a maximum of 50°F.

2. Heating equipment is either separate from the dwelling unit equipment or installed as a separate zone.

3. Separate heating equipment shall be sized to provide a maximum indoor temperature of 50°F.

**(5)** 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 08−043: cr. Register March 2009 No. 639, eff. 4−1−09; correction in (4) (a) 2., 3. made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

**SPS 322.31 Prescriptive insulation and fenestration criteria. (1)** REQUIREMENTS. (a) Except as specifically provided under this subchapter, dwellings using the prescriptive method shall meet the requirements of Table 322.31−1 or 322.31−2.

(b) In Tables 322.31−1 and 322.31−2, zone 2 consists of the following 15 northern counties: Ashland, Bayfield, Burnett, Douglas, Florence, Forest, Iron, Langlade, Lincoln, Oneida, Price, Sawyer, Taylor, Vilas and Washburn. Zone 1 consists of all other counties not included in zone 2.

**(2)** THERMAL ENVELOPE. (a) *General.* If the total dwelling thermal envelope UA is less than or equal to the total UA resulting from using the U−factors in Table 322.31−2 multiplied by the same assembly area as in the proposed building, the dwelling is in compliance with this chapter. The UA calculation shall be done using a method consistent with the ASHRAE Handbook of Fundamentals and shall include the thermal bridging effects of framing materials.

**Note:** UA is equal to the product of the U−factor times the assembly area.

**Note:** REScheck is an acceptable software program for determining compliance with this section.

(b) *Software version.* If a REScheck software program is used to show compliance with this section, a version approved by the department shall be used.

**Note:** The IECC 2009 version of REScheck meets the thermal envelope requirements of this code.

**(3)** APPLIANCE EFFICIENCY. (a) Except as allowed under par. (b) and s. SPS 322.46, oil−fired and gas−fired furnaces and boilers shall meet the minimum efficiency requirements in Table 322.31−3.

(b) In new construction, an oil−fired or gas−fired furnace or boiler meeting the federal efficiency standard but not the requirements of Table 322.31−3 may be installed if the dwelling thermal envelope requirements of Table 322.31−4 are met.

**TABLE 322.31−1**
**INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]**

| Zone | Fenestration U−Factor | Skylight U−Factor | Ceiling R−Value | Wood Frame Wall R−Value | Mass Wall R−Value[i] | Floor R−Value | Basement Wall R−Value[b] | Crawl Space Wall R−Value[b] | Heated Slab R−Value[c] | Unheated Slab R−Value[d] |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.35 | 0.60 | 49[e] | 20[f] or 13+5[g] | 15/19 | 30[h] | 15/19 | 10/13 | 10/15 | 10 |
| 2 | 0.35 | 0.60 | 49[e] | 21[f] | 19/21 | 38[h] | 15/19 | 10/13 | 10/15 | 10 |

[a] R−values are minimums. U−factors are maximums.

[b] "15/19" means R−15 continuous insulated sheathing on the interior or exterior of the home or R−19 cavity insulation at the interior of the basement wall. "15/19" shall be permitted to be met with R−13 cavity insulation on the interior of the basement wall plus R−5 continuous insulated sheathing on the interior or exterior of the home. "10/13" means R−10 continuous insulated sheathing on the interior or exterior of the home or R−13 cavity insulation at the interior of the basement wall.

[c] The first R−value applies under the entire slab, regardless of depth below grade. The second R−value applies to the slab edge where the bottom of the slab is less than 12 inches below adjacent grade. Slab edge 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. Also, see s. SPS 321.16 for protection against frost for slabs with supports less that 4 feet below grade.

[d] The R−value applies to any slab, the bottom of which is less than 12 inches below adjacent grade. Also, see s. SPS 321.16 for protection against frost for slabs with supports less than 4 feet below grade.

[e] See s. SPS 322.32 (1) for application and permitted reduced R−value.

[f] R−20 and R−21 may be compressed into a 2X6 cavity.

[g] "13+5" means R−13 cavity insulation plus R−5 insulated sheathing. If structural sheathing covers 25% or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25% of the exterior, structural sheathing shall be covered with insulated sheathing of at least R−2.

[h] Or insulation sufficient to fill the framing cavity with a minimum of R−19.

[i] The second R−value applies when more than half of the insulation is on the interior of the mass wall.

**TABLE 322.31−2**
**EQUIVALENT U−FACTORS**

| Zone | Fenestration U−Factor | Skylight U−Factor | Ceiling U−Factor | Wood Frame Wall U−Factor | Mass Wall U−Factor | Floor U−Factor | Basement Wall U−Factor | Crawl Space U−Factor | Unheated Slab U−Factor |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.35 | 0.60 | 0.026 | 0.057 | 0.060[a] | 0.033 | 0.050 | 0.065 | 10 |
| 2 | 0.35 | 0.60 | 0.026 | 0.057 | 0.057[a] | 0.028 | 0.050 | 0.065 | 10 |

[a] When more than half the insulation is on the interior, the mass wall U−factors shall be the same as the frame wall U−factor.

**TABLE 322.31−3**
**WARM AIR FURNACES AND BOILERS, MINIMUM EFFICIENCY REQUIREMENTS**

| Equipment Type | Minimum Efficiency | Test Procedure |
|---|---|---|
| Natural gas and propane furnace | 90% AFUE | DOE 10 CFR Part 430 or ANSI Z21.47 |
| Natural gas and propane hot water boilers | 90% AFUE | DOE 10 CFR Part 430 |
| Oil−fired furnaces | 83% AFUE | DOE 10 CFR Part 430 or UL 727 |
| Oil−fired hot water boilers | 84% AFUE | DOE 10 CFR Part 430 |

**TABLE 322.31–4**
**COMPONENT DWELLING THERMAL ENVELOPE REQUIREMENTS**
**FOR DWELLINGS USING LOWER EFFICIENCY APPLIANCES[a]**

| Fenestration U–Factor | Skylight U–Factor | Ceiling R–Value | Wood Frame Wall R–Value | Mass Wall R–Value | Floor R–Value | Basement or Crawl Space Wall R–Value[b] | Heated Slab R–Value[c] | Unheated Slab R–Value[d] |
|---|---|---|---|---|---|---|---|---|
| 0.30 | 0.60 | 49[e] | 21[f] or 19+5[g] | 19 | 30[h] | 15/19 | 10/20 | 15 |
| Equivalent U–Factors | | | | | | | | |
| 0.30 | 0.60 | 0.026 | 0.057 | 0.057 | 0.033 | 0.045 | 0.033 | 0.047 |

[a] R–values are minimums. U–factors are maximums.

[b] The first R–value applies to continuous insulation. The second R–value applies to framing cavity insulation.

[c] The first R–value applies under the entire slab, regardless of depth below grade. The second R–value applies to the slab edge. Slab edge 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.

[d] The R–value applies to the slab perimeter insulation, where the bottom of the slab is less than 12 inches below adjacent grade. Slab edge 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. Also, see s. SPS 321.16 for protection against frost for slabs with supports less than 4 feet below grade.

[e] See s.SPS 322.32 (1) for application and permitted reduced R–value.

[f] R–21 may be compressed into a 2X6 cavity.

[g] "19+5" means R–19 cavity insulation plus R–5 insulated sheathing. If structural sheathing covers 25% or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25% of the exterior, structural sheathing shall be covered with insulated sheathing of at least R–2.

[h] Or insulation sufficient to fill the framing cavity with a minimum of R–19.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09; EmR0917: emerg. am. (2) (b), eff. 9–5–09; CR 09–072: am. (2) (b) Register March 2010 No. 651, eff. 4–1–10; CR 09–104: am. Tables 22.31–1 and 22.31–4 Register December 2010 No. 660, eff. 1–1–11; correction in (1) (a), (b), (2) (a), (b), (3) (a), (b), Table 322.31–1, Table 322.31–4 made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672l; CR 15–041: am. Table 322.31–1, Table 322.31–2, Table 322.31–4 Register December 2015 No. 720, eff. 1–1–16.

**SPS 322.32 Specific insulation requirements.** **(1)** CEILINGS WITH ATTIC SPACES. (a) R–38 will satisfy the ceiling R–value requirement for a dwelling where the full height of uncompressed R–38 insulation extends over the wall top plate at the eaves.

(b) An attic–access cover shall be weatherstripped and insulated to a level equivalent to the insulation on the surrounding surfaces when the attic is an unconditioned space. A wood framed or equivalent baffle or retainer is required to be provided when loose fill insulation is installed, the purpose of which is to prevent loose fill insulation from spilling into the living space when the attic access is opened, and to provide a permanent means of maintaining the installed R–value of the loose fill insulation.

**(2)** CEILINGS WITHOUT ATTIC SPACES. Where the design of the roof or ceiling assembly does not allow sufficient space for the required R–49 insulation, the minimum required insulation for the roof or ceiling assembly shall be R–30. This reduction of insulation shall be limited to 500 square feet of ceiling area.

**(3)** MASS WALLS. The requirements of Table 322.31–1 are applicable to mass walls.

**(4)** STEEL–FRAME CEILINGS, WALLS AND FLOORS. (a) Steel–frame ceilings, walls and floors shall meet the insulation requirements of Table 322.32 or shall meet the U–factor requirements in Table 322.31–2.

(b) The calculation of the U–factor for a steel–frame envelope assembly shall use a series–parallel path calculation method.

**(5)** FLOORS. Floor insulation shall be installed to maintain permanent contact with the underside of the subfloor decking.

**(6)** BASEMENT WALLS. (a) Walls associated with conditioned basements shall be insulated from the top of the basement wall down to the basement floor.

(b) Walls associated with unconditioned basements shall meet the requirement in par. (a) unless the floor overhead is insulated in accordance with Table 322.31–1.

(c) Where the total basement wall area is less than 50 percent below grade, the entire wall area, including the below–grade portion, is included as part of the area of exterior walls.

**(7)** BOX SILL AND RIM JOIST SPACES. Box sills and joist spaces at outside walls shall be insulated to the required wall R–value with air–impermeable insulation that is sealed on all sides to all framing members and the foundation, or with air–permeable insulation held in place as required under s. SPS 322.21 (1).

**(8)** OVERHANG JOIST SPACES. (a) Joist spaces that extend beyond exterior walls shall be insulated with an R–value of 30 or higher with insulation that completely fills the cavity including over the top of the exterior wall supporting the joists.

(b) The joist space insulation shall be air sealed either by using an air–impermeable insulation that is sealed to all framing members or by covering the insulation with a rigid material that is caulked or sealed to all framing members.

(c) If piping that is subject to freezing is located in the joist space, additional insulation shall be provided on the unconditioned side of the space.

**(9)** WALL INSULATION. (a) Except for closed–cell sprayed foam, wall insulation shall completely fill the wall cavity.

(b) The vertical and flared walls in a skylight shall meet the insulation requirements for walls. Tube skylights shall be insulated per the manufacturer's recommendations.

**TABLE 322.32**

**STEEL–FRAME CEILING, WALL AND FLOOR INSULATION R–VALUES**

| Wood Frame R–Value Requirement | Cold–Formed Steel Equivalent R–Value[a] |
|---|---|
| Steel Truss Ceilings[b] | |
| R–30 | R–38 or R–30 + 3 or R–26 + 5 |
| R–38 | R–49 or R–38 + 3 |
| R–49 | R–38 + 5 |
| Steel Joist Ceilings[b] | |
| R–30 | R–38 in 2X4 or 2X6 or 2X8<br>R–49 in any framing |
| R–38 | R–49 in 2X4 or 2X6 or 2X8 or 2X10 |
| Steel Framed Wall | |
| R–13 | R–13 + 5 or R–15 + 4 or R–21 + 3 |
| R–19 | R–13 + 9 or R–19 + 8 or R–25 + 7 |
| R–21 | R–13 + 10 or R–19 + 9 or R–25 + 8 |
| Steel Joist Floor | |
| R–13 | R–19 in 2X6<br>R–19 + 6 in 2X8 or 2X10 |
| R–19 | R–19 + 6 in 2X6<br>R–19 + 12 in 2X8 or 2X10 |

[a] Cavity insulation R–value is listed first, followed by continuous insulation R–value.

[b] Insulation exceeding the height of the framing shall cover the framing.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09; correction in (3) (a), (b), (4) (a), (6) (b), (7) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; CR 15–041: renum. (1) to (1) (a), cr. (1) (b), renum. (3) (a) to (3) and am., r. (3) (b), renum. (9) to (9) (a), cr. (9) (b) Register December 2015 No. 720, eff. 1–1–16.

**SPS 322.33 Slab floors. (1)** HEATED OR UNHEATED SLABS. (a) Any heated or unheated slab floor, the bottom of which is less than 12 inches below adjacent grade, shall be provided with perimeter insulation in accordance with Table 322.31–1 or Table 322.31–4, except as provided in par. (b).

(b) At the threshold or the base of any door opening that leads directly to the exterior of the structure, the vertical perimeter insulation shall be at least R–5, excluding all garage doors.

**(2)** HEATED SLABS. In addition to meeting the requirement under sub. (1), if applicable, heated slab floors of any depth below grade shall meet the under–slab R–value requirement in accordance with Table 322.31–1 or Table 322.31–4.

**(3)** DETAILS. (a) The top edge of insulation installed between the exterior wall and the edge of the interior slab may be cut at a 45 degree angle away from the exterior wall.

(b) Horizontal insulation extending outside of the foundation shall be covered by soil a minimum of 10 inches thick or by pavement.

(c) Insulation on a foundation wall for a basement may be interrupted at the junction with a foundation wall.

**Note:** See Appendix for further explanatory materials.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09; CR 09–104: am. (1), (2) Register December 2010 No. 660, eff. 1–1–11; correction in (1), (2) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; CR 15–041: renum. (1) to (1) (a) and am., cr. (1) (b), (3) (c) Register December 2015 No. 720, eff. 1–1–16.

**SPS 322.34 Crawl spaces. (1)** FROST PROTECTION. If the bottom of the crawl space serving as the dwelling foundation is less than 48 inches below adjacent grade, the foundation shall be frost protected in accordance with Table 322.31–1 for frost protected slabs.

**(2)** VAPOR RETARDER. Any exposed earth in crawl spaces shall be covered with a continuous vapor retarder.

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

(c) All joints of the vapor retarder shall overlap by 6 inches and be sealed or taped.

(d) The edges of the vapor retarder shall extend at least 6 inches up the foundation wall and shall be attached and sealed to the foundation wall or insulation.

**(3)** CRAWL SPACES. (a) Crawl space walls shall be insulated in accordance with Table 322.31–1.

(b) Crawl space wall insulation shall be permanently fastened to the wall and shall extend the entire height of the wall.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09; correction in (1), (3) (c), (4) (a), (c) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672; CR 15–041: am. (2) (d) Register December 2015 No. 720, eff. 1–1–16; **CR 15–090: r. (3), (4) (c), renum. (4) to (3) and am. Register May 2016 No. 725, eff. 6–1–16.**

**SPS 322.35 Thermally isolated sunrooms. (1)** The minimum opaque ceiling insulation R–value shall be R–24. The minimum opaque wall R–value shall be R–13.

**(2)** The maximum fenestration U–factor shall be 0.50 and the maximum skylight U–factor shall be 0.75.

**(3)** New walls, windows and doors separating a sunroom from conditioned space shall meet the building thermal envelope requirements.

**(4)** The temperature in the conditioned space shall be controlled as a separate zone or shall use separate heating equipment.

**(5)** Glazing in a thermally–isolated sunroom is not considered to be in the dwelling thermal envelope.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09.

**SPS 322.36 Fenestration. (1)** AVERAGE U–FACTORS. An area–weighted average of fenestration products may be used to satisfy the U–factor requirements.

**(2)** MAXIMUM FENESTRATION U–FACTOR. The area weighted average maximum fenestration U–factor permitted using trade offs from s. SPS 322.31 (2) or subchapter VI shall be 0.40 for vertical fenestration, and 0.75 for skylights.

**(3)** GLAZED FENESTRATION EXEMPTION. Up to 15 square feet of glazed fenestration per dwelling unit may be exempt from U–factor requirements of the chapter.

**(4)** OPAQUE DOOR EXEMPTION. One opaque door assembly is exempted from the U–factor requirements of this chapter.

**(5)** REPLACEMENT FENESTRATION. Where an existing fenestration unit is replaced with a new fenestration unit, including sash and glazing, the replacement unit shall meet the U–factor requirements of this chapter.

**(6)** CERTIFIED PRODUCTS. Except as provided in sub. (7), fenestration rating, certification and labeling of U–factors for windows, doors and skylights shall be in accordance with NFRC 100.

**(7)** DEFAULT VALUES. When a manufacturer has not determined product U–factor in accordance with NFRC 100, U–factors shall be determined by assigning a default value in accordance with Tables 322.36–1 and 322.36–2. Where a composite of materials of two different product types is used, the product shall be assigned the higher U–factor.

**TABLE 322.36–1**

**U–FACTOR DEFAULT TABLE FOR WINDOWS, GLAZED DOORS AND SKYLIGHTS [a]**

| Metal without Thermal Break | Single Glazed | Double Glazed |
|---|---|---|
| Operable | 1.27 | 0.87 |

| | | |
|---|---|---|
| Fixed | 1.13 | 0.69 |
| 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 |
| Door | 1.10 | 0.66 |
| Skylight | 1.89 | 1.11 |
| Site–assembled Skylight | 1.25 | 0.70 |
| **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 or Fiberglass** | | |
| Operable | 0.89 | 0.55 |
| Fixed | 0.98 | 0.56 |
| Door | 0.98 | 0.56 |
| Skylight | 1.47 | 0.84 |

[a] Glass block assemblies shall have a default value of 0.60.

**TABLE 322.36–2**
**U–FACTOR DEFAULT TABLE FOR NON–GLAZED DOORS**

| **Steel Doors (1¾ inches thick)** | **With Foam Core** | **Without Foam Core** |
|---|---|---|
| | 0.35 | 0.60 |
| **Wood Doors (1¾ 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 08–043: cr. Register March 2009 No. 639, eff. 4–1–09; correction in (2), (7) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

**SPS 322.37 Air leakage. (1)** GENERAL. The requirements of this section apply to those components that separate interior conditioned space from a garage or an unconditioned space.

**(2)** WINDOW AND DOOR ASSEMBLIES. (a) *General.* Except as specified in par. (b), windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cfm per square foot, and swinging doors no more than 0.5 cfm per square foot, when tested according to NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/A440 by an accredited, independent laboratory and listed and labeled by the manufacturer.

(b) *Exception.* Site–constructed doors and windows shall be sealed with gasketing or weatherstripping or shall be covered with a storm door or storm window.

**(3)** JOINT AND PENETRATION SEALING. (a) Exterior joints, seams or penetrations in the dwelling envelope, which are sources of air leakage, shall be sealed with durable caulking materials, closed with gasketing systems, taped, or covered with water–vapor–permeable house wrap. 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, including between interior and exterior walls.

4. Penetrations of utility services through walls, floor and roof assemblies, and penetrations through top and bottom wall plates.

(b) Sealing shall be provided 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 thermal envelope.

(c) The sealing methods between dissimilar materials shall allow for differential expansion and contraction.

**(4)** RECESSED LIGHTING. When installed in the dwelling envelope, recessed lighting fixtures shall be sealed to limit air leakage between conditioned and unconditioned spaces by one of the following means:

(a) The fixture shall be IC–rated and labeled with enclosures that are sealed or gasketed to prevent air leakage to the ceiling cavity or unconditioned space.

(b) The fixture shall be IC–rated and labeled as meeting ASTM E 283 when tested at 1.57 psi pressure differential with no more than 2.0 cfm of air movement from the conditioned space to the ceiling cavity.

(c) 1. The fixture shall be located inside an airtight sealed box with clearances of at least 0.5 inch from combustible material and 3 inches from insulation.

2. If the fixture is non–IC–rated, the box shall be constructed of noncombustible material that does not readily conduct heat.

**Note:** The department will accept cement board, drywall, and other materials that exhibit flame spread and smoke developed indices of 10 or less when tested in accordance with ASTM E–84.

**(5)** FAN HOUSINGS. Gaps between a fan housing and a ceiling or wall that could result in air leaks shall be gasketed, sealed or caulked.

**(6)** COMPLIANCE DEMONSTRATION. Building envelope air tightness and insulation installation shall be demonstrated to comply with one of the following options:

(a) *Testing option.* Building envelope tightness and insulation installation shall be considered acceptable when tested air leakage is less than seven air changes per hour (ACH) when tested with a blower door at a pressure of 33.5 psf (50 Pa). Testing shall occur after rough in and after installation of penetrations of the building envelope, including penetrations for utilities, plumbing, electrical, ventilation and combustion appliances. During testing all of the following shall be done:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed.

2. Dampers shall be closed, but not sealed, including exhaust, intake, makeup air, backdraft and flue dampers.

3. Interior doors shall be open.

4. Exterior openings for continuous ventilation systems and heat recovery ventilators shall be closed and sealed.

5. Heating and cooling system(s) shall be turned off.

6. HVAC ducts shall not be sealed.

7. Supply and return registers shall not be sealed.

(b) *Visual inspection option.* Building envelope tightness and insulation installation shall be considered acceptable when the items listed in Table 332.37, applicable to the method of construction, are field verified. Where required by the code official, an approved party independent from the installer of the insulation shall inspect the air barrier and insulation.

**TABLE 332.37**
**AIR BARRIER AND INSULATION INSPECTION COMPONENT CRITERIA**

| COMPONENT | CRITERIA |
|---|---|
| Air barrier and thermal barrier | Exterior thermal envelope insulation for framed walls is installed in substantial contact and continuous alignment with building envelope air barrier.<br>Breaks or joints in the air barrier are filled or repaired.<br>Air–permeable insulation is not used as a sealing material.<br>Air–permeable insulation is inside of an air barrier. |
| Ceiling/attic | Air barrier in any dropped ceiling/soffit is substantially aligned with insulation and any gaps are sealed.<br>Attic access (except unvented attic), knee wall door, or drop down stair is sealed. |
| Walls | Corners and headers are insulated.<br>Junction of foundation and sill plate is sealed. |
| Windows and doors | Space between window/door jambs and framing is sealed. |
| Rim joists | Rim joists are insulated and include an air barrier. |
| Floors (including above–garage and cantilevered floors) | Insulation is installed to maintain permanent contact with underside of subfloor decking.<br>Air barrier is installed at any exposed edge of insulation. |
| Crawl space walls | Insulation is permanently attached to walls.<br>Exposed earth in unvented crawl spaces is covered with Class I vapor retarder with overlapping joints taped. |
| Shafts, penetrations | Duct shafts, utility penetrations, knee walls and flue shafts opening to exterior or unconditioned space are sealed. |
| Narrow cavities | Batts in narrow cavities are cut to fit, or narrow cavities are filled by sprayed/blown insulation. |
| Garage separation | Air sealing is provided between the garage and conditioned spaces. |
| Recessed lighting | Recessed light fixtures are air tight, IC rated, and sealed to drywall.<br>Exception–fixtures in conditioned space. |
| Plumbing and wiring | Insulation is placed between outside and pipes. Batt insulation is cut to fit around wiring and plumbing, or sprayed/blown insulation extends behind piping and wiring. |
| Shower/tub on exterior wall | Showers and tubs on exterior walls have insulation and an air barrier separating them from the exterior wall. |
| Electrical/phone box on exterior walls | Air barrier extends behind boxes or air sealed–type boxes are installed. |
| Common wall | Air barrier is installed in common wall between dwelling units. |
| HVAC register boots | HVAC register boots that penetrate building envelope are sealed to subfloor or drywall. |
| Fireplace | Fireplace walls include an air barrier. |

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09; CR 15–041: cr. (6), Table 322.37 Register December 2015 No. 720, eff. 1–1–16; correction in (6) (a) 6. made under s. 35.17, Stats., Register December 2015 No. 720.

**SPS 322.38 Vapor retarders. (1)** GENERAL. (a) *Definition.* Under this section, a vapor retarder is a material with no intrinsic thermal or structural properties that has a rating of 1.0 perm or less when tested in accordance with ASTM standard E 96, Procedure A.

(b) *Continuity.* 1. The vapor retarder shall be continuous. All joints in a vapor retarder consisting of sheet material shall be overlapped 6 inches and taped or sealed, except as provided in subd. 2. Rips, punctures, and voids in the vapor retarder shall be patched with vapor retarder materials and taped or sealed. Seams that are not over a framing member shall be taped or sealed.

2. Taping or sealing a vapor retarder is not required around doors and windows, behind bathtub enclosures, and at top and bottom wall plates, if the retarder is held to those materials in an airtight manner by other building components, such as gypsum wallboard.

**(2)** FRAME ASSEMBLIES. (a) *General.* Except as provided under par. (c), all frame walls, frame floors and frame ceilings that comprise the thermal envelope, shall have a vapor retarder installed on the warm–in–winter side of the thermal insulation.

(b) *Coverage.* The vapor retarder shall cover the exposed insulation and the interior face of the framing.

(c) *Exceptions.* 1. Where the vapor retarder is omitted, as allowed under subds. 2. to 4., all sources of air leakage, such as between double top or bottom plates or between double studs, shall be caulked or sealed.

2. No vapor retarder is required in the box sill.

3. No vapor retarder is required where batt insulation is provided with foil or kraft paper backing on the warm–in–winter side and the nailing tabs are tightly fastened to the warm–in–winter face of the framing members.

4. No vapor retarder is required over cavities that have at least 50% of the required R–value provided by spray–applied foam having a perm rating of 1.0 or less, unless required by the foam manufacturer.

5. A vapor retarder for a floor over an open, unheated area may consist of 5/8–inch tongue–and–groove oriented–strand board, or 3/4–inch tongue–and–groove CDX plywood, which is exposure–rated plywood.

**(3)** CONCRETE FLOORS. (a) Except as allowed under par. (d), a vapor retarder shall be installed directly under the concrete floor slab or under the base course of concrete floor slabs.

(b) Vapor retarder material shall be at least 6 mils in thickness or shall be a reinforced material.

(c) Joints in the vapor retarder shall be overlapped at least 6 inches and taped or sealed.

(d) A vapor retarder is not required under the slab of an unconditioned attached garage.

**(4)** CONCRETE OR MASONRY BASEMENT WALLS. A non–rigid sheet vapor retarder with a perm rating of 0.1 or less is prohibited in all of the following locations:

(a) On a concrete or masonry wall which is below grade to any extent.

(b) On an insulated frame wall constructed in front of a concrete or masonry wall which is below grade to any extent.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09; CR 09–104: r. (3) (d), renum. (3) (e) to be (3) (d) Register December 2010 No. 660, eff. 1–1–11; correction in (3) (a) made under s. 13.92 (4) (b) 7. Register December 2010 No. 660; CR 15–041: renum. (1) (b) to (1) (b) 1. and am., cr. (1) (b) 2., am. (2) (c) 4., cr. (2) (c) 5. Register December 2015 No. 720, eff. 1–1–16.

**SPS 322.39 Ventilation and moisture control. (1)** GENERAL. Design and construction shall prevent deterioration from moisture condensation and ice damming.

**(2)** VENTED ATTICS. (a) 1. Except as allowed under subd. 6., where air–permeable ceiling or attic insulation is installed in a horizontal position, ventilation shall be provided above the insulation in accordance with this paragraph.

2. At least 50% of the net free ventilating area shall be distributed at the high sides of the roof.

3. The remainder of the net free ventilating area shall be distributed in the lower half of the roof or attic area.

4. If more than 50%, but less than 75% of the net free ventilating area is provided at the high sides of the roof, the total net free ventilating area shall be a minimum of 1/300 of the horizontal area of the ceiling.

5. If 75% or more of the net free ventilating area is provided at the upper sides of the roof, the total net free ventilating area shall be at least 1/150 of the horizontal area of the ceiling.

6. Ventilation is not required for separated roof areas, such as dormers, bump–outs or bays that cover a floor area of 40 $ft^2$ or less.

(b) Engineered systems that provide equivalent ventilation to that required under this subsection may be used.

(c) Insulation shall not block the free flow of air.

**(3)** CONDITIONED ATTICS. Attic spaces are not required to be vented where air–impermeable insulation is attached directly to the underside of the roof deck and all of the following conditions are met:

(a) No interior vapor retarders are installed between the living space and the conditioned attic.

(b) The temperature in the attic space is maintained high enough to prevent any moisture condensation on the insulation.

**Note:** Maintaining the interior surface temperature of the insulation at or above the dew point temperature of the interior air will minimize condensation. Maintaining at least 45°F on the surface of the insulation will minimize condensation on the surface when the interior air temperature is 70°F and the interior relative humidity is 45%.

**(4)** CATHEDRAL CEILINGS. Air–permeable insulation in a cathedral ceiling assembly shall fill the entire cavity space unless an air barrier separates the top of the insulation from the ventilation space.

**(5)** MECHANICAL VENTILATION. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

**(6)** CLOTHES DRYERS. Clothes dryers shall be vented to the outside of the structure.

**Note:** See s. SPS 323.14 for vent material requirements.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09.

## Subchapter V — Systems

**SPS 322.40 Indoor temperatures and equipment sizing. (1)** GENERAL. The indoor temperatures listed under sub. (2) shall be used to determine the total dwelling heat loss and to select the size of the of the heating equipment.

**(2)** INDOOR DESIGN TEMPERATURES. Unheated, non–habitable basement areas shall use a heating design temperature of less than 50°F. All other areas of a dwelling shall use a heating design temperature of 70°F.

**(3)** EQUIPMENT SIZING. Heating design loads including ventilation loads for the purpose of sizing systems shall be determined in accordance with the REScheck or REM/RATE software programs or one of the procedures described in Chapter 29 of ASHRAE Handbook of Fundamentals.

**Note:** Residential heat balance, residential load factor, Canadian F280 and ACCA Manuals J and S are among the methods recognized as equipment–sizing protocols under chapter 29.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09.

**SPS 322.41 Temperature control. (1)** GENERAL. Each system shall be provided with an adjustable thermostat for the regulation of temperature.

**(2)** CIRCULATING HOT WATER SYSTEMS. Circulating hot water systems shall include an automatic or readily accessible manual switch to turn off the circulating pump when the system is not in use.

**(3)** MERCURY THERMOSTATS. The installation of thermostats containing mercury is prohibited.

**Note:** This section does not require the replacement of existing mercury–containing thermostats.

**(4)** HEAT PUMP SUPPLEMENTARY HEAT. Heat pumps having supplementary electric–resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09.

**SPS 322.42 Duct systems. (1)** Supply and return heating ducts, or portions thereof, that are not located completely within the thermal envelope, shall be provided with insulation with a thermal resistance of at least R–8.

**(1m)** Cooling supply ducts that pass through unconditioned spaces conducive to condensation, such as attics, shall be provided with insulation having a thermal resistance of at least R–8. The exterior of that insulation shall be covered with a vapor retarder that meets the requirements in s. SPS 322.38 (1)

**(2)** Building framing cavities may not be used as supply ducts.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09; CR 15–041: cr. (1m) Register December 2015 No. 720, eff. 1–1–16.

**SPS 322.43 Duct and plenum sealing. (1)** Duct systems with joints not located entirely within the conditioned space or with joints located on the unconditioned side of stud bays, joist cavities and similar spaces, shall be sealed in accordance with this section.

**(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.

**(7)** Except where exempted as indicated in sub. (8), duct tightness shall be verified by either of the following:

(a) Postconstruction test: Leakage to outdoors shall be less than or equal to 8 cfm per 100 $ft^2$ of conditioned floor area or a total leakage less than or equal to 12 cfm per 100 $ft^2$ of conditioned floor area when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. All register boots shall be taped or otherwise sealed during the test.

(b) Rough–in test: Total leakage shall be less than or equal to 6 cfm per 100 $ft^2$ of conditioned floor area when tested at a pressure differential of 0.1 inches w.c. (25 Pa) across the roughed in system, including the manufacturer's air handler enclosure. All register boots shall be taped or otherwise sealed during the test. If the air handler is not installed at the time of the test, total leakage

shall be less than or equal to 4 cfm per 100 $ft^2$ of conditioned floor area.

**(8)** A duct tightness test is not required if the air handler and all ducts are located within conditioned space.

**Note:** Standard duct tape or "duck tape" has a rubber–based adhesive and does not comply with the requirements of this section.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09; CR 15–041: cr. (7), (8) Register December 2015 No. 720, eff. 1–1–16; numbering correction in (7) made under s. 13.92 (4) (b) 1., Stats., and correction in (7) (intro.), (b) made under s. 35.17, Stats., Register December 720, eff. 1–1–16.

**SPS 322.44 Pipe insulation. (1)** Mechanical system piping capable of carrying fluids above 105°F (41°C) or below 55°F (13°C) shall be insulated to a minimum of R–3.

**(2)** All circulating service hot water piping shall be insulated to at least R–2. Circulating hot water systems shall include an automatic or readily accessible manual switch that can turn off the hotwater circulating pump when the system is not in use.

**(3)** Heating pipes in unheated spaces shall be insulated with material providing a minimum thermal resistance of R–4 as measured on a flat surface in accordance with ASTM standard C 335 at a mean temperature of 75°F.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09; CR 15–041: renum. 322.44 to 322.44 (3), cr. (1), (2) Register December 2015 No. 720, eff. 1–1–16.

**SPS 322.45 Air conditioner and heat pump efficiencies. (1)** Heating and cooling equipment shall meet the minimum efficiency requirements in Table 322.45 when tested and rated in accordance with the applicable test procedure.

**(2)** The efficiency shall be verified through certification under an approved certification program or, if no certification program exists, the equipment efficiency ratings shall be supported by data furnished by the manufacturer.

**(3)** Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all efficiency requirements under this chapter.

**(4)** Where components, such as indoor or outdoor coils, from different manufacturers are used, calculations and supporting data shall be furnished by the designer that demonstrate that the combined efficiency of the specified components meets the requirements under this section.

**TABLE 322.45**
**UNITARY AIR CONDITIONERS AND CONDENSING UNITS AND UNITARY AND APPLIED HEAT PUMPS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY REQUIREMENTS**

| Equipment Type | Minimum Efficiency | Minimum Efficiency | Test Procedure |
|---|---|---|---|
| Split system and single package air conditioner, air cooled | 13.0 SEER | | ARI 210/240 |
| Space constrained product–air conditioner | 12 SEER | | ARI 210/240 |
| Through–the–wall air conditioner, air cooled, split system | 10.9 SEER (before Jan. 23, 2010) 12.0 SEER (as of Jan. 23, 2010) | | ARI 210/240 |
| Through–the–wall air conditioner, air cooled, single package | 10.6 SEER (before Jan. 23, 2010) 12.0 SEER (as of Jan. 23, 2010) | | ARI 210/240 |
| Split system and single package air conditioner, water and evaporatively cooled | 12.1 SEER | | ARI 210/240 |
| Split system and single package heat pump, air cooled | 13.0 SEER | 7.7 HSPF | ARI 210/240 |
| Through–the–wall air conditioner and heat pump–split system | 10.9 SEER (before Jan. 23, 2010) 12.0 SEER (as of Jan. 23, 2010) | 7.1 HSPF (before Jan. 23, 2010) 7.4 HSPF (as of Jan. 23, 2010) | ARI 210/240 |
| Through–the–wall air conditioners and heat pumps–single package | 10.6 SEER (before Jan. 23, 2010) 12.0 SEER (as of Jan. 23, 2010) | 7.0 HSPF (before Jan. 23, 2010) 7.4 HSPF (as of Jan. 23, 2010) | ARI 210/240 |
| Space constrained products–heat pumps | 12 SEER | 7.4 HSPF | ARI 210/240 |
| Water source, heating mode, 68°F entering water | | 4.2 COP | ARI/ASHRAE 13256–1 |
| Groundwater source, heating mode, 50°F entering water | | 3.6 COP | ARI/ASHRAE 13256–1 |
| Ground source, heating mode, 32°F entering water | | 3.1 COP | ARI/ASHRAE 13256–1 |

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09; correction in (1) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

**SPS 322.46 Replacement furnace and boiler efficiencies. (1)** A replacement furnace in existing construction may meet only the prevailing federal efficiency standard provided the duct distribution system is sealed and tested at 0.02 inches water gage across the entire system, including the manufacturer's air handler enclosure, to have air leakage less than 10 percent of the furnace manufacturer's rated air flow across the blower at high speed.

**Note:** 0.02 inches water gage is equal to approximately 25 pascals.

**(2)** A replacement boiler in existing construction may meet only the prevailing federal standard provided there is no installed circulation pump larger than $^1/_{20}$ horsepower and no circulation pump runs continuously.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09.

**SPS 322.47 Equipment requirements. (1)** Mechanical ventilation outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

**(2)** Snow melt system controls. Snow– and ice–melting systems, supplied through energy service to the building, shall include automatic controls capable of shutting off the system when the pavement temperature is above 50°F, and no precipitation is falling and an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F.

**History:** CR 15–041: cr. Register December 2015 No. 720, eff. 1–1–16.

**SPS 322.48 Indoor Pools.** Indoor pools shall be provided with energy–conserving measures in accordance with all of the following:

**(1)** POOL HEATERS. All pool heaters shall be equipped with a readily accessible on–off switch to allow shutting off the heater without adjusting the thermostat setting. Pool heaters fired by natural gas shall not have continuously burning pilot lights.

**(2)** TIME SWITCHES. (a) Except where allowed in pars. (b) and (c), time switches that can automatically turn off and on heaters and pumps according to a preset schedule shall be installed on swimming pool heaters and pumps.

(b) Where public health standards require 24–hour pump operation, time switches are not required.

(c) Where pumps are required to operate solar– and waste–heat–recovery pool heating systems, time switches are not required.

**History:** CR 15–041: cr. Register December 2015 No. 720, eff. 1–1–16.

**SPS 322.49 Lighting Equipment.** A minimum of 50 percent of the lamps in permanently installed lighting fixtures shall be high–efficacy lamps.

**History:** CR 15–041: cr. Register December 2015 No. 720, eff. 1–1–16.

## Subchapter VI — Simulated Performance Alternative

**SPS 322.50 General.** This subchapter establishes criteria for compliance using simulated energy performance analysis. The analysis shall include heating, cooling, and service water heating energy only.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09.

**SPS 322.51 Performance–based compliance.** Compliance based on simulated energy performance requires that a proposed dwelling be shown to have an annual energy cost that is less than or equal to the annual energy cost of the standard reference design.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09.

**SPS 322.52 Documentation. (1)** COMPLIANCE SOFTWARE TOOLS. Documentation verifying that the methods and accuracy of the compliance software tools conform to the provisions of this subchapter shall be provided to the inspector.

**Note:** REM/Rate is an acceptable software program for determining compliance with this section.

**(2)** COMPLIANCE REPORT. Compliance software tools shall generate a report that documents that the proposed design has annual energy costs less than or equal to the annual energy costs of the standard reference design. The compliance documentation shall include all of the following information:

(a) Address of the dwelling.

(b) 1. An inspection checklist documenting the building component characteristics of the proposed design as listed in Table 322.53–1.

2. The inspection checklist shall show the estimated annual energy cost for both the standard reference design and the proposed design.

(c) Name of individual completing the compliance report.

(d) Name and version of the compliance software tool.

**(3)** ADDITIONAL DOCUMENTATION. The inspector may require any of the following documents:

(a) Documentation of the building component characteristics of the standard reference design.

(b) A certification signed by the builder providing the building component characteristics of the proposed design as given in Table 322.53–1.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09; correction in (2) (b), (3) (b) made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

**SPS 322.53 Calculation procedure. (1)** GENERAL. Except as specifically allowed under this section, the standard reference design and proposed design shall be configured and analyzed using identical methods and techniques.

**(2)** REFERENCE AND PROPOSED DESIGNS. The standard reference design and proposed design shall be configured and analyzed as specified by Table 322.53–1. Table 322.53–1 shall include by reference all notes contained in Table 322.31–1.

**(3)** CALCULATION SOFTWARE TOOLS. Calculation procedures used to comply with this section shall be capable of calculating the annual energy consumption of all building elements that differ between the standard reference design and the proposed design and shall include the following capabilities:

(a) Computer generation of the standard reference design using only the input for the proposed design. The calculation procedure may not allow the user to directly modify the building component characteristics of the standard reference design.

(b) Calculation of whole–building sizing as a single zone for the heating and cooling equipment in the standard reference design residence in accordance with s. SPS 322.40 (3).

(c) Calculations that account for the effects of indoor and outdoor temperatures and part–load ratios on the performance of heating, ventilating and air conditioning equipment based on climate and equipment sizing.

(d) Printed code official inspection checklist listing each of the proposed design component characteristics from Table 322.53–1 determined by the analysis to provide compliance, along with their respective performance ratings.

**TABLE 322.53–1**
**SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

| Building Component | Standard Reference Design | Proposed Design |
|---|---|---|
| Above–grade walls | Type: mass wall if proposed wall is mass; otherwise wood frame | As proposed |
| | Gross area: same as proposed | As proposed |
| | U–Factor: from Table 322.31–2 | As proposed |
| | Solar absorptance = 0.75 | As proposed |
| | Emittance = 0.90 | As proposed |
| Basement and crawlspace walls | Type: same as proposed | As proposed |
| | Gross area: same as proposed | As proposed |
| | U–Factor: from Table 322.31–2 with insulation layer on interior side of walls | As proposed |
| Above–grade floors | Type: wood frame | As proposed |
| | Gross area: same as proposed | As proposed |
| | U–Factor: from Table 322.31–2 | As proposed |
| Ceilings | Type: wood frame | As proposed |
| | Gross area: same as proposed | As proposed |
| | U–Factor: from Table 322.31–2 | As proposed |
| Roofs | Type: composition shingle on wood sheathing | As proposed |
| | Gross area: same as proposed | As proposed |
| | Solar absorptance = 0.75 | As proposed |
| | Emittance = 0.90 | As proposed |
| Attics | Type: vented with aperture = 1 $ft^2$ per 300 $ft^2$ ceiling area | As proposed |
| Foundations | Type: same as proposed | As proposed |
| Doors | Area: 40 $ft^2$ | As proposed |
| | Orientation: North | As proposed |
| | U–Factor: same as fenestration from Table 322.31–2 | As proposed |
| Glazing[a] | Total area[b] = | |
| | (a) The proposed glazing area; where the proposed glazing area is less than 18% of the conditioned floor area | As proposed |
| | (b) 18% of the conditioned floor area; where the proposed glazing area is 18% or more of the conditioned floor area | |
| | Orientation: equally distributed to four cardinal compass orientations | As proposed |
| | U–Factor: from Table 322.31–2 | As proposed |
| | SHGC = 0.40 | As proposed |
| | Interior shade fraction: | |
| | Summer (all hours when cooling is required) = 0.70 | Same as standard reference design[c] |
| | Winter (all hours when heating is required) = 0.85 | |
| | External shading: none | As proposed |
| Skylights | U–Factor: from Table 322.31–2 | As proposed |
| Thermally isolated sunrooms | None | As proposed |

**TABLE 322.53−1 (Continued)**
**SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

| Building Component | Standard Reference Design | Proposed Design |
|---|---|---|
| Air exchange rate | Specific Leakage Area (SLA)[d] = 0.00036 assuming no energy recovery | For residences that are not tested, the same as the standard reference design;<br>For residences without mechanical ventilation that are tested in accordance with ASHRAE 119, Section 5.1, the measured air exchange rate[e] but not less than 0.35 ACH;<br>For residences with mechanical ventilation that are tested in accordance with ASHRAE 119, Section 5.1, the measured air exchange rate[e] combined with the mechanical ventilation rate[f], which may not be less than 0.01 X CFA + 7.5 X (N br + 1) where:<br>CFA = conditioned floor area<br>N br = number of bedrooms |
| Mechanical ventilation | None, except where mechanical ventilation is specified by the proposed design, in which case:<br>Annual vent fan energy use: kWh/yr = 0.03942 X CFA + 29.565 X (N br + 1) where:<br>CFA = conditioned floor area<br>N br = number of bedrooms | As proposed |
| Internal gains | IGain = 17,900 + 23.8 x CFA + 4,104 X N br (Btu/day per dwelling unit) | Same as standard reference design |
| Internal mass | An internal mass for furniture and contents of 8 pounds per square foot of floor area | Same as standard reference design, plus any additional mass specifically designed as a thermal storage element[g] but not integral to the building envelope or structure |
| Structural mass | For masonry floor slabs, 80% of floor area covered by R−2 carpet and pad, and 20% of floor directly exposed to room air;<br>For masonry basement walls, as proposed, but with insulation required by Table 322.31−2 located on the interior side of the walls;<br>For other walls, for ceilings, floors, and interior walls, wood frame construction | As proposed<br>As proposed<br>As proposed |
| Heating systems [h,i] | Fuel type: same as proposed design efficiencies:<br>Electric: air−source heat pump with prevailing federal minimum efficiency;<br>Nonelectric furnaces: natural gas furnace in accordance with Table 322.31−3;<br>Nonelectric boilers: natural gas boiler in accordance with Table 322.31−3;<br>Capacity: sized in accordance with section SPS 322.40 (3) | As proposed<br>As proposed<br>As proposed<br>As proposed<br>As proposed |
| Cooling systems [h,j] | Fuel type: electric<br>Efficiency: in accordance with prevailing federal minimum standards<br>Capacity: sized in accordance with section SPS 322.40 (3) | As proposed<br>As proposed<br>As proposed |
| Service Water Heating [h,k] | Fuel type: same as proposed design<br>Efficiency: in accordance with prevailing federal minimum standards<br>Use: gal/day = 30 + 10 X N br<br>Tank temperature: 120°F | As proposed<br>As proposed<br>Same as standard reference<br>Same as standard reference |

**TABLE 322.53–1 (Continued)**
**SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

| Building Component | Standard Reference Design | Proposed Design |
|---|---|---|
| Thermal distribution systems | A thermal distribution system efficiency (DSE) of 0.80 shall be applied to both the heating and cooling system efficiencies | Same as standard reference design, except as specified by Table 322.53–2 |
| Thermostat | Type: manual, cooling temperature set point = 78°F; heating temperature set point = 68°F | Same as standard reference design |

a Glazing shall be defined as sunlight–transmitting fenestration, including the area of sash, curbing or other framing elements, that enclose conditioned space. Glazing includes the area of sunlight–transmitting fenestration assemblies in walls bounding conditioned basements. For doors where the sunlight–transmitting opening is less than 50% of the door area, the glazing area is the sunlight transmitting opening area. For all other doors, the glazing area is the rough frame opening area for the door including the door and the frame.

b For residences with conditioned basements, R–2 and R–4 residences and townhouses, the following formula shall be used to determine glazing area: AF = As X FA X F where:

1. AF = Total glazing area.
2. As = Standard reference design total glazing area.
3. FA = (Above–grade thermal boundary gross wall area)/(above–grade boundary wall area + 0.5 x below–grade boundary wall area).
4. F = (Above–grade thermal boundary wall area)/(above–grade thermal boundary wall area + common wall area) or 0.56, whichever is greater.

And where:

5. Thermal boundary wall is any wall that separates conditioned space from unconditioned space or ambient conditions.
6. Above–grade thermal boundary wall is any thermal boundary wall component not in contact with soil.
7. Below–grade boundary wall is any thermal boundary wall in soil contact.
8. Common wall area is the area of walls shared with an adjoining dwelling unit.

c For fenestrations facing within 15 degrees of true south that are directly coupled to thermal storage mass, the winter interior shade fraction may be increased to 0.95 in the proposed design.

d Where Leakage Area (L) is defined in accordance with Section 5.1 of ASHRAE 119 and where: SLA = L/CFA where L and CFA are in the same units.

e Tested envelope leakage shall be determined and documented by an independent party approved by the code official. Hourly calculations as specified in the 2005 ASHRAE Handbook of Fundamentals, Chapter 27, page 27.21, Equation 40, Sherman–Grimsrud model, or the equivalent shall be used to determine the energy loads resulting from infiltration.

f The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2005 ASHRAE Handbook of Fundamentals page 27.23 and the "Whole–house Ventilation" provisions of 2005 ASHRAE Handbook of Fundamentals, page 27.18 for intermittent mechanical ventilation.

g Thermal Storage Element means a component not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase–change containers. A thermal storage element must be in the same room as fenestration that faces within 15 degrees of true south, or must be connected to a room with pipes or ducts that allow the element to be actively charged.

h For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.

i For a proposed design without a proposed heating system, a heating system of 90% annual fuel utilization shall be assumed for both the standard reference design and proposed design. For electric heating systems, the prevailing federal minimum efficiency air–source heat pump shall be used for the standard reference design.

j For a proposed design home without a proposed cooling system, an electric air conditioner with the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.

k For a proposed design with a non–storage–type water heater, a 40–gallon storage–type water heater with the prevailing federal minimum energy factor for the same fuel as the predominant heating fuel type shall be assumed. For the case of a proposed design without a proposed water heater, a 40–gallon storage–type water heater with the prevailing federal minimum efficiency for the same fuel as the predominant heating fuel type shall be assumed for both the proposed design and standard reference design.

**TABLE 322.53–2**
**DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES FOR PROPOSED DESIGNS[a]**

| Distribution System Configuration and Condition | Forced Air Systems | Hydronic Systems[b] |
|---|---|---|
| Distribution system components located in unconditioned space | 0.80 | 0.95 |
| Distribution systems entirely located in conditioned space[c] | 0.88 | 1.00 |
| Proposed "reduced leakage" with entire air distribution system located in the conditioned space[d] | 0.96 | — |
| Proposed "reduced leakage" air distribution system with components located in the unconditioned space | 0.88 | — |
| Ductless systems[e] | 1.00 | — |

a Default values given by this table are for untested distribution systems, which must still meet minimum requirements for duct system insulation.

b Hydronic systems means those systems that distribute heating and cooling energy directly to individual spaces using liquids pumped through closed loop piping and that do not depend on ducted, forced air flows to maintain space temperatures.

c Entire system in conditioned space means that no component of the distribution system, including the air handler unit, is located outside of the conditioned space.

d Proposed "reduced leakage" means leakage to outdoors not greater than 3 cfm per 100 $ft^2$ of conditioned floor area and total leakage not greater than 9 cfm per 100 $ft^2$ of conditioned floor area at a pressure differential of 0.02 inches w.g. across the entire system, including the manufacturer's air handler enclosure. Total leakage of not greater than 3 cfm per 100 $ft^2$ of conditioned floor area at a pressure difference of 0.02 inches w.g. across the entire system, including the manufacturer's air handler enclosure, shall be deemed to meet this requirement without measurement of leakage to the outdoors. This performance shall be specified as required in the construction documents and confirmed through field–testing of installed systems as documented by an approved independent party.

e Ductless systems may have forced airflow across a coil but may not have any ducted airflows external to the manufacturer's air handler enclosure.

**History:** CR 08–043: cr. Register March 2009 No. 639, eff. 4–1–09; correction in (2), (3) (b), (d), Table 322.53–1 made under s. 13.92 (4) (b) 7., Stats., Register December 2011 No. 672.

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# Chapter SPS 322

## Introduction

This chapter of the UDC sets minimum standards for energy conservation for new one- and two-family dwellings. It sets requirements for insulation and moisture protection of the building envelope and capacity and efficiency requirements for heating, ventilating and air conditioning systems.

The standards attempt to satisfy the human comfort needs of proper temperature, air movement and humidity as well as economical and building-preserving construction and operation. To assist you in better understanding these standards, we've included the following energy basics section. Following that is the code section-by-section commentary.

Note that the effective date of the original energy conservation standards was December 1, 1978, differing from the June 1, 1980, effective date of the other chapters of the UDC.

Special electrically heated dwelling standards were removed by March 2008 Legislative action.

## Some Energy Basics

The following information is offered as background material to the intent and proper application of the Ch. SPS 322 requirements.

Chapter SPS 322 requirements can be put into the four categories of heat loss control, moisture control, ventilation design, and heating equipment requirements with some overlap between the four.

I. Heat Loss

The heat loss control requirements of Ch. SPS 322 are meant to limit heat transfer. Heat transfer is the tendency of heat or energy to move from a warmer space to a cooler space until both spaces are the same temperature. Obviously, the greater the difference in temperatures, the greater will be the heat flow. There are three types of heat transfer:

- Radiation - transfer of heat through space. An example is your body heat radiating out a closed window on a winter night. The glass is cold so there is no radiation to you and it is a poor reflector of your own heat back to you. Another example is sunshine coming in through a window.

- Conduction - transfer of heat through a material. An example is your warm hand held against the inside surface of a cold exterior wall. You will note that the code has a lower allowable R-value for what are called mass walls, versus frame walls. This reflects that capacity for such walls to maintain a certain temperature relatively longer because of its heat capacity.

- Convection - transfer of heat by moving masses of air. An example is heated air leaking out through door and window openings.

The code does not say much about radiative heat losses. It does say a lot about conductive and convective heat losses. Let's discuss these further.

A. Heat Loss By Conduction

1. C-Values and k-Values

   A measure of a material's ability to Conduct heat is its "C"-value which is expressed in BTUs per (hour)($^{o}$F). A BTU is a British Thermal Unit which is the heat required to raise one pound (about a pint) of water by one degree Fahrenheit and is roughly equal to the heat given off by the burning of one kitchen match. A human body gives off about 400 BTUs per hour. Since a C-value is a flow rate of heat, it needs a per time unit similar to other rate measures such as speed, "55 miles per hour." An hourly rate is also used in the C-value. Finally, as you recall, heat flow is greater as the temperature difference increases. So the C-value needs to be expressed in terms of what the difference is. For simplicity, it is taken at 1 degree Fahrenheit difference.

   Another term to be familiar with is a "k"-value which is merely the C-value for one inch of material.

   Typically, building components such as walls or ceilings consist of a "series" or layers of different materials as you follow the heat flow path out. However, you cannot add C-values together because if you were to take two insulating materials with a C-value of .5 each and were to add them together, you get the result of a total C-value of 1.0. This would mean that the heat flow rate has increased with the addition of more insulating material. Obviously then you cannot add C-values to find the "series" value.

2. R-Values

   Therefore, we now have to bring in the perhaps more familiar "R"-value which is a measure of a material's Resistance to heat flow and is the inverse or reciprocal of the material's C-value (R=1/C).

   So if a material has a C-value of 0.5, it has an R-value of 2 (as 2 = 1/0.5). If you have to add two materials in series or layers, say each with a C-value of 0.5, you take the inverse of both to get an R-value for each of 2. These can be added together to get a total R-value of 4. Usually materials are labeled or tables are

written so that the material's R-value is given [see SPS 322.20(5)(a)], which relieves you of finding the inverse of the material's C-value.

3. U-Values
For thermal heat loss calculations, we normally use "U"-values (U for Unrestrained heat flow or transmittance) which is a material's C-value but also includes the insulating effect of the air films on either side of the material. So it is, therefore, a smaller number (less heat flow).

A U-value can also refer to thermal transmittance of a series of materials in layers. To obtain a U-value for such an assembly, you add the individual R-values of the layers and the air films on either side of the assembly. Then you take the reciprocal of the total R-value to get the total U-value of the assembly (U = 1/R). (As with C-values discussed above, you can not add U-values for series calculations.)

4. Heat Loss Calculations
The purpose of these C-, k-, R- and U-values is to be able to calculate heat loss through a building component (wall, ceiling, floor). The basic equation is U x A x TD = Heat Loss or

U x Area ($ft^2$) x Temperature Difference ($^oF$) = Conduction Heat Loss (BTU/hr)

So to find the heat loss per hour through a building section of wall, you:

- determine its U-value by finding the inverse of the sum of individual R-values for each layer of material;

- decide on the inside and outside temperatures (in the case of the UDC, the winter design temperatures are mandated – see SPS 322.40(c) and the UDC Appendix A 323.02(1));

- measure the surface area of the building section;

- multiply these numbers together and get a result in BTUs per hour.

If you did this for every different building section (solid wall, window, ceiling, etc.), you could obtain the total heat loss through the envelope at design temperatures, which is the worst case situation. Normally this maximum figure along with the heat loss by infiltration (see discussion later) is used to size the furnace or other heating source. It is referred to as the heating load.

If you wanted to know the total envelope loss for a heating season, you do a degree-day calculation. A degree-day is the difference between 65°F and the average temperature for a day if it was below 65°F. If this calculation is done for

each day of the heating season, you can find the total heating degree-days for the year. This can be plugged into a modified version of the heat loss calculation as follows:

U x Surface Area x Degree-days x 24 hours/day = Season Heat Loss

5. U-Overall
   One more term to know is U-overall or $U_o$ which refers to the overall U-value of a building component such as a wall or ceiling. For example, a wall will have different individual U-values for the windows, stud cavities and stud locations. The UDC sets a minimum $U_o$ for each overall component surface. If a designer has a large window area, more insulation will need to be placed in the wall cavities or sheathing areas so that the overall or "average" wall surface U-value is acceptable.

   The U-overall value is calculated by taking the weighted average of the U-values (not R-values) of the different parallel paths through the same component (wall, ceiling or other) that you're dealing with.

6. System Design
   As an alternative, the system design method can be used so that more insulation is put in the ceiling to make up for the extra windows. However, it is not a one-for-one tradeoff because of the thermal transfer properties and mathematics of reciprocals involved. Let's say you have an R-10 (U = 0.1) wall and R-10 (U = 0.1) ceiling of equal area. If you transfer half of the wall insulation, to the ceiling, the wall becomes R-5 (U = 0.2) and the ceiling becomes R-15 (U = 0.07). However, you can see that the wall U-value increased by 0.1 and the ceiling U-value only decreased by 0.03. (Remember U-values are used to calculate heat losses.)

B. Heat Loss By Convection
   As mentioned, the other mechanism of heat loss addressed by the UDC is convection, or heat loss by air movement. In homes, this is principally heat loss by exfiltration and infiltration. Exfiltration is the loss of heated air through building cracks and other openings. Infiltration is the introduction of outside cold air into the building. This air movement also causes discomfort (drafts) to occupants in addition to the heat loss itself.

   The driving force for this exchange of air is the difference between indoor and outdoor air pressures. Air pressure differences are principally caused by wind pressures and the "stack" effect of warm inside air that tends to rise. Mechanically induced air pressure differences can also occur due to such things as exhaust fans and furnace venting.

   To calculate the heat loss by convection, we go back to the general heat loss calculation and modify it to:

$$\text{Heat Loss} = \text{Air's Heat Capacity} \times \frac{\text{Air Volume Exchanged}}{\text{Hour}} \times \text{Temp. Difference}$$

The volume exchanged can be determined by measuring or judging how many air changes that a house goes through in an hour. To do this, you calculate the volume of the heated space and multiply by an air change rate. For a UDC home, you can assume a rate between 0.2 and 0.5 air changes per hour [see SPS 322.30(2)], usually with a lower rate for basements with little outside air exposure, and higher rates for living areas or exposed basements. If you have a 1500 square foot house on a crawl space with 8-foot ceilings, the calculation of the volume exchanged can be:

1500 sq. ft. x 8 ft. x 0.5 Air Changes/hr = 6,000 cu. ft./hr

The heat capacity of air is a physical constant and is 0.018 BTU per (°F)(cu. ft.). The temperature difference, which varies by site location, used is the same as for heat loss by conduction. So the whole equation for this example is:

$$\frac{0.018 \text{ BTU}}{(^{o}\text{F})(\text{cu. ft.})} \times 6{,}000 \text{ cu. ft./hr.} \times 90^{o} = 9{,}720 \text{ BTUs/hr}$$

This figure is the design or maximum heat loss by convection. If you wanted to figure the total seasonal infiltration heat loss, you would perform a degree day calculation as for the seasonal conduction heat loss calculation. You substitute the seasonal degree days and the 24-hour multiplier for the temperature difference figure in the infiltration heat loss equation above.

Another method of determining heat loss by convection is the crack method. For this method you obtain the air leakage rates in cubic feet per minute for the doors and windows from their manufacturers and multiply by the lineal feet of sash crack or square feet of door area. (A more exact analysis would multiply the door infiltration rates by 1 or 2 due to open/close cycles and add 0.07 cfm per lineal feet of foundation sill crack.) This gives an air change rate per minute. This has to be converted to an hourly rate by multiplying by 60. Then you substitute this figure for the air change rate in the infiltration heat loss equation above.

C. Total Dwelling Heat Loss

If you add the heat losses by conduction and convection, you arrive at the total dwelling heat loss for purposes of the UDC. Of course this figure is approximate and ignores other means of heat loss. However, it also ignores the major heat gain from secondary sources such as electric lights, human bodies, cooking, etc. So the figure tends to overstate the heat loss but this ensures an adequately sized heating plant.

II. Moisture Control

The second area of concern addressed by the UDC is control of moisture. The occupancy of a dwelling produces a large amount of water vapor. As you may recall from weather

forecasts, warmer air can hold more moisture than cold air. In the winter, the inside air is warmer than the outside, so if moisture moving outside by convection or dispersion (similar to conduction) reaches too cold of air, it will "condense out." This occurs at the dew point for that water vapor/air mixture. This condensation can be damaging to the building if it happens inside part of the wall or ceiling construction. It can promote structural member decay and lessening of the insulation's effective R-value.

There are three methods of reducing the possibility of condensation--vapor retarders and cold-side venting.

A. Vapor Retarders and Air Barriers

A vapor retarder (sometimes called a vapor barrier) acts to resist the movement of moisture through a section of the building envelope by water vapor diffusion and bulk movement of moist air. A vapor retarder's efficiency at reducing moisture movement by water vaper diffusion is measured by its permeability in "perms." A perm is one grain of water per (hour) (square foot) (inch of mercury vapor). The lower the number, the more resistant is the material to moisture flowing through it.

The required continuity of the vapor retarder over the warm-in-Winter surface provides the required barrier to bulk movement of moist air through the assembly. This means the retarder also needs to be continuous with seams and holes lapped or sealed. This bypass effect can be much greater than the movement of water vapor by diffusion. Note that the code also requires sealing of the building envelope against air infiltration from the exterior – typically the vapor retarder will satisfy the requirement for this "air barrier".

Vapor condenses when it comes in contact with material that is at a temperature lower than its dew point. This temperature typically occurs within the wall cavity and thus would condense out water vapor before it can escape from the dwelling. This moisture can cause decay of building materials and a reduction in insulating value.

Additional areas where condensation occurs are generally at corners of rooms at the exterior walls. This area is subject to condensation for a number of reasons. The temperature at the corners is generally cooler due to the fact that it is difficult to insulate at this location due to the method of construction. The insulation may be further reduced due to the roof system allowing less insulation to be placed above the corner. Condensation also occurs in areas with poor air circulation such as closets.

B. Cold-Side Venting

The other means of controlling moisture is cold-side venting. This is usually employed in attics and unheated crawlspaces. The venting removes excess moisture that bypassed the ceiling vapor retarders or comes out of the earth in the crawl space. This venting is usually done by natural means through the use of grills or louvers from the space to the outside. However, for that to work, there must be high and low venting in the case of the attic or cross ventilation in the case of the crawl space.

Cold-side attic venting also keeps the roof cooler so that there is less melting of snow and contributes to less creation of ice dams at the eaves in the winter. It also helps dissipate summertime attic heat, which increases comfort and reduces cooling costs.

C. Impervious Insulations
Thus use of closed-cell foam plastic insulation or similar non-absorbent insulating materials that are unaffected by moisture condensation is another effective method used for some designs of dwellings to deal with this issue.

D. Moisture Control During Construction
Unless proper construction techniques are utilized during construction, serious problems can occur as a result of water vapor that is trapped inside and then causes deterioration of gypsum wallboard.

Over the years we have seen many improvements in both materials and methods in home construction. Often times the use of a new material required the change in a technique or method of construction previously unheard of. Most building codes are only a reflection of our latest achievements in technology and engineering. The vapor retarder requirements in the Uniform Dwelling Code are a reflection of state of the art insulation techniques. Simply stated, the purpose of the vapor retarder is to prevent (as much as possible) water vapor from penetrating into the insulation and thereby reducing the effectiveness of the insulation. The problem is that builders who are not familiar with the use of vapor retarders, particularly during winter construction months, can inadvertently create problems for the homeowner if precautionary measures are not taken during construction. We offer the following suggestions to incorporate in construction procedures, especially during winter months:

1. Do not allow gypsum board to pick up excess moisture prior to installation.
2. Make sure attics are insulated prior to putting heat into the home for gypsum board taping and finishing. Many builders neglect to do this and create condensation problems when the water vapor condenses upon hitting the cold, attic air above the gypsum board. Gypsum board ceilings should be hung and insulated prior to putting heat into the home.
3. Make sure all heating appliances, i.e., furnaces, temporary heaters, salamanders, etc., are vented to the outside of the home. Builders who do not follow this warning are adding additional water vapor created by combustion of heating fuels.
4. Make sure all required attic ventilation is installed and operable to remove any water vapor trapped in the attic.
5. Provide a means for the water vapor in the home to escape; such as periodic opening of windows, doors, etc. Perhaps the installation of a humidistatically controlled exhaust fan is necessary, particularly where electric baseboard heat or heat pump systems are utilized.
6. Do not overload gypsum board ceilings with insulation beyond their capacity. See s. SPS 321.02 (1)(a) of this commentary.

Incorporation of these techniques will avoid major problems with condensation. These methods are not new and have been proven successful by many hundreds of builders operating in climates such as ours.

E. Post-Construction" Moisture Control Problems

As discussed in the basics section of this commentary chapter, moisture must be dealt with in all homes. The following is a general discussion of typical symptoms, causes and prevention techniques regarding moisture problems in homes. It is intended as background information to help explain some UDC requirements. Additional recommendations above and beyond the UDC minimums are included for homeowners who may experience more severe moisture problems.

1.How can you determine if a home has a moisture problem?

You can get a good idea of whether your home has an excess moisture problem that may lead to damage by checking for the following symptoms.

- Extensive condensation on windows during the heating season. Some condensation is normal. Condensation that streams off the window and puddles on the frame and sill when outside temperatures are 10°F or above and inside temperatures are above 65°F indicates humidity levels are probably too high.
    - If condensation is limited to the inside surface of storm windows, then your primary windows may be allowing moist interior air to leak by them. Because of the "stack" pressure effect, this problem may be worse on second floor windows.
    - If condensation is limited to the inside surface of the primary windows, then your storm windows may be allowing cold air to leak by them which then cools the primary window.
- Staining and mold on window frames.
- Mold or water spots in numerous locations on the inside surface of outside walls. Common trouble spots include closets on outside walls; corners between two outside walls or between an outside wall and ceiling; and outside walls behind furniture; or other areas where air circulation is limited.
- Soft or buckling interior wall surfaces. Gypsum board is a common interior surface. When dampened it may pull away from studs or ceiling rafters. Additional moisture may cause the gypsum board to crumble.
- Staining or warping of exterior siding.
- Paint peeling from exterior siding, especially extensive peeling of paint down to the primer.

If you have not experienced any of these symptoms, the home probably does not have a moisture problem. However, it may be a good idea to consider some of the measures in the following Section III to assure that future problems do not develop.

2. What are typical causes of moisture problems in homes?

Through breathing and normal daily activities, each member of a household produces about seven pounds of water vapor. Naturally this number varies greatly depending on living habits. This water vapor becomes part of the air. However, air can hold only a limited amount of water vapor. This amount depends on temperature. The higher the temperature the more moisture the air can hold. When more moisture is introduced into the air than it can hold, some of the moisture will condense on surfaces. If cold surfaces sufficiently cool the surrounding air, condensation will occur on that surface even though the remaining room air is not saturated with moisture. The frosted cold beverage glass in summer is an example.

In most older homes there is enough movement of air into and out of the house that moisture does not build up and only small amounts of condensation occurs. However, when air leaks into and out of a house it not only takes moisture but heat as well. In order to make homes more energy efficient, builders have been trying to seal cracks and cut air leaks.

These efforts to tighten homes have meant that more moisture remains in the home. Unless controlled ventilation is added, moisture accumulates, and condensation occurs near the ceiling on outside walls or on outside walls of closets. These areas generally have cooler surfaces. If condensation persists on these surfaces, molds and mildews may develop. In addition, fungal growth and possible deterioration of material may occur when temperatures are at or above 50°F and the material remains wet. Such fungal growth could damage wood members in extreme circumstances.

3. Besides the UDC requirements, what measures can help prevent moisture problems?
    - Reduce Moisture Production In The Home
        - One way to substantially reduce the chances that condensation will occur either on inside surfaces or within walls is to keep indoor moisture levels low. The first step is to reduce the amount of moisture produced in the home. Some major sources of moisture that can be controlled are listed below.
        - Prevent moisture from entering through basements. Many basements feel damp in the summer due to condensation of moisture from the air on cool basement surfaces. However, in some cases damp basements may be due to ground moisture entering the home through basement walls. Cracks or stains on basement walls and floors are signs of dampness entering through these surfaces.
            - You can check whether dampness is coming through walls by using a simple patch test. Tape a piece of plastic sheeting tightly against the basement wall where you suspect moisture penetration. After a couple of days pull the patch off and look for signs of moisture on the wall side of the patch. If you detect moisture, it means moisture is coming through the wall rather than condensing on the walls.
            - If you suspect a basement water problem, check the surface drainage around you home. Most basement water problems result from poor surface drainage. Make sure that the ground slopes away from the foundation. Consider installing gutters. If you have gutters, make sure they are clear of debris and functioning properly. Downspouts should direct water away from the foundation.

  - Do not store large amounts of firewood in the basement. Even seasoned wood can contain large amounts of moisture. It also may be a source for fungus.
  - Other ways you can reduce moisture generation:
    - Vent clothes dryers outdoors;
    - Don't line dry clothes indoors;
    - Limit the number of houseplants;
    - Cover kettles when cooking;
    - Limit the length of showers; and
    - Do not operate a humidifier in the wintertime unless your indoor relative humidity is below 25 percent.
    - Be sure any crawlspace floors have a vapor retarder covering.
  - If problems persist, you should also check for any blocked chimney flues that may be preventing moisture-laden flue gasses from exhausting out of the house.
  - Correct any plumbing and roof leaks. If ice dams are a problem, consider more attic ventilation and adding insulation.

- Add Mechanical Ventilation
  - A second way to reduce moisture levels is to add mechanical supply and exhaust ventilation. As an added benefit, ventilation will reduce concentrations of other possible air contaminants such as combustion by-products from heating, cooking and smoking.
  - A widely recommended ventilation rate for homes is one half air change per hour. In a 1,200-square-foot house with 8-foot high ceilings, there are about 9,600 cubic feet of air. To meet the ventilation standard, half of that amount or 4,800 cubic feet of air must be exchanged every hour. This roughly equals 100 cubic feet per minute (cfm) of air exchange. Even in a tight house some of this air exchange occurs naturally. A constantly running or humidstat-controlled bathroom fan would typically ensure adequate ventilation.
  - However, in a house that is experiencing severe moisture problems, it can be assumed you are getting less than one half air change per hour. A balanced ventilation system should be used to make up the remaining necessary air exchange. A balanced system is one that not only exhausts stale air but provides a source of fresh replacement air. Currently the UDC per SPS 323.02(3)(b)2. only mandates that 40% of exhaust ventilation be made up through another means. Without proper replacement air the home could have what is known as negative air pressure.
  - Negative pressure could cause exhaust gases from your furnace or water heater, which should be going up your chimney or out a vent, to be sucked into the living space.
  - Additional ventilation is needed only during the heating season. When you provide controlled ventilation for your home, the heat lost is relatively small. For a 1,200-square-foot home, the cost of this lost energy and the electricity to run the fan would amount to about a dollar a day assuming you heat with the most expensive heat source, electric baseboard. This cost should be much less if you heat with gas or other fuels. Also, some ventilation systems can reclaim a portion

of the heat (up to 80%) from the exhaust air by heat-recovery ventilators. This could help reduce energy costs.

- Stop Moisture At The Inside Wall Surface (In Addition To The Required Moisture Vapor Retarder)
    - In addition to reducing moisture levels of the interior air, carefully seal all openings in the inside surface of all exterior walls to prevent moist air penetration. This includes joints around window and door casings, baseboards, electrical outlets and switches and any other penetrations. Gaskets for electrical penetrations are now commonly available, be sure that they extend to the outside edge of the cover plate of electrical devices.

Relative Humidity

In winter, the ideal relative humidity range for comfort is 30 percent - 45 percent. A lower humidity may cause excessive skin evaporation which in turn will cause an undesired cooling effect. For the sake of protecting the structure from damage due to excessive moisture, an ideal relative humidity range of less than 45 percent is recommended. Therefore, to provide comfort and still protect the building, a relative humidity range between 30 percent to 45 percent is recommended.

In summer, the ideal comfort range is 30 percent to 50 percent. Higher humidity won't allow adequate skin evaporation and the resulting desired cooling effect.

III. Mechanical Ventilation

As the code has mandated tighter home construction, the UDC has had to provide increase of mechanical ventilation as an alternative to infiltration to maintain indoor air quality so excessive humidity or other pollutant levels are checked. This has taken the form of required exhaust ventilation for rooms with a toilet, tub or shower and for kitchen exhaust.

A designer may decide to use an air-to-air heat exchanger to satisfy the exhaust requirement, while at the same time recovering heat from the exhausted air. This is done by moving the exhausted air past the intake air with a heat exchanging barrier between the two air streams.

IV. Equipment Efficiency Requirements

The final area that Ch. SPS 322 regulates is heating and cooling equipment efficiencies.

## Subchapter I — Scope and Application

322.01(3) Scope

Dwellings that use renewable sources of energy, such as wood or solar, for heat generation, including for what is used by any heat pumps, are exempt from the building envelope insulation requirements. Non-renewable sources of energy may be used to distribute heat by fans or pumps without affecting the dwelling exemption. Although homes that are heated with renewable sources of fuel, such as wood, are exempt from the insulation requirements, they are still subject

to the moisture control requirements for vapor retarders and ventilation. These are needed to protect framing and keep insulation dry and protected from degradation.

322.02(2) Declaration of Method of Compliance
As there are more than one method, submitters of plans & calculations should clearly communicate which method of compliance is being provided for the dwelling.

## Subchapter III — Materials and Equipment.

322.20(4) Material Installation
This section requires all insulation, mechanical equipment and systems to be installed per the manufacturer's installation instructions which are to be available at job sites during inspection.

322.20(6) Building Certification
This section requires that a permanent certificate of insulation R-values and fenestration U-factors be provided on or immediately adjacent to the electrical distribution panel. If REScheck or REM/Rate software program was used, that certificate print-out shall be provided. Otherwise, a copy of the following form may be used.

# 2016 Wisconsin/2009 IECC Energy Efficiency Certificate (Post on or immediately adjacent to electrical distribution panel per SPS 322.20(6))

| **Insulation Rating** | **R-Value** |
|---|---|
| Ceiling/roof | _____ |
| Wall | _____ |
| Floor/Foundation | _____ |
| Ductwork (unconditioned spaces) | _____ |
| Beneath Heated Slab | _____ |
| Perimeter of Heated Slab | _____ |

| **Glass & Door Rating** | **U-Factor** |
|---|---|
| Window | _____ |
| Skylight | _____ |
| Door | _____ |

**Name** _____ **Date** _____

**Comments** _____

These Efficiency and Compliance Certificates may be used in lieu of the REScheck Certificates

## 2016 Wisconsin/2009 IECC UDC Compliance Certificate (Submit with building plans)

**Owner/Agent** _____ **Location** _____

**Heating Appliance Type & Efficiency**_____ **Insulation Zone (SPS 322.31(1)(b)** ___

| **Building Component** | **Code Min. Insulation Value (Table 322.31-1)** | | **Code Min. Insulation Value For Lower Efficiency Appliances[1] (Table 322.31-3)** | | **Enter Actual Insulation Value & if Cavity or Continuous** |
|---|---|---|---|---|---|
| | Zone 1 | Zone 2 | Zone 1 | Zone 2 | |
| **Fenestration (U-Value)** | | | | | |
| **Window** | 0.35 | 0.35 | 0.30 | 0.30 | |
| **Door** | 0.35 | 0.35 | 0.30 | 0.30 | |
| **Skylight (U-Value)** | 0.60 | 0.60 | 0.60 | 0.60 | |
| **Ceiling** | | | | | |
| **Energy Heel** | R-38 | R-38 | R-38 | R-38 | |
| **Flat** | R-49 | R-49 | R-49 | R-49 | |
| **Wood Framed Wall** | R-20 or R-13 cav + R-5 cont | R-21 cav | R-21 cav or R-19 cav + R-5 cont | R-21 cav or R-19 cav + R-5 cont | |
| **Mass Wall** | R-15/19 | R-19/21 | R-19 | R-19 | |
| **Floor** | R-30 | R-38 | R-30 | R-30 | |
| **Basement** | R-15 cav or R-19 cont | R-15 cav or R-19 cont | R-15 cav/ R-19 cont | R-15 cav or R-20 cont | |
| **Crawl Space** | R-10 cav or R-13 cont | R-10 cav or R-13 cont | R-15 cav/ R-19 cont | R-15 cav or R-20 cont | |
| **Heated Slab** | R-10 / R-15 | R-10 / R-15 | R-10 / R-20 | R-10 / R-20 | |
| **Unheated Slab** | R-10 | R-10 | R-15 | R-15 | |

1. Includes less than 90% efficient natural gas and propane furnaces and hot water boilers, less than 83% efficient oil-fired furnaces and less than 84% oil-fired hot water heater boilers. (See Table 322.31-3)

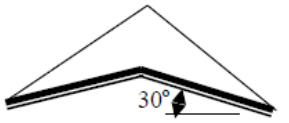
SBD10891 (R 1/16)

322.21(1)&(2) Protection of Insulation

This section requires blanket insulation to be held in place by a covering or mechanical fastening. SPS 322.21(2) requires cold-in-Winter side windwash protection of air-permeable insulation, thus also keeping insulation in place and maintaining the R-value of that insulation. Normally the exterior sheathing would do this, but where that is not present, some other vapor-permeable material, such as housewrap would be required.

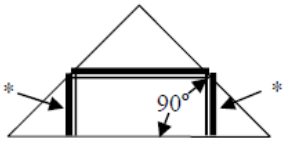
Question: If I have a sloped ceiling that is not a cathedral ceiling, such as that created by scissor trusses, that is insulated with an air-permeable insulation material, e.g. fiberglass or cellulose, do I need the wind wash protection required by this section?

Answer: No, if the ceiling is sloped less than 60 degrees from the horizontal and it is not a cathedral ceiling, wind wash protection is not required. A cathedral ceiling is a sloped ceiling, with closely-spaced, parallel ceiling and roof finishes. It is the intent of SPS 322.21(2)(a) to require the wind wash protection for walls or exposed vertical ends of air-permeable insulation at the perimeter of floor systems, open to attic space or other unconditioned space. The intent of incorporating the phrase "in a position other than horizontal" into this section is intended to exclude insulated ceilings, other than cathedral ceilings from the wind wash protection requirement. If that is the intent of that section, what is a wall? In model building codes and in Rescheck is the following guidance:



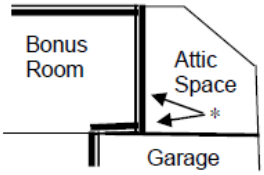

Bottom Chord Less Than 60° to Horizontal - Ceiling

* Wind Wash Protection Above Insulation Not Required.




Building Segment More Than 60° to Horizontal - Wall.

* Wind Wash Protection on Cold-in-Winter Side Required.




Building Segment More Than 60° to Horizontal - Wall.

* Wind Wash Protection on Cold-in-Winter Side Required, Including the End of the Floor Insulation.

In summary, a wall is defined as a building element that is sloped 60 degrees or more to the horizontal. Wind wash protection is not required for ceilings that are horizontal or tilted at less than 60 degrees to the horizontal.

## Subchapter IV — Dwelling Thermal Envelope

322.31 Envelope Compliance

Envelope compliance may be by prescriptive method of SPS 322.31(1) by either complying with Table 322.31-1 or Table 322.31-4 or alternatively, per SPS 322.31(2) by showing the overall

envelope U-value multiplied by Area complies. The latter method may be done by hand calculation or more typically by the use of the free software program, Rescheck, available from the federal government at www.energycodes.gov . Rescheck version 4.3.0 or greater offers the required code of 2009 IECC. (Do **not** select "2009 Wisconsin".) Note that after selecting the 2009 IECC code, the previously available Loads tab in which to calculate your heating plant size will not be available. See SPS 323.02 of this commentary for methods of obtaining the heating load. See the last page of this chapter for an example of a Rescheck Compliance Report.

Note that if the permit applicant elects to install a heating appliance with efficiency lower than required by Table 322.31-3 and is therefore subject to the thermal envelope requirements of Table 322.31-4, Rescheck is **not** an acceptable method of showing code compliance.

The Rescheck program produces an inspection report based on the unamended 2009 IECC for use by builders and inspectors. Note that the following items in that report need to be modified per the amended Wisconsin adoption of the 2009 IECC:

- Duct tightness testing is only required per SPS 322.43 if any portion of the distribution system is outside the conditioned space.
- Thermostats are required per SPS 322.41 for all heating and cooling systems, but are not required to be programmable.
- The protective covering for exterior foundation insulation is only required to be installed **2"** below grade per SPS 322.21(3).
- All ducts located outside conditioned spaces shall be insulated to R-8 per SPS 322.42.
- Only ducts located outside the conditioned space shall be sealed per SPS 322.43.

Finally, compliance may be shown per SPS 322.51 by calculations or software that models the whole house energy usage. Remrate is a type of acceptable software for that purpose if its version is 14.6.2.1 or greater. Contact the Wisconsin Focus on Energy program for more information.

With any of the envelope compliance methods, any authorized party to the design or construction process may complete the necessary calculations or form completion.

322.32 (1) Ceilings With Attic Spaces.

This section permits the use of R-38 in the attic space in lieu of R-49 specified in Table 321.23-1 as long as the R-38 insulation covers the entire attic area including over the exterior wall top plates. This could be accomplished with the use of "energy heel" trusses. The height of the heel would depend on the type of insulation used to attain the R-38 insulation value.

322.33 Slab Floors

Shallow slabs less than 12" below grade must meet Table 322.31-1 or 322.31-4 for Unheated Slab R-value with perimeter insulation. Heated slabs of any depth with embedded, uninsulated heating ducts or pipes require slab insulation throughout, with additional insulation at the perimeter. Horizontal slab insulation that projects away from the building shall be protected by either pavement or a minimum of 10 inches of soil. See UDC Appendix drawings showing

acceptable and unacceptable perimeter insulation in terms of ensuring the edge of the slab is properly insulated.

322.32(6) Discontinuities in Foundation Wall Insulation

See SPS 322.33(3)(c) for an exception that allows discontinuity in foundation insulation where interrupted by an intersecting foundation wall.

322.34 Crawl Spaces

This section requires a vapor retarder on the floor of a crawl space. Per Table 332.37, it shall be a Class I vapor retarder, which is defined by the IBC as having a perm rating of 0.1 or less. Note that requirement to run the vapor retarder 6" up the foundation wall is applicable when there is no floor present to maintain the vapor retarder in place.

322.35 Sunroom vs Screen Porch

This option for reduced insulation levels is only available to heated sunrooms with opaque walls and glazing. It is not available to heated screen rooms with only screens for a portion of the walls. Note that the requirement for a separate heating zone is not satisfied by dampers on the supply ducts.

322.36 Fenestration

Fenestration is an architectural term for windows and doors. The UDC generally requires them to be certified under the NFRC 100 standard for the values used, which is easily verified in the inspection of the window label on each unit. Where windows are not labeled, the conservative, default table values must be used for determining compliance. The code allows a single door and a single window to be exempt from door and window requirements which permits the installation of elements such as stained-glass windows

Different types of window operating hardware will produce different U-values for similar-sized windows. Therefore, a 3'-0" x 3'-0" double hung window would have a different U-value from a 3'-0" x 3'-0" fixed window sash. Similar size windows produced by two different manufacturers would most likely also have different U-values. Averaging of U-values is by area-weighting per SPS 322.36(1).

322.37 Air Leakage

Air leakage at fenestration and at other penetrations in the envelope are to be sealed properly per SPS 322.37(3), (4) & (6)(b) requirements or pass a blower door test per (6)(a).

SPS 322.37(4) provides specific guidance on recessed lighting installed at envelope areas, without leading to overheating fires.

322.37 Air Infiltration Barrier

The UDC does not define materials to be used as an infiltration barrier. It does require them to:

1. Be installed on the interior face, typically as part of the vapor retarder, or on the exterior face of the wall, typically as a house wrap or caulked building panels.
2. Form a continuous barrier over the walls of the building from the bearing points of the roof to the top of the foundation.
3. Have all seams, joints, tears, and punctures sealed.

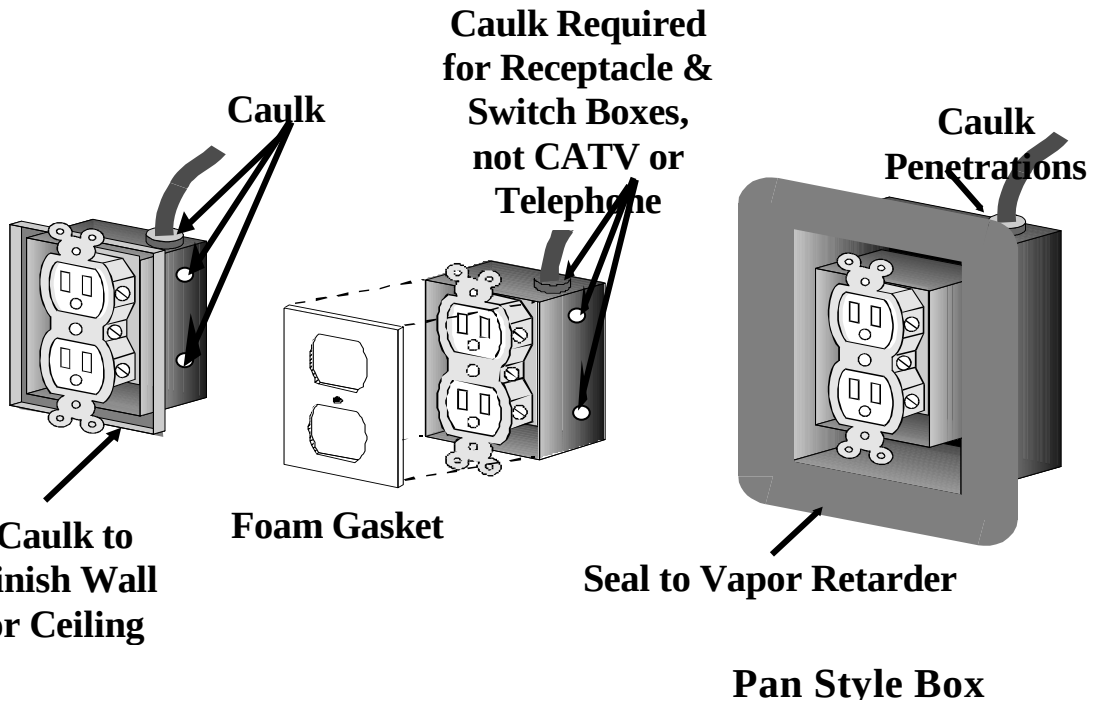
Additionally, the department has determined such infiltration barrier construction:

1. Be water vapor permeable to prevent moisture problems within the wall if installed on the cold side of the wall. The perm rating must be significantly higher than the interior vapor retarder. Alternatively, it is acceptable to have an exterior infiltration barrier that is vapor impermeable, but provides insulation to keep the dew point out of the wall.
2. Restrict infiltration to an appreciable extent.

These materials include:

- Spun bond polyolefin sheets, with taped joints.
- Micro-perforated polyethylene film sheets, with taped joints.
- Building panel sheets such as foam sheathing or plywood sheathing with taped joints, regardless if the panels have butt or tongue and groove edges

322.37(3)(b) Air Sealing of Electrical Switch and Receptacle Boxes




**Pan Style Box**

322.37(6)(b) Air Barrier & Insulation Inspection Component Criteria Table

Note that some of the items on this list need to be verified at the insulation inspection and others at the final inspection. Also the Table has several additional requirements that are not applicable if the Blower Door Test option is chosen. To highlight several items the list:

- Corners and headers of walls are required to be insulated.
- The reference to a Class I vapor retarder on the floor of a crawl space means a vapor retarder with a perm rating of 0.1 or less.
- Non-IC rated recessed ceiling light fixtures may be used in insulated ceilings if installed per SPS 322.37(4)(c)2., since this is a more specific treatment of the topic than the Table.
- The requirement to place insulation in the building envelope to the exterior of plumbing piping is based on SPS 382.40(8)(a)1. that requires piping to be protected against freezing.
- Common walls of duplexes require an air barrier, and exterior wall insulation, only if the two units are separately owned and therefore may not necessarily both be heated.

322.38(1) Paint as a Vapor Retarder

Certain paints have been tested per ASTM E-96 to provide a vapor retarder with a perm of 1 or lower or labeled as Class II (Class I would also be acceptable) when applied at specified rates and coats for certain surfaces. Regardless of the type of vapor retarder used, per SPS 322.38(1)(b), it shall be continuous. So in the case of vapor retarder paint, any discontinuities in the surface being painted, must caulked, gasketed or otherwise sealed.

In order to assure building officials and owners that vapor retarder paint has in fact been installed and the intent of SPS 322.38 met, a certificate of compliance (see following sample certificate) may be filled out and submitted to the building official with a copy to the owner. In addition to the certificate, the contractor should provide the inspection agency with the labels from the paint cans that were used by the applicator.

The following is the recommended procedure to be followed by building inspection agencies to assure compliance with the vapor retarder requirement:

1. At the time of plan submittal, the builder should state or have shown on the plans what type of vapor retarder is to be used in the dwelling.
2. At the time the plan is approved, the inspector should provide a blank Certificate of Application if one will be locally required.
3. At the time the insulation/rough energy inspection is made, the inspector will be able to determine where the standard vapor retarder was applied in the dwelling.
4. At the final inspection, the contractor should supply to the building inspector the completed certificate as well as the labels from the paint cans.
5. The inspector may then destroy the labels and the Certificate of Application can be filed with the building file.

# VAPOR RETARDER PAINT
# CERTIFICATE OF APPLICATION

THIS CERTIFIES THAT A VAPOR RETARDER PAINT HAVING A PERM RATING BELOW 1.0 WAS APPLIED TO THE FOLLOWING STRUCTURE:

_____

_____

PAINT MANUFACTURER: _____

SUPPLIER: _____

GALLONS USED: _____ LABELS SUBMITTED: □ YES □ NO

CEILINGS - TOTAL SQUARE FEET COVERED: _____

WALLS - TOTAL SQUARE FEET COVERED: _____

NUMBER OF GALLONS USED ON: 1st COAT _____ 2nd COAT _____

APPLICATION MADE BY NAME: _____

ADDRESS: _____

SIGNATURE: _____

322.38(1)(b) Vapor Retarder Continuity

Vapor retarder continuity is important for purposes of preventing bulk movement of warm, moist air into building assemblies, which is a more significant source of moisture than diffusion through the vapor retarder.

322.38(2)(a) Vapor Retarders Not on In-Winter Warm Side

Occasionally it occurs that a wall will have two materials or layers that may act as vapor retarders. It is important in this situation that the better vapor retarder (lower perm rating) be placed closer to the warm side. Also, extreme care should be taken to make the interior vapor retarder continuous with good joint and penetration sealing. This will help avoid condensation of moisture in the wall.

In some dwelling designs, double walls are constructed with insulation in both walls. Often this is to avoid making electrical box and other penetrations in the vapor retarder. A single vapor retarder is placed between the two walls. This conflicts with the requirements that vapor retarders be placed on the warm side of all insulation. However it may be acceptable depending on the distribution of the insulation between the two walls. If there is enough insulation on the exterior side of the vapor retarder, the air temperature in the insulation at the interior face of the vapor retarder may still be warm enough to prevent condensation.

A DEW POINT CALCULATION estimates expected temperatures throughout the thickness of the wall. Interior temperature, exterior temperature, and wall component R-values must be known. Additionally, a "design" interior air relative humidity must be assumed. Since typical wintertime reported indoor humidities range from 40 percent to 60 percent, the department will accept 50 percent as an average indoor relative humidity (RH) design value for such a calculation.

In order to do such a calculation, a person must have access to a psychrometric chart or table to determine dew points throughout the wall section given specific design temperatures, RH, and wall component R-values.

Example: Fictional Wall
R = 10, uniformly distributed across thickness of 4 inches
RH = 50% (interior)
Temp = 70°F interior and -10°F exterior

This would result in condensation if interior air was lowered in temperature or exposed to a surface temperature of approximately 50°F. In this wall, the 50°F dew point occurs at 1 inch from the interior surface. Therefore, a recessed vapor retarder must be to the inside of this 1-inch limit.

Detailed calculations shall be submitted for each specific project where a designer wishes to recess a vapor retarder into the wall cavity, other than as permitted by SPS 322.38(2)(c)4. for spray-applied foam insulation, that is relatively air impermeable. For air

permeable insulation such as fiberglass and cellulose, a rule of thumb is that no more than one-third of the insulation should be on the warm side of the vapor retarder.

322.38(2)(c)1. Exceptions to Vapor Retarder

If the exceptions in this section to a continuous vapor retarder at boxsills or over spray-applied foam are used, you are also required to stop air leakage at those locations that would have been otherwise provided by a continuous vapor retarder.

322.38(3) Omission of Taping of Vapor Retarder Joints Under Concrete Slabs

Similar to the exception in (1)(b) for taping of vapor retarder seams that are compressed between framing and finish materials, properly lapped seams that are under a poured floor are considered effectively sealed and will not require taping. Note that the negative impact from the small amount water vapor that may diffuse through any gaps into the dwelling is much less of a problem than gaps in wall and ceiling vapor retarders that allow bulk moisture laded-air from the interior into the building construction.

322.38(4) Vapor Retarders Prohibited on Concrete or Masonry Walls

The code prohibits installing a non-rigid vapor retarder of a 0.1 perm or less rating, such as roll polyethylene sheeting ("Visqueen"), on or in front of masonry or concrete below grade foundation walls. This is avoiding the potential for moisture from adjoining earth being trapped between an interior vapor retarder and the wall and possibly causing degradation and mold.

322.39 Attic Ventilation

Attic ventilation is generally required where air-permeable insulation is installed. This means that attic ventilation is not required above closed-cell foam insulation. Note that insulation shall not block the ventilation route, so attic vent chutes may be required at the eaves.

The code requirements of these sections for venting areas are based on effective venting area. Louvers and screening greatly decrease the effective venting of attic vents. Usually the effective venting area of a vent is indicated on it. Otherwise the following is a guide:

| Obstruction in Ventilator (Louvers and Screens) | To Determine Total Free Area of Ventilator Multiply Gross Area by: |
|---|---|
| 1/4 inch mesh hardware cloth | 1 |
| 1/8 inch mesh screen | 0.8 |
| No. 16 mesh insect screen (with or without plain metal louvers) | 0.5 |
| Wood louvers and 1/4 inch mesh hardware cloth | 0.5 |
| Wood louvers and 1/8 inch mesh screen | 0.44 |
| Wood louvers and No. 16 mesh insect screen | 0.33 |

Regarding turbine vents, the effective area is equal to the bottom opening area.

Regarding power vents, manufacturer's requirements should be followed. Otherwise an installed mechanical ventilation capacity of 0.25 cfm per square foot of attic floor area is acceptable.

Additionally, adequate air intakes must be provided. Control of the fan must be provided by a humidistat or combination humidistat/thermostat. A humidistat setting of 90 percent is acceptable.

322.39(4) Cathedral Ceiling Venting Exception
A cathedral ceiling is a sloped ceiling, with closely-spaced, parallel ceiling and roof finishes.

## Subchapter V — Systems

322.40 Outdoor Design Temperatures
The design of heating equipment to satisfy the heating load is regulated by ss. SPS 323.02 and 323.03. Those sections refer to the UDC Appendix table for determining outdoor design temperatures. See the commentary for SPS for SPS 323.02 for methods of calculating heating load now that the more recent versions of Rescheck do not offer that option anymore.

322.42 Ducts in Unconditioned Spaces
Ducts located outside conditioned space, including those in attics, unheated garages, and vented crawl spaces and under slabs, shall be insulated to at least R-8. Per SPS 322.10(3), conditioned is defined as being heated to 50 degrees or more at design conditions. Burying the ducts in attic insulation that provides the minimum R-8 value is acceptable, except if the ducts are used for cooling purposes. Per (1m) of this section, cooling supply ducts require at least R-8 duct insulation with an exterior vapor retarder to reduce surface condensation. Note that any ducts outside the conditioned space, which per SPS 322.37 includes the required air barrier, would generally trigger duct sealing and testing of the complete duct system per SPS 322.44.

Also note SPS 323.08(3) that requires exterior ducts that are susceptible to damage to be metal.

Ducts in underslab locations may be insulated per either of the following methods:

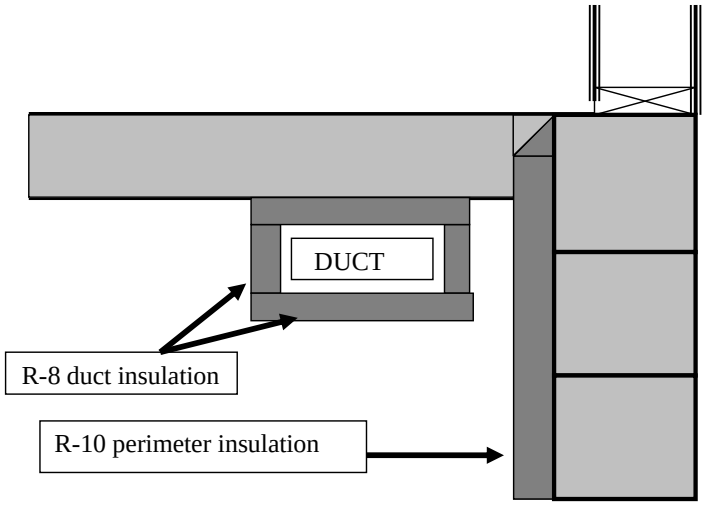



Fig. 1 - Acceptable design for insulated duct outside building thermal envelope of an unheated slab on grade design

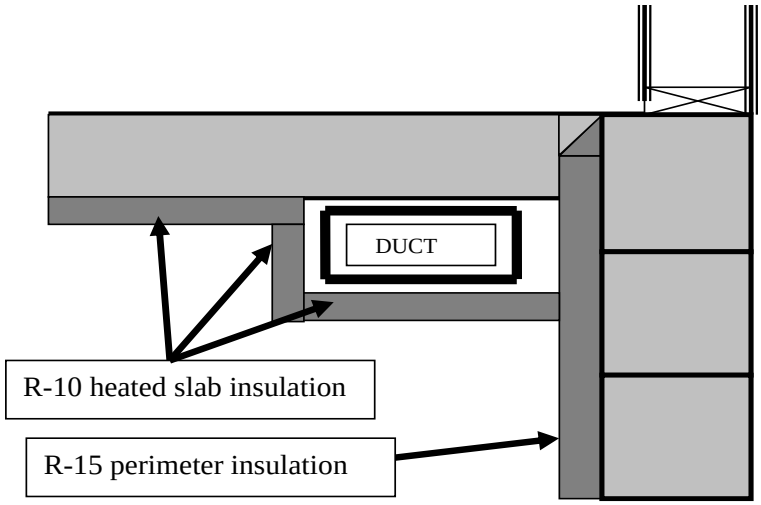



Fig. 2 - Acceptable design for heated slab-on-grade design as duct is within building thermal envelope

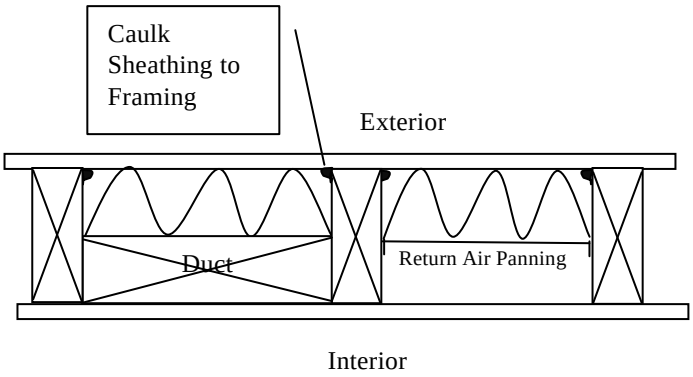
322.43 Duct Sealing and Testing

Any part of the supply and return duct system that is outside the conditioned space, including those in unconditioned attics, unheated garages, insulated floors, exterior stud spaces and vented crawl spaces and under slabs, shall be sealed per this section. Additionally, the whole duct system, including the air handler and both supply and return ducts, shall be tested for air tightness at either the rough-in or post-construction testing. Note that the post-construction test measures just the leakage to the outdoors, whereas the rough-in test measures the total system leakage, including leakage from the duct system to the conditioned space. The latter rough-in test would typically require that all of the ductwork of the dwelling be sealed in order to past the test.

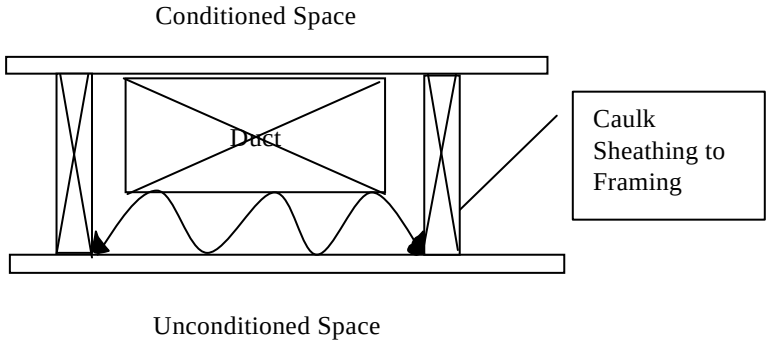
Duct tightness, especially relative to the outdoors, is important in that any air lost to the outdoors causes negative dwelling pressure as the result of the air handler drawing in outside air to replace the leaked duct air. Negative dwelling pressure potentially causes backdrafting of any open combustion appliances and infiltration of unconditioned air into the dwelling.

There are several exceptions to these general sealing and testing requirements:

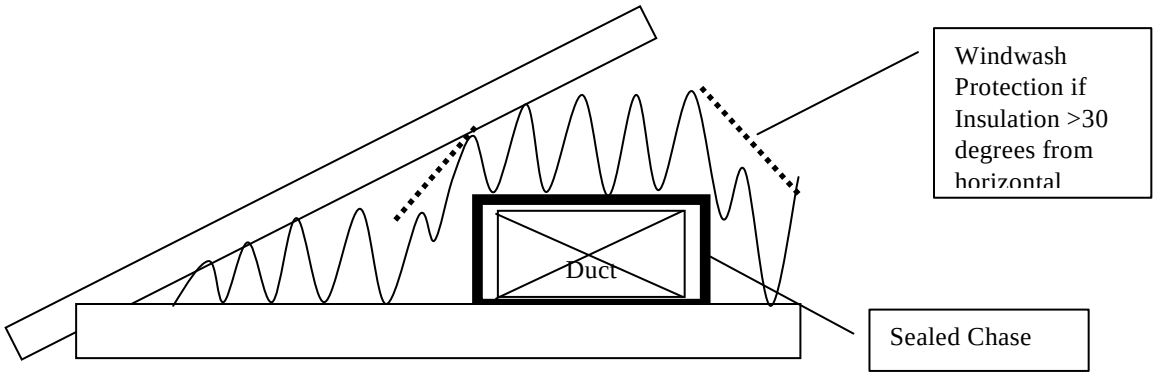
- Ducts that are in insulated ceilings, floors or walls that are insulated on the unconditioned side the same as the rest of the component (unless a different R-value of at least R-8 for the duct area has been entered into Rescheck) and there is a continuous air barrier separating the duct from the outdoors, are considered to be in the conditioned space and are exempt from the insulating, sealing and testing provisions. Additionally:
    - In exterior walls, this air barrier may be achieved with appropriate caulking and taping.




- An insulated floor, as below a bonus room over an unheated garage, would require sealing of the ceiling finish as well as the required windwash protection, per SPS 322.21(2), at any exposed, non-horizontal insulation.




- In attics, a sealed chase would be accepted as keeping the ducts within the conditioned space. If the sides of the chase are insulated with air permeable insulation exposed to the attic at more than 30 degrees from horizontal, then that insulation requires windwash protection per SPS 322.21(2).



- Just the ductwork in the unconditioned space may be tested at rough-in stage, meaning the remaining ductwork would not need to be sealed and tested. The "conditioned floor area" for calculation purposes would be the area served by the tested ducts.
- Ductwork located under a slab that is insulated per above Fig. 2 for underground ducts, will be considered within the conditioned space if the foam insulation joints are taped or otherwise sealed
- Ductwork located under a slab may be tested for leakage per the post-construction or rough-in methods required by the code, or alternatively, rigid plastic ductwork may be tested with a static air pressure of at least 5 psi, that holds for at least 15 minutes. Note that SPS 323.08(4) also requires underground duct to be moisture-proof.

If the rough-in testing option is chosen, then any stud or joist spaces used for return air purposes would need to be panned by the time of testing, rather than being panned with drywall at a later time.

322.44(1) Pipe Insulation

Subsection (1) requires hydronic heating pipes in **all** areas to have at least R-3 insulation and subsection (3) requires hydronic spaces in unheated spaces to have at least R-4 insulation. Generally basements are not considered unheated spaces, even without radiators installed.

The requirement for insulating circulating service hot water piping is applicable to systems mechanically circulated with pumps, not to thermosiphon systems that use convection to circulate the water.

322.46 Replacement Furnace & Boiler Efficiencies

Normally replacement equipment may meet the code at the time of their original installation per s. SPS 320.07(61) definition of repair, as opposed to alterations that need to meet the current code. (Note that the federal government has evolving minimum heating appliance efficiencies that apply to all residential installations, new or replacement.) However, this section requires that replacement furnaces also comply with specified duct sealing criteria and that replacement boilers comply with circulating motor limits. Alternatively, the replacement equipment may instead just comply with the more stringent Wisconsin heating equipment efficiency requirements of Table 322.31-3 (as for new construction that is permitted reduced thermal envelope insulation levels) without duct sealing or circulating motor limits.

## Subchapter VI — Simulated Performance Alternative

322.51 Documentation of Simulated Performance Alternative

Compliance by SPS 322.52 is typically shown by REMrate software that models the whole house energy usage. REM/Rate software is proprietary to certain providers. The version 12.6.2.1 or greater is acceptable to show compliance with the current code.

REScheck Software Version 4.6.2

# Compliance Certificate

Project North Meadows Development

| | |
|---|---|
| Energy Code: | **2009 IECC** |
| Location: | **Abbotsford, Wisconsin** |
| Construction Type: | **Single-family** |
| Project Type: | **New Construction** |
| Conditioned Floor Area: | **2,000 ft2** |
| Glazing Area | **15%** |
| Climate Zone: | **6 (9125 HDD)** |
| Permit Date: | **3/17/00** |
| Permit Number: | |

Construction Site: Owner/Agent: Designer/Contractor:

**Compliance: Fails using UA trade-off**

Compliance: **6.7% Worse Than Code** Maximum UA: **326** Your UA: **348**

The % Better or Worse Than Code Index reflects how close to compliance the house is based on code trade-off rules. It DOES NOT provide an estimate of energy use or cost relative to a minimum-code home.

## Envelope Assemblies

| Assembly | Gross Area or Perimeter | Cavity R-Value | Cont. R-Value | U-Factor | UA |
|---|---|---|---|---|---|
| Ceiling 1: Flat Ceiling or Scissor Truss | 729 | 38.0 | 0.0 | 0.030 | 22 |
| Ceiling 2: Flat Ceiling or Scissor Truss | 592 | 30.0 | 0.0 | 0.035 | 21 |
| Wall 1: Wood Frame, 16" o.c. | 1,647 | 13.0 | 6.0 | 0.053 | 71 |
| Door 1: Glass | 84 | | | 0.310 | 26 |
| Window 1: Vinyl Frame, Double Pane with Low-E | 204 | | | 0.320 | 65 |
| Door 2: Solid | 20 | | | 0.350 | 7 |
| Wall 2: Wood Frame, 16" o.c. | 276 | 13.0 | 0.0 | 0.082 | 21 |
| Door 3: Solid | 18 | | | 0.350 | 6 |
| Floor 1: All-Wood Joist/Truss, Over Unconditioned Space | 938 | 19.0 | 0.0 | 0.047 | 44 |
| Floor 2: All-Wood Joist/Truss, Over Outside Air | 32 | 30.0 | 0.0 | 0.033 | 1 |
| Floor 3: Slab-On-Grade:Unheated<br>Insulation depth: 2.0' | 82 | | 8.0 | 0.779 | 64 |

Project Notes:
Previously saved project information:
1010 Construction Ave.