NC Residential Code
Ad-Hoc Committee

Submitted to
the NC Building Code Council on
December 13, 2016

Recommended Amendments for the 2018 NC Residential Code

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OCTOBER 12, 2016
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PREFACE

Introduction

Internationally, code officials recognize the need for a modern, up-to-date residential code addressing the design and construction of one- and two-family dwellings and townhouses. The *International Residential Code*®, in this 2015 edition, is designed to meet these needs through model code regulations that safeguard the public health and safety in all communities, large and small.

This comprehensive, stand-alone residential code establishes minimum regulations for one- and two-family dwellings and townhouses using prescriptive provisions. It is founded on broad-based principles that make possible the use of new materials and new building designs. This 2015 edition is fully compatible with all of the *International Codes*® (I-Codes®) published by the International Code Council® (ICC)®, including the *International Building Code*®*, International Energy Conservation Code*®*, International Existing Building Code*®*, International Fire Code*®, *International Fuel Gas Code*®*, International Green Construction Code*® *International Mechanical Code*®, ICC *Performance Code*®*, International Plumbing Code*®*, International Private Sewage Disposal Code*®*, International Property Maintenance Code*®*, International Swimming Pool and Spa Code*™, *International Wildland-Urban Interface Code*® and *International Zoning Code*®*.*

The *International Residential Code* provisions provide many benefits, among which is the model code development process that offers an international forum for residential construction professionals to discuss prescriptive code requirements. This forum provides an excellent arena to debate proposed revisions. This model code also encourages international consistency in the application of provisions.

Development

The first edition of the *International Residential Code* (2000) was the culmination of an effort initiated in 1996 by a developement committee appointed by ICC and consisting of representatives from the three statutory members of the International Code Council at the time, including: Building Officials and Code Administrators International, Inc. (BOCA), International Conference of Building Officials (ICBO) and Southern Building Code Congress International (SBCCI), and representatives from the National Association of Home Builders (NAHB). The intent was to draft a stand-alone residential code consistent with and inclusive of the scope of the existing model codes. Technical content of the 1998 *International One- and Two-Family Dwelling Code* and the latest model codes promulgated by BOCA, ICBO, SBCCI and ICC was used as the basis for the development, followed by public hearings in 1998 and 1999 to consider proposed changes. This 2015 edition represents the code as originally issued, with changes reflected in the 2009 through 2012 editions, and further changes developed through the ICC Code Development Process through 2013. Residential electrical provisions are based on the 2014 *National Electrical Code*® (NFPA 70). A new edition such as this is promulgated every three years.

Energy provisions in Chapter 11 are duplicated from the *International Energy Conservation Code*®—Residential Provisions applicable to residential buildings which fall under the scope of this code.

Fuel gas provisions have been included through an agreement with the American Gas Association (AGA). Electrical provisions have been included through an agreement with the National Fire Protection Association (NFPA).

This code is founded on principles intended to establish provisions consistent with the scope of a residential code that adequately protects public health, safety and welfare; provisions that do not unnecessarily increase construction costs; provisions that do not restrict the use of new materials, products or methods of construction; and provisions that do not give preferential treatment to particular types or classes of materials, products or methods of construction.

Adoption

The International Code Council maintains a copyright in all of its codes and standards. Maintaining copyright allows ICC to fund its mission through sales of books, in both print and electronic formats. The *International Residential Code* is designed for adoption and use by jurisdictions that recognize and acknowledge the ICC's copyright in the code, and further acknowledge the substantial shared value of the public/private partnership for code development between jurisdictions and the ICC.

The ICC also recognizes the need for jurisdictions to make laws available to the public. All ICC codes and ICC standards, along with the laws of many jurisdictions, are available for free in a non-downloadable form on the ICC's website. Jurisdictions should contact the ICC at adoptions@iccsafe.org to learn how to adopt and distribute laws based on the *International Residential Code* in a manner that provides necessary access, while maintaining the ICC's copyright.

Maintenance

The *International Residential Code* is kept up-to-date through the review of proposed changes submitted by code enforcing officials, industry representatives, design professionals and other interested parties. Proposed changes are carefully considered through an open code development process in which all interested and affected parties may participate.

The contents of this work are subject to change both through the code development cycles and the governmental body that enacts the code into law. For more information regarding the code development process, contact the Codes and Standards Development Department of the International Code Council.

The maintenance process for the fuel gas provisions is based upon the process used to maintain the *International Fuel Gas Code*, in conjunction with the American Gas Association.

The maintenance process for the electrical provisions is undertaken by the National Fire Protection Association.

While the development procedure of the *International Residential Code* ensures the highest degree of care, ICC, the founding members of ICC, its members and those participating in the development of this code do not accept any liability resulting from compliance or noncompliance with the provisions because ICC and its founding members do not have the power or authority to police or enforce compliance with the contents of this code. Only the governmental body that enacts the code into law has such authority.

~~Code Development Committee Responsibilities~~

~~In each code development cycle, proposed changes to the code are considered at the Committee Action Hearings by the applicable International Code Development Committee as follows:~~

~~[RB] = IRC—Building Code Development Committee~~
~~[RE] = Residential Energy Code Development Committee~~
~~[RMP] = IRC—Mechanical/Plumbing Code Development Committee~~

~~The [RE] committee is also responsible for the IECC—Residential Provisions.~~

~~For the development of the 2018 edition of the I-Codes, there will be three groups of code development committees and they will meet in separate years. Note that these are tentative groups.~~

~~Group A Codes (Heard in 2015, Code Change Proposals Deadline: January 12, 2015)~~	**~~Group B Codes (Heard in 2016, Code Change Proposals Deadline: January 11, 2016)~~**	**~~Group C Codes (Heard in 2017, Code Change Proposals Deadline: January 11, 2017)~~**
~~International Building Code~~ ~~– Fire Safety (Chapters 7, 8, 9, 14, 26)~~ ~~– Means of Egress (Chapters 10, 11, Appendix E)~~ ~~– General (Chapters 2-6, 12, 27-33, Appendices A, B, C, D, K)~~	~~Administrative Provisions (Chapter 1 all codes except the IRC and IECC, administrative updates to currently referenced standards, and designated definitions)~~	~~International Green Construction Code~~
~~International Fuel Gas Code~~	~~International Building Code~~ ~~— Structural (Chapters 15-25, Appendices F, G, H, I, J, L, M)~~	
~~International Existing Building Code~~	~~International Energy Conservation Code~~	
~~International Mechanical Code~~	~~International Fire Code~~	
~~International Plumbing Code~~	**~~International Residential Code~~** ~~— IRC-Building (Chapters 1, 3-10, Appendices E, F, H, J, K, L, M, O, R, S, T, U)~~	
~~International Private Sewage Disposal Code~~	~~International Wildland-Urban Interface Code~~	

~~International Property Maintenance Code~~		
~~International Residential Code~~ ~~— IRC-Mechanical (Chapters 12-24)~~ ~~— IRC-Plumbing (Chapters 25-33, Appendices G, I, N, P)~~		
~~International Swimming Pool and Spa Code~~		
~~International Zoning Code~~		

~~**Note:** Proposed changes to the ICC *Performance Code* will be heard by the code development committee noted in brackets [ ] in the text of the code.~~

~~Code change proposals submitted to Chapters 1 and 3 through 10, Appendices E, F, H, J, K, L, M, O, R, S, T, U and Definitions designated [RB] of the *International Residential Code* are heard by the IRC—Building Committee during the Group B (2016) cycle code development hearing. Proposed changes to all other chapters are heard by the IRC Plumbing and Mechanical Committee during the Group A (2015) code development cycle.~~

~~It is very important that anyone submitting code change proposals understand which code development committee is responsible for the section of the code that is the subject of the code change proposal. For further information on the code development committee responsibilities, please visit the ICC web site at www.iccsafe.org/scoping.~~

Marginal Markings

Solid vertical lines in the margins within the body of the code indicate a technical change from the requirements of the 2012 edition. Deletion indicators in the form of an arrow (☒) are provided in the margin where an entire section, paragraph, exception or table has been deleted or an item in a list of items or a table has been deleted.

A single asterisk [*] placed in the margin indicates that text or a table has been relocated within the code. A double asterisk [**] placed in the margin indicates that the text or table immediately following it has been relocated there from elsewhere in the code. The following table indicates such relocations in the 2015 edition of the *International Residential Code*.

2015 LOCATION	2012 LOCATION
R302.13	R501.3
R403.1.3.4	R403.1.4.2
R404.1.1	R404.1.3
R502.2.2	R502.1.2
Tables R602.7(1) and (2)	Tables R502.5(1) and (2)
P2902.3.7	P2905.4.1

Italicized Terms

Selected terms set forth in Chapter 2, Definitions, are italicized where they appear in code text. Such terms are not italicized where the definition set forth in Chapter 2 does not impart the intended meaning in the use of the term. The terms selected have definitions that the user should read carefully to better understand the code.

EFFECTIVE USE OF THE INTERNATIONAL RESIDENTIAL CODE

Effective Use of the International Residential Code

The *International Residential Code*® (IRC®) was created to serve as a complete, comprehensive code regulating the construction of single-family houses, two-family houses (duplexes) and buildings consisting of three or more townhouse units. All buildings within the scope of the IRC are limited to three stories above grade plane. For example, a four-story single-family house would fall within the scope of the *International Building Code*® (IBC®), not the IRC. The benefits of devoting a separate code to residential construction include the fact that the user need not navigate through a multitude of code provisions that do not apply to residential construction in order to locate that which is applicable. A separate code also allows for residential and nonresidential code provisions to be distinct and tailored to the structures that fall within the appropriate code's scopes.

The IRC contains coverage for all components of a house or townhouse, including structural components, fireplaces and chimneys, thermal insulation, mechanical systems, fuel gas systems, plumbing systems and electrical systems.

The IRC is a prescriptive-oriented (specification) code with some examples of performance code language. It has been said that the IRC is the complete cookbook for residential construction. Section R301.1, for example, is written in performance language, but states that the prescriptive requirements of the code will achieve such performance.

It is important to understand that the IRC contains coverage for what is conventional and common in residential construction practice. While the IRC will provide all of the needed coverage for most residential construction, it might not address construction practices and systems that are atypical or rarely encountered in the industry. Sections such as R301.1.3, R301.2.2.1.1, R320.1, M1301.1, G2401.1 and P2601.1 refer to other codes either as an alternative to the provisions of the IRC or where the IRC lacks coverage for a particular type of structure, design, system, appliance or method of construction. In other words, the IRC is meant to be all inclusive for typical residential construction and it relies on other codes only where alternatives are desired or where the code lacks coverage for the uncommon aspect of residential construction. Of course, the IRC constantly evolves to address new technologies and construction practices that were once uncommon, but now common.

The IRC is unique in that much of it, including Chapters 3 through 9 and Chapters 34 through 43, is presented in an ordered format that is consistent with the normal progression of construction, starting with the design phase and continuing through the final trim-out phase. This is consistent with the “cookbook” philosophy of the IRC.

The IRC is divided into eight main parts, specifically, Part I—Administration, Part II—Definitions, Part III—Building Planning and Construction, Part IV—Energy Conservation, Part V—Mechanical, Part VI—Fuel Gas, Part VII—Plumbing and Part VIII—Electrical.

The following provides a brief description of the content of each chapter and appendix of the IRC:

Chapter 1 Scope and Administration. This chapter contains provisions for the application, enforcement and administration of subsequent requirements of the code. In addition to establishing the scope of the code, Chapter 1 identifies which buildings and structures come under its purview. Chapter 1 is largely concerned with maintaining “due process of law” in enforcing the building criteria contained in the body of the code. Only through careful observation of the administrative provisions can the building official reasonably expect to demonstrate that “equal protection under the law” has been provided.

Chapter 2 Definitions. Terms defined in the code are listed alphabetically in Chapter 2. It is important to note that two chapters have their own definitions sections: Chapter 24 for the defined terms that are unique to fuel gas and Chapter 35 containing terms that are applicable to electrical Chapters 34 through 43. In the case where Chapter 2 and another chapter both define the same term differently, the definition found in Chapter 24 and/or 35 is intended to prevail where the term is used in Chapter 24 and/or 35 and the definition contained in Chapter 2 is intended to prevail where the term is used in all other locations in the code. Except where Chapter 24 or 35 has a definition that will prevail therein, the definitions in Chapter 2 are applicable throughout the code.

Where understanding a term’s definition is key to or necessary for understanding a particular code provision, the term is shown in italics where it appears in the code. This is true only for those terms that have a meaning that is unique to the code. In other words, the generally understood meaning of a term or phrase might not be sufficient or consistent with the meaning prescribed by the code; therefore, it is essential that the code-defined meaning be known.

Guidance regarding not only tense, gender and plurality of defined terms, but also terms not defined in this code, is provided.

Chapter 3 Building Planning. Chapter 3 provides guidelines for a minimum level of structural integrity, life safety, fire safety and livability for inhabitants of dwelling units regulated by this code. Chapter 3 is a compilation of the code requirements specific to the building planning sector of the design and construction process. This chapter sets forth code requirements dealing with light, ventilation, sanitation, minimum room size, ceiling height and environmental comfort. Chapter 3 establishes life-safety provisions including limitations on glazing used in hazardous areas, specifications on stairways, use of guards at elevated surfaces, window and fall protection, and rules for means of egress. Snow, wind and seismic design live and dead loads and flood-resistant construction, as well as solar energy systems, and swimming pools, spas and hot tubs, are addressed in this chapter.

Chapter 4 Foundations. Chapter 4 provides the requirements for the design and construction of foundation systems for buildings regulated by this code. Provisions for seismic load, flood load and frost protection are contained in this chapter. A foundation system consists of two interdependent components: the foundation structure itself and the supporting soil.

The prescriptive provisions of this chapter provide requirements for constructing footings and walls for foundations of wood, masonry, concrete and precast concrete. In addition to a foundation's ability to support the required design loads, this chapter addresses several other factors that can affect foundation performance. These include controlling surface water and subsurface drainage, requiring soil tests where conditions warrant and evaluating proximity to slopes and minimum depth requirements. The chapter also provides requirements to minimize adverse effects of moisture, decay and pests in basements and crawl spaces.

Chapter 5 Floors. Chapter 5 provides the requirements for the design and construction of floor systems that will be capable of supporting minimum required design loads. This chapter covers four different types: wood floor framing, wood floors on the ground, cold-formed steel floor framing and concrete slabs on the ground. Allowable span tables are provided that greatly simplify the determination of joist, girder and sheathing sizes for raised floor systems of wood framing and cold-formed steel framing. This chapter also contains prescriptive requirements for wood-framed exterior decks and their attachment to the main building.

Chapter 6 Wall Construction. Chapter 6 contains provisions that regulate the design and construction of walls. The wall construction covered in Chapter 6 consists of five different types: wood framed, cold-formed steel framed, masonry, concrete and structural insulated panel (SIP). The primary concern of this chapter is the structural integrity of wall construction and transfer of all imposed loads to the supporting structure. This chapter provides the requirements for the design and construction of wall systems that are capable of supporting the minimum design vertical loads (dead, live and snow loads) and lateral loads (wind or seismic loads). This chapter contains the prescriptive requirements for wall bracing and/or shear walls to resist the imposed lateral loads due to wind and seismic.

Chapter 6 also regulates exterior windows and doors installed in walls. The chapter contains criteria for the performance of exterior windows and doors and includes provisions for testing and labeling, garage doors, wind-borne debris protection and anchorage details.

Chapter 7 Wall Covering. Chapter 7 contains provisions for the design and construction of interior and exterior wall coverings. This chapter establishes the various types of materials, materials standards and methods of application permitted for use as interior coverings, including interior plaster, gypsum board, ceramic tile, wood veneer paneling, hardboard paneling, wood shakes and wood shingles. Chapter 7 also contains requirements for the use of vapor retarders for moisture control in walls.

Exterior wall coverings provide the weather-resistant exterior envelope that protects the building's interior from the elements. Chapter 7 provides the requirements for wind resistance and water-resistive barrier for exterior wall coverings. This chapter prescribes the exterior wall coverings as well as the water-resistive barrier required beneath the exterior materials. Exterior wall coverings regulated by this section include aluminum, stone and masonry veneer, wood, hardboard, particleboard, wood structural panel siding, wood shakes and shingles, exterior plaster, steel, vinyl, fiber cement and exterior insulation finish systems.

Chapter 8 Roof-ceiling Construction. Chapter 8 regulates the design and construction of roof-ceiling systems. This chapter contains two roof-ceiling framing systems: wood framing and cold-formed steel framing. Allowable span tables are provided to simplify the selection of rafter and ceiling joist size for wood roof framing and cold-formed steel framing. Chapter 8 also provides requirements for the application of ceiling finishes, the proper ventilation of concealed spaces in roofs (e.g., enclosed attics and rafter spaces), unvented attic assemblies and attic access.

Chapter 9 Roof Assemblies. Chapter 9 regulates the design and construction of roof assemblies. A roof assembly includes the roof deck, vapor retarder, substrate or thermal barrier, insulation, vapor retarder and roof covering. This chapter provides the requirement for wind resistance of roof coverings.

The types of roof covering materials and installation regulated by Chapter 9 are: asphalt shingles, clay and concrete tile, metal roof shingles, mineral-surfaced roll roofing, slate and slate-type shingles, wood shakes and shingles, built-up roofs, metal roof panels, modified bitumen roofing, thermoset and thermoplastic single-ply roofing, sprayed polyurethane foam roofing, liquid applied coatings and photovoltaic shingles. Chapter 9 also provides requirements for roof drainage, flashing, above deck thermal insulation, rooftop-mounted photovoltaic systems and recovering or replacing an existing roof covering.

Chapter 10 Chimneys and Fireplaces. Chapter 10 contains requirements for the safe construction of masonry chimneys and fireplaces and establishes the standards for the use and installation of factory-built chimneys, fireplaces and masonry heaters. Chimneys and fireplaces constructed of masonry rely on prescriptive requirements for the details of their construction; the factory-built type relies on the listing and labeling method of approval. Chapter 10 provides the requirements for seismic reinforcing and anchorage of masonry fireplaces and chimneys.

Chapter 11 [RE] Energy Efficiency. The purpose of Chapter 11 [RE] is to provide minimum design requirements that will promote efficient utilization of energy in buildings. The requirements are directed toward the design of building envelopes with adequate thermal resistance and low air leakage, and toward the design and selection of mechanical, water heating, electrical and illumination systems that promote effective use of depletable energy resources. The provisions of Chapter 11 [RE] are duplicated from the *International Energy Conservation Code—Residential Provisions*, as applicable for buildings which fall under the scope of the IRC.

For ease of use and coordination of provisions, the corresponding IECC—Residential Provisions section number is indicated following the IRC section number [e.g. N1102.1 (R402.1)].

Chapter 12 Mechanical Administration. Chapter 12 establishes the limits of applicability of the code and describes how the code is to be applied and enforced. A mechanical code, like any other code, is intended to be adopted as a legally enforceable document and it cannot be effective without adequate provisions for its administration and enforcement. The provisions of Chapter 12 establish the authority and duties of the code official appointed by the jurisdiction having authority and also establish the rights and privileges of the design professional, contractor and property owner. It also relates this chapter to the administrative provisions in Chapter 1.

Chapter 13 General Mechanical System Requirements. Chapter 13 contains broadly applicable requirements related to appliance listing and labeling, appliance location and installation, appliance and systems access, protection of structural elements and clearances to combustibles, among others.

Chapter 14 Heating and Cooling Equipment and Appliances. Chapter 14 is a collection of requirements for various heating and cooling appliances, dedicated to single topics by section. The common theme is that all of these types of appliances use energy in one form or another, and the improper installation of such appliances would present a hazard to the occupants of the dwellings, due to either the potential for fire or the accidental release of refrigerants. Both situations are undesirable in dwellings that are covered by this code.

Chapter 15 Exhaust Systems. Chapter 15 is a compilation of code requirements related to residential exhaust systems, including kitchens and bathrooms, clothes dryers and range hoods. The code regulates the materials used for constructing and installing such duct systems. Air brought into the building for ventilation, combustion or makeup purposes is protected from contamination by the provisions found in this chapter.

Chapter 16 Duct Systems. Chapter 16 provides requirements for the installation of ducts for supply, return and exhaust air systems. This chapter contains no information on the design of these systems from the standpoint of air movement, but is concerned with the structural integrity of the systems and the overall impact of the systems on the fire-safety performance of the building. This chapter regulates the materials and methods of construction which affect the performance of the entire air distribution system.

Chapter 17 Combustion Air. Complete combustion of solid and liquid fuel is essential for the proper operation of appliances, control of harmful emissions and achieving maximum fuel efficiency. If insufficient quantities of oxygen are supplied, the combustion process will be incomplete, creating dangerous byproducts and wasting energy in the form of unburned fuel (hydrocarbons). The byproducts of incomplete combustion are poisonous, corrosive and combustible, and can cause serious appliance or equipment malfunctions that pose fire or explosion hazards.

The combustion air provisions in this code from previous editions have been deleted from Chapter 17 in favor of a single section that directs the user to NFPA 31 for oil-fired appliance combustion air requirements and the manufacturer's installation instructions for solid fuel-burning appliances. If fuel gas appliances are used, the provisions of Chapter 24 must be followed.

Chapter 18 Chimneys and Vents. Chapter 18 regulates the design, construction, installation, maintenance, repair and approval of chimneys, vents and their connections to fuel-burning appliances. A properly designed chimney or vent system is needed to conduct the flue gases produced by a fuel-burning appliance to the outdoors. The provisions of this chapter are intended to minimize the hazards associated with high temperatures and potentially toxic and corrosive combustion gases. This chapter addresses factory-built and masonry chimneys, vents and venting systems used to vent oil-fired and solid fuel-burning appliances.

Chapter 19 Special Appliances, Equipment and Systems. Chapter 19 regulates the installation of fuel-burning appliances that are not covered in other chapters, such as ranges and ovens, sauna heaters, fuel cell power plants and hydrogen systems. Because the subjects in this chapter do not contain the volume of text necessary to warrant individual chapters, they have been combined into a single chapter. The only commonality is that the subjects use energy to perform some task or function. The intent is to provide a reasonable level of protection for the occupants of the dwelling.

Chapter 20 Boilers and Water Heaters. Chapter 20 regulates the installation of boilers and water heaters. Its purpose is to protect the occupants of the dwelling from the potential hazards associated with such appliances. A water heater is any appliance that heats potable water and supplies it to the plumbing hot water distribution system. A boiler either heats water or generates steam for space heating and is generally a closed system.

Chapter 21 Hydronic Piping. Hydronic piping includes piping, fittings and valves used in building space conditioning systems. Applications include hot water, chilled water, steam, steam condensate, brines and water/antifreeze mixtures. Chapter 21 regulates installation, alteration and repair of all hydronic piping systems to insure the reliability, serviceability, energy efficiency and safety of such systems.

Chapter 22 Special Piping and Storage Systems. Chapter 22 regulates the design and installation of fuel oil storage and piping systems. The regulations include reference to construction standards for above-ground and underground storage tanks, material standards for piping systems (both above-ground and underground) and extensive requirements for the proper assembly of system piping and components. The purpose of this chapter is to prevent fires, leaks and spills involving fuel oil storage and piping systems, whether inside or outside structures and above or underground.

Chapter 23 Solar Thermal Energy Systems. Chapter 23 contains requirements for the construction, alteration and repair of all systems and components of solar thermal energy systems used for space heating or cooling, and domestic hot water heating or processing. The provisions of this chapter are limited to those necessary to achieve installations that are relatively hazard free.

A solar thermal energy system can be designed to handle 100 percent of the energy load of a building, although this is rarely accomplished. Because solar energy is a low-intensity energy source and dependent on the weather, it is usually necessary to supplement a solar thermal energy system with traditional energy sources.

As our world strives to find alternate means of producing power for the future, the requirements of this chapter will become more and more important over time.

Chapter 24 Fuel Gas. Chapter 24 regulates the design and installation of fuel gas distribution piping and systems, appliances, appliance venting systems and combustion air provisions. The definition of “Fuel gas” includes natural, liquefied petroleum and manufactured gases and mixtures of these gases.

The purpose of this chapter is to establish the minimum acceptable level of safety and to protect life and property from the potential dangers associated with the storage, distribution and use of fuel gases and the byproducts of combustion of such fuels. This code also protects the personnel who install, maintain, service and replace the systems and appliances addressed herein.

Chapter 24 is composed entirely of text extracted from the IFGC; therefore, whether using the IFGC or the IRC, the fuel gas provisions will be identical. Note that to avoid the potential for confusion and conflicting definitions, Chapter 24 has its own definition section.

Chapter 25 Plumbing Administration. The requirements of Chapter 25 do not supersede the administrative provisions of Chapter 1. Rather, the administrative guidelines of Chapter 25 pertain to plumbing installations that are best referenced and located within the plumbing chapters. This chapter addresses how to apply the plumbing provisions of this code to specific types or phases of construction. This chapter also outlines the responsibilities of the applicant, installer and inspector with regard to testing plumbing installations.

Chapter 26 General Plumbing Requirements. The content of Chapter 26 is often referred to as “miscellaneous,” rather than general plumbing requirements. This is the only chapter of the plumbing chapters of the code whose requirements do not interrelate. If a requirement cannot be located in another plumbing chapter, it should be located in this chapter. Chapter 26 contains safety requirements for the installation of plumbing systems and includes requirements for the identification of pipe, pipe fittings, traps, fixtures, materials and devices used in plumbing systems. If specific provisions do not demand that a requirement be located in another chapter, the requirement is located in this chapter.

Chapter 27 Plumbing Fixtures. Chapter 27 requires fixtures to be of the proper type, approved for the purpose intended and installed properly to promote usability and safe, sanitary conditions. This chapter regulates the quality of fixtures and faucets by requiring those items to comply with nationally recognized standards. Because fixtures must be properly installed so that they are usable by the occupants of the building, this chapter contains the requirements for the installation of fixtures.

Chapter 28 Water Heaters. Chapter 28 regulates the design, approval and installation of water heaters and related safety devices. The intent is to minimize the hazards associated with the installation and operation of water heaters. Although this chapter does not regulate the size of a water heater, it does regulate all other aspects of the water heater installation such as temperature and pressure relief valves, safety drip pans and connections. Where a water heater also supplies water for space heating, this chapter regulates the maximum water temperature supplied to the water distribution system.

Chapter 29 Water Supply and Distribution. This chapter regulates the supply of potable water from both public and individual sources to every fixture and outlet so that it remains potable and uncontaminated by cross connections. Chapter 29 also regulates the design of the water distribution system, which will allow fixtures to function properly. Because it is critical that the potable water supply system remain free of actual or potential sanitary hazards, this chapter has the requirements for providing backflow protection devices.

Chapter 30 Sanitary Drainage. The purpose of Chapter 30 is to regulate the materials, design and installation of sanitary drainage piping systems as well as the connections made to the system. The intent is to design and install sanitary drainage systems that will function reliably, are neither undersized nor oversized and are constructed from materials, fittings and connections whose quality is regulated by this section. This chapter addresses the proper use of fittings for directing the flow into and within the sanitary drain piping system. Materials and provisions necessary for servicing the drainage system are also included in this chapter.

Chapter 31 Vents. Venting protects the trap seal of each trap. The vents are designed to limit differential pressures at each trap to 1 inch of water column (249 Pa). Because waste flow in the drainage system creates pressure fluctuations that can negatively affect traps, the sanitary drainage system must have a properly designed venting system. Chapter 31 covers the requirements for vents and venting. All of the provisions set forth in this chapter are intended to limit the pressure differentials in the drainage system to a maximum of 1 inch of water column (249 Pa) above or below atmospheric pressure (i.e., positive or negative pressures).

Chapter 32 Traps. Traps prevent sewer gas from escaping from the drainage piping into the building. Water seal traps are the simplest and most reliable means of preventing sewer gas from entering the interior environment. This chapter lists prohibited trap types as well as specifies the minimum trap size for each type of fixture.

Chapter 33 Storm Drainage. Rainwater infiltration into the ground adjacent to a building can cause the interior of foundation walls to become wet. The installation of a subsoil drainage system prevents the build-up of rainwater on the exterior of the foundation walls. This chapter provides the specifications for subsoil drain piping. Where the discharge of the subsoil drain system is to a sump, this chapter also provides coverage for sump construction, pumps and discharge piping.

Chapter 34 General Requirements. This chapter contains broadly applicable, general and miscellaneous requirements including scope, listing and labeling, equipment locations and clearances for conductor materials and connections and conductor identification.

Chapter 35 Electrical Definitions. Chapter 35 is the repository of the definitions of terms used in the body of Part VIII of the code. To avoid the potential for confusion and conflicting definitions, Part VIII, Electrical, has its own definition chapter.

Codes are technical documents and every word, term and punctuation mark can impact the meaning of the code text and the intended results. The code often uses terms that have a unique meaning in the code, which can differ substantially from the ordinarily understood meaning of the term as used outside of the code.

The terms defined in Chapter 35 are deemed to be of prime importance in establishing the meaning and intent of the electrical code text that uses the terms. The user of the code should be familiar with and consult this chapter because the definitions are essential to the correct interpretation of the code and because the user may not be aware that a term is defined.

Chapter 36 Services. This chapter covers the design, sizing and installation of the building's electrical service equipment and grounding electrode system. It includes an easy-to-use load calculation method and service conductor sizing table. The electrical service is generally the first part of the electrical system to be designed and installed.

Chapter 37 Branch Circuit and Feeder Requirements. Chapter 37 addresses the requirements for designing the power distribution system which consists of feeders and branch circuits emanating from the service equipment. This chapter dictates the ratings of circuits and the allowable loads, the number and types of branch circuits required, the wire sizing for such branch circuits and feeders and the requirements for protection from overcurrent for conductors. A load calculation method specific to feeders is also included. This chapter is used to design the electrical system on the load side of the service.

Chapter 38 Wiring Methods. Chapter 38 specifies the allowable wiring methods, such as cable, conduit and raceway systems, and provides the installation requirements for the wiring methods. This chapter is primarily applicable to the “rough-in” phase of construction.

Chapter 39 Power and Lighting Distribution. This chapter mostly contains installation requirements for the wiring that serves the lighting outlets, receptacle outlets, appliances and switches located throughout the building. The required distribution and spacing of receptacle outlets and lighting outlets is prescribed in this chapter, as well as the requirements for ground-fault and arc-fault circuit interrupter protection.

Chapter 40 Devices and Luminaires. This chapter focuses on the devices, including switches and receptacles, and lighting fixtures that are typically installed during the final phase of construction.

Chapter 41 Appliance Installation. Chapter 41 addresses the installation of appliances including HVAC appliances, water heaters, fixed space-heating equipment, dishwashers, garbage disposals, range hoods and suspended paddle fans.

Chapter 42 Swimming Pools. This chapter covers the electrical installation requirements for swimming pools, storable swimming pools, wading pools, decorative pools, fountains, hot tubs, spas and hydromassage bathtubs. The allowable wiring methods are specified along with the required clearances between electrical system components and pools, spas and tubs. This chapter includes the special grounding requirements related to pools, spas and tubs, and also prescribes the equipotential bonding requirements that are unique to pools, spas and tubs.

Chapter 43 Class 2 Remote-control, Signaling and Power-limited Circuits. This chapter covers the power supplies, wiring methods and installation requirements for the Class 2 circuits found in dwellings. Such circuits include thermostat wiring, alarm systems, security systems, automated control systems and doorbell systems.

Chapter 44 Referenced Standards. The code contains numerous references to standards that are used to regulate materials and methods of construction. Chapter 44 contains a comprehensive list of all standards that are referenced in the code. The standards are part of the code to the extent of the reference to the standard. Compliance with the referenced standard is necessary for compliance with this code. By providing specifically adopted standards, the construction and installation requirements necessary for compliance with the code can be readily determined. The basis for code compliance is, therefore, established and available on an equal basis to the code official, contractor, designer and owner.

Chapter 44 is organized in a manner that makes it easy to locate specific standards. It lists all of the referenced standards, alphabetically, by acronym of the promulgating agency of the standard. Each agency’s standards are then listed in either alphabetical or numeric order based upon the standard identification. The list also contains the title of the standard; the edition (date) of the standard referenced; any addenda included as part of the ICC adoption; and the section or sections of this code that reference the standard.

Chapter 45 High Wind Zones. This chapter applies to buildings constructed in North Carolina high wind zones. These provisions shall be in addition to or in lieu of the requirements of Chapters 1-10.

Chapter 46 Coastal and Flood Plain Standards. The requirements of this chapter apply to all construction location within areas identified by governmental agency (state and federal) as coastal high hazard area, ocean hazard areas, the regulatory flood plain areas, and all areas designated as 150 miles per hour (67 m/s) wind zone.

~~**Appendix A Sizing and Capacities of Gas Piping.** This appendix is informative and not part of the code. It provides design guidance, useful facts and data and multiple examples of how to apply the sizing tables and sizing methodologies of Chapter 24.~~

~~**Appendix B Sizing of Venting Systems Serving Appliances Equipped with Draft Hoods, Category I Appliances and Appliances Listed for Use with Type B Vents.** This appendix is informative and not part of the code. It contains multiple examples of how to apply the vent and chimney tables and methodologies of Chapter 24.~~

~~**Appendix C Exit Terminals of Mechanical Draft and Direct-vent Venting Systems**. This appendix is informative and not part of the code. It consists of a figure and notes that visually depict code requirements from Chapter 24 for vent terminals with respect to the openings found in building exterior walls.~~

~~**Appendix D Recommended Procedure for Safety Inspection of an Existing Appliance Installation.** This appendix is informative and not part of the code. It provides recommended procedures for testing and inspecting an appliance installation to determine if the installation is operating safely and if the appliance is in a safe condition.~~

~~**Appendix E Manufactured Housing Used as Dwellings.** The criteria for the construction of manufactured homes are governed by the National Manufactured Housing Construction and Safety Act. While this act may seem to cover the bulk of the construction of manufactured housing, it does not cover those areas related to the placement of the housing on the property. The provisions of Appendix E are not applicable to the design and construction of manufactured homes. Appendix E provides a complete set of regulations in conjunction with federal law for the installation of manufactured housing. This appendix also contains provisions for existing manufactured home installations.~~

~~**Appendix F Passive Radon Gas Controls.** Radon comes from the natural (radioactive) decay of the element radium in soil, rock and water and finds its way into the air. Appendix F contains requirements to mitigate the transfer of radon gases from the soil into the dwelling. The provisions of this appendix regulate the design and construction of radon-resistant measures intended to reduce the entry of radon gases into the living space of residential buildings.~~

~~**Appendix G Piping Standards for Various Applications.** Appendix G provides standards for various types of plastic piping products. This appendix is informative and is not part of the code.~~

~~**Appendix H Patio Covers.** Appendix H sets forth the regulations and limitations for patio covers. The provisions address those uses permitted in patio cover structures, the minimum design loads to be assigned for structural purposes, and the effect of the patio cover on egress and emergency escape or rescue from sleeping rooms. This appendix also contains the special provisions for aluminum screen enclosures in hurricane-prone regions.~~

~~**Appendix I Private Sewage Disposal.** Appendix I simply provides the opportunity to utilize the International Private Sewage Disposal Code for the design and installation of private sewage disposal in one- and two-family dwellings.~~

~~**Appendix J Existing Buildings and Structures**. Appendix J contains the provisions for the repair, renovation, alteration and reconstruction of existing buildings and structures that are within the scope of this code. To accomplish this objective and to make the rehabilitation~~

~~process more available, this appendix allows for a controlled departure from full code compliance without compromising minimum life safety, fire safety, structural and environmental features of the rehabilitated existing building or structure.~~

~~**Appendix K Sound Transmission**. Appendix K regulates the sound transmission of wall and floor-ceiling assemblies separating dwelling units and townhouse units. Air-borne sound insulation is required for walls. Air-borne sound insulation and impact sound insulation are required for floor-ceiling assemblies. The provisions in Appendix K set forth a minimum Sound Transmission Class (STC) rating for common walls and floor-ceiling assemblies between dwelling units. In addition, a minimum Impact Insulation Class (IIC) rating is also established to limit structure-borne sound through common floor-ceiling assemblies separating dwelling units.~~

~~**Appendix L Permit Fees.** Appendix L provides guidance to jurisdictions for setting appropriate permit fees. This appendix will aid many jurisdictions to assess permit fees that will assist to fairly and properly administer the code. This appendix can be used for informational purposes only or may be adopted when specifically referenced in the adopting ordinance.~~

~~**Appendix M Home Day Care–R-3 Occupancy**. Appendix M provides means of egress and smoke detection requirements for a Group R-3 Occupancy that is to be used as a home day care for more than five children who receive custodial care for less than 24 hours. This appendix is strictly for guidance and/or adoption by those jurisdictions that have Licensed Home Care Provider laws and statutes that allow more than five children to be cared for in a person's home. When a jurisdiction adopts this appendix, the provisions for day care and child care facilities in the IBC should be considered also.~~

~~**Appendix N Venting Methods.** Because venting of sanitary drainage systems is perhaps the most difficult concept to understand, and Chapter 31 uses only words to describe venting requirements, illustrations can offer greater insight into what the words mean. Appendix N has a number of illustrations for commonly installed sanitary drainage systems in order for the reader to gain a better understanding of this code's venting requirements.~~

~~**Appendix O Automatic Vehicular Gates**. Appendix O provides the requirements for the design and construction of automatic vehicular gates. The provisions are for where automatic gates are installed for use at a vehicular entrance or exit on the lot of a one- or two-family dwelling. The requirements provide protection for individuals from potential entrapment between an automatic gate and a stationary object or surface.~~

~~**Appendix P Sizing of Water Piping System**. Appendix P provides two recognized methods for sizing the water service and water distribution piping for a building. The method under Section AP103 provides friction loss diagrams that require the user to “plot” points and read values from the diagrams in order to perform the required calculations and necessary checks. This method is the most accurate of the two presented in this appendix. The method under Section AP201 is known to be conservative; however, very few calculations are necessary in order to determine a pipe size that satisfies the flow requirements of any application.~~

~~**Appendix Q ICC International Residential Code Electrical Provisions/National Electrical Code Cross Reference.** This appendix provided a cross reference that allowed the code user to trace the code sections in Chapters 34 through 43 back to their source: the *National Electrical Code*. This appendix is no longer provided.~~

~~**Appendix R Light Straw-Clay Construction.**~~ ~~This appendix regulates the use of light straw-clay as a construction material. It is limited in application to nonbearing wall infill systems.~~

~~**Appendix S Strawbale Construction.**~~ ~~This appendix provides prescriptive requirements for the use of strawbale as a construction material. It is limited in application to the walls of one-story structures, except where additional engineering is provided.~~

~~**Appendix T Recommended Procedure for Worst-Case Testing of Atmospheric Venting Systems under N1102.4 or N1105 Conditions ≤ 5ACH$_{50}$.**~~ ~~This appendix is an informative appendix that is provided for testing of atmospheric venting conditions in a house when the leak tightness is less than five air changes per hour at 50 Pascals. The air leakage limitations in the energy provisions of Chapter 11 could have a direct impact on the building pressure boundary affecting the safe operation of combustion equipment.~~

~~Appendix T is intended to provide clear guidance to builders, code officials and home performance contractors for worst-case testing of atmospheric venting systems where air-sealing techniques and air-leakage performance testing requirements of Chapter 11 or the 2015 IECC are employed. Worst-case testing is used by home performance contractors to identify problems that weaken draft and restrict combustion air. Worst-case vent testing uses the home's exhaust fans, air-handling appliances and chimneys to create worst-case depressurization in the combustion appliance zone (CAZ).~~

~~**Appendix U Solar-Ready Provisions—Detached One- and Two-Family Dwellings, Multiple Single-Family Dwellings (Townhouses).**~~ ~~This appendix provides requirements for preparation of a house for future installation of solar equipment for electrical power or heating. Given the growing popularity of solar power and the possible need for the equipment in the future, this appendix, if adopted, would require an area be provided on the building roof that would accommodate solar equipment. In addition, pathways for routing of plumbing and conduit need to be provided.~~

Table of Contents

(For supplemental use. Not part of NCRC amendments.)

Part I—Administrative

CHAPTER 1
SCOPE AND ADMINISTRATION

PART 1—SCOPE AND APPLICATION

SECTION R101
GENERAL

R101.1 Title.
These provisions shall be known as the North Carolina *Residential Code for One- and Two-family Dwellings* ~~of [NAME OF JURISDICTION],~~ and shall be cited as such and will be referred to herein as “this code.” These regulations were adopted by the North Carolina Building Code Council on Month Day, Year, to be effective Month Day, Year. References to the *International Codes* shall mean the North Carolina Codes. The North Carolina Amendments to the *International Codes* are underlined.

R101.2 Scope.
The provisions of the *International Residential Code for One- and Two-family Dwellings* shall apply to the construction, *alteration*, movement, enlargement, replacement, repair, *equipment*, use and occupancy, location, removal and demolition of detached one- and two-family dwellings and *townhouses* not more than three stories above *grade plane* in height with a separate means of egress and their *accessory structures* not more than three stories above *grade plane* in height. Single family *dwellings* otherwise permitted by this code shall include *bed and breakfast homes*.

Exceptions:

1. Live/work units located in *townhouses* and complying with the requirements of Section 419 of the *International Building Code* shall be permitted to be built as one- and two- family *dwellings* or *townhouses*. ~~constructed in accordance with the *International Residential Code for One- and Two-Family Dwellings*~~. Fire suppression required by Section 419.5 of the *International Building Code* where constructed under the *International Residential Code for One- and Two-family Dwellings* shall conform to Section P2904.

2. ~~Owner-occupied lodging houses with five or fewer guestrooms shall be permitted to be constructed in accordance with the *International Residential Code for One- and Two-family Dwellings* where equipped with a fire sprinkler system in accordance with Section P2904.~~ Deleted.

R101.2.1 Accessory buildings.
Accessory buildings with any dimension greater than 12 feet (3658 mm) shall meet the provisions of this code. *Accessory buildings* are permitted to be constructed without a masonry or concrete foundation, except in *coastal high hazard* or *ocean hazard areas*, provided all of the following conditions are met:

1. The *accessory building* shall not exceed 400 square feet (37 m^2) or one story in height;

2. The building is supported on a wood foundation of minimum 2” x 6” (51 mm x 152 mm) or 3”x 4” (76 mm x 102 mm) mudsill of approved wood in accordance with Section R317; and

3. The building is anchored to resist overturning and sliding by installing a minimum of one ground anchor at each corner of the building. The total resisting force of the anchors shall be equal to 20 psf (958 Pa) times the plan area of the building.

R101.2.2 Accessory structures.

The following *accessory structures* shall meet the provisions of this code.

1. Decks, see Appendix M,

2. Gazebos,

3. Retaining walls, see Section R404.4,

4. Detached masonry chimneys located less than 10 feet (3048 mm) from other buildings or lot lines,

5. Swimming pools and spas, see Appendix V,

6. Detached carports,

7. *Docks, piers, bulkheads*, and waterway structures, see Section R327.

Exception: Portable lightweight carports not exceeding 400 square feet (37 m^2) or 12 foot (3658 mm) mean roof height.

R101.3 ~~Intent~~ Purpose.

The purpose of this code is to establish minimum requirements to safeguard the public safety, health and general welfare through affordability, structural strength, means of egress facilities, stability, sanitation, light and ventilation, energy conservation and safety to life and property from fire and other hazards attributed to the built environment ~~and to provide safety to fire fighters and emergency responders during emergency operations~~.

SECTION R102
APPLICABILITY

R102.4 Referenced codes and standards.

The codes and standards referenced in this code shall be considered part of the requirements of this code to the prescribed extent of each such reference ~~and as further regulated in Sections R102.4.1 and R102.4.2~~.

Exception: Where enforcement of a code provision would violate the conditions of the *listing* of the *equipment* or *appliance*, the conditions of the *listing* and manufacturer's instructions shall apply.

R102.4.1 Conflicts. Deleted.
~~Where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.~~

R102.4.2 Provisions in referenced codes and standards. Deleted.
~~Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard.~~

R102.7 Existing structures.
~~The legal occupancy of any structure existing on the date of adoption of this code shall be permitted to continue without change, except as is specifically covered in this code, the *International Property Maintenance Code*, or the *International Fire Code*, or as is deemed necessary by the *building official* for the general safety and welfare of the occupants and the public.~~ For requirements of existing structures, refer to the *North Carolina Administrative Code and Policies* and the *North Carolina Existing Building Code*.

PART 2—ADMINISTRATION AND ENFORCEMENT

SECTION R103
DEPARTMENT OF BUILDING SAFETY

Deleted. See the *North Carolina Administrative Code and Policies*.
~~**R103.1 Creation of enforcement agency.**~~
~~The department of building safety is hereby created and the official in charge thereof shall be known as the *building official*.~~

~~**R103.2 Appointment.**~~
~~The *building official* shall be appointed by the *jurisdiction*.~~

~~**R103.3 Deputies.**~~
~~In accordance with the prescribed procedures of this *jurisdiction* and with the concurrence of the appointing authority, the *building official* shall have the authority to appoint a deputy *building official*, the related technical officers, inspectors, plan examiners and other employees. Such employees shall have powers as delegated by the *building official*.~~

SECTION R104
DUTIES AND POWERS OF THE BUILDING OFFICIAL

Deleted. See the *North Carolina Administrative Code and Policies*.

~~**R104.1 General.**~~
~~The *building official* is hereby authorized and directed to enforce the provisions of this code. The~~

~~*building official* shall have the authority to render interpretations of this code and to adopt policies and procedures in order to clarify the application of its provisions. Such interpretations, policies and procedures shall be in conformance with the intent and purpose of this code. Such policies and procedures shall not have the effect of waiving requirements specifically provided for in this code.~~

~~**R104.2 Applications and permits.**~~

~~The *building official* shall receive applications, review *construction documents* and issue *permits* for the erection and *alteration* of buildings and structures, inspect the premises for which such permits have been issued and enforce compliance with the provisions of this code.~~

~~**R104.3 Notices and orders.**~~

~~The *building official* shall issue necessary notices or orders to ensure compliance with this code.~~

~~**R104.4 Inspections.**~~

~~The *building official* shall make the required inspections, or the *building official* shall have the authority to accept reports of inspection by *approved agencies* or individuals. Reports of such inspections shall be in writing and be certified by a responsible officer of such *approved agency* or by the responsible individual. The *building official* is authorized to engage such expert opinion as deemed necessary to report upon unusual technical issues that arise, subject to the approval of the appointing authority.~~

~~**R104.5 Identification.**~~

~~The *building official* shall carry proper identification when inspecting structures or premises in the performance of duties under this code.~~

~~**R104.6 Right of entry.**~~

~~Where it is necessary to make an inspection to enforce the provisions of this code, or where the *building official* has reasonable cause to believe that there exists in a structure or upon a premises a condition that is contrary to or in violation of this code that makes the structure or premises unsafe, dangerous or hazardous, the *building official* or designee is authorized to enter the structure or premises at reasonable times to inspect or to perform the duties imposed by this code, provided that if such structure or premises be occupied that credentials be presented to the occupant and entry requested. If such structure or premises is unoccupied, the *building official* shall first make a reasonable effort to locate the owner, the owner's authorized agent, or other person having charge or control of the structure or premises and request entry. If entry is refused, the *building official* shall have recourse to the remedies provided by law to secure entry.~~

~~**R104.7 Department records.**~~

~~The *building official* shall keep official records of applications received, *permits* and certificates issued, fees collected, reports of inspections, and notices and orders issued. Such records shall be retained in the official records for the period required for the retention of public records.~~

~~**R104.8 Liability.**~~

~~The *building official*, member of the board of appeals or employee charged with the enforcement of this code, while acting for the *jurisdiction* in good faith and without malice in the discharge of the duties required by this code or other pertinent law or ordinance, shall not thereby be rendered civilly or criminally liable personally and is hereby relieved from personal liability for any damage accruing to persons or property as a result of any act or by reason of an act or omission in the discharge of official duties.~~

~~R104.8.1 Legal defense.~~

~~Any suit or criminal complaint instituted against an officer or employee because of an act performed by that officer or employee in the lawful discharge of duties and under the provisions of this code shall be defended by legal representatives of the *jurisdiction* until the final termination of the proceedings. The *building official* or any subordinate shall not be liable for cost in any action, suit or proceeding that is instituted in pursuance of the provisions of this code.~~

~~R104.9 Approved materials and equipment.~~

~~Materials, *equipment* and devices *approved* by the *building official* shall be constructed and installed in accordance with such approval.~~

~~R104.9.1 Used materials and equipment.~~

~~Used materials, *equipment* and devices shall not be reused unless *approved* by the *building official.*~~

~~R104.10 Modifications.~~

~~Where there are practical difficulties involved in carrying out the provisions of this code, the *building official* shall have the authority to grant modifications for individual cases, provided the *building official* shall first find that special individual reason makes the strict letter of this code impractical and the modification is in compliance with the intent and purpose of this code and that such modification does not lessen health, life and fire safety or structural requirements. The details of action granting modifications shall be recorded and entered in the files of the department of building safety.~~

~~R104.10.1 Flood hazard areas.~~

~~The *building official* shall not grant modifications to any provisions required in flood hazard areas as established by Table R301.2(1) unless a determination has been made that:~~

1. ~~There is good and sufficient cause showing that the unique characteristics of the size, configuration or topography of the site render the elevation standards of Section R322 inappropriate.~~

2. ~~Failure to grant the modification would result in exceptional hardship by rendering the lot undevelopable.~~

3. ~~The granting of modification will not result in increased flood heights, additional threats to public safety, extraordinary public expense, cause fraud on or victimization of the public, or conflict with existing laws or ordinances.~~

4. ~~The modification is the minimum necessary to afford relief, considering the flood hazard.~~

5. ~~Written notice specifying the difference between the design flood elevation and the elevation to which the building is to be built, stating that the cost of flood insurance will be commensurate with the increased risk resulting from the reduced floor elevation and stating that construction below the design flood elevation increases risks to life and property, has been submitted to the applicant.~~

~~**R104.11 Alternative materials, design and methods of construction and equipment.**~~
~~The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. An alternative material, design or method of construction shall be *approved* where the *building official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code. Compliance with the specific performance-based provisions of the International Codes shall be an alternative to the specific requirements of this code. Where the alternative material, design or method of construction is not *approved*, the *building official* shall respond in writing, stating the reasons why the alternative was not *approved*.~~

~~**R104.11.1 Tests.**~~
~~Where there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the *building official* shall have the authority to require tests as evidence of compliance to be made at no expense to the *jurisdiction*. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the *building official* shall approve the testing procedures. Tests shall be performed by an *approved* agency. Reports of such tests shall be retained by the *building official* for the period required for retention of public records.~~

SECTION R105

PERMITS

Deleted. See the *North Carolina Administrative Code and Policies*.

~~**R105.1 Required.**~~
~~Any owner or owner's authorized agent who intends to construct, enlarge, alter, repair, move, demolish or change the occupancy of a building or structure, or to erect, install, enlarge, alter, repair, remove, convert or replace any electrical, gas, mechanical or plumbing system, the installation of which is regulated by this code, or to cause any such work to be performed, shall first make application to the *building official* and obtain the required *permit*.~~

~~**R105.2 Work exempt from permit.**~~
~~Exemption from *permit* requirements of this code shall not be deemed to grant authorization for any work to be done in any manner in violation of the provisions of this code or any other laws or ordinances of this *jurisdiction*. *Permits* shall not be required for the following:~~

~~**Building:**~~

1. ~~One-*story* detached *accessory structures,* provided that the floor area does not exceed 200 square feet (18.58 m^2).~~
2. ~~Fences not over 7 feet (2134 mm) high.~~
3. ~~Retaining walls that are not over 4 feet (1219 mm) in height measured from the bottom of the footing to the top of the wall, unless supporting a surcharge.~~

4. ~~Water tanks supported directly upon *grade* if the capacity does not exceed 5,000 gallons (18 927 L) and the ratio of height to diameter or width does not exceed 2 to 1.~~

5. ~~Sidewalks and driveways.~~

6. ~~Painting, papering, tiling, carpeting, cabinets, counter tops and similar finish work.~~

7. ~~Prefabricated swimming pools that are less than 24 inches (610 mm) deep.~~

8. ~~Swings and other playground equipment.~~

9. ~~Window awnings supported by an exterior wall that do not project more than 54 inches (1372 mm) from the exterior wall and do not require additional support.~~

10. ~~Decks not exceeding 200 square feet (18.58 m^2) in area, that are not more than 30 inches (762 mm) above *grade* at any point, are not attached to a dwelling do not serve the exit door required by Section R311.4.~~

~~Electrical:~~

1. ~~*Listed* cord-and-plug connected temporary decorative lighting.~~

2. ~~Reinstallation of attachment plug receptacles but not the outlets therefor.~~

3. ~~Replacement of branch circuit overcurrent devices of the required capacity in the same location.~~

4. ~~Electrical wiring, devices, *appliances,* apparatus or *equipment* operating at less than 25 volts and not capable of supplying more than 50 watts of energy.~~

5. ~~Minor repair work, including the replacement of lamps or the connection of *approved* portable electrical *equipment* to *approved* permanently installed receptacles.~~

~~Gas:~~

1. ~~Portable heating, cooking or clothes drying *appliances*.~~

2. ~~Replacement of any minor part that does not alter approval of *equipment* or make such *equipment* unsafe.~~

3. ~~Portable-fuel-cell *appliances* that are not connected to a fixed piping system and are not interconnected to a power grid.~~

~~Mechanical:~~

1. ~~Portable heating *appliances*.~~

2. ~~Portable ventilation *appliances*.~~

3. ~~Portable cooling units.~~

4. ~~Steam, hot- or chilled-water piping within any heating or cooling *equipment* regulated by this code.~~

5. ~~Replacement of any minor part that does not alter approval of *equipment* or make such *equipment* unsafe.~~

6. ~~Portable evaporative coolers.~~

7. ~~Self-contained refrigeration systems containing 10 pounds (4.54 kg) or less of refrigerant or that are actuated by motors of 1 horsepower (746 W) or less.~~

8. ~~Portable-fuel-cell *appliances* that are not connected to a fixed piping system and are not interconnected to a power grid.~~

~~Plumbing:~~

1. ~~The stopping of leaks in drains, water, soil, waste or vent pipe; provided, however, that if any concealed trap, drainpipe, water, soil, waste or vent pipe becomes defective and it becomes necessary to remove and replace the same with new material, such work shall be considered as new work and a *permit* shall be obtained and inspection made as provided in this code.~~

2. ~~The clearing of stoppages or the repairing of leaks in pipes, valves or fixtures, and the removal and reinstallation of water closets, provided such repairs do not involve or require the replacement or rearrangement of valves, pipes or fixtures.~~

~~R105.2.1 Emergency repairs.~~
~~Where *equipment* replacements and repairs must be performed in an emergency situation, the *permit* application shall be submitted within the next working business day to the *building official*.~~

~~R105.2.2 Repairs.~~
~~Application or notice to the *building official* is not required for ordinary repairs to structures, replacement of lamps or the connection of *approved* portable electrical *equipment* to *approved* permanently installed receptacles. Such repairs shall not include the cutting away of any wall, partition or portion thereof, the removal or cutting of any structural beam or load-bearing support, or the removal or change of any required means of egress, or rearrangement of parts of a structure affecting the egress requirements; nor shall ordinary repairs include *addition* to, *alteration* of, replacement or relocation of any water supply, sewer, drainage, drain leader, gas, soil, waste, vent or similar piping, electric wiring or mechanical or other work affecting public health or general safety.~~

~~R105.2.3 Public service agencies.~~
~~A *permit* shall not be required for the installation, *alteration* or repair of generation, transmission, distribution, metering or other related *equipment* that is under the ownership and control of public service agencies by established right.~~

~~**R105.3 Application for permit.**~~

~~To obtain a *permit*, the applicant shall first file an application therefor in writing on a form furnished by the department of building safety for that purpose. Such application shall:~~

1. ~~Identify and describe the work to be covered by the *permit* for which application is made.~~
2. ~~Describe the land on which the proposed work is to be done by legal description, street address or similar description that will readily identify and definitely locate the proposed building or work.~~
3. ~~Indicate the use and occupancy for which the proposed work is intended.~~
4. ~~Be accompanied by *construction documents* and other information as required in Section R106.1.~~
5. ~~State the valuation of the proposed work.~~
6. ~~Be signed by the applicant or the applicant’s authorized agent.~~
7. ~~Give such other data and information as required by the *building official*.~~

~~**R105.3.1 Action on application.**~~

~~The *building official* shall examine or cause to be examined applications for *permits* and amendments thereto within a reasonable time after filing. If the application or the *construction documents* do not conform to the requirements of pertinent laws, the *building official* shall reject such application in writing stating the reasons therefor. If the *building official* is satisfied that the proposed work conforms to the requirements of this code and laws and ordinances applicable thereto, the *building official* shall issue a *permit* therefor as soon as practicable.~~

~~**R105.3.1.1 Determination of substantially improved or substantially damaged existing buildings in flood hazard areas.**~~

~~For applications for reconstruction, rehabilitation, *addition,* alteration, repair or other improvement of existing buildings or structures located in a flood hazard area as established by Table R301.2(1), the *building official* shall examine or cause to be examined the *construction documents* and shall make a determination with regard to the value of the proposed work. For buildings that have sustained damage of any origin, the value of the proposed work shall include the cost to repair the building or structure to its predamaged condition. If the *building official* finds that the value of proposed work equals or exceeds 50 percent of the market value of the building or structure before the damage has occurred or the improvement is started, the proposed work is a substantial improvement or restoration of substantial damage and the building official shall require existing portions of the entire building or structure to meet the requirements of Section R322.~~

~~For the purpose of this determination, a substantial improvement shall mean any repair, reconstruction, rehabilitation, addition or improvement of a building or structure, the cost of which equals or exceeds 50 percent of the market value of the building or structure before the improvement or repair is started. Where the building or structure has sustained substantial damage, repairs necessary to restore the building or structure to~~

~~its predamaged condition shall be considered substantial improvements regardless of the actual repair work performed. The term shall not include either of the following:~~

1. ~~Improvements to a building or structure that are required to correct existing health, sanitary or safety code violations identified by the building official and that are the minimum necessary to ensure safe living conditions.~~

2. ~~Any alteration of a historic building or structure, provided that the alteration will not preclude the continued designation as a historic building or structure. For the purposes of this exclusion, a historic building shall be any of the following:~~

    2.1. ~~Listed or preliminarily determined to be eligible for listing in the National Register of Historic Places.~~

    2.2. ~~Determined by the Secretary of the U.S. Department of Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined to qualify as an historic district.~~

    2.3. ~~Designated as historic under a state or local historic preservation program that is approved by the Department of Interior.~~

~~R105.3.2 Time limitation of application.~~
~~An application for a *permit* for any proposed work shall be deemed to have been abandoned 180 days after the date of filing unless such application has been pursued in good faith or a *permit* has been issued; except that the *building official* is authorized to grant one or more extensions of time for additional periods not exceeding 180 days each. The extension shall be requested in writing and justifiable cause demonstrated.~~

~~R105.4 Validity of permit.~~
~~The issuance or granting of a *permit* shall not be construed to be a *permit* for, or an *approval* of, any violation of any of the provisions of this code or of any other ordinance of the *jurisdiction*. *Permits* presuming to give authority to violate or cancel the provisions of this code or other ordinances of the *jurisdiction* shall not be valid. The issuance of a *permit* based on *construction documents* and other data shall not prevent the *building official* from requiring the correction of errors in the *construction documents* and other data. The *building official* is authorized to prevent occupancy or use of a structure where in violation of this code or of any other ordinances of this *jurisdiction*.~~

~~R105.5 Expiration.~~
~~Every *permit* issued shall become invalid unless the work authorized by such *permit* is commenced within 180 days after its issuance, or if the work authorized by such *permit* is suspended or abandoned for a period of 180 days after the time the work is commenced. The *building official* is authorized to grant, in writing, one or more extensions of time, for periods not more than 180 days each. The extension shall be requested in writing and justifiable cause demonstrated.~~

~~R105.6 Suspension or revocation.~~
~~The *building official* is authorized to suspend or revoke a *permit* issued under the provisions of this code wherever the *permit* is issued in error or on the basis of incorrect, inaccurate or~~

~~incomplete information, or in violation of any ordinance or regulation or any of the provisions of this code.~~

~~**R105.7 Placement of permit.**~~
~~The building *permit* or a copy shall be kept on the site of the work until the completion of the project.~~

~~**R105.8 Responsibility.**~~
~~It shall be the duty of every person who performs work for the installation or repair of building, structure, electrical, gas, mechanical or plumbing systems, for which this code is applicable, to comply with this code.~~

~~**R105.9 Preliminary inspection.**~~
~~Before issuing a *permit,* the *building official* is authorized to examine or cause to be examined buildings, structures and sites for which an application has been filed.~~

SECTION R106
CONSTRUCTION DOCUMENTS

Deleted. See the *North Carolina Administrative Code and Policies*.

~~**R106.1 Submittal documents.**~~
~~Submittal documents consisting of *construction documents*, and other data shall be submitted in two or more sets with each application for a *permit.* The *construction documents* shall be prepared by a registered *design professional* where required by the statutes of the *jurisdiction* in which the project is to be constructed. Where special conditions exist, the *building official* is authorized to require additional *construction documents* to be prepared by a registered *design professional.*~~

> ~~**Exception:** The *building official* is authorized to waive the submission of *construction documents* and other data not required to be prepared by a registered *design professional* if it is found that the nature of the work applied for is such that reviewing of *construction documents* is not necessary to obtain compliance with this code.~~
>
> ~~**R106.1.1 Information on construction documents.**~~
> ~~*Construction documents* shall be drawn upon suitable material. Electronic media documents are permitted to be submitted where *approved* by the *building official*. *Construction documents* shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules and regulations, as determined by the *building official.*~~
>
> ~~**R106.1.2 Manufacturer's installation instructions.**~~
> ~~Manufacturer's installation instructions, as required by this code, shall be available on the job site at the time of inspection.~~
>
> ~~**R106.1.3 Information on braced wall design.**~~
> ~~For buildings and structures utilizing braced wall design, and where required by the *building official*, braced wall lines shall be identified on the *construction documents.* Pertinent information including, but not limited to, bracing methods, location and length of *braced wall*~~

~~*panels* and foundation requirements of braced wall panels at top and bottom shall be provided.~~

~~R106.1.4 Information for construction in flood hazard areas.~~

~~For buildings and structures located in whole or in part in flood hazard areas as established by Table R301.2(1), *construction documents* shall include:~~

1. ~~Delineation of flood hazard areas, floodway boundaries and flood zones and the design flood elevation, as appropriate.~~

2. ~~The elevation of the proposed lowest floor, including *basement*; in areas of shallow flooding (AO Zones), the height of the proposed lowest floor, including *basement*, above the highest adjacent *grade*.~~

3. ~~The elevation of the bottom of the lowest horizontal structural member in coastal high hazard areas (V Zone) and in Coastal A Zones where such zones are delineated on flood hazard maps identified in Table R301.2(1) or otherwise delineated by the jurisdiction.~~

4. ~~If design flood elevations are not included on the community's Flood Insurance Rate Map (FIRM), the *building official* and the applicant shall obtain and reasonably utilize any design flood elevation and floodway data available from other sources.~~

~~R106.2 Site plan or plot plan.~~

~~The *construction documents* submitted with the application for *permit* shall be accompanied by a site plan showing the size and location of new construction and existing structures on the site and distances from *lot lines*. In the case of demolition, the site plan shall show construction to be demolished and the location and size of existing structures and construction that are to remain on the site or plot. The *building official* is authorized to waive or modify the requirement for a site plan where the application for *permit* is for *alteration* or repair or where otherwise warranted.~~

~~R106.3 Examination of documents.~~

~~The *building official* shall examine or cause to be examined *construction documents* for code compliance.~~

~~R106.3.1 Approval of construction documents.~~

~~Where the *building official* issues a *permit*, the *construction documents* shall be *approved* in writing or by a stamp that states "REVIEWED FOR CODE COMPLIANCE." One set of *construction documents* so reviewed shall be retained by the *building official*. The other set shall be returned to the applicant, shall be kept at the site of work and shall be open to inspection by the *building official* or a duly authorized representative.~~

~~R106.3.2 Previous approvals.~~

~~This code shall not require changes in the *construction documents*, construction or designated occupancy of a structure for which a lawful *permit* has been heretofore issued or otherwise lawfully authorized, and the construction of which has been pursued in good faith within 180 days after the effective date of this code and has not been abandoned.~~

~~R106.3.3 Phased approval.~~

~~The *building official* is authorized to issue a *permit* for the construction of foundations or any other part of a building or structure before the *construction documents* for the whole building or structure have been submitted, provided that adequate information and detailed statements have been filed complying with pertinent requirements of this code. The holder of such *permit* for the foundation or other parts of a building or structure shall proceed at the holder's own risk with the building operation and without assurance that a *permit* for the entire structure will be granted.~~

~~R106.4 Amended construction documents.~~

~~Work shall be installed in accordance with the *approved construction documents*, and any changes made during construction that are not in compliance with the *approved construction documents* shall be resubmitted for approval as an amended set of *construction documents*.~~

~~R106.5 Retention of construction documents.~~

~~One set of *approved construction documents* shall be retained by the *building official* for a period of not less than 180 days from date of completion of the permitted work, or as required by state or local laws.~~

SECTION R107
TEMPORARY STRUCTURES AND USES

Deleted. See the *North Carolina Administrative Code and Policies*.

~~R107.1 General.~~

~~The *building official* is authorized to issue a *permit* for temporary structures and temporary uses. Such *permits* shall be limited as to time of service, but shall not be permitted for more than 180 days. The *building official* is authorized to grant extensions for demonstrated cause.~~

~~R107.2 Conformance.~~

~~Temporary structures and uses shall conform to the structural strength, fire safety, means of egress, light, ventilation and sanitary requirements of this code as necessary to ensure the public health, safety and general welfare.~~

~~R107.3 Temporary power.~~

~~The *building official* is authorized to give permission to temporarily supply and use power in part of an electric installation before such installation has been fully completed and the final certificate of completion has been issued. The part covered by the temporary certificate shall comply with the requirements specified for temporary lighting, heat or power in NFPA 70.~~

~~R107.4 Termination of approval.~~

~~The *building official* is authorized to terminate such *permit* for a temporary structure or use and to order the temporary structure or use to be discontinued.~~

SECTION R108

FEES

Deleted. See the *North Carolina Administrative Code and Policies*.

~~R108.1 Payment of fees.~~

~~A *permit* shall not be valid until the fees prescribed by law have been paid, nor shall an amendment to a *permit* be released until the additional fee, if any, has been paid.~~

~~R108.2 Schedule of permit fees.~~

~~On buildings, structures, electrical, gas, mechanical and plumbing systems or *alterations* requiring a *permit*, a fee for each *permit* shall be paid as required, in accordance with the schedule as established by the applicable governing authority.~~

~~R108.3 Building permit valuations.~~

~~Building *permit* valuation shall include total value of the work for which a *permit* is being issued, such as electrical, gas, mechanical, plumbing *equipment* and other permanent systems, including materials and labor.~~

~~R108.4 Related fees.~~

~~The payment of the fee for the construction, *alteration*, removal or demolition for work done in connection to or concurrently with the work authorized by a building *permit* shall not relieve the applicant or holder of the *permit* from the payment of other fees that are prescribed by law.~~

~~R108.5 Refunds.~~

~~The *building official* is authorized to establish a refund policy.~~

~~R108.6 Work commencing before permit issuance.~~

~~Any person who commences work requiring a *permit* on a building, structure, electrical, gas, mechanical or plumbing system before obtaining the necessary permits shall be subject to a fee established by the applicable governing authority that shall be in addition to the required *permit* fees.~~

SECTION R109
INSPECTIONS

Deleted. See the *North Carolina Administrative Code and Policies*.

~~R109.1 Types of inspections.~~

~~For on-site construction, from time to time the *building official*, upon notification from the *permit* holder or his agent, shall make or cause to be made any necessary inspections and shall either approve that portion of the construction as completed or shall notify the *permit* holder or his or her agent wherein the same fails to comply with this code.~~

~~R109.1.1 Foundation inspection.~~

~~Inspection of the foundation shall be made after poles or piers are set or trenches or *basement* areas are excavated and any required forms erected and any required reinforcing steel is in place and supported prior to the placing of concrete. The foundation inspection shall include excavations for thickened slabs intended for the support of bearing walls, partitions, structural supports, or *equipment* and special requirements for wood foundations.~~

~~R109.1.2 Plumbing, mechanical, gas and electrical systems inspection.~~

~~Rough inspection of plumbing, mechanical, gas and electrical systems shall be made prior to covering or concealment, before fixtures or *appliances* are set or installed, and prior to framing inspection.~~

~~**Exception:** Backfilling of ground-source heat pump loop systems tested in accordance with Section M2105.1 prior to inspection shall be permitted.~~

~~**R109.1.3 Floodplain inspections.**~~

~~For construction in flood hazard areas as established by Table R301.2(1), upon placement of the lowest floor, including *basement*, and prior to further vertical construction, the *building official* shall require submission of documentation, prepared and sealed by a registered *design professional*, of the elevation of the lowest floor, including *basement*, required in Section R322.~~

~~**R109.1.4 Frame and masonry inspection.**~~

~~Inspection of framing and masonry construction shall be made after the roof, masonry, framing, firestopping, draftstopping and bracing are in place and after the plumbing, mechanical and electrical rough inspections are *approved*.~~

~~**R109.1.5 Other inspections.**~~

~~In addition to inspections in Sections R109.1.1 through R109.1.4, the *building official* shall have the authority to make or require any other inspections to ascertain compliance with this code and other laws enforced by the *building official*.~~

~~**R109.1.5.1 Fire-resistance-rated construction inspection.**~~

~~Where fire-resistance-rated construction is required between *dwelling units* or due to location on property, the *building official* shall require an inspection of such construction after lathing or gypsum board or gypsum panel products are in place, but before any plaster is applied, or before board or panel joints and fasteners are taped and finished.~~

~~**R109.1.6 Final inspection.**~~

~~Final inspection shall be made after the permitted work is complete and prior to occupancy.~~

~~**R109.1.6.1 Elevation documentation.**~~

~~If located in a flood hazard area, the documentation of elevations required in Section R322.1.10 shall be submitted to the *building official* prior to the final inspection.~~

~~**R109.2 Inspection agencies.**~~

~~The *building official* is authorized to accept reports of *approved* agencies, provided such agencies satisfy the requirements as to qualifications and reliability.~~

~~**R109.3 Inspection requests.**~~

~~It shall be the duty of the *permit* holder or their agent to notify the *building official* that such work is ready for inspection. It shall be the duty of the person requesting any inspections required by this code to provide access to and means for inspection of such work.~~

~~**R109.4 Approval required.**~~

~~Work shall not be done beyond the point indicated in each successive inspection without first obtaining the approval of the *building official*. The *building official* upon notification, shall make the requested inspections and shall either indicate the portion of the construction that is satisfactory as completed, or shall notify the *permit* holder or an agent of the *permit* holder wherein the same fails to comply with this code. Any portions that do not comply shall be corrected and such portion shall not be covered or concealed until authorized by the *building official*.~~

SECTION R110
CERTIFICATE OF OCCUPANCY

Deleted. See the *North Carolina Administrative Code and Policies*.

~~**R110.1 Use and occupancy.**~~

~~A building or structure shall not be used or occupied, and a change in the existing use or occupancy classification of a building or structure or portion thereof shall not be made, until the *building official* has issued a certificate of occupancy therefor as provided herein. Issuance of a certificate of occupancy shall not be construed as an approval of a violation of the provisions of this code or of other ordinances of the *jurisdiction*. Certificates presuming to give authority to violate or cancel the provisions of this code or other ordinances of the *jurisdiction* shall not be valid.~~

~~**Exceptions:**~~

1. ~~Certificates of occupancy are not required for work exempt from permits under Section R105.2.~~
2. ~~Accessory buildings or structures.~~

~~**R110.2 Change in use.**~~

~~Changes in the character or use of an existing structure shall not be made except as specified in Sections 3408 and 3409 of the *International Building Code*.~~

~~**R110.3 Certificate issued.**~~

~~After the *building official* inspects the building or structure and does not find violations of the provisions of this code or other laws that are enforced by the department of building safety, the *building official* shall issue a certificate of occupancy containing the following:~~

1. ~~The building *permit* number.~~
2. ~~The address of the structure.~~
3. ~~The name and address of the owner or the owner’s authorized agent.~~
4. ~~A description of that portion of the structure for which the certificate is issued.~~
5. ~~A statement that the described portion of the structure has been inspected for compliance with the requirements of this code.~~
6. ~~The name of the *building official*.~~
7. ~~The edition of the code under which the *permit* was issued.~~
8. ~~If an automatic sprinkler system is provided and whether the sprinkler system is required.~~
9. ~~Any special stipulations and conditions of the building *permit*.~~

~~**R110.4 Temporary occupancy.**~~

~~The *building official* is authorized to issue a temporary certificate of occupancy before the completion of the entire work covered by the *permit*, provided that such portion or portions shall be occupied safely. The *building official* shall set a time period during which the temporary certificate of occupancy is valid.~~

~~**R110.5 Revocation.**~~

~~The *building official* shall, in writing, suspend or revoke a certificate of occupancy issued under the provisions of this code wherever the certificate is issued in error, or on the basis of incorrect information supplied, or where it is determined that the building or structure or portion thereof is in violation of any ordinance or regulation or any of the provisions of this code.~~

SECTION R111

SERVICE UTILITIES

Deleted. See the *North Carolina Administrative Code and Policies*.

~~**R111.1 Connection of service utilities.**~~

~~A person shall not make connections from a utility, source of energy, fuel or power to any building or system that is regulated by this code for which a *permit* is required, until *approved* by the *building official*.~~

~~**R111.2 Temporary connection.**~~

~~The *building official* shall have the authority to authorize the temporary connection of the building or system to the utility, source of energy, fuel or power.~~

~~**R111.3 Authority to disconnect service utilities.**~~

~~The *building official* shall have the authority to authorize disconnection of utility service to the building, structure or system regulated by this code and the referenced codes and standards set forth in Section R102.4 in case of emergency where necessary to eliminate an immediate hazard to life or property or where such utility connection has been made without the approval required by Section R111.1 or R111.2. The *building official* shall notify the serving utility and where possible the owner or the owner’s authorized agent and occupant of the building, structure or service system of the decision to disconnect prior to taking such action. If not notified prior to disconnection, the owner, the owner’s authorized agent or occupant of the building, structure or service system shall be notified in writing as soon as practical thereafter.~~

SECTION R112

BOARD OF APPEALS

Deleted. See the *North Carolina Administrative Code and Policies*.

~~**R112.1 General.**~~

~~In order to hear and decide appeals of orders, decisions or determinations made by the *building official* relative to the application and interpretation of this code, there shall be and is hereby created a board of appeals. The *building official* shall be an ex officio member of said board but shall not have a vote on any matter before the board. The board of appeals shall be appointed~~

~~by the governing body and shall hold office at its pleasure. The board shall adopt rules of procedure for conducting its business, and shall render decisions and findings in writing to the appellant with a duplicate copy to the *building official*.~~

~~**R112.2 Limitations on authority.**~~
~~An application for appeal shall be based on a claim that the true intent of this code or the rules legally adopted thereunder have been incorrectly interpreted, the provisions of this code do not fully apply or an equally good or better form of construction is proposed. The board shall not have authority to waive requirements of this code.~~

~~**R112.3 Qualifications.**~~
~~The board of appeals shall consist of members who are qualified by experience and training to pass judgement on matters pertaining to building construction and are not employees of the *jurisdiction*.~~

~~**R112.4 Administration.**~~
~~The *building official* shall take immediate action in accordance with the decision of the board.~~

SECTION R113
VIOLATIONS

Deleted. See the *North Carolina Administrative Code and Policies*.

~~**R113.1 Unlawful acts.**~~
~~It shall be unlawful for any person, firm or corporation to erect, construct, alter, extend, repair, move, remove, demolish or occupy any building, structure or *equipment* regulated by this code, or cause same to be done, in conflict with or in violation of any of the provisions of this code.~~

~~**R113.2 Notice of violation.**~~
~~The *building official* is authorized to serve a notice of violation or order on the person responsible for the erection, construction, *alteration*, extension, repair, moving, removal, demolition or occupancy of a building or structure in violation of the provisions of this code, or in violation of a detail statement or a plan *approved* thereunder, or in violation of a *permit* or certificate issued under the provisions of this code. Such order shall direct the discontinuance of the illegal action or condition and the abatement of the violation.~~

~~**R113.3 Prosecution of violation.**~~
~~If the notice of violation is not complied with in the time prescribed by such notice, the *building official* is authorized to request the legal counsel of the *jurisdiction* to institute the appropriate proceeding at law or in equity to restrain, correct or abate such violation, or to require the removal or termination of the unlawful occupancy of the building or structure in violation of the provisions of this code or of the order or direction made pursuant thereto.~~

~~**R113.4 Violation penalties.**~~
~~Any person who violates a provision of this code or fails to comply with any of the requirements thereof or who erects, constructs, alters or repairs a building or structure in violation of the *approved construction documents* or directive of the *building official,* or of a *permit* or certificate issued under the provisions of this code, shall be subject to penalties as prescribed by law.~~

SECTION R114

STOP WORK ORDER

Deleted. See the *North Carolina Administrative Code and Policies*.

~~**R114.1 Notice to owner or the owner's authorized agent.**~~

~~Upon notice from the *building official* that work on any building or structure is being executed contrary to the provisions of this code or in an unsafe and dangerous manner, such work shall be immediately stopped. The stop work order shall be in writing and shall be given to the owner of the property involved, or to the owner's authorized agent or to the person performing the work and shall state the conditions under which work will be permitted to resume.~~

~~**R114.2 Unlawful continuance.**~~

~~Any person who shall continue any work in or about the structure after having been served with a stop work order, except such work as that person is directed to perform to remove a violation or unsafe condition, shall be subject to penalties as prescribed by law.~~

Part II—Definitions

CHAPTER 2
DEFINITIONS

~~Code change proposals to definitions in this chapter preceded by a bracketed letter are considered by the IRC-Building Code Development Committee [RB] or the IECC-Residential Code Development Committee [RE] during the Group B (2016) Code Development cycle. See page xvii for explanation.~~
Definitions in this chapter preceded by a bracketed letter correlate with the abridged chapters for Energy [RE], Plumbing [RP], Fuel Gas [RG], and Mechanical [RM] of this code. Definitions that are not preceded by a bracket are general definitions utilized throughout this code.

SECTION R201
GENERAL

R201.3 Terms defined in other codes.
Where terms are not defined in this code such terms shall have the meanings ascribed in other code publications of the ~~International~~ North Carolina Building Code Council.

SECTION R202
DEFINITIONS

[RE] ABOVE-GRADE WALL. A wall more than 50 percent above grade and enclosing *conditioned space*. This includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.

[RP] ACCEPTED ENGINEERING PRACTICE. That which conforms to accepted principles, tests or standards of nationally recognized technical or scientific authorities.

ACCESS (TO). That which enables a device, *appliance* or *equipment* to be reached by ready *access* or by a means that first requires the removal or movement of a panel, door or similar obstruction.

[RP] ACCESS COVER. A removable plate, usually secured by bolts or screws, to permit access to a pipe or pipe fitting for the purposes of inspection, repair or cleaning.

ACCESSIBLE. Signifies access that requires the removal of an access panel or similar removable obstruction. For energy purposes, ACCESSIBLE means admitting close approach as a result of not being guarded by locked doors, elevation or other effective means (see "Readily *accessible*").

ACCESSORY BUILDING. In one- and two-family *dwellings* not more than three stories *above grade plane* in height with a separate means of egress, a building, the use of which is incidental to that of the main building and which is detached and located on the same lot. An accessory building is a building that is roofed over and more than 50% of its exterior walls are enclosed. Examples of accessory buildings are garages, storage buildings, workshops, boat houses, treehouses, etc.

ACCESSORY STRUCTURE. A structure that is ~~accessory to and incidental to that of the *dwelling*(*s*) and that is located on the same *lot*~~ not defined as an *accessory building*. Examples of accessory structures are fencing, decks, gazebos, arbors, retaining walls, barbecue pits, detached chimneys, playground equipment, yard art, *docks, piers*, etc.

[RE] ACH50. Air changes per hour of measured airflow in relation to the building volume while the building is maintained at a pressure difference of 50 Pascals.

[RP] ADAPTER FITTING. An *approved* connecting device that suitably and properly joins or adjusts pipes and fittings that do not otherwise fit together**.**

ADDITION. An extension or increase in floor area or height of a building or structure. For energy purposes, an extension or increase in the *conditioned space* floor area or height of a building or structure.

[RP] AIR ADMITTANCE VALVE. A one-way valve designed to allow air into the plumbing drainage system where a negative pressure develops in the piping. This device shall close by gravity and seal the vent terminal under conditions of zero differential pressure (no flow conditions) and under positive internal pressure. The purpose of an air admittance valve is to provide a method of allowing air to enter the plumbing drainage system without the use of a vent extended to open air and to prevent *sewer* gases from escaping into a building.

~~**AIR BARRIER.** See Section N1101.6 for definition applicable in Chapter 11.~~

[RE] AIR BARRIER MATERIAL. Material(s) that have an air permeability not to exceed 0.004 cfm/ft^2 under a pressure differential of 0.3 in. water (1.57 psf) (0.02 L/s.m^2@75 Pa) when tested in accordance with ASTM E 2178.

[RE] AIR BARRIER SYSTEM. Material(s) assembled and joined together to provide a barrier to air leakage through the building envelope. An air barrier is a combination of *air barrier materials* and sealants.

[RP] AIR BREAK (DRAINAGE SYSTEM). An arrangement where a discharge pipe from a fixture, *appliance* or device drains indirectly into a receptor below the flood-level rim of the receptor and above the trap seal.

[RG] AIR CONDITIONER, GAS-FIRED. A gas-burning, automatically operated *appliance* for supplying cooled and/or dehumidified air or chilled liquid.

[RG] AIR CONDITIONING. The treatment of air so as to control simultaneously the temperature, humidity, cleanness and distribution of the air to meet the requirements of a conditioned space.

[RG] AIR, EXHAUST. Air being removed from any space or piece of *equipment* or *appliance* and conveyed directly to the atmosphere by means of openings or ducts.

[RG] AIR-HANDLING UNIT. A blower or fan used for the purpose of distributing supply air to a room, space or area.

[RG] AIR, MAKEUP. Any combination of outdoor and transfer air intended to replace exhaust air and exfiltration.

[RM] AIR, OUTDOOR. Ambient air that enters a building through a ventilation system, through intentional openings for natural ventilation, or by infiltration.

[RM] AIR, TRANSFER. Air moved from one indoor space to another.

ALTERATION. Any construction~~, retrofit~~ or renovation to an existing structure other than repair or addition that requires a permit. Also, a change in a building, electrical, gas, mechanical or plumbing system that involves an extension, addition or change to the arrangement, type or purpose of the original installation that requires a permit.

[RP] ALTERNATE ON-SITE NON-POTABLE WATER. Non-potable water from other than public utilities, on-site surface sources and subsurface natural freshwater sources. Examples of such water are gray water, on-site reclaimed water, collected rainwater, captured condensate and rejected water from reverse osmosis systems.

[RP] ALTERNATIVE ENGINEERED DESIGN. A plumbing system that performs in accordance with the intent of Chapters 29 through 33 and provides an equivalent level of performance for the protection of public health, safety and welfare. The system design is not specifically regulated by Chapters 29 through 33.

~~**ALTERNATING TREAD DEVICE .**A device that has a series of steps between 50 and 70 degrees (0.87 and 1.22 rad) from horizontal, usually attached to a center support rail in an alternating manner so that the user does not have both feet on the same level at the same time.~~

[RG] ANODELESS RISER. A transition assembly in which plastic *piping* is installed and terminated above ground outside of a building.

[RG] APPLIANCE, AUTOMATICALLY CONTROLLED. Appliances equipped with an automatic *burner* ignition and safety shut-off device and other automatic devices, which accomplish complete turn-on and shut-off of the gas to the *main burner* or *burners*, and graduate the gas supply to the *burner* or *burners*, but do not affect complete shut-off of the gas.

[RG] APPLIANCE, FAN-ASSISTED COMBUSTION. An *appliance* equipped with an integral mechanical means to either draw or force products of combustion through the combustion chamber or heat exchanger.

[RG] APPLIANCE, UNVENTED. An *appliance* designed or installed in such a manner that the products of combustion are not conveyed by a vent or *chimney* directly to the outside atmosphere.

[RG] APPLIANCE, VENTED. An *appliance* designed and installed in such a manner that all of the products of combustion are conveyed directly from the *appliance* to the outside atmosphere through an *approved chimney* or vent system.

APPROVED. Acceptable to the ~~*building*~~ code *official*.

[RP] AREA DRAIN. A receptacle designed to collect surface or storm water from an open area.

[RP] ASPIRATOR. A fitting or device supplied with water or other fluid under positive pressure that passes through an integral orifice or constriction, causing a vacuum. Aspirators are also referred to as suction apparatus, and are similar in operation to an ejector.

[RG] ATMOSPHERIC PRESSURE. The pressure of the weight of air and water vapor on the surface of the earth, approximately 14.7 pounds per square inch (psia) (101 kPa absolute) at sea level.

ATTIC, HABITABLE. A ~~finished or unfinished area, not considered a *story*,~~ finished attic area meeting the definition of *habitable space* and complying with all of the following requirements:

1. The occupiable floor area is not less than 70 square feet (17 m^2), in accordance with Section R304.
2. The occupiable floor area has a ceiling height in accordance with Section R305.
3. The occupiable space is enclosed by the roof assembly above, knee walls (if applicable) on the sides and the floor-ceiling assembly below.

ATTIC STORAGE. A floored area, regardless of size, within an attic space that is served by an attic access.

> **Exception:** A floor walkway not less than 24 inches (610 mm) wide or greater than 48 inches (1219 mm) wide that serves as an access for the service of utilities or equipment, and a level service space not less than 30 inches (762 mm) deep or greater than 48 inches (1219 mm) deep and not less than 30 inches (762 mm) wide or greater than 48 inches (1219 mm) wide at the front or service side of the appliance, shall not be considered as attic storage. Such floored area shall be labeled at the attic access opening, "NOT FOR STORAGE." The lettering shall be a minimum of 2 inches (51 mm) in height.

[RE] AUTOMATIC. Self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength, pressure, temperature or mechanical configuration (see "Manual").

[RG] AUTOMATIC IGNITION. Ignition of gas at the *burner(s)* when the gas controlling device is turned on, including reignition if the flames on the *burner(s)* have been extinguished by means other than by the closing of the gas controlling device.

[RP] BACKFLOW CONNECTION. Any arrangement whereby backflow is possible.

[RP] BACKFLOW, DRAINAGE. A reversal of flow in the drainage system.

[RP] BACKFLOW PREVENTER. A backflow prevention assembly, a backflow prevention device or other means or method to prevent backflow into the potable water supply.

[RP] BACKFLOW PREVENTER, REDUCED-PRESSURE-ZONE TYPE. A backflow-prevention device consisting of two independently acting check valves, internally force loaded to a normally closed position and separated by an intermediate chamber (or zone) in which there is an automatic relief means of venting to atmosphere internally loaded to a normally open position between two tightly closing shutoff valves and with means for testing for tightness of the checks and opening of relief means.

[RP] BACKFLOW, WATER DISTRIBUTION. The flow of water or other liquids into the potable water-supply piping from any sources other than its intended source. Backsiphonage is one type of backflow.

[RP] BACKPRESSURE. Pressure created by any means in the water distribution system that by being in excess of the pressure in the water supply mains causes a potential backflow condition.

[RP] BACKPRESSURE, LOW HEAD. A pressure less than or equal to 4.33 psi (29.88 kPa) or the pressure exerted by a 10-foot (3048 mm) column of water.

[RP] BACKSIPHONAGE. The flowing back of used or contaminated water from piping into a potable water-supply pipe due to a negative pressure in such pipe.

[RP] BACKWATER VALVE. ~~A device installed in a drain or pipe to prevent backflow of sewage.~~ A device or valve installed in the *building drain* or *sewer* pipe where a *sewer* is subject to backflow, and that prevents drainage or waste from backing up into a lower level or fixtures and causing a flooding condition.

BALCONY, EXTERIOR. An exterior floor projecting from and supported by a structure without additional independent supports**.**

[RG] BAROMETRIC DRAFT REGULATOR. A balanced *damper* device attached to a *chimney,* vent *connector,* breeching or flue gas manifold to protect combustion *appliances* by controlling *chimney draft*. A double-acting *barometric draft regulator* is one whose balancing *damper* is free to move in either direction to protect combustion *appliances* from both excessive *draft* and backdraft.

BASEMENT. ~~A *story* that is not a *story above grade plane*~~. That portion of a building that is partly or completely below *grade*. (see “Story above grade plane”).

BASEMENT WALL. The opaque portion of a wall that encloses one side of a *basement* and has an average below *grade* wall area that is 50 percent or more of the total opaque and nonopaque area of that enclosing side. For energy purposes, a wall 50 percent or more below grade and enclosing conditioned space.

BASIC WIND SPEED. Three-second gust speed at 33 feet (10 058 mm) above the ground in Exposure C (see Section R301.2.1) as given in ~~Figure~~ Tables R301.2(4)~~A~~ and R301.2(5).

[RM] BATHROOM. A room containing a bathtub, shower, spa or similar bathing fixture. (see *toilet room* also).

[RP] BATTERY OF FIXTURES. Any group of two or more similar adjacent fixtures that discharge into a common horizontal waste or soil branch.

BED AND BREAKFAST HOME. A detached single family *dwelling* occupied by the *dwelling* owner and containing eight or fewer guest rooms for rent for a period of less than one week.

BEDROOM. *Sleeping room.*

~~**BEND.** A drainage fitting, designed to provide a change in direction of a drain pipe of less than the angle specified by the amount necessary to establish the desired slope of the line (see "Elbow" and "Sweep").~~

BOAT SLIP. A berthing place for one or two watercraft where the watercraft can be securely moored to cleats, piling, or other devices while the boats are in the water. Boat slips are commonly configured as "side-ties" or as single or double loaded "U" shaped berths.

[RG] BOILER, LOW-PRESSURE. A self-contained *appliance* for supplying steam or hot water.

Hot water heating boiler. A boiler in which no steam is generated, from which hot water is circulated for heating purposes and then returned to the boiler, and that operates at water pressures not exceeding 160 pounds per square inch gauge (psig) (1100 kPa gauge) and at water temperatures not exceeding 250ºF (121ºC) at or near the boiler outlet.

Hot water supply boiler. A boiler, completely filled with water, which furnishes hot water to be used externally to itself, and that operates at water pressures not exceeding 160 psig (1100 kPa gauge) and at water temperatures not exceeding 250ºF (121ºC) at or near the boiler outlet.

Steam heating boiler. A boiler in which steam is generated and that operates at a steam pressure not exceeding 15 psig (100 kPa gauge).

[RG] BONDING JUMPER. A conductor installed to electrically connect metallic gas *piping* to the grounding electrode system.

[RE] BPI ENVELOPE PROFESSIONAL. An individual that has passed the Building Performance Institute written and field examination requirements for the Building Envelope certification and has a current certification.

~~**BRACED WALL LINE.** A straight line through the building plan that represents the location of the lateral resistance provided by the wall bracing.~~

BRACED WALL ~~LINE,~~ CONTINUOUSLY SHEATHED. A *braced wall* ~~*line*~~ with structural sheathing applied to all sheathable surfaces including the areas above and below openings.

[RP] BRANCH INTERVAL. ~~A vertical measurement of distance, 8 feet (2438 mm) or more in *developed length*, between the connections of horizontal branches to a drainage stack. Measurements are taken down the stack from the highest horizontal branch connection.~~ A distance along a soil or waste stack corresponding, in general, to a story height, but not less than 8 feet (2438 mm) within which the horizontal branches from one floor or story of a structure are connected to the stack. Measurements are taken down the stack from the highest horizontal branch connection.

[RP] BRANCH, MAIN. A water-distribution pipe that extends horizontally off a main or riser to convey water to branches or fixture groups.

[RP] BRANCH, VENT. A vent connecting two or more individual vents with a vent stack or stack vent.

[RM] BRAZED JOINT. A gas-tight joint obtained by the joining of metal parts with metallic mixtures or alloys which melt at a temperature above 1,000ºF (538ºC), but lower than the melting temperature of the parts to be joined.

[RG] BRAZING. A metal-joining process wherein coalescence is produced by the use of a nonferrous filler metal having a melting point above 1,000ºF (538ºC), but lower than that of the base metal being joined. The filler material is distributed between the closely fitted surfaces of the joint by capillary action.

[RG] BROILER. A general term including salamanders, barbecues and other appliances cooking primarily by radiated heat, excepting toasters.

[RG] BTU. Abbreviation for British thermal unit, which is the quantity of heat required to raise the temperature of 1 pound (454 g) of water 1ºF (0.56ºC) (1 *Btu* = 1055 J).

[RP] BUILDING DRAIN. The lowest piping that collects the discharge from all other drainage piping inside the house and extends ~~30 inches (762 mm) in *developed length* of pipe,~~ to 10 feet (3048 mm) beyond the *exterior walls* of the building and conveys the drainage to the *building sewer*.

> **Exception:** Drain lines connecting to septic tanks within 25 feet (7620 mm) of the building foundation wall for one- and two-family dwellings with 3 water closets or less shall be considered to be building drain with a minimum size of 3 inches (76.2 mm).

~~**BUILDING OFFICIAL.** The officer or other designated authority charged with the administration and enforcement of this code.~~

[RP] BUILDING SEWER. That part of the drainage system that extends from the end of the *building drain* and conveys its discharge to a public sewer, private sewer, individual sewage-disposal system or other point of disposal.

> **Sanitary.** A *building sewer* that conveys sewage only.
>
> **Storm.** A *building sewer* that conveys storm water or other drainage, but not sewage.

[RE] BUILDING SITE. A continguous area of land that is under the ownership or control of one entity.

[RP] BUILDING SUBDRAIN. That portion of a drainage system that does not drain by gravity into the *building sewer*.

[RE] BUILDING THERMAL ENVELOPE. The *basement walls*, *exterior walls*, floor, roof and any other building element that enclose *conditioned spaces*. This boundary also includes the boundary between *conditioned space* and any exempt or unconditioned space.

[RG] BURNER. A device for the final conveyance of the gas, or a mixture of gas and air, to the combustion zone.

Induced-draft. A *burner* that depends on *draft* induced by a fan that is an integral part of the *appliance* and is located downstream from the *burner*.

Power. A *burner* in which gas, air or both are supplied at pressures exceeding, for gas, the line pressure, and for air, atmospheric pressure, with this added pressure being applied at the *burner*.

[RE] C-FACTOR (THERMAL CONDUCTANCE). The coefficient of heat transmission (surface to surface) through a building component or assembly, equal to the time rate of heat flow per unit area and the unit temperature difference between the warm side and cold side surfaces (Btu/h·ft^2·°F)[W/(m^2·K)].

[RE] CFM25. Cubic Feet per Minute of measured air flow while the building is maintained at a pressure difference of 25 Pascals (0.1 inches w.p.).

[RE] CFM50. Cubic Feet per Minute of measured air flow while the building is maintained at a pressure difference of 50 Pascals (0.2 inches w.p.).

CHIMNEY. A primarily vertical structure containing one or more flues, for the purpose of carrying gaseous products of combustion and air from a fuel-burning *appliance* to the outside atmosphere.

Factory-built chimney. A listed and labeled chimney composed of factory-made components, assembled in the field in accordance with manufacturer's instructions and the conditions of the listing.

Masonry chimney. A field-constructed chimney composed of solid masonry units, bricks, stones or concrete.

[RP] CIRCUIT VENT. A vent that connects to a horizontal drainage branch and vents two traps to not more than eight traps or trapped fixtures connected into a battery.

[RP] CISTERN. A small covered tank for storing water for a home or farm. Generally, this tank stores rainwater to be utilized for purposes other than in the potable water supply, and such tank is placed underground in most cases.

CLEANOUT. An accessible opening in the drainage system used for the removal of possible obstruction. Types of cleanouts include a removable plug or cap, and a removable fixture or fixture trap.

[RG] CLEARANCE. The minimum distance through air measured between the heat-producing surface of the mechanical *appliance*, device or *equipment* and the surface of the combustible material or assembly.

[RE] CLIMATE ZONE. A geographical region based on climatic criteria as specified in this code.

CLOSED CRAWLSPACE. A foundation without wall vents that uses air sealed walls, ground and foundation moisture control, and mechanical drying potential to control crawl space moisture. Insulation may be located at the floor level or at the exterior walls.

[RM] CLOTHES DRYER. An *appliance* used to dry wet laundry by means of heat.

CODE OFFICIAL. The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative.

[RG] CLOTHES DRYER. An *appliance* used to dry wet laundry by means of heated air.

Type 1. Factory-built package, multiple production. Primarily used in the family living environment. Usually the smallest unit physically and in function output.

[RP] COMBINATION FIXTURE. A fixture combining one sink and laundry tray or a two- or three-compartment sink or laundry tray in one unit.

[RP] COMBINATION WASTE AND VENT SYSTEM. A specially designed system of waste piping embodying the horizontal wet venting of one or more sinks, lavatories or floor drains by means of a common waste and vent pipe adequately sized to provide free movement of air above the flow line of the drain.

[RG] COMBUSTIBLE ASSEMBLY. Wall, floor, ceiling or other assembly constructed of one or more component materials that are not defined as noncombustible.

[RG] COMBUSTION. In the context of this code, refers to the rapid oxidation of fuel accompanied by the production of heat or heat and light.

COMBUSTION AIR. ~~The air provided to fuel-burning *equipment* including air for fuel combustion, draft hood dilution and ventilation of the *equipment* enclosure.~~Air necessary for complete combustion of a fuel, including theoretical air and excess air.

[RG] COMBUSTION CHAMBER. The portion of an *appliance* within which combustion occurs.

[RG] COMBUSTION PRODUCTS. Constituents resulting from the combustion of a fuel with the oxygen of the air, including the inert gases, but excluding excess air.

~~**COMMERCIAL, BUILDING.** See Section N1101.6.~~

[RP] COMMON VENT. ~~A single pipe venting two trap arms within the same *branch interval*, either back-to-back or one above the other.~~ A vent connecting at the junction of two *fixture drains* or to a fixture *branch* and serving as a vent for both fixtures.

[RP] CONCEALED FOULING SURFACE. Any surface of a plumbing fixture that is not readily visible and is not scoured or cleansed with each fixture operation.

[RG] CONCEALED LOCATION. A location that cannot be accessed without damaging permanent parts of the building structure or finish surface. Spaces above, below or behind readily removable panels or doors shall not be considered as concealed.

[RG] CONCEALED PIPING. *Piping* that is located in a *concealed location* (see *“Concealed location”*).

CONDITIONED CRAWL SPACE. A conditioned crawl space is a foundation without wall vents that encloses an intentionally heated or cooled space. Insulation is located at the exterior walls.

[RE] CONDITIONED FLOOR AREA. The horizontal projection of the floors associated with the *conditioned space*.

[RE] CONDITIONED SPACE. ~~An area, room or space that is enclosed within the building thermal envelope and that is directly heated or cooled or that is indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate thru openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings or where they contain uninsulated ducts, piping or other sources of heating or cooling.~~ A space within a building that is provided with heating or cooling equipment or systems capable of maintaining, through design or heat loss/gain, 50°F (10°C) during the heating season or 85°F (29°C) during the cooling season, or communicates directly with a conditioned space. Spaces within the building thermal envelope are considered conditioned space.

[RG] CONNECTOR, APPLIANCE (Fuel). Rigid metallic *pipe* and fittings, semirigid metallic *tubing* and fittings or a listed and labeled device that connects an *appliance* to the *gas piping system*.

[RG] CONNECTOR, CHIMNEY OR VENT. The *pipe* that connects an *appliance* to a chimney or vent.

CONTAMINATION. An ~~high hazard or health hazard~~ impairment of the quality of the potable water that creates an actual hazard to the public health through poisoning or through the spread of disease by sewage, industrial fluids or waste.

[RG] CONTROL. A manual or automatic device designed to regulate the gas, air, water or electrical supply to, or operation of, a mechanical system.

[RG] CONVERSION BURNER. A unit consisting of a *burner* and its *controls* for installation in an *appliance* originally utilizing another fuel.

[RE] CRAWL SPACE WALL. The opaque portion of a wall that encloses a crawl space and is partially or totally below grade.

[RP] CRITICAL LEVEL (C-L). An elevation (height) reference point that determines the minimum height at which a backflow preventer or vacuum breaker is installed above the *flood level rim* of the fixture or receptor served by the device. The critical level is the elevation level below which there is a potential for backflow to occur. If the critical level marking is not indicated on the device, the bottom of the device shall constitute the critical level.

[RP] CROSS CONNECTION. ~~Any connection between two otherwise separate piping systems that allows a flow from one system to the other.~~ Any physical connection or arrangement between two otherwise separate piping systems, one of which contains potable water and the other either water of unknown or questionable safety or steam, gas or chemical, whereby there exists the possibility for flow from one system to the other, with the direction of flow depending on the pressure differential between the two systems (see “Backflow”).

[RG] CUBIC FOOT. The amount of gas that occupies 1 cubic foot (0.02832 m^3) when at a temperature of 60ºF (16ºC), saturated with water vapor and under a pressure equivalent to that of 30 inches of mercury (101 kPa).

~~**[RE] CURTAIN WALL.** See Section N1101.6 for definition applicable in Chapter 11.~~

[RG] DAMPER. A manually or automatically controlled device to regulate *draft* or the rate of flow of air or combustion gases.

DAMPPROOFING. A coating or the application of coatings applied to retard the penetration of water vapor and moisture through or into walls or into interior spaces.

[RP] DEAD END. A *branch* leading from a soil, waste or vent pipe; a *building drain*; or a *building sewer*, and terminating at a *developed length* of 2 feet (610 mm) or more by means of a plug, cap or other closed fitting.

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

[RG] DECORATIVE APPLIANCE, VENTED. A *vented appliance* wherein the primary function lies in the aesthetic effect of the flames.

[RG] DECORATIVE APPLIANCES FOR INSTALLATION IN VENTED FIREPLACES. A *vented appliance* designed for installation within the fire chamber of a vented *fireplace*, wherein the primary function lies in the aesthetic effect of the flames.

[RG] DEMAND. The maximum amount of gas input required per unit of time, usually expressed in cubic feet per hour, or *Btu*/h (1 *Btu*/h = 0.2931 W).

[RP] DEMAND RECIRCULATION WATER SYSTEM. ~~See Section N1101.6 for definition applicable in Chapter 11~~. A water distribution system where pump(s) prime the service hot water piping with heated water upon a demand for hot water.

[RM] DESIGN WORKING PRESSURE. The maximum allowable working pressure for which a specific part of a system is designed.

[RP] DISCHARGE PIPE. A pipe that conveys the discharge from plumbing fixtures or appliances.

[RM] DISCRETE PRODUCT. Products that are noncontinuous, individual, distinct pieces such as, but not limited to, electrical, plumbing and mechanical products and duct straps, duct fittings, duct registers and pipe hangers.

DOCK. A structure extending alongshore or out from the shore into a body of water, usually accommodating multiple boat slips, to which boats may be moored in order to load or unload people or cargo.

[RP] DRAINAGE FITTING. ~~A pipe fitting designed to provide connections in the drainage system that have provisions for establishing the desired slope in the system. These fittings are~~

~~made from a variety of both metals and plastics. The methods of coupling provide for required slope in the system.~~ The type of fitting or fittings utilized in the drainage system. Drainage fittings are similar to cast-iron fittings, except that instead of having a bell and spigot, drainage fittings are recessed and tapped to eliminate ridges on the inside of the installed pipe.

[RP] DRAINAGE SYSTEM. Piping within a *public* or *private* premise that conveys sewage, rainwater or other liquid waste to a point of disposal. A drainage system does not include the mains of a *public sewer* system or a private or public sewage treatment or disposal plant.

Building gravity. A drainage system that drains by gravity into the *building sewer*.

Sanitary. A drainage system that carries sewage and excludes storm, surface and ground water**.**

Storm. A drainage system that carries rainwater, surface water, subsurface water and similar liquid waste**.**

[RG] DRIP. The container placed at a low point in a system of *piping* to collect *condensate* and from which the *condensate* is removable.

[RE] DUCT. A tube or conduit utilized for conveying air. The air passages of self-contained systems are not to be construed as air ducts.

[RG] DUCT FURNACE. A warm-air *furnace* normally installed in an air-distribution duct to supply warm air for heating. This definition shall apply only to a warm-air heating *appliance* that depends for air circulation on a blower not furnished as part of the *furnace*.

[RM] DUCTLESS MINI-SPLIT SYSTEM. A heating and cooling system that is comprised of one or multiple indoor evaporator/air-handling units and an outdoor condensing unit that is connected by refrigerant piping and electrical wiring. A ductless mini-split system is capable of cooling or heating one or more rooms without the use of a traditional ductwork system.

DUCT SYSTEM. A continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, plenums, fans and accessory air-handling *equipment* and *appliances*.

~~For definition applicable in Chapter 11, see Section N1101.6.~~

DURHAM FITTING. A special type of drainage fitting for use in the durham systems installations in which the joints are made with recessed and tapered threaded fittings, as opposed to bell and spigot lead/oakum or solvent/cemented or soldered joints. The tapping is at an angle (not 90 degrees) to provide for proper slope in otherwise rigid connections.

DURHAM SYSTEM. A term used to describe soil or waste systems where all piping is of threaded pipe, tube or other such rigid construction using recessed drainage fittings to correspond to the types of piping.

[RP] EFFECTIVE OPENING. The minimum cross-sectional area at the point of water-supply discharge, measured or expressed in terms of diameter of a circle and if the opening is not circular, the diameter of a circle of equivalent cross-sectional area. (This is ~~applicable to~~ used in the determination of the air gap.)

~~**ELBOW.** A pressure pipe fitting designed to provide an exact change in direction of a pipe run. An elbow provides a sharp turn in the flow path (see “Bend” and “Sweep”).~~

[RM] ELECTRIC HEATING APPLIANCE. An *appliance* that produces heat energy to create a warm environment by the application of electric power to resistance elements, refrigerant compressors or dissimilar material junctions.

[RE] ENERGY ANALYSIS. A method for estimating the annual energy use of the *proposed design* and *standard reference design* based on estimates of energy use.

[RE] ENERGY COST. The total estimated annual cost for purchased energy for the building functions regulated by this code, including applicable demand charges.

[RM] ENERGY RECOVERY VENTILATION SYSTEM. Systems that employ air-to-air heat exchangers to recover energy from or reject energy to *exhaust air* for the purpose of preheating, pre-cooling, humidifying or dehumidifying outdoor *ventilation air* prior to supplying such air to a space, either directly or as part of an HVAC system.

[RE] ENERGY SIMULATION TOOL. An *approved* software program or calculation-based methodology that projects the annual energy use of a building.

[RM] ENVIRONMENTAL AIR. Air that is conveyed to or from occupied areas through ducts which are not part of the heating or air-conditioning system, such as ventilation for human usage, domestic kitchen range exhaust, bathroom exhaust, domestic clothes dryer exhaust.

[RM] EQUIPMENT, EXISTING. Any *equipment* regulated by this code which was legally installed prior to the effective date of this code, or for which a permit to install has been issued.

[RG] EXCESS FLOW VALVE (EFV). A valve designed to activate when the fuel gas passing through it exceeds a prescribed flow rate.

[RM] EXFILTRATION. Uncontrolled outward air leakage from conditioned spaces through unintentional openings in ceilings, floors and walls to unconditioned spaces or the outdoors caused by pressure differences across these openings resulting from wind, the stack effect created by temperature differences between indoors and outdoors, and imbalances between supply and exhaust airflow rates.

[RM] EXHAUST SYSTEM. An assembly of connected ducts, plenums, fittings, registers, grilles and hoods through which air is conducted from the space or spaces and exhausted to the outdoor atmosphere.

[RP] EXISTING INSTALLATIONS. Any plumbing system regulated by this code that was legally installed prior to the effective date of this code, or for which a *permit* to install has been issued.

[RG] EXTERIOR MASONRY CHIMNEYS. Masonry chimneys exposed to the outdoors on one or more sides below the roof line.

~~**EXTERIOR WALL COVERING.** A material or assembly of materials applied on the exterior side of exterior walls for the purpose of providing a weather-resistive barrier, insulation or for~~

~~aesthetics, including but not limited to, veneers, siding, exterior insulation and finish systems, architectural trim and embellishments such as cornices, soffits, and fascias.~~

***F*-FACTOR.** The perimeter heat loss factor for slab-on-grade floors (Btu/h x ft x °F) [W/(m x K)].

FAMILY. Family is an individual, two or more persons related by blood, marriage or law, or a group of not more than any five persons living together in a dwelling unit. Servants having common housekeeping facilities with a family consisting of an individual, or more persons related by blood, marriage or law, are a part of the family for this code.

[RP] FAUCET. A valve end of a water pipe through which water is drawn from or held within the pipe.

[RE] FENESTRATION. Skylights, roof windows, vertical windows (whether fixed or moveable); opaque doors; glazed doors; glass block; and combination opaque and glazed doors.

~~For definition applicable in Chapter 11, see Section N1101.6.~~

[RE] FENESTRATION PRODUCT, FIELD-FABRICATED. A fenestration product whose frame is made at the construction site of standard dimensional lumber or other materials that were not previously cut, or otherwise formed with the specific intention of being used to fabricate a fenestration product or exterior door. Field fabricated does not include site-built fenestration.

[RE] FENESTRATION PRODUCT, SITE-BUILT. A fenestration designed to be made up of field-glazed or field-assembled units using specific factory cut or otherwise factory-formed framing and glazing units.

[RE] FENESTRATION, VERTICAL. Windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of a least 60 degrees (1.05 rad) from horizontal.

[RE] F-FACTOR. The perimeter heat loss factor for slab-on-grade floors (Btu/h·ft °F) [W/(m K)].

~~**FIBER-CEMENT (BACKERBOARD, SIDING, SOFFIT, TRIM AND UNDERLAYMENT) PRODUCTS.** Manufactured thin section composites of hydraulic cementitious matrices and discrete nonasbestos fibers~~.

FIBER-CEMENT SIDING. A manufactured, fiber-reinforcing product made with an inorganic hydraulic or calcium silicate binder formed by chemical reaction and reinforced with discrete organic or inorganic nonasbestos fibers, or both. Additives which enhance manufacturing or product performance are permitted. Fiber-cement siding products have either smooth or textured faces and are intended for *exterior wall* and related applications.

[RP] FILL VALVE. A water supply valve, opened or closed by means of a float or similar device, utilized to supply water to a tank. An antisiphon fill valve contains an antisiphon device in the form of an *approved air gap* or vacuum breaker that is an integral part of the fill valve unit and that is positioned on the discharge side of the water supply control valve.

FIREPLACE. An assembly consisting of a hearth and fire chamber and smoke chamber, beginning at the hearth and ending at the top of the smoke chamber, of noncombustible material and provided with a chimney, for use with solid fuels.

Factory-built fireplace. A *listed* and *labeled* fireplace and chimney system composed of factory-made components, and assembled in the field in accordance with manufacturer's instructions and the conditions of the listing.

Masonry chimney. A field-constructed chimney composed of solid masonry units, bricks, stones or concrete, beginning at the top of the smoke chamber and ending at the flue termination.

Masonry fireplace. A field-constructed fireplace composed of solid masonry units, bricks, stones or concrete, beginning at the hearth and ending at the top of the smoke chamber.

Smoke chamber. That part of a masonry fireplace which extends from the top of the firebox to the start of the chimney flue lining. A smoke chamber shall have a damper and a smoke shelf.

[RP] FIXTURE BRANCH, DRAINAGE. A drain serving two or more fixtures that discharges into another ~~portion of the drainage system~~ drain or to a *stack*.

[RP] FIXTURE BRANCH, WATER-SUPPLY. A water-supply pipe between the fixture supply and a main water-distribution pipe or fixture group main.

[RP] FIXTURE DRAIN. The drain from the trap of a fixture to the junction of that drain with any other drain pipe.

[RP] FIXTURE FITTING.

Supply fitting. A fitting that controls the volume or directional flow or both of water and that is either attached to or accessible from a fixture or is used with an open or atmospheric discharge.

Waste fitting. A combination of components that conveys the sanitary waste from the outlet of a fixture to the connection of the sanitary drainage system.

[RP] FIXTURE GROUP, MAIN. The main water-distribution pipe (or secondary branch) serving a plumbing fixture grouping such as a bath, kitchen or laundry area to which two or more individual fixture branch pipes are connected.

[RP] FIXTURE SUPPLY. The water-supply pipe connecting a fixture or fixture fitting to a ~~fixture branch~~ *branch* water supply pipe or directly to a main water supply pipe branch.

[RP] FIXTURE UNIT, DRAINAGE (d.f.u.). A measure of probable discharge into the drainage system by various types of plumbing fixtures, used to size DWV piping systems. The drainage fixture-unit value for a particular fixture depends on its volume rate of drainage discharge, on the time duration of a single drainage operation and on the average time between successive operations.

[RP] FIXTURE UNIT, WATER-SUPPLY (w.s.f.u.). A measure of the probable hydraulic demand on the water supply by various types of plumbing fixtures used to size water-piping systems. The water-supply fixture-unit value for a particular fixture depends on its volume rate of supply, on the time duration of a single supply operation and on the average time between successive operations.

[RG] FLAME SAFEGUARD. A device that will automatically shut off the fuel supply to a *main burner* or group of *burners* when the means of ignition of such *burners* becomes inoperative, and when flame failure occurs on the *burner* or group of *burners*.

[RG] FLASHBACK ARRESTOR CHECK VALVE. A device that will prevent the backflow of one gas into the supply system of another gas and prevent the passage of flame into the gas supply system.

FLOOD HAZARD AREA. For definition, see Section R322.

[RG] FLOOR FURNACE. A completely self-contained *furnace* suspended from the floor of the space being heated, taking air for combustion from outside such space, and with means for lighting the *appliance* from such space.

> **Fan type.** A floor furnace equipped with a fan that provides the primary means for circulating air.
>
> **Gravity type.** A floor furnace depending primarily upon circulation of air by gravity. This classification shall also include floor furnaces equipped with booster-type fans that do not materially restrict free circulation of air by gravity flow when such fans are not in operation.

[RM] FLUE CONNECTION (BREECHING). A passage for conducting the products of *combustion* from a fuel-fired *appliance* to the vent or *chimney* (see also "*Chimney* connector" and "Vent connector").

FLUE GASES. Products of combustion plus excess air in *appliance* flues or heat exchangers.

[RG] FLUE LINER (LINING). A system or material used to form the inside surface of a flue in a *chimney* or vent, for the purpose of protecting the surrounding structure from the effects of *combustion products* and for conveying *combustion products* without leakage to the atmosphere.

[RP] FLUSH VALVE. A device located at the bottom of a flush tank that is operated to flush water closets.

[RP] FLUSH TANK. A tank designed with a fill valve and flush valve to flush the contents of the bowl or usable portion of the fixture.

[RP] FLUSHOMETER TANK. A device integrated within an air accumulator vessel that is designed to discharge a predetermined quantity of water to fixtures for flushing purposes.

[RP] FLUSHOMETER VALVE. ~~A flushometer valve is a device that discharges a predetermined quantity of water to fixtures for flushing purposes and is actuated by direct water pressure.~~ A valve attached to a pressurized water supply pipe and so designed that when activated it opens the line for direct flow into the fixture at a rate and quantity to operate the fixture properly, and then gradually closes to reseal fixture traps and avoid water hammer.

[RG] FUEL GAS. A natural gas, manufactured gas, *liquefied petroleum gas* or mixtures of these gases.

[RM] FUEL OIL. Kerosene or any hydrocarbon oil having a flash point not less than 100ºF (38ºC).

[RM] FUEL-OIL PIPING SYSTEM. A closed piping system that connects a combustible liquid from a source of supply to a fuel-oil-burning *appliance*.

[RE] FULLY ENCLOSED ATTIC FLOOR SYSTEM. The ceiling insulation is enclosed on all six sides by an air barrier system, such as taped drywall below, solid framing joists on the sides, solid blocking on the ends, and solid sheathing on top which totally enclose the insulation.

[RG] FURNACE, CENTRAL. A self-contained *appliance* for heating air by transfer of heat of *combustion* through metal to the air, and designed to supply heated air through ducts to spaces remote from or adjacent to the *appliance* location.

Downflow furnace. A furnace designed with airflow discharge vertically downward at or near the bottom of the furnace.

Forced air furnace with cooling unit. A single-package unit, consisting of a gas-fired forced-air furnace of one of the types listed below combined with an electrically or fuel gas-powered summer air-conditioning system, contained in a common casing.

Forced-air type. A central furnace equipped with a fan or blower that provides the primary means for circulation of air.

Gravity furnace with booster fan. A furnace equipped with a booster fan that does not materially restrict free circulation of air by gravity flow when the fan is not in operation.

Gravity type. A central furnace depending primarily on circulation of air by gravity.

Horizontal forced-air type. A furnace with airflow through the *appliance* essentially in a horizontal path.

Multiple-position furnace. A furnace designed so that it can be installed with the airflow discharge in the upflow, horizontal or downflow direction.

Upflow furnace. A furnace designed with airflow discharge vertically upward at or near the top of the furnace. This classification includes “highboy” furnaces with the blower mounted below the heating element and “lowboy” furnaces with the blower mounted beside the heating element

[RG] FURNACE, ENCLOSED. A specific heating, or heating and ventilating, furnace incorporating an integral total enclosure and using only outside air for combustion.

[RM] FURNACE ROOM. A room primarily utilized for the installation of fuel-burning, space-heating and water-heating appliances other than boilers.

[RM] FUSIBLE PLUG. A device arranged to relieve pressure by operation of a fusible member at a predetermined temperature.

[RG] GAS CONVENIENCE OUTLET. A permanently mounted, manually operated device that provides the means for connecting an *appliance* to, and disconnecting an *appliance* from, the supply *piping*. The device includes an integral, manually operated valve with a nondisplaceable valve member and is designed so that disconnection of an *appliance* only occurs when the manually operated valve is in the closed position.

[RG] GAS PIPING. An installation of pipe, valves or fittings installed on a premises or in a building and utilized to convey fuel gas.

~~**GUESTROOM.** Any room or rooms used or intended to be used by one or more guests for living or sleeping purposes.~~

~~**GYPSUM BOARD.** The generic name for a family of sheet products consisting of a noncombustible core primarily of gypsum with paper surfacing. Gypsum wallboard, gypsum sheathing, gypsum base for gypsum *veneer* plaster, exterior gypsum soffit board, predecorated gypsum board and water-resistant gypsum backing board complying with the standards listed in Section R702.3 and Part IX of this code are types of gypsum board.~~

~~**GYPSUM PANEL PRODUCT.** The general name for a family of sheet products consisting essentially of gypsum.~~

HAZARDOUS LOCATION, GLAZING. See Section R308.4.

[RM] HEAT TRANSFER LIQUID. The operating or thermal storage liquid in a mechanical system, including water or other liquid base, and additives at the concentration present under operating conditions used to move heat from one location to another. Refrigerants are not included as heat transfer liquids.

HEAT TRAP. An arrangement of piping and fittings, such as elbows, or a commercially available heat trap that prevents thermosyphoning of hot water during standby periods.

HEATED SLAB. Slab-on-grade construction in which the heating elements, hydronic tubing, or hot air distribution system is in contact with, or placed within or under, the slab.

[RE] HERS RATER. An individual that has completed training and been certified by RESNET (Residential Energy Services Network) Accredited Rating Provider and has a current certification.

[RE] HIGH-EFFICACY LAMPS. ~~See Section N1101.6 for definition applicable in Chapter 11.~~ Compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps, or lamps with a minimum efficacy of:

1. 60 lumens per watt for lamps over 40 watts;

2. 50 lumens per watt for lamps over 15 watts to 40 watts; and

3. 40 lumens per watt for lamps 15 watts or less.

HISTORIC BUILDING. ~~Buildings that are listed in or eligible for listing in the National Register of Historic Places, or designated as historic under an appropriate state or local law.~~
Any building or structure that is one or more of the following:

1. Listed, or certified as eligible for listing by the State Historic Preservation Officer or the Keeper of the National Register of Historic Places, in the National Register of Historic Places.
2. Designated as historic or contributing resource under an applicable state or local law.
3. Certified as a contributing resource within a National Register-listed, state designated or locally designated historic district.

[RM] HOOD, FULL OPENING. An exhaust hood with an opening not less than the diameter of the connecting vent.

[RP] HORIZONTAL BRANCH, DRAINAGE. ~~A drain pipe extending laterally from a soil or waste stack or *building drain*, that receives the discharge from one or more *fixture drains*.~~ A drainage *branch* pipe extending laterally from a soil or waste *stack* or *building drain*, with or without vertical sections or *branches*, that receives the discharge from two or more *fixture drains* or *branches* and conducts the discharge to the soil or waste *stack* or to the *building drain*.

HOT WATER. Water at a temperature greater than ~~or equal to~~ 110°F (43°C).

[RG] HOUSE PIPING. See *"Piping system."*

HUMIDISTAT. A regulatory device, actuated by changes in humidity, used for automatic control of relative humidity.

HURRICANE-PRONE REGIONS. Areas vulnerable to hurricanes, defined as the U.S. Atlantic Ocean ~~and Gulf of Mexico~~ coast~~s~~ where the ultimate design wind speed, V_{ult}, is greater than 115 miles per hour (51 m/s)~~, and Hawaii, Puerto Rico, Guam, Virgin Islands and America Samoa~~.

[RG] IGNITION PILOT. A *pilot* that operates during the lighting cycle and discontinues during *main burner* operation.

[RP] INDIRECT WASTE PIPE. A waste pipe that discharges into the drainage system through an *air break* or *air gap* into a trap, fixture or receptor.

[RP] INDIRECT WASTE RECEPTOR. A plumbing fixture designed to collect and dispose of liquid waste from other plumbing fixtures, plumbing equipment or appliances that are required to discharge to the drainage system through an air gap. The following types of fixtures fall within the classification of indirect liquid waste receptors: floor sinks, mop receptors, service sinks and standpipe drains with integral air gaps.

[RP] INDIVIDUAL SEWAGE DISPOSAL SYSTEM. A system for disposal of sewage by means of a septic tank or mechanical treatment, designed for use apart from a public sewer to serve a single establishment or building.

[RP] INDIVIDUAL VENT. A pipe installed to vent a single *fixture* ~~*drain*~~ trap that connects with the vent system above ~~or terminates independently outside the building~~ the fixture served or terminates in the open air.

[RP] INDIVIDUAL WATER SUPPLY. ~~A supply other than an approved public water supply that serves one or more families.~~ A water supply that serves one or more families, and that is not an *approved* public water supply.

[RE] INFILTRATION. The uncontrolled inward air leakage into a building caused by the pressure effects of wind or the effect of differences in the indoor and outdoor air density or both.

[RG] INFRARED RADIANT HEATER. A heater which directs a substantial amount of its energy output in the form of infrared radiant energy into the area to be heated. Such heaters are of either the vented or unvented type.

[RE] INSULATING SHEATHING. An insulating board having a thermal resistance of not less than R-2 of the core material.

~~For definition applicable in Chapter 11, see Section N1101.6.~~

[RM] INTERLOCK. A device actuated by another device with which it is directly associated, to govern succeeding operations of the same or allied devices. A circuit in which a given action cannot occur until after one or more other actions have taken place.

[RP] JOINT.

Expansion. A loop, return bend or return offset that provides for the expansion and contraction in a piping system and is utilized in tall buildings or where there is a rapid change of temperature, as in power plants, steam rooms and similar occupancies.

Flexible. Any joint between two pipes that permits one pipe to be deflected or moved without movement or deflection of the other pipe.

Mechanical. See "Mechanical joint."

Slip. A type of joint made by means of a washer or a special type of packing compound in which one pipe is slipped into the end of an adjacent pipe.

[RM] JOINT, FLANGED. A joint made by bolting together a pair of flanged ends.

[RG] JOINT, FLARED. A metal-to-metal compression joint in which a conical spread is made on the end of a tube that is compressed by a flare nut against a mating flare.

[RG] JOINT, PLASTIC ADHESIVE. A joint made in thermoset plastic *piping* by the use of an adhesive substance which forms a continuous bond between the mating surfaces without dissolving either one of them.

[RM] JOINT, PLASTIC HEAT FUSION. A joint made in thermoplastic piping by heating the parts sufficiently to permit fusion of the materials when the parts are pressed together.

[RM] JOINT, PLASTIC SOLVENT CEMENT. A joint made in thermoplastic piping by the use of a solvent or solvent cement which forms a continuous bond between the mating surfaces.

[RM] JOINT, SOLDERED. A gas-tight joint obtained by the joining of metal parts with metallic mixtures of alloys which melt at temperatures between 400ºF (204ºC) and 1,000ºF (538ºC).

[RM] JOINT, WELDED. A gas-tight joint obtained by the joining of metal parts in molten state.

LABELED. Appliances, ~~E~~e*quipment*, materials or products to which have been affixed a *label*, seal, symbol or other identifying *mark* of a nationally recognized testing laboratory, inspection agency or other organization as approved by the North Carolina Building Code Council concerned with product evaluation that maintains periodic inspection of the production of the above *labeled* items and whose labeling indicates either that the appliance, *equipment*, material or product meets identified standards or has been tested and found suitable for a specified purpose.

LAMP. The device in a lighting fixture that provides illumination, typically a bulb, fluorescent tube, or light emitting diode (LED).

[RP] LAUNDRY TRAY: a fixed tub with running water and drainpipe for washing clothes and other household linens, also called set tub.

[RP] LEAD-FREE PIPE AND FITTINGS. Containing not more than a weighted average of ~~8.0~~ 0.25-percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures.

[RP] LEAD-FREE SOLDER AND FLUX. Containing not more than 0.2-percent lead.

[RP] LEADER. An exterior drainage pipe for conveying storm water from roof or gutter drains to an *approved* means of disposal.

[RG] LEAK CHECK. An operation performed on a gas *piping system* to verify that the system does not leak.

[RG] LIQUEFIED PETROLEUM GAS or LPG (LP-GAS). *Liquefied petroleum gas* composed predominately of propane, propylene, butanes or butylenes, or mixtures thereof that is gaseous under normal atmospheric conditions, but is capable of being liquefied under moderate pressure at normal temperatures.

LISTED. Appliances, e~~E~~*quipment*, materials, products or services included in a list published by an organization acceptable to the code official and concerned with evaluation of products or services that maintains periodic inspection of production of *listed equipment* or materials or periodic evaluation of services and whose listing states either that the appliance, *equipment*, material, product or service meets identified standards or has been tested and found suitable for a specified purpose.

~~**LOCAL EXHAUST.** An exhaust system that uses one or more fans to exhaust air from a specific room or rooms within a dwelling.~~

~~**LODGING HOUSE.** A one-family dwelling where one or more occupants are primarily permanent in nature, and rent is paid for guestrooms.~~

[RG] LOG LIGHTER. A manually operated solid-fuel ignition *appliance* for installation in a vented solid-fuel-burning *fireplace*.

[RM] LOW-PRESSURE HOT-WATER-HEATING BOILER. A boiler furnishing hot water at pressures not exceeding 160 psi (1103 kPa) and at temperatures not exceeding 250ºF (121ºC).

[RM] LOW-PRESSURE STEAM-HEATING BOILER. A boiler furnishing steam at pressures not exceeding 15 psi (103 kPa).

[RE] LOW-VOLTAGE LIGHTING. Lighting equipment powered through a transformer such as a cable conductor, a rail conductor and track lighting.

[RP] MACERATING TOILET SYSTEMS. A system comprised of a sump with macerating pump and with connections for a water closet and other plumbing fixtures, that is designed to accept, grind and pump wastes to an *approved* point of discharge.

[RP] MAIN. The principal pipe artery to which branches may be connected.

[RG] MAIN BURNER. A device or group of devices essentially forming an integral unit for the final conveyance of gas or a mixture of gas and air to the combustion zone, and on which combustion takes place to accomplish the function for which the *appliance* is designed.

[RP] MAIN SEWER. See “Public sewer.”

[RP] MANIFOLD WATER DISTRIBUTION SYSTEMS. A fabricated piping arrangement in which a large supply main is fitted with multiple branches in close proximity in which water is distributed separately to fixtures from each branch.

[RE] MANUAL. Capable of being operated by personal intervention (see “Automatic”).

~~**MANUFACTURED HOME.** *Manufactured home* means a structure, transportable in one or more sections, that in the traveling mode is 8 body feet (2438 body mm) or more in width or 40 body feet (12 192 body mm) or more in length, or, where erected on site, is 320 square feet (30 m^2) or more, and that is built on a permanent chassis and designed to be used as a *dwelling* with or without a permanent foundation where connected to the required utilities, and includes the plumbing, heating, air-conditioning and electrical systems contained therein; except that such term shall include any structure that meets all the requirements of this paragraph except the size requirements and with respect to which the manufacturer voluntarily files a certification required by the secretary (HUD) and complies with the standards established under this title. For mobile homes built prior to June 15, 1976, a *label* certifying compliance to the Standard for Mobile Homes, NFPA 501, in effect at the time of manufacture is required. For the purpose of these provisions, a mobile home shall be considered to be a *manufactured home*.~~

[RM] MECHANICAL JOINT.

1. A connection between pipes, fittings or pipes and fittings that is not welded, brazed, caulked, soldered, solvent cemented or heat-fused.

2. A general form of gas- or liquid-tight connections obtained by the joining of parts through a positive holding mechanical construction such as, but not limited to, flanged, screwed, clamped or flared connections.

METER. The instrument installed to measure the volume of gas delivered through it or a measuring device used to collect data and indicate water usage.

[RG] MODULATING. Modulating or throttling is the action of a *control* from its maximum to minimum position in either predetermined steps or increments of movement as caused by its actuating medium.

~~**NAILABLE SUBSTRATE.** A product or material such as framing, sheathing or furring, composed of wood or wood-based materials, or other materials and fasteners providing equivalent fastener withdrawal resistance.~~

[RM] NATURAL VENTILATION. The movement of air into and out of a space through intentionally provided openings, such as windows and doors, or through nonpowered ventilators

[RM] OCCUPIABLE SPACE. An enclosed space intended for human activities, excluding those spaces intended primarily for other purposes, such as storage rooms and *equipment* rooms, that are only intended to be occupied occasionally and for short periods of time.

[RG] OFFSET (VENT). A combination of *approved* bends that make two changes in direction bringing one section of the vent out of line, but into a line parallel with the other section.

[RE] ON-SITE RENEWABLE ENERGY. Includes solar photovoltaic; active solar thermal that employs collection panels, heat transfer mechanical components; wind; small hydro; tidal; wave energy; geothermal (core earth); biomass energy systems; landfill gas and bio-fuel based electrical production. Onsite energy shall be generated on or adjacent to the project site and shall not be delivered to the project through the utility service.

[RP] OPEN AIR. Outside the structure.

[RM] OUTDOOR AIR. Air taken from the outdoors, and therefore not previously circulated through the system.

[RM] OUTDOOR OPENING. A door, window, louver or skylight openable to the outdoor atmosphere.

[RG] OUTLET. The point at which a gas-fired *appliance* connects to the gas *piping system*.

[RG] OXYGEN DEPLETION SAFETY SHUTOFF SYSTEM (ODS). A system designed to act to shut off the gas supply to the main and *pilot burners* if the oxygen in the surrounding atmosphere is reduced below a predetermined level.

~~**PAN FLASHING.** Corrosion-resistant flashing at the base of an opening that is integrated into the building exterior wall to direct water to the exterior and is premanufactured, fabricated, formed or applied at the job site.~~

[RM] PANEL HEATING. A method of radiant space heating in which heat is supplied by large heated areas of room surfaces. The heating element usually consists of warm water piping, warm air ducts, or electrical resistance elements embedded in or located behind ceiling, wall or floor surfaces.

~~**PERFORMANCE CATEGORY.** A designation of wood structural panels as related to the panel performance used in Chapters 4, 5, 6 and 8.~~

PIER. An elevated deck structure, usually pile supported, extending out into the water from the shore.

[RG] PILOT. A small flame that is utilized to ignite the gas at the *main burner* or *burners*.

[RP] PIPE SIZES. For the purposes of determining the minimum size of pipe required, cross-sectional areas are the essential characteristic, not the pipe diameter. When the Code instructs to “increase by one pipe size,” some pipe sizes may not be commercially available. The following pipe sizes are presumed to be commercially available: 1/2, 3/4, 1, 1-1/4, 1-1/2, 2, 2-1/2, 3, 3-1/2, 4, 4-1/2, 5, 6, 7, 8, 9, 10.

[RM] PIPING. Where used in this code, “piping” refers to either pipe or tubing, or both.

Pipe. A rigid conduit of iron, steel, copper, brass or plastic.

Tubing. Semirigid conduit of copper, aluminum, plastic or steel

[RG]PIPING. Where used in this code, *“piping”* refers to either *pipe* or *tubing*, or both.

Pipe. A rigid conduit of iron, steel, copper, brass or plastic.

Tubing. Semirigid conduit of copper, aluminum, plastic or steel.

[RG] PIPING SYSTEM. All fuel *piping,* valves and fittings from the outlet of the *point of delivery* to the outlets of the *appliance* shutoff valves.

PLANS. Construction documents.

[RG] PLASTIC, THERMOPLASTIC. A plastic that is capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature.

~~**PLENUM.** A chamber that forms part of an air-circulation system other than the *occupied space* being conditioned.~~

[RM] PLENUM. An enclosed portion of the building structure, other than an *occupiable space* being conditioned, that is designed to allow air movement, and thereby serve as part of an air distribution system.

[RP] PLUMBING. The practice, materials and fixtures utilized in the installation, maintenance, extension and alteration of all piping, fixtures, plumbing appliances and plumbing appurtenances, within or adjacent to any structure, in connection with sanitary drainage or storm drainage facilities; venting systems; and public or private water supply systems. For the purpose of this code, plumbing refers to those installations, repairs, maintenance and *alterations* regulated by Chapters 25 through 33.

[RP] PLUMBING APPLIANCE. An energized household *appliance* with plumbing connections, such as a dishwasher, food waste disposer, clothes washer or water heater. Water or drain-connected devices intended to perform a special function. These devices have their operation or control dependent on one or more energized components, such as motors, controls or heating elements. Such devices are manually adjusted or controlled by the owner or operator, or are operated automatically through one or more of the following actions: a time cycle, a temperature range, a pressure range, a measured volume or weight.

[RP] PLUMBING APPURTENANCE. ~~A device or assembly that is an adjunct to the basic plumbing system and does not demand additional water supply or add any discharge load to the system. It is presumed that it performs some useful function in the operation, maintenance, servicing, economy or safety of the plumbing system.~~ A manufactured device, prefabricated assembly or on-the-job assembly of component parts that is an adjunct to the basic piping system and plumbing fixtures. An appurtenance demands no additional water supply and does not add any discharge load to a fixture or to the drainage system. Examples include filters, relief valves and aerators.

[RP] PLUMBING FIXTURE. ~~A receptacle or device that is connected to a water supply system or discharges to a drainage system or both. Such receptacles or devices require a supply of water; or discharge liquid waste or liquid-borne solid waste; or require a supply of water and discharge waste to a drainage system.~~ A receptacle or device that is either permanently or temporarily connected to the water distribution system of the premises and demands a supply of water therefrom; or discharges wastewater, liquid-borne waste materials or sewage either directly or indirectly to a drainage system of the premises; or requires both a water supply connection and a discharge to the drainage system of the premises.

[RP] PLUMBING SYSTEMS. Includes the water distribution pipes; plumbing fixtures and traps; water-treating or water-using *equipment*; soil, waste and vent pipes; and building drains; in addition to their respective connections, devices and appurtenances within a structure or premises; and the water service, building sewer and building storm sewer serving such structure or premises.

[RG] POINT OF DELIVERY. For natural gas systems, the *point of delivery* is the outlet of the service meter assembly or the outlet of the service regulator or service shutoff valve where a meter is not provided. Where a valve is provided at the outlet of the service meter assembly, such valve shall be considered to be downstream of the *point of delivery*. For undiluted liquefied petroleum gas systems, the point of delivery shall be considered to be the outlet of the first regulator that reduces pressure.

POLLUTION. An ~~low-hazard or non-health hazard~~ impairment of the quality of the potable water to a degree that does not create a hazard to the public health but [and] that does adversely and unreasonably affect the aesthetic qualities of such potable water for domestic use.

[RP] POTABLE WATER. Water free from impurities present in amounts sufficient to cause disease or harmful physiological effects and conforming in bacteriological and chemical quality of the Public Health Service Drinking Water Standards or to the ~~requirements~~ regulations of the public health authority having jurisdiction.

[RM] PRESS JOINT. A permanent mechanical joint incorporating an elastomeric seal or an elastomeric seal and corrosion-resistant grip ring. The joint is made with a pressing tool and jaw or ring approved by the fitting manufacturer.

[RG] PRESSURE DROP. The loss in pressure due to friction or obstruction in pipes, valves, fittings, *regulators* and *burners*.

[RM] PRESSURE RELIEF DEVICE. A pressure-actuated valve or rupture member designed to relieve excessive pressure automatically.

[RG] PRESSURE TEST. An operation performed to verify the gas-tight integrity of *gas piping* following its installation or modification.

[RE] PROPOSED DESIGN. A description of the proposed building used to estimate annual energy use for determining compliance based on total building performance.

[RM] PROTECTIVE ASSEMBLY (REDUCED CLEARANCE). Any noncombustible assembly that is *labeled* or constructed in accordance with Table M1306.2 and is placed between combustible materials or assemblies and mechanical appliances, devices or *equipment*, for the purpose of reducing required airspace clearances. Protective assemblies attached directly to a combustible assembly shall not be considered as part of that combustible assembly.

[RP] PUBLIC SEWER. A common sewer directly controlled by public authority.

[RP] PUBLIC WATER MAIN. A water-supply pipe for public use controlled by public authority.

[RM] PUSH-FIT JOINTS. A type of mechanical joint consisting of elastomeric seals and corrosion-resistant tube grippers. Such joints are permanent or removable depending on the design.

[RP] QUICK-CLOSING VALVE. A valve or faucet that closes automatically where released manually or controlled by mechanical means for fast-action closing.

[RM] RADIANT HEATER. A heater designed to transfer heat primarily by direct radiation.

[RP] RAINWATER. Water from natural precipitation.

READY ACCESS (TO). That which enables a device, *appliance* or *equipment* to be directly reached, without requiring the removal or movement of any panel, door or similar obstruction [see “Access (to)”].

[RM] RECIRCULATED AIR. Air removed from a conditioned space and intended for reuse as supply air.

[RP] REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTION ASSEMBLY. A backflow prevention device consisting of two independently acting check valves, internally force-loaded to a normally closed position and separated by an intermediate chamber (or zone) in which there is an automatic relief means of venting to the atmosphere, internally loaded to a normally open position between two tightly closing shutoff valves and with a means for testing for tightness of the checks and opening of the relief means.

REGISTERED DESIGN PROFESSIONAL. An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or *jurisdiction* in which the project is to be constructed. Design by a registered design professional is not required where exempt under the registration or licensure laws.

[RG] REGULATOR. A device for controlling and maintaining a uniform gas supply pressure, either pounds-to-inches water column (MP regulator) or inches-to-inches water column (*appliance regulator*).

[RG] REGULATOR, GAS APPLIANCE. A *pressure regulator* for controlling pressure to the manifold of the gas *appliance*.

Adjustable.

1. Spring type, limited adjustment. A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is adjustable over a range of not more than 15 percent of the outlet pressure at the midpoint of the adjustment range.

2. Spring type, standard adjustment. A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is adjustable. The adjustment means shall be concealed.

Multistage. A regulator for use with a single gas whose adjustment means is capable of being positioned manually or automatically to two or more predetermined outlet pressure settings. Each of these settings shall be adjustable or nonadjustable. The regulator may modulate outlet pressures automatically between its maximum and minimum predetermined outlet pressure settings.

Nonadjustable.

1. Spring type, nonadjustable. A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is not field adjustable.

2. Weight type. A regulator in which the regulating force acting upon the diaphragm is derived from a weight or combination of weights.

[RG] REGULATOR, LINE GAS PRESSURE. A device placed in a gas line between the *service pressure regulator* and the *appliance* for controlling, maintaining or reducing the pressure in that portion of the *piping system* downstream of the device.

[RG] REGULATOR, MEDIUM-PRESSURE (MP Regulator). A line *pressure regulator* that reduces gas pressure from the range of greater than 0.5 psig (3.4 kPa) and less than or equal to 5 psig (34.5 kPa) to a lower pressure.

[RG] REGULATOR, PRESSURE. A device placed in a gas line for reducing, controlling and maintaining the pressure in that portion of the *piping system* downstream of the device.

[RG] REGULATOR, SERVICE PRESSURE. For natural gas systems, a device installed by the serving gas supplier to reduce and limit the service line pressure to delivery pressure. For undiluted liquefied petroleum gas systems, the regulator located upstream from all line gas pressure regulators, where installed, and downstream from any first stage or a high pressure regulator in the system.

[RG] RELIEF OPENING. The opening provided in a *draft hood* to permit the ready escape to the atmosphere of the flue products from the *draft hood* in the event of no *draft*, backdraft or stoppage beyond the *draft hood*, and to permit air into the *draft hood* in the event of a strong chimney updraft.

[RG] RELIEF VALVE (DEVICE). A safety valve designed to forestall the development of a dangerous condition by relieving either pressure, temperature or vacuum in the hot water supply system.

RELIEF VALVE, PRESSURE.
An *automatic valve* that opens and closes a relief vent, depending on whether the pressure is above or below a predetermined value.

RELIEF VALVE, TEMPERATURE.

> **Manual reset type.** A valve that automatically opens a *relief* vent at a predetermined temperature and that must be manually returned to the closed position.
>
> **Reseating or self-closing type.** An *automatic valve* that opens and closes a relief vent, depending on whether the temperature is above or below a predetermined value.

[RP] RELIEF VENT. A vent whose primary function is to provide circulation of air between drainage and vent systems.

REPAIR. The restoration ~~reconstruction~~ or renewal of any part of an existing building for the purpose of its maintenance or to correct damage.

~~For definition applicable in Chapter 11, see Section N1101.6.~~

REROOFING. The process of recovering or replacing an existing roof covering. See “Roof recover.”

~~For definition applicable in Chapter 11, see Section N1101.6.~~

[RM] RETURN AIR SYSTEM. An assembly of connected ducts, plenums, fittings, registers and grilles through which air from the space or spaces to be heated or cooled is conducted back to the supply unit (see also “Supply air system”).

[RP] RIM. An unobstructed open edge of a fixture.

RISER.

1. The vertical component of a step or stair.
2. A water pipe that extends vertically one full *story* or more to convey water to branches or to a group of fixtures.

[RG] RISER, GAS. A vertical *pipe* supplying fuel gas.

ROOF RECOVER. The process of installing an additional roof covering over a prepared existing roof covering without removing the existing roof covering.

~~For definition applicable in Chapter 11, see Section N1101.6.~~

ROOF REPAIR. Reconstruction or renewal of any part of an existing roof for the purposes of its maintenance.

~~For definition applicable in Chapter 11, see Section N1101.6.~~

~~**ROOM HEATER.** A freestanding heating *appliance* installed in the space being heated and not connected to ducts.~~

[RG] ROOM HEATER, UNVENTED. An unvented heating *appliance* designed for stationary installation and utilized to provide comfort heating. Such *appliances* provide radiant heat or convection heat by gravity or fan circulation directly from the heater and do not utilize ducts.

[RG] ROOM HEATER, VENTED. A free-standing heating unit used for direct heating of the space in and adjacent to that in which the unit is located.

[RE} R-VALUE (THERMAL RESISTANCE). The inverse of the time rate of heat flow through a body from one of its bounding surfaces to the other surface for a unit temperature difference between the two surfaces, under steady state conditions, per unit area ($h \cdot \text{ft}^2 \cdot {}^\circ\text{F/Btu})[(\text{m}^2 \cdot \text{K})/\text{W}]$.

[RG] SAFETY SHUTOFF DEVICE. See *Flame safeguard.*

[RP] SANITARY SEWER. A sewer that carries sewage and excludes storm, surface and groundwater.

SCREEN ENCLOSURE. A building or part thereof, in whole or in part self-supporting, and having walls of insect screening with or without removable vinyl or acrylic wind break panels 10 mil or less with a Class A Flame Spread, and a roof.

SCREW LAMP HOLDERS. A lamp base that requires a screw-in-type lamp, such as a compact-fluorescent, incandescent, or tungsten-halogen bulb.

[RP] SELF-CLOSING FAUCET. A faucet containing a valve that automatically closes upon deactivation of the opening means.

[RM] SELF-CONTAINED EQUIPMENT. Complete, factory assembled and tested, heating, air-conditioning or refrigeration *equipment* installed as a single unit, and having all working parts, complete with motive power, in an enclosed unit of said machinery.

SEMI-CONDITIONED SPACE. A space within the building thermal envelope that is not directly heated and/or cooled.

SERVICE WATER HEATING. Supply of hot water for purposes other than comfort heating.

[RP] SEWAGE. Any liquid waste containing animal matter, vegetable matter or other impurity in suspension or solution. Any liquid waste containing animal or vegetable matter in suspension or solution, including liquids containing chemicals in solution.

[RP] SEWAGE EJECTOR. A device for lifting sewage by entraining the sewage in a high-velocity jet of steam, air or water.

[RP]SEWAGE PUMP. A permanently installed mechanical device for removing sewage or liquid waste from a sump.

[RP] SEWER.

Building sewer. See “Building sewer.”

Public sewer. That part of the drainage system of pipes, installed and maintained by a city, township, county, public utility company or other public entity, and located on public property, in the street or in an approved dedicated easement of public or community use.

Sanitary sewer. A *sewer* that carries sewage and excludes storm, surface and ground water.

Storm sewer. A *sewer* that conveys rainwater, surface water, subsurface water and similar liquid wastes.

SHAFT. An enclosed space extending through one or more stories of a building, connecting vertical openings in successive floors, or floors and the roof.

SHAFT ENCLOSURE. The walls or construction forming the boundaries of a shaft.

SIDE VENT. A vent connecting to the drain pipe through a fitting at an angle less than 45 degrees (0.79 rad) to the horizontal.

[RE] SITE-RECOVERED ENERGY. Waste energy recovered at the building site that is used to off-set consumption of purchased fuel or electrical energy supplies.

[RE] SKYLIGHT. ~~See Section N1101.6 for definition applicable in Chapter 11.~~ Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal. Glazing material in skylights, including unit skylights, solariums, sunrooms, roofs and sloped walls is included in this definition.

SLEEPING ROOM. A room designated as sleeping or bedroom on the plans and permit application.

~~**[RE] SLEEPING UNIT.** See Section N1101.6 for definition applicable in Chapter 11.~~

[RP] SOIL STACK OR PIPE. A pipe that conveys sewage containing fecal material to the *building drain* or *building sewer*.

[RE] SOLAR ENERGY SOURCE. Source of thermal, chemical, or electrical energy derived from direct conversion of incident solar radiation at the building site.

[RE] SOLAR HEAT GAIN COEFFICIENT (SHGC). ~~The solar heat gain through a fenestration or glazing assembly relative to the incident solar radiation (Btu/h • ft^2 • °F).~~ The ratio of the solar heat gain entering the space through the fenestration assembly to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation which is then reradiated, conducted or convected into the space. This value is related to the Shading Coefficient (SC) by the formula SHGC = 0.87 x SC.

[RG] SPECIFIC GRAVITY. As applied to gas, *specific gravity* is the ratio of the weight of a given volume to that of the same volume of air, both measured under the same condition.

[RP] SPILLPROOF VACUUM BREAKER. An assembly consisting of one check valve force-loaded closed and an air-inlet vent valve force-loaded open to atmosphere, positioned downstream of the check valve, and located between and including two tightly closing shutoff valves and a test cock.

[RP] STACK. ~~Any main vertical DWV line, including offsets, that extends one or more stories~~ A general term for any vertical line of soil, waste, vent or inside conductor piping that extends through at least one story with or without offsets as directly as possible to its vent terminal.

[RP] STACK VENT. The extension of soil or waste stack above the highest horizontal drain connected to the *stack*.

[RP] STACK VENTING. A method of venting a fixture or fixtures through the soil or waste *stack*.

~~**STAIRWAY, SPIRAL.** A stairway with a plan view of closed circular form and uniform section-shaped treads radiating from a minimum-diameter circle.~~

[RE] STANDARD REFERENCE DESIGN. A version of the *proposed design* that meets the minimum requirements of this code and is used to determine the maximum annual energy use requirement for compliance based on total building performance.

[RM] STEAM-HEATING BOILER. A boiler operated at pressures not exceeding 15 psi (103 kPa) for steam.

STORY. That portion of a building included between the upper surface of a floor and the upper surface of the floor or roof next above. A flood resistant enclosure, designed to break away so as not to cause collapse, shall not be considered as a story when determining height.

STORY, ATTIC. Any story situated wholly or partly in the roof, so designated, arranged or built as to be used for storage or habitation. If an attic which is accessible by a fixed stairway has a 7 foot clear height for greater than 50 percent of the floor area of the story below, then the space shall be considered as a story.

STORY ABOVE GRADE PLANE. ~~Any *story* having its finished floor surface entirely above *grade plane*, or in which the finished surface of the floor next above is either of the following:~~

1. ~~More than 6 feet (1829 mm) *above grade plane*.~~
2. ~~More than 12 feet (3658 mm) above the finished ground level at any point.~~

Any *story* having its finished floor surface entirely above *grade plane*, except that a *basement* shall be considered as a *story above grade plane* where the finished surface of the floor above the *basement* meets any one of the following:

1. Is more than 6 feet (1829 mm) *above grade plane*.
2. Is more than 6 feet (1829 mm) above the finished ground level for more than 50 percent of the total building perimeter.
3. Is more than 12 feet (3658 mm) above the finished ground level at any point.

~~**STRUCTURE.** That which is built or constructed.~~

SUMP PUMP. ~~A pump installed to empty a sump. These pumps are used for removing storm water only.~~ An automatic water pump powered by an electric motor for the removal of drainage, except raw sewage, from a sump, pit or low point. The pump is selected for the specific head and volume of the load and is usually operated by level controllers.

[RP] SUMP VENT. A vent from pneumatic sewage ejectors, or similar equipment, that terminates separately to the open air.

SUNROOM. A one-story structure attached to a *dwelling* with a *glazing area* in excess of 40 percent of the gross area of the structure's *exterior walls* and roof.

~~For definition applicable in Chapter 11, see Section N1101.6.~~

~~**SUPPLY AIR.** Air delivered to a *conditioned space* through ducts or plenums from the heat exchanger of a heating, cooling or ventilating system.~~

[RM] SUPPLY AIR. That air delivered to each or any space supplied by the air distribution system or the total air delivered to all spaces supplied by the air distribution system, which is provided for ventilating, heating, cooling, humidification, dehumidification and other similar purposes.

[RM] SUPPLY AIR SYSTEM. An assembly of connected ducts, plenums, fittings, registers and grilles through which air, heated or cooled, is conducted from the supply unit to the space or spaces to be heated or cooled (see also "Return air system").

[RP] SWEEP. A cast iron drainage fitting designed to provide a change in direction of a drain pipe of less than the angle specified by the amount necessary to establish the desired slope of the line. Sweeps provide a longer turning radius than bends and a less turbulent flow pattern (see “Bend” and “Elbow”).

[RP] TEMPERED WATER. Water having a temperature range between 85°F (29°C) and 110°F (43°C).

THERMAL ISOLATION. Physical and space conditioning separation from *conditioned space(s)* consisting of existing or new walls, doors or windows. The *conditioned space(s)* shall be controlled as separate zones for heating and cooling or conditioned by separate *equipment*.

~~For definition applicable in Chapter 11, see Section N1101.6.~~

[RG] THERMOSTAT.

Electric switch type. A device that senses changes in temperature and controls electrically, by means of separate components, the flow of gas to the *burner(s)* to maintain selected temperatures.

Integral gas valve type. An automatic device, actuated by temperature changes, designed to control the gas supply to the *burner(s)* in order to maintain temperatures between predetermined limits, and in which the thermal actuating element is an integral part of the device.

1. Graduating thermostat. A thermostat in which the motion of the *valve* is approximately in direct proportion to the effective motion of the thermal element induced by temperature change.

2. Snap-acting thermostat. A thermostat in which the thermostatic valve travels instantly from the closed to the open position, and vice versa.

TOILET ROOM. A room containing a water closet and, frequently, a lavatory, but not a bathtub, shower, spa or similar bathing fixture.

TOWNHOUSE. A single-family *dwelling unit* constructed in a group of three or more attached units separated by property lines in which each unit extends from foundation to roof and with a *yard* or public way on not less than two sides.

[RG] TRANSITION FITTINGS, PLASTIC TO STEEL. An adapter for joining plastic *pipe* to steel *pipe*. The purpose of this fitting is to provide a permanent, pressure-tight connection between two materials that cannot be joined directly one to another.

[RE] U-FACTOR, THERMAL TRANSMITTANCE. ~~See Section N1101.6 for definition applicable in Chapter 11.~~ The coefficient of heat transmission (air to air) through a building component or assembly, equal to the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films (Btu/h·ft^2·°F)[W/(m^2·K)].

[RG] UNIT HEATER.

High-static pressure type. A self-contained, automatically controlled, vented *appliance* having integral means for circulation of air against 0.2 inch w.c. (50 Pa) or greater static pressure. Such *appliance* is equipped with provisions for attaching an outlet air duct and, where the *appliance* is for indoor installation remote from the space to be heated, is also equipped with provisions for attaching an inlet air duct.

Low-static pressure type. A self-contained, automatically controlled, vented *appliance*, intended for installation in the space to be heated without the use of ducts, having integral means for circulation of air. Such units are allowed to be equipped with louvers or face extensions made in accordance with the manufacturer's specifications.

[RM] UNIT HEATER. A self-contained *appliance* of the fan type, designed for the delivery of warm air directly into the space in which the *appliance* is located.

[RP] VACUUM. Any pressure less than that exerted by the atmosphere.

[RG] VALVE. A device used in *piping* to control the gas supply to any section of a system of *piping* or to an *appliance*.

Appliance shutoff. A *valve* located in the *piping system*, used to isolate individual *appliances* for purposes such as service or replacement.

Automatic. An automatic or semiautomatic device consisting essentially of a *valve* and an operator that control the gas supply to the *burner(s)* during operation of an *appliance*. The operator shall be actuated by application of gas pressure on a flexible diaphragm, by electrical means, by mechanical means or by other *approved* means.

Automatic gas shutoff. A *valve* used in conjunction with an automatic gas shutoff device to shut off the gas supply to a water-heating system. It shall be constructed integrally with the gas shutoff device or shall be a separate assembly.

Individual main burner. A *valve* that controls the gas supply to an individual *main burner*.

Main burner control. A *valve* that controls the gas supply to the *main burner* manifold.

Manual main gas-control. A manually operated *valve* in the gas line for the purpose of completely turning on or shutting off the gas supply to the *appliance*, except to *pilot* or pilots that are provided with independent shutoff.

Manual reset. An automatic shutoff valve installed in the gas supply *piping* and set to shut off when unsafe conditions occur. The device remains closed until manually reopened.
Service shutoff. A valve, installed by the serving gas supplier between the service meter or source of supply and the customer *piping system,* to shut off the entire *piping system.*

[RG] VENT. ~~A passageway for conveying flue gases from fuel-fired *appliances*, or their vent connectors, to the outside atmosphere.~~A *pipe* or other conduit composed of factory-made components, containing a passageway for conveying *combustion products* and air to the atmosphere, listed and labeled for use with a specific type or class of *appliance*.

Special gas vent. A vent listed and labeled for use with listed Category II, III and IV gas *appliances*.

Type B vent. A vent listed and labeled for use with *appliances* with *draft hoods* and other Category I *appliances* that are listed for use with Type B vents.

Type BW vent. A vent listed and labeled for use with wall *furnaces*.

Type L vent. A vent listed and labeled for use with *appliances* that are listed for use with Type L or Type B vents.

[RP] VENT PIPE. See *Vent system*.

[RG] VENT PIPING.

Breather. *Piping* run from a pressure-regulating device to the outdoors, designed to provide a reference to *atmospheric pressure*. If the device incorporates an integral pressure *relief* mechanism, a breather vent can also serve as a *relief* vent.

Relief. *Piping* run from a pressure-regulating or pressure-limiting device to the outdoors, designed to provide for the safe venting of gas in the event of excessive pressure in the *gas piping system*.

[RP] VENT SYSTEM. ~~Piping installed to equalize pneumatic pressure in a drainage system to prevent trap seal loss or blow-back due to siphonage or back pressure.~~ A pipe or pipes installed to provide a flow of air to or from a plumbing drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and backpressure.

[RG] VENTED APPLIANCE CATEGORIES. *Appliances* that are categorized for the purpose of vent selection are classified into the following four categories:

Category I. An *appliance* that operates with a nonpositive vent static pressure and with a vent gas temperature that avoids excessive *condensate* production in the vent.

Category II. An *appliance* that operates with a nonpositive *vent* static pressure and with a vent gas temperature that is capable of causing excessive *condensate* production in the vent.

Category III. An *appliance* that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive *condensate* production in the vent.

Category IV. An *appliance* that operates with a positive vent static pressure and with a vent gas temperature that is capable of causing excessive *condensate* production in the vent.

[RG] VENTED WALL FURNACE. A self-contained vented *appliance* complete with grilles or equivalent, designed for incorporation in or permanent attachment to the structure of a building, mobile home or travel trailer, and furnishing heated air circulated by gravity or by a fan directly into the space to be heated through openings in the casing. This definition shall exclude *floor furnaces, unit heaters* and *central furnaces* as herein defined.

VENTILATION. The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space.

~~For definition applicable in Chapter 11, see Section N1101.6.~~

[RM] VENTILATION AIR. That portion of supply air that comes from the outside (outdoors), plus any recirculated air that has been treated to maintain the desired quality of air within a designated space.

VENTING. Removal of combustion products to the outdoors.

[RG] VENTING SYSTEM. A continuous open passageway from the flue collar of an *appliance* to the outside atmosphere for the purpose of removing flue or vent gases. A venting system is usually composed of a vent or a chimney and vent connector, if used, assembled to form the open passageway.

Forced-draft venting system. A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under positive static vent pressure.

Induced draft venting system. A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under nonpositive static vent pressure.

Mechanical draft venting system. A venting system designed to remove flue or vent gases by mechanical means, that consists of an induced draft portion under nonpositive static pressure or a forced draft portion under positive static pressure.

Natural draft venting system. A venting system designed to remove flue or vent gases under nonpositive static vent pressure entirely by natural draft.

[RE] VERTICAL FENESTRATION. Windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of a least 60 degrees (1.05 rad) from horizontal.

[RE] VISIBLE TRANSMITTANCE [VT]. The ratio of visible light entering the space through the fenestration product assembly to the incident visible light, Visible Transmittance, includes the effects of glazing material and frame and is expressed as a number between 0 and 1.

WALL, ABOVE-GRADE. A wall more than 50 percent above grade and enclosing *conditioned space*. This includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.

WALL, CRAWLSPACE. The opaque portion of a wall that encloses a crawl space and is partially or totally below grade.

[RG] WALL HEATER, UNVENTED TYPE. A room heater of the type designed for insertion in or attachment to a wall or partition. Such heater does not incorporate concealed venting arrangements in its construction and discharges all products of *combustion* through the front into the room being heated.

[RG] WATER HEATER. Any heating *appliance* or *equipment* that heats potable water and supplies such water to the potable hot water distribution system.

WALL VENTED CRAWL SPACE. A foundation that uses foundation wall vents as a primary means to control space moisture. Insulation is located at the floor level.

[RP] WASTE. Liquid-borne waste ~~that is free of~~ does not contain fecal matter.

[RP] WATER-HAMMER ARRESTOR. A device utilized to absorb the pressure surge (water hammer) that occurs when water flow is suddenly stopped in a water supply system.

[RP] WATER MAIN. ~~A water supply pipe for public use.~~ A water supply pipe or system of pipes, installed and maintained by a city, township, county, public utility company or other public entity, on public property, in the street or in an approved dedicated easement of public or community use.

[RP] WATER OUTLET. ~~A valved discharge opening, including a hose bibb, through which water is removed from the potable water system supplying water to a plumbing fixture or plumbing *appliance* that requires either an *air gap* or backflow prevention device for protection of the supply system.~~ A discharge opening through which water is supplied to a fixture, into the atmosphere, such as a hose bibb, (except into an open tank that is part of the water supply system), to a boiler or heating system, or to any devices or equipment requiring water to operate but which are not part of the plumbing system.

[RP] WATER PIPE.

Riser. A water supply pipe that extends one full story or more to convey water to *branches* or to a group of fixtures.

Water distribution pipe. A pipe within the structure or on the premises that conveys water from the water service pipe, or from the meter when the meter is at the structure, to the points of utilization.

Water service pipe. The pipe from the water main or other source of potable water supply, or from the meter when the meter is at the public right of way, to the water distribution system of the building served. Water service pipe shall terminate 5 feet (1524 mm) outside the foundation wall.

~~**WATER SERVICE PIPE.** The outside pipe from the water main or other source of potable water supply to the water distribution system inside the building, terminating at the service valve.~~

WATERPROOFING. A coating or the application of coatings applied to prevent the penetration of water through or into walls or into interior spaces.

[RP] WEIGHTED AVERAGE LEAD CONTENT. The weighted average lead content of a pipe, pipe fitting, plumbing fitting, or fixture shall be calculated by using the following formula: For each wetted component, the percentage of lead in the component shall be multiplied by the ratio of the wetted surface area of that component to the total wetted surface area of the entire product to arrive at the weighted percentage of lead of the component. The weighted percentage of lead of each wetted component shall be added together, and the sum of these wetted percentages shall constitute the weighted average lead content of the product. For lead content of materials that are provided as a range, the maximum content of the range shall be used.

[RP] WHIRLPOOL BATHTUB. A plumbing appliance consisting of a bathtub fixture that is equipped and fitted with a circulating piping system designed to accept, circulate and discharge bathtub water upon each use.

WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM. An exhaust system, supply system, or combination thereof that is designed to mechanically exchange indoor air for outdoor air where operating continuously or through a programmed intermittent schedule to satisfy the whole-house ventilation rate.

~~For definition applicable in Chapter 11, see Section N1101.6.~~

WINDOW. See *Fenestration*.

WINDBORNE DEBRIS REGION. ~~Areas within *hurricane-prone regions* located in accordance with one of the following:~~

1. ~~Within 1 mile (1.61 km) of the coastal mean high water line where the ultimate design wind speed, V_{ult}, is 130 mph (58 m/s) or greater.~~

2. ~~In areas where the ultimate design wind speed, V_{ult}, is 140 mph (63.6 m/s) or greater; or Hawaii.~~

Areas within hurricane prone regions defined as that area east of the Intracoastal waterway from the NC/SC state line north to Beaufort Inlet and from that point to include the barrier islands to the NC/VA state line.

[RP] YARD HYDRANT A freeze proof yard hydrant is an outdoor water supply outlet that has a valve and outlet above ground and a drain opening below the frost level.

ZONE. A space or group of spaces within a building with heating or cooling requirements that are sufficiently similar so that desired conditions can be maintained throughout using a single controlling device.

Part III—Building Planning and Construction

CHAPTER 3
BUILDING PLANNING

SECTION R301
DESIGN CRITERIA

R301.1.1 Alternative provisions.
As an alternative to the requirements in Section R301.1, the following standards are permitted subject to the limitations of this code and the limitations therein. Where engineered design is used in conjunction with these standards, the design shall comply with the *International Building Code*.

1. AF&PA *Wood Frame Construction Manual* (WFCM).
2. AISI *Standard for Cold-Formed Steel Framing—Prescriptive Method for One- and Two-Family Dwellings* (AISI S230).
3. ICC *Standard on the Design and Construction of Log Structures* (ICC 400).
4. *Sunrooms* complying with AAMA/NPEA/NSA 2100.

TABLE R301.2(1)
CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA

GROUND SNOW LOAD	WIND DESIGN				SEISMIC DESIGN CATEGORY[f]	SUBJECT TO DAMAGE FROM			WINTER DESIGN TEMP[e]	ICE BARRIER UNDERLAYMENT REQUIRED[h]	FLOOD HAZARDS[g]	AIR FREEZING INDEX[i]	MEAN ANNUAL TEMP[j]
	Speed[d] (mph)	Topographic effects[k]	Special wind region[l]	Wind-borne debris zone[m]		Weathering[a]	Frost line depth[b]	Termite[c]					

~~For SI: 1 pound per square foot = 0.0479 kPa, 1 mile per hour = 0.447 m/s.~~

~~a. Weathering may require a higher strength concrete or *grade* of masonry than necessary to satisfy the structural requirements of this code. The weathering column shall be filled in with the weathering index, "negligible," "moderate" or "severe" for concrete as determined from Figure R301.2(3). The *grade* of masonry units shall be determined from ASTM C 34, C 55, C 62, C 73, C 90, C 129, C 145, C 216 or C 652.~~

~~b. The frost line depth may require deeper footings than indicated in Figure R403.1(1). The *jurisdiction* shall fill in the frost line depth column with the minimum depth of footing below finish *grade*.~~

~~c. The *jurisdiction* shall fill in this part of the table to indicate the need for protection depending on whether there has been a history of local subterranean termite damage.~~

~~d. The *jurisdiction* shall fill in this part of the table with the wind speed from the basic wind speed map [Figure R301.2(4)A]. Wind exposure category shall be determined on a site-specific basis in accordance with Section R301.2.1.4.~~

~~e. The outdoor design dry-bulb temperature shall be selected from the columns of 97 $\frac{1}{2}$ -percent values for winter from Appendix D of the *International Plumbing Code*. Deviations from the Appendix D temperatures shall be permitted to reflect local climates or local weather experience as determined by the *building official*.~~

~~f. The *jurisdiction* shall fill in this part of the table with the seismic design category determined from Section R301.2.2.1.~~

~~g. The *jurisdiction* shall fill in this part of the table with (a) the date of the *jurisdiction's* entry into the National Flood Insurance Program (date of adoption of the first code or ordinance for management of flood hazard areas), (b) the date(s) of the Flood Insurance Study and (c) the panel numbers and dates of the currently effective FIRMs and FBFMs or other flood hazard map adopted by the authority having *jurisdiction*, as amended.~~

~~h. In accordance with Sections R905.1.2, R905.4.3.1, R905.5.3.1, R905.6.3.1, R905.7.3.1 and R905.8.3.1, where there has been a history of local damage from the effects of ice damming, the *jurisdiction* shall fill in this part of the table with "YES." Otherwise, the *jurisdiction* shall fill in this part of the table with "NO."~~

~~i. The *jurisdiction* shall fill in this part of the table with the 100-year return period air freezing index (BF-days) from Figure R403.3(2) or from the 100-year (99 percent) value on the National Climatic Data Center data table "Air Freezing Index-USA Method (Base 32°F)."~~

~~j. The *jurisdiction* shall fill in this part of the table with the mean annual temperature from the National Climatic Data Center data table "Air Freezing Index-USA Method (Base 32°F)."~~

~~k. In accordance with Section R301.2.1.5, where there is local historical data documenting structural damage to buildings due to topographic wind speed-up effects, the *jurisdiction* shall fill in this part of the table with "YES." Otherwise, the *jurisdiction* shall indicate "NO" in this part of the table.~~

~~l. In accordance with Figure R301.2(4)A, where there is local historical data documenting unusual wind conditions, the *jurisdiction* shall fill in this part of the table with "YES" and identify any specific requirements. Otherwise, the *jurisdiction* shall indicate "NO" in this part of the table.~~

~~m. In accordance with Section R301.2.1.2.1, the *jurisdiction* shall indicate the wind-borne debris wind zone(s). Otherwise, the *jurisdiction* shall indicate "NO" in this part of the table.~~

ROOF LOAD (psf)	WIND SPEED (mph)	SEISMIC DESIGN CATEGORY	SUBJECT TO DAMAGE FROM			WINTER DEISGN TEMP	ICE BARRIER UNLDERLAYMENT REQUIRED	FLOOD HAZARD[b]	AIR FREEZING INDEX	MEAN ANNUAL TEMP
			Weathering[a]	Frost Line Depth	Termite[c]					
20	Tables R301.2(4)&(5)	Table R301.2(7)	Moderate	12 inches	Moderate- Heavy	Local	Local	Local	Local	Local

For SI: 1 pound per square foot = 0.0479 kPa, 1 mile per hour = 0.447 m/s.

a. Weathering may require a higher strength concrete or grade of masonry than necessary to satisfy the structural requirements of this code. The grade of masonry units shall be determined from ASTM C 34, C 55, C 62, C 73, C 90, C 129, C 145, C 216 or C 652.

b. The jurisdiction shall fill in this part of the table with (a) the date of the jurisdiction's entry into the National Flood Insurance Program (date of adoptions of the first code or ordinance for management of flood hazard areas), (b) the date(s) of the currently effective FIRM and FBFM, or other flood hazard map adopted by the community, as may be amended.

c. Protection is required in all of North Carolina per Section R318.

TABLE R301.2(2)
COMPONENT AND CLADDING LOADS FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B (ASD) (psf)[a, b, c, d, e, f]

	ZONE	EFFECTIVE WIND AREA (feet²)	ULTIMATE DESIGN WIND SPEED, V_{ULT} (mph)																	
			110		115		120		130		140		150		160		170		180	
Roof 0 to 7 degrees	1	10	10.0	-13.0	10.0	-14.0	10.0	-15.0	10.0	-18.0	10.0	-21.0	9.9	-24.0	11.2	-27.0	12.6	-31.0	14.2	-35.0
	1	20	10.0	-12.0	10.0	-13.0	10.0	-15.0	10.0	-17.0	10.0	-20.0	9.2	-23.0	10.6	-26.0	11.9	-30.0	13.3	-34.1
	1	50	10.0	-12.0	10.0	-13.0	10.0	-14.0	10.0	-17.0	10.0	-19.0	8.5	-22.0	10.0	-26.0	10.8	-29.0	12.2	-32.9
	1	100	10.0	-11.0	10.0	-13.0	10.0	-14.0	10.0	-16.0	10.0	-19.0	7.8	-22.0	10.0	-25.0	10.0	-28.0	11.3	-32.0
	2	10	10.0	-21.0	10.0	-23.0	10.0	-26.0	10.0	-30.0	10.0	-35.0	9.9	-40.0	11.2	-46.0	12.6	-52.0	14.2	-58.7
	2	20	10.0	-19.0	10.0	-21.0	10.0	-23.0	10.0	-27.0	10.0	-31.0	9.2	-36.0	10.6	-41.0	11.9	-46.0	13.3	-52.4
	2	50	10.0	-16.0	10.0	-18.0	10.0	-19.0	10.0	-23.0	10.0	-26.0	8.5	-30.0	10.0	-34.0	10.8	-39.0	12.2	-44.1
	2	100	10.0	-14.0	10.0	-15.0	10.0	-16.0	10.0	-19.0	10.0	-22.0	7.8	-26.0	10.0	-30.0	10.0	-33.0	11.3	-37.9
	3	10	10.0	-33.0	10.0	-36.0	10.0	-39.0	10.0	-46.0	10.0	-53.0	9.9	-61.0	11.2	-69.0	12.6	-78.0	14.2	-88.3
	3	20	10.0	-27.0	10.0	-29.0	10.0	-32.0	10.0	-38.0	10.0	-44.0	9.2	-50.0	10.6	-57.0	11.9	-65.0	13.3	-73.1
	3	50	10.0	-19.0	10.0	-21.0	10.0	-23.0	10.0	-27.0	10.0	-32.0	8.5	-36.0	10.0	-41.0	10.8	-47.0	12.2	-53.1
	3	100	10.0	-14.0	10.0	-15.0	10.0	-16.0	10.0	-19.0	10.0	-22.0	7.8	-26.0	10.0	-30.0	10.0	-33.0	11.3	-37.9
Roof > 7 to 27 degrees	1	10	10.0	-11.0	10.0	-13.0	10.0	-14.0	10.5	-16.0	12.2	-19.0	14.0	-22.0	15.9	-25.0	17.9	-28.0	20.2	-32.0
	1	20	10.0	-11.0	10.0	-12.0	10.0	-13.0	10.0	-16.0	11.1	-18.0	12.8	-21.0	14.5	-24.0	16.4	-27.0	18.4	-31.1
	1	50	10.0	-11.0	10.0	-12.0	10.0	-13.0	10.0	-15.0	10.0	-18.0	11.1	-20.0	12.7	-23.0	14.3	-26.0	16.0	-29.9
	1	100	10.0	-10.0	10.0	-11.0	10.0	-12.0	10.0	-15.0	10.0	-17.0	9.9	-20.0	11.2	-22.0	12.6	-25.0	14.2	-29.0
	2	10	10.0	-20.0	10.0	-22.0	10.0	-24.0	10.5	-29.0	12.2	-33.0	14.0	-38.0	15.9	-44.0	17.9	-49.0	20.2	-55.8
	2	20	10.0	-19.0	10.0	-20.0	10.0	-22.0	10.0	-26.0	11.1	-31.0	12.8	-35.0	14.5	-40.0	16.4	-45.0	18.4	-51.2
	2	50	10.0	-16.0	10.0	-18.0	10.0	-20.0	10.0	-23.0	10.0	-27.0	11.1	-31.0	12.7	-35.0	14.3	-40.0	16.0	-45.4
	2	100	10.0	-15.0	10.0	-16.0	10.0	-18.0	10.0	-21.0	10.0	-24.0	9.9	-28.0	11.2	-32.0	12.6	-36.0	14.2	-40.9
	3	10	10.0	-30.0	10.0	-33.0	10.0	-36.0	10.5	-43.0	12.2	-49.0	14.0	-57.0	15.9	-65.0	17.9	-73.0	20.2	-82.4
	3	20	10.0	-28.0	10.0	-31.0	10.0	-34.0	10.0	-40.0	11.1	-46.0	12.8	-53.0	14.5	-60.0	16.4	-68.0	18.4	-77.0
	3	50	10.0	-26.0	10.0	-28.0	10.0	-31.0	10.0	-36.0	10.0	-42.0	11.1	-48.0	12.7	-55.0	14.3	-62.0	16.0	-69.9
	3	100	10.0	-24.0	10.0	-26.0	10.0	-28.0	10.0	-33.0	10.0	-39.0	9.9	-44.0	11.2	-51.0	12.6	-57.0	14.2	-64.6
Roof > 27 to 45 degrees	1	10	11.9	-13.0	13.1	-14.0	14.2	-15.0	16.7	-18.0	19.4	-21.0	22.2	-24.0	25.3	-27.0	28.5	-31.0	32.0	-35.0
	1	20	11.6	-12.0	12.7	-13.0	13.8	-14.0	16.2	-17.0	18.8	-20.0	21.6	-23.0	24.6	-26.0	27.7	-29.0	31.1	-33.2
	1	50	11.2	-11.0	12.2	-12.0	13.3	-13.0	15.6	-16.0	18.1	-18.0	20.8	-21.0	23.6	-24.0	26.7	-27.0	29.9	-30.8
	1	100	10.9	-10.0	11.9	-11.0	12.9	-12.0	15.1	-15.0	17.6	-17.0	20.2	-20.0	22.9	-22.0	25.9	-25.0	29.0	-29.0
	2	10	11.9	-15.0	13.1	-16.0	14.2	-18.0	16.7	-21.0	19.4	-24.0	22.2	-28.0	25.3	-32.0	28.5	-36.0	32.0	-40.9
	2	20	11.6	-14.0	12.7	-16.0	13.8	-17.0	16.2	-20.0	18.8	-23.0	21.6	-27.0	24.6	-30.0	27.7	-34.0	31.1	-39.1
	2	50	11.2	-13.0	12.2	-15.0	13.3	-16.0	15.6	-19.0	18.1	-22.0	20.8	-25.0	23.6	-29.0	26.7	-32.0	29.9	-36.8
	2	100	10.9	-13.0	11.9	-14.0	12.9	-15.0	15.1	-18.0	17.6	-21.0	20.2	-24.0	22.9	-27.0	25.9	-31.0	29.0	-35.0
	3	10	11.9	-15.0	13.1	-16.0	14.2	-18.0	16.7	-21.0	19.4	-24.0	22.2	-28.0	25.3	-32.0	28.5	-36.0	32.0	-40.9
	3	20	11.6	-14.0	12.7	-16.0	13.8	-17.0	16.2	-20.0	18.8	-23.0	21.6	-27.0	24.6	-30.0	27.7	-34.0	31.1	-39.1
	3	50	11.2	-13.0	12.2	-15.0	13.3	-16.0	15.6	-19.0	18.1	-22.0	20.8	-25.0	23.6	-29.0	26.7	-32.0	29.9	-36.8
	3	100	10.9	-13.0	11.9	-14.0	12.9	-15.0	15.1	-18.0	17.6	-21.0	20.2	-24.0	22.9	-27.0	25.9	-31.0	29.0	-35.0
Wall	4	10	13.1	-14.0	14.3	-15.0	15.5	-16.0	18.2	-19.0	21.2	-22.0	24.3	-26.0	27.7	-30.0	31.2	-33.0	35.0	-37.9
	4	20	12.5	-13.0	13.6	-14.0	14.8	-16.0	17.4	-19.0	20.2	-22.0	23.2	-25.0	26.4	-28.0	29.7	-32.0	33.4	-36.4
	4	50	11.7	-12.0	12.8	-14.0	13.9	-15.0	16.3	-17.0	19.0	-20.0	21.7	-23.0	24.7	-27.0	27.9	-30.0	31.3	-34.3
	4	100	11.1	-12.0	12.1	-13.0	13.2	-14.0	15.5	-17.0	18.0	-19.0	20.6	-22.0	23.5	-25.0	26.5	-29.0	29.8	32.7
	4	500	10.0	-10.0	10.6	-11.0	11.6	-12.0	13.6	-15.0	15.8	-17.0	18.1	-20.0	20.6	-22.0	23.2	-25.0	26.1	-29.0
	5	10	13.1	-17.0	14.3	-19.0	15.5	-20.0	18.2	-24.0	21.2	-28.0	24.3	-32.0	27.7	-37.0	31.2	-41.0	35.0	-46.8
	5	20	12.5	-16.0	13.6	-17.0	14.8	-19.0	17.4	-22.0	20.2	-26.0	23.2	-30.0	26.4	-34.0	29.7	-39.0	33.4	-43.7
	5	50	11.7	-14.0	12.8	-16.0	13.9	-17.0	16.3	-20.0	19.0	-23.0	21.7	-27.0	24.7	-31.0	27.9	-35.0	31.3	-39.5
	5	100	11.1	-13.0	12.1	-14.0	13.2	-16.0	15.5	-19.0	18.0	-22.0	20.6	-25.0	23.5	-28.0	26.5	-32.0	29.8	-36.4
	5	500	10.0	-10.0	10.6	-11.0	11.6	-12.0	13.6	-15.0	15.8	-17.0	18.1	-20.0	20.6	-22.0	23.2	-25.0	26.1	-29.0

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa.

a. The effective wind area shall be equal to the span length multiplied by an effective width. This width shall be permitted to be not less than one-third the span length. For cladding fasteners, the effective wind area shall not be greater than the area that is tributary to an individual fastener.

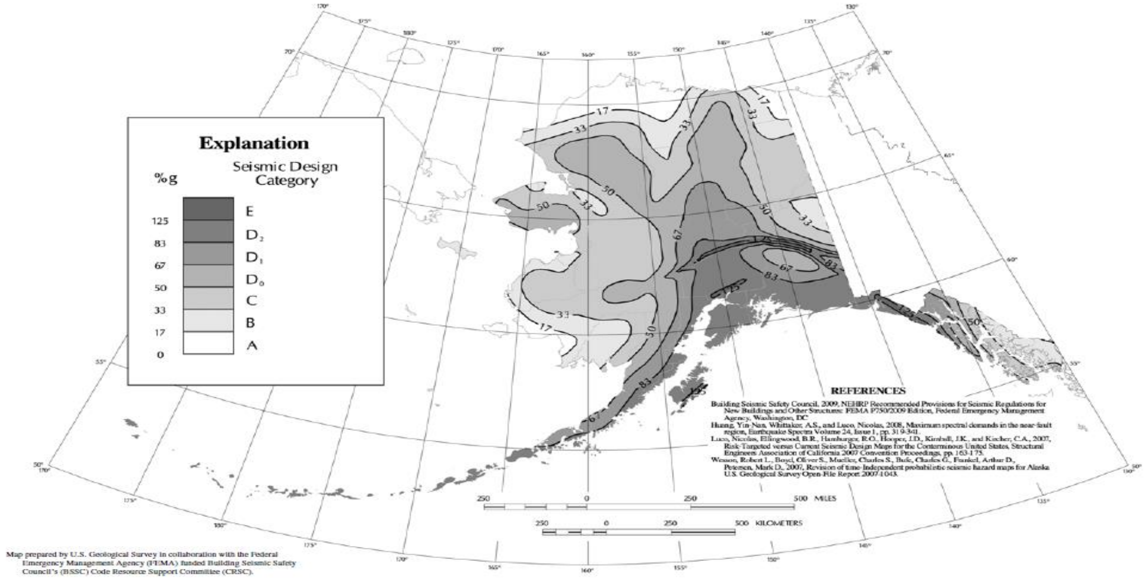
b. For effective areas between those given, the load shall be interpolated or the load associated with the lower effective area shall be used.

c. Table values shall be adjusted for height and exposure by multiplying by the adjustment coefficient in Table R301.2(3).

d. See Figure R301.2(~~7~~2) for location of zones.

e. Plus and minus signs signify pressures acting toward and away from the building surfaces.

f. Openings for exterior balconies, decks, or porches under roofs enclosed with screen or removable vinyl or acrylic wind break panels shall be exempt from the loads listed in Table R301.2(2) and the height and exposure factors listed in Table R301.2(3). Vinyl and acrylic glazed panels shall be removable. Removable panels shall be identified as removable by a decal. The identification decal shall state "Removable panel SHALL be removed when wind speeds exceed 75 mph (34 m/s)." Decals shall be placed such that the decal is visible when the panel is installed.



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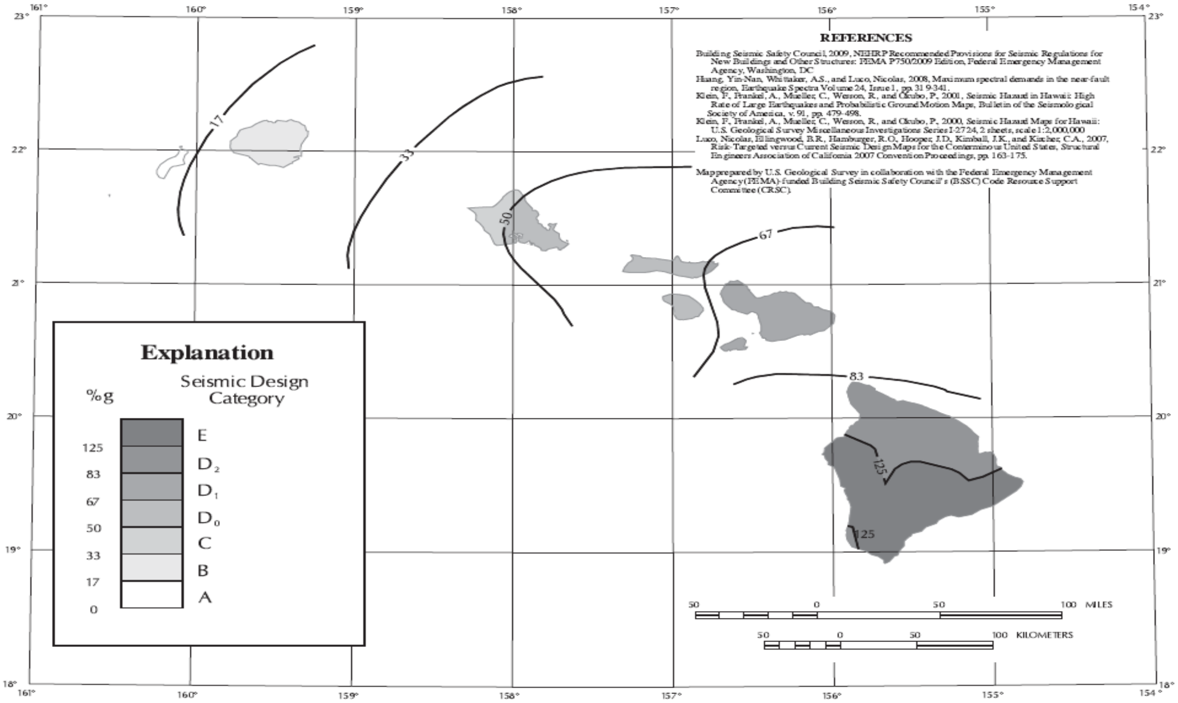
Map prepared by U.S. Geological Survey in collaboration with the Federal Emergency Management Agency (FEMA) funded Building Seismic Safety Council's (BSSC) Code Resource Support Committee (CRSC).

~~FIGURE R301.2(2)~~
~~SEISMIC DESIGN CATEGORIES—SITE CLASS D~~

~~(continued)~~



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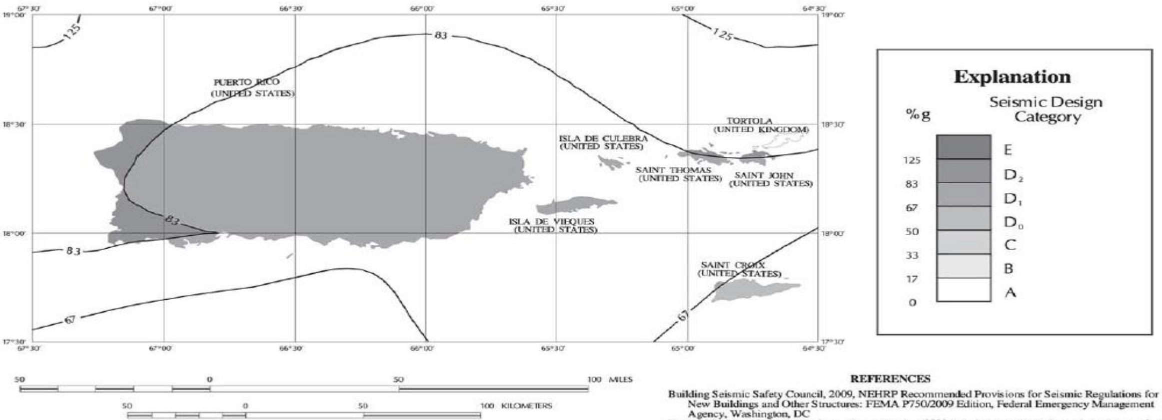
Map prepared by U.S. Geological Survey in collaboration with the Federal Emergency Management Agency (FEMA)-funded Building Seismic Safety Council's (BSSC) Code Resource Support Committee (CRSC).

~~FIGURE R301.2(2)—continued~~
~~SEISMIC DESIGN CATEGORIES—SITE CLASS D~~



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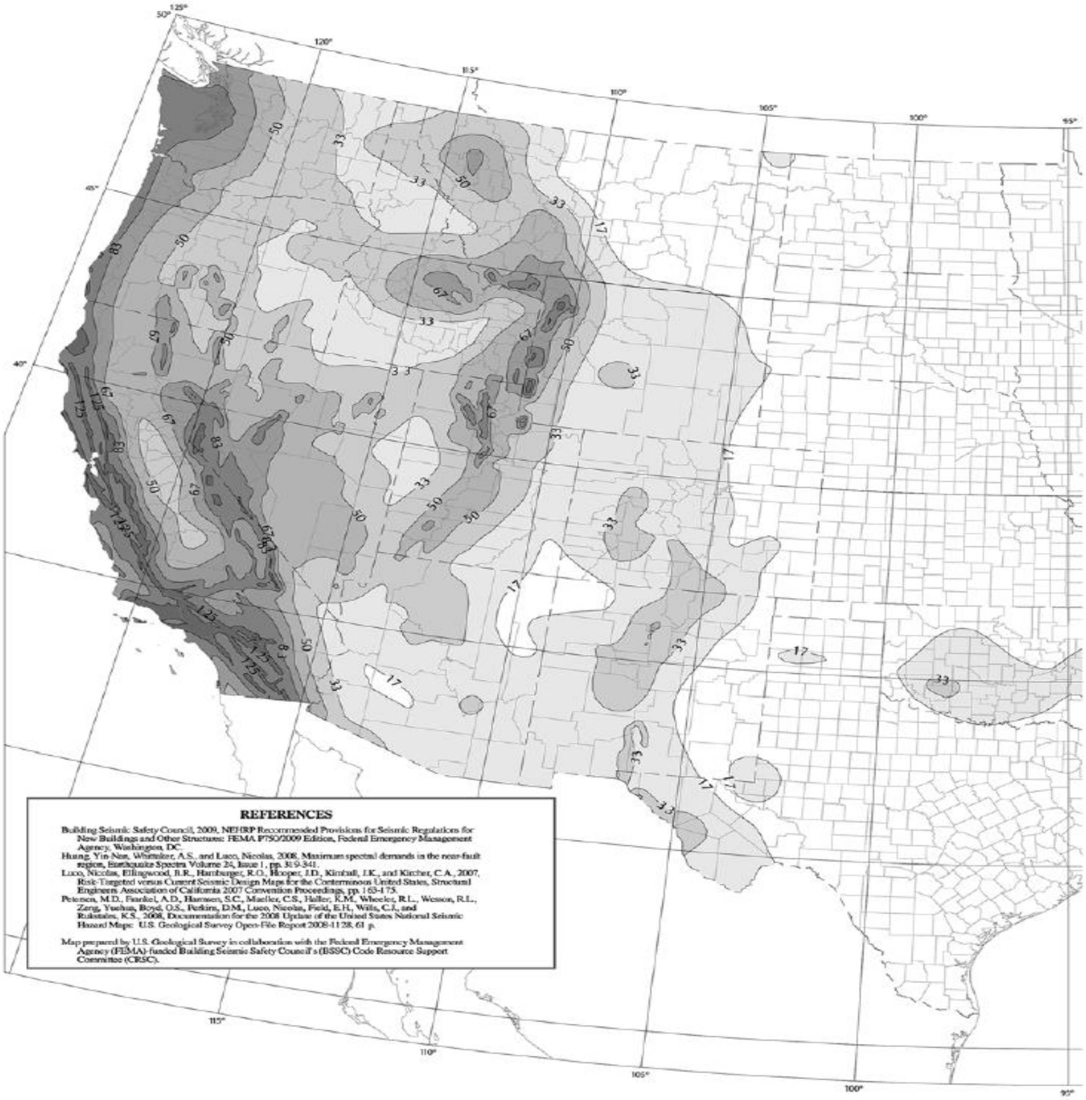
Map prepared by U.S. Geological Survey in collaboration with the Federal Emergency Management Agency (FEMA)-funded Building Seismic Safety Council's (BSSC) Code Resource Support Committee (CRSC).

~~FIGURE R301.2(2)—continued~~
~~SEISMIC DESIGN CATEGORIES—SITE CLASS D~~



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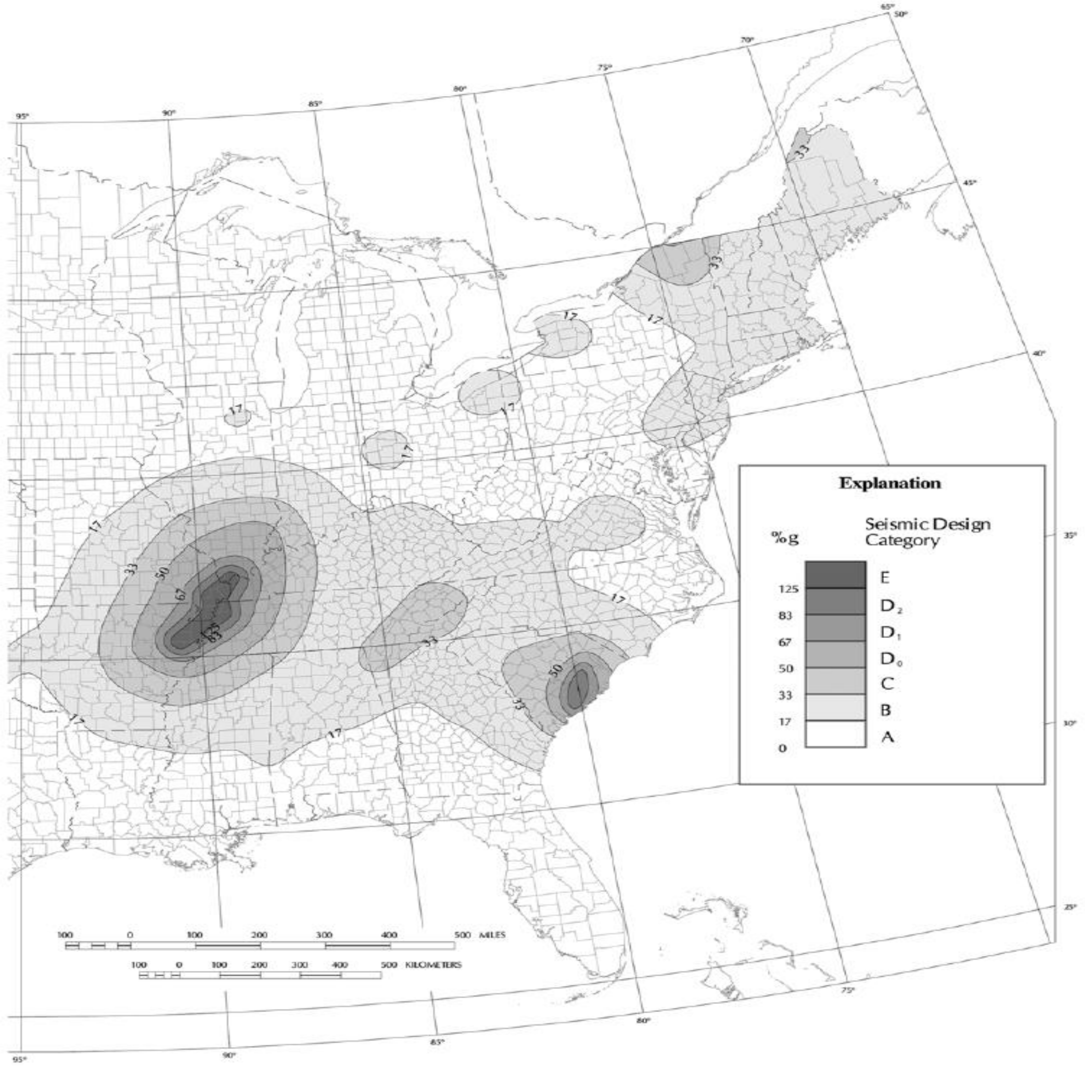
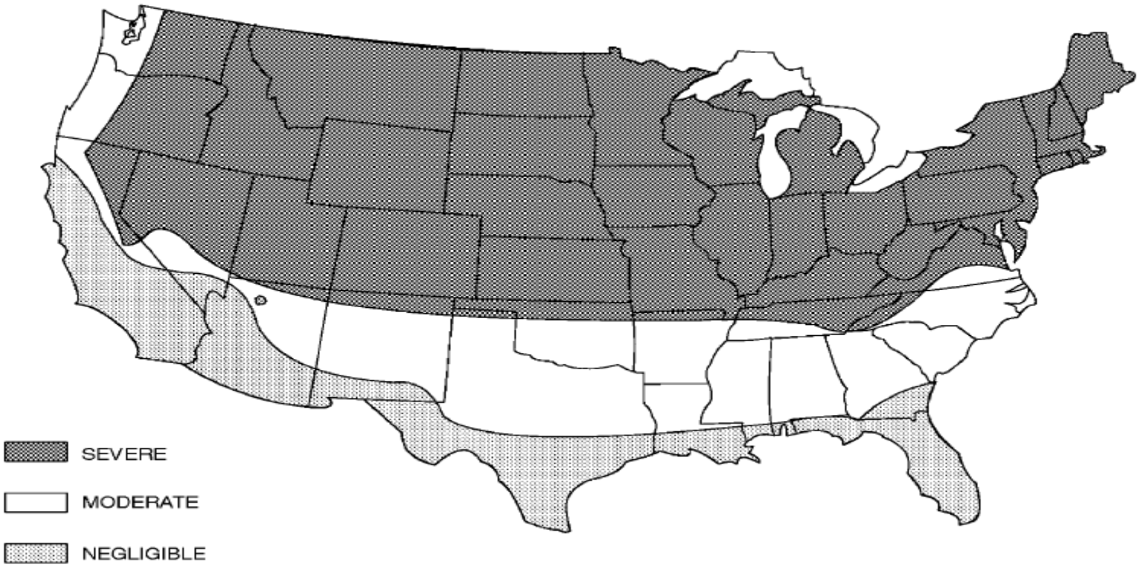
Map prepared by U.S. Geological Survey in collaboration with the Federal Emergency Management Agency (FEMA)-funded Building Seismic Safety Council's (BSSC) Code Resource Support Committee (CRSC).

~~**FIGURE R301.2(2)—continued**~~
~~**SEISMIC DESIGN CATEGORIES—SITE CLASS D**~~



~~FIGURE R301.2(2)—continued~~
~~SEISMIC DESIGN CATEGORIES—SITE CLASS D~~

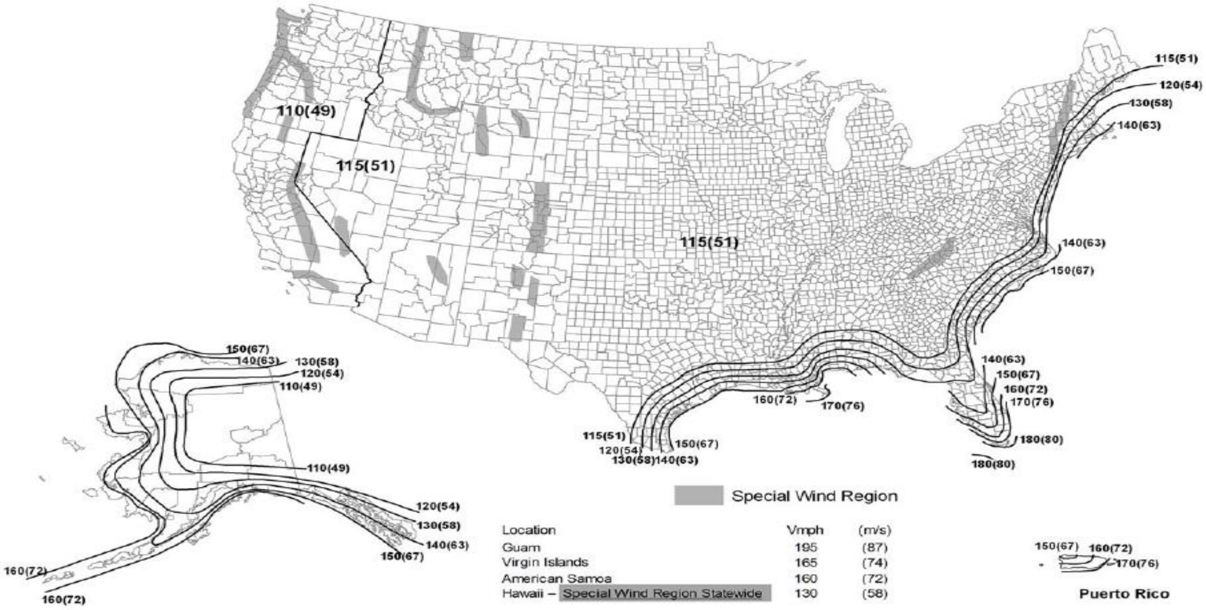


~~a. Alaska and Hawaii are classified as severe and negligible, respectively.~~

~~b. Lines defining areas are approximate only. Local conditions may be more or less severe than indicated by region classification. A severe classification is where weather conditions result in significant snowfall combined with extended periods during which there is little or no natural thawing causing deicing salts to be used extensively.~~

~~FIGURE R301.2(3)~~

~~WEATHERING PROBABILITY MAP FOR CONCRETE~~[~~a, b~~]

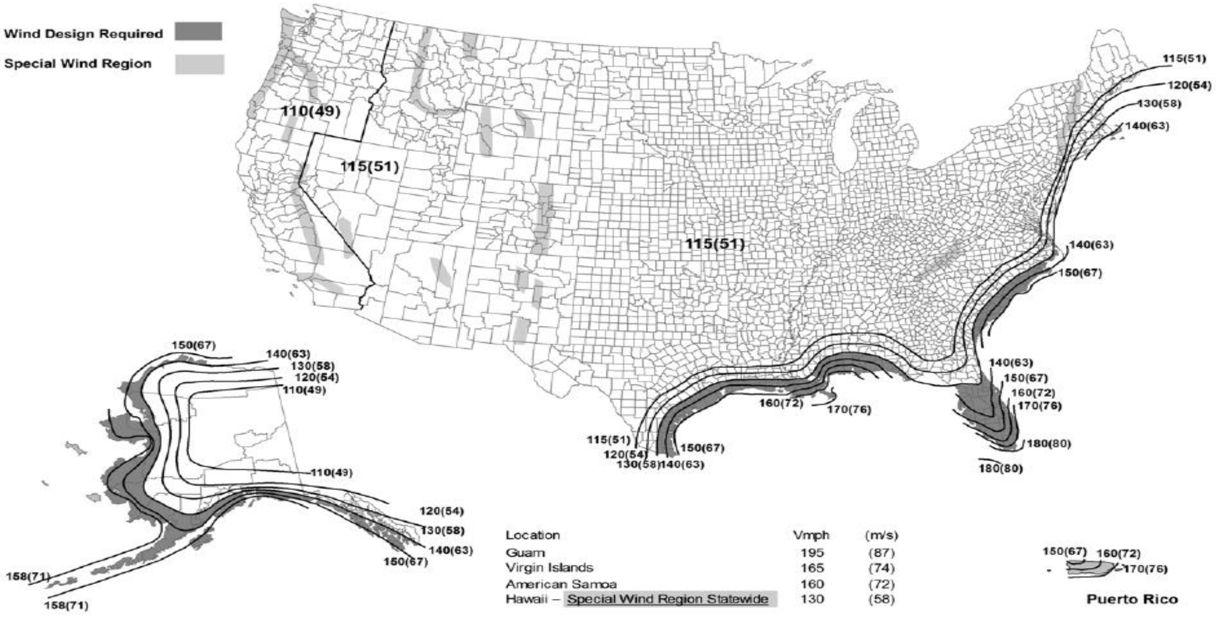


Location	Vmph	(m/s)
Guam	195	(87)
Virgin Islands	165	(74)
American Samoa	160	(72)
Hawaii – Special Wind Region Statewide	130	(58)

Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

~~FIGURE R301.2(4)A~~
~~ULTIMATE DESIGN WIND SPEEDS~~



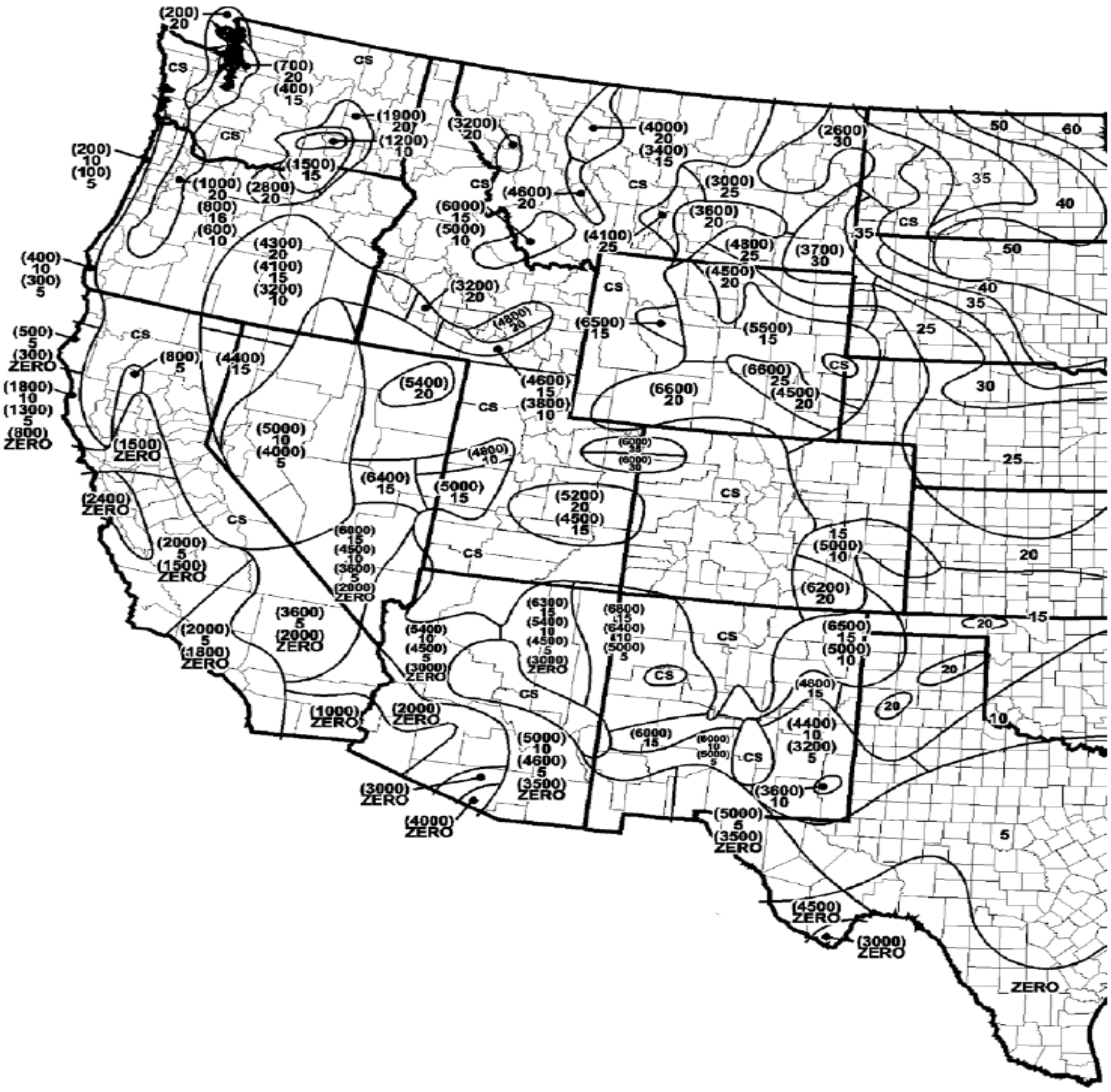
Location	Vmph	(m/s)
Guam	195	(87)
Virgin Islands	165	(74)
American Samoa	160	(72)
Hawaii – Special Wind Region Statewide	130	(58)

Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

~~FIGURE R301.2(4)B~~

~~REGIONS WHERE WIND DESIGN IS REQUIRED~~



~~For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 mile = 1.61 km.~~

~~a. In CS areas, site-specific Case Studies are required to establish ground snow loads. Extreme local variations in ground snow loads in these areas preclude mapping at this scale.~~

~~b. Numbers in parentheses represent the upper elevation limits in feet for the ground snow load values presented below. Site-specific case studies are required to establish ground snow loads at elevations not covered.~~

~~**FIGURE R301.2(5)**~~

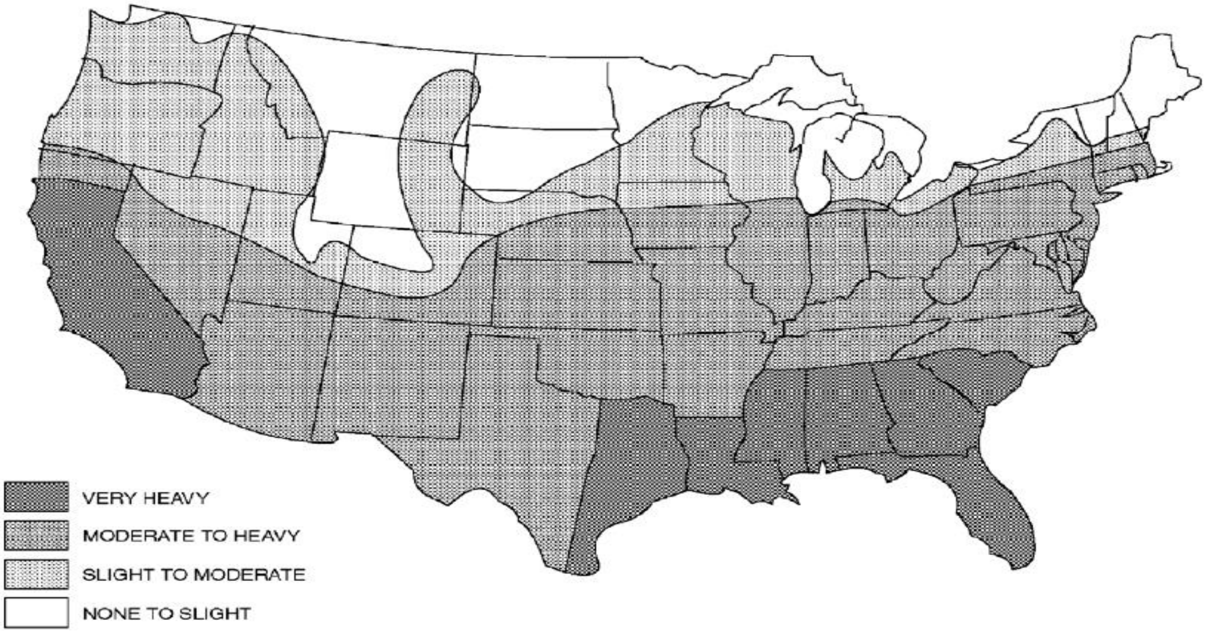
~~**GROUND SNOW LOADS, P_g, FOR THE UNITED STATES (lb/ft^2)**~~

~~(continued)~~

~~For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa~~.

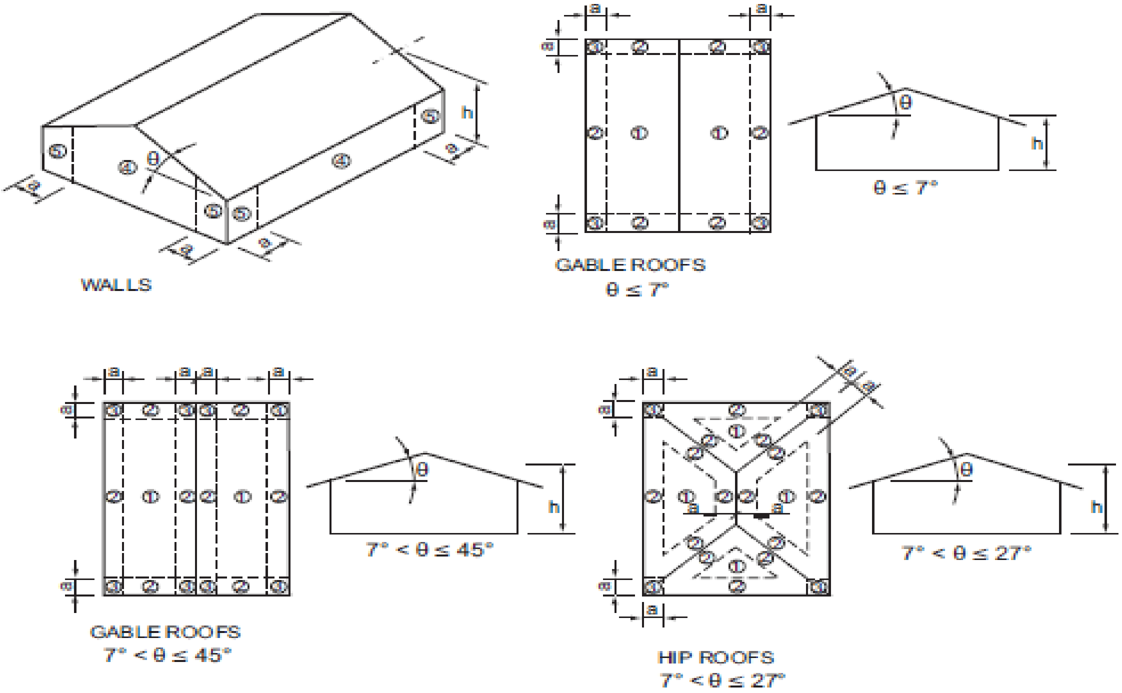
~~FIGURE R301.2(5)—continued~~

~~GROUND SNOW LOADS, P_g, FOR THE UNITED STATES (lb/ft^2)~~



~~Note: Lines defining areas are approximate only. Local conditions may be more or less severe than indicated by the region classification.~~

~~**FIGURE R301.2(6)**~~
~~**TERMITE INFESTATION PROBABILITY MAP**~~



For SI: 1 foot = 304.8 mm, 1 degree = 0.0175 rad.
Note: a = 4 feet in all cases

FIGURE R301.2(~~7~~2)
COMPONENT AND CLADDING PRESSURE ZONES

TABLE R301.2(4)
ULTIMATE DESIGN WIND SPEEDS BY COUNTY (mph)

Counties not listed	115		
Alleghany	special mountain region	Johnston	120
Ashe	special mountain region	Jones	140
Avery	special mountain region	Lenoir	130
Beaufort	130	Madison	special mountain region
Bertie[1]	120/130	Martin[7]	120/130
Bladen[2]	130/140	Mitchell	special mountain region
Brunswick[3]	140/150	New Hanover[8]	140/150
Buncombe	special mountain region	Onslow[9]	130/140/150
Camden	130	Pamlico	140
Carteret	150	Pasquotank	130
Chowan	130	Pender[10]	130/140/150
Columbus	140	Perquimans	130
Craven	140	Pitt	130
Cumberland[4]	120/130	Richmond	120
Currituck	130	Robeson	130
Dare[5]	130/140	Sampson	130
Duplin	130	Scotland	120
Gates	120	Swain	special mountain region
Graham	special mountain region	Tyrell	130
Greene	130	Washington	130
Harnett	120	Watauga	special mountain region
Haywood	special mountain region	Wayne	130
Hoke	120	Wilson	120
Hyde[6]	130/140	Yancey	special mountain region
Jackson	special mountain region		

For SI: 1 foot = 304.8, 1 mile per hour = 0.44 m/s.

1. Bertie County – 120 mph zone west of Hwy. 17, 130 mph zone east of Hwy. 17.
2. Bladen County – 130 mph zone west of Hwy. 701, 140 mph zone east of Hwy. 701.
3. Brunswick County – 140 mph zone west of Hwy. 17, 150 mph zone east of Hwy. 17, 150 mph on Bald Head Island.
4. Cumberland County – 120 mph zone west of I-95, 130 mph zone east of I-95.
5. Dare County - 130 mph zone west of U.S. Route 264, 140 mph zone east of U.S. Route 264.
6. Hyde County – 130 mph zone west of U.S. Route 264, 140 mph zone east of U.S. Route 264.
7. Martin County – 120 mph zone west of Hwy. 17, 130 mph zone east of Hwy 17.
8. New Hanover County – 140 mph zone west of Hwy. 17, 150 mph zone east of Hwy. 17.
9. Onslow County – 130 mph zone west of Hwy. 17, 140 mph zone east of Hwy 17 to the Intracoastal Waterway, 150 mph zone east of the Intracoastal Waterway.
10. Pender County – 140 mph zone in the Township of Topsail west of the Intracoastal Waterway, 150 mph zone east of the Intracoastal Waterway, 130 mph zone in the remainder of the county.

TABLE R301.2(5)
ULTIMATE DESIGN WIND SPEED FOR MOUNTAIN REGIONS

FIRST FLOOR FINISH ELEVATION (feet)	**ULTIMATE DESIGN WIND SPEED (mph)**
Less than 2,700	115
2,700 to less than 3,000	120
3,000 to less than 3,500	130
3,500 to less than 4,500	140
4,500 or greater	150

For SI: 1 foot = 304.8, 1 mile per hour = 0.44 m/s.

TABLE R301.2(6)
DESIGN PRESSURES FOR DOORS AND WINDOWS [a,b,c,d,e]
POSITIVE AND NEGATIVE (psf)

VELOCITY (mph)	**MEAN ROOF HEIGHT (feet)**		
	15	**25**	**35**
115	15	17	19
120	20	23	25

For SI: 1 foot = 304.8, 1 mile per hour = 0.44 m/s.

a. Alternative design pressures may be determined by using *North Carolina Building Code*, ASCE-7, or the *International Building Code*.

b. If window or door is more than 4 feet (1219 mm) from a corner, the pressure from this table shall be permitted to be multiplied by 0.87. This adjustment does not apply to garage doors.

c. For windows and doors in structures with a roof slope of 10 degrees (0.0745 rad) or less (2:12) from the table may be multiplied by 0.90.

d. Design pressure ratings based on standards listed in Section R609 are adequate documentation of capacity to resist pressures from the table.

e. Design pressures are for windows and doors located in Exposure Category B.

TABLE R301.2(7)
COUNTIES IN SEISMIC DESIGN CATEGORY C

Brunswick
Buncombe
Cherokee
Clay
Columbus
Graham
Haywood
Jackson
Macon
Madison
Robeson
Scotland
Swain

Note: Counties not listed are in Seismic Design Category A or B.

R301.2.1 Wind design criteria.

Buildings and portions thereof shall be constructed in accordance with the wind provisions of this code using the ultimate design wind speed in Table R301.2(1) as determined from ~~Figure R301.2(4)~~Table R301.2(4) and Table R301.2(5) . ~~The structural provisions of this code for wind loads are not permitted where wind design is required as specified in Section R301.2.1.1.~~ Where different construction methods and structural materials are used for various portions of a building, the applicable requirements of this section for each portion shall apply. Where not otherwise specified, the wind loads listed in Table R301.2(2) and Table R301.2(6) adjusted for height and exposure using Table R301.2(3) shall be used to determine design load performance requirements for wall coverings, curtain walls, roof coverings, exterior windows, skylights, garage doors and exterior doors. Asphalt shingles shall be designed for wind speeds in accordance with Section R905.2.4. A continuous load path shall be provided to transmit the applicable uplift forces in Section R802.11.1 from the roof assembly to the foundation.

Exception: Openings for exterior balconies, decks, or porches under roofs enclosed with screen or removable vinyl or acrylic wind break panels shall be exempt from the loads listed in Table R301.2(2) and the height and exposure factors listed in Table R301.2(3). Vinyl and acrylic glazed panels shall be removable. Removable panels shall be identified as removable by a decal. The identification decal shall state "Removable panel SHALL be removed when wind speeds exceed 75 mph (34 m/s)." Decals shall be placed such that the decal is visible when the panel is installed.

R301.2.1.1 Wind limitations and wind design ~~required~~.

~~The wind provisions of this code shall not apply to the design of buildings where wind design is required in accordance with Figure R301.2(4)B.~~

~~**Exceptions:**~~

1. ~~For concrete construction, the wind provisions of this code shall apply in accordance with the limitations of Sections R404 and R608.~~
2. ~~For structural insulated panels, the wind provisions of this code shall apply in accordance with the limitations of Section R610.~~
3. ~~For cold-formed steel light-frame construction, the wind provisions of this code shall apply in accordance with the limitations of Sections R505, R603 and R804.~~

~~In regions where wind design is required in accordance with Figure R301.2(4)B, the design of buildings for wind loads shall be in accordance with one or more of the following methods:~~

Construction in regions where the ultimate wind speeds from Table R301.2(4) and Table R301.2(5) equal or exceed 130 miles per hour (58 m/s) shall be designed in accordance with one of the following:

1. AF&PA *Wood Frame Construction Manual* (WFCM).
2. ICC *Standard for Residential Construction in High-Wind Regions* (ICC 600).
3. ASCE *Minimum Design Loads for Buildings and Other Structures* (ASCE 7)
4. Deleted. ~~AISI *Standard for Cold-Formed Steel Framing—Prescriptive Method For One- and Two-Family Dwellings* (AISI S230).~~

5. *International Building Code.*

6. Concrete construction shall be designed in accordance with the provisions of this code.

7. Structural insulated panel (SIP) walls shall be designed in accordance with the provisions of this code.

8. Chapters 45 and 46.

The elements of design not addressed by the methods in Items 1 through ~~5~~ 8 shall be in accordance with the provisions of this code.

Where ASCE 7 or the *International Building Code* is used for the design of the building, the wind speed map and exposure category requirements as specified in ASCE 7 and the *International Building Code* shall be used.

R301.2.1.1.1 Sunrooms. Deleted.
~~Sunrooms shall comply with AAMA/NPEA/NSA 2100. For the purpose of applying the criteria of AAMA/NPEA/NSA 2100 based on the intended use, sunrooms shall be identified as one of the following categories by the permit applicant, design professional or the property owner or owner's agent in the construction documents. Component and cladding pressures shall be used for the design of elements that do not qualify as main windforce-resisting systems. Main windforce-resisting system pressures shall be used for the design of elements assigned to provide support and stability for the overall *sunroom*.~~

~~**Category I:** A thermally isolated sunroom with walls that are open or enclosed with insect screening or 0.5 mm (20 mil) maximum thickness plastic film. The space is nonhabitable and unconditioned.~~

~~**Category II:** A thermally isolated sunroom with enclosed walls. The openings are enclosed with translucent or transparent plastic or glass. The space is nonhabitable and unconditioned.~~

~~**Category III:** A thermally isolated sunroom with enclosed walls. The openings are enclosed with translucent or transparent plastic or glass. The sunroom fenestration complies with additional requirements for air infiltration resistance and water penetration resistance. The space is nonhabitable and unconditioned.~~

~~**Category IV:** A thermally isolated sunroom with enclosed walls. The sunroom is designed to be heated or cooled by a separate temperature control or system and is thermally isolated from the primary structure. The sunroom fenestration complies with additional requirements for water penetration resistance, air infiltration resistance and thermal performance. The space is nonhabitable and conditioned.~~

~~**Category V:** A sunroom with enclosed walls. The sunroom is designed to be heated or cooled and is open to the main structure. The sunroom fenestration complies with additional requirements for water penetration resistance, air infiltration resistance and thermal performance. The space is habitable and conditioned~~.

R301.2.1.2 Protection of openings.

Exterior glazing in buildings located in windborne debris regions shall be protected from windborne debris. Glazed opening protection for windborne debris shall meet the requirements of the Large Missile Test of ASTM E 1996 and ASTM E 1886 as modified in Section 301.2.1.2.1. Garage door glazed opening protection for windborne debris shall meet the requirements of an *approved* impact-resisting standard or ANSI/DASMA 115.

Exceptions:

1. Wood structural panels with a thickness of not less than $^{7}/_{16}$ inch (11 mm) and a span of not more than 8 feet (2438 mm) shall be permitted for opening protection. Panels shall be precut and attached to the framing surrounding the opening containing the product with the glazed opening. Panels shall be predrilled as required for the anchorage method ~~and shall~~ so that they can be secured with the attachment hardware provided. Attachments shall be designed to resist the component and cladding loads determined in accordance with either Table R301.2(2) or ASCE 7, with the permanent corrosion-resistant attachment hardware provided ~~and anchors permanently installed on the building~~. Attachment in accordance with Table R301.2.1.2 is permitted for buildings with a *mean roof height* of 45 feet (13, 728 mm) or less where the ultimate design wind speed, V_{ult}, is 180 mph (290 kph) or less.

2. Openings for exterior balconies, decks, or porches under roofs enclosed with screen or removable vinyl or acrylic wind break panels shall not be required to be protected provided the spaces are separated from the building interior by a wall and all openings in the wall separating the unit from the balcony, deck or porch are protected in accordance with this section. Vinyl and acrylic glazed panels shall be removable. Removable panels shall be identified as removable by a decal. The identification decal shall state "Removable panel SHALL be removed when wind speeds exceed 75 mph (34 m/s)." Decals shall be placed such that the decal is visible when the panel is installed.

TABLE R301.2.1.2
WINDBORNE DEBRIS PROTECTION FASTENING SCHEDULE FOR WOOD STRUCTURAL PANELS[a, b, c, d]

FASTENER TYPE	FASTENER SPACING (inches)[a, b]		
	Panel span ≤ 4 feet	4 feet < panel span ≤ 6 feet	6 feet < panel span ≤ 8 feet
No. 8 wood screw ~~based anchor with 2-inch embedment length~~	16	10	8

No. 10 wood screw ~~based anchor with 2-inch embedment length~~	16	12	9
$^1/_4$-inch lag screw ~~based anchor with 2-inch embedment length~~	16	16	16

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.448 N,1 mile per hour = 0.447 m/s.

a. This table is based on 180 mph ultimate design wind speeds, V_{ult}, and a ~~33~~ 45 foot *mean roof height*.

b. Fasteners shall be installed at opposing ends of the wood structural panel. Fasteners shall be located not less than 1 inch from the edge of the panel.

c. ~~Anchors~~ Fasteners shall penetrate through the *exterior wall* covering with an embedment length of not less than 2 inches into the building frame. Fasteners shall be located not less than 2$^1/_2$ inches from the edge of concrete block or concrete.

d. Panels attached to masonry or masonry/stucco shall be attached using vibration-resistant anchors having an ultimate withdrawal capacity of not less than 1,500 pounds.

R301.2.1.3 Wind speed conversion.

Where referenced documents are based on nominal design wind speeds and do not provide the means for conversion between ultimate design wind speeds and nominal design wind speeds, the ultimate design wind speeds, V_{ult}, of ~~Figure R301.2(4)A~~ Table R301.2(4) and Table R301.2(5) shall be converted to nominal design wind speeds, V_{asd}, using Table R301.2.1.3.

R301.2.1.5 Topographic wind effects. Deleted.

~~In areas designated in Table R301.2(1) as having local historical data documenting structural damage to buildings caused by wind speed-up at isolated hills, ridges and escarpments that are abrupt changes from the general topography of the area, topographic wind effects shall be considered in the design of the building in accordance with Section R301.2.1.5.1 or in accordance with the provisions of ASCE 7. See Figure R301.2.1.5.1(1) for topographic features for wind speed-up effect.~~

~~In these designated areas, topographic wind effects shall apply only to buildings sited on the top half of an isolated hill, ridge or escarpment where all of the following conditions exist:~~

1. ~~The average slope of the top half of the hill, ridge or escarpment is 10 percent or greater.~~
2. ~~The hill, ridge or escarpment is 60 feet (18 288 mm) or greater in height for Exposure B, 30 feet (9144 mm) or greater in height for Exposure C, and 15 feet (4572 mm) or greater in height for Exposure D.~~
3. ~~The hill, ridge or escarpment is isolated or unobstructed by other topographic features of similar height in the upwind direction for a distance measured from its high point of 100 times its height or 2 miles (3.2 km), whichever is less. See Figure R301.2.1.5.1(3) for upwind obstruction.~~

~~4. The hill, ridge or escarpment protrudes by a factor of two or more above the height of other upwind topographic features located in any quadrant within a radius of 2 miles (3.2 km) measured from its high point.~~

R301.2.1.5.1 Simplified topographic wind speed-up method. Deleted. ~~As an alternative to the ASCE 7 topographic wind provisions, the provisions of Section R301.2.1.5.1 shall be permitted to be used to design for wind speed-up effects, where required by Section R301.2.1.5.~~

~~Structures located on the top half of isolated hills, ridges or escarpments meeting the conditions of Section R301.2.1.5 shall be designed for an increased basic wind speed as determined by Table R301.2.1.5.1. On the high side of an escarpment, the increased basic wind speed shall extend horizontally downwind from the edge of the escarpment 1.5 times the horizontal length of the upwind slope (1.5L) or 6 times the height of the escarpment (6H), whichever is greater. See Figure R301.2.1.5.1(2) for where wind speed increase is applied~~.

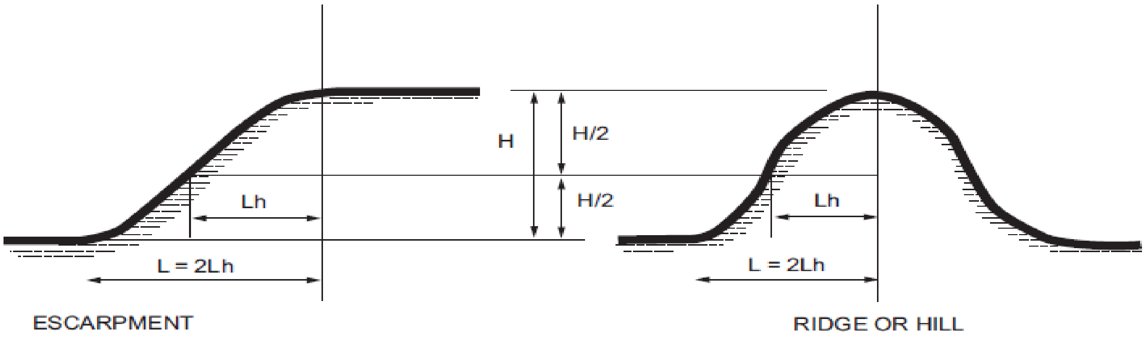
~~TABLE R301.2.1.5.1~~
~~ULTIMATE DESIGN WIND SPEED MODIFICATION FOR TOPOGRAPHIC WIND EFFECT~~ ~~[a, b]~~

~~ULTIMATE DESIGN WIND SPEED FROM FIGURE R301.2(4)A (mph)~~	~~AVERAGE SLOPE OF THE TOP HALF OF HILL, RIDGE OR ESCARPMENT (percent)~~						
	~~0.10~~	~~0.125~~	~~0.15~~	~~0.175~~	~~0.20~~	~~0.23~~	~~0.25~~
	~~Required ultimate design wind speed-up, modified for topographic wind speed-up (mph)~~						
~~110~~	~~132~~	~~137~~	~~142~~	~~147~~	~~152~~	~~158~~	~~162~~
~~115~~	~~138~~	~~143~~	~~148~~	~~154~~	~~159~~	~~165~~	~~169~~
~~120~~	~~144~~	~~149~~	~~155~~	~~160~~	~~166~~	~~172~~	~~176~~
~~130~~	~~156~~	~~162~~	~~168~~	~~174~~	~~179~~	~~N/A~~	~~N/A~~
~~140~~	~~168~~	~~174~~	~~181~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~
~~150~~	~~180~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~

~~For SI: 1 mile per hour = 0.447 m/s, 1 foot = 304.8 mm.~~

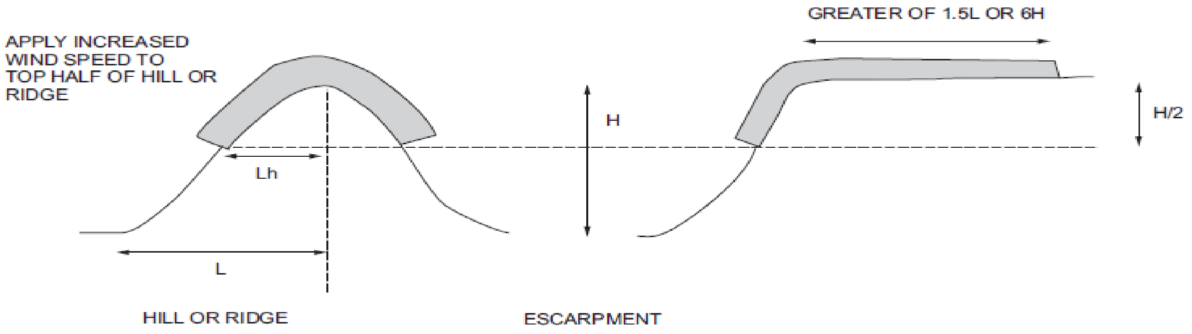
~~a. Table applies to a feature height of 500 feet or less and dwellings sited a distance equal or greater than half the feature height.~~

~~b. Where the ultimate design wind speed as modified by Table R301.2.1.5.1 equals or exceeds 140 miles per hour, the building shall be considered as "wind design required" in accordance with Section R301.2.1.1.~~

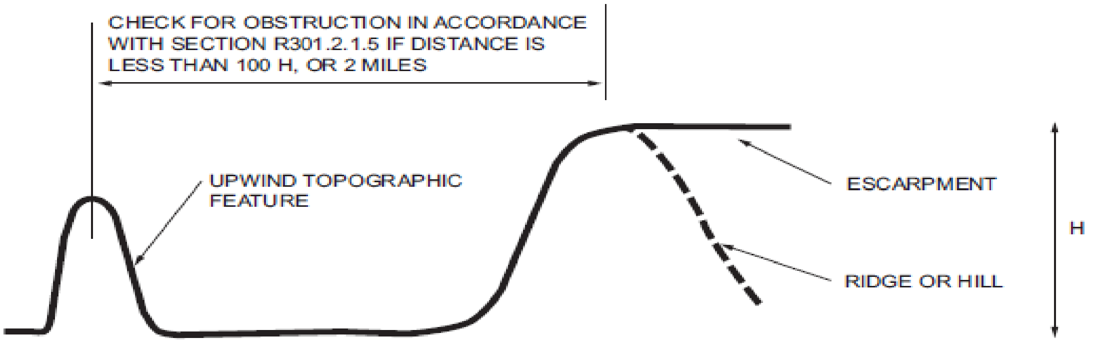


Note: H/2 determines the measurement point for Lh. L is twice Lh.

~~FIGURE R301.2.1.5.1(1)~~
~~TOPOGRAPHIC FEATURES FOR WIND SPEED-UP EFFECT~~



~~FIGURE R301.2.1.5.1(2)~~
~~ILLUSTRATION OF WHERE ON A TOPOGRAPHIC FEATURE, WIND SPEED INCREASE IS APPLIED~~



~~FIGURE R301.2.1.5.1(3)~~
~~UPWIND OBSTRUCTION~~

R301.2.2 Seismic provisions.

The seismic provisions of this code shall apply to ~~as follows~~:

~~1.~~ *Townhouses* in Seismic Design Categories C~~, D$_0$, D$_1$ and D$_2$~~.

~~2. Detached one- and two-family *dwellings* in Seismic Design Categories, D$_0$, D$_1$ and D$_2$~~.

R301.2.2.1 Determination of seismic design category.

Buildings shall be assigned a seismic design category in accordance with ~~Figure R301.2(2)~~ Table R301.2(7).

R301.2.2.1.1 Alternate determination of seismic design category. Deleted. ~~The seismic design categories and corresponding short-period design spectral response accelerations, S_{DS} shown in Figure R301.2(2) are based on soil Site Class D, as defined in Section 1613.3.2 of the *International Building Code*. I If soil conditions are other than Site Class D, the shortperiod design spectral response accelerations, S_{DS}, for a site can be determined in accordance with Section 1613.3 of the International Building Code. The value of S_{DS} determined in accordance with Section 1613.3 of the International Building Code is permitted to be used to set the seismic design category in accordance with Table R301.2.2.1.1, and to interpolate between values in Tables R602.10.3(3), R603.9.2(1) and other seismic design requirements of this code.~~

~~TABLE R301.2.2.1.1~~
~~SEISMIC DESIGN CATEGORY DETERMINATION~~

~~CALCULATED S_{DS}~~	~~SEISMIC DESIGN CATEGORY~~
~~$S_{DS} \le 0.17g$~~	~~A~~
~~$0.17g < S_{DS} \le 0.33g$~~	~~B~~
~~$0.33g < S_{DS} \le 0.50g$~~	~~C~~
~~$0.50g < S_{DS} \le 0.67g$~~	~~D_0~~
~~$0.67g < S_{DS} \le 0.83g$~~	~~D_1~~
~~$0.83g < S_{DS} \le 1.25g$~~	~~D_2~~
~~$1.25g < S_{DS}$~~	~~E~~

R301.2.2.1.2 Alternative determination of Seismic Design Category E. Deleted. ~~Buildings located in Seismic Design Category E in accordance with Figure R301.2(2) are permitted to be reclassified as being in Seismic Design Category D_2 provided that one of the following is done:~~

1. ~~A more detailed evaluation of the seismic design category is made in accordance with the provisions and maps of the *International Building Code*. Buildings located in Seismic Design Category E in accordance with Table R301.2.2.1.1, but located in Seismic Design Category D in accordance with the *International Building Code*, shall be permitted to be designed using the Seismic Design Category D_2 requirements of this code.~~

2. ~~Buildings located in Seismic Design Category E that conform to the following additional restrictions are permitted to be constructed in accordance with the provisions for Seismic Design Category D_2 of this code:~~

   ~~2.1. All exterior shear wall lines or *braced wall panels* are in one plane vertically from the foundation to the uppermost *story*.~~

~~2.2. Floors shall not cantilever past the *exterior walls*.~~

~~2.3. The building is within the requirements of Section R301.2.2.2.5 for being considered as regular.~~

R301.2.2.2 Seismic Design Category C.
Townhouse structures assigned to Seismic Design Category C shall conform to the requirements of this section.

R301.2.2.2.1 Weights of materials.
Average dead loads shall not exceed 15 pounds per square foot (720 Pa) for the combined roof and ceiling assemblies (on a horizontal projection) or 10 pounds per square foot (480 Pa) for floor assemblies, except as further limited by Section R301.2.2. Dead loads for walls above *grade* shall not exceed:

1. Fifteen pounds per square foot (720 Pa) for exterior light-frame wood walls.
2. Deleted. ~~Fourteen pounds per square foot (670 Pa) for exterior light-frame cold-formed steel walls~~.
3. Ten pounds per square foot (480 Pa) for interior light-frame wood walls.
4. Deleted. ~~Five pounds per square foot (240 Pa) for interior light-frame cold-formed steel walls.~~
5. Eighty pounds per square foot (3830 Pa) for 8-inch-thick (203 mm) masonry walls.
6. Eighty-five pounds per square foot (4070 Pa) for 6-inch-thick (152 mm) concrete walls.
7. Ten pounds per square foot (480 Pa) for SIP walls.

Exceptions:

1. Deleted. ~~Roof and ceiling dead loads not exceeding 25 pounds per square foot (1190 Pa) shall be permitted provided that the wall bracing amounts in Section R602.10.3 are increased in accordance with Table R602.10.3(4).~~
2. Light-frame walls with stone or masonry veneer shall be permitted in accordance with the provisions of Sections R702.1 and R703.
3. Fireplaces and chimneys shall be permitted in accordance with Chapter 10.

R301.2.2.2.4 Concrete construction.
~~Detached one- and two-family *dwellings* with exterior above-*grade* concrete walls shall comply with the requirements of Section R608, PCA 100 or shall be designed in~~

~~accordance with ACI 318.~~ *Townhouses* with above-*grade* exterior concrete walls shall comply with the requirements of PCA 100 or shall be designed in accordance with ACI 318.

R301.2.2.2.5 Irregular buildings.

The seismic provisions of this code shall not be used for irregular structures located in Seismic Design Category~~ies~~ C~~, D_0, D_1 and D_2~~. Irregular portions of structures shall be designed in accordance with accepted engineering practice to the extent the irregular features affect the performance of the remaining structural system. Where the forces associated with the irregularity are resisted by a structural system designed in accordance with accepted engineering practice, design of the remainder of the building shall be permitted using the provisions of this code. A building or portion of a building shall be considered to be irregular where one or more of the following conditions occur:

1. Where exterior shear wall lines or *braced wall panels* are not in one plane vertically from the foundation to the uppermost *story* in which they are required.

    Exception: For wood light-frame construction, floors with cantilevers or setbacks not exceeding four times the nominal depth of the wood floor joists are permitted to support *braced wall panels* that are out of plane with *braced wall panels* below provided that:

    1. Floor joists are nominal 2 inches by 10 inches (51 mm by 254 mm) or larger and spaced not more than 16 inches (406 mm) on center.
    2. The ratio of the back span to the cantilever is not less than 2 to 1.
    3. Floor joists at ends of *braced wall panels* are doubled.
    4. For wood-frame construction, a continuous rim joist is connected to ends of cantilever joists. When spliced, the rim joists shall be spliced using a galvanized metal tie not less than 0.058 inch (1.5 mm) (16 gage) and $1^1/_2$ inches (38 mm) wide fastened with six 16d nails on each side of the splice or a block of the same size as the rim joist of sufficient length to fit securely between the joist space at which the splice occurs fastened with eight 16d nails on each side of the splice; and
    5. Gravity loads carried at the end of cantilevered joists are limited to uniform wall and roof loads and the reactions from headers having a span of 8 feet (2438 mm) or less.

2. Where a section of floor or roof is not laterally supported by shear walls or *braced wall lines* on all edges.

    Exception: Portions of floors that do not support shear walls or *braced wall panels* above, or roofs, shall be permitted to extend not more than 6 feet (1829 mm) beyond a shear wall or *braced wall line*.

3. Where the end of a *braced wall panel* occurs over an opening in the wall below and ends at a horizontal distance greater than 1 foot (305 mm) from the edge of the opening. This provision is applicable to shear walls and *braced wall panels* offset in plane and to *braced wall panels* offset out of plane as permitted by the exception to Item 1.

   Exception: For wood light-frame wall construction, one end of a *braced wall panel* shall be permitted to extend more than 1 foot (305 mm) over an opening not more than 8 feet (2438 mm) in width in the wall below provided that the opening includes a header in accordance with the following:

   1. The building width, loading condition and framing member species limitations of Table R602.7(1) shall apply; and
   2. Not less than one 2 × 12 or two 2 × 10 for an opening not more than 4 feet (1219 mm) wide; or
   3. Not less than two 2 × 12 or three 2 × 10 for an opening not more than 6 feet (1829 mm) in width; or
   4. Not less than three 2 × 12 or four 2 × 10 for an opening not more than 8 feet (2438 mm) in width; and
   5. The entire length of the *braced wall panel* does not occur over an opening in the wall below.

4. Where an opening in a floor or roof exceeds the lesser of 12 feet (3658 mm) or 50 percent of the least floor or roof dimension.

5. Where portions of a floor level are vertically offset.

   Exceptions:

   1. Framing supported directly by continuous foundations at the perimeter of the building.
   2. For wood light-frame construction, floors shall be permitted to be vertically offset when the floor framing is lapped or tied together as required by Section R502.6.1.

6. Where shear walls and *braced wall lines* do not occur in two perpendicular directions.

7. Where stories above *grade plane* partially or completely braced by wood wall framing in accordance with Section R602 ~~or cold-formed steel wall framing in accordance with Section R603~~ include masonry or concrete construction. Where this irregularity applies, the entire *story* shall be designed in accordance with accepted engineering practice.

   Exception: Fireplaces, chimneys and masonry veneer as permitted by this code.

R301.2.2.3 Seismic Design Categories D0, D1 and D2. Deleted.
~~Structures assigned to Seismic Design Categories D_0, D_1 and D_2 shall conform to the requirements for Seismic Design Category C and the additional requirements of this section.~~

~~**R301.2.2.3.1 Height limitations.**~~
~~Wood-framed buildings shall be limited to three stories above *grade plane* or the limits given in Table R602.10.3(3). Cold-formed, steel-framed buildings shall be limited to less than or equal to three stories above *grade plane* in accordance with AISI S230. Mezzanines as defined in Section R202 that comply with Section R325 shall not be considered as stories. Structural insulated panel buildings shall be limited to two stories above *grade plane*.~~

~~**R301.2.2.3.2 Stone and masonry veneer.**~~
~~Anchored stone and masonry veneer shall comply with the requirements of Sections R702.1 and R703.~~

~~**R301.2.2.3.3 Masonry construction.**~~
~~Masonry construction in Seismic Design Categories D_0 and D_1 shall comply with the requirements of Section R606.12.1. Masonry construction in Seismic Design Category D_2 shall comply with the requirements of Section R606.12.4.~~

~~**R301.2.2.3.4 Concrete construction.**~~
~~Buildings with exterior above-*grade* concrete walls shall comply with PCA 100 or shall be designed in accordance with ACI 318.~~

~~**R301.2.2.3.5 Cold-formed steel framing in Seismic Design Categories D0, D1 and D2.**~~
~~In Seismic Design Categories D_0, D_1 and D_2 in addition to the requirements of this code, cold-formed steel framing shall comply with the requirements of AISI S230.~~

~~**R301.2.2.3.6 Masonry chimneys.**~~
~~Masonry chimneys shall be reinforced and anchored to the building in accordance with Sections R1003.3 and R1003.4.~~

~~**R301.2.2.3.7 Anchorage of water heaters.**~~
~~Water heaters shall be anchored against movement and overturning in accordance with Section M1307.2.~~

R301.2.2.4 Seismic Design Category E. Deleted.
~~Buildings in Seismic Design Category E shall be designed to resist seismic loads in accordance with the *International Building Code*, except where the seismic design category is reclassified to a lower seismic design category in accordance with Section R301.2.2.1. Components of buildings not required to be designed to resist seismic loads shall be constructed in accordance with the provisions of this code.~~

R301.2.3 Snow loads. Deleted.
~~Wood-framed construction, cold-formed, steel-framed construction and masonry and concrete construction, and structural insulated panel construction in regions with ground snow loads 70 pounds per square foot (3.35 kPa) or less, shall be in accordance with Chapters 5, 6 and 8. Buildings in regions with ground snow loads greater than 70 pounds per square foot (3.35 kPa) shall be designed in accordance with accepted engineering practice.~~

R301.3 Story height.
The wind and seismic provisions of this code shall apply to buildings with *story heights* not exceeding the following:

1. For wood wall framing, the *story height* shall not exceed 11 feet 7 inches (3531 mm) and the laterally unsupported bearing wall stud height permitted by Table R602.3(5).

2. Deleted.~~For cold-formed steel wall framing, the *story height* shall be not more than 11 feet 7 inches (3531 mm) and the unsupported bearing wall stud height shall be not more than 10 feet (3048 mm).~~

3. For masonry walls, the *story height* shall be not more than 13 feet 7 inches (4140 mm) and the bearing wall clear height shall be not greater than 12 feet (3658 mm).

   Exception: An additional 8 feet (2438 mm) of bearing wall clear height is permitted for gable end walls.

4. For insulating concrete form walls, the maximum story height shall not exceed 11 feet 7 inches (3531 mm) and the maximum unsupported wall height per *story* as permitted by Section R608 tables shall not exceed 10 feet (3048 mm).

5. For structural insulated panel (SIP) walls, the story height shall be not greater than 11 feet 7 inches (3531 mm) and the bearing wall height per *story* as permitted by Section R610 tables shall not exceed 10 feet (3048 mm).

Individual walls or wall studs shall be permitted to exceed these limits as permitted by Chapter 6 provisions, provided that *story heights* are not exceeded. An engineered design shall be provided for the wall or wall framing members where the limits of Chapter 6 are exceeded. Where the *story height* limits of this section are exceeded, the design of the building, or the noncompliant portions thereof, to resist wind and seismic loads shall be in accordance with the *International Building Code*.

TABLE R301.5
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS

(in pounds per square foot)

USE	LIVE LOAD
Uninhabitable attics without storage[b]	10
Uninhabitable attics with limited storage[b,g]	20
Habitable attics and attics served with fixed stairs	30
Balconies (exterior) and decks[e]	40
Fire escapes	40
Guards and handrails[d]	200[h]
Guard in-fill components[f]	50[h]
Passenger vehicle garages[a]	50[a]
Rooms other than sleeping rooms	40
Sleeping rooms	30
Stairs	40[c]

For SI: 1 pound per square foot = 0.0479 kPa, 1 square inch = 645 mm^2,1 pound = 4.45 N.

a. Elevated garage floors shall be capable of supporting a 2,000-pound load applied over a 20-square-inch area.

b. Uninhabitable *attics* without storage are those where the clear height between joists and rafters is not more than 42 inches, or where there are not two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches in height by 24 inches in width, or greater, within the plane of the trusses. This live load need not be assumed to act concurrently with any other live load requirements.

c. Individual stair treads shall be designed for the uniformly distributed live load or a 300-pound concentrated load acting over an area of 4 square inches, whichever produces the greater stresses.

d. A single concentrated load applied in any direction at any point along the top.

e. See ~~Section R507.1~~ Appendix M for decks attached to *exterior walls*.

f. *Guard* in-fill components (all those except the handrail), balusters and panel fillers shall be designed to withstand a horizontally applied normal load of 50 pounds on an area equal to 1 square foot. This load need not be assumed to act concurrently with any other live load requirement.

g. Uninhabitable *attics* with limited storage are those where the clear height between joists and rafters is not greater than 42 inches, or where there are two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches in height by 24 inches in width, or greater, within the plane of the trusses.

The live load need only be applied to those portions of the joists or truss bottom chords where all of the following conditions are met:

1. The *attic* area is accessible from an opening not less than 20 inches in width by 30 inches in length that is located where the clear height in the *attic* is not less than 30 inches.
2. The slopes of the joists or truss bottom chords are not greater than 2 inches vertical to 12 units horizontal.
3. Required insulation depth is less than the joist or truss bottom chord member depth.

The remaining portions of the joists or truss bottom chords shall be designed for a uniformly distributed concurrent live load of not less than 10 pounds per square foot.

h. Glazing used in handrail assemblies and *guards* shall be designed with a safety factor of 4. The safety factor shall be applied to each of the concentrated loads applied to the top of the rail, and to the load on the in-fill components. These loads shall be determined independent of one another, and loads are assumed not to occur with any other live load.

R301.6 Roof load.

The roof shall be designed for the live load indicated ~~in Table R301.6 or the snow load indicated~~ in Table R301.2(1)~~, whichever is greater~~.

~~TABLE R301.6~~
~~MINIMUM ROOF LIVE LOADS IN POUNDS-FORCE PER SQUARE~~

~~FOOT OF HORIZONTAL PROJECTION~~

~~ROOF SLOPE~~	~~TRIBUTARY LOADED AREA IN SQUARE FEET FOR ANY STRUCTURAL MEMBER~~		
	~~0 to 200~~	~~201 to 600~~	~~Over 600~~
~~Flat or rise less than 4 inches per foot (1:3)~~	~~20~~	~~16~~	~~12~~
~~Rise 4 inches per foot (1:3) to less than 12 inches per foot (1:1)~~	~~16~~	~~14~~	~~12~~
~~Rise 12 inches per foot (1:1) and greater~~	~~12~~	~~12~~	~~12~~

~~For SI: 1 square foot = 0.0929 m^2, 1 pound per square foot = 0.0479 kPa,1 inch per foot = 83.3 mm/m.~~

TABLE R301.7
ALLOWABLE DEFLECTION OF STRUCTURAL MEMBERS[b, c, f]

STRUCTURAL MEMBER	**ALLOWABLE DEFLECTION**
Rafters having slopes greater than 3:12 with finished ceiling not attached to rafters	*L*/180
Interior walls and partitions	*H*/180
Floors	*L*/360
Ceilings with brittle finishes (including plaster and stucco)	L/360
Ceilings with flexible finishes (including gypsum board)	L/240
All other structural members	*L*/240
Exterior walls—wind loads[a] with plaster or stucco finish	*H*/360
Exterior walls—wind loads[a] with other brittle finishes	*H*/240
Exterior walls—wind loads[a] with flexible finishes	*H*/120[d]
Lintels supporting masonry veneer walls[e]	*L*/600

Note: *L* = span length, *H* = span height.

a. For the purpose of the determining deflection limits herein, the wind load shall be permitted to be taken as 0.7 times the component and cladding (ASD) loads obtained from Table R301.2(2).

b For cantilever members, *L* shall be taken as twice the length of the cantilever.

c. For aluminum structural members or panels used in roofs or walls of sunroom additions or patio covers, not supporting edge of glass or sandwich panels, the total load deflection shall not exceed *L*/60. For continuous aluminum structural members supporting edge of glass, the total load deflection shall not exceed *L*/175 for each glass lite or *L*/60 for the entire length of the member, whichever is more stringent. For sandwich panels used in roofs or walls of sunroom additions or patio covers, the total load deflection shall not exceed *L*/120.

d. Deflection for *exterior walls* with interior gypsum board finish shall be limited to an allowable deflection of *H*/180.

e. Refer to Section R703.8.2.

f. When floor spans exceed 20 feet, joists, built-up beams and trusses shall not be spaced greater than 24 inches and deflection shall not exceed L/480.

R301.8 Nominal sizes.

For the purposes of this code, dimensions of lumber specified shall be deemed to be nominal dimensions unless specifically designated as actual dimensions.

SECTION R302
FIRE-RESISTANT CONSTRUCTION

R302.1 Exterior walls.

Construction, projections, openings and penetrations of *exterior walls* of *dwellings* and accessory buildings shall comply with Table R302.1~~(1); or *dwellings* equipped throughout with an *automatic sprinkler system* installed in accordance with Section P2904 shall comply with Table R302.1(2)~~.

Exceptions:

1. Walls, projections, openings or penetrations in walls perpendicular to the line used to determine the *fire separation distance*. *Townhouse* eave projections shall comply with Sections R302.2.5 and R302.2.6.
2. Walls of *dwellings* and *accessory* *buildings* ~~*structures*~~ located on the same *lot*.
3. Detached tool sheds and storage sheds, playhouses and similar structures exempted from permits are not required to provide wall protection based on location on the *lot*. Projections beyond the *exterior wall* shall not extend over the *lot line*.
4. Detached garages accessory to a *dwelling* located within 2 feet (610 mm) of a *lot line* are permitted to have roof eave projections not exceeding 4 inches (102 mm).
5. Foundation vents installed in compliance with this code are permitted.

R302.1.1 Soffit protection.

In construction using vinyl or aluminum soffit material the following application shall apply. Soffit assemblies located on buildings with less than a 10 feet (3048 mm) fire separation distance shall be securely attached to framing members and applied over fire retardant treated wood, $^{23}/_{32}$-inch (18.3 mm) wood sheathing or $^{5}/_{8}$-inch (15.9 mm) exterior grade or moisture resistant gypsum board. Venting requirements shall be provided in both soffit and underlayments. Vents shall be either nominal 2-inch (51 mm) continuous or equivalent intermittent and shall not exceed the minimum net free air requirements established in Section R806.2 by more than 50 percent. *Townhouse* construction shall meet the additional requirements of Sections R302.2.5 and R302.2.6.

Exceptions:

1. Any portion of soffits having 10 feet (3048 mm) or more *fire separation distance*.
2. Roof rake lines where soffit does not communicate to attic are not required to be protected per this section.
3. Soffits with less than 3 feet (914 mm) *fire separation distance* shall meet the projection fire rating requirements of Table R302.1.

4. Soffits between buildings located on the same lot.

R302.1.2 Flame spread.

Vinyl siding and vinyl soffit materials shall have a flame spread index of 25 or less as tested in accordance with ASTM E-84.

TABLE R302.1~~(1)~~
EXTERIOR WALLS

EXTERIOR WALL ELEMENT		MINIMUM FIRE-RESISTANCE RATING	MINIMUM FIRE SEPARATION DISTANCE
Walls	Fire-resistance rated	1 hour—tested in accordance with ASTM E 119 or UL 263 with exposure from both sides	< ~~5~~ 3 feet
	Not fire-resistance rated	0 hours	≥ ~~5~~ 3 feet
Projections	~~Not allowed~~	~~N/A~~	~~< 2 feet~~
	Fire-resistance rated	1 hour on the underside~~[a, b]~~	~~≥ 2 feet to < 5~~ <3 feet
	Not fire-resistance rated	0 hours	~~≥ 5~~ 3 feet
Openings in walls	Not allowed	N/A	< 3 feet
	~~25% maximum of wall area~~	~~0 hours~~	~~3 feet~~
	Unlimited	0 hours	~~5~~ 3 feet
Penetrations	All	Comply with Section R302.4	< 3 feet
		None required	3 feet

For SI: 1 foot = 304.8 mm.

N/A = Not Applicable.

~~a. Roof eave fire-resistance rating shall be permitted to be reduced to 0 hours on the underside of the eave if fireblocking is provided from the wall top plate to the underside of the roof sheathing.~~

~~b. Roof eave fire-resistance rating shall be permitted to be reduced to 0 hours on the underside of the eave provided that gable vent openings are not installed.~~

~~TABLE R302.1(2)~~
~~EXTERIOR WALLS—DWELLINGS WITH FIRE SPRINKLERS~~

~~EXTERIOR WALL ELEMENT~~		~~MINIMUM FIRE-RESISTANCE RATING~~	~~MINIMUM FIRE SEPARATION DISTANCE~~
~~Walls~~	~~Fire-resistance rated~~	~~1 hour—tested in accordance with ASTM E 119 or UL 263 with exposure from the outside~~	~~0 feet~~
	~~Not fire-resistance rated~~	~~0 hours~~	~~3 feet[a]~~
~~Projections~~	~~Not allowed~~	~~N/A~~	~~< 2 feet~~
	~~Fire-resistance rated~~	~~1 hour on the underside[b, c]~~	~~2 feet[a]~~

	~~Not fire-resistance rated~~	~~0 hours~~	~~3 feet~~
~~Openings in walls~~	~~Not allowed~~	~~N/A~~	~~< 3 feet~~
	~~Unlimited~~	~~0 hours~~	~~3 feet[a]~~
~~Penetrations~~	~~All~~	~~Comply with Section R302.4~~	~~< 3 feet~~
		~~None required~~	~~3 feet[a]~~

~~For SI: 1 foot = 304.8 mm.~~
~~N/A = Not Applicable~~

~~a. For residential subdivisions where all *dwellings* are equipped throughout with an automatic sprinkler system installed in accordance with Section P2904, the *fire separation distance* for nonrated exterior walls and rated projections shall be permitted to be reduced to 0 feet, and unlimited unprotected openings and penetrations shall be permitted, where the adjoining *lot* provides an open setback *yard* that is 6 feet or more in width on the opposite side of the property line.~~

~~b. The roof eave fire-resistance rating shall be permitted to be reduced to 0 hours on the underside of the eave if fireblocking is provided from the wall top plate to the underside of the roof sheathing.~~

~~c. The roof eave fire-resistance rating shall be permitted to be reduced to 0 hours on the underside of the eave provided that gable vent openings are not installed.~~

R302.2 Townhouses.

~~Common walls separating *townhouses* shall be assigned a fire-resistance rating in accordance with Section R302.2, Item 1 or 2. The common wall shared by two *townhouses* shall be constructed without plumbing or mechanical equipment, ducts or vents in the cavity of the common wall. The wall shall be rated for fire exposure from both sides and shall extend to and be tight against exterior walls and the underside of the roof sheathing. Electrical installations shall be in accordance with Chapters 34 through 43. Penetrations of the membrane of common walls for electrical outlet boxes shall be in accordance with Section R302.4.~~

1. ~~Where a fire sprinkler system in accordance with Section P2904 is provided, the common wall shall be not less than a 1-hour fire-resistance-rated wall assembly tested in accordance with ASTM E 119 or UL 263.~~

2. ~~Where a fire sprinkler system in accordance with Section P2904 is not provided, the common wall shall be not less than a 2-hour fire-resistance-rated wall assembly tested in accordance with ASTM E 119 or UL 263.~~

Each *townhouse* shall be considered a separate building and shall be separated by fire-resistance-rated wall assemblies meeting the requirements of Section R302.1 for exterior walls.

> **Exception:** If an automatic residential fire sprinkler is installed, a common 1-hour fire-resistance-rated wall assembly tested in accordance with ASTME 119 or UL 263 is permitted for townhouses if such walls do not contain plumbing or mechanical equipment, ducts or vents in the cavity of the common wall. The wall shall be rated for fire exposure from both sides and shall extend to and be tight against exterior wall sheathing and the underside of the roof sheathing. Electrical installations shall be installed in accordance with Section R302.4.

R302.2.1 Continuity.

The fire-resistance-rated wall or assembly separating *townhouses* shall be continuous from the foundation to the underside of the roof sheathing, deck or slab, or exterior wall sheathing. The fire-resistance rating shall extend the full length of the wall or assembly, including wall extensions through and separating attached enclosed *accessory structures*.

R302.2.3 Parapet construction.

Parapets shall have the same fire-resistance rating as that required for the supporting wall or walls. On any side adjacent to a roof surface, the parapet shall have noncombustible faces for the uppermost 18 inches (457 mm), to include counterflashing and coping materials. Where the roof slopes toward a parapet at slopes greater than 2 units vertical in 12 units horizontal (16.7-percent slope), the parapet shall extend to the same height as any portion of the roof within a distance of 3 feet (914 mm), and the height shall be not less than 30 inches (762 mm).

R302.2.4 Structural independence.

Each individual *townhouse* shall be structurally independent.

Exceptions:

1. Foundations supporting *exterior walls* or common walls.
2. Structural roof and wall sheathing from each unit fastened to the common wall framing.
3. Nonstructural wall and roof coverings.
4. Flashing at termination of roof covering over common wall.
5. *Townhouses* separated by a common wall as provided in Section R302.2~~, Item 1 or 2~~.

R302.2.5 Townhouse eave protection.

In *townhouse* construction (with three or more attached dwellings) projections extending into the fire separation distance shall have not less than 1 hour fire resistive construction on the underside. Soffit material beyond the fire separation distance shall be securely attached to framing members and shall be constructed using either noncombustible soffit material; fire-retardant-treated soffit material; vinyl soffit installed over $^{3}/_{4}$-inch (19 mm) wood sheathing or $^{5}/_{8}$-inch (15.9 mm) gypsum board; or aluminum soffit installed over $^{3}/_{4}$-inch (19 mm) wood sheathing or $^{5}/_{8}$-inch (15.9 mm) gypsum board. Venting requirements shall be provided in both soffit and underlayments. Vents shall be either nominal 2-inch (51 mm) continuous or equivalent intermittent and shall not exceed the minimum net free air requirements established in Section R806.2 by more than 50 percent. Vents in soffit are not allowed within 4 feet (1219 mm) of fire walls or property lines.

R302.2.6 Townhouse eave projections.

Overhang projections not exceeding 12 inches (305 mm) shall be allowed to extend beyond the property line in townhouse buildings provided all the following conditions are met:

1. Required fire resistant rated wall assembly is tight to roof deck; and

2. Eaves shall be protected with roof decking and fascia of non-combustible materials or approved fire-retardant- treated wood; and
3. Eaves shall have not less than one layer of 5/8-inch (15.9 mm) Type X gypsum board or equivalent fire-resistive construction on the underside.

R302.2.7 Sound transmission.

See Appendix K.

R302.5.1 Opening protection.

Openings from a private garage directly into a room used for sleeping purposes shall not be permitted. Other openings between the garage and residence shall be equipped with solid wood doors not less than 1 3/8 inches (35 mm) in thickness, solid or honeycomb-core steel doors not less than 1 3/8 inches (35 mm) thick, or 20-minute fire-rated doors~~, equipped with a self-closing device~~.

> **Exception:** A disappearing/pull-down stairway to uninhabited attic space with minimum ⅜-inch (9.53 mm) (nominal) fire retardant-treated structural panel is equivalent to the separation requirement from attics in Table R302.6.

R302.6 Dwelling-garage fire separation.

The garage shall be separated as required by Table R302.6. Openings in garage walls shall comply with Section R302.5. ~~Attachment of gypsum board shall comply with Table R702.3.5.~~ The wall separation provisions of Table R302.6 shall not apply to garage walls that are perpendicular to the adjacent *dwelling unit* wall.

TABLE R302.6
DWELLING-GARAGE SEPARATION

SEPARATION	MATERIAL
From the residence and attics	Not less than 1/2-inch gypsum board or equivalent applied to the garage side
From habitable rooms above the garage[a]	Not less than 5/8-inch Type X gypsum board or equivalent
Structure(s) supporting floor/ceiling assemblies used for separation required by this section	Not less than 1/2-inch gypsum board or equivalent
Garages located less than 3 feet from a dwelling unit on the same lot	Not less than 1/2-inch gypsum board or equivalent applied to the interior side of exterior walls that are within this area

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

a. For dwelling units constructed prior to the *2012 North Carolina Residential Code* edition, ½” or greater existing gypsum board on the bottom side of the garage ceiling shall be acceptable. Joints shall be taped.

R302.11 Fireblocking.

In combustible construction, fireblocking shall be provided to cut off both vertical and horizontal concealed draft openings and to form an effective fire barrier between stories, and between a top *story* and the roof space.

Fireblocking shall be provided in wood-framed construction in the following locations:

1. In concealed spaces of stud walls and partitions, ~~including furred spaces and parallel rows of studs or staggered studs,~~ as follows:
    - 1.1. Vertically at the ceiling and floor levels.
    - 1.2. Horizontally at intervals not exceeding 10 feet (3048 mm) in furred spaces and parallel rows of studs or staggered studs.
2. At interconnections between concealed vertical and horizontal spaces such as occur at soffits, drop ceilings and cove ceilings.
3. In concealed spaces between stair stringers at the top and bottom of the run. Enclosed spaces under stairs shall comply with Section R302.7.
4. At openings around vents, pipes, ducts, cables and wires at ceiling and floor level, with an *approved* material to resist the free passage of flame and products of combustion. The material filling this annular space shall not be required to meet the ASTM E 136 requirements.
5. For the fireblocking of chimneys and fireplaces, see Section R1003.19.
6. Fireblocking of cornices of a two-family *dwelling* is required at the line of *dwelling unit* separation.

R302.13 Fire protection of floors. Deleted.

~~Floor assemblies that are not required elsewhere in this code to be fire-resistance rated, shall be provided with a $^{1}/_{2}$-inch (12.7 mm) gypsum wallboard membrane, $^{5}/_{8}$-inch (16 mm) wood structural panel membrane, or equivalent on the underside of the floor framing member. Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping and similar openings or penetrations shall be permitted.~~

~~**Exceptions:**~~

~~1. Floor assemblies located directly over a space protected by an automatic sprinkler system in accordance with Section P2904, NFPA 13D, or other approved equivalent sprinkler system.~~

~~2. Floor assemblies located directly over a crawl space not intended for storage or fuel-fired appliances.~~

3. ~~Portions of floor assemblies shall be permitted to be unprotected where complying with the following:~~

    ~~3.1. The aggregate area of the unprotected portions does not exceed 80 square feet (7.4 m^2) per story~~

    ~~3.2. Fireblocking in accordance with Section R302.11.1 is installed along the perimeter of the unprotected portion to separate the unprotected portion from the remainder of the floor assembly.~~

4. ~~Wood floor assemblies using dimension lumber or structural composite lumber equal to or greater than 2-inch by 10-inch (50.8 mm by 254 mm) nominal dimension, or other approved floor assemblies demonstrating equivalent fire performance.~~

SECTION R303
LIGHT, VENTILATION AND HEATING

R303.2.1 Sunroom additions.
Required glazed openings shall be permitted to open into sunroom *additions* or patio covers that abut a street, *yard* or court if in excess of 40 percent of the exterior sunroom walls are open, or are enclosed only by insect screening, and the ceiling height of the sunroom is not less than 7 feet (2134 mm).

R303.4 Mechanical ventilation. Deleted.
~~Where the air infiltration rate of a *dwelling unit* is 5 air changes per hour or less where tested with a blower door at a pressure of 0.2 inch w.c (50 Pa) in accordance with Section N1102.4.1.2, the *dwelling unit* shall be provided with whole-house mechanical ventilation in accordance with Section M1507.3.~~

R303.8.1 Sunroom additions. Deleted.
~~Required glazed openings shall be permitted to open into sunroom *additions* or patio covers that abut a street, *yard* or court if in excess of 40 percent of the exterior sunroom walls are open, or are enclosed only by insect screening, and the ceiling height of the sunroom is not less than 7 feet (2134 mm).~~

R303.9 Required heating.
Where the winter design temperature in Table R301.2(1) is below 60°F (16°C), every *dwelling unit* shall be provided with heating facilities capable of maintaining a room temperature of not less than 68°F (20°C) at a point 3 feet (914 mm) above the floor and 2 feet (610 mm) from exterior walls in habitable rooms at the design temperature. The installation of one or more portable space heaters shall not be used to achieve compliance with this section.

Exception: Unconditioned *sunrooms* that are thermally isolated from the dwelling.

SECTION R305
CEILING HEIGHT

R305.1 Minimum height.

Habitable space, hallways and portions of *basements* containing these spaces shall have a ceiling height of not less than 7 feet (2134 mm). Bathrooms, toilet rooms and laundry rooms shall have a ceiling height of not less than 6 feet 8 inches (2032 mm).

Exceptions:

1. For rooms with sloped ceilings, the required floor area of the room shall have a ceiling height of not less than 5 feet (1524 mm) and not less than 50 percent of the required floor area shall have a ceiling height of not less than 7 feet (2134 mm).

2. The ceiling height above bathroom and toilet room fixtures shall be such that the fixture is capable of being used for its intended purpose. A shower or tub equipped with a showerhead shall have a ceiling height of not less than 6 feet 8 inches (2032 mm) above an area of not less than 30 inches (762 mm) by 30 inches (762 mm) at the showerhead.

3. Beams, girders, ducts or other obstructions in ~~*basements* containing~~ *habitable space* shall be permitted to project to within 6 feet 4 inches (1931 mm) of the finished floor.

SECTION R308
GLAZING

R308.4.2 Glazing adjacent to doors.

Glazing in an individual fixed or operable panel ~~adjacent to a~~ in the same plane as the door shall be considered to be a hazardous location where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) above the floor or walking surface and it meets either of the following conditions:

1. Where the glazing is within 24 inches (610 mm) of either side of the door in the plane of the door in a closed position.

2. Deleted.~~Where the glazing is on a wall perpendicular to the plane of the door in a closed position and within 24 inches (610 mm) of the hinge side of an in-swinging door.~~

   Exceptions:

   1. Decorative glazing.

   2. Where there is an intervening wall or other permanent barrier between the door and the glazing.

   3. Where access through the door is to a closet or storage area 3 feet (914 mm) or less in depth. Glazing in this application shall comply with Section R308.4.3.

   4. Glazing that is adjacent to the fixed panel of patio doors.

R308.4.6 Glazing adjacent to stairs and ramps.
Glazing where the bottom exposed edge of the glazing is less than 36 inches (914 mm) above the plane of the adjacent walking surface of stairways, landings between flights of stairs and ramps shall be considered to be a hazardous location.

Exceptions:

1. Where a rail is installed on the accessible side(s) of the glazing 34 to 38 inches (864 to 965 mm) above the walking surface. The rail shall be capable of withstanding a horizontal load of 50 pounds per linear foot (730 N/m) without contacting the glass and have a cross-sectional height of not less than $1^1/_2$ inches (38 mm).
2. Glazing 36 inches (914 mm) or more measured horizontally from the walking surface.
3. Where a change in elevation is 8 ¼ inches (210 mm) or less at an exterior door.

R308.6.9.1 Comparative analysis for glass-glazed unit skylights.
Structural wind load design pressures for glass-glazed unit skylights smaller ~~different~~ than the size tested in accordance with Section R308.6.9 shall be permitted. ~~to be different than the design value of the tested unit where determined in accordance with one of the following comparative analysis methods:~~

~~1. Structural wind load design pressures for glass-glazed unit skylights smaller than the size tested in accordance with Section R308.6.9 shall be permitted to be higher than the design value of the tested unit provided that such higher pressures are determined by accepted engineering analysis. Components of the smaller unit shall be the same as those of the tested unit. Such calculated design pressures shall be validated by an additional test of the glass-glazed unit skylight having the highest allowable design pressure.~~

~~2. In accordance with WDMA I.S. 11.~~

SECTION R309
GARAGES AND CARPORTS

R309.5 Fire sprinklers. Deleted.
~~Private garages shall be protected by fire sprinklers where the garage wall has been designed based on Table R302.1(2), Footnote a. Sprinklers in garages shall be connected to an automatic sprinkler system that complies with Section P2904. Garage sprinklers shall be residential sprinklers or quick-response sprinklers, designed to provide a density of 0.05 gpm/ft~~^{2}~~. Garage doors shall not be considered obstructions with respect to sprinkler placement.~~

SECTION R310
EMERGENCY ESCAPE AND RESCUE OPENINGS

R310.2.1 Minimum opening area.
Emergency and escape rescue openings shall have a ~~net clear opening of not less than 5.7 square feet (0.530 m^2). The net clear opening dimensions required by this section shall be obtained by the normal operation of the emergency escape and rescue opening from the inside. The net clear height opening shall be not less than 24 inches (610 mm) and the net clear width shall be not less than 20 inches (508 mm).~~ minimum net clear openable area of 4 square feet (0.372 m^2). The minimum net clear opening height shall be 22 inches (558 mm). The minimum net clear opening width shall be 20 inches (508 mm). Emergency escape and rescue openings must have a minimum total glazing area of not less than 5 square feet (0.465 m^2) in the case of a ground floor level window and not less than 5.7 square feet (0.530 m^2) in the case of an upper story window.

> ~~**Exception:** *Grade* floor or below *grade* openings shall have a net clear opening of not less than 5 square feet (0.465 m^2).~~

> **R310.2.3.2 Drainage.** Deleted.
> ~~Window wells shall be designed for proper drainage by connecting to the building's foundation drainage system required by Section R405.1 or by an approved alternative method.~~
>
> > ~~**Exception:** A drainage system for window wells is not required where the foundation is on well-drained soil or sand-gravel mixture soils in accordance with the United Soil Classification System, Group I Soils, as detailed in Table R405.1.~~

> **R310.3.2.1 Drainage.** Deleted.
> ~~Bulkhead enclosures shall be designed for proper drainage by connecting to the building's foundation drainage system required by Section R405.1 or by an *approved* alternative method.~~
>
> > ~~**Exception:** A drainage system for bulkhead enclosures is not required where the foundation is on well-drained soil or sand-gravel mixture soils in accordance with the United Soil Classification System, Group I Soils, as detailed in Table R405.1.~~

SECTION R311
MEANS OF EGRESS

R311.1 Means of egress.
All d*wellings* shall be provided with a means of egress ~~in accordance with~~ as provided in this section. The means of egress shall provide a continuous and unobstructed path of vertical and horizontal egress travel from all portions of the *dwelling* to the exterior of the *dwelling* at the required exterior egress door without requiring travel through a garage. ~~The required egress door shall open directly into a public way or to a *yard* or court that opens to a public way.~~

> **Exception:** Equipment service platforms may be served by ladders constructed per Section R310.2.3.1.

R311.2 Egress door.
Not less than one exterior egress door shall be provided for each *dwelling* unit. The egress door shall be side-hinged, and shall provide a clear width of not less than 32 inches (813 mm) where

measured between the face of the door and the stop, with the door open 90 degrees (1.57 rad). The clear height of the door opening shall be not less than 78 inches (1981 mm) in height measured from the top of the threshold to the bottom of the stop. Other exterior doors shall not be required to comply with these minimum dimensions. Egress doors shall be readily openable from inside the *dwelling* without the use of a key or special knowledge or effort.

R311.3.1 Floor elevations at the required egress doors.

Landings or finished floors at the required egress door shall be not more than $1^{1}/_{2}$ inches (38 mm) lower than the top of the threshold.

Exception: The exterior landing or floor~~ on the exterior side ~~shall be not more than ~~$7^{3}/_{4}$~~ $8^{1}/_{4}$ inches (~~196~~ 210 mm) below the top of the threshold provided the door does not swing over the landing or floor.

Where exterior landings or floors serving the required egress door are not at *grade*, they shall be provided with access to *grade* by means of a ramp in accordance with Section R311.8 or a stairway in accordance with Section R311.7.

R311.3.2 Floor elevations for other exterior doors.

Doors other than the required egress door shall be provided with landings or floors not more than ~~$7^{3}/_{4}$~~ $8^{1}/_{4}$ inches (~~196~~ 210 mm) below the top of the threshold.

Exception: A ~~top~~ landing is not required where a stairway ~~of not more than two risers~~ is located on the exterior side of the door, provided that the door does not swing over the stairway.

R311.4 Vertical egress. Deleted.

~~Egress from habitable levels including habitable attics and *basements* not provided with an egress door in accordance with Section R311.2 shall be by a ramp in accordance with Section R311.8 or a stairway in accordance with Section R311.7.~~

R311.5 Construction.

R311.5.1 Attachment. Deleted.

~~Exterior landings, decks, balconies, stairs and similar facilities shall be positively anchored to the primary structure to resist both vertical and lateral forces or shall be designed to be self-supporting. Attachment shall not be accomplished by use of toenails or nails subject to withdrawal.~~

R311.6 Hallways.

The width of a hallway shall be not less than 3 feet (914 mm) measured from the finished surface of the walls.

R311.6.1 Interior egress doors.

All doors providing egress from habitable rooms shall have nominal minimum dimensions of 2 feet 6 inches (782 mm) width by 6 feet 8 inches (2032 mm) height. Interior egress doors shall be readily openable from the side from which egress is to be made without the use of a key or special knowledge or effort.

R311.7 Stairways.

R311.7.1 Width.

Stairways shall be not less than 36 inches (914 mm) in clear width at all points above the permitted handrail height and below the required headroom height. Handrails shall not project more than $4^{1}/_{2}$ inches (114 mm) on either side of the stairway and the clear width of the stairway at and below the handrail height, including treads and landings, shall be not less than $31^{1}/_{2}$ inches (787 mm) where a handrail is installed on one side and 27 inches (698 mm) where handrails are provided on both sides.

Exceptions:

1. The width of spiral stairways shall be in accordance with Section R311.7.10.1.

2. Stairways not required for egress shall be permitted to be a minimum width of 26 inches (660 mm).

R311.7.4 Walkline. Deleted.
~~The walkline across winder treads shall be concentric to the curved direction of travel through the turn and located 12 inches (305 mm) from the side where the winders are narrower. The 12-inch (305 mm) dimension shall be measured from the widest point of the clear stair width at the walking surface of the winder. If winders are adjacent within the flight, the point of the widest clear stair width of the adjacent winders shall be used.~~

R311.7.5.1 Risers.

The riser height shall be not more than ~~$7^{3}/_{4}$~~ $8^{1}/_{4}$ inches (~~196~~ 210 mm).The riser shall be measured vertically between leading edges of the adjacent treads. The greatest riser height within any flight of stairs shall not exceed the smallest by more than $^{3}/_{8}$ inch (9.5 mm). ~~Risers shall be vertical or sloped from the underside of the nosing of the tread above at an angle not more than 30 degrees (0.51 rad) from the vertical. Open risers are permitted provided that the openings located more than 30 inches (762 mm), as measured vertically, to the floor or grade below do not permit the passage of a 4-inch-diameter (102 mm) sphere.~~ The top and bottom riser of interior stairs shall not exceed the smallest riser within that stair run by more than 3/4 inch (19 mm). The height of the top and bottom riser of the interior stairs shall be measured from the permanent finished surface (carpet excluded). Where the bottom riser of an exterior stair adjoins an exterior walk, porch, driveway, patio, garage floor, or finish grade, the height of the riser may be less than the height of the adjacent risers.

~~**Exceptions:**~~

1. ~~The opening between adjacent treads is not limited on spiral stairways.~~

2. ~~The riser height of spiral stairways shall be in accordance with Section R311.7.10.1.~~

R311.7.5.2 Treads.

The minimum tread depth shall be not less than ~~10~~ 9 inches (~~254~~ 229 mm).The tread depth shall be measured horizontally between the vertical planes of the foremost projection of adjacent treads and at a right angle to the tread's leading edge. The greatest tread depth within any flight of stairs shall not exceed the smallest by more than $^{3}/_{8}$ inch (9.5 mm).

R311.7.5.2.1 Winder treads.

Winder treads shall have a tread depth of not less than ~~10~~ 9 inches (~~254~~ 229 mm) measured between the vertical planes of the foremost projection of adjacent treads at the intersections with the walkline. Winder treads shall have a tread depth of not less than ~~6~~ 4 inches (~~152~~ 102 mm) at any point within the clear width of the stair. Within any flight of stairs, the largest winder tread depth at the walkline shall not exceed the smallest winder tread by more than $^{3}/_{8}$ inch (9.5 mm). ~~Consistently shaped winders at the walkline shall be allowed within the same flight of stairs as rectangular treads and do not have to be within $^{3}/_{8}$ inch (9.5 mm) of the rectangular tread depth.~~

~~**Exception:** The tread depth at spiral stairways shall be in accordance with Section R311.7.10.1.~~

R311.7.5.3 Nosings.

The radius of curvature at the nosing shall be not greater than $^{9}/_{16}$ inch (14 mm). A nosing projection not less than $^{3}/_{4}$ inch (19 mm) and not more than 1$^{1}/_{4}$ inches (32 mm) shall be provided on stairways with solid risers. The greatest nosing projection shall not exceed the smallest nosing projection by more than $^{3}/_{8}$ inch (9.5 mm) between two stories, including the nosing at the level of floors and landings. Beveling of nosings shall not exceed $^{1}/_{2}$ inch (12.7 mm).

Exceptions:

1. A nosing projection is not required where the tread depth is not less than 11 inches (279 mm).
2. The opening between adjacent treads is not limited on stairs with a total rise of 30 inches (762 mm) or less.

R311.7.5.4 Exterior plastic composite stair treads.

Plastic composite exterior stair treads shall comply with the provisions of this section and ~~Section R507.3~~ the requirements of ASTM D 7032.

R311.7.6 Landings for stairways.

~~There shall be a floor or landing at the top and bottom of each stairway. The width perpendicular to the direction of travel shall be not less than the width of the flight served.~~

~~Landings of shapes other than square or rectangular shall be permitted provided that the depth at the walk line and the total area is not less than that of a quarter circle with a radius equal to the required landing width. Where the stairway has a straight run, the depth in the direction of travel shall be not less than 36 inches (914 mm).~~
There shall be a floor or landing at the top and bottom of each stairway. A flight of stairs shall not have a vertical rise larger than 12 feet 3 inches (3734 mm) between floor levels or landings. The width of each landing shall not be less than the width of the stairway served. Every landing shall have a minimum dimension of 36 inches (914 mm) measured in the direction of travel.

Exception: A floor or landing is not required at the top of an interior flight of stairs, including stairs in an enclosed garage, provided that a door does not swing over the stairs.

R311.7.8.2 Continuity.

Handrails for stairways shall be continuous for the full length of the flight, from a point directly above the top riser of the flight to a point directly above the lowest riser of the flight. Handrail ends shall be returned or shall terminate in newel posts or safety terminals. Handrails adjacent to a wall shall have a space of not less than $1^{1}/_{2}$ inches (38 mm) between the wall and the handrails.

Exceptions:

1. Handrails shall be permitted to be interrupted by a newel post at the turn.
2. The use of a volute, turnout, starting easing or starting newel shall be allowed over the lowest tread.
3. Two or more separate rails shall be considered continuous if the termination of the rails occurs within 6 inches (152 mm) of each other. If transitioning between a wall-mounted handrail and a guardrail/handrail, the wall-mounted rail shall return into the wall.

R311.7.8.3 Grip-size.

Required handrails shall be of one of the following types or provide equivalent graspability.

1. Type I. Handrails with a circular cross section shall have an outside diameter of not less than $1^{1}/_{4}$ inches (32 mm) and not greater than 2 inches (51 mm). If the handrail is not circular, it shall have a perimeter dimension of not less than 4 inches (102 mm) and not greater than $6^{1}/_{4}$ inches (160 mm) with a cross section of dimension of not more than $2^{1}/_{4}$ inches (57 mm). Edges shall have a radius of not less than 0.01 inch (0.25 mm).

2. Type II. Handrails with a perimeter greater than $6^{1}/_{4}$ inches (160 mm) shall have a graspable finger recess area on both sides of the profile. The finger recess shall begin within a distance of $^{3}/_{4}$ inch (19 mm) measured vertically from the tallest portion of the profile and achieve a depth of not less than 5/16 inch (8 mm) within $^{7}/_{8}$ inch (22 mm) below the widest portion of the profile. This required depth shall continue for not less than $^{3}/_{8}$ inch (10 mm) to a level that is not less than $1^{3}/_{4}$ inches (45 mm) below the tallest portion of the profile. The width of the handrail above the recess shall be not less than $1^{1}/_{4}$ inches (32 mm) and not more than $2^{3}/_{4}$ inches (70 mm). Edges shall have a radius of not less than 0.01 inch (0.25 mm).

   Exception: Exterior handrails (garages and areas exposed to the weather) shall not be more than $3^{1}/_{2}$ inches (89 mm) in cross-section dimension.

R311.7.8.4 Exterior plastic composite handrails.

Plastic composite exterior handrails shall comply with the requirements of ~~Section R507.3~~ ASTM D 7032.

R311.7.10 Special stairways.

Spiral stairways, ~~and~~ bulkhead enclosure stairways and bowed tread stairways shall comply with the requirements of Section R311.7 except as specified in Sections R311.7.10.1 ~~and~~ through R311.7.10.~~2~~3.

R311.7.10.3 Bowed tread stairways.

Bowed tread stairways are permitted provided they are uniform in bowed tread depth along the entire width of the tread with not more than $^{3}/_{8}$ inch (9.5 mm) variance from greatest to smallest tread in the stairway flight. At no point shall the tread be less than 9 inches (229 mm) with a nosing as listed in Sections R311.7.5.2 and R311.7.5.3 respectively.

R311.7.10.3.1 Standard stairway application.

The bottom 3 treads in a standard straight run stairway application as listed under Section R311.7.5.2 are permitted to bow provided at no point along the width of the tread they are less than 9 inches (229 mm) as measured under Section R311.7.5.2 and each bowed tread is uniform with other bowed treads with no more than $^{3}/_{8}$ inch (9.5 mm) variance from greatest to least. Nosing is required as listed in Section R311.7.5.3.

R311.7.10.3.2 Bowed tread circular stairways.

Bowed treads in a circular stairway are permitted provided they are uniformed as per winder treads as listed in Section R311.7.5.2 measured at a point 12 inches (305 mm) from the side where the treads are narrower. At this walk line, bowed treads must be uniform with other circular stairway treads with the greatest tread not to exceed the smallest by more than 3/8 inch (9.5 mm). Nosing is required as listed in Section R311.7.5.3.

R311.7.11 Alternating tread devices. Deleted.
~~Alternating tread devices shall not be used as an element of a means of egress. Alternating tread devices shall be permitted provided that the required means of egress stairway or ramp serves the same space at each adjoining level or where a means of egress is not required. The clear width at and below the handrails shall be not less than 20 inches (508 mm).~~

~~**R311.7.11.1 Treads of alternating tread devices.**~~
~~Alternating tread devices shall have a tread depth of not less than 5 inches (127 mm), a projected tread depth of not less than 8 1/2 inches (216 mm), a tread width of not less than 7 inches (178 mm) and a riser height of not more than 9 1/2 inches (241 mm). The tread depth shall be measured horizontally between the vertical planes of the foremost projections of adjacent treads. The riser height shall be measured vertically between the leading edges of adjacent treads. The riser height and tread depth provided shall result in an angle of ascent from the horizontal of between 50 and 70 degrees (0.87 and 1.22 rad). The initial tread of the device shall begin at the same elevation as the platform, landing or floor surface.~~

~~**R311.7.11.2 Handrails of alternating tread devices.**~~
~~Handrails shall be provided on both sides of alternating tread devices and shall comply with Sections R311.7.8.2 to R311.7.8.4. Handrail height shall be uniform, not less than 30 inches (762 mm) and not more than 34 inches (864 mm).~~

SECTION R312
GUARDS AND WINDOW FALL PROTECTION

R312.1.4 Exterior plastic composite guards. Deleted.
~~Plastic composite exterior *guards* shall comply with the requirements of Section R317.4.~~

SECTION R313
AUTOMATIC FIRE SPRINKLER SYSTEMS

R313.1 Townhouse automatic fire sprinkler systems.
An automatic residential fire sprinkler system shall be installed in *townhouses*.

Exceptions:

1. Townhouses constructed with a common 2-hour fire-resistance-rated wall assembly tested in accordance with ASTM E 119 or UL 263 provided such walls do not contain plumbing or mechanical equipment, ducts or vents in the cavity of the common wall. The wall shall be rated for fire exposure from both sides and shall extend to and be tight against exterior wall sheathing and the underside of

the roof sheathing. Electrical installations shall be installed in accordance with Chapters 34 through 43. Penetrations for electrical outlet boxes shall be in accordance with Section R302.4.

2. An automatic residential fire sprinkler system shall not be required where *additions* or *alterations* are made to existing *townhouses* that do not have an automatic residential fire sprinkler system installed.

R313.2 One- and two-family dwellings automatic fire systems. Deleted.
~~An automatic residential fire sprinkler system shall be installed in one- and two-family *dwellings*.~~

~~**Exception:** An automatic residential fire sprinkler system shall not be required for *additions* or *alterations* to existing buildings that are not already provided with an automatic residential sprinkler system.~~

~~**R313.2.1 Design and installation.**~~
~~Automatic residential fire sprinkler systems shall be designed and installed in accordance with Section P2904 or NFPA 13D.~~

SECTION R314
SMOKE ALARMS

R314.2.2 Alterations, repairs and additions.
Where *alterations*, *repairs* or *additions* requiring a building permit occur, or where one or more sleeping rooms are added or created in existing *dwellings*, the individual *dwelling unit* shall be equipped with smoke alarms located as required for new *dwellings*.

Exceptions:

1. Work involving the exterior surfaces of *dwellings*, such as the replacement of roofing or siding, the *addition* or replacement of windows or doors, or the addition of a porch or deck, are exempt from the requirements of this section.

2. Installation, alteration or repairs of plumbing or mechanical systems are exempt from the requirements of this section.

R314.4 Interconnection.
Where more than one smoke alarm is required to be installed within an individual dwelling unit in accordance with Section R314.3, the alarm devices shall be interconnected in such a manner that the actuation of one alarm will activate all of the alarms in the individual *dwelling unit*. Physical interconnection of smoke alarms shall not be required where listed wireless alarms are installed and all alarms sound upon activation of one alarm.

Exception: Interconnection of smoke alarms in existing areas shall not be required where *alterations* or repairs do not result in removal of interior wall or ceiling finishes exposing the structure~~, unless there is an *attic*, crawl space or *basement* available that could provide access for interconnection without the removal of interior finishes~~.

SECTION R315
CARBON MONOXIDE ALARMS

R315.2.1 New construction.
For new construction, carbon monoxide alarms shall be provided in dwelling units where either or both of the following conditions exist.

1. The *dwelling unit* contains a fuel-fired *appliance* or fireplace.
2. The *dwelling unit* has an attached garage with an opening that communicates with the dwelling unit.

R315.2.2 Alterations, repairs and additions.
Where *alterations*, repairs or *additions* requiring a building permit occur, or where one or more sleeping rooms are added or created in existing *dwellings*, or where fuel-fired *appliances* or fireplaces are added or replaced, the individual *dwelling unit* shall be equipped with carbon monoxide alarms located as required for new *dwellings*.

Exceptions:

1. Work involving the exterior surfaces of *dwellings*, such as the replacement of roofing or siding, or the addition or replacement of windows or doors, or the addition of a porch or deck, or the installation of a fuel fired appliance that cannot introduce carbon monoxide to the interior of the dwelling, is exempt from the requirements of this section.
2. ~~Installation, alteration or repairs of plumbing or mechanical systems are exempt from the requirements of this section.~~ Deleted.

SECTION R316
FOAM PLASTIC

R316.5.3 Attics.
The thermal barrier specified in Section R316.4 is not required where all of the following apply:

1. *Attic* access is required by Section R807.1.
2. The space is entered only for purposes of repairs or maintenance.
3. The foam plastic insulation has been tested in accordance with Section R316.6 or the foam plastic insulation is protected against ignition using one of the following ignition barrier materials:
    - 3.1. $1^{1}/_{2}$-inch-thick (38 mm) mineral fiber insulation.
    - 3.2. $^{1}/_{4}$-inch-thick (6.4 mm) wood structural panels.

3.3. $^{3}/_{8}$-inch (9.5 mm) particleboard.

3.4. $^{1}/_{4}$-inch (6.4 mm) hardboard.

3.5. $^{3}/_{8}$-inch (9.5 mm) gypsum board.

3.6. Corrosion-resistant steel having a base metal thickness of 0.016 inch (0.406 mm).

3.7. $1^{1}/_{2}$-inch-thick (38 mm) cellulose insulation; or

3.8. $^{1}/_{4}$-inch (6.4 mm) fiber-cement panel, soffit or backer board.

~~The ignition barrier is not required where the foam plastic insulation has been tested in accordance with Section R316.6.~~

R316.5.4 Crawl spaces.

The thermal barrier specified in Section R316.4 is not required where all of the following apply:

1. Crawl space access is required by Section R408.~~4~~8.
2. Entry is made only for purposes of repairs or maintenance.
3. The foam plastic insulation has been tested in accordance with Section R316.6 or the foam plastic insulation is protected against ignition using one of the following ignition barrier materials:

3.1. $1^{1}/_{2}$-inch-thick (38 mm) mineral fiber insulation;

3.2. $^{1}/_{4}$-inch-thick (6.4 mm) wood structural panels;

3.3. $^{3}/_{8}$-inch (9.5 mm) particleboard;

3.4. $^{1}/_{4}$-inch (6.4 mm) hardboard;

3.5. $^{3}/_{8}$-inch (9.5 mm) gypsum board; or

3.6. Corrosion-resistant steel having a base metal thickness of 0.016 inch (0.406 mm).

R316.7 Termite damage.

The use of foam plastics in areas of “~~very~~ moderate- heavy” termite infestation probability shall be in accordance with Section R318.4.

SECTION R317
PROTECTION OF WOOD AND WOOD-BASED PRODUCTS AGAINST DECAY

R317.1 Location required.

Protection of wood and wood- based products from decay shall be provided in the following locations by the use of naturally durable wood or wood that is preservative-treated in accordance with AWPA U1 for the species, product, preservative and end use. Preservatives shall be listed in Section 4 of AWPA U1.

1. Wood joists or the bottom of a wood structural floor when closer than 18 inches (457 mm) or wood girders when closer than 12 inches (305 mm) to the exposed ground in crawl spaces or unexcavated area located within the periphery of the building foundation.

2. Wood framing members that rest on concrete or masonry exterior foundation walls ~~and are less than 8 inches (203 mm) from the exposed ground~~.

3. Sills and sleepers on a concrete or masonry unless the slab that is in direct contact with the ground is separated from the ground ~~unless separated from such slab~~ by an impervious moisture barrier.

4. The ends of wood girders entering exterior masonry or concrete walls having clearances of less than $^{1}/_{2}$ inch (12.7 mm) on tops, sides and ends.

5. Wood siding~~,~~ and sheathing ~~and wall framing~~ on the exterior of a building having a clearance of less than 6 inches (152 mm) from the ground ~~or less than 2 inches (51 mm) measured vertically from concrete steps, porch slabs, patio slabs and similar horizontal surfaces exposed to the weather~~.

6. Wood structural members supporting moisture-permeable floors or roofs that are exposed to the weather, such as concrete or masonry slabs, unless separated from such floors or roofs by an impervious moisture barrier.

7. Wood furring strips or other wood framing members attached directly to the interior of exterior masonry walls or concrete walls below *grade* except where an *approved* vapor retarder is applied between the wall and the furring strips or framing members.

8. All portions of a porch, screen porch or deck from the bottom of the header down, including posts, guardrails, pickets, steps, and floor structure. Coverings that would prevent moisture or water accumulation on the surface or at joints between members are allowed.

Exception: Columns complying with Section R317.1.4 Exception #3.

R317.1.1 Field treatment. Deleted.
~~Field-cut ends, notches and drilled holes of preservative-treated wood shall be treated in the field in accordance with AWPA M4.~~

R317.1.3 Geographical areas. Deleted.
~~In geographical areas where experience has demonstrated a specific need, *approved* naturally durable or pressure-preservative-treated wood shall be used for those portions of wood members that form the structural supports of buildings, balconies, porches or similar permanent building appurtenances when those members are exposed to the weather without adequate protection from a roof, eave, overhang or other covering that would prevent moisture or water accumulation on the surface or at joints between members. Depending on local experience, such members may include:~~

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

R317.1.4 Wood columns.
Wood columns shall be *approved* wood of natural decay resistance or *approved* pressure-preservative-treated wood.

Exceptions:

1. ~~Columns exposed to the weather or in *basements* where supported by concrete piers or metal pedestals projecting 1 inch (25 mm) above a concrete floor or 6 inches (152 mm) above exposed earth and the earth is covered by an *approved* impervious moisture barrier.~~
2. ~~Columns in enclosed crawl spaces or unexcavated areas located within the periphery of the building when supported by a concrete pier or metal pedestal at a height more than 8 inches (203 mm) from exposed earth and the earth is covered by an impervious moisture barrier.~~
3. ~~Deck posts supported by concrete piers or metal pedestals projecting not less than 1 inch (25 mm) above a concrete floor or 6 inches (152 mm) above exposed earth.~~

1. Columns in *basements* when supported by a concrete floor with an *approved* impervious moisture barrier installed between the slab and earth.

2. Columns exposed to the weather when all of the following conditions are met:

   a. The column is supported by piers or metal pedestals projecting 1 inch (25.4 mm) above a concrete floor or 6 inches (152 mm) above exposed earth and the earth is covered by an approved impervious moisture barrier; and

b. There are no joints in or between structural members (from the header to the base of the column); and

c. The column is protected from exposure to surface moisture at the top by a roof, eave, or overhang; and

d. The exterior surface of the column is fully sealed (paint, sealer, etc.) against moisture intrusion.

3. Columns in enclosed crawl spaces or unexcavated areas located within the periphery of the building when supported by a concrete pier or metal pedestal at a height more than 8 inches (203 mm) from exposed earth and the earth is covered by an impervious moisture barrier.

R317.4 Plastic composites.
Plastic composite exterior deck boards, stair treads, guards and handrails containing wood, cellulosic or other biodegradable materials shall comply with the requirements of ~~Section R602.11~~ ASTM D 7032.

SECTION R318
PROTECTION AGAINST SUBTERRANEAN TERMITES

R318.1 Subterranean termite control methods.
In areas subject to damage from termites as indicated by Table R301.2(1), methods of protection shall be one, or a combination, of the following methods:

1. Chemical termiticide treatment in accordance with Section R318.2.
2. Termite baiting system installed and maintained in accordance with the *label*.
3. Pressure-preservative-treated wood in accordance with the provisions of Section R317.1.
4. Naturally durable termite-resistant wood.
5. Physical barriers in accordance with Section R318.3 and used in locations as specified in Section R317.1.
6. ~~Cold-formed steel framing in accordance with Sections R505.2.1 and R603.2.1.~~ Deleted.

R318.1.2 Field treatment. Deleted.
~~Field-cut ends, notches and drilled holes of pressure-preservative-treated wood shall be retreated in the field in accordance with AWPA M4.~~

R318.2 Chemical ~~termiticide~~ soil treatment.
~~Chemical termiticide treatment shall include soil treatment or field-applied wood treatment.~~ The concentration, rate of application and method of treatment of the chemical termiticide shall be in strict accordance with the termiticide *label* and applied according to the standards of the North Carolina Department of Agriculture.

R318.4 Foam plastic protection.

This section shall apply to both treated and untreated foam plastic. ~~In areas where the probability of termite infestation is "very heavy" as indicated in Figure R301.2(6), extruded and expanded polystyrene, polyisocyanurate and other foam plastics shall not be installed on the exterior face or under interior or exterior foundation walls or slab foundations located below *grade*. The clearance between foam plastics installed above *grade* and exposed earth shall be not less than 6 inches (152 mm).~~

~~**Exceptions:**~~

1. ~~Buildings where the structural members of walls, floors, ceilings and roofs are entirely of noncombustible materials or pressure-preservative-treated wood.~~
2. ~~Where in *addition* to the requirements of Section R318.1, an *approved* method of protecting the foam plastic and structure from subterranean termite damage is used.~~
3. ~~On the interior side of *basement walls*.~~

R318.4.1 Foundation walls.

All foam plastic shall be a minimum of 8 inches (203 mm) above grade. See Appendix O.

Exception: Foam plastic less than 8 inches (203 mm) above or in contact with grade shall be installed in accordance with Section 318.4.5 and Appendix O.

R318.4.2 Termite control.

When foam plastic is in contact with the ground, subterranean termite control shall be in accordance with Section 318.1.

R318.4.3 Slab on grade (non-structural).

Foam plastic shall be installed along the vertical edge and underneath the slab as specified in Section R318.4.5.

R318.4.4 Slab on grade (structural).

All slabs which distribute the wall loads to the foundation shall be insulated as specified in this section. Foam plastic shall be installed along the vertical edge and underneath grade as specified in Appendix O, Figure O-3.

R318.4.5 Foam plastic in contact with ground.

Foam plastic in contact with the ground shall comply with Sections R318.4.5.1 through R318.4.5.4.

R318.4.5.1 Inspection and treatment gaps.

Foam plastic in contact with the ground shall not be continuous to the bottom of the weather-resistant siding. A clear and unobstructed 2-inch (51 mm) minimum inspection gap shall be maintained from the bottom of the weather-resistant siding to the top of any foam plastic. A minimum 4-inch (102 mm) treatment gap shall be provided beginning not more than 6 inches (152 mm) below grade. The top and bottom edges of the foam plastic installed between the inspection gap and the treatment gap shall be cut at a 45-degree (0.79 rad) angle. See Appendix O. For additional requirements for ICF foundations see Section R404.1.3.3.6.1.

R318.4.5.2 Protection of exposed foam plastic.
Exposed foam plastic shall be protected from physical damage. The required inspection gap foam plastic and treatment gap shall be on the exterior with a cementitious coating that extends at least 2 inches (51 mm) below the foam plastic onto the surface of the foundation wall. See Appendix O.

R318.4.5.3 Waterproofing foam plastic between inspection gap and treatment gap.
Waterproofing shall be installed over the required cementitious coating from 6 inches (152 mm) above grade to the treatment gap per manufacturer's installation instructions.

R318.4.5.4 Dampproofing of below grade walls.
Any foam plastic applied below the treatment gap shall be installed after required foundation wall dampproofing is in place. See Section R406 and Appendix O.

SECTION R319
SITE ADDRESS

R319.1 Address identification.
Buildings shall be provided with *approved* address identification. The address identification shall be legible and placed in a position that is visible from the street or road fronting the property. Address identification characters shall contrast with their background. Address numbers shall be Arabic numbers or alphabetical letters. Numbers shall not be spelled out. Each character shall be not less than 4 inches (102 mm) in height with a stroke width of not less than 0.5 inch (12.7 mm). Where required by the fire code official, address identification shall be provided in additional *approved* locations to facilitate emergency response. Where access is by means of a private road and the building address cannot be viewed from the public way, a monument, pole or other sign or means shall be used to identify the structure. ~~Address identification shall be maintained.~~

SECTION R320
ACCESSIBILITY

R320.1 Scope.
Where there are four or more *dwelling units* or sleeping units in a single structure, the provisions of Chapter 11 of the *International Building Code* for Group R-3 shall apply.

R320.1.1 Guestrooms. Deleted.
~~A *dwelling* with guestrooms shall comply with the provisions of Chapter 11 of the *International Building Code* for Group R-3. For the purpose of applying the requirements of Chapter 11 of the *International Building Code*, guestrooms shall be considered to be sleeping units.~~

~~**Exception:** Owner-occupied lodging houses with five or fewer guestrooms constructed in accordance with the *International Residential Code* are not required to be accessible.~~

SECTION R321
ELEVATORS AND PLATFORM LIFTS

R321.3 Accessibility. Deleted.
~~Elevators or platform lifts that are part of an accessible route required by Chapter 11 of the *International Building Code*, shall comply with ICC A117.1.~~

R321.4 Certification.
The installer shall certify that the following conditions have been met.

1. The elevator or platform lift has been installed in accordance with the manufacturer's installation instructions.

2. The elevator meets the requirements of ASME A17.1, Part 5, Section 5.3 and other applicable parts.

3. The elevator or platform lift meets the requirements of the *North Carolina Electrical Code*. Before a Certificate of Occupancy is issued, the permit holder shall provide the code enforcement official a letter of certification from the installer, evidencing compliance with the above conditions. Any maintenance requirements required by the manufacturer shall be stated and affixed to the component. When an elevator or platform lift or its components has been serviced, the service provider shall certify to the owner that the elevator continues to meet the above conditions.

SECTION R322
FLOOD-RESISTANT CONSTRUCTION

R322.1 General.
Buildings and structures constructed in whole or in part in flood hazard areas, including A or V Zones and Coastal A Zones, as established in Table R301.2(1), and substantial improvement and restoration of substantial damage of buildings and structures in flood hazard areas, shall be designed and constructed in accordance with the provisions contained in this section. Buildings and structures that are located in more than one flood hazard area shall comply with the provisions associated with the most restrictive flood hazard area. Buildings and structures located in whole or in part in identified floodways shall be designed and constructed in accordance with ASCE 24. See additional provisions in Chapter 46.

R322.1.7 Protection of water supply and sanitary sewage systems.
New and replacement water supply systems shall be designed to minimize or eliminate infiltration of flood waters into the systems in accordance with the plumbing provisions of this code. New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of floodwaters into systems and discharges from systems into floodwaters in accordance with the plumbing provisions of this code ~~and Chapter 3 of the *International Private Sewage Disposal Code*~~.

R322.2 Flood hazard areas (including A Zones).
Areas that have been determined to be prone to flooding and that are not subject to high-velocity wave action shall be designated as flood hazard areas. Flood hazard areas that have been delineated as subject to wave heights between 1$^1/_2$ feet (457 mm) and 3 feet (914 mm) or otherwise designated by the jurisdiction shall be designated as Coastal A Zones and are subject to the requirements of Section R322.3. Buildings and structures constructed in whole or in part

in flood hazard areas shall be designed and constructed in accordance with Sections R322.2.1 through R322.2.3.

R322.2.1 Elevation requirements.

1. Buildings and structures in flood hazard areas, including flood hazard areas designated as Coastal A Zones, shall have the lowest floors elevated to or above the base flood elevation ~~plus 1 foot (305 mm)~~, or the design flood elevation.

2. In areas of shallow flooding (AO Zones), buildings and structures shall have the lowest floor (including basement) elevated to a height of not less than the highest adjacent grade as the depth number specified in feet (mm) on the FIRM ~~plus 1 foot (305 mm)~~, or not less than 3 feet (15 mm) if a depth number is not specified.

3. Basement floors that are below grade on all sides shall be elevated to or above base flood elevation ~~plus 1 foot (305 mm)~~, or the design flood elevation, whichever is higher.

Exception: Enclosed areas below the design flood elevation, including basements with floors that are not below grade on all sides, shall meet the requirements of Section R322.2.2.

R322.2.4 Tanks. Deleted.
~~Underground tanks shall be anchored to prevent flotation, collapse and lateral movement under conditions of the base flood. Above-ground tanks shall be installed at or above the elevation required in Section R322.2.1 or shall be anchored to prevent flotation, collapse and lateral movement under conditions of the base flood.~~

R322.3.1 Location and site preparation. Deleted**.**

~~1. New buildings and buildings that are determined to be substantially improved pursuant to Section R105.3.1.1 shall be located landward of the reach of mean high tide.~~

2. ~~For any alteration of sand dunes and mangrove stands, the building official shall require submission of an engineering analysis that demonstrates that the proposed alteration will not increase the potential for flood damage~~.

R322.3.2 Elevation requirements.

1. Buildings and structures erected within coastal high-hazard areas and Coastal A Zones, shall be elevated so that the bottom of the lowest portion of horizontal structural members supporting the lowest floor, with the exception of piling, pile caps, columns, grade beams and bracing, is elevated to or above the base flood elevation ~~plus 1 foot (305 mm)~~ or the design flood elevation, whichever is higher.

2. Basement floors that are below grade on all sides are prohibited.

3. The use of fill for structural support is prohibited.

4. Minor grading, and the placement of minor quantities of fill, shall be permitted for

landscaping and for drainage purposes under and around buildings and for support of parking slabs, pool decks, patios and walkways.

5. Walls and partitions enclosing areas below the design flood elevation shall meet the requirements of Sections R322.3.4 and R322.3.5.

R322.3.5.1 Protection of building envelope. Deleted.
~~An exterior door that meets the requirements of Section R609 shall be installed at the top of stairs that provide access to the building and that are enclosed with walls designed to break away in accordance with Section R322.3.4.~~

R322.3.6 Construction documents.
The *construction documents* shall include documentation that is prepared and sealed by a registered *design professional* that the design and methods of construction to be used meet the applicable criteria of this section.

Exception: *Piers* and *docks* meeting the requirements of Section R327.

R322.3.7 Tanks. Deleted.
~~Underground tanks shall be anchored to prevent flotation, collapse and lateral movement under conditions of the base flood. Above-ground tanks shall be installed at or above the elevation required in Section R322.3.2. Where elevated on platforms, the platforms shall be cantilevered from or knee braced to the building or shall be supported on foundations that conform to the requirements of Section R322.3.~~

SECTION 324
SOLAR ENERGY SYSTEMS

R324.2 Solar thermal systems.
Solar thermal systems shall be designed and installed in accordance with Chapter 23 ~~and the *International Fire Code*~~.

R324.4 Rooftop-mounted photovoltaic systems. Deleted.
~~Rooftop-mounted photovoltaic panel systems installed on or above the roof covering shall be designed and installed in accordance with Section R907.~~

~~**R324.4.1 Roof live load.**~~
~~Roof structures that provide support for photovoltaic panel systems shall be designed for applicable roof live load. The design of roof structures need not include roof live load in the areas covered by photovoltaic panel systems. Portions of roof structures not covered by photovoltaic panels shall be designed for roof live load. Roof structures that provide support for photovoltaic panel systems shall be designed for live load, L_R, for the load case where the photovoltaic panel system is not present.~~

R324.5 Building-integrated photovoltaic systems. Deleted.
~~Building-integrated photovoltaic systems that serve as roof coverings shall be designed and installed in accordance with Section R905.~~

~~**R324.5.1 Photovoltaic shingles.**~~
~~Photovoltaic shingles shall comply with Section R905.16.~~

SECTION R326
SWIMMING POOLS, SPAS AND HOT TUBS

R326.1 General.

The design and construction of pools and spas shall comply with Appendix V. ~~the *International Swimming Pool and Spa Code*~~.

SECTION R327
DOCKS, PIERS, BULKHEADS AND WATERWAY STRUCTURES

R327.1 General.

Docks, piers, bulkheads and waterway structures shall be constructed in accordance with Chapter 36 of the *North Carolina Building Code.*

> **Exception:** Structures complying with the following are not required to meet the provisions of Chapter 36 of the *North Carolina Building Code* or this code.

1. Fixed piers associated with a one- or two- family dwelling meeting all of the following:
    - 1.1 A maximum of four boat slips for a single owner of a one- or two- family dwelling or two adjacent, riparian owners.
    - 1.2 A maximum height of 15 feet (4572 mm) measured from deck to mud line at any location along the pier.
    - 1.3 A maximum normal pool depth of 13 feet (3962 mm) on lakes and ponds and a maximum mean low water depth of 7 feet (2134 mm) in other locations.
    - 1.4 A maximum walkway width of 6 feet (1829 mm).
    - 1.5 A maximum pile spacing of 8 feet (2438 mm), in both directions.
    - 1.6 A maximum of 576 sq. ft. (53.5 m^2) for non-walkways areas.
    - 1.7 A maximum boat slip length of 40 feet (12.2 m).
    - 1.8 A maximum roofed area of 576 sq. ft. (53.5 m^2) with an additional maximum 2 foot (610 mm) overhang.
    - 1.9 Constructed with no enclosed or multilevel structures.
    - 1.10 Supports a boatlift with a maximum design capacity no greater than 16,000 pounds (71.2 kN).
2. Floating docks associated with a one- or two- family dwelling meeting all of the following:
    - 2.1 A maximum of four boat slips for a single owner of a one- or two- family dwelling or two adjacent, riparian owners.

2.2 A maximum normal pool depth of 20 feet (6096 mm) for docks with guide piles on lakes and ponds and a maximum mean low water of 10 feet (3048 mm) for docks with guide piles in other locations.

2.3 A maximum boat slip length of 40 feet (12.2 m).

2.4 Finger piers, crosswalks or other floating surfaces having a minimum width of 3 feet (914 mm) wide to a maximum of 6 feet (1829 mm) wide, except for a single 8 foot x 16 foot (2438 mm x 4877 mm) section.

2.5 When constructed with a roof the following conditions exist:

   i. Ultimate design wind speed is 115 mph (51 m/s) or less;
   ii. Roof load is 20 psf (0.96 kPa) or less;
   iii. A maximum eave height of 10 feet (3048 mm);
   iv. A maximum roof slope of 4:12;
   v. A maximum roofed area of 576 sq. ft. (53.5 m^2) with an additional maximum 2 foot (610 mm) overhang;
   vi. A minimum boat slip width of 12 feet (3658 mm);
   vii. A minimum floating dock width of 4 feet (1219 mm) along both sides of the boat slip;
   viii. A maximum dead load of 12 psf (0.57 kPa);
   ix. Floating structures supporting roof structures are balanced or anchored to reduce the possibility of tipping.

2.6 Constructed with no enclosed or multilevel structures.

2.7 Supports a boat lift with a maximum design capacity no greater than 16,000 pounds (71.2 kN).

CHAPTER 4
FOUNDATIONS

SECTION R401
GENERAL

R401.1 Application.

The provisions of this chapter shall control the design and construction of the foundation and foundation spaces for buildings. In addition to the provisions of this chapter, the design and construction of foundations in areas prone to flooding as established by Table R301.2(1) shall meet the provisions of Section R322. Wood foundations shall be designed and installed in accordance with AWC PWF.

> **Exception:** The provisions of this chapter shall be permitted to be used for wood foundations only in the following situations:
>
> 1. In buildings that have no more than two floors and a roof.
> 2. When interior *basement* and foundation walls are constructed at intervals not exceeding 50 feet (15240 mm).

~~Wood foundations in Seismic Design Category D_0, D_1 or D_2 shall be designed in accordance with accepted engineering practice.~~

R401.4.1 Geotechnical evaluation.

~~In lieu of a complete geotechnical evaluation, the load-bearing values in Table R401.4.1 shall be assumed.~~ The load bearing values greater than 2000 psf (95.8 kPa) in Table R401.4.1 require an engineering evaluation.

TABLE R401.4.1
PRESUMPTIVE LOAD-BEARING VALUES OF FOUNDATION MATERIALS[a]

CLASS OF MATERIAL	LOAD-BEARING PRESSURE (pounds per square foot)
Crystalline bedrock	12,000
Sedimentary and foliated rock	~~4,000~~ 6,000
Sandy gravel and/or gravel (GW and GP)	~~3,000~~ 5,000
Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	~~2,000~~ 3,000
Clay, sandy, silty clay, clayey silt, silt and sandy siltclay (CL, ML, MH and CH)	~~1,500~~ 2,000[b]

For SI: 1 pound per square foot = 0.0479 kPa.

a. Where soil tests are required by Section R401.4, the allowable bearing capacities of the soil shall be part of the recommendations.

b. Where the building official determines that in-place soils with an allowable bearing capacity of less than ~~1,500~~ 2,000 psf are likely to be present at the site, the allowable bearing capacity shall be determined by a soils investigation.

SECTION R403
FOOTINGS

R403.1 General.

All exterior walls shall be supported on continuous solid or fully grouted masonry or concrete footings, crushed stone footings, wood foundations, or other *approved* structural systems which shall be of sufficient design to accommodate all loads according to Section R301 and to transmit the resulting loads to the soil within the limitations as determined from the character of the soil. Footings shall be supported on undisturbed natural soils or engineered fill. Concrete footing shall be designed and constructed in accordance with the provisions of Section R403 ~~or in accordance with ACI 332~~. Discontinuous footings shall be permitted to be constructed in accordance with ACI 332 for concrete foundation walls and Appendix Q for masonry foundation walls.

TABLE R403.1(1)
MINIMUM WIDTH OF CONCRETE, PRECAST OR MASONRY FOOTINGS (inches)[a]

	LOAD-BEARING VALUE OF SOIL (psf)			
	1,500	**2,000**	**3,000**	**4,000**
Conventional light–frame construction				
1-story	12[b]	12[b]	12	12
2-story	15[b]	12[b]	12	12
3-story	23	17	12	12
4-inch brick veneer over light frame or 8-inch hollow concrete masonry				
1-story	12[b]	12[b]	12	12
2-story	15[b]	15[b]	12	12
3-story	32	24	16	12
8-inch solid or fully grouted masonry				
1-story	16	12[b]	12	12
2-story	29	21	14	12
3-story	42	32	21	16

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Where minimum footing width is 12 inches, use of a single wythe of solid or fully grouted 12-inch nominal concrete masonry units is permitted.

b. A minimum footing width of 12 inches is acceptable for monolithic slab foundations.

TABLE R403.1(2)
PIER[a] AND FOOTING[b] SIZES FOR SUPPORT OF GIRDERS

	1 (ONE) STORY		2 (TWO) STORY		2- ½ (TWO & ONE HALF) STORY	
Area[e]	**Pier[c,d]**	**Footing**	**Pier[c,d]**	**Footing**	**Pier[c,d]**	**Footing**

50	8” x 16”	1’-4” x 2’-0” x 8”	8” x 16”	1’-4” x 2’-6” x 8”	8” x 16”	1’-4” x 2’-6” x 8”
100	8” x 16”	1’-4” x 2’-0” x 8”	8” x 16”	2’-0” x 2’-0” x 10”	16” x 16”	2’-6” x 2’-6” x 10”
150	8” x 16”	2’-0” x 2’-0” x 8”	16” x 16”	2’-8” x 2’-8” x 10”	16” x 16”	3’-0” x 3’-0” x 10”
200	8” x 16”	2’-4” x 2’-4” x 10”	16” x 16”	3’-0” x 3’-0” x 10”	16” x 16”	4’-0” x 4’-0” x 1’-0”
250	-	-	16” x 16”	3’-4” x 3’-4” x 1’-0”	16” x 24”	4’-0” x 4’-0” x 1’-0”
300	-	-	16” x 16”	3’-8” x 3’-8” x 1’-0”	16” x 24”	4’-6” x 4’-6” x 1’-0”

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Pier sizes are based on hollow CMU capped with 4 inches of solid masonry or concrete for 1 (one) story and 8 inches of solid masonry or concrete for 2 (two), 2 ½ (two and one half) or 3 (three) story houses or shall have cavities of the top course filled with concrete or grout or other approved methods. Mortar shall be Type S.A minimum footing width of 12 inches is acceptable for monolithic slab foundations.

b. Footing sizes are based on 2000 psf allowable soil bearing and 2500 psi concrete. This table is based upon the limitations of a tributary area using dimensional framing lumber only.

c. Centers of piers shall bear in the middle one-third of the footings. Girders must have full bearing on piers. Footings shall be full thickness over the entire area of the footing.

d. Pier sizes given are minimum. For height/thickness limitations see Section R606.7.

e. Area at first level supported by pier and footing in square feet.

~~TABLE R403.1(1)~~

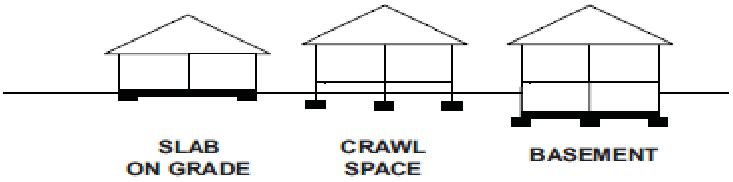
~~MINIMUM WIDTH AND THICKNESS FOR CONCRETE FOOTINGS FOR LIGHT-FRAME CONSTRUCTION (inches)~~~~[a, b]~~

~~SNOW LOAD OR ROOF LIVE LOAD~~	~~STORY AND TYPE OF STRUCTURE WITH LIGHT FRAME~~	~~LOAD-BEARING VALUE OF SOIL (psf)~~					
		~~1500~~	~~2000~~	~~2500~~	~~3000~~	~~3500~~	~~4000~~
~~20 psf~~	~~1 story—slab-on-grade~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—with crawl space~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—plus basement~~	~~18 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—slab-on-grade~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—with crawl space~~	~~16 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—plus basement~~	~~22 × 6~~	~~16 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—slab-on-grade~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—with crawl space~~	~~19 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—plus basement~~	~~25 × 8~~	~~19 × 6~~	~~15 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~
~~30 psf~~	~~1 story—slab-on-grade~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~

	~~1 story—with crawl space~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—plus basement~~	~~19 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—slab-on-grade~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—with crawl space~~	~~17 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—plus basement~~	~~23 × 6~~	~~17 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—slab-on-grade~~	~~15 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—with crawl space~~	~~20 × 6~~	~~15 ×´ 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—plus basement~~	~~26 × 8~~	~~20 × 6~~	~~16 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~
~~50 psf~~	~~1 story—slab-on-grade~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—with crawl space~~	~~16 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—plus basement~~	~~21 × 6~~	~~16 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—slab-on-grade~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—with crawl space~~	~~19 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—plus basement~~	~~25 × 7~~	~~19 × 6~~	~~15 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—slab-on-grade~~	~~17 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—with crawl space~~	~~22 × 6~~	~~17 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—plus basement~~	~~28 × 9~~	~~21 × 6~~	~~17 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~
~~70 psf~~	~~1 story—slab-on-grade~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—with crawl space~~	~~18 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—plus basement~~	~~24 × 7~~	~~18 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—slab-on-grade~~	~~16 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—with crawl space~~	~~21 × 6~~	~~16 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—plus basement~~	~~27 × 9~~	~~20 × 6~~	~~16 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—slab-on-grade~~	~~19 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—with crawl space~~	~~25 × 7~~	~~18 × 6~~	~~15 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—plus basement~~	~~30 × 10~~	~~23 × 6~~	~~18 × 6~~	~~15 × 6~~	~~13 × 6~~	~~12 × 6~~

~~For SI: 1 inch = 25.4 mm, 1 plf = 14.6 N/m, 1 pound per square foot = 47.9 N/m2.~~
~~a. Interpolation allowed. Extrapolation is not allowed.~~

~~b. Based on 32-foot-wide house with load-bearing center wall that carries half of the tributary attic, and floor framing. For every 2 feet of adjustment to the width of the house, add or subtract 2 inches of footing width and 1 inch of footing thickness (but not less than 6 inches thick).~~



~~TABLE R403.1(2)~~

~~MINIMUM WIDTH AND THICKNESS FOR CONCRETE FOOTINGS FOR LIGHT-FRAME CONSTRUCTION WITH BRICK VENEER (inches)[a, b]~~

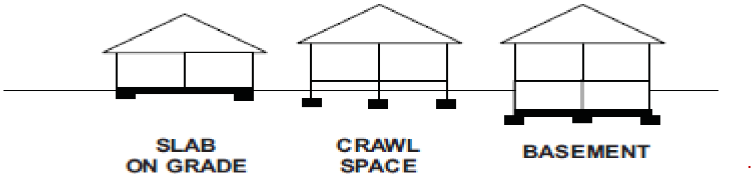
~~SNOW LOAD OR ROOF LIVE LOAD~~	~~STORY AND TYPE OF STRUCTURE WITH BRICK VENEER~~	~~LOAD-BEARING VALUE OF SOIL (psf)~~					
		~~1500~~	~~2000~~	~~2500~~	~~3000~~	~~3500~~	~~4000~~
~~20 psf~~	~~1 story—slab-on-grade~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—with crawl space~~	~~15 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—plus basement~~	~~21 × 6~~	~~15 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—slab-on-grade~~	~~15 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—with crawl space~~	~~20 × 6~~	~~15 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—plus basement~~	~~26 × 8~~	~~20 × 6~~	~~16 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—slab-on-grade~~	~~20 × 6~~	~~15 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—with crawl space~~	~~26 × 8~~	~~19 × 6~~	~~15 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—plus basement~~	~~32 × 11~~	~~24 × 7~~	~~19 × 6~~	~~16 × 6~~	~~14 × 6~~	~~12 × 6~~
~~30 psf~~	~~1 story—slab-on-grade~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—with crawl space~~	~~16 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—plus basement~~	~~22 × 6~~	~~16 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—slab-on-grade~~	~~16 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—with crawl space~~	~~22 × 6~~	~~16 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—plus basement~~	~~27 × 9~~	~~21 × 6~~	~~16 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—slab-on-grade~~	~~21 × 6~~	~~16 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—with crawl space~~	~~27 × 8~~	~~20 × 6~~	~~16 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—plus basement~~	~~33 × 11~~	~~24 × 7~~	~~20 × 6~~	~~16 × 6~~	~~14 × 6~~	~~12 × 6~~
~~50 psf~~	~~1 story—slab-on-grade~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—with crawl space~~	~~18 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—plus basement~~	~~24 × 7~~	~~18 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—slab-on-grade~~	~~18 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—with crawl space~~	~~24 × 7~~	~~18 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—plus basement~~	~~29 × 10~~	~~22 × 6~~	~~18 × 6~~	~~15 × 6~~	~~13 × 6~~	~~12 × 6~~
	~~3 story—slab-on-grade~~	~~27 × 7~~	~~18 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~

	~~3 story—with crawl space~~	~~29 × 9~~	~~22 × 6~~	~~17 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—plus basement~~	~~35 × 12~~	~~26 × 8~~	~~21 × 6~~	~~17 × 6~~	~~15 × 6~~	~~13 × 6~~
~~70 psf~~	~~1 story—slab-on-grade~~	~~15 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—with crawl space~~	~~20 × 6~~	~~15 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—plus basement~~	~~26 × 8~~	~~20 × 6~~	~~16 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—slab-on grade~~	~~20 × 6~~	~~15 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—with crawl space~~	~~26 × 8~~	~~19 × 6~~	~~15 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—plus basement~~	~~32 × 11~~	~~24 × 7~~	~~19 × 6~~	~~16 × 6~~	~~14 × 6~~	~~12 × 6~~
	~~3 story—slab-on-grade~~	~~26 × 8~~	~~19 × 6~~	~~15 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~3 story—with crawl space~~	~~31 × 11~~	~~23 × 7~~	~~19 × 6~~	~~16 × 6~~	~~13 × 6~~	~~12 × 6~~
	~~3 story—plus basement~~	~~37 × 13~~	~~28 × 9~~	~~22 × 6~~	~~18 × 6~~	~~16 × 6~~	~~14 × 6~~

~~For SI: 1 inch = 25.4 mm, 1 plf = 14.6 N/m, 1 pound per square foot = 47.9 N/m2.~~

~~a. Interpolation allowed. Extrapolation is not allowed.~~

~~b. Based on 32-foot-wide house with load-bearing center wall that carries half of the tributary attic, and floor framing. For every 2 feet of adjustment to the width of the house, add or subtract 2 inches of footing width and 1 inch of footing thickness (but not less than 6 inches thick).~~



~~TABLE R403.1(3)~~
~~MINIMUM WIDTH AND THICKNESS FOR CONCRETE FOOTINGS WITH CAST-IN-PLACE CONCRETE OR FULLY GROUTED MASONRY WALL CONSTRUCTION (inches)~~[a, b]

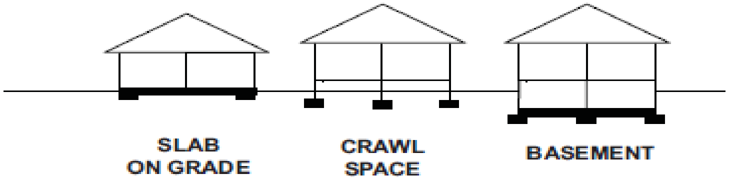
~~SNOW LOAD OR ROOF LIVE LOAD~~	~~STORY AND TYPE OF STRUCTURE WITH CMU~~	~~LOAD-BEARING VALUE OF SOIL (psf)~~					
		~~1500~~	~~2000~~	~~2500~~	~~3000~~	~~3500~~	~~4000~~
~~20 psf~~	~~1 story—slab-on-grade~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—with crawl space~~	~~19 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—plus basement~~	~~25 × 8~~	~~19 × 6~~	~~15 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—slab-on-grade~~	~~23 × 7~~	~~18 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—with crawl space~~	~~29 × 9~~	~~22 × 6~~	~~17 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—plus basement~~	~~35 × 12~~	~~26 × 8~~	~~21 × 6~~	~~17 × 6~~	~~15 × 6~~	~~13 × 6~~
	~~3 story—slab-on-grade~~	~~32 × 11~~	~~24 × 7~~	~~19 × 6~~	~~16 × 6~~	~~14 × 6~~	~~12 × 6~~
	~~3 story—with crawl space~~	~~38 × 14~~	~~28 × 9~~	~~23 × 6~~	~~19 × 6~~	~~16 × 6~~	~~14 × 6~~
	~~3 story—plus basement~~	~~43 × 17~~	~~33 × 11~~	~~26 × 8~~	~~22 × 6~~	~~19 × 6~~	~~16 × 6~~
~~30 psf~~	~~1 story—slab-on-grade~~	~~15 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—with crawl space~~	~~20 × 6~~	~~15 × 6~~	~~12 ×6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—plus basement~~	~~26 × 8~~	~~20 × 6~~	~~16 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—slab-on-grade~~	~~24 × 7~~	~~18 × 6~~	~~15 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—with crawl space~~	~~30 × 10~~	~~22 × 6~~	~~18 × 6~~	~~15 × 6~~	~~13 × 6~~	~~12 × 6~~
	~~2 story—plus basement~~	~~36 × 13~~	~~27 × 8~~	~~21 × 6~~	~~18 × 6~~	~~15 × 6~~	~~13 × 6~~
	~~3 story—slab-on-grade~~	~~33 × 12~~	~~25 × 7~~	~~20 × 6~~	~~17 × 6~~	~~14 × 6~~	~~12 × 6~~

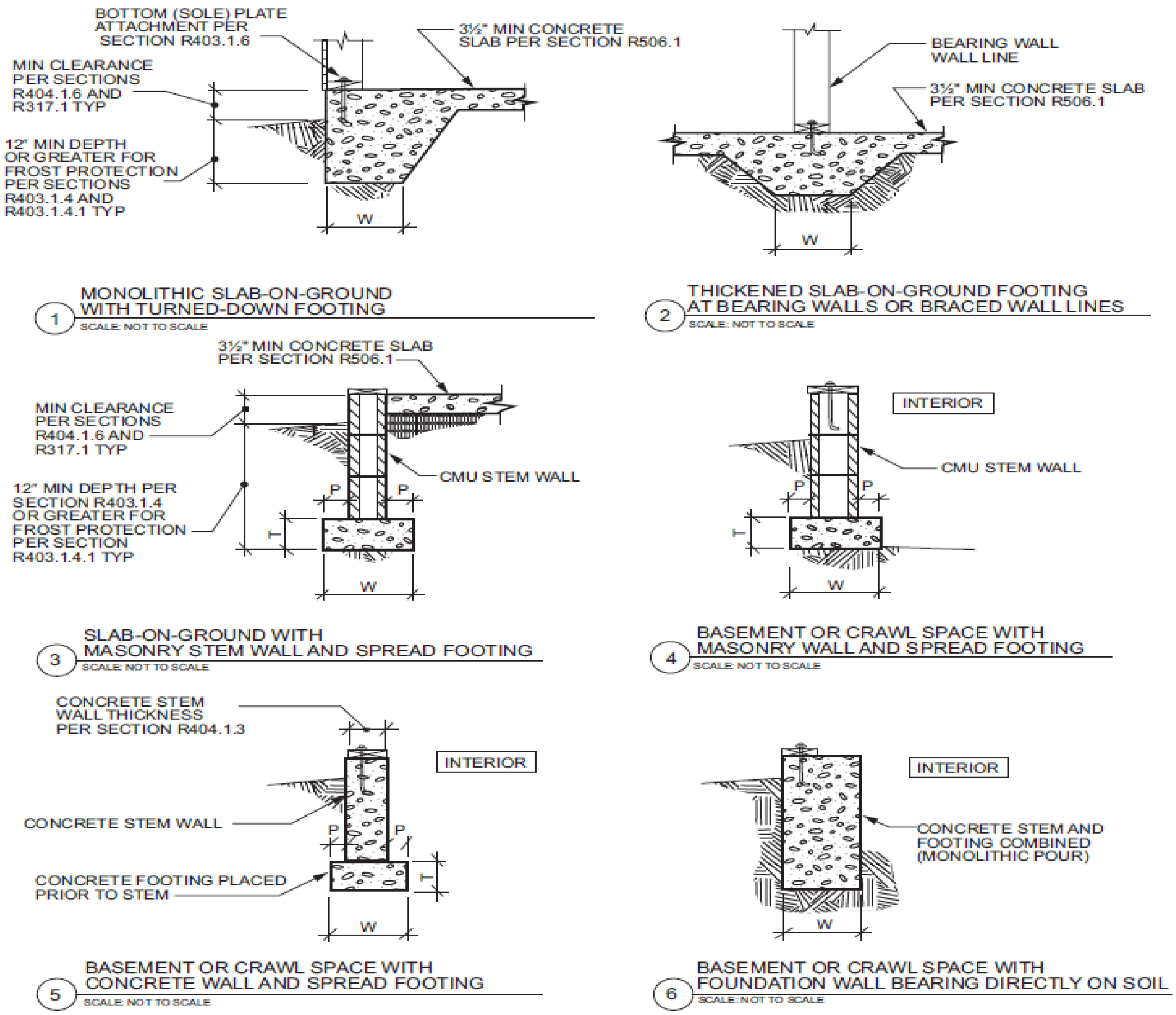
	~~3 story—with crawl space~~	~~39 × 14~~	~~29 × 9~~	~~23 × 7~~	~~19 × 6~~	~~17 × 6~~	~~14 × 6~~
	~~3 story—plus basement~~	~~44 × 17~~	~~33 × 12~~	~~27 × 8~~	~~22 × 6~~	~~19 × 6~~	~~17 × 6~~
~~50 psf~~	~~1 story—slab-on-grade~~	~~17 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—with crawl space~~	~~22 × 6~~	~~17 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—plus basement~~	~~28 × 9~~	~~21 × 6~~	~~17 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—slab-on-grade~~	~~27 × 8~~	~~20 × 6~~	~~16 × 6~~	~~13 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—with crawl space~~	~~32 × 11~~	~~24 × 7~~	~~19 × 6~~	~~16 × 6~~	~~14 × 6~~	~~12 × 6~~
	~~2 story—plus basement~~	~~38 × 14~~	~~28 × 9~~	~~23 × 6~~	~~19 × 6~~	~~16 × 6~~	~~14 × 6~~
	~~3 story—slab-on-grade~~	~~35 × 13~~	~~27 × 8~~	~~21 × 6~~	~~18 × 6~~	~~15 × 6~~	~~13 × 6~~
	~~3 story—with crawl space~~	~~41 × 15~~	~~31 × 10~~	~~24 × 7~~	~~20 × 6~~	~~17 × 6~~	~~15 × 6~~
	~~3 story—plus basement~~	~~47 × 18~~	~~35 × 12~~	~~28 × 9~~	~~23 × 7~~	~~20 × 6~~	~~17 × 6~~
~~70 psf~~	~~1 story—slab-on-grade~~	~~19 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—with crawl space~~	~~25 × 7~~	~~18 × 6~~	~~15 × 6~~	~~12 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~1 story—plus basement~~	~~30 × 10~~	~~23 × 6~~	~~18 × 6~~	~~15 × 6~~	~~13 × 6~~	~~12 × 6~~
	~~2 story—slab-on-grade~~	~~29 × 9~~	~~22 × 6~~	~~17 × 6~~	~~14 × 6~~	~~12 × 6~~	~~12 × 6~~
	~~2 story—with crawl space~~	~~34 × 12~~	~~26 × 8~~	~~21 × 6~~	~~17 × 6~~	~~15 × 6~~	~~13 × 6~~
	~~2 story—plus basement~~	~~40 × 15~~	~~30 × 10~~	~~24 × 7~~	~~20 × 6~~	~~17 × 6~~	~~15 × 6~~
	~~3 story—slab-on-grade~~	~~38 × 14~~	~~28 × 9~~	~~23 × 6~~	~~19 × 6~~	~~16 × 6~~	~~14 × 6~~
	~~3 story—with crawl space~~	~~43 × 16~~	~~32 × 11~~	~~26 × 8~~	~~21 × 6~~	~~18 × 6~~	~~16 × 6~~
	~~3 story—plus basement~~	~~49 × 19~~	~~37 × 13~~	~~29 × 10~~	~~24 × 7~~	~~21 × 6~~	~~18 × 6~~

~~For SI: 1 inch = 25.4 mm, 1 plf = 14.6 N/m, 1 pound per square foot = 47.9 N/m2.~~

~~a. Interpolation allowed. Extrapolation is not allowed.~~

~~b. Based on 32-foot-wide house with load-bearing center wall that carries half of the tributary attic, and floor framing. For every 2 feet of adjustment to the width of the house add or subtract 2 inches of footing width and 1 inch of footing thickness (but not less than 6 inches thick).~~





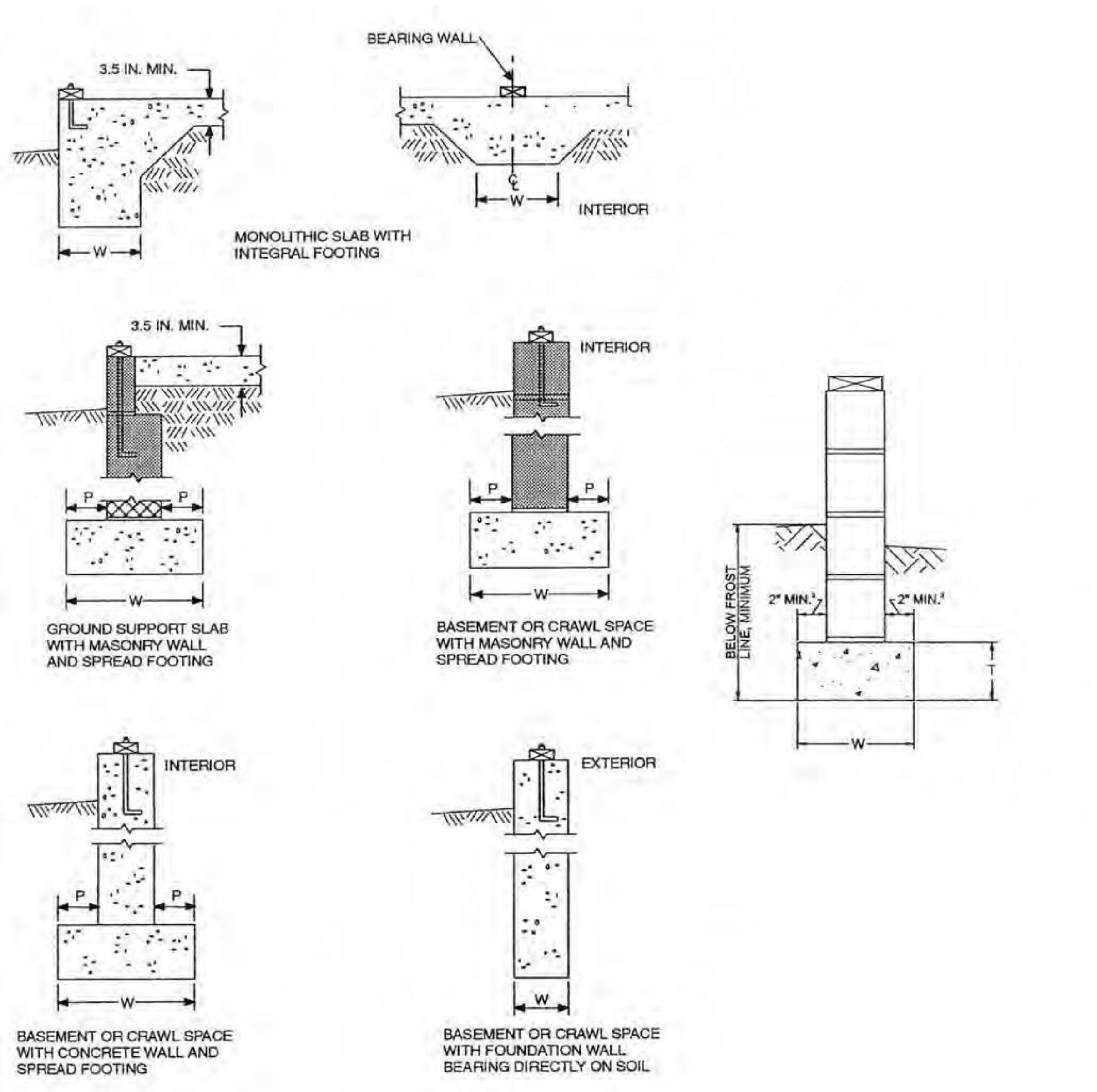
~~For SI: 1 inch = 25.4 mm.~~

~~W = Width of footing, T = Thickness of footing and P = Projection per Section R403.1.1~~

~~**NOTES:**~~

~~a. See Section R404.3 for sill requirements.~~
~~b. See Section R403.1.6 for sill attachment.~~
~~c. See Section R506.2.3 for vapor barrier requirements.~~
~~d. See Section R403.1 for base.~~
~~e. See Figure R403.1.3 for additional footing requirements for structures in SDC~~ ~~D_0, D_1 and D_2 and townhouses in SDC C.~~
~~f. See Section R408 for under-floor ventilation and access requirements.~~

~~**FIGURE R403.1(1)**~~
~~**PLAIN CONCRETE FOOTINGS WITH MASONRY AND CONCRETE STEM WALLS IN SDC A, B AND C**~~ ~~$^{a, b, c, d, e, f}$~~



For SI: 1 inch = 25.4 mm.

W = Width of footing, T = Thickness of footing and P = Projection per Section R403.1.1

NOTES:

1. Foundations shall extend not less than 12 inches below finished grade and in no case less than the frost line depth.
2. Footing sizes are based on soil with an allowable soil pressure of 2,000 pounds per square foot. Footings on soil with a lower allowable soil pressure shall be designed in accordance with accepted engineering practice.
3. Footing projections shall not exceed the footing thickness.
4. For minimum footing width (W) see Table R403.1(1).
5. Minimum footing thickness (T) is : 6” for 1 story, 8” for 2 story and 10” for 3 story.
6. Install anchor bolts per Section R403.1.6.

FIGURE R403.1(1)
CONCRETE AND MASONRY FOUNDATION DETAILS

R403.1.1 Minimum size.

~~The minimum width, W, and thickness, T, for concrete footings shall be in accordance with Tables R403.1(1) through R403.1(3) and Figure R403.1(1) or R403.1.3, as applicable.~~ Minimum sizes for concrete and masonry footings shall be as set forth in Table R403.1(1) and Figure R403.1(1). The footing width shall be based on the load-bearing value of the soil in accordance with Table R401.4.1. Spread footings shall be at least 6 inches (152 mm) in thickness, T. Footing projections, P, shall be not less than 2 inches (51 mm) and shall not exceed the thickness of the footing. Footing thickness and projection for fireplaces shall be in accordance with Section R1001.2. The size of footings supporting piers and columns shall be based on the tributary load in accordance with Table R403.1(2) and allowable soil pressure in accordance with Table R401.4.1. Footings for wood foundations shall be in accordance with the details set forth in Section R403.2, and Figures R403.1(2) and R403.1(3).

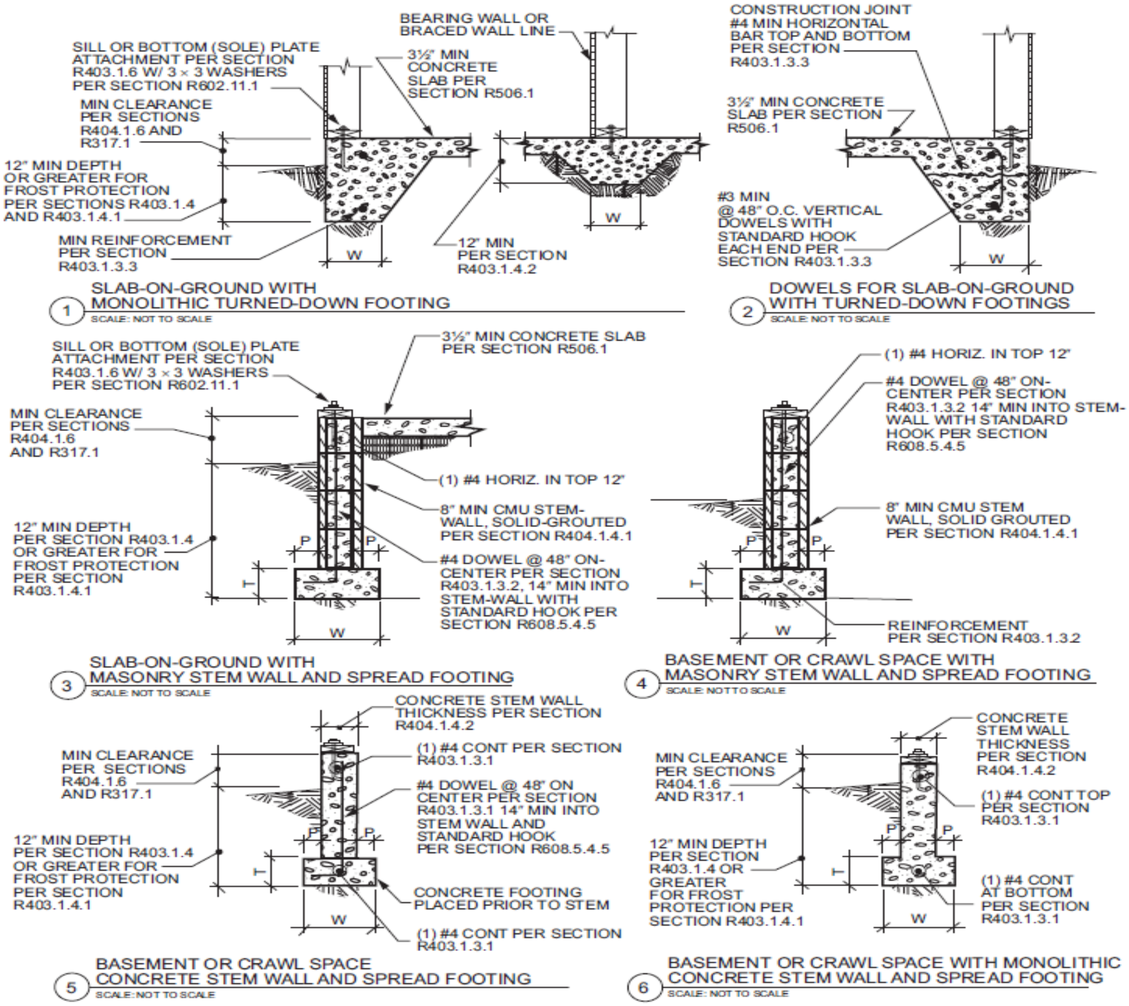
R403.1.2 Continuous footing in Seismic Design Categories D0, D1 and D2. Deleted.

~~Exterior walls of buildings located in Seismic Design Categories D$_0$, D$_1$ and D$_2$ shall be supported by continuous solid or fully grouted masonry or concrete footings. Other footing materials or systems shall be designed in accordance with accepted engineering practice. All required interior *braced wall panels* in buildings located in Seismic Design Categories D$_0$, D$_1$ and D$_2$ with plan dimensions greater than 50 feet (15240 mm) shall be supported by continuous solid or fully grouted masonry or concrete footings in accordance with Section R403.1.3.4, except for two-story buildings in Seismic Design Category D2, in which all *braced wall panels*, interior and exterior, shall be supported on continuous foundations.~~

> ~~**Exception:** Two-story buildings shall be permitted to have interior *braced wall panels* supported on continuous foundations at intervals not exceeding 50 feet (15 240 mm) provided that:~~
>
> 1. ~~The height of cripple walls does not exceed 4 feet (1219 mm).~~
> 2. ~~First-floor braced wall panels are supported on doubled floor joists, continuous blocking or floor beams.~~
> 3. ~~The distance between bracing lines does not exceed twice the building width measured parallel to the braced wall line.~~

R403.1.3 Footing and stem wall reinforcing in Seismic Design Categories D0, D1, and D2. Deleted.

~~Concrete footings located in Seismic Design Categories D$_0$, D$_1$ and D$_2$, as established in Table R301.2(1), shall have minimum reinforcement in accordance with this section and Figure R403.1.3. Reinforcement shall be installed with support and cover in accordance with Section R403.1.3.5.~~



~~W = Width of footing, T = Thickness of footing and P = Projection per Section R403.1.1~~

~~**NOTES:**~~

~~a. See Section R404.3 for sill requirements.~~

~~b. See Section R403.1.6 for sill attachment.~~

~~c. See Section R506.2.3 for vapor barrier requirements.~~

~~d. See Section R403.1 for base.~~

~~e. See Section R408 for under-floor ventilation and access requirements.~~
~~f. See Section R403.1.3.5 for reinforcement requirements.~~

~~FIGURE R403.1.3~~
~~REINFORCED CONCRETE FOOTINGS AND MASONRY AND CONCRETE STEM WALLS IN SDC D_0, D_1 AND D_2~~ ~~[a, b, c, d, e, f,]~~

~~R403.1.3.1 Concrete stem walls with concrete footings.~~

~~In Seismic Design Categories D_0, D_1 and D_2 where a construction joint is created between a concrete footing and a concrete stem wall, a minimum of one No. 4 vertical bar shall be installed at not more than 4 feet (1219 mm) on center. The vertical bar shall have a standard hook and extend to the bottom of the footing and shall have support and cover as specified in Section R403.1.3.5.3 and extend a minimum of 14 inches (357 mm) into the stem wall. Standard hooks shall comply with Section R608.5.4.5. A minimum of one No. 4 horizontal bar shall be installed within 12 inches (305 mm) of the top of the stem wall and one No. 4 horizontal bar shall be located 3 to 4 inches (76 mm to 102 mm) from the bottom of the footing.~~

~~R403.1.3.2 Masonry stem walls with concrete footings.~~

~~In Seismic Design Categories D_0, D_1 and D_2 where a masonry stem wall is supported on a concrete footing, a minimum of one No. 4 vertical bar shall be installed at not more than 4 feet (1219 mm) on center. The vertical bar shall have a standard hook and extend to the bottom of the footing and shall have support and cover as specified in Section R403.1.3.5.3 and extend a minimum of 14 inches (357 mm) into the stem wall. Standard hooks shall comply with Section R608.5.4.5. A minimum of one No. 4 horizontal bar shall be installed within 12 inches (305 mm) of the top of the wall and one No. 4 horizontal bar shall be located 3 to 4 inches (76 mm to 102 mm) from the bottom of the footing. Masonry stem walls shall be solid grouted.~~

~~R403.1.3.3 Slabs-on-ground with turned-down footings.~~

~~In Seismic Design Categories D_0, D_1 and D_2, slabs on ground cast monolithically with turned-down footings shall have a minimum of one No. 4 bar at the top and the bottom of the footing or one No. 5 bar or two No. 4 bars in the middle third of the footing depth.~~

~~Where the slab is not cast monolithically with the footing, No. 3 or larger vertical dowels with standard hooks on each end shall be installed at not more than 4 feet (1219 mm) on center in accordance with Figure R403.1.3, Detail 2. Standard hooks shall comply with Section R608.5.4.5.~~

~~R403.1.3.4 Interior bearing and braced wall panel footings in Seismic Design Categories D0, D1 and D2.~~

~~In Seismic Design Categories D_0, D_1 and D_2, interior footings supporting bearing walls or *braced wall panels*, and cast monolithically with a slab on *grade*, shall extend to a depth of not less than 12 inches (305 mm) below the top of the slab.~~

~~R403.1.3.5 Reinforcement.~~

~~Footing and stem wall reinforcement shall comply with Sections R403.1.3.5.1 through R403.1.3.5.4.~~

~~R403.1.3.5.1 Steel reinforcement.~~

~~Steel reinforcement shall comply with the requirements of ASTM A 615, A 706 or A 996. ASTM A 996 bars produced from rail steel shall be Type R. The minimum yield strength of reinforcing steel shall be 40,000 psi (Grade 40) (276 MPa).~~

~~R403.1.3.5.2 Location of reinforcement in wall.~~

~~The center of vertical reinforcement in stem walls shall be located at the centerline of the wall. Horizontal and vertical reinforcement shall be located in footings and stem walls to provide the minimum cover required by Section R403.1.3.5.3.~~

~~R403.1.3.5.3 Support and cover.~~

~~Reinforcement shall be secured in the proper location in the forms with tie wire or other bar support system to prevent displacement during the concrete placement operation. Steel reinforcement in concrete cast against the earth shall have a minimum cover of 3 inches (75 mm). Minimum cover for reinforcement in concrete cast in removable forms that will be exposed to the earth or weather shall be $1\frac{1}{2}$ inches (38 mm) for No. 5 bars and smaller, and 2 inches (50 mm) for No. 6 bars and larger. For concrete cast in removable forms that will not be exposed to the earth or weather, and for concrete cast in stay-in-place forms, minimum cover shall be $\frac{3}{4}$ inch (19 mm).~~

~~R403.1.3.5.4 Lap splices.~~

~~Vertical and horizontal reinforcement shall be the longest lengths practical. Where splices are necessary in reinforcement, the length of lap splice shall be in accordance with Table R608.5.4. (1) and Figure R608.5.4(1). The maximum gap between noncontact parallel bars at a lap splice shall not exceed the smaller of one-fifth the required lap length and 6 inches (152 mm) [see Figure R608.5.4(1)].~~

~~R403.1.3.6 Isolated concrete footings.~~

~~In detached one- and two-family dwellings that are three stories or less in height and constructed with stud bearing walls, isolated plain concrete footings supporting columns or pedestals are permitted.~~

R403.1.4 Minimum depth.

~~Exterior footings shall be placed not less than 12 inches (305 mm) below the undisturbed ground surface. Where applicable, the depth of footings shall also conform to Sections R403.1.4.1 through R403.1.4.2.~~

All exterior footings and foundation systems shall extend below the frost line specified in Table R301.2(1). In no case shall the bottom of the exterior footings be less than 12 inches (305 mm) below the finished grade.

Exception: Footings and foundations erected on solid rock shall not be required to extend below the frost line.

R403.1.4.1 Frost protection. Deleted.

~~Except where otherwise protected from frost, foundation walls, piers and other~~

~~permanent supports of buildings and structures shall be protected from frost by one or more of the following methods:~~

1. ~~Extended below the frost line specified in Table R301.2. (1).~~
2. ~~Constructed in accordance with Section R403.3.~~
3. ~~Constructed in accordance with ASCE 32.~~
4. ~~Erected on solid rock.~~

~~**Exceptions:**~~

1. ~~Protection of freestanding *accessory structures* with an area of 600 square feet (56 m^2) or less, of light-frame construction, with an eave height of 10 feet (3048 mm) or less shall not be required.~~
2. ~~Protection of freestanding *accessory structures* with an area of 400 square feet (37 m^2) or less, of other than light-frame construction, with an eave height of 10 feet (3048 mm) or less shall not be required.~~
3. ~~Decks not supported by a dwelling need not be provided with footings that extend below the frost line.~~

~~Footings shall not bear on frozen soil unless the frozen condition is permanent.~~

R403.1.5 Slope.

The top surface of footings shall be level (1/2 inch in 10 feet) or shall be brought level, under the width of the wall, with masonry units with full mortar joints. The bottom surface of footings shall not have a slope exceeding one unit vertical in 10 units horizontal (10-percent slope). Footings shall be stepped where it is necessary to change the elevation of the top surface of the footings or where the slope of the bottom surface of the footings will exceed one unit vertical in 10 units horizontal (10-percent slope).

R403.1.6 Foundation anchorage.

Wood sill plates and wood walls supported directly on continuous foundations shall be anchored to the foundation in accordance with this section.

~~Cold-formed steel framing shall be anchored directly to the foundation or fastened to wood sill plates anchored to the foundation. Anchorage of cold-formed steel framing and sill plates supporting cold-formed steel framing shall be in accordance with this section and Section R505.3.1 or R603.3.1.~~

Wood sole plates at all exterior walls on monolithic slabs, wood sole plates of *braced wall panels* at building interiors on monolithic slabs and all wood sill plates shall be anchored to the foundation with minimum $^1/_2$-inch- diameter (12.7 mm) anchor bolts spaced a maximum of 6 feet (1829 mm) on center or *approved* anchors or anchor straps spaced as required to provide equivalent anchorage to $^{1}/_{2}$-inch-diameter (12.7 mm) anchor bolts. Bolts shall extend a minimum of 7 inches (178 mm) into concrete or grouted cells of concrete masonry units. The bolts shall be located in the middle third of the width of the plate. A nut and washer shall be tightened on each anchor bolt. There shall be a minimum of two bolts per plate section with one bolt located not more than 12 inches (305 mm) from the corner ~~or less than seven bolt diameters from each end of the plate section.~~ Interior bearing wall sole plates on monolithic slab foundation that are not part of a *braced wall panel* shall be positively anchored with *approved* fasteners. Sill plates and sole plates shall be protected against decay and termites where required by Sections R317 and R318.

Exceptions:

1. Walls 24 inches (610 mm) total length or shorter connecting offset braced wall panels shall be anchored to the foundation with a minimum of one anchor bolt located in the center third of the plate section and shall be attached to adjacent braced wall panels at corners as shown in ~~Item 9 of~~ Table R602.3(1).

2. Connection of walls 12 inches (305 mm) total length or shorter connecting offset *braced wall panels* to the foundation without anchor bolts shall be permitted. The wall shall be attached to adjacent braced wall panels at corners as shown in ~~Item 9 of~~ Table R602.3(1).

R403.1.6.1 Foundation anchorage in Seismic Design Category~~ies~~ C~~, D0, D1 and D2.~~

In addition to the requirements of Section R403.1.6, the following requirements shall apply to ~~wood light-frame structures in Seismic Design Categories D_0, D_1 and D_2 and~~ wood light-frame townhouses in Seismic Design Category C.

1. Plate washers conforming to Section R602.11.1 shall be used on each bolt. ~~provided for all anchor bolts over the full length of required *braced wall lines* except where *approved* anchor straps are used. Properly sized cut washers shall be permitted for anchor bolts in wall lines not containing *braced wall panels*.~~

2. Interior braced wall plates shall have anchor bolts spaced at not more than 6 feet (1829 mm) on center and not more than ~~located within~~ 12 inches (305 mm) from the corner ~~of the ends of each plate section when supported on a continuous foundation~~.

3. Interior bearing wall sole plates shall have anchor bolts spaced at not more than 6 feet (1829 mm) on center and not more than ~~located within~~ 12 inches (305 mm) from the corner ~~of the ends of each plate section when supported on a continuous foundation~~.

4. The maximum anchor bolt spacing shall be 4 feet (1219 mm) for buildings over two stories in height.

5. ~~Stepped cripple walls shall conform to Section R602.11.2.~~ Deleted.

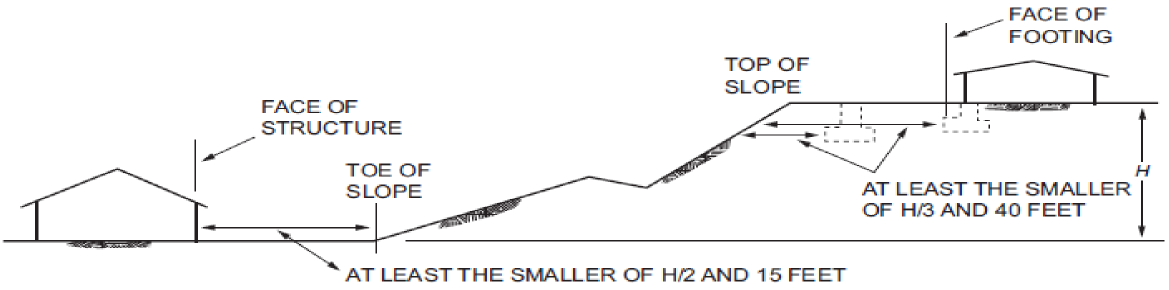
6. Where continuous wood foundations in accordance with Section R404.2 are used, the force transfer shall have a capacity equal to or greater than the connections required by Section R602.11.1 or the *braced wall panel* shall be connected to the wood foundations in accordance with the *braced wall panel*-to-floor fastening requirements of Table R602.3(1).

R403.1.7 Footings on or adjacent to slopes. Deleted.

~~The placement of buildings and structures on or adjacent to slopes steeper than one unit vertical in three units horizontal (33.3-percent slope) shall conform to Sections R403.1.7.1 through R403.1.7.4.~~

~~R403.1.7.1 Building clearances from ascending slopes.~~

~~In general, buildings below slopes shall be set a sufficient distance from the slope to provide protection from slope drainage, erosion and shallow failures. Except as provided in Section R403.1.7.4 and Figure R40 3.1.7.1, the following criteria will be assumed to provide this protection. Where the existing slope is steeper than one unit vertical in one unit horizontal (100-percent slope), the toe of the slope shall be assumed to be at the intersection of a horizontal plane drawn from the top of the foundation and a plane drawn tangent to the slope at an angle of 45 degrees (0.79 rad) to the horizontal. Where a retaining wall is constructed at the toe of the slope, the height of the slope shall be measured from the top of the wall to the top of the slope.~~



~~For SI: 1 foot = 304.8 mm.~~

~~FIGURE R403.1.7.1~~
~~FOUNDATION CLEARANCE FROM SLOPES~~

~~R403.1.7.2 Footing setback from descending slope surfaces.~~

~~Footings on or adjacent to slope surfaces shall be founded in material with an embedment and setback from the slope surface sufficient to provide vertical and lateral support for the footing without detrimental settlement. Except as provided for in Section R403.1.7.4 and Figure R403.1.7.1, the following setback is deemed adequate to meet the criteria. Where the slope is steeper than one unit vertical in one unit horizontal (100-percent slope), the required setback shall be measured from an imaginary plane 45 degrees (0.79 rad) to the horizontal, projected upward from the toe of the slope.~~

~~R403.1.7.3 Foundation elevation.~~

~~On graded sites, the top of any exterior foundation shall extend above the elevation of~~

~~the street gutter at point of discharge or the inlet of an *approved* drainage device a minimum of 12 inches (305 mm) plus 2 percent. Alternate elevations are permitted subject to the approval of the *building official*, provided it can be demonstrated that required drainage to the point of discharge and away from the structure is provided at all locations on the site.~~

~~R403.1.7.4 Alternate setbacks and clearances.~~

~~Alternate setbacks and clearances are permitted, subject to the approval of the *building official*. The *building official* is permitted to require an investigation and recommendation of a qualified engineer to demonstrate that the intent of this section has been satisfied. Such an investigation shall include consideration of material, height of slope, slope gradient, load intensity and erosion characteristics of slope material.~~

R403.1.8 Foundations on expansive soils. Deleted.

~~Foundation and floor slabs for buildings located on expansive soils shall be designed in accordance with Section 1808.6 of the *International Building Code*.~~

> ~~**Exception:** Slab-on-ground and other foundation systems which have performed adequately in soil conditions similar to those encountered at the building site are permitted subject to the approval of the *building official*.~~

~~R403.1.8.1 Expansive soils classifications.~~

~~Soils meeting all four of the following provisions shall be considered expansive, except that tests to show compliance with Items 1, 2 and 3 shall not be required if the test prescribed in Item 4 is conducted:~~

1. ~~Plasticity Index (PI) of 15 or greater, determined in accordance with ASTM D 4318.~~
2. ~~More than 10 percent of the soil particles pass a No. 200 sieve (75 µm), determined in accordance with ASTM D 422.~~
3. ~~More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D 422.~~
4. ~~Expansion Index greater than 20, determined in accordance with ASTM D 4829.~~

R403.1.9 Excavations near footings or foundations.

Excavations shall not remove lateral support from any footing or foundation without first shoring, underpinning or protecting the footing or foundation against settlement or lateral translation. Where footings of adjacent buildings or structures are undercut by excavations measured from the bottom of the adjacent existing footing at a 45 degree angle (0.79 rad) within 10 feet (3048 mm) as shown in Figure R403.1.9, the footings shall require evaluation by a *registered design professional.*

> **Exception:** *Accessory buildings* not exceeding 400 square feet (37 m^2) exempt from providing a masonry or concrete foundation in accordance with Section R101.2.1.

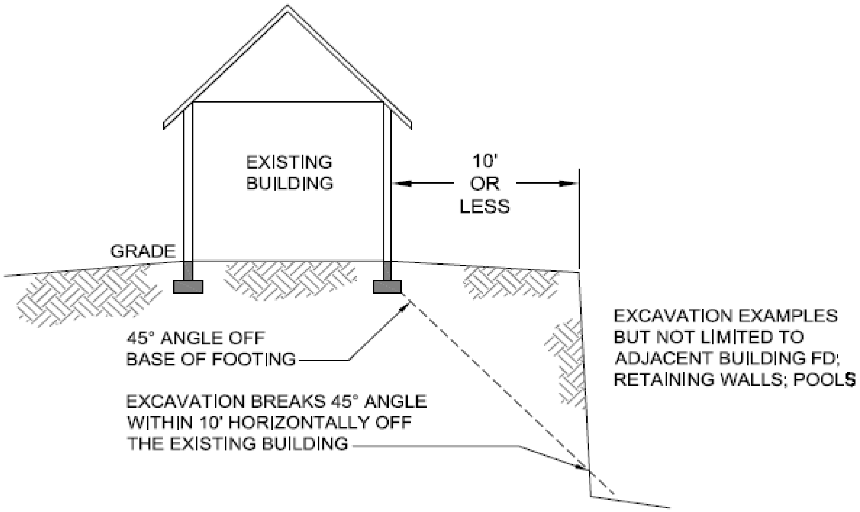
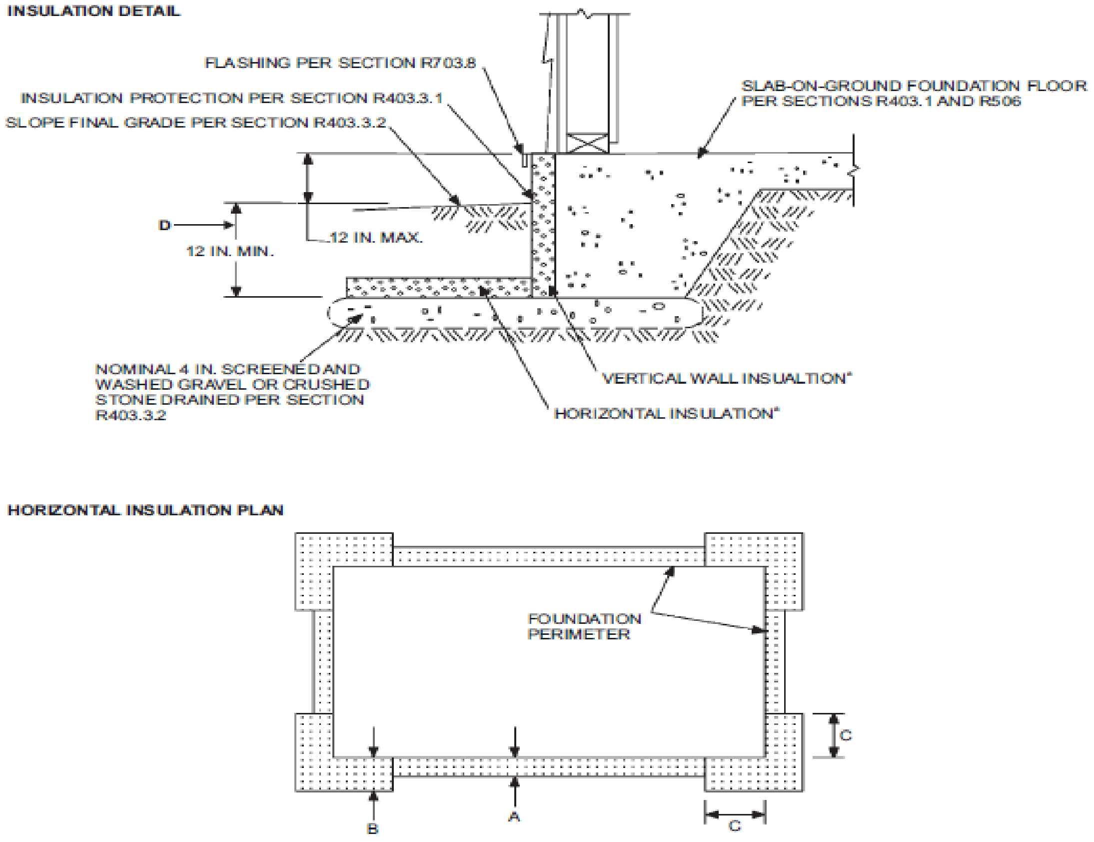


FIGURE R403.1.9
EXCAVATIONS NEAR FOOTINGS OR FOUNDATIONS

R403.3 Frost-protected shallow foundations. Deleted.
~~For buildings where the monthly mean temperature of the building is maintained at a minimum of 64°F (18°C), footings are not required to extend below the frost line when protected from frost by insulation in accordance with Figure R403.3(1) and Table R403.3(1). Foundations protected from frost in accordance with Figure R403.3(1) and Table R403.3(1) shall not be used for unheated spaces such as porches, utility rooms, garages and carports, and shall not be attached to basements or crawl spaces that are not maintained at a minimum monthly mean temperature of 64°F (18°C).~~

~~Materials used below *grade* for the purpose of insulating footings against frost shall be *labeled* as complying with ASTM C 578.~~



~~For SI: 1 inch = 25.4 mm.~~

~~a. See Table R403.3(1) for required dimensions and R-values for vertical and horizontal insulation and minimum footing depth.~~

~~FIGURE R403.3(1)~~
~~INSULATION PLACEMENT FOR FROST-PROTECTED FOOTINGS IN HEATED BUILDINGS~~

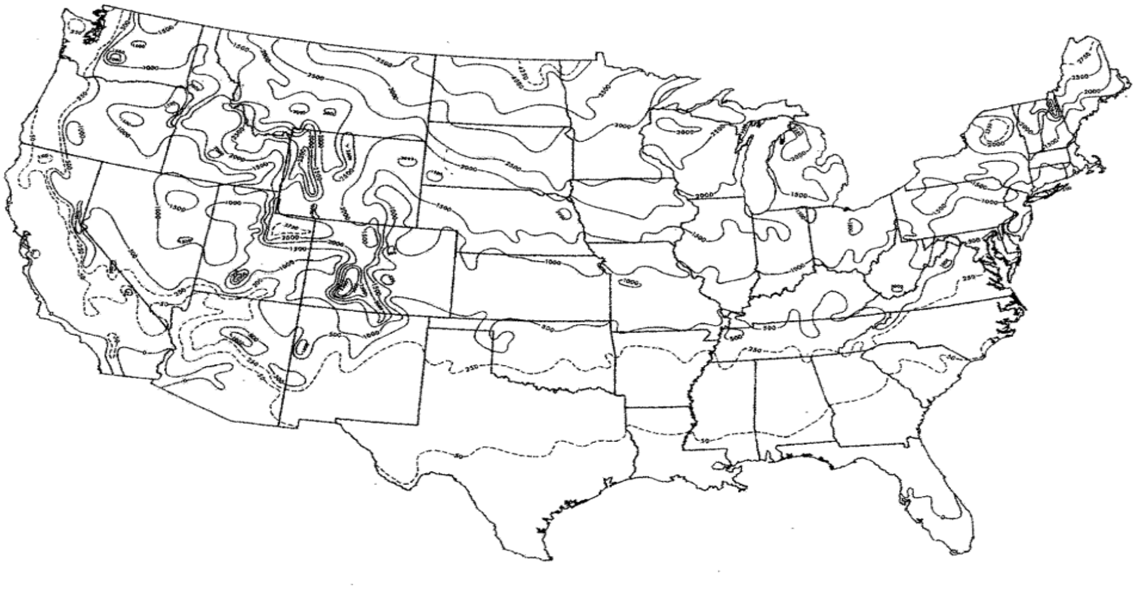
~~TABLE R403.3(1)~~

~~MINIMUM FOOTING DEPTH AND INSULATION REQUIREMENTS FOR FROST-PROTECTED FOOTINGS IN HEATED BUILDINGS~~[a]

~~AIR FREEZING INDEX (°F-days)~~[~~b~~]	~~MINIMUM FOOTING DEPTH, D (inches)~~	~~VERTICAL INSULATION R-VALUE~~[~~c, d~~]	~~HORIZONTAL INSULATION R-VALUE~~[~~c, e~~]		~~HORIZONTAL INSULATION DIMENSIONS PER FIGURE R403.3(1) (inches)~~		
			~~Along walls~~	~~At corners~~	~~A~~	~~B~~	~~C~~
~~1,500 or less~~	~~12~~	~~4.5~~	~~Not required~~	~~Not required~~	~~Not required~~	~~Not required~~	~~Not required~~
~~2,000~~	~~14~~	~~5.6~~	~~Not required~~	~~Not required~~	~~Not required~~	~~Not required~~	~~Not required~~
~~2,500~~	~~16~~	~~6.7~~	~~1.7~~	~~4.9~~	~~12~~	~~24~~	~~40~~
~~3,000~~	~~16~~	~~7.8~~	~~6.5~~	~~8.6~~	~~12~~	~~24~~	~~40~~
~~3,500~~	~~16~~	~~9.0~~	~~8.0~~	~~11.2~~	~~24~~	~~30~~	~~60~~
~~4,000~~	~~16~~	~~10.1~~	~~10.5~~	~~13.1~~	~~24~~	~~36~~	~~60~~

~~For SI: 1 inch = 25.4 mm, °C = [(°F) - 32]/1.8.~~

- ~~a. Insulation requirements are for protection against frost damage in heated buildings. Greater values may be required to meet energy conservation standards.~~
- ~~b. See Figure R403.3(2) or Table R403.3(2) for Air Freezing Index values.~~
- ~~c. Insulation materials shall provide the stated minimum *R*-values under long-term exposure to moist, below-ground conditions in freezing climates. The following *R*-values shall be used to determine insulation thicknesses required for this application: Type II expanded polystyrene-2.4*R* per inch; Type IV extruded polystyrene-4.5*R* per inch; Type VI extruded polystyrene-4.5*R* per inch; Type IX expanded polystyrene-3.2*R* per inch; Type X extruded polystyrene-4.5*R* per inch.~~
- ~~d. Vertical insulation shall be expanded polystyrene insulation or extruded polystyrene insulation.~~
- ~~e. Horizontal insulation shall be expanded polystyrene insulation or extruded polystyrene insulation.~~



~~For SI: „aC = [(„aF) -32]/1.8.~~

~~Note: The air-freezing index is defined as cumulative degree days below 32„aF. It is used as a measure of the combined magnitude and duration of air temperature below freezing. The index was computed over a 12-month period (July-June) for each of the 3,044 stations used in the above analysis. Dates from the 1951-80 period were fitted to a Weibull probability distribution to produce an estimate of the 100-year return period.~~

~~FIGURE R403.3(2)~~
~~AIR-FREEZING INDEX AN ESTIMATE OF THE 100-YEAR RETURN PERIOD~~

~~TABLE R403.3(2)~~
~~AIR-FREEZING INDEX FOR U.S. LOCATIONS BY COUNTY~~

~~STATE~~	~~AIR-FREEZING INDEX~~					
	~~1500 or less~~	~~2000~~	~~2500~~	~~3000~~	~~3500~~	4000
~~Alabama~~	~~All counties~~	—	—	—	—	—

~~Alaska~~	~~Ketchikan Gateway, Prince of Wales-Outer Ketchikan (CA), Sitka, Wrangell-Petersburg (CA)~~	—	~~Aleutians West (CA), Haines, Juneau, Skagway-Hoonah-Angoon (CA), Yakutat~~	—	—	All counties not listed
~~Arizona~~	~~All counties~~	—	—	—	—	—
~~Arkansas~~	~~All counties~~	—	—	—	—	—
~~California~~	~~All counties not listed~~	~~Nevada, Sierra~~	—	—	—	—
~~Colorado~~	~~All counties not listed~~	~~Archuleta, Custer, Fremont, Huerfano, Las Animas, Ouray, Pitkin, San Miguel~~	~~Clear Creek, Conejos, Costilla, Dolores, Eagle, La Plata, Park, Routt, San Juan, Summit~~	~~Alamosa, Grand, Jackson, Larimer, Moffat, Rio Blanco, Rio Grande~~	~~Chaffee, Gunnison, Lake, Saguache~~	Hinsdale, Mineral
~~Connecticut~~	~~All counties not listed~~	~~Hartford, Litchfield~~	—	—	—	—
~~Delaware~~	~~All counties~~	—	—	—	—	—
~~District of Columbia~~	~~All counties~~	—	—	—	—	—
~~Florida~~	~~All counties~~	—	—	—	—	—
~~Georgia~~	~~All counties~~	—	—	—	—	—
~~Hawaii~~	~~All counties~~	—	—	—	—	—
~~Idaho~~	~~All counties not listed~~	~~Adams, Bannock, Blaine, Clearwater, Idaho, Lincoln, Oneida, Power, Valley, Washington~~	~~Bingham, Bonneville, Camas, Caribou, Elmore, Franklin, Jefferson, Madison, Teton~~	~~Bear Lake, Butte, Custer, Fremont, Lemhi~~	~~Clark~~	—

~~Illinois~~	~~All counties not listed~~	~~Boone, Bureau, Cook, Dekalb, DuPage, Fulton, Grundy, Henderson, Henry, Iroquois, Jo Daviess, Kane, Kankakee, Kendall, Knox, La Salle, Lake, Lee, Livingston, Marshall, Mason, McHenry, McLean, Mercer, Peoria, Putnam, Rock Island, Stark, Tazewell, Warren, Whiteside, Will, Woodford~~	~~Carroll, Ogle, Stephenson, Winnebago~~	—	—	—
~~Indiana~~	~~All counties not listed~~	~~Allen, Benton, Cass, Fountain, Fulton, Howard, Jasper, Kosciusko, La Porte, Lake, Marshall, Miami, Newton, Porter, Pulaski, Starke, Steuben, Tippecanoe, Tipton, Wabash, Warren, White~~	—	—	—	—

(continued)

~~TABLE R403.3(2)—continued~~
~~AIR-FREEZING INDEX FOR U.S. LOCATIONS BY COUNTY~~

~~STATE~~	**~~AIR-FREEZING INDEX~~**					
	~~1500 or less~~	**~~2000~~**	**~~2500~~**	**~~3000~~**	**~~3500~~**	**~~4000~~**

~~Iowa~~	~~Appanoose, Davis, Fremont, Lee, Van Buren~~	~~All counties not listed~~	~~Allamakee, Black Hawk, Boone, Bremer, Buchanan, Buena Vista, Butler, Calhoun, Cerro Gordo, Cherokee, Chickasaw, Clay, Clayton, Delaware, Dubuque, Fayette, Floyd, Franklin, Grundy, Hamilton, Hancock, Hardin, Humboldt, Ida, Jackson, Jasper, Jones, Linn, Marshall, Palo Alto, Plymouth, Pocahontas, Poweshiek, Sac, Sioux, Story, Tama, Webster, Winnebago, Woodbury, Worth, Wright~~	~~Dickinson, Emmet, Howard, Kossuth, Lyon, Mitchell, O'Brien, Osceola, Winneshiek~~	~~—~~	~~—~~
~~Kansas~~	~~All counties~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Kentucky~~	~~All counties~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Louisiana~~	~~All counties~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Maine~~	~~York~~	~~Knox, Lincoln, Sagadahoc~~	~~Androscoggin, Cumberland, Hancock, Kennebec, Waldo, Washington~~	~~Aroostook, Franklin, Oxford, Penobscot, Piscataquis, Somerset~~	~~—~~	~~—~~
~~Maryland~~	~~All counties~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Massachusetts~~	~~All counties not listed~~	~~Berkshire, Franklin, Hampden, Worcester~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Michigan~~	~~Berrien, Branch, Cass, Kalamazoo, Macomb, Ottawa, St. Clair, St. Joseph~~	~~All counties not listed~~	~~Alger, Charlevoix, Cheboygan, Chippewa, Crawford, Delta, Emmet, Iosco, Kalkaska, Lake, Luce, Mackinac, Menominee, Missaukee, Montmorency, Ogemaw, Osceola, Otsego, Roscommon, Schoolcraft, Wexford~~	~~Baraga, Dickinson, Iron, Keweenaw, Marquette~~	~~Gogebic, Houghton, Ontonagon~~	~~—~~

~~Minnesota~~	~~—~~	~~—~~	~~Houston, Winona~~	~~All counties not listed~~	~~Aitkin, Big Stone, Carlton, Crow Wing, Douglas, Itasca, Kanabec, Lake, Morrison, Pine, Pope, Stearns, Stevens, Swift, Todd, Wadena~~	~~Becker, Beltrami, Cass, Clay, Clearwater, Grant, Hubbard, Kittson, Koochiching, Lake of the Woods, Mahnomen, Marshall, Norman, Otter Tail, Pennington, Polk, Red Lake, Roseau, St. Louis, Traverse, Wilkin~~

(continued)

~~TABLE R403.3(2)—continued~~
~~AIR-FREEZING INDEX FOR U.S. LOCATIONS BY COUNTY~~

~~**STATE**~~	~~**AIR-FREEZING INDEX**~~					
	~~**1500 or less**~~	~~**2000**~~	~~**2500**~~	~~**3000**~~	~~**3500**~~	~~**4000**~~
~~Mississippi~~	~~All counties~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Missouri~~	~~All counties not listed~~	~~Atchison, Mercer, Nodaway, Putnam~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Montana~~	~~Mineral~~	~~Broadwater, Golden Valley, Granite, Lake, Lincoln, Missoula, Ravalli, Sanders, Sweet Grass~~	~~Big Horn, Carbon, Jefferson, Judith Basin, Lewis and Clark, Meagher, Musselshell, Powder River, Powell, Silver Bow, Stillwater, Westland~~	~~Carter, Cascade, Deer Lodge, Falcon, Fergus, Flathead, Gallanting, Glacier, Madison, Park, Petroleum, Ponder, Rosebud, Teton, Treasure, Yellowstone~~	~~Beaverhead, Blaine, Chouteau, Custer, Dawson, Garfield, Liberty, McCone, Prairie, Toole, Wibaux~~	~~Daniels, Hill, Phillips, Richland, Roosevelt, Sheridan, Valley~~

~~Nebraska~~	~~Adams, Banner, Chase, Cheyenne, Clay, Deuel, Dundy, Fillmore, Franklin, Frontier, Furnas, Gage, Garden, Gosper, Harlan, Hayes, Hitchcock, Jefferson, Kimball, Morrill, Nemaha, Nuckolls, Pawnee, Perkins, Phelps, Red Willow, Richardson, Saline, Scotts Bluff, Seward, Thayer, Webster~~	~~All counties not listed~~	~~Boyd, Burt, Cedar, Cuming, Dakota, Dixon, Dodge, Knox, Thurston~~	~~—~~	~~—~~	~~—~~
~~Nevada~~	~~All counties not listed~~	~~Elko, Eureka, Nye, Washoe, White Pine~~	~~—~~	~~—~~	~~—~~	~~—~~
~~New Hampshire~~	~~—~~	~~All counties not listed~~	~~—~~	~~—~~	~~—~~	~~Carroll, Coos, Grafton~~
~~New Jersey~~	~~All counties~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~New Mexico~~	~~All counties not listed~~	~~Rio Arriba~~	~~Colfax, Mora, Taos~~	~~—~~	~~—~~	~~—~~

~~New York~~	~~Albany, Bronx, Cayuga, Columbia, Cortland, Dutchess, Genessee, Kings, Livingston, Monroe, Nassau, New York, Niagara, Onondaga, Ontario, Orange, Orleans, Putnam, Queens, Richmond, Rockland, Seneca, Suffolk, Wayne, Westchester, Yates~~	~~All counties not listed~~	~~Clinton, Essex, Franklin, Hamilton, Herkimer, Jefferson, Lewis, St. Lawrence, Warren~~	~~—~~	~~—~~	~~—~~
~~North Carolina~~	~~All counties~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~

(continued)

~~TABLE R403.3(2)—continued~~
~~AIR-FREEZING INDEX FOR U.S. LOCATIONS BY COUNTY~~

~~STATE~~	**~~AIR-FREEZING INDEX~~**					
	~~1500 or less~~	**~~2000~~**	**~~2500~~**	**~~3000~~**	**~~3500~~**	**~~4000~~**
~~North Dakota~~	~~—~~	~~—~~	~~—~~	~~Billings, Bowman~~	~~Adams, Dickey, Golden Valley, Hettinger, LaMoure, Oliver, Ransom, Sargent, Sioux, Slope, Stark~~	~~All counties not listed~~
~~Ohio~~	~~All counties not listed~~	~~Ashland, Crawford, Defiance, Holmes, Huron, Knox, Licking, Morrow, Paulding, Putnam, Richland, Seneca, Williams~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Oklahoma~~	~~All counties~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Oregon~~	~~All counties not listed~~	~~Baker, Crook, Grant, Harney~~	~~—~~	~~—~~	~~—~~	~~—~~

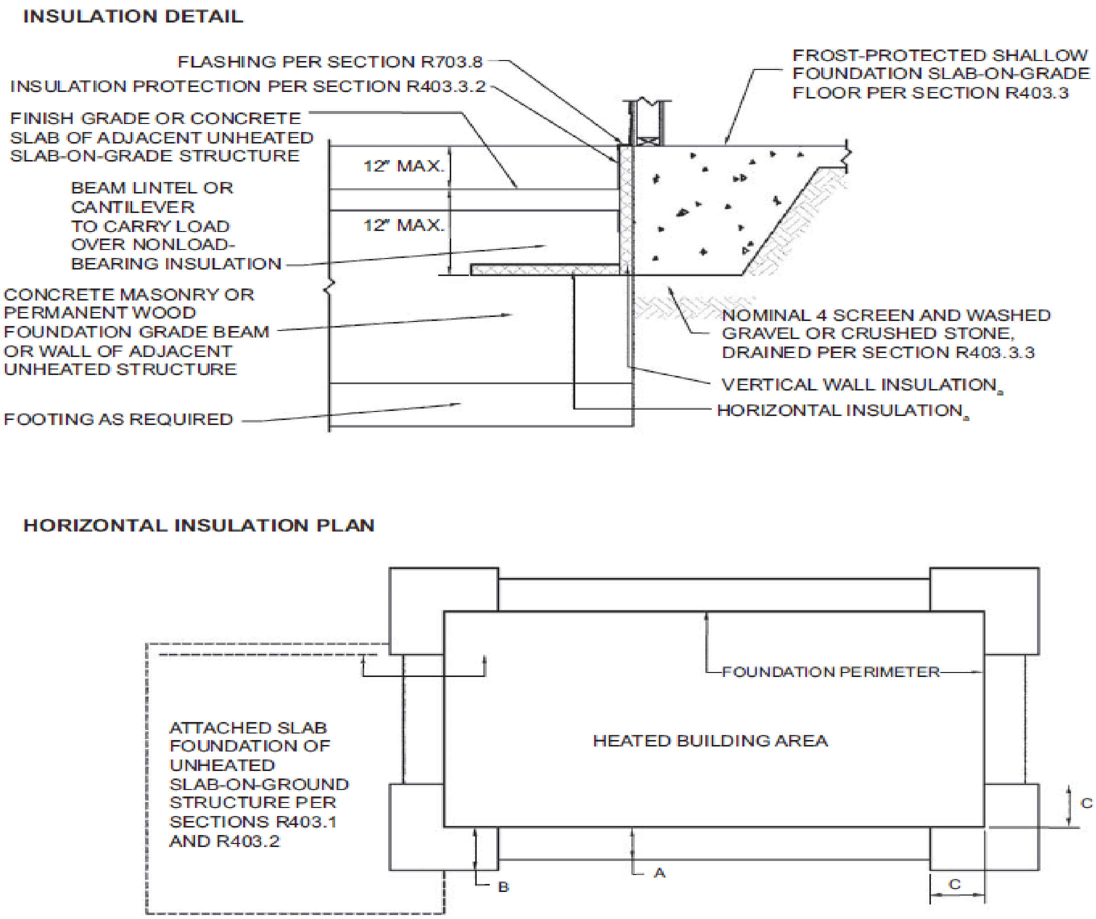
~~Pennsylvania~~	~~All counties not listed~~	~~Berks, Blair, Bradford, Cambria, Cameron, Centre, Clarion, Clearfield, Clinton, Crawford, Elk, Forest, Huntingdon, Indiana, Jefferson, Lackawanna, Lycoming, McKean, Pike, Potter, Susquehanna, Tioga, Venango, Warren, Wayne, Wyoming~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Rhode Island~~	~~All counties~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~South Carolina~~	~~All counties~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~South Dakota~~	~~—~~	~~Bennett, Custer, Fall River, Lawrence, Mellette, Shannon, Todd, Tripp~~	~~Bon Homme, Charles Mix, Davison, Douglas, Gregory, Jackson, Jones, Lyman~~	~~All counties not listed~~	~~Beadle, Brookings, Brown, Campbell, Codington, Corson, Day, Deuel, Edmunds, Faulk, Grant, Hamlin, Kingsbury, Marshall, McPherson, Perkins, Roberts, Spink, Walworth~~	~~—~~
~~Tennessee~~	~~All counties~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Texas~~	~~All counties~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Utah~~	~~All counties not listed~~	~~Box Elder, Morgan, Weber~~	~~Garfield, Salt Lake, Summit~~	~~Carbon, Daggett, Duchesne, Rich, Sanpete, Uintah, Wasatch~~	~~—~~	~~—~~

~~(continued)~~

~~TABLE R403.3(2)—continued~~
~~AIR-FREEZING INDEX FOR U.S. LOCATIONS BY COUNTY~~

~~STATE~~	~~AIR-FREEZING INDEX~~					
	~~1500 or less~~	~~2000~~	~~2500~~	~~3000~~	~~3500~~	~~4000~~

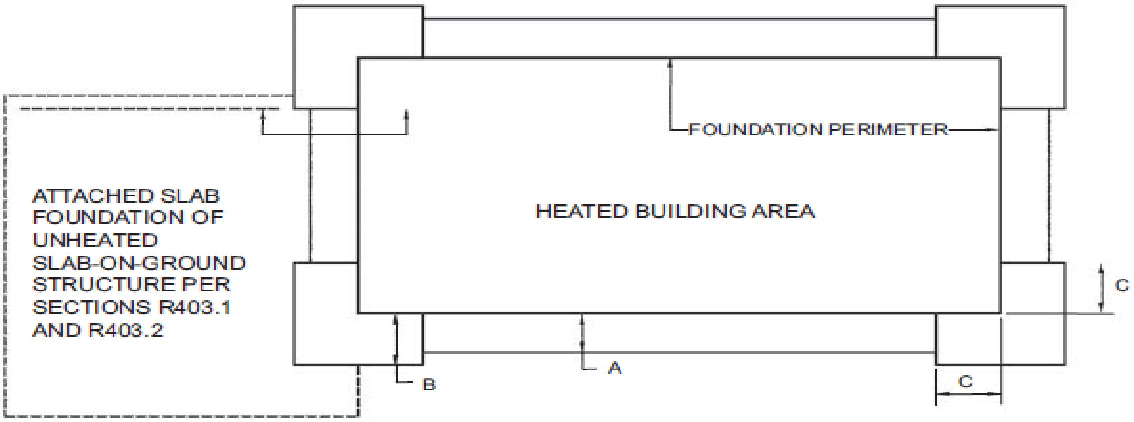
~~Vermont~~	~~—~~	~~Bennington, Grand Isle, Rutland, Windham~~	~~Addison, Chittenden, Franklin, Orange, Washington, Windsor~~	~~Caledonia, Essex, Lamoille, Orleans~~	~~—~~	~~—~~
~~Virginia~~	~~All counties~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Washington~~	~~All counties not listed~~	~~Chelan, Douglas, Ferry, Okanogan~~	~~—~~	~~—~~	~~—~~	~~—~~
~~West Virginia~~	~~All counties~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~Wisconsin~~	~~—~~	~~Kenosha, Kewaunee, Racine, Sheboygan, Walworth~~	~~All counties not listed~~	~~Ashland, Barron, Burnett, Chippewa, Clark, Dunn, Eau Claire, Florence, Forest, Iron, Jackson, La Crosse, Langlade, Marathon, Monroe, Pepin, Polk, Portage, Price, Rust, St. Croix, Taylor, Trempealeau, Vilas, Wood~~	~~Bayfield, Douglas, Lincoln, Oneida, Sawyer, Washburn~~	~~—~~
~~Wyoming~~	~~Goshen, Platte~~	~~Converse, Crook, Laramie, Niobrara~~	~~Campbell, Carbon, Hot Springs, Johnson, Natrona, Sheridan, Uinta, Weston~~	~~Albany, Big Horn, Park, Washakie~~	~~Fremont, Teton~~	~~Lincoln, Sublette, Sweetwater~~



~~For SI: 1 inch = 25.4 mm.~~

~~a. See Table R403.3(1) for required dimensions and R-values for vertical and horizontal insulation.~~

~~FIGURE R403.3(3)~~
~~INSULATION PLACEMENT FOR FROST-PROTECTED FOOTINGS ADJACENT TO UNHEATED SLAB-ON-GROUND STRUCTURE~~



~~FIGURE R403.3(4)~~
~~INSULATION PLACEMENT FOR FROST-PROTECTED FOOTINGS ADJACENT TO HEATED STRUCTURE~~

~~R403.3.1 Foundations adjoining frost-protected shallow foundations.~~
~~Foundations that adjoin frost-protected shallow foundations shall be protected from frost in accordance with Section R403.1.4.~~

~~R403.3.1.1 Attachment to unheated slab-on-ground structure.~~
~~Vertical wall insulation and horizontal insulation of frost-protected shallow foundations that adjoin a slab-on-ground foundation that does not have a monthly mean temperature maintained at a minimum of 64°F (18°C) shall be in accordance with Figure R403.3(3) and Table R403.3(1). Vertical wall insulation shall extend between the frost-protected shallow foundation and the adjoining slab foundation. Required horizontal insulation shall be continuous under the adjoining slab foundation and through any foundation walls adjoining the frost- protected shallow foundation. Where insulation passes through a foundation wall, it shall be either of a type complying with this section and having bearing capacity equal to or greater than the structural loads imposed by the building, or the building shall be designed and constructed using beams, lintels, cantilevers or other means of transferring building loads such that the structural loads of the building do not bear on the insulation.~~

~~R403.3.1.2 Attachment to heated structure.~~
~~Where a frost-protected shallow foundation abuts a structure that has a monthly mean temperature maintained at a minimum of 64°F (18°C), horizontal insulation and vertical wall insulation shall not be required between the frost-protected shallow foundation and the adjoining structure. Where the frost-protected shallow foundation abuts the heated structure, the horizontal insulation and vertical wall insulation shall extend along the adjoining foundation in accordance with Figure R403.3(4) a distance of not less than Dimension A in Table R403.3(1).~~

> **~~Exception:~~** ~~Where the frost-protected shallow foundation abuts the heated structure to form an inside corner, vertical insulation extending along the adjoining foundation is not required.~~

~~R403.3.2 Protection of horizontal insulation below ground.~~
~~Horizontal insulation placed less than 12 inches (305 mm) below the ground surface or that portion of horizontal insulation extending outward more than 24 inches (610 mm) from the foundation edge shall be protected against damage by use of a concrete slab or asphalt paving on the ground surface directly above the insulation or by cementitious board, plywood rated for below-ground use, or other *approved* materials placed below ground, directly above the top surface of the insulation.~~

~~R403.3.3 Drainage.~~
~~Final *grade* shall be sloped in accordance with Section R401.3. In other than Group I Soils, as detailed in Table R405.1, gravel or crushed stone beneath horizontal insulation below ground shall drain to daylight or into an *approved* sewer system.~~

~~**R403.3.4 Termite protection.**~~

~~The use of foam plastic in areas of “very heavy” termite infestation probability shall be in accordance with Section R318.4.~~

SECTION R404
FOUNDATION AND RETAINING WALLS

TABLE R404.1.1(2)
8-INCH MASONRY FOUNDATION WALLS WITH REINFORCING WHERE d ≥ 5 INCHES[a, c, f]

WALL HEIGHT	**HEIGHT OF UNBALANCED BACKFILL**[e]	**MINIMUM VERTICAL REINFORCEMENT AND SPACING (INCHES)**[b, c]		
		Soil classes and lateral soil load[d] **(psf per foot below grade)**		
		GW, GP, SW and SP soils 30	**GM, GC, SM, SM-SC and ML soils 45**	**SC, ML-CL and inorganic CL soils 60**
6 feet 8 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#4 at 48
	6 feet 8 inches	#4 at 48	#5 at 48	#6 at 48
7 feet 4 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#4 at 48
	6 feet	#4 at 48	#5 at 48	#5 at 48
	7 feet 4 inches	#5 at 48	#6 at 48	#6 at 40
8 feet	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#4 at 48
	6 feet	#4 at 48	#5 at 48	#5 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 40
	8 feet	#5 at 48	#6 at 48	#6 at 32
8 feet 8 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#5 at 48
	6 feet	#4 at 48	#5 at 48	#6 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 40
	8 feet 8 inches	#6 at 48	#6 at 32	#6 at 24
9 feet 4 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#5 at 48
	6 feet	#4 at 48	#5 at 48	#6 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 40
	8 feet	#6 at 48	#6 at 40	#6 at 24
	9 feet 4 inches	#6 at 40	#6 at 24	#6 at 16
10 feet	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#5 at 48
	6 feet	#4 at 48	#5 at 48	#6 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 32
	8 feet	#6 at 48	#6 at 32	#6 at 24
	9 feet	#6 at 40	#6 at 24	#6 at 16
	10 feet	#6 at 32	#6 at 16	#6 at 16

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/mm.

a. Mortar shall be Type M or S and masonry shall be laid in running bond.

b. Alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per lineal foot of wall shall be permitted provided the spacing of the reinforcement does not exceed 72 inches in Seismic Design Categories A, B and C~~, and 48 inches in Seismic Design Categories D_0, D_1 and D_2~~.

c. Vertical reinforcement shall be Grade 60 minimum. The distance, *d*, from the face of the soil side of the wall to the center of vertical reinforcement shall be not less than 5 inches.

d. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. Refer to Table R405.1.

e. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.

f. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.1(3)

10-INCH MASONRY FOUNDATION WALLS WITH REINFORCING WHERE d □ 6.75 INCHES[a, c, f]

WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL[e]	MINIMUM VERTICAL REINFORCEMENT AND SPACING (INCHES)[b, c]		
		Soil classes and later soil load[d] (psf per foot below grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and inorganic CL soils 60
6 feet 8 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet 8 inches	#4 at 56	#5 at 56	#5 at 56
7 feet 4 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#4 at 56	#5 at 56
	7 feet 4 inches	#4 at 56	#5 at 56	#6 at 56
8 feet	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#4 at 56	#5 at 56
	7 feet	#4 at 56	#5 at 56	#6 at 56
	8 feet	#5 at 56	#6 at 56	#6 at 48
8 feet 8 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#4 at 56	#5 at 56
	7 feet	#4 at 56	#5 at 56	#6 at 56
	8 feet 8 inches	#5 at 56	#6 at 48	#6 at 32
9 feet 4 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#5 at 56	#5 at 56
	7 feet	#4 at 56	#5 at 56	#6 at 56
	8 feet	#5 at 56	#6 at 56	#6 at 40
	9 feet 4 inches	#6 at 56	#6 at 40	#6 at 24
10 feet	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#5 at 56	#5 at 56
	7 feet	#5 at 56	#6 at 56	#6 at 48
	8 feet	#5 at 56	#6 at 48	#6 at 40
	9 feet	#6 at 56	#6 at 40	#6 at 24
	10 feet	#6 at 48	#6 at 32	#6 at 24

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/mm.

a. Mortar shall be Type M or S and masonry shall be laid in running bond.

b. Alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per lineal foot of wall shall be permitted provided the spacing of the reinforcement does not exceed 72 inches in Seismic Design Categories A, B and C~~, and 48 inches in Seismic Design Categories D0, D1 and D2~~.

c. Vertical reinforcement shall be Grade 60 minimum. The distance, *d*, from the face of the soil side of the wall to the center of vertical reinforcement shall be not less than 6.75 inches.

d. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. Refer to Table R405.1.

e. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.

f. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.1(4)

12-INCH MASONRY FOUNDATION WALLS WITH REINFORCING WHERE $d \geq 8.75$ INCHES[a, c, f]

WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL[e]	MINIMUM VERTICAL REINFORCEMENT AND SPACING (INCHES)[b, c]		
		Soil classes and lateral soil load[d] (psf per foot below grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and inorganic CL soils 60
6 feet 8 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet 8 inches	#4 at 72	#4 at 72	#5 at 72
7 feet 4 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#4 at 72	#5 at 72
	7 feet 4 inches	#4 at 72	#5 at 72	#6 at 72
8 feet	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#4 at 72	#5 at 72
	7 feet	#4 at 72	#5 at 72	#6 at 72
	8 feet	#5 at 72	#6 at 72	#6 at 64
8 feet 8 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#4 at 72	#5 at 72
	7 feet	#4 at 72	#5 at 72	#6 at 72
	8 feet 8 inches	#5 at 72	#7 at 72	#6 at 48
9 feet 4 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#5 at 72	#5 at 72
	7 feet	#4 at 72	#5 at 72	#6 at 72
	8 feet	#5 at 72	#6 at 72	#6 at 56
	9 feet 4 inches	#6 at 72	#6 at 48	#6 at 40
10 feet	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#5 at 72	#5 at 72
	7 feet	#4 at 72	#6 at 72	#6 at 72
	8 feet	#5 at 72	#6 at 72	#6 at 48
	9 feet	#6 at 72	#6 at 56	#6 at 40
	10 feet	#6 at 64	#6 at 40	#6 at 32

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/mm.

a. Mortar shall be Type M or S and masonry shall be laid in running bond.

b. Alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per lineal foot of wall shall be permitted provided the spacing of the reinforcement does not exceed 72 inches in Seismic Design Categories A, B and C~~, and 48 inches in Seismic Design Categories D_0, D_1 and D_2~~.

c. Vertical reinforcement shall be Grade 60 minimum. The distance, *d*, from the face of the soil side of the wall to the center of vertical reinforcement shall be not less than 8.75 inches.

d. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. Refer to Table R405.1.

e. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground levels. Where an interior concrete slab-on-grade is provided and in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height is permitted to be measured from the exterior finish ground level to the top of the interior concrete slab is permitted.

f. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.2(1)
MINIMUM HORIZONTAL REINFORCEMENT FOR CONCRETE BASEMENT WALLS[a, b]

MAXIMUM UNSUPPORTED HEIGHT OF BASEMENT WALL (feet)	LOCATION OF HORIZONTAL REINFORCEMENT
≤ 8	One No. 4 bar within 12 inches of the top of the wall story and one No. 4 bar near mid-height of the wall story.
> 8	One No. 4 bar within 12 inches of the top of the wall story and one No. 4 bar near third points in the wall story.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa.

a. Horizontal reinforcement requirements are for reinforcing bars with a minimum yield strength of 40,000 psi and concrete with a minimum concrete compressive strength of 2,500 psi.

b. See Section ~~R404.1.2.2~~ R404.1.3.2 for minimum reinforcement required for foundation walls supporting above-grade concrete walls.

TABLE R404.1.2(2)
MINIMUM VERTICAL REINFORCEMENT FOR 6-INCH NOMINAL FLAT CONCRETE BASEMENT WALLS[b, c, d, e, g, h, i, j, k]

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[f] (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes[a] and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	NR	NR	NR
	5	NR	6 @ 39	6 @ 48
	6	5 @ 39	6 @ 48	6 @ 35
	7	6 @ 48	6 @ 34	6 @ 25
	8	6 @ 39	6 @ 25	6 @ 18
9	4	NR	NR	NR
	5	NR	5 @ 37	6 @ 48

	6	5 @ 36	6 @ 44	6 @ 32
	7	6 @ 47	6 @ 30	6 @ 22
	8	6 @ 34	6 @ 22	6 @ 16
	9	6 @ 27	6 @ 17	DR
10	4	NR	NR	NR
	5	NR	5 @ 35	6 @ 48
	6	6 @ 48	6 @ 41	6 @ 30
	7	6 @ 43	6 @ 28	6 @ 20
	8	6 @ 31	6 @ 20	DR
	9	6 @ 24	6 @ 15	DR
	10	6 @ 19	DR	DR

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot per foot = 0.1571 kPa^2/m, 1 pound per square inch = 6.895 kPa.

NR = Not required.

- a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.
- b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.
- c. Vertical reinforcement with a yield strength of less than 60,000 psi and/or bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(~~9~~5).
- d. Deflection criterion is *L*/240, where *L* is the height of the basement wall in inches.
- e. Interpolation is not permitted.
- f. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
- g. NR indicates no vertical wall reinforcement is required, except for 6-inch-nominal walls formed with stay-in-place forming systems in which case vertical reinforcement shall be No. 4@48 inches on center.
- h. See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
- i. See Table R608.3 for tolerance from nominal thickness permitted for flat walls.
- j. DR means design is required in accordance with the applicable building code, or where there is no code, in accordance with ACI 318.
- k. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.2(3)
MINIMUM VERTICAL REINFORCEMENT FOR 8-INCH (203 mm) NOMINAL FLAT CONCRETE BASEMENT WALLS[b, c, d, e, f, h, i, j]

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	**MAXIMUM UNBALANCED BACKFILL HEIGHT[g] (feet)**	**MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)**		
		Soil classes[a] and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	**GM, GC, SM, SM-SC and ML 45**	**SC, ML-CL and inorganic CL 60**
8	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6 @ 37
	7	NR	6 @ 36	6 @ 35
	8	6 @ 41	6 @ 35	6 @ 26
9	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6 @ 35
	7	NR	6 @ 35	6 @ 32

	8	6 @ 36	6 @ 32	6 @ 23
	9	6 @ 35	6 @ 25	6 @ 18
10	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6 @ 35
	7	NR	6 @ 35	6 @ 29
	8	6 @ 35	6 @ 29	6 @ 21
	9	6 @ 34	6 @ 22	6 @ 16
	10	6 @ 27	6 @ 17	6 @ 13

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot per foot = 0.1571 kPa^{2}/m, 1 pound per square inch = 6.895 kPa.

NR = Not required.

a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi, concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.

c. Vertical reinforcement with a yield strength of less than 60,000 psi and/or bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(~~9~~5).

d. NR indicates no vertical reinforcement is required.

e. Deflection criterion is *L*/240, where *L* is the height of the basement wall in inches.

f. Interpolation is not permitted.

g. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.

h. See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.

i. See Table R608.3 for tolerance from nominal thickness permitted for flat walls.

j. The use of this table shall be prohibited for soil classifications not shown.

TABLE R404.1.2(4)
MINIMUM VERTICAL REINFORCEMENT FOR 10-INCH NOMINAL FLAT CONCRETE BASEMENT WALLS[b, c, d, e, f, h, i, j]

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[g] (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes[a] and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	NR
	7	NR	NR	NR
	8	6 @ 48	6 @ 35	6 @ 28
9	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	NR
	7	NR	NR	6 @ 31
	8	NR	6 @ 31	6 @ 28
	9	6 @ 37	6 @ 28	6 @ 24
10	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	NR

	7	NR	NR	6 @ 28
	8	NR	6 @ 28	6 @ 28
	9	6 @ 33	6 @ 28	6 @ 21
	10	6 @ 28	6 @ 23	6 @ 17

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot per foot = 0.1571 kPa^2/m, 1 pound per square inch = 6.895 kPa.

NR = Not required.

a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.
b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.
c. Vertical reinforcement with a yield strength of less than 60,000 psi and/or bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(~~9~~5).
d. NR indicates no vertical reinforcement is required.
e. Deflection criterion is *L*/240, where *L* is the height of the basement wall in inches.
f. Interpolation is not permitted.
g. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
h. See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
i. See Table R608.3 for tolerance from nominal thickness permitted for flat walls.
j. The use of this table shall be prohibited for soil classifications not shown.

~~TABLE R404.1.2(5)~~

~~MINIMUM VERTICAL WALL REINFORCEMENT FOR 6-INCH WAFFLE-GRID BASEMENT WALLS~~[~~b, c, d, e, g, h, i, j~~]

~~MAXIMUM UNSUPPORTED WALL HEIGHT (feet)~~	~~MAXIMUM UNBALANCED BACKFILL HEIGHT~~[~~f~~] ~~(feet)~~	~~MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)~~		
		~~Soil classes~~[~~a~~] ~~and design lateral soil (psf per foot of depth)~~		
		~~GW, GP, SW, SP 30~~	~~GM, GC, SM, SM-SC and ML 45~~	~~SC, ML-CL and inorganic CL 60~~
~~8~~	~~4~~	~~4 @ 48~~	~~4 @ 46~~	~~6 @ 39~~
	~~5~~	~~4 @ 45~~	~~5 @ 46~~	~~6 @ 47~~
	~~6~~	~~5 @ 45~~	~~6 @ 40~~	~~DR~~
	~~7~~	~~6 @ 44~~	~~DR~~	~~DR~~
	~~8~~	~~6 @ 32~~	~~DR~~	~~DR~~
~~9~~	~~4~~	~~4 @ 48~~	~~4 @ 46~~	~~4 @ 37~~
	~~5~~	~~4 @ 42~~	~~5 @ 43~~	~~6 @ 44~~
	~~6~~	~~5 @ 41~~	~~6 @ 37~~	~~DR~~
	~~7~~	~~6 @ 39~~	~~DR~~	~~DR~~
	~~> 8~~	~~DR~~[~~i~~]	~~DR~~	~~DR~~
~~10~~	~~4~~	~~4 @ 48~~	~~4 @ 46~~	~~4 @ 35~~
	~~5~~	~~4 @ 40~~	~~5 @ 40~~	~~6 @ 41~~
	~~6~~	~~5 @ 38~~	~~6 @ 34~~	~~DR~~
	~~7~~	~~6 @ 36~~	~~DR~~	~~DR~~
	~~> 8~~	~~DR~~	~~DR~~	~~DR~~

~~For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot per foot = 0.1571 kPa~~^{2}~~/m, 1 pound per square inch = 6.895 kPa.~~

~~a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.~~

~~b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.~~

~~c. Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches (i.e., 12, 24, 36 and 48) that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and/or bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).~~

~~d. Deflection criterion is *L*/240, where *L* is the height of the basement wall in inches.~~

~~e. Interpolation is not permitted.~~

~~f. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.~~

~~g. See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.~~

~~h. See Table R608.3 for thicknesses and dimensions of waffle-grid walls.~~

~~i. DR means design is required in accordance with the applicable building code, or where there is no code, in accordance with ACI 318.~~

~~j. The use of this table shall be prohibited for soil classifications not shown.~~

~~TABLE R404.1.2(6)~~

~~MINIMUM VERTICAL REINFORCEMENT FOR 8-INCH WAFFLE-GRID BASEMENT WALLS~~[~~b, c, d, e, f, h, i, j, k~~]

~~MAXIMUM UNSUPPORTED WALL HEIGHT (feet)~~	~~MAXIMUM UNBALANCED BACKFILL HEIGHT~~[~~g~~] ~~(feet)~~	~~MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)~~		
		~~Soil classes and design lateral soil (psf per foot of depth)~~		
		~~GW, GP, SW, SP 30~~	~~GM, GC, SM, SM-SC and ML 45~~	~~SC, ML-CL and inorganic CL 60~~
~~8~~	~~4~~	~~NR~~	~~NR~~	~~NR~~
	~~5~~	~~NR~~	~~5 @ 48~~	~~5 @ 46~~
	~~6~~	~~5 @ 48~~	~~5 @ 43~~	~~6 @ 45~~
	~~7~~	~~5 @ 46~~	~~6 @ 43~~	~~6 @ 31~~
	~~8~~	~~6 @ 48~~	~~6 @ 32~~	~~6 @ 23~~
~~9~~	~~4~~	~~NR~~	~~NR~~	~~NR~~
	~~5~~	~~NR~~	~~5 @ 47~~	~~5 @ 46~~
	~~6~~	~~5 @ 46~~	~~5 @ 39~~	~~6 @ 41~~
	~~7~~	~~5 @ 42~~	~~6 @ 38~~	~~6 @ 28~~
	~~8~~	~~6 @ 44~~	~~6 @ 28~~	~~6 @ 20~~
	~~9~~	~~6 @ 34~~	~~6 @ 21~~	~~DR~~
~~10~~	~~4~~	~~NR~~	~~NR~~	~~NR~~
	~~5~~	~~NR~~	~~5 @ 46~~	~~5 @ 44~~
	~~6~~	~~5 @ 46~~	~~5 @ 37~~	~~6 @ 38~~
	~~7~~	~~5 @ 38~~	~~6 @ 35~~	~~6 @ 25~~
	~~8~~	~~6 @ 39~~	~~6 @ 25~~	~~DR~~
	~~9~~	~~6 @ 30~~	~~DR~~	~~DR~~
	~~10~~	~~6 @ 24~~	~~DR~~	~~DR~~

~~For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot per foot = 0.1571 kPa2/m, 1 pound per square inch = 6.895 kPa.~~

~~NR = Not required.~~

~~a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.~~

~~b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.~~

~~c. Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 (420 MPa) and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches (i.e., 12, 24, 36 and 48) that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and/or bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).~~

~~d. NR indicates no vertical reinforcement is required.~~

~~e. Deflection criterion is L/240, where L is the height of the basement wall in inches.~~

~~f. Interpolation shall not be permitted.~~

~~g. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.~~

~~h. See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.~~

~~i. See Table R608.3 for thicknesses and dimensions of waffle-grid walls.~~

~~j. DR means design is required in accordance with the applicable building code, or where there is no code, in accordance with ACI 318.~~

~~k. The use of this table shall be prohibited for soil classifications not shown.~~

~~TABLE R404.1.2(7)~~

~~MINIMUM VERTICAL REINFORCEMENT FOR 6-INCH (152 mm) SCREEN-GRID BASEMENT WALLS~~[~~b, c, d, e, g, h, i, j~~]

~~MAXIMUM UNSUPPORTED WALL HEIGHT (feet)~~	**~~MAXIMUM UNBALANCED BACKFILL HEIGHT~~**[~~f~~] **~~(feet)~~**	**~~MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)~~**		
		~~Soil classes~~[~~a~~] **~~and design lateral soil (psf per foot of depth)~~**		
		~~GW, GP, SW, SP 30~~	**~~GM, GC, SM, SM-SC and ML 45~~**	**~~SC, ML-CL and inorganic CL 60~~**
~~8~~	~~4~~	~~4 @ 48~~	~~4 @ 48~~	~~5 @ 43~~
	~~5~~	~~4 @ 48~~	~~5 @ 48~~	~~5 @ 37~~
	~~6~~	~~5 @ 48~~	~~6 @ 45~~	~~6 @ 32~~
	~~7~~	~~6 @ 48~~	~~DR~~	~~DR~~
	~~8~~	~~6 @ 36~~	~~DR~~	~~DR~~
~~9~~	~~4~~	~~4 @ 48~~	~~4 @ 48~~	~~4 @ 41~~
	~~5~~	~~4 @ 48~~	~~5 @ 48~~	~~6 @ 48~~
	~~6~~	~~5 @ 45~~	~~6 @ 41~~	~~DR~~
	~~7~~	~~6 @ 43~~	~~DR~~	~~DR~~
	~~> 8~~	~~DR~~	~~DR~~	~~DR~~
~~10~~	~~4~~	~~4 @ 48~~	~~4 @ 48~~	~~4 @ 39~~
	~~5~~	~~4 @ 44~~	~~5 @ 44~~	~~6 @ 46~~
	~~6~~	~~5 @ 42~~	~~6 @ 38~~	~~DR~~
	~~7~~	~~6 @ 40~~	~~DR~~	~~DR~~
	~~> 8~~	~~DR~~	~~DR~~	~~DR~~

~~For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot per foot = 0.1571 kPa~~^{2}~~/m, 1 pound per square inch = 6.895 kPa.~~

~~a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.~~

~~b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi, concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.~~

~~c. Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches (i.e., 12, 24, 36 and 48) that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and/or bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).~~

- ~~d. Deflection criterion is *L*/240, where *L* is the height of the basement wall in inches.~~
- ~~e. Interpolation is not permitted.~~
- ~~f. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.~~
- ~~g. See Sections R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.~~
- ~~h. See Table R608.3 for thicknesses and dimensions of screen-grid walls.~~
- ~~i. DR means design is required in accordance with the applicable building code, or where there is no code, in accordance with ACI 318.~~
- ~~j. The use of this table shall be prohibited for soil classifications not shown.~~

~~TABLE R404.1.2(8)~~
~~MINIMUM VERTICAL REINFORCEMENT FOR 6-, 8-, 10- AND 12-INCH NOMINAL FLAT BASEMENT WALLS~~[b, c, d, e, f, h, i, k, n, o]

~~MAXIMUM WALL HEIGHT (feet)~~	~~MAXIMUM UNBALANCED BACKFILL HEIGHT~~[g] ~~(feet)~~	~~MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)~~											
		~~Soil classes~~[a] ~~and design lateral soil (psf per foot of depth)~~											
		~~GW, GP, SW, SP 30~~				~~GM, GC, SM, SM-SC and ML 45~~				~~SC, ML-CL and inorganic CL 60~~			
		~~Minimum nominal wall thickness (inches)~~											
		~~6~~	~~8~~	~~10~~	~~12~~	~~6~~	~~8~~	~~10~~	~~12~~	~~6~~	~~8~~	~~10~~	~~12~~
~~5~~	~~4~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
	~~5~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
~~6~~	~~4~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
	~~5~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~[l]	~~NR~~	~~NR~~	~~4 @ 35~~	~~NR~~[l]	~~NR~~	~~NR~~
	~~6~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~5 @ 48~~	~~NR~~	~~NR~~	~~NR~~	~~5 @ 36~~	~~NR~~	~~NR~~	~~NR~~
~~7~~	~~4~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
	~~5~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~5 @ 47~~	~~NR~~	~~NR~~	~~NR~~
	~~6~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~5 @ 42~~	~~NR~~	~~NR~~	~~NR~~	~~6 @ 43~~	~~5 @ 48~~	~~NR~~[l]	~~NR~~
	~~7~~	~~5 @ 46~~	~~NR~~	~~NR~~	~~NR~~	~~6 @ 42~~	~~5 @ 46~~	~~NR~~[l]	~~NR~~	~~6 @ 34~~	~~6 @ 48~~	~~NR~~	~~NR~~
~~8~~	~~4~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
	~~5~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~4 @ 38~~	~~NR~~[l]	~~NR~~	~~NR~~	~~5 @ 43~~	~~NR~~	~~NR~~	~~NR~~
	~~6~~	~~4 @ 37~~	~~NR~~[l]	~~NR~~	~~NR~~	~~5 @ 37~~	~~NR~~	~~NR~~	~~NR~~	~~6 @ 37~~	~~5 @ 43~~	~~NR~~[l]	~~NR~~
	~~7~~	~~5 @ 40~~	~~NR~~	~~NR~~	~~NR~~	~~6 @ 37~~	~~5 @ 41~~	~~NR~~[l]	~~NR~~	~~6 @ 34~~	~~6 @ 43~~	~~NR~~	~~NR~~
	~~8~~	~~6 @ 43~~	~~5 @ 47~~	~~NR~~[l]	~~NR~~	~~6 @ 34~~	~~6 @ 43~~	~~NR~~	~~NR~~	~~6 @ 27~~	~~6 @ 32~~	~~6 @ 44~~	~~NR~~
~~9~~	~~4~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
	~~5~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~4 @ 35~~	~~NR~~[l]	~~NR~~	~~NR~~	~~5 @ 40~~	~~NR~~	~~NR~~	~~NR~~
	~~6~~	~~4 @ 34~~	~~NR~~[l]	~~NR~~	~~NR~~	~~6 @ 48~~	~~NR~~	~~NR~~	~~NR~~	~~6 @ 36~~	~~6 @ 39~~	~~NR~~[l]	~~NR~~
	~~7~~	~~5 @ 36~~	~~NR~~	~~NR~~	~~NR~~	~~6 @ 34~~	~~5 @ 37~~	~~NR~~	~~NR~~	~~6 @ 33~~	~~6 @ 38~~	~~5 @ 37~~	~~NR~~[l]

	~~8~~	~~6 @ 38~~	~~5 @ 41~~	~~NR~~[l]	~~NR~~	~~6 @ 33~~	~~6 @ 38~~	~~5 @ 37~~	~~NR~~[l]	~~6 @ 24~~	~~6 @ 29~~	~~6 @ 39~~	~~4 @ 48~~[m]
	~~9~~	~~6 @ 34~~	~~6 @ 46~~	~~NR~~	~~NR~~	~~6 @ 26~~	~~6 @ 30~~	~~6 @ 41~~	~~NR~~	~~6 @ 19~~	~~6 @ 23~~	~~6 @ 30~~	~~6 @ 39~~
~~10~~	~~4~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~
	~~5~~	~~NR~~	~~NR~~	~~NR~~	~~NR~~	~~4 @ 33~~	~~NR~~[l]	~~NR~~	~~NR~~	~~5 @ 38~~	~~NR~~	~~NR~~	~~NR~~
	~~6~~	~~5 @ 48~~	~~NR~~[l]	~~NR~~	~~NR~~	~~6 @ 45~~	~~NR~~	~~NR~~	~~NR~~	~~6 @ 34~~	~~5 @ 37~~	~~NR~~	~~NR~~
	~~7~~	~~6 @ 47~~	~~NR~~	~~NR~~	~~NR~~	~~6 @ 34~~	~~6 @ 48~~	~~NR~~	~~NR~~	~~6 @ 30~~	~~6 @ 35~~	~~6 @ 48~~	~~NR~~[l]
	~~8~~	~~6 @ 34~~	~~5 @ 38~~	~~NR~~	~~NR~~	~~6 @ 30~~	~~6 @ 34~~	~~6 @ 47~~	~~NR~~[l]	~~6 @ 22~~	~~6 @ 26~~	~~6 @ 35~~	~~6 @ 45~~[m]
	~~9~~	~~6 @ 34~~	~~6 @ 41~~	~~4 @ 48~~	~~NR~~[l]	~~6 @ 23~~	~~6 @ 27~~	~~6 @ 35~~	~~4 @ 48~~[m]	~~DR~~	~~6 @ 22~~	~~6 @ 27~~	~~6 @ 34~~
	~~10~~	~~6 @ 28~~	~~6 @ 33~~	~~6 @ 45~~	~~NR~~	~~DR~~[j]	~~6 @ 23~~	~~6 @ 29~~	~~6 @ 38~~	~~DR~~	~~6 @ 22~~	~~6 @ 22~~	~~6 @ 28~~

~~For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot per foot = 0.1571 kPa^2/m, 1 pound per square inch = 6.895 kPa.~~

~~NR = Not required.~~

~~a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.~~

~~b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi.~~

~~c. Vertical reinforcement with a yield strength of less than 60,000 psi and/or bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).~~

~~d. NR indicates no vertical wall reinforcement is required, except for 6-inch nominal walls formed with stay-in-place forming systems in which case vertical reinforcement shall be No. 4@48 inches on center.~~

~~e. Allowable deflection criterion is *L*/240, where *L* is the unsupported height of the basement wall in inches.~~

~~f. Interpolation is not permitted.~~

~~g. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.~~

~~h. Vertical reinforcement shall be located to provide a cover of 1$^1/_4$ inches measured from the inside face of the wall. The center of the steel shall not vary from the specified location by more than the greater of 10 percent of the wall thickness or $^3/_8$ inch.~~

~~i. Concrete cover for reinforcement measured from the inside face of the wall shall be not less than $^3/_4$ inch. Concrete cover for reinforcement measured from the outside face of the wall shall be not less than 1$^1/_2$ inches for No. 5 bars and smaller, and not less than 2 inches for larger bars.~~

~~j. DR means design is required in accordance with the applicable building code, or where there is no code, in accordance with ACI 318.~~

~~k. Concrete shall have a specified compressive strength, *f*¢$_c$, of not less than 2,500 psi at 28 days, unless a higher strength is required by Footnote l or m.~~

~~l. The minimum thickness is permitted to be reduced 2 inches, provided the minimum specified compressive strength of concrete, *f* ′$_c$, is 4,000 psi.~~

~~m. A plain concrete wall with a minimum nominal thickness of 12 inches is permitted, provided minimum specified compressive strength of concrete, *f* ′$_c$, is 3,500 psi.~~

~~n. See Table R608.3 for tolerance from nominal thickness permitted for flat walls.~~

~~o. The use of this table shall be prohibited for soil classifications not shown.~~

TABLE R404.1.2(~~9~~5)

MINIMUM SPACING FOR ALTERNATE BAR SIZE AND/OR ALTERNATE GRADE OF STEEL[a, b, c]

BAR SPACING FROM APPLICABLE TABLE IN SECTION R404.1.3.2 (inches)	BAR SIZE FROM APPLICABLE TABLE IN SECTION R404.1.3.2														
	#4					#5					#6				
	Alternate bar size and/or alternate grade of steel desired														
	Grade 60		Grade 40			Grade 60		Grade 40			Grade 60		Grade 40		
	#5	#6	#4	#5	#6	#4	#6	#4	#5	#6	#4	#5	#4	#5	#6
	Maximum spacing for alternate bar size and/or alternate grade of steel (inches)														
8	12	18	5	8	12	5	11	3	5	8	4	6	2	4	5
9	14	20	6	9	13	6	13	4	6	9	4	6	3	4	6
10	16	22	7	10	15	6	14	4	7	9	5	7	3	5	7
11	17	24	7	11	16	7	16	5	7	10	5	8	3	5	7
12	19	26	8	12	18	8	17	5	8	11	5	8	4	6	8
13	20	29	9	13	19	8	18	6	9	12	6	9	4	6	9
14	22	31	9	14	21	9	20	6	9	13	6	10	4	7	9
15	23	33	10	16	22	10	21	6	10	14	7	11	5	7	10
16	25	35	11	17	23	10	23	7	11	15	7	11	5	8	11
17	26	37	11	18	25	11	24	7	11	16	8	12	5	8	11
18	28	40	12	19	26	12	26	8	12	17	8	13	5	8	12
19	29	42	13	20	28	12	27	8	13	18	9	13	6	9	13
20	31	44	13	21	29	13	28	9	13	19	9	14	6	9	13
21	33	46	14	22	31	14	30	9	14	20	10	15	6	10	14
22	34	48	15	23	32	14	31	9	15	21	10	16	7	10	15
23	36	48	15	24	34	15	33	10	15	22	10	16	7	11	15
24	37	48	16	25	35	15	34	10	16	23	11	17	7	11	16
25	39	48	17	26	37	16	35	11	17	24	11	18	8	12	17
26	40	48	17	27	38	17	37	11	17	25	12	18	8	12	17
27	42	48	18	28	40	17	38	12	18	26	12	19	8	13	18
28	43	48	19	29	41	18	40	12	19	26	13	20	8	13	19
29	45	48	19	30	43	19	41	12	19	27	13	20	9	14	19
30	47	48	20	31	44	19	43	13	20	28	14	21	9	14	20
31	48	48	21	32	45	20	44	13	21	29	14	22	9	15	21
32	48	48	21	33	47	21	45	14	21	30	15	23	10	15	21
33	48	48	22	34	48	21	47	14	22	31	15	23	10	16	22
34	48	48	23	35	48	22	48	15	23	32	15	24	10	16	23
35	48	48	23	36	48	23	48	15	23	33	16	25	11	16	23
36	48	48	24	37	48	23	48	15	24	34	16	25	11	17	24
37	48	48	25	38	48	24	48	16	25	35	17	26	11	17	25
38	48	48	25	39	48	25	48	16	25	36	17	27	12	18	25
39	48	48	26	40	48	25	48	17	26	37	18	27	12	18	26
40	48	48	27	41	48	26	48	17	27	38	18	28	12	19	27
41	48	48	27	42	48	26	48	18	27	39	19	29	12	19	27
42	48	48	28	43	48	27	48	18	28	40	19	30	13	20	28
43	48	48	29	44	48	28	48	18	29	41	20	30	13	20	29
44	48	48	29	45	48	28	48	19	29	42	20	31	13	21	29
45	48	48	30	47	48	29	48	19	30	43	20	32	14	21	30
46	48	48	31	48	48	30	48	20	31	44	21	32	14	22	31
47	48	48	31	48	48	30	48	20	31	44	21	33	14	22	31
48	48	48	32	48	48	31	48	21	32	45	22	34	15	23	32

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa.

a. This table is for use with tables in Section R404.1.3.2 that specify the minimum bar size and maximum spacing of vertical wall reinforcement for foundation walls and above-grade walls. Reinforcement specified in tables in Section R404.1.3.2 is based on Grade 60 steel reinforcement.
b. Bar spacing shall not exceed 48 inches on center and shall be not less than one-half the nominal wall thickness.
c. For Grade 50 steel bars (ASTM A 996, Type R), use spacing for Grade 40 bars or interpolate between Grades 40 and 60.

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### R404.1.2.1 Masonry foundation walls.

Concrete masonry and clay masonry foundation walls shall be constructed as set forth in Table R404.1.1(1), R404.1.1(2), R404.1.1(3) or R404.1.1(4) and shall also comply with applicable provisions of Section R606. ~~In buildings assigned to Seismic Design Categories $D_0$, $D_1$ and $D_2$, concrete masonry and clay masonry foundation walls shall also comply with Section R404.1.4.1.~~ Rubble stone masonry foundation walls shall be constructed in accordance with Sections R404.1.8 and R606.3.2. ~~Rubble stone masonry walls shall not be used in Seismic Design Categories $D_0$, $D_1$ and $D_2$.~~

### R404.1.3.2 Reinforcement for foundation walls.

Concrete foundation walls shall be laterally supported at the top and bottom. Horizontal reinforcement shall be provided in accordance with Table R404.1.2(1). Vertical reinforcement shall be provided in accordance with Table R404.1.2(2), R404.1.2(3), or R404.1.2(4), ~~R404.1.2(5), R404.1.2(6), R404.1.2(7) or R404.1.2(8).~~ Vertical reinforcement for flat *basement* walls retaining 4 feet (1219 mm) or more of unbalanced backfill is permitted to be determined in accordance with Table R404.1.2(~~9~~5). For *basement* walls supporting above-grade concrete walls, vertical reinforcement shall be the greater of that required by Tables R404.1.2(2) through ~~R404.1.2(8)~~ R404.1.2(4) or by Section R608.6 for the above-grade wall. ~~In buildings assigned to Seismic Design Category $D_0$, $D_1$ or $D_2$, concrete foundation walls shall also comply with Section R404.1.4.2.~~

#### R404.1.3.2.2 Concrete foundation stem walls supporting light-frame above-grade walls.

Concrete foundation stem walls that support light-frame above-grade walls shall be designed and constructed in accordance with this section.

1. Stem walls not laterally supported at top. Concrete stem walls that are not monolithic with slabs-on-ground or are not otherwise laterally supported by slabs-on-ground and retain 48 inches (1219 mm) or less of unbalanced fill, measured from the top of the wall, shall be constructed in accordance with Section R404.1.3. Foundation stem walls that retain more than 48 inches (1219 mm) of unbalanced fill, measured from the top of the wall, shall be designed in accordance with Section~~s R404.1.4 and~~ R404.4.

2. Stem walls laterally supported at top. Concrete stem walls that are monolithic with slabs-on-ground or are otherwise laterally supported by slabs-on-ground shall be constructed in accordance with Section R404.1.3. Where the unbalanced backfill retained by the stem wall is greater than 48 inches (1219 mm), the connection between the stem wall and the slab-on-ground, and the portion of the slab-on-ground providing lateral support for the wall, shall be designed in accordance with PCA 100 or in accordance with accepted engineering practice.
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R404.1.3.3.1 Compressive strength.

The minimum specified compressive strength of concrete, *f ′c*, shall comply with Section R402.2 and shall be not less than 2,500 psi (17.2 MPa) at 28 days in buildings assigned to Seismic Design Category A, B or C ~~and 3000 psi (20.5 MPa) in buildings assigned to Seismic Design Category D_0, D_1 or D_2~~.

R404.1.3.3.6.1 Stay-in-place forms.

Stay-in-place concrete forms shall comply with this section.

1. Surface burning characteristics. The flame-spread index and smoke-developed index of forming material, other than foam plastic, left exposed on the interior shall comply with Section R302. The surface burning characteristics of foam plastic used in insulating concrete forms shall comply with Section R316.3.

2. Interior covering. Stay-in-place forms constructed of rigid foam plastic shall be protected on the interior of the building as required by Section R316. Where gypsum board is used to protect the foam plastic, it shall be installed with a mechanical fastening system. Use of adhesives in addition to mechanical fasteners is permitted.

3. Exterior wall covering. Stay-in-place forms constructed of rigid foam plastics shall be protected from sunlight and physical damage by the application of an approved exterior wall covering complying with this code. Exterior surfaces of other stay-in-place forming systems shall be protected in accordance with this code.

4. Deleted.~~Termite protection. In areas where the probability of termite infestation is “very heavy” as indicated by Table R301.2(1) or Figure R301.2(6), foam plastic insulation shall be permitted below grade on foundation walls in accordance with Section R318.4.~~

5. Flat ICF wall system forms shall conform to ASTM E 2634.

R404.1.3.3.7 Reinforcement.

R404.1.3.3.7.1 Steel reinforcement.

Steel reinforcement shall comply with the requirements of ASTM A 615, A 706, or A 996. ASTM A 996 bars produced from rail steel shall be Type R. In buildings assigned to Seismic Design Category A, B or C, the minimum yield strength of reinforcing steel shall be 40,000 psi (Grade 40) (276 MPa). ~~In buildings assigned to Seismic Design Category D_0, D_1 or D_2, reinforcing steel shall comply with the requirements of ASTM A 706 for low-alloy steel with a minimum yield strength of 60,000 psi (Grade 60) (414 MPa).~~

R404.1.3.3.7.2 Location of reinforcement in wall.

The center of vertical reinforcement in *basement* walls determined from Tables R404.1.2(2) through ~~R404.1.2(7)~~ R404.1.2(4) shall be located at the centerline of the wall. Vertical reinforcement in *basement* walls determined from Table R404.1.2(8) shall be located to provide a maximum cover of $1^{1}/_{4}$ inches (32 mm) measured from the inside face of the wall. Regardless of the table used to determine vertical wall reinforcement, the center of the steel shall not vary from the specified location by more than the greater of 10 percent of the wall thickness and $^{3}/_{8}$ inch (10 mm). Horizontal and vertical reinforcement shall be located in foundation walls to provide the minimum cover required by Section R404.1.3.3.7.4.

R404.1.3.3.7.6 Alternate grade of reinforcement and spacing.
Where tables in Section R404.1.3.2 specify vertical wall reinforcement based on minimum bar size and maximum spacing, which are based on Grade 60 (414 MPa) steel reinforcement, different size bars or bars made from a different grade of steel are permitted provided an equivalent area of steel per linear foot of wall is provided. Use of Table R404.1.2(~~9~~5) is permitted to determine the maximum bar spacing for different bar sizes than specified in the tables or bars made from a different grade of steel. Bars shall not be spaced less than one-half the wall thickness, or more than 48 inches (1219 mm) on center.

R404.1.3.3.7.8 Construction joint reinforcement.
Construction joints in foundation walls shall be made and located to not impair the strength of the wall. Construction joints in plain concrete walls, including walls required to have not less than No. 4 bars at 48 inches (1219 mm) on center by Section~~s~~ R404.1.3.2 ~~and R404.1.4.2~~, shall be located at points of lateral support, and a minimum of one No. 4 bar shall extend across the construction joint at a spacing not to exceed 24 inches (610 mm) on center. Construction joint reinforcement shall have a minimum of 12 inches (305 mm) embedment on both sides of the joint. Construction joints in reinforced concrete walls shall be located in the middle third of the span between lateral supports, or located and constructed as required for joints in plain concrete walls.

Exception: Use of vertical wall reinforcement required by this code is permitted in lieu of construction joint reinforcement provided the spacing does not exceed 24 inches (610 mm), or the combination of wall reinforcement and No.4 bars described above does not exceed 24 inches (610 mm).

R404.1.4 Seismic Design Category D0, D1 or D2. Deleted.

~~**R404.1.4.1 Masonry foundation walls.**~~
~~In buildings assigned to Seismic Design Category D_0, D_1 or D_2, as established in Table R301.2(1), masonry foundation walls shall comply with this section. In addition to the requirements of Table R404.1.1(1), plain masonry foundation walls shall comply with the following:~~

1. ~~Wall height shall not exceed 8 feet (2438 mm).~~

2. ~~Unbalanced backfill height shall not exceed 4 feet (1219 mm).~~

3. ~~Minimum nominal thickness for plain masonry foundation walls shall be 8 inches (203 mm).~~

4. ~~Masonry stem walls shall have a minimum vertical reinforcement of one No. 4 (No. 13) bar located a maximum of 4 feet (1219 mm) on center in grouted cells. Vertical reinforcement shall be tied to the horizontal reinforcement in the footings.~~

~~Foundation walls, supporting more than 4 feet (1219 mm) of unbalanced backfill or exceeding 8 feet (2438 mm) in height shall be constructed in accordance with Table R404.1.1(2), R404.1.1(3) or R404.1.1(4). Masonry foundation walls shall have two No. 4 (No. 13) horizontal bars located in the upper 12 inches (305 mm) of the wall.~~

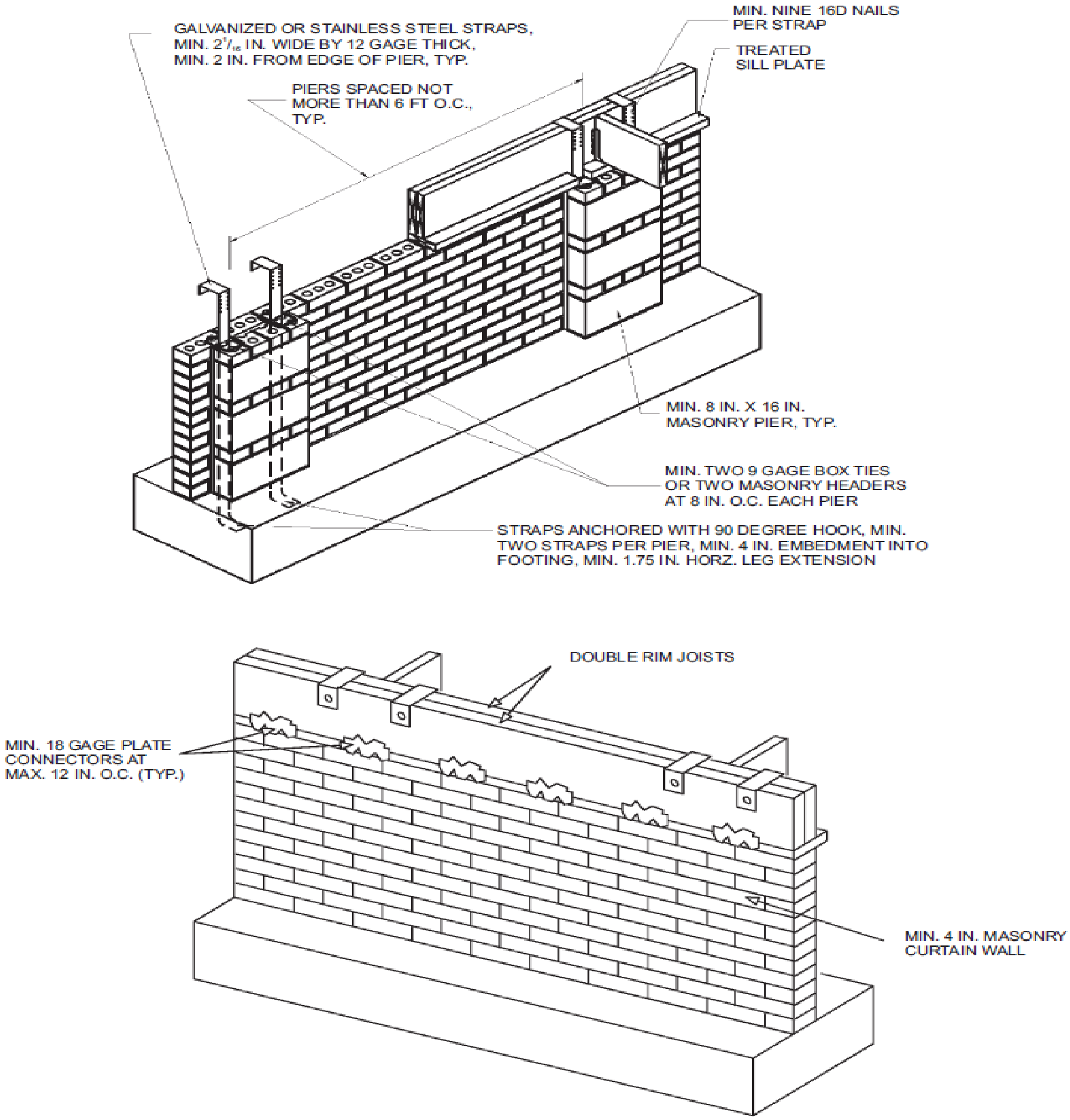
~~R404.1.4.2 Concrete foundation walls.~~
~~In buildings assigned to Seismic Design Category~~ ~~D_0, D_1 or D_2~~ ~~, as established in Table R301.2(1), concrete foundation walls that support light-frame walls shall comply with this section, and concrete foundation walls that support above-grade concrete walls shall comply with ACI 318, ACI 332 or PCA 100 (see Section R404.1.3). In addition to the horizontal reinforcement required by Table R404.1.2(1), plain concrete walls supporting light-frame walls shall comply with the following.~~

1. ~~Wall height shall not exceed 8 feet (2438 mm).~~

2. ~~Unbalanced backfill height shall not exceed 4 feet (1219 mm).~~

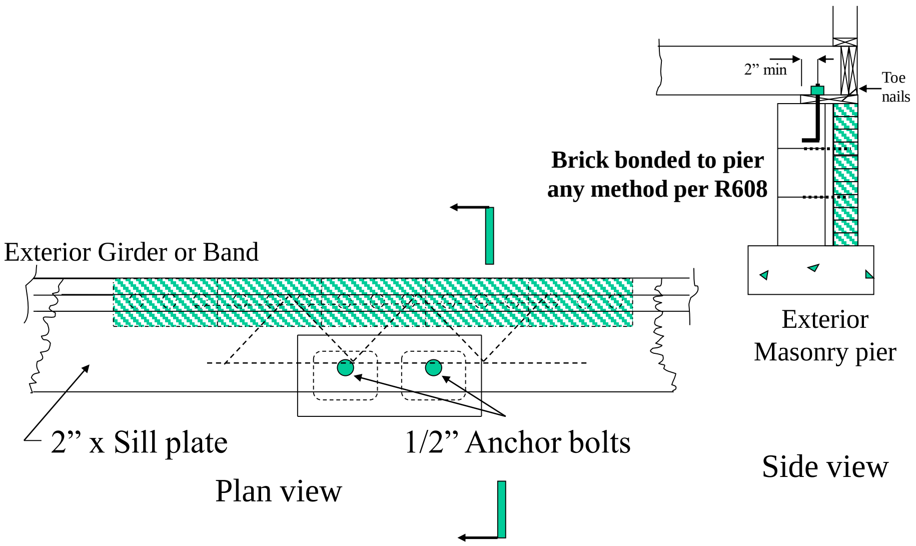
3. ~~Minimum thickness for plain concrete foundation walls shall be 7.5 inches (191 mm) except that 6 inches (152 mm) is permitted where the maximum wall height is 4 feet, 6 inches (1372 mm).~~

~~Foundation walls less than 7.5 inches (191 mm) in thickness, supporting more than 4 feet (1219 mm) of unbalanced backfill or exceeding 8 feet (2438 mm) in height shall be provided with horizontal reinforcement in accordance with Table R404.1.2(1), and vertical reinforcement in accordance with Table R404.1.2(2), R404.1.2(3), R404.1.2(4), R404.1.2(5), R404.1.2(6), R404.1.2(7) or R404.1.2(8). Where Tables R404.1.2(2) through R404.1.2(8) permit plain concrete walls, not less than No. 4 (No. 13) vertical bars at a spacing not exceeding 48 inches (1219 mm) shall be provided.~~

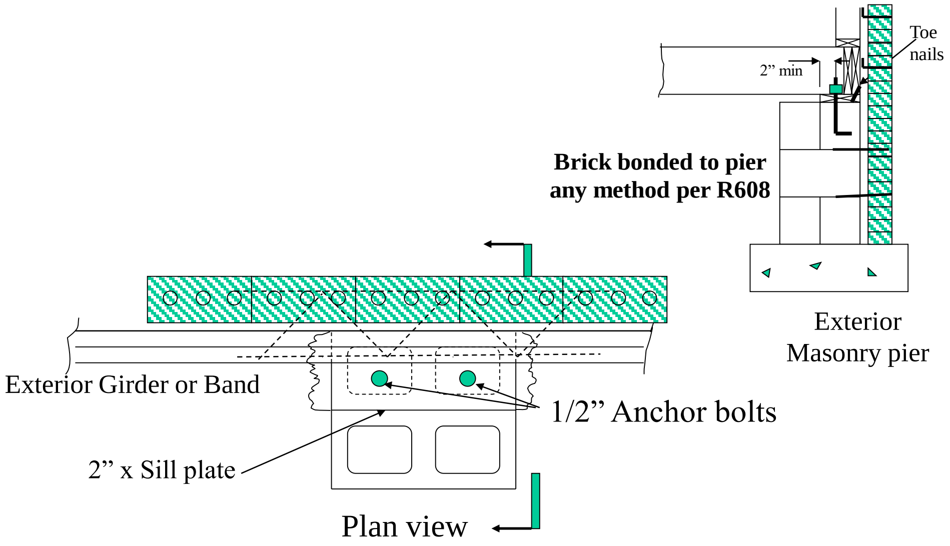


For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad.

~~FIGURE R404.1.5(1)~~
~~FOUNDATION WALL CLAY MASONRY CURTAIN WALL WITH CONCRETE MASONRY PIERS~~



Max pier spacing limited to girder span or 12'-0", whichever is less



Max pier spacing limited to girder span or 12'-0", whichever is less

FIGURE R404.1.5(1)
ALTERNATE ANCHORAGE FOR MASONRY CURTAIN WALL WITH CONCRETE MASONRY PIERS

R404.1.5.3 Pier and curtain wall foundations.

Use of pier and curtain wall foundations shall be permitted to support light-frame construction not more than two stories in height, provided the following requirements are met:

1. ~~All load-bearing walls shall be placed on continuous concrete footings placed integrally with the exterior wall footings.~~ Curtain walls shall be bonded into piers and supported on concrete footings poured integrally with pier footings.

2. The minimum actual thickness of ~~a load-bearing masonry~~ curtain walls shall be not less than 4 inches (102 mm) nominal or $3^{3}/_{8}$ inches (92 mm) actual thickness, and shall be bonded integrally with piers spaced in accordance with Section R606.6.4

3. Piers shall be constructed in accordance with Sections R606.7 and R606.7.1, and shall be bonded into the load-bearing masonry wall in accordance with Section R606.13.1 or R606.13.1.1.

4. The maximum height of ~~a 4-inch (102 mm) load-bearing masonry foundation wall supporting wood-frame walls and floors~~ pier and curtain wall foundations shall be not more than ~~4 feet (1219 mm)~~ 6 feet (1829 mm).

5. Anchorage shall be in accordance with Section R403.1.6, Figure R404.1.5(1), or as specified by engineered design accepted by the *building official*.

6. The unbalanced fill for 4-inch (102 mm) foundation walls shall not exceed 24 inches (610 mm) for solid masonry or ~~12 inches (305 mm)~~ 16 inches (406 mm) for hollow masonry.

7. ~~In Seismic Design Categories D_0, D_1 and D_2, prescriptive reinforcement shall be provided in the horizontal and vertical direction. Provide minimum horizontal joint reinforcement of two No. 9 gage wires spaced not less than 6 inches (152 mm) or one $^{1}/_{4}$-inch-diameter (6.4 mm) wire at 10 inches (254 mm) on center vertically. Provide minimum vertical reinforcement of one No. 4 bar at 48 inches (1220 mm) on center horizontally grouted in place.~~

   Pier size shall be based on Table R403.1(2).

8. See Chapter 45 for special anchorage and reinforcement in high wind zones.

R404.1.5.4 Piers.

The unsupported height of masonry piers shall not exceed 10 times their least dimension. When structural clay tile or hollow concrete masonry units are used for isolated piers to support beams and girders, the cellular spaces shall be filled solidly with concrete or Type M or S mortar, except that unfilled hollow piers may be used if their unsupported height is not more than four times their least dimension. When hollow masonry units are solidly filled with concrete or Type M or S mortar, the allowable compressive stress may be increased as provided in Table R606.9.

R404.1.8 Rubble stone masonry.

Rubble stone masonry foundation walls shall have a minimum thickness of 16 inches (406 mm), shall not support an unbalanced backfill exceeding 8 feet (2438 mm) in height, shall not support a soil pressure greater than 30 pounds per square foot per foot (4.71 kPa/m), and shall not be constructed in ~~Seismic Design Categories D$_0$, D$_1$, D$_2$ or~~ townhouses in Seismic Design Category C, as established in ~~Figure R301.2(2)~~ Table R301.2(7).

R404.1.9 Isolated masonry piers. Deleted.

~~Isolated masonry piers shall be constructed in accordance with this section and the general masonry construction requirements of Section R606. Hollow masonry piers shall have a minimum nominal thickness of 8 inches (203 mm), with a nominal height not exceeding four times the nominal thickness and a nominal length not exceeding three times the nominal thickness. Where hollow masonry units are solidly filled with concrete or grout, piers shall be permitted to have a nominal height not exceeding ten times the nominal thickness. Footings for isolated masonry piers shall be sized in accordance with Section R403.1.1.~~

~~R404.1.9.1 Pier cap.~~

~~Hollow masonry piers shall be capped with 4 inches (102 mm) of solid masonry or concrete, a masonry cap block, or shall have cavities of the top course filled with concrete or grout. Where required, termite protection for the pier cap shall be provided in accordance with Section R318.~~

~~R404.1.9.2 Masonry piers supporting floor girders.~~

~~Masonry piers supporting wood girders sized in accordance with Tables R602.7(1) and R602.7(2) shall be permitted in accordance with this section. Piers supporting girders for interior bearing walls shall have a minimum nominal dimension of 12 inches (305 mm) and a maximum height of 10 feet (3048 mm) from top of footing to bottom of sill plate or girder. Piers supporting girders for exterior bearing walls shall have a minimum nominal dimension of 12 inches (305 mm) and a maximum height of 4 feet (1220 mm) from top of footing to bottom of sill plate or girder. Girders and sill plates shall be anchored to the pier or footing in accordance with Section R403.1.6 or Figure R404.1.5(1). Floor girder bearing shall be in accordance with Section R502.6.~~

~~R404.1.9.3 Masonry piers supporting braced wall panels.~~

~~Masonry piers supporting *braced wall panels* shall be designed in accordance with accepted engineering practice.~~

~~R404.1.9.4 Seismic design of masonry piers.~~

~~Masonry piers in *dwellings* located in Seismic Design Category D$_0$, D$_1$ or D$_2$, and townhouses in Seismic Design Category C, shall be designed in accordance with accepted engineering practice.~~

~~R404.1.9.5 Masonry piers in flood hazard areas.~~

~~Masonry piers for *dwellings* in flood hazard areas shall be designed in accordance with Section R322.~~

R404.4 Retaining walls.

~~Retaining walls that are not laterally supported at the top and that retain in excess of 48 inches (1219 mm) of unbalanced fill, or retaining walls exceeding 24 inches (610 mm) in height that resist lateral loads in addition to soil, shall be designed in accordance with accepted engineering practice to ensure stability against overturning, sliding, excessive foundation pressure and water uplift. Retaining walls shall be designed for a safety factor of 1.5 against lateral sliding and overturning. This section shall not apply to foundation walls supporting buildings.~~

Retaining walls that are not laterally supported at the top and that retain in excess of 48 inches (1219 mm) of unbalanced fill shall be designed to ensure stability against overturning, sliding, excessive foundation pressure and water uplift. In addition any retaining wall which meets the following:

1. Any retaining wall systems on a residential site that cross over adjacent property lines regardless of vertical height, and

2. Retaining walls that support buildings and their accessory structures.

Retaining walls shall be designed for a safety factor of 1.5 against lateral sliding and overturning.

R404.5 Precast concrete foundation walls.

R404.5.1 Design.

Precast concrete foundation walls shall be designed in accordance with accepted engineering practice. The design and manufacture of precast concrete foundation wall panels shall comply with the materials requirements of Section R402.3 or ACI 318. The panel design drawings shall be prepared by a registered design professional ~~where required by the statutes of the *jurisdiction* in which the project is to be constructed in accordance with Section R106.1~~.

SECTION R406
FOUNDATION WATERPROOFING AND DAMPPROOFING

R406.1 Concrete and masonry foundation dampproofing.

~~Except where required by Section R406.2 to be waterproofed, foundation walls that retain earth and enclose interior spaces and floors below *grade* shall be dampproofed from the higher of (a) the top of the footing or (b) 6 inches (152 mm) below the top of the basement floor, to the finished grade. Masonry walls shall have not less than $^{3}/_{8}$ inch (9.5 mm) portland cement parging applied to the exterior of the wall. The parging shall be dampproofed in accordance with one of the following:~~

1. ~~Bituminous coating.~~

2. ~~Three pounds per square yard (1.63 kg/m^2) of acrylic modified cement.~~

3. ~~One-eighth-inch (3.2 mm) coat of surface-bonding cement complying with ASTM C 887.~~

4. ~~Any material permitted for waterproofing in Section R406.2.~~

~~5. Other *approved* methods or materials.~~

> ~~**Exception:** Parging of unit masonry walls is not required where a material is approved for direct application to the masonry.~~

~~Concrete walls shall be dampproofed by applying any one of the listed dampproofing materials or any one of the waterproofing materials listed in Section R406.2 to the exterior of the wall.~~

Foundation walls where the outside grade is higher than the inside grade shall be dampproofed from the top of the footing to the finished grade. The foundation walls shall be darnpproofed with a bituminous coating, 3 pounds per square yard (1.63 kg/m) of acrylic modified cement, or 1/8-inch (3.2 mm) coat of surface bonding mortar complying with ASTM C 887 or any material permitted for waterproofing in Section R406.2. Concrete walls shall be dampproofed by applying any one of the above listed dampproofing materials or any one of the waterproofing materials listed in Section R406.2 to the exterior of the wall.

SECTION R407
COLUMNS

R407.3 Structural requirements.

The columns shall be restrained to prevent lateral displacement at the top and bottom ends. Wood columns shall be not less in nominal size than 4 inches by 4 inches (102 mm by 102 mm). Steel columns shall be not less than 3-inch-diameter (76 mm) Schedule 40 pipe manufactured in accordance with ASTM A 53 Grade B or *approved* equivalent.

> **Exception:** In Seismic Design Categories A, B and C, columns not more than 48 inches (1219 mm) in height on a pier or footing are exempt from the bottom end lateral displacement requirement within under-floor areas enclosed by a continuous foundation.

SECTION R408
~~UNDER-FLOOR SPACE~~ WALL VENTED CRAWL SPACES

~~R408.1 Ventilation.~~

~~The under-floor space between the bottom of the floor joists and the earth under any building (except space occupied by a *basement*) shall have ventilation openings through foundation walls or exterior walls. The minimum net area of ventilation openings shall be not less than 1 square foot (0.0929 m^2) for each 150 square feet (14 m^2) of under-floor space area, unless the ground surface is covered by a Class 1 vapor retarder material. Where a Class 1 vapor retarder material is used, the minimum net area of ventilation openings shall be not less than 1 square foot (0.0929 m^2) for each 1,500 square feet (140 m^2) of under-floor space area. One such ventilating opening shall be within 3 feet (914 mm) of each corner of the building.~~

~~R408.2 Openings for under-floor ventilation.~~

~~The minimum net area of ventilation openings shall be not less than 1 square foot (0.0929 m^2) for each 150 square feet (14 m^2) of under-floor area. One ventilation opening shall be within 3 feet (915 mm) of each corner of the building. Ventilation openings shall be covered for their~~

~~height and width with any of the following materials provided that the least dimension of the covering shall not exceed $^{1}/_{4}$ inch (6.4 mm):~~

1. ~~Perforated sheet metal plates not less than 0.070 inch (1.8 mm) thick.~~
2. ~~Expanded sheet metal plates not less than 0.047 inch (1.2 mm) thick.~~
3. ~~Cast-iron grill or grating.~~
4. ~~Extruded load-bearing brick vents.~~
5. ~~Hardware cloth of 0.035 inch (0.89 mm) wire or heavier.~~
6. ~~Corrosion-resistant wire mesh, with the least dimension being $^{1}/_{8}$ inch (3.2 mm) thick.~~

~~**Exception:** The total area of ventilation openings shall be permitted to be reduced to $^{1}/_{1,500}$ of the under-floor area where the ground surface is covered with an *approved* Class I vapor retarder material and the required openings are placed to provide cross ventilation of the space. The installation of operable louvers shall not be prohibited.~~

~~R408.3 Unvented crawl space.~~

~~Ventilation openings in under-floor spaces specified in Sections R408.1 and R408.2 shall not be required where the following items are provided:~~

1. ~~Exposed earth is covered with a continuous Class I vapor retarder. Joints of the vapor retarder shall overlap by 6 inches (152 mm) and shall be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (152 mm) up the stem wall and shall be attached and sealed to the stem wall or insulation.~~
2. ~~One of the following is provided for the under-floor space:~~
    - ~~2.1. Continuously operated mechanical exhaust ventilation at a rate equal to 1 cubic foot per minute (0.47 L/s) for each 50 square feet (4.7 m^2) of crawl space floor area, including an air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with Section N1102.2.11 of this code.~~
    - ~~2.2. *Conditioned air* supply sized to deliver at a rate equal to 1 cubic foot per minute (0.47 L/s) for each 50 square feet (4.7 m^2) of under-floor area, including a return air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with Section N1102.2.11 of this code.~~
    - ~~2.3. Plenum in existing structures complying with Section M1601.5, if under-floor space is used as a plenum.~~

~~R408.4 Access.~~

~~Access shall be provided to all under-floor spaces. Access openings through the floor shall be a minimum of 18 inches by 24 inches (457 mm by 610 mm). Openings through a perimeter wall shall be not less than 16 inches by 24 inches (407 mm by 610 mm). Where any portion of the through-wall access is below *grade*, an areaway not less than 16 inches by 24 inches (407 mm by 610 mm) shall be provided. The bottom of the areaway shall be below the threshold of the access opening. Through wall access openings shall not be located under a door to the residence. See Section M1305.1.4 for access requirements where mechanical *equipment* is located under floors.~~

~~R408.5 Removal of debris.~~

~~The under-floor *grade* shall be cleaned of all vegetation and organic material. All wood forms used for placing concrete shall be removed before a building is occupied or used for any purpose. All construction materials shall be removed before a building is occupied or used for any purpose.~~

~~R408.6 Finished grade.~~

~~The finished *grade* of under-floor surface shall be permitted to be located at the bottom of the footings; however, where there is evidence that the groundwater table can rise to within 6 inches (152 mm) of the finished floor at the building perimeter or where there is evidence that the surface water does not readily drain from the building site, the *grade* in the under-floor space shall be as high as the outside finished *grade*, unless an *approved* drainage system is provided.~~

R408.1 Space moisture vapor control.

Vented crawl space foundations shall be provided with foundation vent openings through the exterior foundation walls.

R408.1.1 Foundation vent sizing.

The minimum net area of ventilation openings shall be not less than 1 square foot (0.0929 m^2) for each 150 square feet (13.9 m^2) of crawl space ground area.

> **Exception:** The total area of ventilation openings may be reduced to 1/1,500 of the under-floor area where the ground surface is treated with an approved vapor retarder material in accordance with Section R408.2 and the required openings are placed so as to provide cross-ventilation of the crawl space. The installation of operable louvers shall not be prohibited.

R408.1.2 Foundation vent location.

One foundation vent shall be within 3 feet (914 mm) of each corner of the building. To prevent rainwater entry when the crawlspace is built on a sloped site, the uphill foundation walls may be constructed without wall vent openings. Vent dams shall be provided when the bottom of the foundation vent opening is less than 4 inches (102 mm) above the finished exterior grade.

R408.1.3 Covering material.

To prevent rodent entry, foundation vents shall be covered with any of the following materials provided that the ventilation holes through the covering material shall not exceed 1/4 inch (6.4 mm) in any direction:

1. Perforated sheet metal plates not less than 0.070 inch (1.8 mm) thick.

2. Expanded sheet metal plates no less than 0.047 inch (1.2 mm) thick.
3. Cast iron grills or grating.
4. Extruded load-bearing brick vents.
5. Hardware cloth of 0.035 inch (0.89 mm) wire or heavier.
6. Corrosion-resistant mesh, with the least dimension being 1/8 inch (3.2 mm).

R408.1.4 Drains and vent terminations.

Drains (including but not limited to pressure relief and drain pans) shall terminate outdoors, to crawl space floor drains or interior pumps, and shall not intentionally discharge water into the crawl space. Crawl space drains shall be separate from roof gutter drain systems and foundation perimeter drains. Dryer vents shall terminate outdoors.

R408.1.5 Space separation.

Wall vented crawl spaces shall be separated from adjoining basements, porches and garages by permanent solid wall surfaces with all utility penetrations through the separating wall sealed. Latched, weather-stripped doors or access panels shall provide access between the crawl space and such adjoining spaces.

R408.2 Ground vapor retarder.

When required by Section R408.1.1 Exception, a minimum 6-mil (0.15 mm) polyethylene vapor retarder or equivalent shall be installed to nominally cover all exposed earth in the crawl space, with joints lapped not less than 12 inches (305 mm). Where there is no evidence that the groundwater table can rise to within 6 inches (152 mm) of the floor of the crawl space, it is acceptable to puncture the ground vapor retarder at low spots to prevent water puddles from forming on top of the vapor retarder due to condensation.

R408.3 Wall damp proofing.

Where the outside grade is higher than the inside grade the exterior walls shall be dampproofed from the top of the footing to the finished grade as required by Section R406.1.

R408.4 Site grading.

Building site shall be graded to drain water away from the crawl space foundation per the requirements of Section R401.3.

R408.5 Insulation.

The thermal insulation in a wall vented crawl space shall be placed in the floor system. Wall insulation is not allowed as the only insulation system in a wall vented crawl space. The required insulation value can be determined from Table N1102.1.

R408.6 Floor air leakage control.

All plumbing, electrical, duct, plenum, phone, cable, computer wiring and other penetrations through the subfloor shall be sealed with non-porous materials, caulks, or sealants. The use of rock wool or fiberglass insulation is prohibited as an air sealant.

R408.7 Duct air leakage control.

All heating and cooling ductwork located in the crawl space shall be sealed with mastic or other industry approved duct closure systems.

R408.8 Access.

A minimum access opening measuring 18 inches by 24 inches (457 mm by 610 mm) shall be provided to the crawl space. See the *North Carolina Mechanical Code* for access requirements where mechanical equipment is located under floors.

R408.9 Removal of debris.

The crawl space floor shall be cleaned of all vegetation and organic material. All wood forms used for placing shall be removed before the building is occupied or used for any purpose. All construction materials shall be removed before the building is occupied or used for any purpose.

R408.10 Finished grade.

The finished grade of the crawl space is permitted to be located at the bottom of the footings; however, where there is evidence that the groundwater table can rise to within 6 inches (152 mm) of the finished grade of the crawl space at the perimeter or where there is evidence that the surface water does not readily drain from the building site, the grade in the crawl space shall be as high as the outside finished grade, unless an approved drainage system is provided.

R408.~~7~~ 11 Flood resistance.

For buildings located in flood hazard areas as established in Table R301.2(1):

1. Walls enclosing the under-floor space shall be provided with flood openings in accordance with Section R322.2.2.

2. The finished ground level of the under-floor space shall be equal to or higher than the outside finished ground level on at least one side.

Exception: Under-floor spaces that meet the requirements of FEMA/FIA TB 11-1.

SECTION R409
CLOSED CRAWL SPACES

R409.1 Air sealed walls.

Closed crawl spaces shall be built to minimize the entry of outdoor air into the crawl space. Specifically prohibited are foundation wall vents and wall openings to ventilated porch foundations. When outdoor packaged heating and cooling equipment is used, solid blocking and sealants shall be used to seal gaps between the exterior wall opening and the smaller supply and return ducts that pass through the opening.

R409.1.1 Caulking and sealants.

Air sealing caulk, gaskets or sealants shall be applied to the foundation wall and floor assemblies that separate the crawl space from outside and other ventilated areas such as joints around access door and frame, between foundation and sill plate, at penetrations for plumbing, mechanical, electrical and gas lines and at duct penetrations.

R409.1.2 Access panel/door.

A minimum access opening measuring 18 inches by 24 inches (457 mm by 610 mm) shall be provided to the crawl space. See the *North Carolina Mechanical Code* for access requirements where mechanical equipment is located under floors. To minimize air entry, provide a tight fitting access panel/door with a latch mechanism. Access panels or doors shall be insulated to a minimum of R-2.

R409.2 Groundwater vapor retarder.

Closed crawl spaces shall be protected from water entry by the evaporation of water from the ground surface.

R409.2.1 Ground vapor retarder.

A minimum 6-mil (0.15 mm) polyethylene vapor retarder or equivalent shall be installed to nominally cover all exposed earth in the crawl space, with joints lapped not less than 12 inches (305 mm). Minor pockets or wrinkles that prevent total drainage across the surface of the vapor retarder are allowed. The floor of the crawl space shall be graded so that it drains to one or more low spots. Install a drain to daylight or sump pump at each low spot. Crawl space drains shall be kept separate from roof gutter drain systems and foundation perimeter drains.

R409.2.2 Liner.

The ground vapor retarder is permitted to be installed as a full interior liner by sealing the edges to the walls and beam columns and sealing the seams. Single piece liner systems are approved. The top edge of the wall liner shall terminate 3 inches (76 mm) below the top edge of the masonry foundation wall. The top edge of the liner shall be brought up the interior columns a minimum of 4 inches (102 mm) above the crawl space floor. The floor of the crawl space shall be graded so that it drains to one or more low spots. Install a drain to daylight or sump pump at each low spot. Crawl space drains shall be separate from roof gutter drain systems and foundation perimeter drains.

R409.2.2.1 Wall liner termite inspection gap.

Provide a clear and unobstructed 3 inch (76 mm) minimum, 4 inch (102 mm) maximum inspection gap between the top of the wall liner and the bottom of the wood sill. This inspection gap may be ignored with regards to energy performance and is not intended to create an energy penalty.

R409.2.3 Concrete floor surfacing.

The ground vapor retarder may be protected against ripping and displacement by pouring an unreinforced, minimum 2 inch (51 mm) thick, concrete surface directly over the vapor barrier. A base course of gravel or other drainage material under the ground moisture barrier is not required. The floor of the crawl space shall be graded so that the concrete surface drains to one or more low spots. Install a drain to daylight or sump pump at each low spot. Crawl space drains shall be separate from roof gutter drain systems and foundation perimeter drains.

R409.2.4 Drains and vent terminations.

Drains (including but not limited to pressure relief and drain pans) shall terminate outdoors, to crawl space floor drains or interior pumps, and shall not intentionally discharge water into the crawl space. Crawl space drains shall be separate from roof gutter drain systems and foundation perimeter drains. Dryer vents shall terminate outdoors.

R409.3 Wall damp proofing.

Where the outside grade is higher than the inside grade, the exterior walls shall be dampproofed from the top of the footing to the finished grade as required by Section R406.1.

R409.4 Site grading.

Building site shall be graded to drain water away from the crawl space foundation per the requirements of Section R401.3.

R409.5 Space moisture vapor control.

Closed crawl spaces shall be provided with a mechanical drying capability to control space moisture levels. The allowed methods are listed below in Sections R409.5.1 through R409.5.5. At least one method shall be provided; however, combination systems shall be allowed.

R409.5.1 Dehumidifier.

A permanently installed dehumidifier shall be provided in the crawl space. The minimum rated capacity per day is 15 pints (7.1 Liters). Condensate discharge shall be drained to daylight or interior condensate pump. Permanently installed dehumidifier shall be provided with an electrical outlet.

R409.5.2 Supply air.

Supply air from the dwelling air conditioning system shall be ducted into the crawl space at the rate of 1 cubic foot per minute (0.5 L/s) per 30 square feet (4.6 m^2) of crawl space floor area. No return air duct from the crawl space to the dwelling air conditioning system is allowed. The crawl space supply air duct shall be fitted with a backflow damper to prevent the entry of crawl space air into the supply duct system when the system fan is not operating. An air relief vent to the outdoors may be installed. Crawl spaces with moisture vapor control installed in accordance with this section are not considered plenums.

R409.5.3 House air.

House air shall be blown into the crawl space with a fan at the rate of 1 cubic foot per minute (0.5 L/s) per 50 square feet (4.6 m^2) of crawl space floor area.

The fan motor shall be rated for continuous duty. No return air duct from the crawl space to the dwelling air conditioning system is allowed. An air relief vent to the outdoors may be installed. Crawl spaces with moisture vapor control installed in accordance with this section are not considered plenums.

R409.5.4 Exhaust fan.

Crawl space air shall be exhausted to outside with a fan at the rate of 1 cubic foot per minute (0.5 L/s) per 50 square feet (4.6 m^2) of crawl space floor area. The fan motor shall be rated for continuous duty. There is no requirement for make-up air.

R409.5.5 Conditioned space.

The crawl space shall be designed as a heated and cooled, conditioned space with wall insulation installed in accordance with the requirements of Section R409.8. Intentionally returning air from the crawl space to space-conditioning equipment that serves the dwelling shall be allowed. Foam plastic insulation located in a crawl space plenum shall be protected against ignition by an approved thermal barrier.

R409.6 Plenums.

Closed crawl spaces used as supply or return plenums for distribution of heated or cooled air shall comply with the requirements of the *North Carolina Mechanical Code*. Crawl space plenums shall not contain plumbing cleanouts, gas lines or other prohibited components. Foam plastic insulation located in a crawl space plenum shall be protected against ignition by an approved thermal barrier.

R409.7 Combustion air.

The air sealing requirements of a closed crawl space may result in a foundation which cannot provide adequate combustion air for fuel-burning appliances; therefore, fuel-burning appliances located in the crawl space such as furnaces and water heaters shall obtain combustion air from outdoors as per the *North Carolina Mechanical Code*.

R409.8 Insulation.

The thermal insulation in a crawl space may be located in the floor system or at the exterior walls. The required insulation value can be determined from Table N1102.1.

> **Exception:** Insulation shall be placed at the walls when the closed crawl space is designed to be intentionally heated or cooled, conditioned space.

R409.8.1 Wall insulation.

Where the floor above a crawl space is not insulated, the walls shall be insulated. Wall insulation is permitted to be located on any combination of the exterior and interior surfaces and within the structural cavities or materials of the exterior crawl space walls. Wall insulation systems require that the band joist area of the floor frame be insulated. Wall insulation shall begin 3 inches (76 mm) below the top of the masonry foundation wall and shall extend down to 3 inches (76 mm) above the top of the footing or concrete floor, 3 inches (76 mm) above the interior ground surface or 24-inches (610 mm) below the outside finished ground level, whichever is less. No insulation shall be required on masonry walls of 9 inches (229 mm) height or less.

R409.8.1.1 Foam plastic termite inspection gap.

For outside walls, Section R318.4 governs applications. When expanded polystyrene, polyisocyanurate, or other foam plastic insulation is installed on the inside surface of the exterior foundation walls, provisions in Sections R409.8.1.1.1 through R409.8.1.1.2 below apply.

R409.8.1.1.1 Earth floored crawl spaces.

Provide a clear and unobstructed 3-inch (76 mm) minimum, 4 inch (102 mm) maximum termite inspection gap between the top of the foam plastic wall insulation and the bottom of the wood sill. Because insulation ground contact is not allowed, provide a continuous 3-inch (76 mm) minimum clearance gap between the bottom edge of the foam plastic wall insulation and the earth floor surface. Refer to Section N1102.2.9 to determine maximum allowances for insulation gaps.

R409.8.1.1.2 Concrete floor surfaced crawl spaces.

Provide a clear and unobstructed 3-inch (76 mm) minimum, 4 inch (102 mm) maximum termite inspection gap between the top of the foam plastic wall insulation and the bottom of the wood sill. Provide a continuous 3-inch (76 mm) minimum clearance gap between the bottom edge of the foam plastic wall insulation and the concrete floor surface. Refer to Section N1102.2.9 to determine maximum allowances for insulation gaps.

R409.8.1.2 Porous insulation material.

When fiberglass, rockwool, cellulose or other porous insulation materials are installed on the inside wall surface of a closed crawl space, provide a clear and unobstructed 3-inch (76 mm) minimum termite inspection gap between the top of the porous wall insulation and the bottom of the wood sill.

To reduce wicking potential, porous insulation ground contact is not allowed in earth floored or concrete surfaces crawl spaces. Provide a continuous 3-inch (76 mm) minimum wicking gap between the bottom edge of the porous wall insulation and the earth or concrete floor surface. Refer to Section N1102.1.7 to determine maximum allowances for insulation gaps.

R409.8.2 Foam plastic fire safety.

Foam plastic insulation may be installed inside crawl spaces without a thermal cover when the insulation product has been tested in accordance with ASTM E 84 to have a flame-spread rating of not more than 25 and a smoke developed rating of not more than 450. Foam plastics that have not been tested to meet these ratings shall be protected against ignition by covering them with a thermal barrier. Acceptable thermal barriers include but are not limited to 1/2 inch (13 mm) cement board, metal foil sheets, metal foil tape, steel or aluminum metal sheets or other approved materials installed in such a manner that the foam is not exposed.

Exception: Foam plastic insulation located in closed crawl spaces used as conditioned spaces or plenums shall be protected against ignition by an approved thermal barrier.

R409.9 Floor air leakage control.

All plumbing, electrical, duct, plenum, phone, cable, computer wiring and other penetrations through the subfloor shall be sealed with non-porous materials, caulks, or sealants. The use of rockwool or fiberglass insulation is prohibited as an air sealant.

R409.10 Duct air leakage control.

All heating and cooling ductwork located in the crawl space shall be sealed with mastic or other industry approved duct closure systems.

R409.11 Access.

A minimum access opening measuring 18 inches by 24 inches (457 mm by 610 mm) shall be provided to the crawl space. See the *North Carolina Mechanical Code* for access requirements where mechanical equipment is located under floors.

R409.12 Removal of debris.

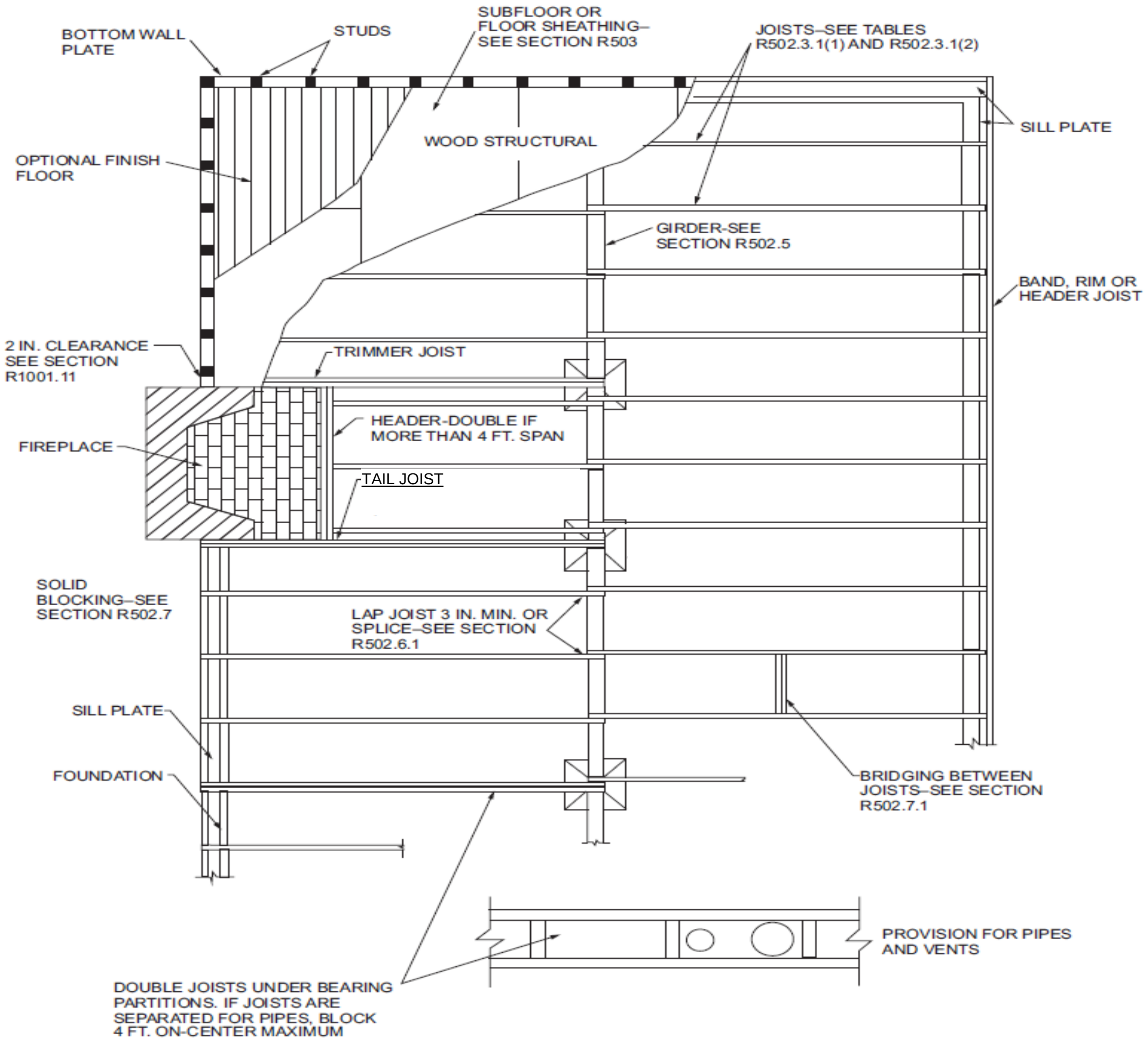
The crawl space floor shall be cleaned of all vegetation and organic material. All wood forms used for placing shall be removed before the building is occupied or used for any purpose. All construction materials shall be removed before the building is occupied or used for any purpose.

R409.13 Finished grade.

The finished grade of the crawlspace is permitted to be located at the bottom of the footings; however, where there is evidence that the groundwater table can rise to within 6 inches (152 mm) of the finished grade of the crawl space at the perimeter or where there is evidence that the surface water does not readily drain from the building site, the grade in the crawl space shall be as high as the outside finished grade, unless an approved drainage system is provided.

CHAPTER 5
FLOORS

SECTION R502
WOOD FLOOR FRAMING



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

FIGURE R502.2
FLOOR CONSTRUCTION
(Note to ICC – fix leader to point to tail joist)

R502.2.1 Framing at braced wall lines.
A load path for lateral forces shall be provided between floor framing and *braced wall panels* located above or below a floor, as specified in Section ~~R602.10.8~~ R602.10.4.

TABLE R502.3.1(1) FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES (Residential sleeping areas, live load = 30 psf, L/D = 360)[a]

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas fir-larch	SS	12-6	16-6	21-0	25-7	12-6	16-6	21-0	25-7
	Douglas fir-larch	#1	12-0	15-10	20-3	24-8	12-0	15-7	19-0	22-0
	Douglas fir-larch	#2	11-10	15-7	19-10	23-4	11-8	14-9	18-0	20-11
	Douglas fir-larch	#3	9-11	12-7	15-5	17-10	8-11	11-3	13-9	16-0
	Hem-fir	SS	11-10	15-7	19-10	24-2	11-10	15-7	19-10	24-2
	Hem-fir	#1	11-7	15-3	19-5	23-7	11-7	15-3	18-9	21-9
	Hem-fir	#2	11-0	14-6	18-6	22-6	11-0	14-4	17-6	20-4
	Hem-fir	#3	9-8	12-4	15-0	17-5	8-8	11-0	13-5	15-7
	Southern pine	SS	12-3	16-2	20-8	25-1	12-3	16-2	20-8	25-1
	Southern pine	#1	11-10	15-7	19-10	24-2	11-10	15-7	18-7	22-0
	Southern pine	#2	11-3	14-11	18-1	21-4	10-9	13-8	16-2	19-1
	Southern pine	#3	9-2	11-6	14-0	16-6	8-2	10-3	12-6	14-9
	Spruce-pine-fir	SS	11-7	15-3	19-5	23-7	11-7	15-3	19-5	23-7
	Spruce-pine-fir	#1	11-3	14-11	19-0	23-0	11-3	14-7	17-9	20-7
	Spruce-pine-fir	#2	11-3	14-11	19-0	23-0	11-3	14-7	17-9	20-7
	Spruce-pine-fir	#3	9-8	12-4	15-0	17-5	8-8	11-0	13-5	15-7
16	Douglas fir-larch	SS	11-4	15-0	19-1	23-3	11-4	15-0	19-1	23-3
	Douglas fir-larch	#1	10-11	14-5	18-5	21-4	10-8	13-6	16-5	19-1
	Douglas fir-larch	#2	10-9	14-2	17-5	20-3	10-1	12-9	15-7	18-1
	Douglas fir-larch	#3	8-7	10-11	13-4	15-5	7-8	9-9	11-11	13-10
	Hem-fir	SS	10-9	14-2	18-0	21-11	10-9	14-2	18-0	21-11
	Hem-fir	#1	10-6	13-10	17-8	21-1	10-6	13-4	16-3	18-10
	Hem-fir	#2	10-0	13-2	16-10	19-8	9-10	12-5	15-2	17-7

	Hem-fir	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6
	Southern pine	SS	11-2	14-8	18-9	22-10	11-2	14-8	18-9	22-10
	Southern pine	#1	10-9	14-2	18-0	21-4	10-9	13-9	16-1	19-1
	Southern pine	#2	10-3	13-3	15-8	18-6	9-4	11-10	14-0	16-6
	Southern pine	#3	7-11	10-0	11-1	14-4	7-1	8-11	10-10	12-10
	Spruce-pine-fir	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-4
	Spruce-pine-fir	#1	10-3	13-6	17-2	19-11	9-11	12-7	15-5	17-10
	Spruce-pine-fir	#2	10-3	13-6	17-2	19-11	9-11	12-7	15-5	17-10
	Spruce-pine-fir	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6

(continued)

TABLE R502.3.1(1)—continued
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES
(Residential sleeping areas, live load = 30 psf, L/D = 360)[a]

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft.-in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas fir-larch	SS	10-8	14-1	18-0	21-10	10-8	14-1	18-0	21-4
	Douglas fir-larch	#1	10-4	13-7	16-9	19-6	9-8	12-4	15-0	17-5
	Douglas fir-larch	#2	10-1	13-0	15-11	18-6	9-3	11-8	14-3	16-6
	Douglas fir-larch	#3	7-10	10-0	12-2	14-1	7-0	8-11	10-11	12-7
	Hem-fir	SS	10-1	13-4	17-0	20-8	10-1	13-4	17-0	20-7
	Hem-fir	#1	9-10	13-0	16-7	19-3	9-7	12-2	14-10	17-2
	Hem-fir	#2	9-5	12-5	15-6	17-1	8-11	11-4	13-10	16-1
	Hem-fir	#3	7-8	9-9	11-10	13-9	6-10	8-8	10-7	12-4
	Southern pine	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-6
	Southern pine	#1	10-1	13-4	16-5	19-6	9-11	12-7	14-8	17-5
	Southern pine	#2	9-6	12-1	14-4	16-10	8-6	10-10	12-10	15-1
	Southern pine	#3	7-3	9-1	11-0	13-1	6-5	8-2	9-10	11-8

	Spruce-pine-fir	SS	9-10	13-0	16-7	20-2	9-10	13-0	16-7	19-6
	Spruce-pine-fir	#1	9-8	12-9	15-8	18-3	9-1	11-6	14-1	16-3
	Spruce-pine-fir	#2	9-8	12-9	15-8	18-3	9-1	11-6	14-1	16-3
	Spruce-pine-fir	#3	7-8	9-9	11-10	13-9	6-10	8-8	10-7	12-4
24	Douglas fir-larch	SS	9-11	13-1	16-8	20-3	9-11	13-1	16-5	19-1
	Douglas fir-larch	#1	9-7	12-4	15-0	17-5	8-8	11-0	13-5	15-7
	Douglas fir-larch	#2	9-3	11-8	14-3	16-6	8-3	10-5	12-9	14-9
	Douglas fir-larch	#3	7-0	8-11	10-11	12-7	6-3	8-0	9-9	11-3
	Hem-fir	SS	9-4	12-4	15-9	19-2	9-4	12-4	15-9	18-5
	Hem-fir	#1	9-2	12-1	14-10	17-2	8-7	10-10	13-3	15-5
	Hem-fir	#2	8-9	11-4	13-10	16-1	8-0	10-2	12-5	14-4
	Hem-fir	#3	6-10	8-8	10-7	12-4	6-2	7-9	9-6	11-0
	Southern pine	SS	9-9	12-10	16-5	19-11	9-9	12-10	16-5	19-8
	Southern pine	#1	9-4	12-4	14-8	17-5	8-10	11-3	13-1	15-7
	Southern pine	#2	8-6	10-10	12-10	15-1	7-7	9-8	11-5	13-6
	Southern pine	#3	6-5	8-2	9-10	11-8	5-9	7-3	8-10	10-5
	Spruce-pine-fir	SS	9-2	12-1	15-5	18-9	9-2	12-1	15-0	17-5
	Spruce-pine-fir	#1	8-11	11-6	14-1	16-3	8-1	10-3	12-7	14-7
	Spruce-pine-fir	#2	8-11	11-6	14-1	16-3	8-1	10-3	12-7	14-7
	Spruce-pine-fir	#3	6-10	8-8	10-7	12-4	6-2	7-9	9-6	11-0

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

Note: Check sources for availability of lumber in lengths greater than 20 feet.

a. Dead load limits for townhouses in Seismic Design Category C ~~and all structures in Seismic Design Categories D_0, D_1 and D_2~~ shall be determined in accordance with Section R301.2.2.2.1.

TABLE R502.3.1(2)
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES
(Residential living areas, live load = 40 psf, L/D = 360)[b]

JOIST SPACING (inches)	SPECIES AND GRADE	DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
		2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
		Maximum floor joist spans							
		(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)

12	Douglas fir-larch	SS	11-4	15-0	19-1	23-3	11-4	15-0	19-1	23-3
	Douglas fir-larch	#1	10-11	14-5	18-5	22-0	10-11	14-2	17-4	20-1
	Douglas fir-larch	#2	10-9	14-2	18-0	20-11	10-8	13-6	16-5	19-1
	Douglas fir-larch	#3	8-11	11-3	13-9	16-0	8-1	10-3	12-7	14-7
	Hem-fir	SS	10-9	14-2	18-0	21-11	10-9	14-2	18-0	21-11
	Hem-fir	#1	10-6	13-10	17-8	21-6	10-6	13-10	17-1	19-10
	Hem-fir	#2	10-0	13-2	16-10	20-4	10-0	13-1	16-0	18-6
	Hem-fir	#3	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
	Southern pine	SS	11-2	14-8	18-9	22-10	11-2	14-8	18-9	22-10
	Southern pine	#1	10-9	14-2	18-0	21-11	10-9	14-2	16-11	20-1
	Southern pine	#2	10-3	13-6	16-2	19-1	9-10	12-6	14-9	17-5
	Southern pine	#3	8-2	10-3	12-6	14-9	7-5	9-5	11-5	13-6
	Spruce-pine-fir	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-6
	Spruce-pine-fir	#1	10-3	13-6	17-3	20-7	10-3	13-3	16-3	18-10
	Spruce-pine-fir	#2	10-3	13-6	17-3	20-7	10-3	13-3	16-3	18-10
	Spruce-pine-fir	#3	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
16	Douglas fir-larch	SS	10-4	13-7	17-4	21-1	10-4	13-7	17-4	21-1
	Douglas fir-larch	#1	9-11	13-1	16-5	19-1	9-8	12-4	15-0	17-5
	Douglas fir-larch	#2	9-9	12-9	15-7	18-1	9-3	11-8	14-3	16-6
	Douglas fir-larch	#3	7-8	9-9	11-11	13-10	7-0	8-11	10-11	12-7
	Hem-fir	SS	9-9	12-10	16-5	19-11	9-9	12-10	16-5	19-11
	Hem-fir	#1	9-6	12-7	16-0	18-10	9-6	12-2	14-10	17-2
	Hem-fir	#2	9-1	12-0	15-2	17-7	8-11	11-4	13-10	16-1
	Hem-fir	#3	7-6	9-6	11-8	13-6	6-10	8-8	10-7	12-4
	Southern pine	SS	10-2	13-4	17-0	20-9	10-2	13-4	17-0	20-9
	Southern pine	#1	9-9	12-10	16-1	19-1	9-9	12-7	14-8	17-5
	Southern pine	#2	9-4	11-10	14-0	16-6	8-6	10-10	12-10	15-1
	Southern pine	#3	7-1	8-11	10-10	12-10	6-5	8-2	9-10	11-8
	Spruce-pine-fir	SS	9-6	12-7	16-0	19-6	9-6	12-7	16-0	19-6
	Spruce-pine-fir	#1	9-4	12-3	15-5	17-10	9-1	11-6	14-1	16-3

	Spruce-pine-fir	#2	9-4	12-3	15-5	17-10	9-1	11-6	14-1	16-3
	Spruce-pine-fir	#3	7-6	9-6	11-8	13-6	6-10	8-8	10-7	12-4

(continued)

TABLE R502.3.1(2)—continued
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES
(Residential living areas, live load = 40 psf, L/D = 360)[b]

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas fir-larch	SS	9-8	12-10	16-4	19-10	9-8	12-10	16-4	19-6
	Douglas fir-larch	#1	9-4	12-4	15-0	17-5	8-10	11-3	13-8	15-11
	Douglas fir-larch	#2	9-2	11-8	14-3	16-6	8-5	10-8	13-0	15-1
	Douglas fir-larch	#3	7-0	8-11	10-11	12-7	6-5	8-2	9-11	11-6
	Hem-fir	SS	9-2	12-1	15-5	18-9	9-2	12-1	15-5	18-9
	Hem-fir	#1	9-0	11-10	14-10	17-2	8-9	11-1	13-6	15-8
	Hem-fir	#2	8-7	11-3	13-10	16-1	8-2	10-4	12-8	14-8
	Hem-fir	#3	6-10	8-8	10-7	12-4	6-3	7-11	9-8	11-3
	Southern pine	SS	9-6	12-7	16-0	19-6	9-6	12-7	16-0	19-6
	Southern pine	#1	9-2	12-1	14-8	17-5	9-0	11-5	13-5	15-11
	Southern pine	#2	8-6	10-10	12-10	15-1	7-9	9-10	11-8	13-9
	Southern pine	#3	6-5	8-2	9-10	11-8	5-11	7-5	9-0	10-8
	Spruce-pine-fir	SS	9-0	11-10	15-1	18-4	9-0	11-10	15-1	17-9
	Spruce-pine-fir	#	8-9	11-6	14-1	16-3	8-3	10-6	12-10	14-10
	Spruce-pine-fir	#2	8-9	11-6	14-1	16-3	8-3	10-6	12-10	14-10
	Spruce-pine-fir	#3	6-10	8-8	10-7	12-4	6-3	7-11	9-8	11-3
24	Douglas fir-larch	SS	9-0	11-11	15-2	18-5	9-0	11-11	15-0	17-5
	Douglas fir-larch	#1	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
	Douglas fir-larch	#2	8-3	10-5	12-9	14-9	7-6	9-6	11-8	13-6
	Douglas fir-larch	#3	6-3	8-0	9-9	11-3	5-9	7-3	8-11	10-4

	Hem-fir	SS	8-6	11-3	14-4	17-5	8-6	11-3	14-4	16-10[a]
	Hem-fir	#1	8-4	10-10	13-3	15-5	7-10	9-11	12-1	14-0
	Hem-fir	#2	7-11	10-2	12-5	14-4	7-4	9-3	11-4	13-1
	Hem-fir	#3	6-2	7-9	9-6	11-0	5-7	7-1	8-8	10-1
	Southern pine	SS	8-10	11-8	14-11	18-1	8-10	11-8	14-11	18-0
	Southern pine	#1	8-6	11-3	13-1	15-7	8-1	10-3	12-0	14-3
	Southern pine	#2	7-7	9-8	11-5	13-6	7-0	8-10	10-5	12-4
	Southern pine	#3	5-9	7-3	8-10	10-5	5-3	6-8	8-1	9-6
	Spruce-pine-fir	SS	8-4	11-0	14-0	17-0	8-4	11-0	13-8	15-11
	Spruce-pine-fir	#1	8-1	10-3	12-7	14-7	7-5	9-5	11-6	13-4
	Spruce-pine-fir	#2	8-1	10-3	12-7	14-7	7-5	9-5	11-6	13-4
	Spruce-pine-fir	#3	6-2	7-9	9-6	11-0	5-7	7-1	8-8	10-1

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

Note: Check sources for availability of lumber in lengths greater than 20 feet.

a. End bearing length shall be increased to 2 inches.

b. Dead load limits for townhouses in Seismic Design Category C ~~and all structures in Seismic Design Categories D$_0$, D$_1$, and D$_2$~~ shall be determined in accordance with Section R301.2.2.2.1.

TABLE R502.3.3(1)
CANTILEVER SPANS FOR FLOOR JOISTS SUPPORTING LIGHT-FRAME EXTERIOR BEARING WALL AND ROOF ONLY[a, b, c, f, g, h]
(Floor Live Load ≤ 40 psf, Roof Live Load ≤ 20 psf)

MEMBER & SPACING	MAXIMUM CANTILEVER SPAN (uplift force at backspan support in lbs.)[d, e]											
	Ground Snow Load											
	≤ 20 psf			30 psf			50 psf			70 psf		
	Roof Width			Roof Width			Roof Width			Roof Width		
	24 ft	32 ft	40 ft	24 ft	32 ft	40 ft	24 ft	32 ft	40 ft	24 ft	32 ft	40 ft
2 × 8 @ 12″	20″ (177)	15″ (227)	—	18″ (209)	—	—	—	—	—	—	—	—
2 × 10 @ 16″	29″ (228)	21″ (297)	16″ (364)	26″ (271)	18″ (354)	—	20″ (375)	—	—	—	—	—
2 × 10 @ 12″	36″ (166)	26″ (219)	20″ (270)	34″ (198)	22″ (263)	16″ (324)	26″ (277)	—	—	19^{2} (356)	—	—
2 × 12 @ 16″	—	32″ (287)	25″ (356)	36″ (263)	29″ (345)	21″ (428)	29″ (367)	20″ (484)	—	23″ (471)	—	—
2 × 12 @ 12″	—	42″ (209)	31″ (263)	—	37″ (253)	27″ (317)	36″ (271)	27″ (358)	17″ (447)	31″ (348)	19″ (462)	—
2 × 12 @ 8″	—	48″ (136)	45″ (169)	—	48″ (164)	38″ (206)	—	40″ (233)	26″ (294)	36″ (230)	29″ (304)	18″ (379)

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Tabulated values are for clear-span roof supported solely by exterior bearing walls.

b. Spans are based on No. 2 Grade lumber of Douglas fir-larch, hem-fir, and spruce-pine-fir for repetitive (three or more) members. No.1 or better shall be used for southern pine or spans shall be multiplied by 0.85 for No. 2 southern pine.

c. Ratio of backspan to cantilever span shall be not less than 3:1.

d. Connections capable of resisting the indicated uplift force shall be provided at the backspan support.

e. Uplift force is for a backspan to cantilever span ratio of 3:1. Tabulated uplift values are permitted to be reduced by multiplying by a factor equal to 3 divided by the actual backspan ratio provided (3/backspan ratio).

f. See Section R301.2.2.2.5, Item 1, for additional limitations on cantilevered floor joists for ~~detached one- and two-family dwellings in Seismic Design Category D_0, D_1, or D_2 and~~ townhouses in Seismic Design Category C~~, D_0, D_1 or D_2~~.

g. A full-depth rim joist shall be provided at the unsupported end of the cantilever joists. Solid blocking shall be provided at the supported end. Where the cantilever length is 24 inches or less~~ and the building is assigned to Seismic Design Category A, B or C~~, solid blocking at the support for the cantilever shall not be required.

h. Linear interpolation shall be permitted for building widths and ground snow loads other than shown.

TABLE R502.3.3(2)
CANTILEVER SPANS FOR FLOOR JOISTS SUPPORTING EXTERIOR BALCONY[a, b, e, f]

MEMBER SIZE	SPACING	MAXIMUM CANTILEVER SPAN (uplift force at backspan support in lbs.)[c, d]		
		Ground Snow Load		
		≤ 30 psf	50 psf	70 psf
2 × 8	12″	42″ (139)	39″ (156)	34″ (165)
2 × 8	16″	36″ (151)	34″ (171)	29″ (180)
2 × 10	12″	61″ (164)	57″ (189)	49″ (201)
2 × 10	16″	53″ (180)	49″ (208)	42″ (220)
2 × 10	24″	43″ (212)	40″ (241)	34″ (255)
2 × 12	16″	72″ (228)	67″ (260)	57″ (268)
2 × 12	24″	58″ (279)	54″ (319)	47″ (330)

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are based on No. 2 Grade lumber of Douglas fir-larch, hem-fir, and spruce-pine-fir for repetitive (three or more) members. No.1 or better shall be used for southern pine or spans shall be multiplied by 0.85 for No. 2 southern pine.

b. Ratio of backspan to cantilever span shall be not less than 2:1.

c. Connections capable of resisting the indicated uplift force shall be provided at the backspan support.

d. Uplift force is for a backspan to cantilever span ratio of 2:1. Tabulated uplift values are permitted to be reduced by multiplying by a factor equal to 2 divided by the actual backspan ratio provided (2/backspan ratio).

e. A full-depth rim joist shall be provided at the unsupported end of the cantilever joists. Solid blocking shall be provided at the supported end. Where the cantilever length is 24 inches or less ~~and the building is assigned to Seismic Design Category A, B or C~~, solid blocking at the support for the cantilever shall not be required.

f. Linear interpolation shall be permitted for ground snow loads other than shown.

R502.7 Lateral restraint at supports.

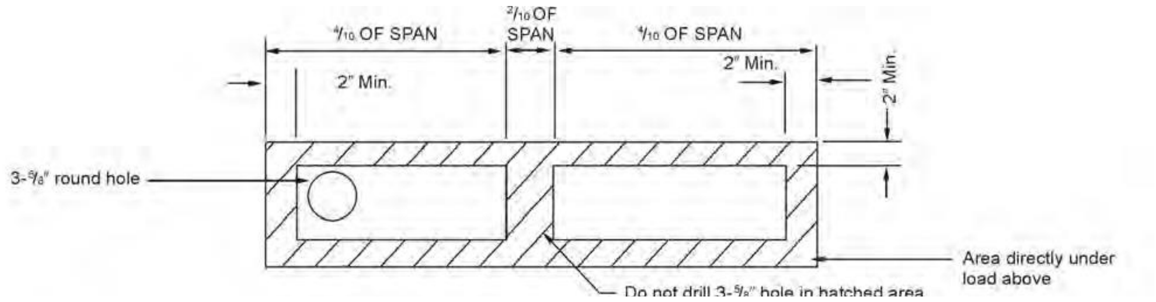
Joists shall be supported laterally at the ends by full-depth solid blocking not less than 2 inches (51 mm) nominal in thickness; or by attachment to a full-depth header, band or rim joist, or to an adjoining stud or shall be otherwise provided with lateral support to prevent rotation.

Exceptions:

1. Trusses, structural composite lumber, structural glued-laminated members and I-joists shall be supported laterally as required by the manufacturer's recommendations.
2. ~~In Seismic Design Categories D$_0$, D$_1$ and D$_2$, lateral restraint shall be provided at each intermediate support.~~ Deleted.

R502.8 Cutting, drilling and notching.

Structural floor members shall not be cut, bored or notched in excess of the limitations specified in this section. See Figure R502.8(1) and Figure R502.8(2).



For SI: 1 inch = 24.5 mm, 1 foot = 304.8 mm

1. Do not drill in center 2/10's of joist span.
2. Do not drill directly under load bearing walls at end.
3. Do not drill closer than 2″ to top or bottom edge.
4. Apply 4′ joist width × 1/2″ CDX plywood with face grain running with joist to both sides using 6d nails or 11/2″ screws 1″ from top and bottom 4″ o.c.
5. Holes shall not be closer than 2′-0″ o.c. within unhatched area only.
6. Plywood shall be attached such that 2′minimumof plywood is centered on each side of the hole location, except when the hole is located within 2′ of the end of joist.

FIGURE R502.8(2)
ACCEPTABLE LOCATION OF 3 5/8 -inch DIAMETER HOLE IN 2 x 10 JOIST

R502.11 Wood trusses.

R502.11.1 Design.

Wood trusses shall be designed in accordance with *approved* engineering practice. The design and manufacture of metal-plate-connected wood trusses shall comply with ANSI/TPI 1. The truss design drawings shall be prepared by a registered professional ~~where required by the statutes of the *jurisdiction* in which the project is to be constructed in accordance with Section R106.1~~.

SECTION R503
FLOOR SHEATHING

R503.2.3 Installation.
Wood structural panels used as subfloor or combination subfloor underlayment shall be attached to wood framing in accordance with Table R602.3(1) ~~and shall be attached to cold-formed steel framing in accordance with Table R505.3.1(2)~~.

SECTION R505
COLD-FORMED STEEL FLOOR FRAMING
Deleted

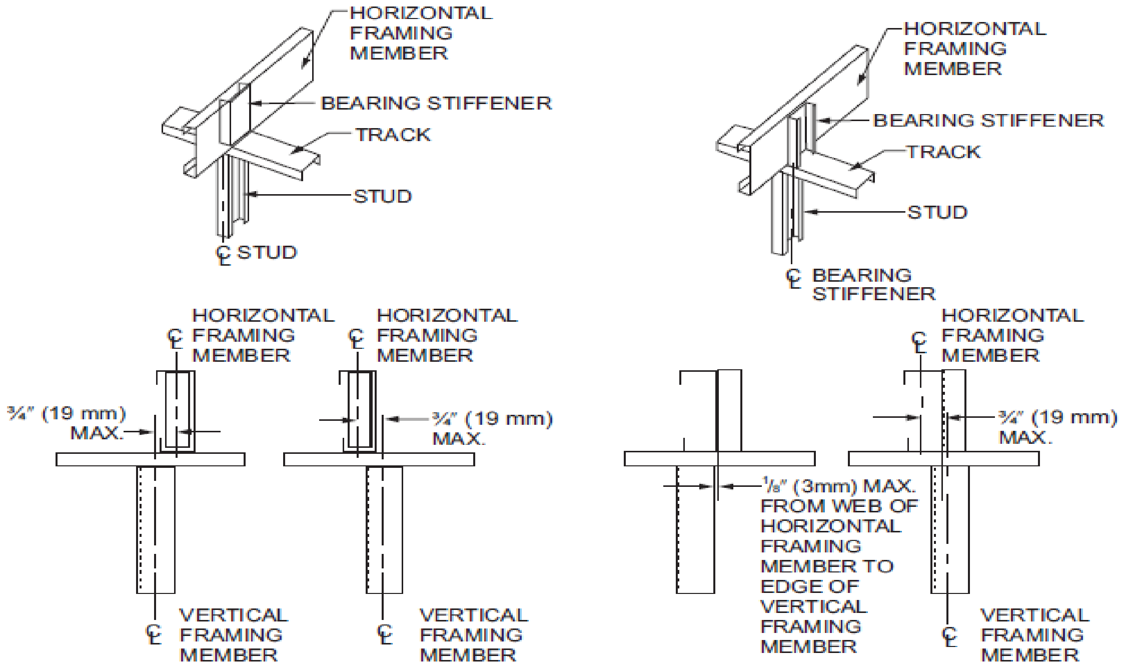
~~**R505.1 Cold-formed steel floor framing.**~~
~~Elements shall be straight and free of any defects that would significantly affect structural performance. Cold-formed steel floor framing members shall be in accordance with the requirements of this section.~~

~~**R505.1.1 Applicability limits.**~~
~~The provisions of this section shall control the construction of cold-formed steel floor framing for buildings not greater than 60 feet (18 288 mm) in length perpendicular to the joist span, not greater than 40 feet (12 192 mm) in width parallel to the joist span and less than or equal to three stories above grade plane. Cold-formed steel floor framing constructed in accordance with the provisions of this section shall be limited to sites where the ultimate design wind speed is less than 139 miles per hour (62 m/s), Exposure Category B or C, and the ground snow load is less than or equal to 70 pounds per square foot (3.35 kPa).~~

~~**R505.1.1Applicability limits.** The provisions of this section shall control the construction of cold-formed steel floor framing for buildings not greater than 60 feet (18 288 mm) in length perpendicular to the joist span, not greater than 40 feet (12 192 mm) in width parallel to the joist span, and less than or equal to three stories above *grade* plane. Cold-formed steel floor framing constructed in accordance with the provisions of this section shall be limited to sites subjected to a maximum design wind speed of 110 miles per hour (49 m/s), Exposure B or C, and a maximum ground snow load of 70 pounds per square foot (3.35 kPa).~~

~~**R505.1.2 In-line framing.**~~
~~Where supported by cold-formed steel framed walls in accordance with Section R603, cold-formed steel floor framing shall be constructed with floor joists located in-line with load-bearing studs located below the joists in accordance with Figure R505.1.2 and the tolerances specified as follows:~~

1. ~~The maximum tolerance shall be $^{3}/_{4}$ inch (19.1 mm) between the centerline of the horizontal framing member and the centerline of the vertical framing member.~~
2. ~~Where the centerline of the horizontal framing member and bearing stiffener are located to one side of the centerline of the vertical framing member, the maximum tolerance shall be $^{1}/_{8}$ inch (3 mm) between the web of the horizontal framing member and the edge of the vertical framing member.~~



~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R505.1.2~~
~~IN-LINE FRAMING~~

~~R505.1.3 Floor trusses.~~
~~Cold-formed steel trusses shall be designed, braced and installed in accordance with AISI S100, Section D4. In the absence of specific bracing requirements, trusses shall be braced in accordance with accepted industry practices, such as the SBCA~~ ~~*Cold-Formed Steel Building Component Safety Information (CFSBCSI), Guide to Good Practice for Handling, Installing & Bracing of Cold-Formed Steel Trusses*~~~~. Truss members shall not be notched, cut or altered in any manner without an~~ ~~*approved*~~ ~~design.~~

~~R505.1.3 Floor trusses.~~ ~~Cold-formed steel trusses shall be designed, braced and installed in accordance with AISI S100, Section D4. Truss members shall not be notched, cut or altered in any manner without an~~ ~~*approved*~~ ~~design.~~

~~R505.2 Structural framing.~~
~~Load-bearing cold-formed steel floor framing members shall be in accordance with this section.~~

~~R505.2.1 Material.~~
~~Load-bearing cold-formed steel framing members shall be cold formed to shape from structural quality sheet steel complying with the requirements of ASTM A 1003: Structural Grades 33 Type H and 50 Type H.~~

~~R505.2.1 Material.~~ ~~Load-bearing cold-formed steel framing members shall be cold-formed to shape from structural quality sheet steel complying with the requirements of one of the following:~~

1. ~~ASTM A 653: Grades 33 and 50 (Class 1 and 3).~~
2. ~~ASTM A 792: Grades 33 and 50A.~~
3. ~~ASTM A 1003: Structural Grades 33 Type H and 50 Type H.~~

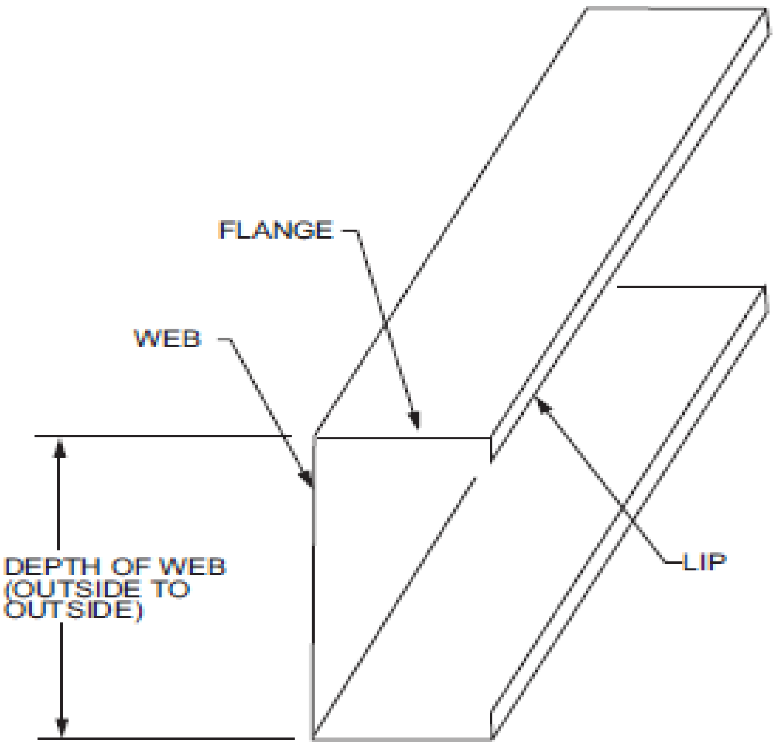
~~R505.2.2 Corrosion protection.~~

~~Load-bearing cold-formed steel framing shall have a metallic coating complying with ASTM A 1003 and one of the following:~~

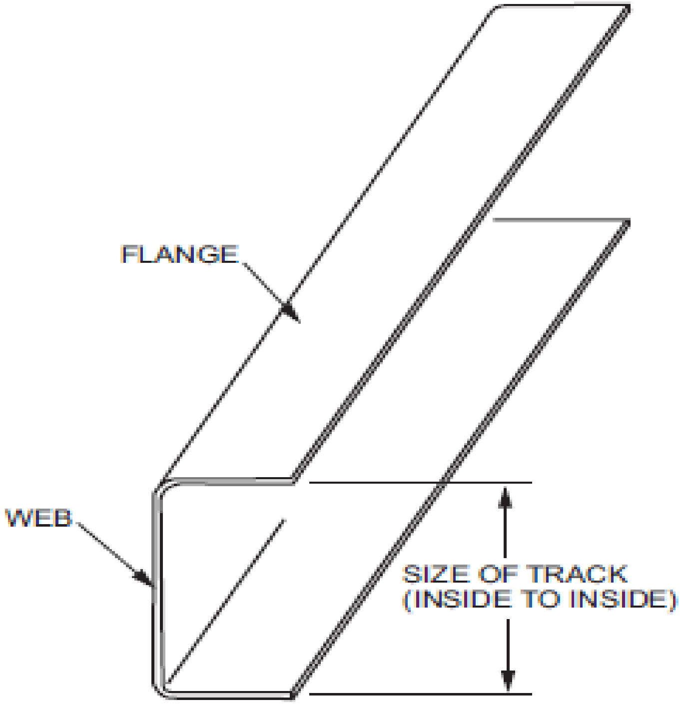
1. ~~A minimum of G 60 in accordance with ASTM A 653.~~
2. ~~A minimum of AZ 50 in accordance with ASTM A 792.~~

~~R505.2.3 Dimension, thickness and material grade.~~

~~Load-bearing cold-formed steel floor framing members shall comply with Figure R505.2.3(1) and with the dimensional and thickness requirements specified in Table R505.2.3. Additionally, all C-shaped sections shall have a minimum flange width of 1.625 inches (41 mm) and a maximum flange width of 2 inches (51 mm). The minimum lip size for C-shaped sections shall be $^1/_2$ inch (12.7 mm). Track sections shall comply with Figure R505.2.3(2) and shall have a minimum flange width of 1$^1/_4$ inch (32 mm). Minimum Grade 33 ksi steel shall be used wherever 33 mil and 43 mil thicknesses are specified. Minimum Grade 50 ksi steel shall be used wherever 54 and 68 mil thicknesses are specified.~~



~~FIGURE R505.2.3(1)~~
~~C-SHAPED SECTION~~



~~FIGURE R505.2.3(2)~~
~~TRACK SECTION~~

~~TABLE R505.2.3~~
~~COLD-FORMED STEEL JOIST SIZES AND THICKNESS~~

~~MEMBER DESIGNATION~~[a]	~~WEB DEPTH (inches)~~	~~MINIMUM BASE STEEL THICKNESS mil (inches)~~
~~550S162-t~~	~~5.5~~	~~33 (0.0329), 43 (0.0428), 54 (0.0538), 68 (0.0677)~~
~~800S162-t~~	~~8~~	~~33 (0.0329), 43 (0.0428), 54 (0.0538), 68 (0.0677)~~
~~1000S162-t~~	~~10~~	~~43 (0.0428), 54 (0.0538), 68 (0.0677)~~
~~1200S162-t~~	~~12~~	~~43 (0.0428), 54 (0.0538), 68 (0.0677)~~

~~For SI: 1 inch = 25.4 mm, 1 mil = 0.0254 mm.~~

~~a. The member designation is defined by the first number representing the member depth in 0.01 inch, the letter “S” representing a stud or joist member, the second number representing the flange width in 0.01 inch, and the letter “t” shall be a number representing the minimum base metal thickness in mils.~~

~~R505.2.4 Identification.~~
~~Load-bearing cold-formed steel framing members shall have a legible *label*, stencil, stamp or embossment with the following information as a minimum:~~

1. ~~Manufacturer’s identification.~~

2. ~~Minimum base steel thickness in inches (mm).~~

3. ~~Minimum coating designation.~~

4. ~~Minimum yield strength, in kips per square inch (ksi) (MPa).~~

~~R505.2.5 Fastening.~~
~~Screws for steel-to-steel connections shall be installed with a minimum edge distance and center-to-center spacing of $^1/_2$ inch (12.7 mm), shall be self-drilling tapping, and shall conform to ASTM C 1513. Floor sheathing shall be attached to cold-formed steel joists with minimum No. 8 self-drilling tapping screws that conform to ASTM C 1513. Screws attaching floor sheathing to cold-formed steel joists shall have a minimum head diameter of 0.292 inch (7.4 mm) with countersunk heads and shall be installed with a minimum edge distance of $^3/_8$ inch (9.5 mm). Gypsum board ceilings shall be attached to cold-formed steel joists with minimum No. 6 screws conforming to ASTM C 954 or ASTM C 1513 with a bugle head style and shall be installed in accordance with Section R702. For all connections, screws shall extend through the steel a minimum of three exposed threads. All fasteners shall have rust-inhibitive coating suitable for the installation in which they are being used, or be manufactured from material not susceptible to corrosion.~~

~~R505.2.6 Web holes, web hole reinforcing and web hole patching.~~
~~Web holes, web hole reinforcing, and web hole patching shall be in accordance with this section.~~

~~R505.2.6.1 Web holes.~~
~~Web holes in floor joists shall comply with all of the following conditions:~~

1. ~~Holes shall conform to Figure R505.2.6.1.~~

2. ~~Holes shall be permitted only along the centerline of the web of the framing member.~~

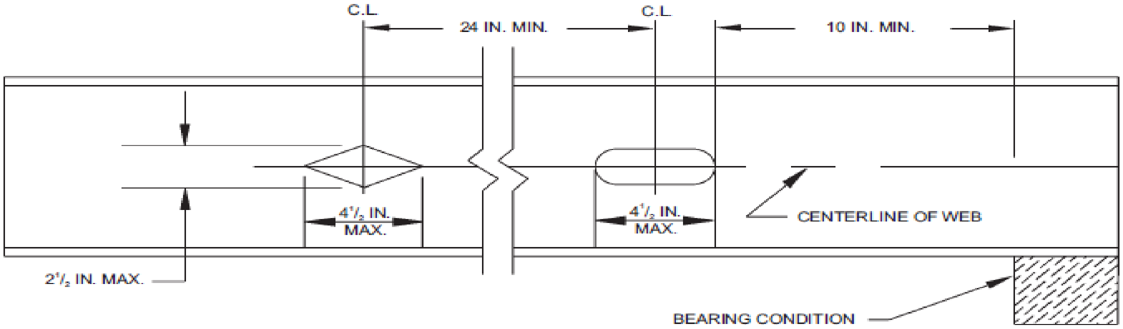
3. ~~Holes shall have a center-to-center spacing of not less than 24 inches (610 mm).~~

4. ~~Holes shall have a web hole width not greater than 0.5 times the member depth, or 2$^1/_2$ inches (64.5 mm).~~

5. ~~Holes shall have a web hole length not exceeding 4$^1/_2$ inches (114 mm).~~

6. ~~Holes shall have a minimum distance between the edge of the bearing surface and the edge of the web hole of not less than 10 inches (254 mm).~~

~~Framing members with web holes not conforming to the above requirements shall be reinforced in accordance with Section R505.2.6.2, patched in accordance with Section R505.2.6.3 or designed in accordance with accepted engineering practices.~~



For SI: 1 inch = 25.4 mm.

~~FIGURE R505.2.6.1~~
~~FLOOR JOIST WEB HOLES~~

~~R505.2.6.2 Web hole reinforcing.~~

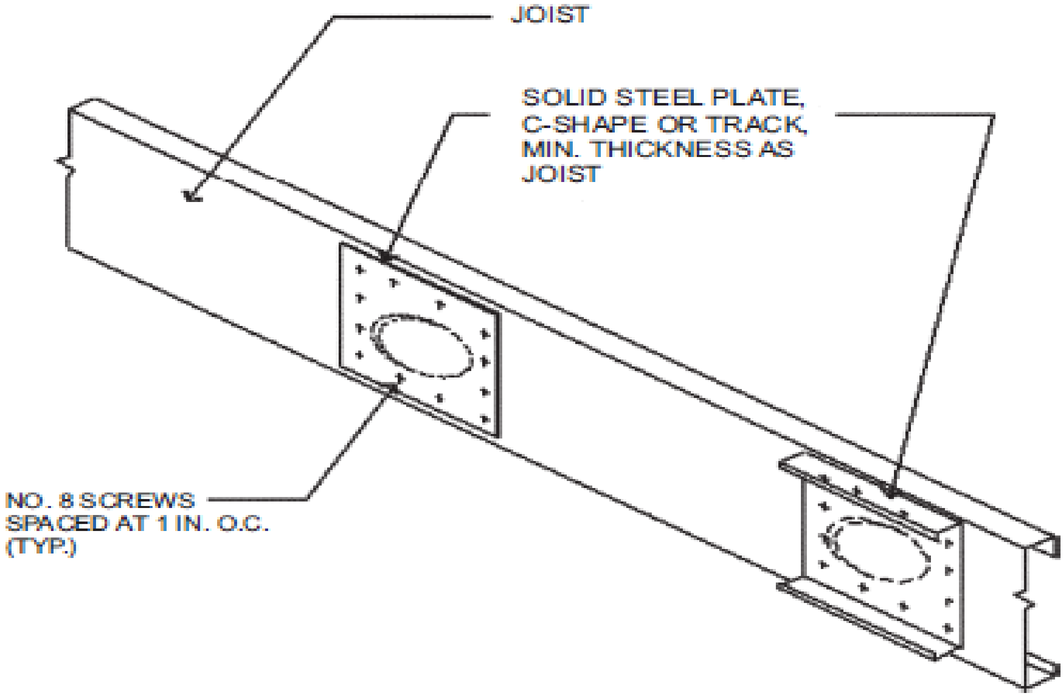
~~Reinforcement of web holes in floor joists not conforming to the requirements of Section R505.2.6.1 shall be permitted if the hole is located fully within the center 40 percent of the span and the depth and length of the hole does not exceed 65 percent of the flat width of the web. The reinforcing shall be a steel plate or C-shape section with a hole that does not exceed the web hole size limitations of Section R505.2.6.1 for the member being reinforced. The steel reinforcing shall be the same thickness as the receiving member and shall extend not less than 1 inch (25 mm) beyond all edges of the hole. The steel reinforcing shall be fastened to the web of the receiving member with No. 8 screws spaced not more than 1 inch (25 mm) center-to-center along the edges of the patch with minimum edge distance of~~ $^{1}/_{2}$ ~~inch (12.7 mm).~~

~~R505.2.6.3 Hole patching.~~

~~Patching of web holes in floor joists not conforming to the requirements in Section R505.2.6.1 shall be permitted in accordance with either of the following methods:~~

~~1. Framing members shall be replaced or designed in accordance with accepted engineering practices where web holes exceed the following size limits:~~
    ~~1.1. The depth of the hole, measured across the web, exceeds 70 percent of the flat width of the web.~~
    ~~1.2. The length of the hole, measured along the web, exceeds 10 inches (254 mm) or the depth of the web, whichever is greater.~~
~~2. Web holes not exceeding the dimensional requirements in Section R505.2.6.3, Item 1, shall be patched with a solid steel plate, stud section or track section in accordance with Figure R505.2.6.3. The steel patch shall, as a minimum, be of the same thickness as the receiving member and shall extend not less than 1 inch (25 mm) beyond all edges of the hole. The steel patch shall be fastened to the web of the receiving member with No. 8 screws spaced not more than 1 inch~~

~~(25 mm) center-to-center along the edges of the patch with minimum edge distance of $^{1}/_{2}$ inch (12.7 mm).~~



~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R505.2.6.3~~
~~FLOOR JOIST WEB HOLE PATCH~~

~~R505.3 Floor construction.~~

~~Cold-formed steel floors shall be constructed in accordance with this section.~~

~~R505.3.1 Floor to foundation or load-bearing wall connections.~~

~~Cold-formed steel framed floors shall be anchored to foundations, wood sills or load-bearing walls in accordance with Table R505.3.1(1) and Figure R505.3.1(1), R505.3.1(2), R505.3.1(3), R505.3.1(4), R505.3.1(5) or R505.3.1(6). Anchor bolts shall be located not more than 12 inches (305 mm) from corners or the termination of bottom tracks. Continuous cold-formed steel joists supported by interior load-bearing walls shall be constructed in accordance with Figure R505.3.1(7). Lapped cold-formed steel joists shall be constructed in accordance with Figure R505.3.1(8). End floor joists constructed on foundation walls parallel to the joist span shall be doubled unless a C-shaped bearing stiffener, sized in accordance with Section R505.3.4, is installed web-to-web with the floor joist beneath each supported wall stud, as shown in Figure R505.3.1(9). Fastening of cold-formed steel joists to other framing members shall be in accordance with Section R505.2.5 and Table R505.3.1(2).~~

~~TABLE R505.3.1(1)~~
~~FLOOR TO FOUNDATION OR BEARING WALL CONNECTION REQUIREMENTS~~[~~a, b~~]

~~FRAMING CONDITION~~	**~~BASIC ULTIMATE WIND SPEED (mph) AND EXPOSURE~~**	
	~~110 mph Exposure Category C or less than 139 mph Exposure Category B~~	**~~Less than 139 mph Exposure Category C~~**
~~Floor joist to wall track of exterior wall in accordance with Figure R505.3.1(1)~~	~~2-No. 8 screws~~	~~3-No. 8 screws~~
~~Rim track or end joist to load-bearing wall top track in accordance with Figure R505.3.1(1)~~	~~1-No. 8 screw at 24 inches o.c.~~	~~1-No. 8 screw at 24 inches o.c.~~
~~Rim track or end joist to wood sill in accordance with Figure R505.3.1(2)~~	~~Steel plate spaced at 4 feet o.c. with 4-No. 8 screws and 4-10d or 6-8d common nails~~	~~Steel plate spaced at 2 feet o.c. with 4-No. 8 screws and 4-10d or 6-8d common nails~~
~~Rim track or end joist to foundation in accordance with Figure R505.3.1(3)~~	~~1/2-inch minimum diameter anchor bolt and clip angle spaced at 6 feet o.c. with 8-No. 8 screws~~	~~1/2-inch minimum diameter anchor bolt and clip angle spaced at 4 feet o.c. with 8-No. 8 screws~~
~~Cantilevered joist to foundation in accordance with Figure R505.3.1(4)~~	~~1/2-inch minimum diameter anchor bolt and clip angle spaced at 6 feet o.c. with 8-No. 8 screws~~	~~1/2-inch minimum diameter anchor bolt and clip angle spaced at 4 feet o.c. with 8-No. 8 screws~~
~~Cantilevered joist to wood sill in accordance with Figure R505.3.1(5)~~	~~Steel plate spaced at 4 feet o.c. with 4-No. 8 screws and 4-10d or 6-8d common nails~~	~~Steel plate spaced at 2 feet o.c. with 4-No. 8 screws and 4-10d or 6-8d common nails~~
~~Cantilevered joist to exterior load-bearing wall track in accordance with Figure R505.3.1(6)~~	~~2-No. 8 screws~~	~~3-No. 8 screws~~

~~For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa, 1 mile per hour = 0.447 m/s, 1 foot = 304.8 mm.~~

~~a. Anchor bolts are to be located not more than 12 inches from corners or the termination of bottom tracks such as at door openings or corners. Bolts extend a minimum of 15 inches into masonry or 7 inches into concrete. Anchor bolts connecting cold-formed steel framing to the foundation structure are to be installed so that the distance from the center of the bolt hole to the edge of the connected member is not less than one and one-half bolt diameters.~~

~~b. All screw sizes shown are minimum.~~

`

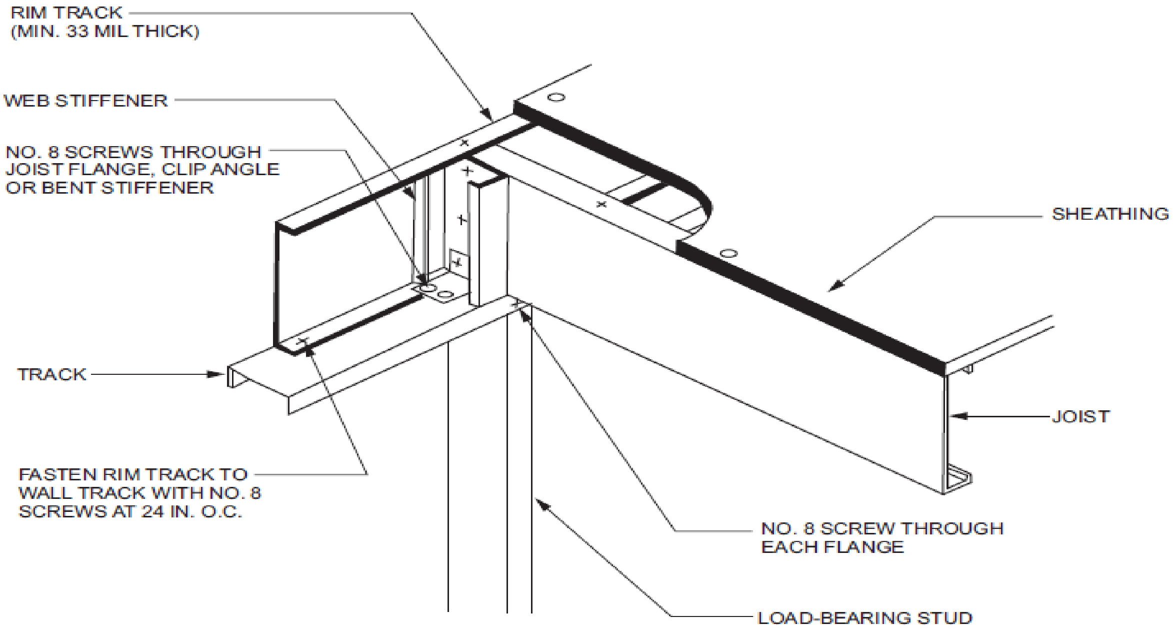
~~TABLE R505.3.1(2)~~

~~FLOOR FASTENING SCHEDULE~~[a]

~~DESCRIPTION OF BUILDING ELEMENTS~~	**~~NUMBER AND SIZE OF FASTENERS~~**	**~~SPACING OF FASTENERS~~**
~~Floor joist to track of an interior load-bearing wall in accordance with Figures R505.3.1(7) and R505.3.1(8)~~	~~2 No. 8 screws~~	~~Each joist~~
~~Floor joist to track at end of joist~~	~~2 No. 8 screws~~	~~One per flange or two per bearing stiffener~~

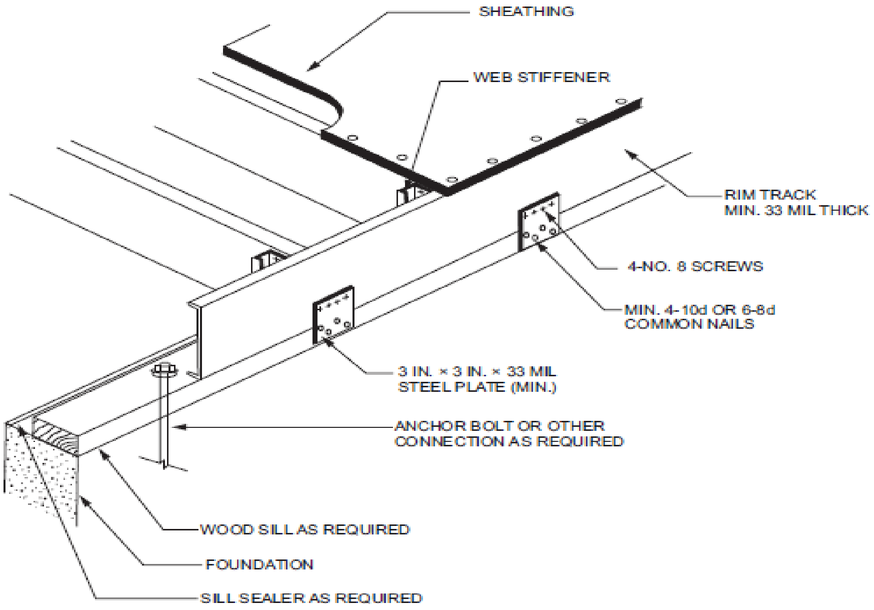
~~Subfloor to floor joists~~	~~No. 8 screws~~	~~6 in. o.c. on edges and 12 in. o.c. at intermediate supports~~

~~For SI: 1 inch = 25.4 mm.~~
~~a. All screw sizes shown are minimum.~~



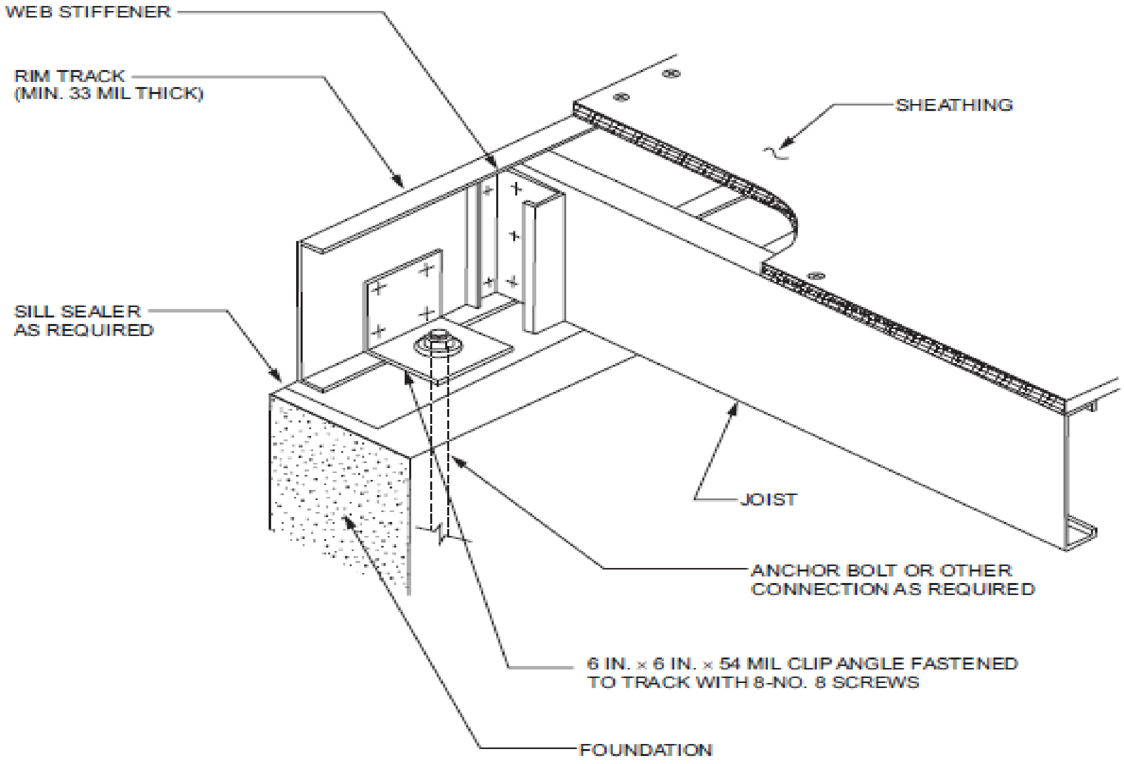
~~For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.~~

~~FIGURE 505.3.1(1)~~
~~FLOOR TO EXTERIOR LOAD-BEARING WALL STUD CONNECTION~~



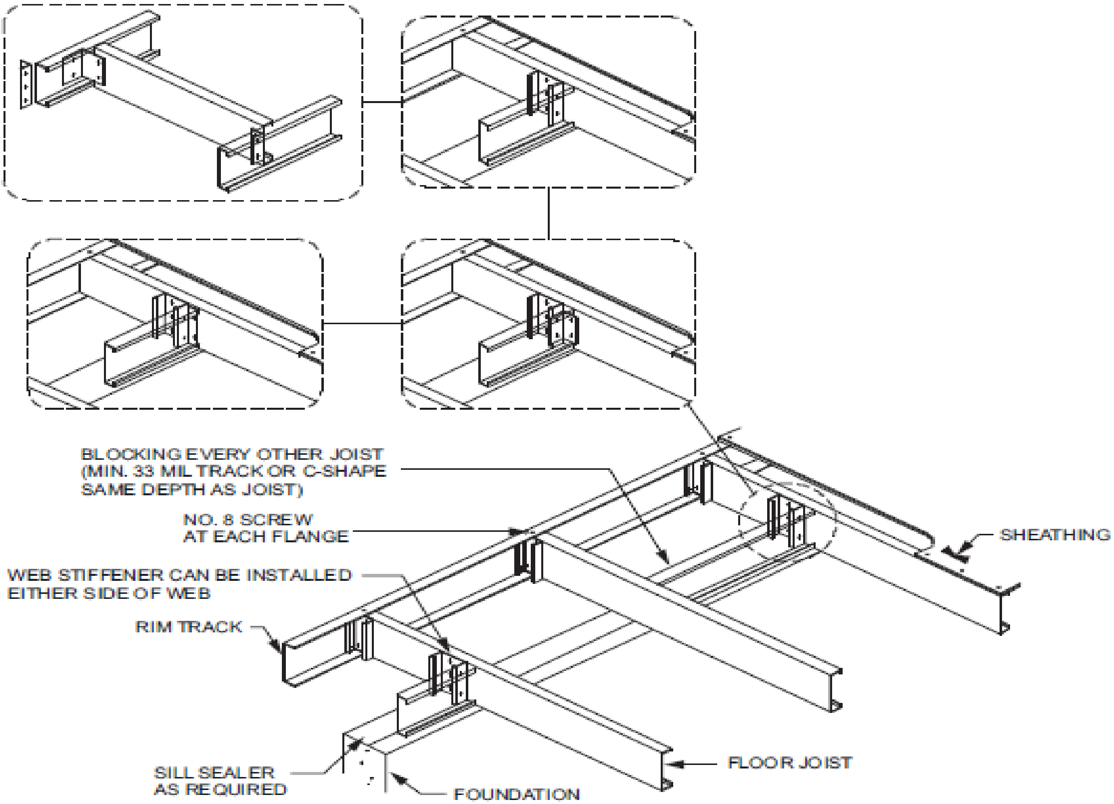
~~For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.~~

~~**FIGURE R505.3.1(2)**~~
~~**FLOOR TO WOOD SILL CONNECTION**~~



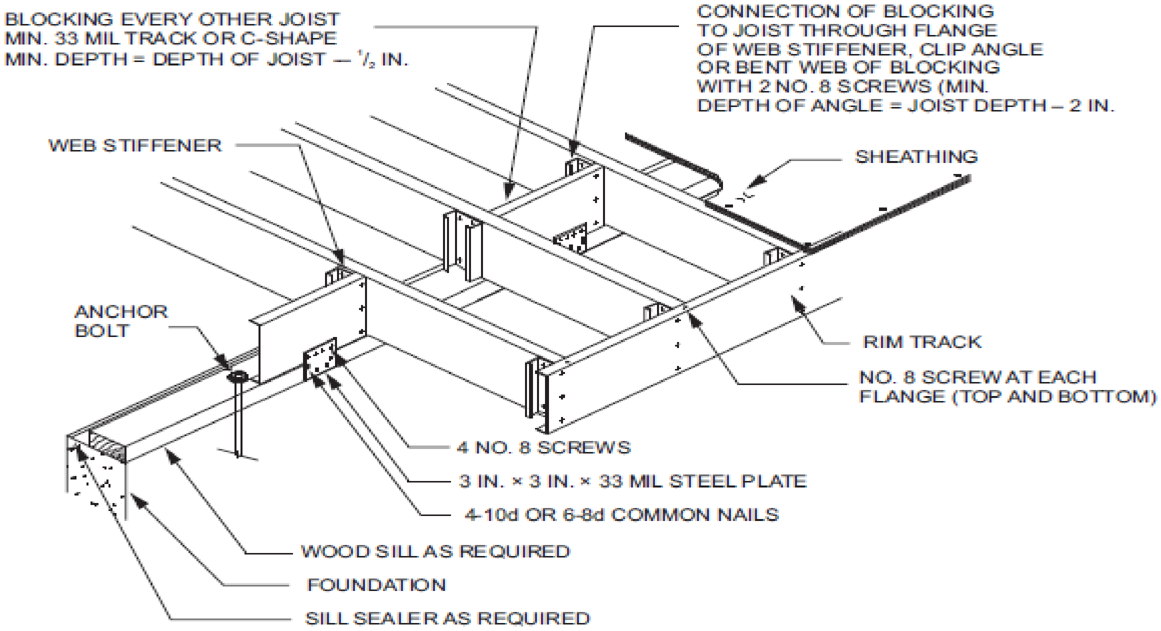
For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.

~~FIGURE R505.3.1(3)~~
~~FLOOR TO FOUNDATION CONNECTION~~



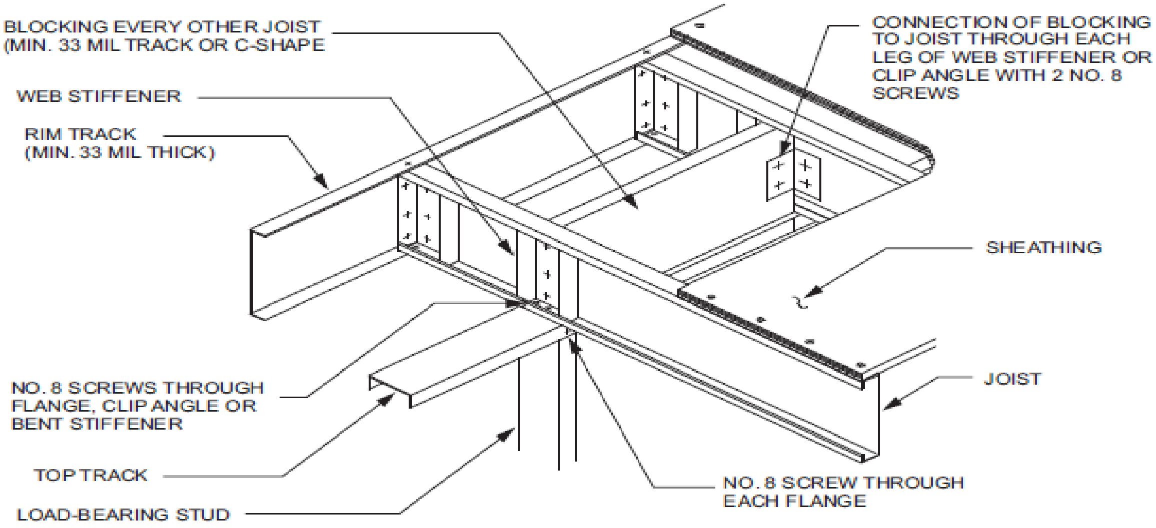
For SI: 1 mil = 0.0254 mm.

~~FIGURE R505.3.1(4)~~
~~CANTILEVERED FLOOR TO FOUNDATION CONNECTION~~



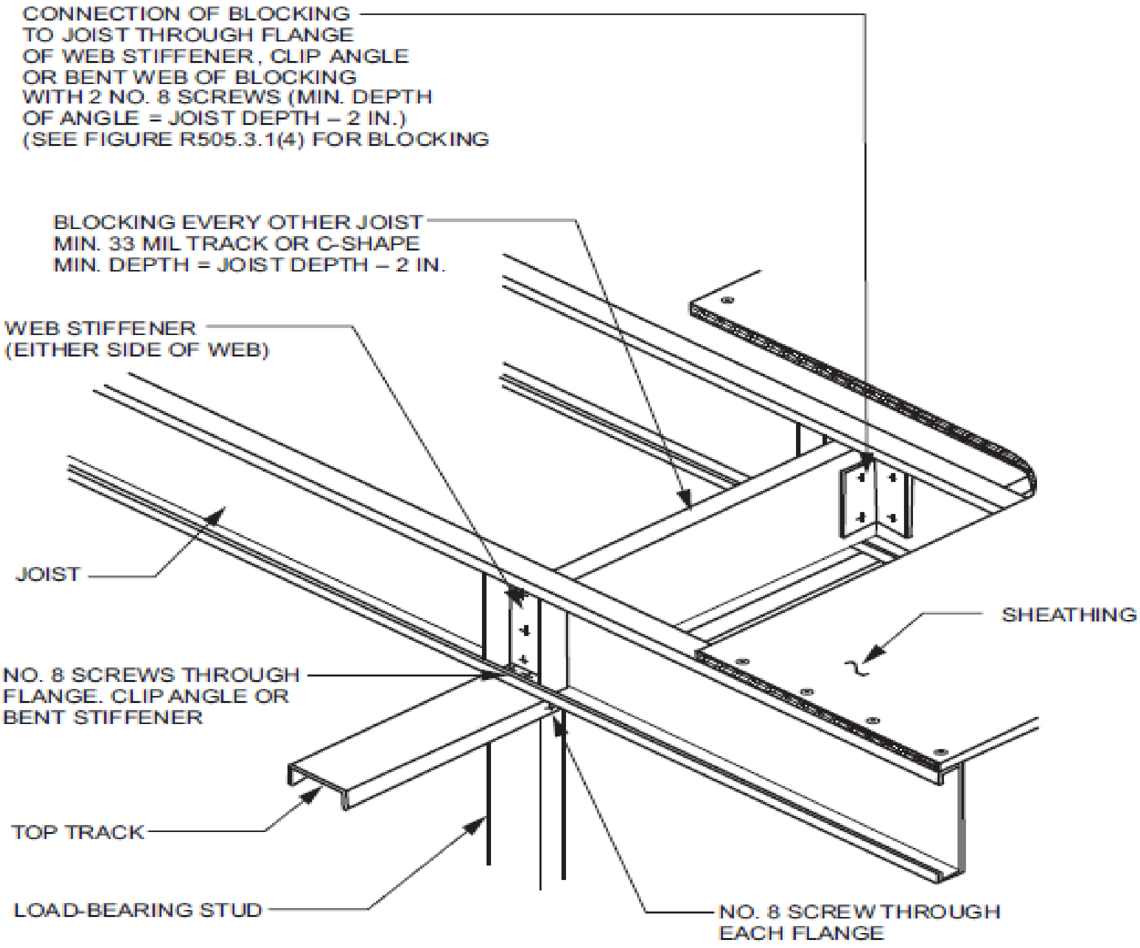
~~For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.~~

~~FIGURE R505.3.1(5)~~
~~CANTILEVERED FLOOR TO WOOD SILL CONNECTION~~



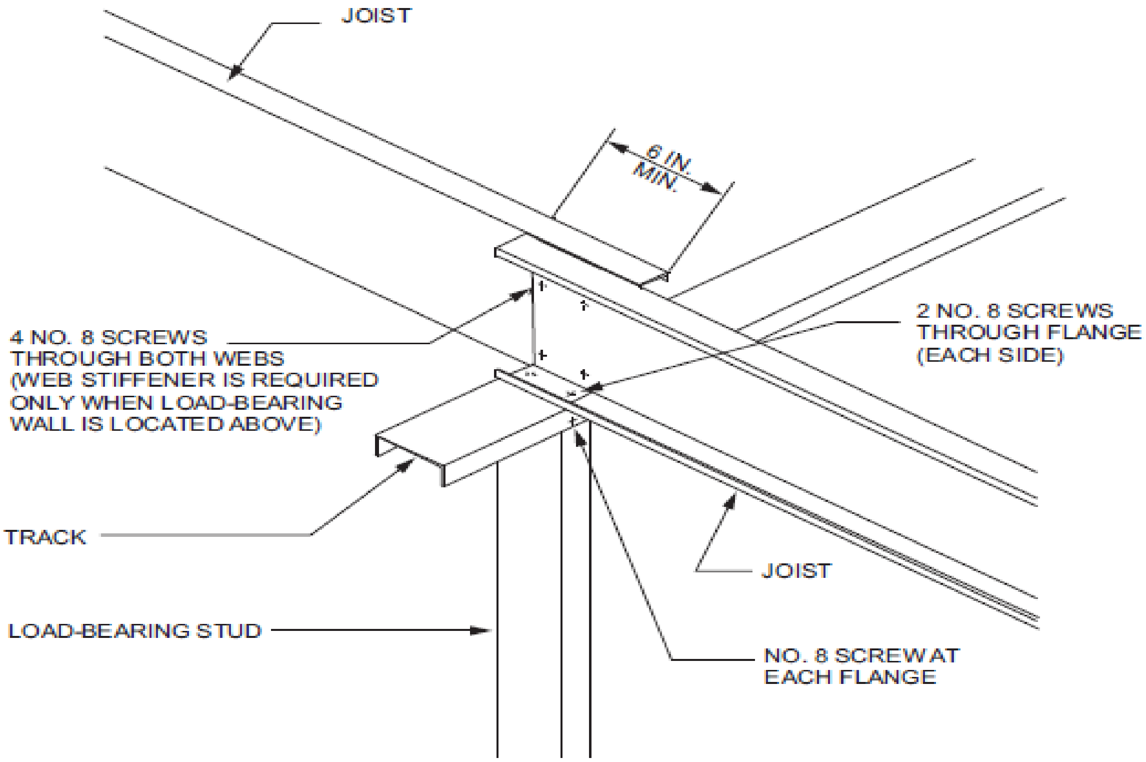
~~For SI: 1 mil = 0.0254 mm.~~

~~FIGURE R505.3.1(6)~~
~~CANTILEVERED FLOOR TO EXTERIOR LOAD-BEARING WALL CONNECTION~~



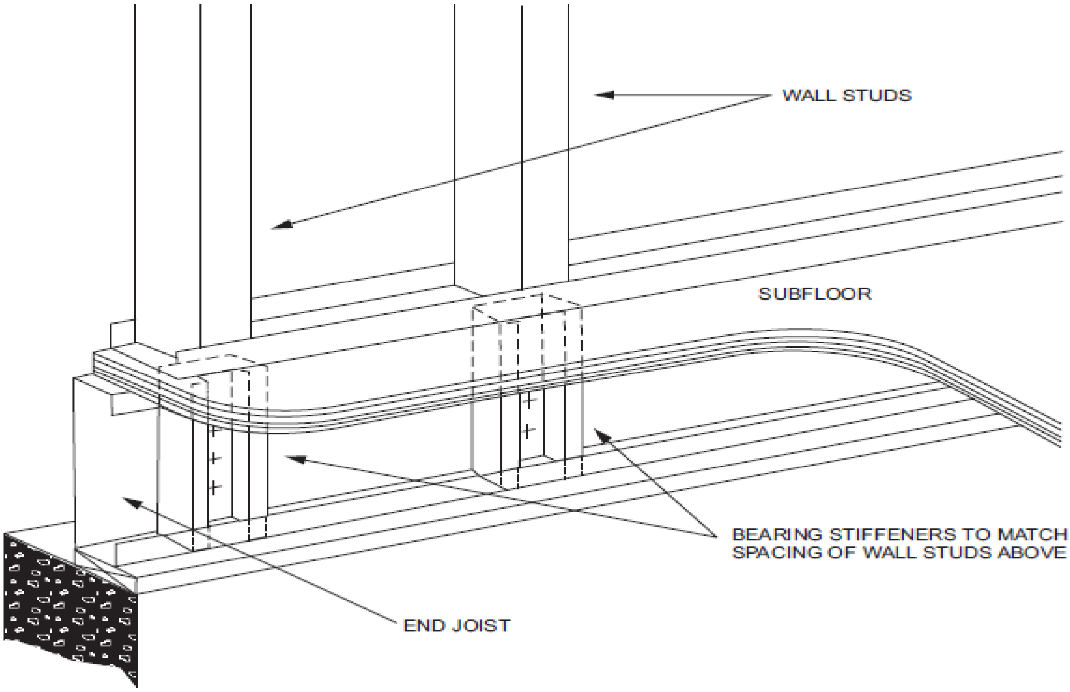
~~For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.~~

~~FIGURE R505.3.1(7)~~
~~CONTINUOUS SPAN JOIST SUPPORTED ON INTERIOR LOAD-BEARING WALL~~



~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R505.3.1(8)~~
~~LAPPED JOISTS SUPPORTED ON INTERIOR LOAD-BEARING WALL~~



~~FIGURE R505.3.1(9)~~
~~BEARING STIFFENERS FOR END JOISTS~~

~~R505.3.2 Minimum floor joist sizes.~~

~~Floor joist size and thickness shall be determined in accordance with the limits set forth in Table R505.3.2 for single or continuous spans. Where continuous joist members are used, the interior bearing supports shall be located within 2 feet (610 mm) of midspan of the cold-formed steel joists, and the individual spans shall not exceed the spans in Table R505.3.2. Floor joists shall have a bearing support length of not less than $1^{1}/_{2}$ inches (38 mm) for exterior wall supports and $3^{1}/_{2}$ inches (89 mm) for interior wall supports. Tracks shall be not less than 33 mils (0.84 mm) thick except when used as part of a floor header or trimmer in accordance with Section R505.3.8. Bearing stiffeners shall be installed in accordance with Section R505.3.4.~~

~~R505.3.2 Minimum floor joist sizes.~~ ~~Floor joist size and thickness shall be determined in accordance with the limits set forth in Table R505.3.2(1) for single spans, and Tables R505.3.2(2) and R505.3.2(3) for multiple spans. When continuous joist members are used, the interior bearing supports shall be located within 2 feet (610 mm) of mid-span of the cold-formed steel joists, and the individual spans shall not exceed the spans in Table R505.3.2(2) or R505.3.2(3), as applicable. Floor joists shall have a bearing support length of not less than 11/2 inches (38 mm) for exterior wall supports and 31/2 inches (89 mm) for interior wall supports. Tracks shall be a minimum of 33 mils (0.84 mm) thick except when used as part of a floor header or trimmer in accordance with Section R505.3.8. Bearing stiffeners shall be installed in accordance with Section R505.3.4.~~

~~TABLE R505.3.2~~
~~ALLOWABLE SPANS FOR COLD-FORMED STEEL JOISTS—SINGLE OR CONTINUOUS SPANS~~[~~a, b, c, d, e~~]

~~JOIST DESIGNATION~~	~~30 PSF LIVE LOAD~~				~~40 PSF LIVE LOAD~~			
	~~Spacing (inches)~~				~~Spacing (inches)~~			
	~~12~~	~~16~~	~~19.2~~	~~24~~	~~12~~	~~16~~	~~19.2~~	~~24~~
~~550S162-33~~	~~11′-7″~~	~~10′-7″~~	~~9′-6″~~	~~8′-6″~~	~~10′-7″~~	~~9′-3″~~	~~8′-6″~~	~~7′-6″~~
~~550S162-43~~	~~12′-8″~~	~~11′-6″~~	~~10′-10″~~	~~10′-2″~~	~~11′-6″~~	~~10′-5″~~	~~9′-10″~~	~~9′-1″~~
~~550S162-54~~	~~13′-7″~~	~~12′-4″~~	~~11′-7″~~	~~10′-9″~~	~~12′-4″~~	~~11′-2″~~	~~10′-6″~~	~~9′-9″~~
~~550S162-68~~	~~14′-7″~~	~~13′-3″~~	~~12′-6″~~	~~11′-7″~~	~~13′-3″~~	~~12′-0″~~	~~11′-4″~~	~~10′-6″~~
~~800S162-33~~	~~15′-8″~~	~~13′-11″~~	~~12′-9″~~	~~11′-5″~~	~~14′-3″~~	~~12′-5″~~	~~11′-3″~~	~~9′-0″~~
~~800S162-43~~	~~17′-1″~~	~~15′-6″~~	~~14′-7″~~	~~13′-7″~~	~~15′-6″~~	~~14′-1″~~	~~13′-3″~~	~~12′-4″~~
~~800S162-54~~	~~18′-4″~~	~~16′-8″~~	~~15′-8″~~	~~14′-7″~~	~~16′-8″~~	~~15′-2″~~	~~14′-3″~~	~~13′-3″~~
~~800S162-68~~	~~19′-9″~~	~~17′-11″~~	~~16′-10″~~	~~15′-8″~~	~~17′-11″~~	~~16′-3″~~	~~15′-4″~~	~~14′-2″~~
~~1000S162-43~~	~~20′-6″~~	~~18′-8″~~	~~17′-6″~~	~~15′-8″~~	~~18′-8″~~	~~16′-11″~~	~~15′-6″~~	~~13′-11″~~
~~1000S162-54~~	~~22′-1″~~	~~20′-0″~~	~~18′-10″~~	~~17′-6″~~	~~20′-0″~~	~~18′-2″~~	~~17′-2″~~	~~15′-11″~~
~~1000S162-68~~	~~23′-9″~~	~~21′-7″~~	~~20′-3″~~	~~18′-10″~~	~~21′-7″~~	~~19′-7″~~	~~18′-5″~~	~~17′-1″~~
~~1200S162-43~~	~~23′-9″~~	~~20′-10″~~	~~19′-0″~~	~~16′-8″~~	~~21′-5″~~	~~18′-6″~~	~~16′-6″~~	~~13′-2″~~
~~1200S162-54~~	~~25′-9″~~	~~23′-4″~~	~~22′-0″~~	~~20′-1″~~	~~23′-4″~~	~~21′-3″~~	~~20′-0″~~	~~17′-10″~~
~~1200S162-68~~	~~27′-8″~~	~~25′-1″~~	~~23′-8″~~	~~21′-11″~~	~~25′-1″~~	~~22′-10″~~	~~21′-6″~~	~~21′-1″~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 mil = 0.0254 mm.~~

~~a. Deflection criteria: *L*/480 for live loads, *L*/240 for total loads.~~
~~b. Floor dead load = 10 psf.~~
~~c. Table provides the maximum clear span in feet and inches.~~
~~d. Bearing stiffeners are to be installed at all support points and concentrated loads.~~
~~e. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thickness. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thickness.~~

~~R505.3.3 Joist bracing and blocking.~~

~~Joist bracing and blocking shall be in accordance with this section.~~

~~R505.3.3.1 Joist top flange bracing.~~

~~The top flanges of cold-formed steel joists shall be laterally braced by the application of floor sheathing fastened to the joists in accordance with Section R505.2.5 and Table R505.3.1(2).~~

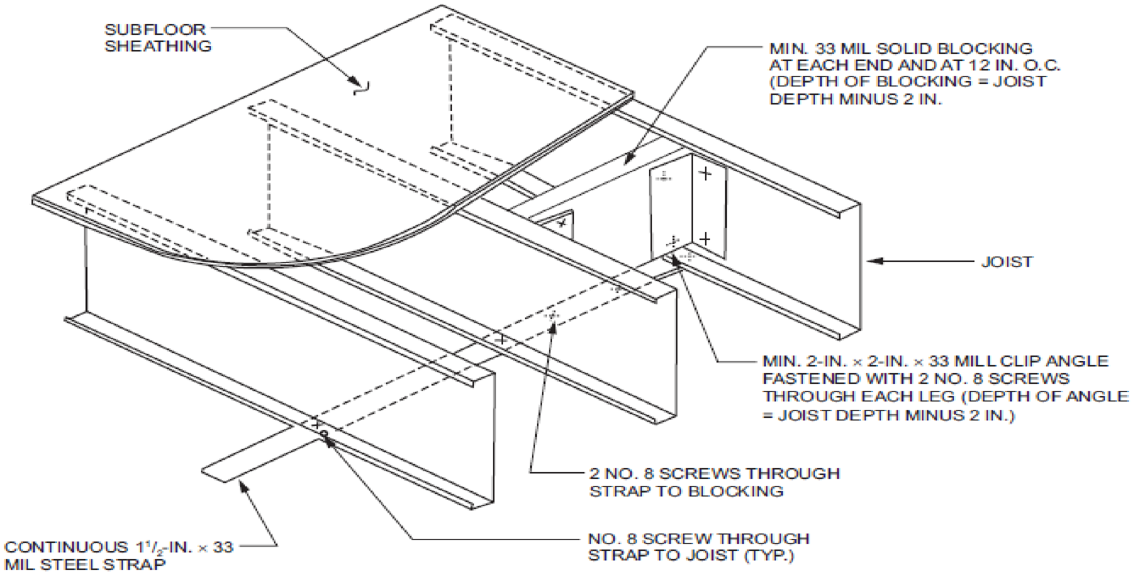
~~R505.3.3.2 Joist bottom flange bracing/blocking.~~

~~Floor joists with spans that exceed 12 feet (3658 mm) shall have the bottom flanges laterally braced in accordance with one of the following:~~

1. ~~Gypsum board installed with minimum No. 6 screws in accordance with Section R702.~~

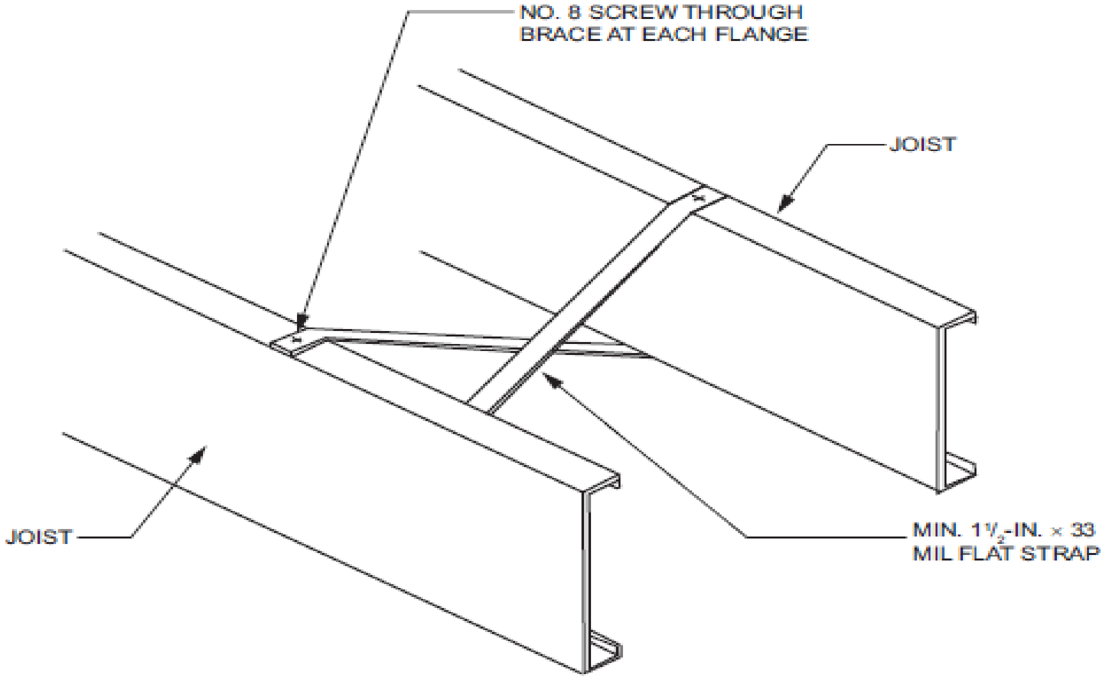
2. ~~Continuous steel straps installed in accordance with Figure R505.3.3.2(1). Steel straps shall be spaced at a maximum of 12 feet (3658 mm) on center and shall be at least 1$\frac{1}{2}$ inches (38 mm) in width and 33 mils (0.84 mm) in thickness. Straps shall be fastened to the bottom flange of each joist with one No. 8 screw, fastened to blocking with two No. 8 screws, and fastened at each end (of strap)~~

~~with two No. 8 screws. Blocking in accordance with Figure R505.3.3.2(1) or R505.3.3.2(2) shall be installed between joists at each end of the continuous strapping and at a maximum spacing of 12 feet (3658 mm) measured along the continuous strapping (perpendicular to the joist run). Blocking shall also be located at the termination of all straps. As an alternative to blocking at the ends, anchoring the strap to a stable building component with two No. 8 screws shall be permitted.~~



~~For SI: 1 mil = 0.0254, 1 inch = 25.4 mm.~~

~~FIGURE R505.3.3.2(1)~~
~~JOIST BLOCKING (SOLID)~~



~~For SI: 1 mil = 0.0254, 1 inch = 25.4 mm.~~

~~FIGURE R505.3.3.2(2)~~
~~JOIST BLOCKING (STRAP)~~

~~R505.3.3.3 Blocking at interior bearing supports.~~
~~Blocking is not required for continuous back-to-back floor joists at bearing supports. Blocking shall be installed between every other joist for single continuous floor joists across bearing supports in accordance with Figure R505.3.1(7). Blocking shall consist of C-shape or track section with a minimum thickness of 33 mils (0.84 mm). Blocking shall be fastened to each adjacent joist through a 33-mil (0.84 mm) clip angle, bent web of blocking or flanges of web stiffeners with two No. 8 screws on each side. The minimum depth of the blocking shall be equal to the depth of the joist minus 2 inches (51 mm). The minimum length of the angle shall be equal to the depth of the joist minus 2 inches (51 mm).~~

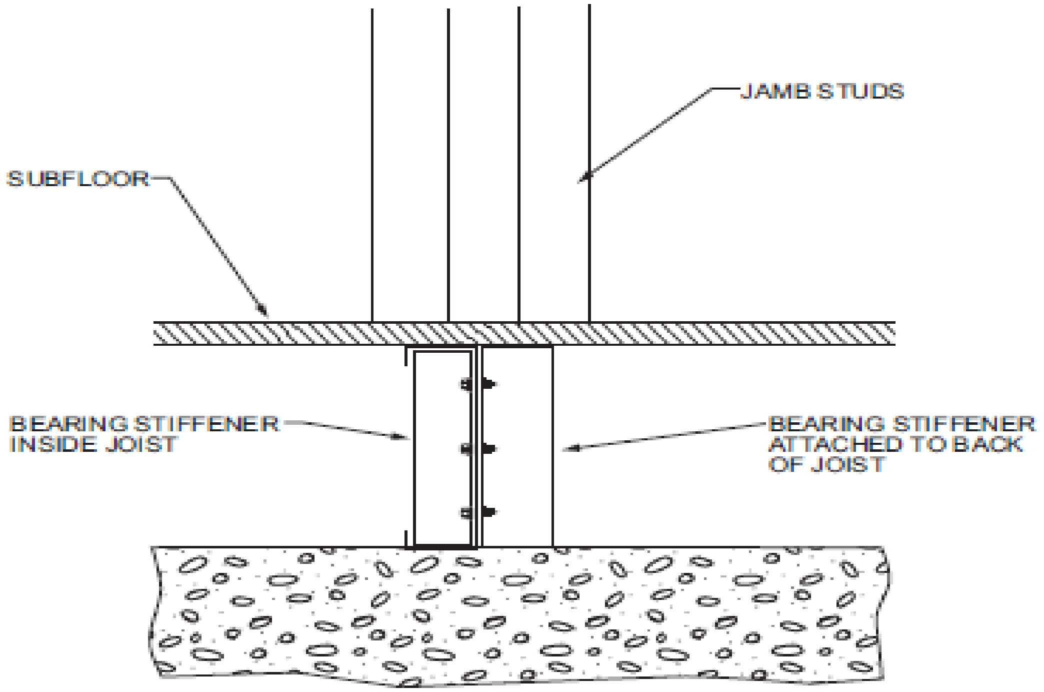
~~R505.3.3.4 Blocking at cantilevers.~~
~~Blocking shall be installed between every other joist over cantilever bearing supports in accordance with Figure R505.3.1(4), R505.3.1(5) or R505.3.1(6). Blocking shall consist of C-shape or track section with minimum thickness of 33 mils (0.84 mm). Blocking shall be fastened to each adjacent joist through bent web of blocking, 33 mil clip angle or flange of web stiffener with two No. 8 screws at each end. The depth of the blocking shall be equal to the depth of the joist. The minimum length of the angle shall be equal to the depth of the joist minus 2 inches (51 mm). Blocking shall be fastened through the floor sheathing and to the support with three No. 8 screws (top and bottom).~~

~~R505.3.4 Bearing stiffeners.~~
~~Bearing stiffeners shall be installed at each joist bearing location in accordance with this~~

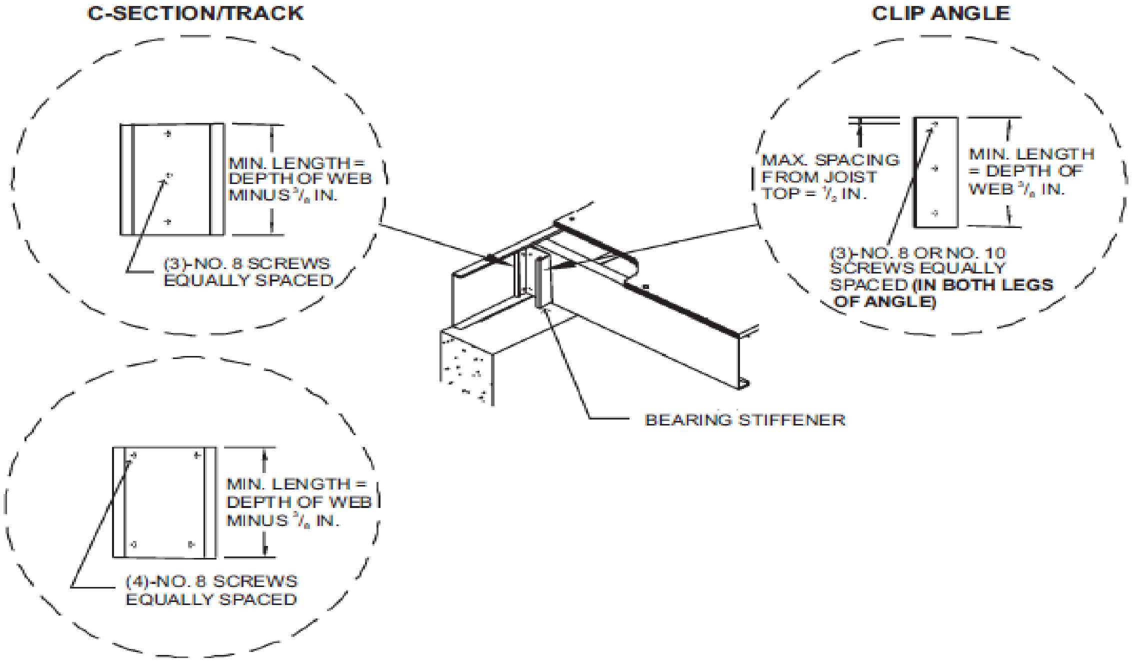
~~section, except for joists lapped over an interior support not carrying a load-bearing wall above. Floor joists supporting jamb studs with multiple members shall have two bearing stiffeners in accordance with Figure R505.3.4(1). Bearing stiffeners shall be fabricated from a C-shaped, track or clip angle member in accordance with the one of following:~~

1. ~~C-shaped bearing stiffeners:~~
    - ~~1.1. Where the joist is not carrying a load-bearing wall above, the bearing stiffener shall be a minimum 33 mil (0.84 mm) thickness.~~
    - ~~1.2. Where the joist is carrying a load-bearing wall above, the bearing stiffener shall be not less than the same designation thickness as the wall stud above.~~
2. ~~Track bearing stiffeners:~~
    - ~~2.1. Where the joist is not carrying a load-bearing wall above, the bearing stiffener shall be a minimum 43 mil (1.09 mm) thickness.~~
    - ~~2.2. Where the joist is carrying a load-bearing wall above, the bearing stiffener shall be not less than one designation thickness greater than the wall stud above.~~

~~The minimum length of a bearing stiffener shall be the depth of member being stiffened minus $^{3}/_{8}$ inch (9.5 mm). Each bearing stiffener shall be fastened to the web of the member it is stiffening as shown in Figure R505.3.4(2).~~



~~FIGURE R505.3.4(1)~~
~~BEARING STIFFENERS UNDER JAMB STUDS~~



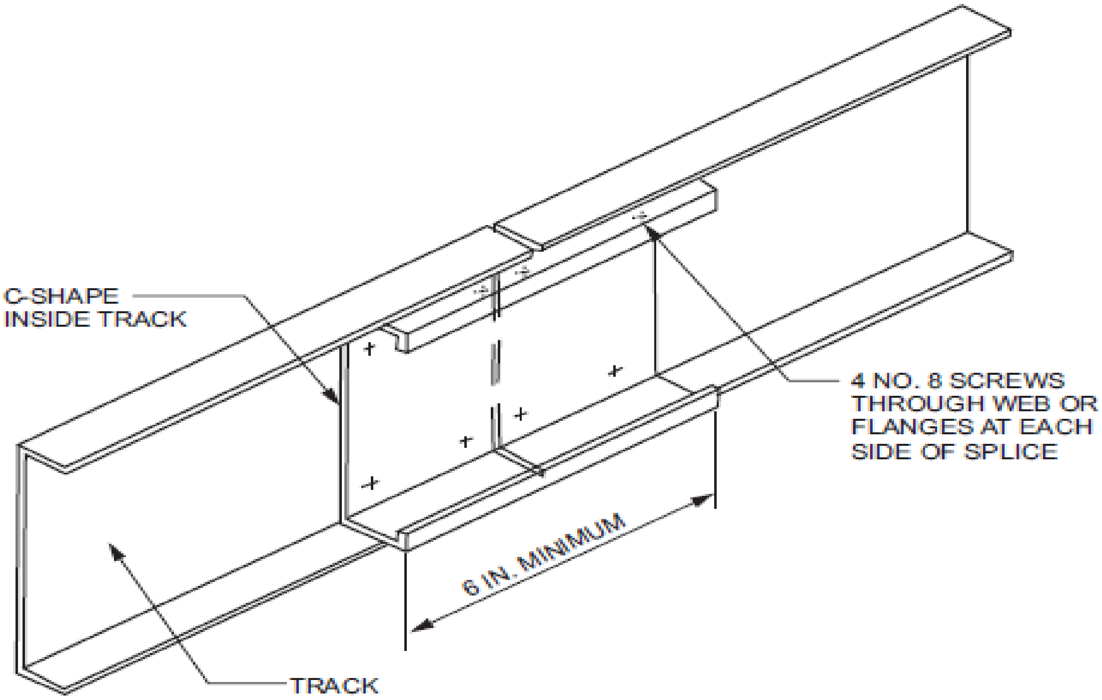
~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R505.3.4(2)~~
~~BEARING STIFFENER~~

~~R505.3.5 Cutting and notching.~~
~~Flanges and lips of load-bearing cold-formed steel floor framing members shall not be cut or notched.~~

~~R505.3.6 Floor cantilevers.~~
~~Floor cantilevers for the top floor of a two- or three-story building or the first floor of a one-story building shall not exceed 24 inches (610 mm). Cantilevers, not exceeding 24 inches (610 mm) and supporting two stories and roof (first floor of a two-story building), shall be permitted provided that all cantilevered joists are doubled (nested or back-to-back). The doubled cantilevered joists shall extend not less than 6 feet (1829 mm) toward the inside and shall be fastened with not less than two No. 8 screws spaced at 24 inches (610 mm) on center through the webs (for back-to-back) or flanges (for nested joists).~~

~~R505.3.7 Splicing.~~
~~Joists and other structural members shall not be spliced. Splicing of tracks shall conform to Figure R505.3.7.~~

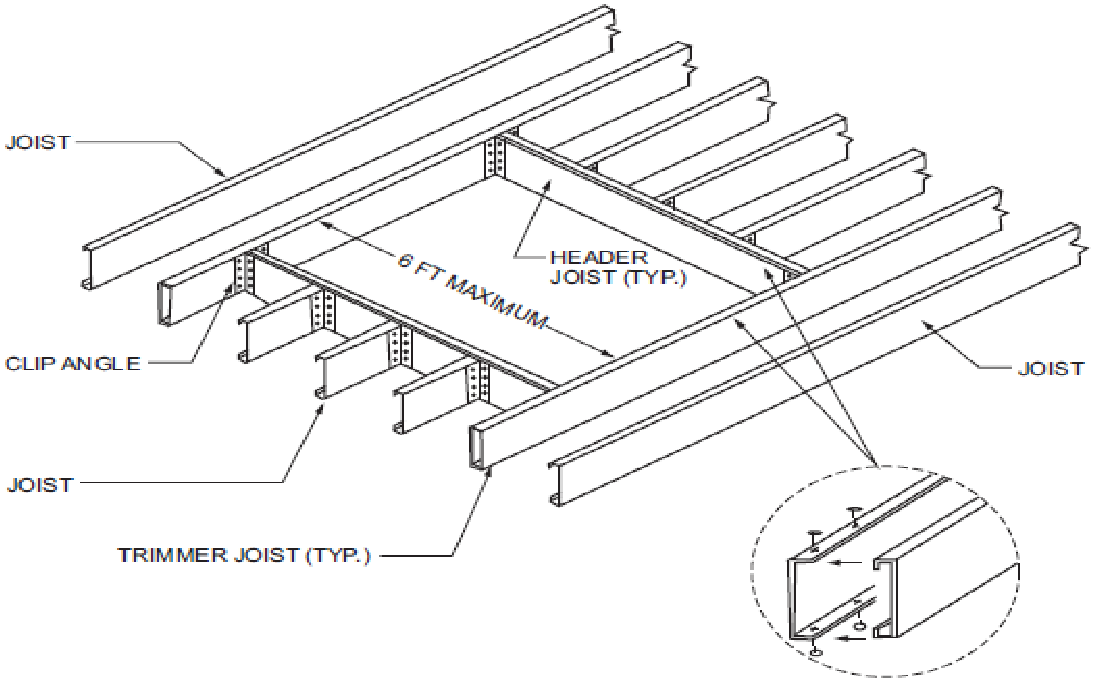


~~For SI: 1 inch = 25.4 mm.~~

~~**FIGURE R505.3.7**~~
~~**TRACK SPLICE**~~

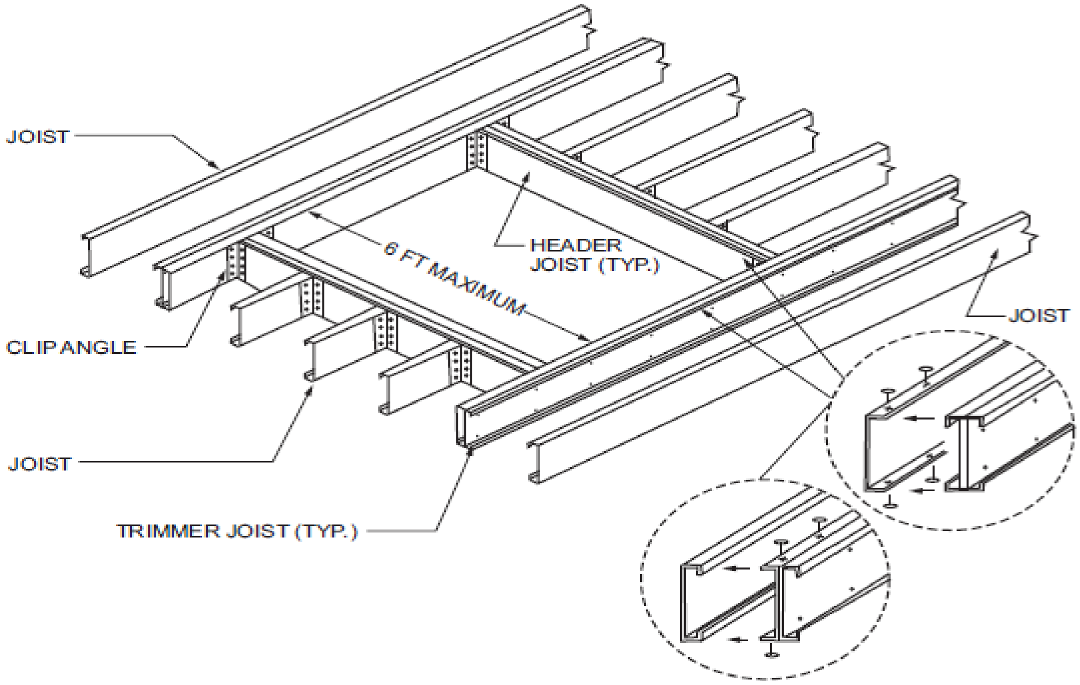
~~R505.3.8 Framing of floor openings.~~

~~Openings in floors shall be framed with header and trimmer joists. Header joist spans shall not exceed 6 feet (1829 mm) or 8 feet (2438 mm) in length in accordance with Figure R505.3.8(1) or R505.3.8(2), respectively. Header and trimmer joists shall be fabricated from joist and track members, having a minimum size and thickness at least equivalent to the adjacent floor joists, and shall be installed in accordance with Figures R505.3.8(1), R505.3.8(2), R505.3.8(3) and R505.3.8(4). Each header joist shall be connected to trimmer joists with four 2-inch by 2-inch (51-mm by 51-mm) clip angles. Each clip angle shall be fastened to both the header and trimmer joists with four No. 8 screws, evenly spaced, through each leg of the clip angle. The clip angles shall have a thickness not less than that of the floor joist. Each track section for a built-up header or trimmer joist shall extend the full length of the joist (continuous).~~



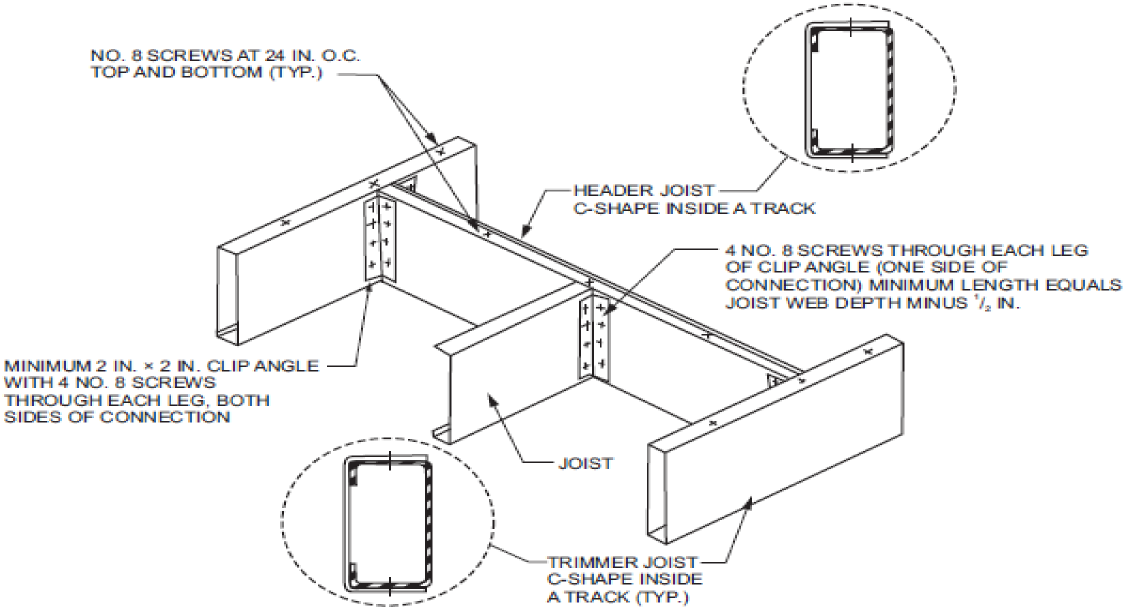
~~For SI: 1 foot = 304.8 mm.~~

~~FIGURE R505.3.8(1)~~
~~COLD-FORMED STEEL FLOOR CONSTRUCTION—6-FOOT FLOOR OPENING~~



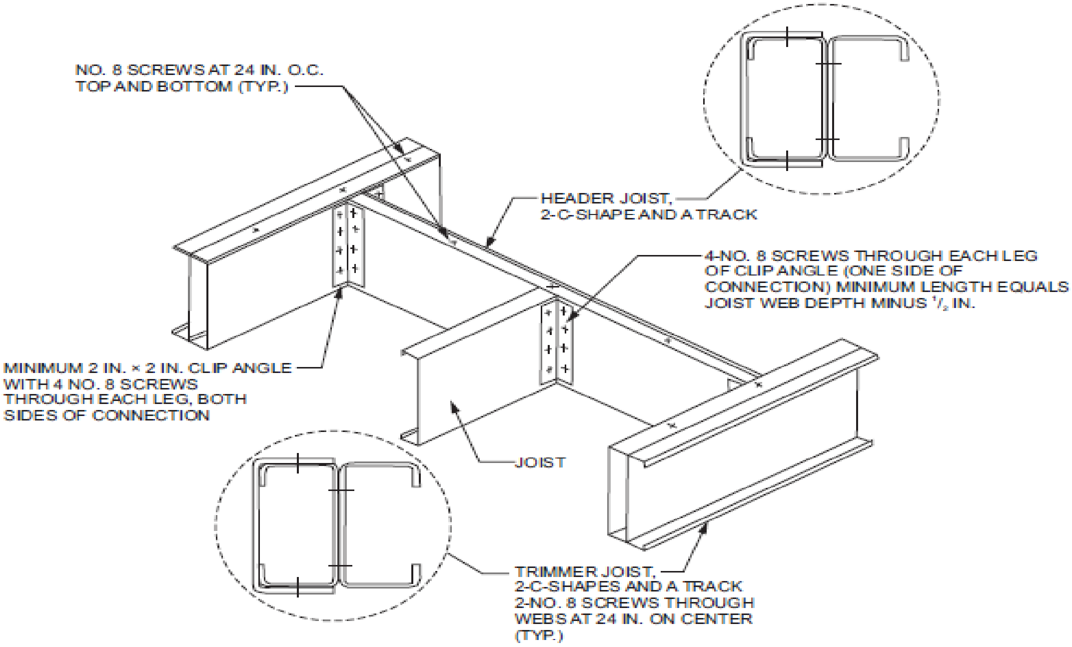
~~For SI: 1 foot = 304.8 mm.~~

~~FIGURE R505.3.8(2)~~
~~COLD-FORMED STEEL FLOOR CONSTRUCTION—8-FOOT FLOOR OPENING~~



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

~~FIGURE R505.3.8(3)~~
~~COLD-FORMED STEEL FLOOR CONSTRUCTION: FLOOR HEADER TO TRIMMER CONNECTION—6-FOOT OPENING~~



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

~~FIGURE R505.3.8(4)~~
~~COLD-FORMED STEEL FLOOR CONSTRUCTION: FLOOR HEADER TO TRIMMER CONNECTION—8-FOOT OPENING~~

SECTION R506
CONCRETE FLOORS (ON GROUND)

R506.1 General.

Concrete slab-on-ground floors shall be designed and constructed in accordance with the provisions of this section or ACI 332. Floors shall be a minimum $3^{1}/_{2}$ inches (89 mm) thick ~~(for expansive soils, see Section R403.1.8)~~. The specified compressive strength of concrete shall be as set forth in Section R402.2.

SECTION R507
EXTERIOR DECKS

Deleted. See Appendix M.

~~R507.1 Decks.~~

~~Wood-framed decks shall be in accordance with this section or Section R301 for materials and conditions not prescribed herein. Where supported by attachment to an exterior wall, decks shall be positively anchored to the primary structure and designed for both vertical and lateral loads.~~

~~Such attachment shall not be accomplished by the use of toenails or nails subject to withdrawal. Where positive connection to the primary building structure cannot be verified during inspection, decks shall be self-supporting. For decks with cantilevered framing members connections to exterior walls or other framing members shall be designed and constructed to resist uplift resulting from the full live load specified in Table R301.5 acting on the cantilevered portion of the deck.~~

~~R507.2 Deck ledger connection to band joist.~~
~~Deck ledger connections to band joists shall be in accordance with this section, Tables R507.2 and R507.2.1, and Figures R507.2.1(1) and R507.2.1(2). For other grades, species, connection details and loading conditions, deck ledger connections shall be designed in accordance with Section R301.~~

~~TABLE R507.2~~
~~DECK LEDGER CONNECTION TO BAND JOIST~~[a, b]
~~(Deck live load = 40 psf, deck dead load = 10 psf, snow load ≤ 40 psf)~~

~~CONNECTION DETAILS~~	~~JOIST SPAN~~						
	~~6′ and less~~	~~6′1″ to 8′~~	~~8′1^2 to 10′~~	~~10′1″ to 12′~~	~~12′1″ to 14′~~	~~14′1″ to 16′~~	~~16′1″ to 18′~~
	~~On-center spacing of fasteners~~						
~~$^1/_2$-inch diameter lag screw with $^1/_2$-inch maximum sheathing~~[c, d]	~~30~~	~~23~~	~~18~~	~~15~~	~~13~~	~~11~~	~~10~~
~~$^1/_2$-inch diameter bolt with $^1/_2$-inch maximum sheathing~~[d]	~~36~~	~~36~~	~~34~~	~~29~~	~~24~~	~~21~~	~~19~~
~~$^1/_2$-inch diameter bolt with 1-inch maximum sheathing~~[e]	~~36~~	~~36~~	~~29~~	~~24~~	~~21~~	~~18~~	~~16~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.~~
~~a. Ledgers shall be flashed in accordance with Section R703.8 to prevent water from contacting the house band joist.~~
~~b. Snow load shall not be assumed to act concurrently with live load.~~
~~c. The tip of the lag screw shall fully extend beyond the inside face of the band joist.~~
~~d. Sheathing shall be wood structural panel or solid sawn lumber.~~
~~e. Sheathing shall be permitted to be wood structural panel, gypsum board, fiberboard, lumber or foam sheathing. Up to $^1/_2$-inch thickness of stacked washers shall be permitted to substitute for up to $^1/_2$ inch of allowable sheathing thickness where combined with wood structural panel or lumber sheathing.~~

~~R507.2.1 Ledger details.~~
~~Deck ledgers installed in accordance with Section R507.2 shall be a minimum 2-inch by 8-~~

~~inch (51 mm by 203 mm) nominal, pressure-preservative-treated southern pine, incised pressure-preservative-treated Hem-fir, or approved, naturally durable, No. 2 grade or better lumber. Deck ledgers installed in accordance with Section R507.2 shall not support concentrated loads from beams or girders. Deck ledgers shall not be supported on stone or masonry veneer.~~

~~TABLE 507.2.1~~
~~PLACEMENT OF LAG SCREWS AND BOLTS IN DECK LEDGERS AND BAND JOISTS~~

~~MINIMUM END AND EDGE DISTANCES AND SPACING BETWEEN ROWS~~				
	~~TOP EDGE~~	~~BOTTOM EDGE~~	~~ENDS~~	~~ROW SPACING~~
~~Ledger[a]~~	~~2 inches[d]~~	~~3/4 inch~~	~~2 inches[b]~~	~~1 5/8 inches[b]~~
~~Band Joist[c]~~	~~3/4 inch~~	~~2 inches~~	~~2 inches[b]~~	~~1 5/8 inches[b]~~

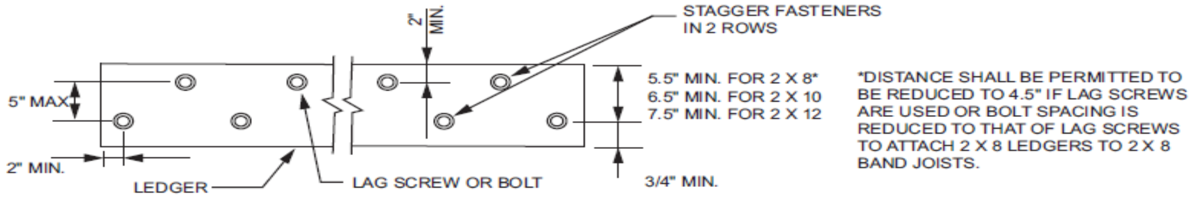
~~For SI: 1 inch = 25.4 mm.~~

~~a. Lag screws or bolts shall be staggered from the top to the bottom along the horizontal run of the deck ledger in accordance with Figure R507.2.1(1).~~

~~b. Maximum 5 inches.~~

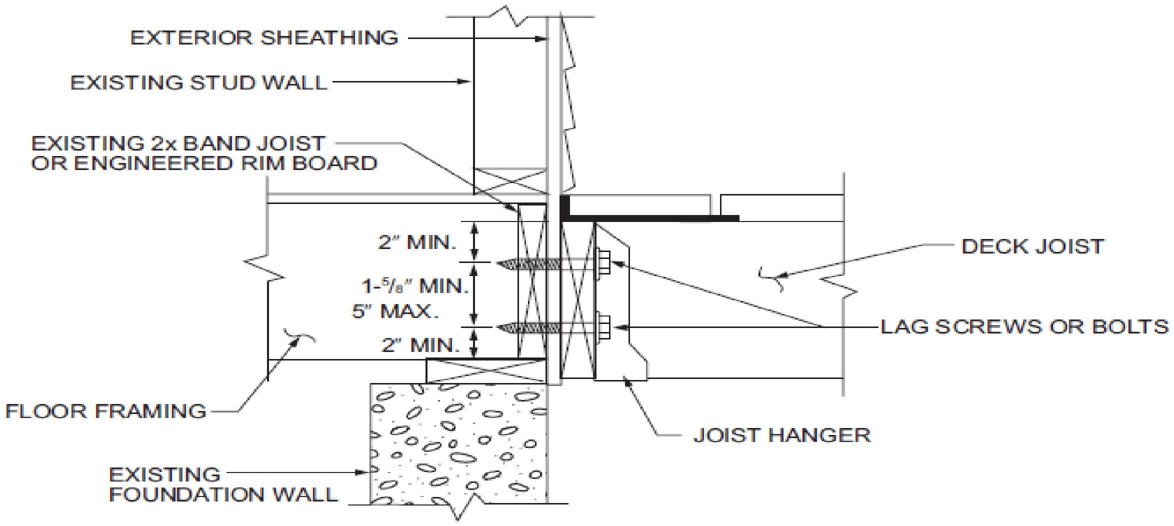
~~c. For engineered rim joists, the manufacturer's recommendations shall govern.~~

~~d. The minimum distance from bottom row of lag screws or bolts to the top edge of the ledger shall be in accordance with Figure R507.2.1(1).~~



~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R507.2.1(1)~~
~~PLACEMENT OF LAG SCREWS AND BOLTS IN LEDGERS~~



~~For SI: 1 inch = 25.4 mm.~~

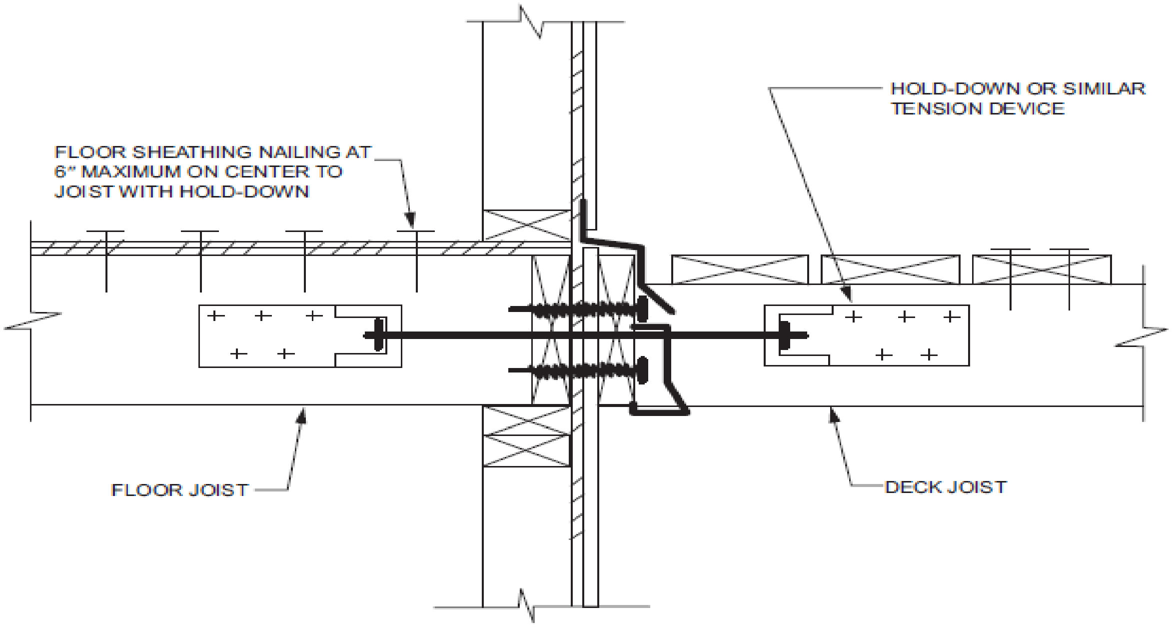
~~FIGURE R507.2.1(2)~~
~~PLACEMENT OF LAG SCREWS AND BOLTS IN BAND JOISTS~~

~~R507.2.2 Band joist details.~~

~~Band joists attached by a ledger in accordance with Section R507.2 shall be a minimum 2-inch-nominal (51 mm), solid-sawn, spruce-pine-fir lumber or a minimum 1-inch by 91/2-inch (25 mm × 241 mm) dimensional, Douglas fir, laminated veneer lumber. Band joists attached by a ledger in accordance with Section R507.2 shall be fully supported by a wall or sill plate below.~~

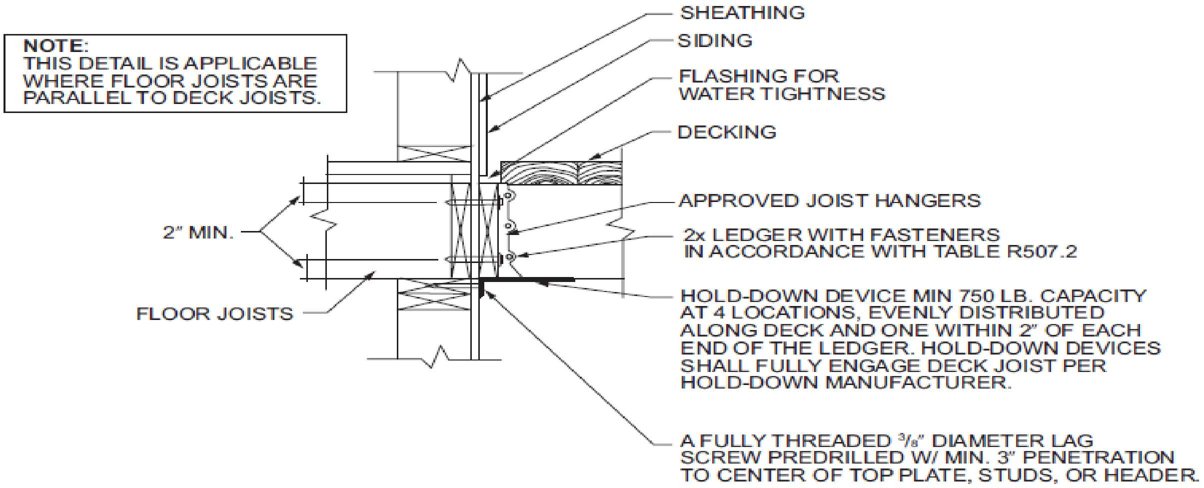
~~R507.2.3 Ledger to band joist fastener details.~~

~~Fasteners used in deck ledger connections in accordance with Table R507.2 shall be hot-dipped galvanized or stainless steel and shall be installed in accordance with Table R507.2.1 and Figures R507.2.1(1) and R507.2.1(2).~~



~~For SI: 1 inch = 25.4 mm.~~

~~**FIGURE 507.2.3(1)**~~
~~**DECK ATTACHMENT FOR LATERAL LOADS**~~



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

~~**FIGURE R507.2.3(2)**~~
~~**DECK ATTACHMENT FOR LATERAL LOADS**~~

~~**R507.2.4 Deck lateral load connection.**~~
~~The lateral load connection required by Section R507.1 shall be permitted to be in accordance with Figure R507.2.3(1) or R507.2.3(2). Where the lateral load connection is provided in accordance with Figure R507.2.3(1), hold-down tension devices shall be~~

~~installed in not less than two locations per deck, within 24 inches of each end of the deck. Each device shall have an allowable stress design capacity of not less than 1,500 pounds (6672 N). Where the lateral load connections are provided in accordance with Figure R507.2.3(2), the hold-down tension devices shall be installed in not less than four locations per deck, and each device shall have an allowable stress design capacity of not less than 750 pounds (3336 N).~~

~~R507.3 Plastic composite deck boards, stair treads, guards, or handrails.~~

~~Plastic composite exterior deck boards, stair treads, guards and handrails shall comply with the requirements of ASTM D 7032 and the requirements of Section 507.3.~~

~~R507.3.1 Labeling.~~

~~Plastic composite deck boards and stair treads, or their packaging, shall bear a label that indicates compliance to ASTM D 7032 and includes the allowable load and maximum allowable span determined in accordance with ASTM D 7032. Plastic or composite handrails and guards, or their packaging, shall bear a label that indicates compliance to ASTM D 7032 and includes the maximum allowable span determined in accordance with ASTM D 7032.~~

~~R507.3.2 Flame spread index.~~

~~Plastic composite deck boards, stair treads, guards, and handrails shall exhibit a flame spread index not exceeding 200 when tested in accordance with ASTM E 84 or UL 723 with the test specimen remaining in place during the test.~~

> ~~**Exception:** Plastic composites determined to be noncombustible.~~

~~R507.3.3 Decay resistance.~~

~~Plastic composite deck boards, stair treads, guards and handrails containing wood, cellulosic or other biodegradable materials shall be decay resistant in accordance with ASTM D 7032.~~

~~R507.3.4 Termite resistance.~~

~~Where required by Section 318, plastic composite deck boards, stair treads, guards and handrails containing wood, cellulosic or other biodegradable materials shall be termite resistant in accordance with ASTM D 7032.~~

~~507.3.5 Installation of plastic composites.~~

~~Plastic composite deck boards, stair treads, guards and handrails shall be installed in accordance with this code and the manufacturer's instructions.~~

~~R507.4 Decking.~~

~~Maximum allowable spacing for joists supporting decking shall be in accordance with Table R507.4. Wood decking shall be attached to each supporting member with not less than (2) 8d threaded nails or (2) No. 8 wood screws.~~

~~TABLE R507.4~~
~~MAXIMUM JOIST SPACING~~

~~MATERIAL TYPE AND NOMINAL SIZE~~	~~MAXIMUM ON-CENTER JOIST SPACING~~	
	~~Perpendicular to joist~~	~~Diagonal to joista~~

~~1$\frac{1}{4}$-inch-thick wood~~	~~16 inches~~	~~12 inches~~
~~2-inch-thick wood~~	~~24 inches~~	~~16 inches~~
~~Plastic composite~~	~~In accordance with Section R507.3~~	~~In accordance with Section R507.3~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.01745 rad.~~

~~a. Maximum angle of 45 degrees from perpendicular for wood deck boards~~

~~R507.5 Deck joists.~~

~~Maximum allowable spans for wood deck joists, as shown in Figure R507.5, shall be in accordance with Table R507.5. Deck joists shall be permitted to cantilever not greater than one-fourth of the actual, adjacent joist span.~~

~~TABLE R507.5~~

~~DECK JOIST SPANS FOR COMMON LUMBER SPECIES[f] (ft. - in.)~~

~~SPECIES[a]~~	~~SIZE~~	~~SPACING OF DECK JOISTS WITH NO CANTILEVER[b] (inches)~~			~~SPACING OF DECK JOISTS WITH CANTILEVERS[c] (inches)~~		
		~~12~~	~~16~~	~~24~~	~~12~~	~~16~~	~~24~~
~~Southern pine~~	~~2 × 6~~	~~9-11~~	~~9-0~~	~~7-7~~	~~6-8~~	~~6-8~~	~~6-8~~
	~~2 × 8~~	~~13-1~~	~~11-10~~	~~9-8~~	~~10-1~~	~~10-1~~	~~9-8~~
	~~2 × 10~~	~~16-2~~	~~14-0~~	~~11-5~~	~~14-6~~	~~14-0~~	~~11-5~~
	~~2 × 12~~	~~18-0~~	~~16-6~~	~~13-6~~	~~18-0~~	~~16-6~~	~~13-6~~
~~Douglas fir-larch[d], hem-fir[d] spruce-pine-fir[d]~~	~~2 × 6~~	~~9-6~~	~~8-8~~	~~7-2~~	~~6-3~~	~~6-3~~	~~6-3~~
	~~2 × 8~~	~~12-6~~	~~11-1~~	~~9-1~~	~~9-5~~	~~9-5~~	~~9-1~~
	~~2 × 10~~	~~15-8~~	~~13-7~~	~~11-1~~	~~13-7~~	~~13-7~~	~~11-1~~
	~~2 × 12~~	~~18-0~~	~~15-9~~	~~12-10~~	~~18-0~~	~~15-9~~	~~12-10~~
~~Redwood, western cedars, ponderosa pine[e], red pine[e]~~	~~2 × 6~~	~~8-10~~	~~8-0~~	~~7-0~~	~~5-7~~	~~5-7~~	~~5-7~~
	~~2 × 8~~	~~11-8~~	~~10-7~~	~~8-8~~	~~8-6~~	~~8-6~~	~~8-6~~
	~~2 × 10~~	~~14-11~~	~~13-0~~	~~10-7~~	~~12-3~~	~~12-3~~	~~10-7~~
	~~2 × 12~~	~~17-5~~	~~15-1~~	~~12-4~~	~~16-5~~	~~15-1~~	~~12-4~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound = 0.454 kg.~~

~~a. No. 2 grade with wet service factor.~~

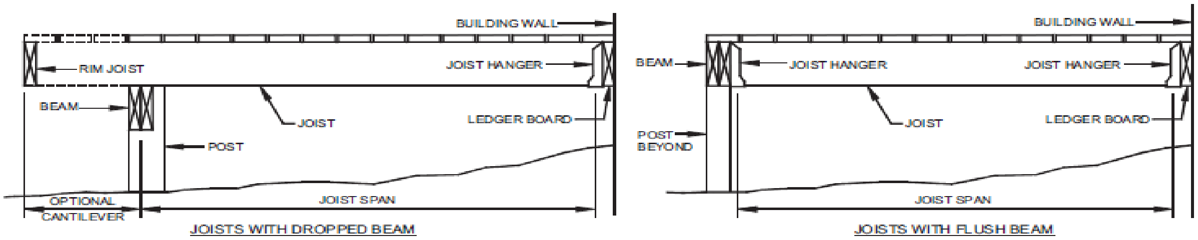
~~b. Ground snow load, live load = 40 psf, dead load = 10 psf, L/D = 360.~~

~~c. Ground snow load, live load = 40 psf, dead load = 10 psf, L/D = 360 at main span, L/D = 180 at cantilever with a 220-pound point load applied to end.~~

~~d. Includes incising factor.~~

~~e. Northern species with no incising factor~~

~~f. Cantilevered spans not exceeding the nominal depth of the joist are permitted.~~



~~FIGURE R507.5~~
~~TYPICAL DECK JOIST SPANS~~

~~R507.5.1 Lateral restraint at supports.~~
~~Joist ends and bearing locations shall be provided with lateral restraint to prevent rotation. Where lateral restraint is provided by joist hangers or blocking between joists, their depth shall equal not less than 60 percent of the joist depth. Where lateral restraint is provided by rim joists, they shall be secured to the end of each joist with not less than (3) 10d (3-inch × 0.128-inch) nails or (3) No. 10 × 3-inch (76 mm) long wood screws.~~

~~R507.6 Deck Beams.~~
~~Maximum allowable spans for wood deck beams, as shown in Figure R507.6, shall be in accordance with Table R507.6. Beam plies shall be fastened with two rows of 10d (3-inch × 0.128-inch) nails minimum at 16 inches (406 mm) on center along each edge. Beams shall be permitted to cantilever at each end up to one-fourth of the actual beam span. Splices of multispan beams shall be located at interior post locations.~~

~~TABLE R507.6~~
~~DECK BEAM SPAN LENGTHS[a, b] (ft. - in.)~~

~~SPECIES[c]~~	**~~SIZE[d]~~**	**~~DECK JOIST SPAN LESS THAN OR EQUAL TO: (feet)~~**						
		~~6~~	**~~8~~**	**~~10~~**	**~~12~~**	**~~14~~**	**~~16~~**	**~~18~~**
~~Southern pine~~	~~2 – 2 × 6~~	~~6-11~~	~~5-11~~	~~5-4~~	~~4-10~~	~~4-6~~	~~4-3~~	~~4-0~~
	~~2 – 2 × 8~~	~~8-9~~	~~7-7~~	~~6-9~~	~~6-2~~	~~5-9~~	~~5-4~~	~~5-0~~
	~~2 – 2 × 10~~	~~10-4~~	~~9-0~~	~~8-0~~	~~7-4~~	~~6-9~~	~~6-4~~	~~6-0~~
	~~2 – 2 × 12~~	~~12-2~~	~~10-7~~	~~9-5~~	~~8-7~~	~~8-0~~	~~7-6~~	~~7-0~~
	~~3 – 2 × 6~~	~~8-2~~	~~7-5~~	~~6-8~~	~~6-1~~	~~5-8~~	~~5-3~~	~~5-0~~
	~~3 – 2 × 8~~	~~10-10~~	~~9-6~~	~~8-6~~	~~7-9~~	~~7-2~~	~~6-8~~	~~6-4~~
	~~3 – 2 × 10~~	~~13-0~~	~~11-3~~	~~10-0~~	~~9-2~~	~~8-6~~	~~7-11~~	~~7-6~~
	~~3 – 2 × 12~~	~~15-3~~	~~13-3~~	~~11-10~~	~~10-9~~	~~10-0~~	~~9-4~~	~~8-10~~
~~Douglas fir-larch[e], hem-fir[e], spruce-pine-fir[e], redwood, western cedars, ponderosa pine[f], red pinef~~	~~3 × 6 or 2 – 2 × 6~~	~~5-5~~	~~4-8~~	~~4-2~~	~~3-10~~	~~3-6~~	~~3-1~~	~~2-9~~
	~~3 × 8 or 2 – 2 × 8~~	~~6-10~~	~~5-11~~	~~5-4~~	~~4-10~~	~~4-6~~	~~4-1~~	~~3-8~~
	~~3 × 10 or 2 – 2 × 10~~	~~8-4~~	~~7-3~~	~~6-6~~	~~5-11~~	~~5-6~~	~~5-1~~	~~4-8~~
	~~3 × 12 or 2 – 2 × 12~~	~~9-8~~	~~8-5~~	~~7-6~~	~~6-10~~	~~6-4~~	~~5-11~~	~~5-7~~
	~~4 × 6~~	~~6-5~~	~~5-6~~	~~4-11~~	~~4-6~~	~~4-2~~	~~3-11~~	~~3-8~~
	~~4 × 8~~	~~8-5~~	~~7-3~~	~~6-6~~	~~5-11~~	~~5-6~~	~~5-2~~	~~4-10~~
	~~4 × 10~~	~~9-11~~	~~8-7~~	~~7-8~~	~~7-0~~	~~6-6~~	~~6-1~~	~~5-8~~
	~~4 × 12~~	~~11-5~~	~~9-11~~	~~8-10~~	~~8-1~~	~~7-6~~	~~7-0~~	~~6-7~~
	~~3 – 2 × 6~~	~~7-4~~	~~6-8~~	~~6-0~~	~~5-6~~	~~5-1~~	~~4-9~~	~~4-6~~

	~~3 – 2 × 8~~	~~9-8~~	~~8-6~~	~~7-7~~	~~6-11~~	~~6-5~~	~~6-0~~	~~5-8~~
	~~3 – 2 × 10~~	~~12-0~~	~~10-5~~	~~9-4~~	~~8-6~~	~~7-10~~	~~7-4~~	~~6-11~~
	~~3 – 2 × 12~~	~~13-11~~	~~12-1~~	~~10-9~~	~~9-10~~	~~9-1~~	~~8-6~~	~~8-1~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound = 0.454 kg.~~

~~a. Ground snow load, live load = 40 psf, dead load = 10 psf, L/Δ = 360 at main span, L/Δ = 180 at cantilever with a 220-pound point load applied at the end.~~

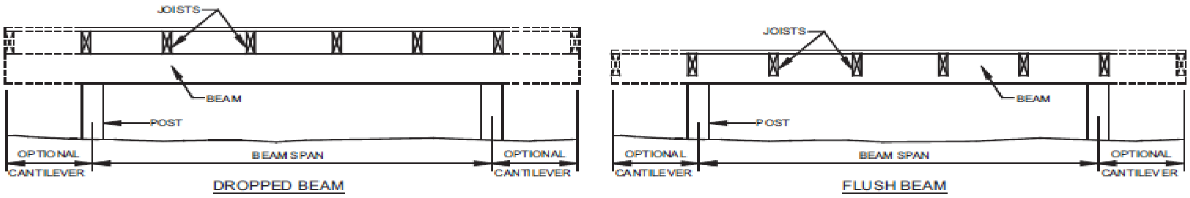
~~b. Beams supporting deck joists from one side only.~~

~~c. No. 2 grade, wet service factor.~~

~~d. Beam depth shall be greater than or equal to depth of joists with a flush beam condition.~~

~~e. Includes incising factor.~~

~~f. Northern species. Incising factor not included.~~



DROPPED BEAM FLUSH BEAM

~~FIGURE R507.6~~
~~TYPICAL DECK BEAM SPANS~~

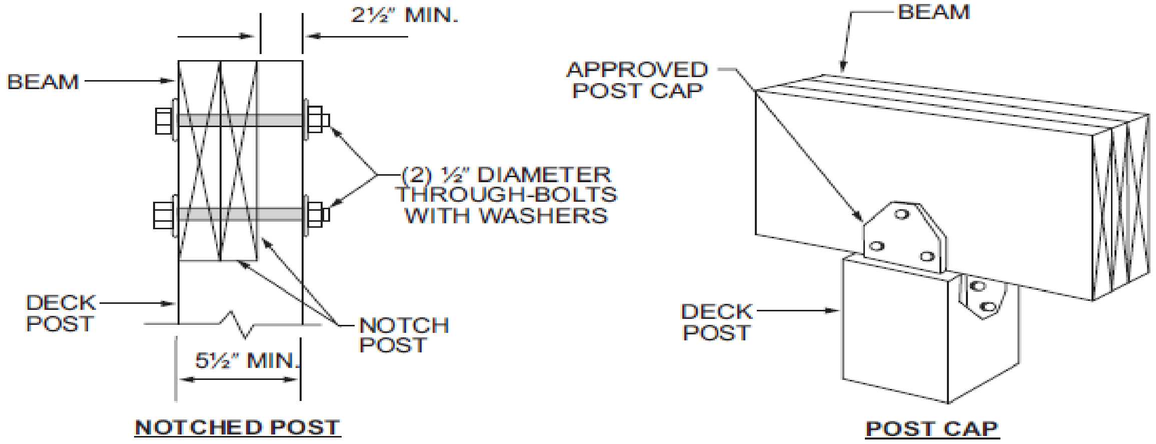
~~R507.7 Deck joist and deck beam bearing.~~

~~The ends of each joist and beam shall have not less than $1\frac{1}{2}$ inches (38 mm) of bearing on wood or metal and not less than 3 inches (76 mm) on concrete or masonry for the entire width of the beam. Joist framing into the side of a ledger board or beam shall be supported by approved joist hangers. Joists bearing on a beam shall be connected to the beam to resist lateral displacement.~~

~~R507.7.1 Deck post to deck beam.~~

~~Deck beams shall be attached to deck posts in accordance with Figure R507.7.1 or by other equivalent means capable to resist lateral displacement. Manufactured post-to-beam connectors shall be sized for the post and beam sizes. All bolts shall have washers under the head and nut.~~

~~**Exception:** Where deck beams bear directly on footings in accordance with Section R507.8.1.~~



NOTCHED POST

POST CAP

~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R507.7.1~~
~~DECK BEAM TO DECK POST~~

~~R507.8 Deck posts.~~

~~For single-level wood-framed decks with beams sized in accordance with Table R507.6, deck post size shall be in accordance with Table R507.8.~~

~~TABLE R507.8~~
~~DECK POST HEIGHT~~[a]

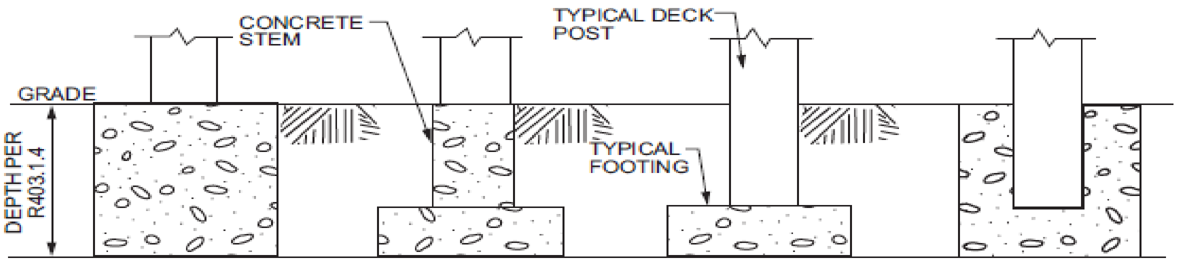
~~DECK POST SIZE~~	~~MAXIMUM HEIGHT~~[a]
~~4 × 4~~	~~8'~~
~~4 × 6~~	~~8'~~
~~6 × 6~~	~~14'~~

~~For SI: 1 foot = 304.8 mm.~~

~~a. Measured to the underside of the beam.~~

~~R507.8.1 Deck post to deck footing.~~

~~Posts shall bear on footings in accordance with Section R403 and Figure R507.8.1. Posts shall be restrained to prevent lateral displacement at the bottom support. Such lateral restraint shall be provided by manufactured connectors installed in accordance with Section R507 and the manufacturers' instructions or a minimum post embedment of 12 inches (305 mm) in surrounding soils or concrete piers.~~



~~**FIGURE R507.8.1**~~
~~**TYPICAL DECK POSTS TO DECK FOOTINGS**~~

CHAPTER 6
WALL CONSTRUCTION

SECTION R602
WOOD WALL FRAMING

~~TABLE R602.3(1)~~
~~FASTENING SCHEDULE~~

~~ITEM~~	~~DESCRIPTION OF BUILDING ELEMENTS~~	~~NUMBER AND TYPE OF FASTENER~~[~~a, b, c~~]	~~SPACING AND LOCATION~~
~~Roof~~			
~~1~~	~~Blocking between ceiling joists or rafters to top plate~~	~~4-8d box (2 1/2″ × 0.113″)~~ ~~or~~ ~~3-8d common (2 1/2″ × 0.131″); or~~ ~~3-10d box (3″ × 0.128″); or~~ ~~3-3″ × 0.131″ nails~~	~~Toe nail~~
~~2~~	~~Ceiling joists to top plate~~	~~4-8d box (2 1/2″ × 0.113″);~~ ~~or~~ ~~3-8d common (2 1/2″ × 0.131″); or~~ ~~3-10d box (3″ × 0.128″); or~~ ~~3-3″ × 0.131″ nails~~	~~Per joist, toe nail~~
~~3~~	~~Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]~~	~~4-10d box (3″ × 0.128″); or~~ ~~3-16d common (3 1/2″ × 0.162″); or~~ ~~4-3″ × 0.131″ nails~~	~~Face nail~~
~~4~~	~~Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]~~	~~Table R802.5.1(9)~~	~~Face nail~~
~~5~~	~~Collar tie to rafter, face nail or 1 1/4″ × 20 ga. ridge strap to rafter~~	~~4-10d box (3″ × 0.128″); or~~ ~~3-10d common (3″ × 0.148″); or~~ ~~4-3″ × 0.131″ nails~~	~~Face nail each rafter~~
~~6~~	~~Rafter or roof truss to plate~~	~~3-16d box nails (3 1/2″ × 0.135″); or~~ ~~3-10d common nails (3″ × 0.148″); or~~	~~2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss~~[~~i~~]

		~~4-10d box (3″ × 0.128″); or~~ ~~4-3″ × 0.131″ nails~~	
~~7~~	~~Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam~~	~~4-16d (3$^{1}/_{2}$″ × 0.135″); or~~ ~~3-10d common (3$^{1}/_{2}$″ × 0.148″); or~~ ~~4-10d box (3″ × 0.128″); or~~ ~~4-3″ × 0.131″ nails~~	~~Toe nail~~
		~~3-16d box 3$^{1}/_{2}$″ × 0.135″); or~~ ~~2-16d common (3$^{1}/_{2}$″ × 0.162″); or~~ ~~3-10d box (3″ × 0.128″); or~~ ~~3-3″ × 0.131″ nails~~	~~End nail~~
		~~Wall~~	
~~8~~	~~Stud to stud (not at braced wall panels)~~	~~16d common (3$^{1}/_{2}$″ × 0.162″)~~	~~24″ o.c. face nail~~
		~~10d box (3″ × 0.128″); or~~ ~~3″ × 0.131″ nails~~	~~16″ o.c. face nail~~
~~9~~	~~Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)~~	~~16d box (3$^{1}/_{2}$″ × 0.135″); or~~ ~~3″ × 0.131″ nails~~	~~12″ o.c. face nail~~
		~~16d common (3$^{1}/_{2}$″ × 0.162″)~~	~~16″ o.c. face nail~~
~~10~~	~~Built-up header (2″ to 2″ header with $^{1}/_{2}$″ spacer)~~	~~16d common (3$^{1}/_{2}$″ × 0.162″)~~	~~16″ o.c. each edge face nail~~
		~~16d box (3$^{1}/_{2}$″ × 0.135″)~~	~~12″ o.c. each edge face nail~~
~~11~~	~~Continuous header to stud~~	~~5-8d box (2$^{1}/_{2}$″ × 0.113″); or~~ ~~4-8d common (2$^{1}/_{2}$″ × 0.131″); or~~ ~~4-10d box (3″ × 0.128″)~~	~~Toe nail~~
~~12~~	~~Top plate to top plate~~	~~16d common (3$^{1}/_{2}$″ × 0.162″)~~	~~16″ o.c. face nail~~
		~~10d box (3″ × 0.128″); or~~ ~~3″ × 0.131″ nails~~	~~12″ o.c. face nail~~

~~13~~	~~Double top plate splice for SDCs A-D2 with seismic braced wall line spacing < 25′~~	~~8-16d common (3$^1/_2$″ × 0.162″); or~~ ~~12-16d box (3$^1/_2$″ × 0.135″); or~~ ~~12-10d box (3″ × 0.128″); or~~ ~~12-3″ × 0.131″ nails~~	~~Face nail on each side of end joint (minimum 24″ lap splice length each side of end joint)~~
	~~Double top plate splice SDCs D_0, D_1, or D_2; and braced wall line spacing ≥ 25′~~	~~12-16d (3$^1/_2$″ × 0.135″)~~	

~~(continued)~~

~~TABLE R602.3(1)—continued~~
~~FASTENING SCHEDULE~~

~~ITEM~~	~~DESCRIPTION OF BUILDING ELEMENTS~~	~~NUMBER AND TYPE OF FASTENER$^{a, b, c}$~~	~~SPACING AND LOCATION~~
~~14~~	~~Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)~~	~~16d common (3$^1/_2$″ × 0.162″)~~	~~16″ o.c. face nail~~
		~~16d box (3$^1/_2$″ × 0.135″); or~~ ~~3″ × 0.131″ nails~~	~~12″ o.c. face nail~~
~~15~~	~~Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)~~	~~3-16d box (3$^1/_2$″ × 0.135″); or~~ ~~2-16d common (3$^1/_2$″ × 0.162″); or~~ ~~4-3″ × 0.131″ nails~~	~~3 each 16″ o.c. face nail~~ ~~2 each 16″ o.c. face nail~~ ~~4 each 16″ o.c. face nail~~
~~16~~	~~Top or bottom plate to stud~~	~~4-8d box (2$^1/_2$″ × 0.113″); or~~ ~~3-16d box (3$^1/_2$″ × 0.135″); or~~ ~~4-8d common (2$^1/_2$″ × 0.131″); or~~ ~~4-10d box (3″ × 0.128″); or~~ ~~4-3″ × 0.131″ nails~~	~~Toe nail~~
		~~3-16d box (3$^1/_2$″ × 0.135″); or~~ ~~2-16d common (3$^1/_2$″ × 0.162″); or~~ ~~3-10d box (3″ × 0.128″); or~~ ~~3-3″ × 0.131″ nails~~	~~End nail~~

~~17~~	~~Top plates, laps at corners and intersections~~	~~3-10d box (3″ × 0.128″); or~~ ~~2-16d common (3$^{1}/_{2}$″ × 0.162″); or~~ ~~3-3″ × 0.131″ nails~~	~~Face nail~~
~~18~~	~~1″ brace to each stud and plate~~	~~3-8d box (2$^{1}/_{2}$″ × 0.113″); or~~ ~~2-8d common (2$^{1}/_{2}$″ × 0.131″); or~~ ~~2-10d box (3″ × 0.128″); or~~ ~~2 staples 1$^{3}/_{4}$″~~	~~Face nail~~
~~19~~	~~1″ × 6″ sheathing to each bearing~~	~~3-8d box (2$^{1}/_{2}$″ × 0.113″)~~ ~~; or~~ ~~2-8d common (2$^{1}/_{2}$″ × 0.131″); or~~ ~~2-10d box (3″ × 0.128″); or~~ ~~2 staples, 1″ crown, 16 ga., 1$^{3}/_{4}$″ long~~	~~Face nail~~
~~20~~	~~1″ × 8″ and wider sheathing to each bearing~~	~~3-8d box (2$^{1}/_{2}$″ × 0.113″); or~~ ~~3-8d common (2$^{1}/_{2}$″ × 0.131″); or~~ ~~3-10d box (3″ × 0.128″); or~~ ~~3 staples, 1″ crown, 16 ga., 1$^{3}/_{4}$″ long~~	~~Face nail~~
		~~Wider than 1″ × 8″~~ ~~4-8d box (2$^{1}/_{2}$″ × 0.113″); or~~ ~~3-8d common (2$^{1}/_{2}$″ × 0.131″); or~~ ~~3-10d box (3″ × 0.128″); or~~ ~~4 staples, 1″ crown, 16 ga., 1$^{3}/_{4}$″ long~~	
		~~Floor~~	
~~21~~	~~Joist to sill, top plate or girder~~	~~4-8d box (2$^{1}/_{2}$″ × 0.113″); or~~ ~~3-8d common (2$^{1}/_{2}$″ × 0.131″); or~~ ~~3-10d box (3″ × 0.128″); or~~ ~~3-3″ × 0.131″ nails~~	~~Toe nail~~
~~22~~		~~8d box (2$^{1}/_{2}$″ × 0.113″)~~	~~4″ o.c. toe nail~~

	~~Rim joist, band joist or blocking to sill or top plate (roof applications also)~~	~~8d common (2 1/2″ × 0.131″); or~~ ~~10d box (3″ × 0.128″); or~~ ~~3″ × 0.131″ nails~~	~~6″ o.c. toe nail~~
~~23~~	~~1″ × 6″ subfloor or less to each joist~~	~~3-8d box (2 1/2″ × 0.113″); or~~ ~~2-8d common (2 1/2″ × 0.131″); or~~ ~~3-10d box (3″ × 0.128″); or~~ ~~2 staples, 1″ crown, 16 ga., 1 3/4″ long~~	~~Face nail~~

~~*(continued)*~~

~~TABLE 602.3(1)-continued~~ ~~FASTENING SCHEDULE~~

~~ITEM~~	~~DESCRIPTION OF BUILDING ELEMENTS~~	~~NUMBER AND TYPE OF FASTENER[a, b, c]~~	~~SPACING AND LOCATION~~
		~~Floor~~	
~~24~~	~~2″ subfloor to joist or girder~~	~~3-16d box (3 1/2″× 0.135″); or~~ ~~2-16d common (3 1/2″× 0.162″)~~	~~Blind and face nail~~
~~25~~	~~2″ planks (plank & beam—floor & roof)~~	~~3-16d box (3 1/2″× 0.135″); or~~ ~~2-16d common (3 1/2″× 0.162″)~~	~~At each bearing, face nail~~
~~26~~	~~Band or rim joist to joist~~	~~3-16d common (3 1/2″× 0.162″)~~ ~~4-10 box (3″× 0.128″), or~~ ~~4-3″× 0.131″nails; or~~ ~~4-3″× 14 ga. staples, 7/16″ crown~~	~~End nail~~
~~27~~	~~Built-up girders and beams, 2-inch lumber layers~~	~~20d common (4″× 0.192″); or~~	~~Nail each layer as follows: 32″ o.c. at top and bottom and staggered.~~
		~~10d box (3″× 0.128″); or~~ ~~3″× 0.131″ nails~~	~~24″ o.c. face nail at top and bottom staggered on opposite sides~~
		~~And:~~ ~~2-20d common (4″× 0.192″); or~~ ~~3-10d box (3″× 0.128″); or~~ ~~3-3″× 0.131″ nails~~	~~Face nail at ends and at each splice~~
~~28~~			~~At each joist or rafter, face nail~~

	~~Ledger strip supporting joists or rafters~~	~~4-16d box (3 1/2″× 0.135″); or~~ ~~3-16d common (3 1/2″× 0.162″); or~~ ~~4-10d box (3″× 0.128″); or~~ ~~4-3″× 0.131″ nails~~		
~~29~~	~~Bridging to joist~~	~~2-10d (3″× 0.128″)~~	~~Each end, toe nail~~	
~~ITEM~~	~~DESCRIPTION OF BUILDING ELEMENTS~~	~~NUMBER AND TYPE OF FASTENER[a, b, c]~~	~~SPACING OF FASTENERS~~	
			~~Edges (inches)[h]~~	~~**Intermediate supports (inches)[c, e]**~~
~~**Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]**~~				
~~30~~	~~3/8″ – 1/2″~~	~~6d common (2″× 0.113″) nail (subfloor, wall)[i]~~ ~~8d common (2 1/2″× 0.131″) nail (roof)~~	~~6~~	~~12[f]~~
~~31~~	~~19/32″ – 1″~~	~~8d common nail (2 1/2″× 0.131″)~~	~~6~~	~~12[f]~~
~~32~~	~~1 1/8″ – 1 1/4″~~	~~10d common (3″× 0.148″) nail; or~~ ~~8d (2 1/2″× 0.131″) deformed nail~~	~~6~~	~~12~~
~~**Other wall sheathing[g]**~~				
~~33~~	~~1/2″ structural cellulosic fiberboard sheathing~~	~~1 1/2″ galvanized roofing nail, 7/16″ head diameter, or 1″ crown staple 16 ga., 1 1/4″ long~~	~~3~~	~~6~~
~~34~~	~~25/32″ structural cellulosic fiberboard sheathing~~	~~1 3/4″ galvanized roofing nail, 7/16″ head diameter, or 1″ crown staple 16 ga., 1 1/4″ long~~	~~3~~	~~6~~
~~35~~	~~1/2″ gypsum sheathing[d]~~	~~1 1/2″ galvanized roofing nail; staple galvanized, 1 1/2″ long; 1 1/4″ screws, Type W or S~~	~~7~~	~~7~~

~~36~~	~~5/8″ gypsum sheathing~~[d]	~~1 3/4″ galvanized roofing nail;~~ ~~staple galvanized,~~ ~~1 5/8″ long; 1 5/8″ screws, Type W or S~~	~~7~~	~~7~~
~~**Wood structural panels, combination subfloor underlayment to framing**~~				
~~37~~	~~3/4″ and less~~	~~6d deformed (2″× 0.120″) nail; or~~ ~~8d common (2 1/2″× 0.131″) nail~~	~~6~~	~~12~~
~~38~~	~~7/8″– 1″~~	~~8d common (2 1/2″× 0.131″) nail; or~~ ~~8d deformed (2 1/2″× 0.120″) nail~~	~~6~~	~~12~~
~~39~~	~~1 1/8″– 1 1/4″~~	~~10d common (3″× 0.148″) nail; or~~ ~~8d deformed (2 1/2″× 0.120″) nail~~	~~6~~	~~12~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.~~

~~a. Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameterslarger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.~~

~~b. Staples are 16 gage wire and have a minimum 7/16-inch on diameter crown width.~~

~~c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.~~

~~d. Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.~~

~~e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).~~

~~f. Where the ultimate design wind speed is 130 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. Where the ultimate design wind speed is greater than 130 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.~~

~~g. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.~~

~~h. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blockingand at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.~~

~~i. Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.~~

TABLE R602.3(1)
WALL FRAMING [a,e,f]

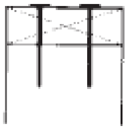
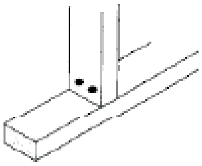
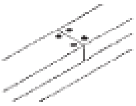
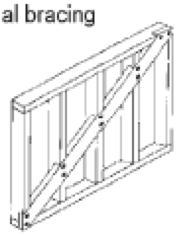
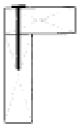
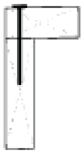
CONNECTION[a] (NAIL SIZE ANDPOSITION EXAGGERATED FOR ILLUSTRATIVE PURPOSES)	FASTENER MINIMUM NOMINAL LENGTH IN INCHES X MINIMUM NOMINAL NAIL DIAMETER IN INCHES	QUANTITY PER CONNECTION, OR SPACING BETWEEN FASTENERS (INCHES ON CENTER)[d]
Top or sole plate to stud (face nail) 	3½" × 0.162" (16d common)[c]	2
	3" × 0.148" nail (10d common)	3
	3¼" × 0.131" nail	
	3" × 0.131" nail	
	3¼" × 0.120" nail	4
	3" × 0.120" nail	
Stud to top or sole plate (toe nail) 	2½" × 0.131" nail (8d common)[c]	4
	3½" × 0.162" nail (16d common)	3
	3" × 0.148" nail (10d common)	4
	3¼" × 0.131" nail	
	3" × 0.131" nail	
	3¼" × 0.120" nail	
	3" × 0.120" nail	
	2⅜" × 0.113" nail	5
	2" × 0.113" nail	
	2¼" × 0.105" nail	
	2¼" × 0.099" nail	
Cap/top plate laps and intersections 	3½" × 0.162" nail (16 common)[c]	2 each side of lap
	3" × 0.148" nail	3 each side of lap
	3¼" × 0.131" nail	
	3" × 0.131" nail	
	3¼" × 0.120" nail	
	3" × 0.120" nail	
Diagonal bracing 	2½" × 0.131" nail (8d common)[c]	2
	3½" × 0.162" nail (16d common)	
	3" × 0.148" nail (10d common)	
	3¼" × 0.131" nail	
	3" × 0.131" nail	
	3¼" × 0.120" nail	3
	3" × 0.120" nail	
	2⅜" × 0.113" nail	
	2" × 0.113" nail	4
	2¼" × 0.105" nail	
	2¼" × 0.099" nail	
Sole plate to joist or blocking at braced panels 	3½" × 0.135" nail (16d box)[c]	3 per 16" space
	3½" × 0.162" nail (16d common)	2 per 16" space
	3" × 0.148 nail (10d common)	3 per 16" space
	3¼" × 0.131" nail	
	3" × 0.131" nail	4 per 16" space
	3¼" × 0.120" nail	
	3" × 0.120" nail	
Sole plate to joist or blocking 	3½" × 0.162" nail (16d common)[c]	16" o.c.
	3" × 0.148" nail (10d common)	8" o.c.
	3¼" × 0.131" nail	
	3" × 0.131" nail	
	3¼" × 0.120" nail	
	3" × 0.120" nail	

TABLE R602.3(1)—continued
WALL FRAMING [a,e]

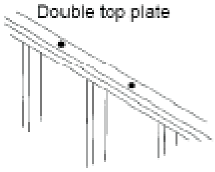
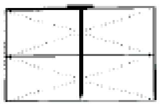
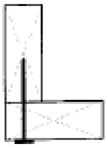
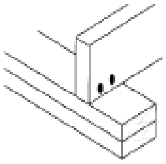
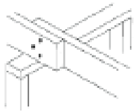
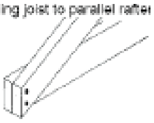
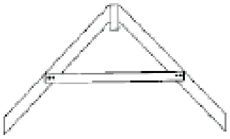
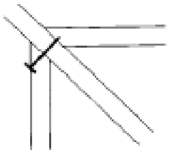
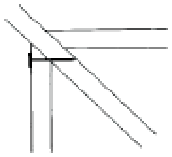
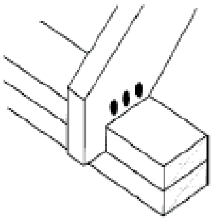
CONNECTION[a] (NAIL SIZE AND POSITION EXAGGERATED FOR ILLUSTRATIVE PURPOSES)	FASTENER MINIMUM NOMINAL LENGTH IN INCHES X MINIMUM NOMINAL NAIL DIAMETER IN INCHES	QUANTITY PER CONNECTION, OR SPACING BETWEEN FASTENERS (INCHES ON CENTER)[d]
Double top plate 	3" × 0.148" nail (10d common)[c]	16" o.c.
	3½" × 0.162" nail (16d common)	
	3¼" × 0.131" nail	12" o.c.
	3" × 0.131"	
	3¼" × 0.120" nail	
	3" × 0.120" nail	
Double Studs 	3" × 0.148" nail (10d common)[c]	12" o.c.
	3½" × 0.162" nail (16d common)	
	3¼" × 0.131" nail	8" o.c.
	3" × 0.131" nail	
	3¼" × 0.120" nail	
	3" × 0.120" nail	
Corner Studs 	3½" × 0.162" nail (16d common)[c]	24" o.c.
	3" × 0.148" nail (10d common)	16" o.c.
	3¼" × 0.131" nail	
	3" × 0.131" nail	
	3¼" × 0.120" nail	12" o.c.
	3" × 0.120" nail	

TABLE R602.3(1)—continued
CEILING AND ROOF FRAMING [a,e]

CONNECTION[a] (NAIL SIZE AND POSITION EXAGGERATED FOR ILLUSTRATIVE PURPOSES)	FASTENER MINIMUM NOMINAL LENGTH IN INCHES X MINIMUM NOMINAL NAIL DIAMETER IN INCHES	QUANTITY PER CONNECTION, OR SPACING BETWEEN FASTENERS (INCHES ON CENTER)[d]
Ceiling joist to plate 	3$^{1}/_{2}$" × 0.162" nail (16d common)[c]	3
	3" × 0.148" nail (10d common)	4
	3$^{1}/_{4}$" × 0.131" nail	5
	3" × 0.131" nail	
	3$^{1}/_{4}$" × 0.120" nail	
	3" × 0.120" nail	
	2$^{3}/_{8}$" × 0.113" nail	6
Ceiling joists, laps over partitions  Ceiling joist to parallel rafter 	3$^{1}/_{2}$" × 0.162" nail (16d common)[c]	3
	3" × 0.148" nail (10d common)	4
	3$^{1}/_{4}$" × 0.131" nail	
	3" × 0.131" nail	
	3$^{1}/_{4}$" × 0.120" nail	
	3" × 0.120" nail	
Collar tie to rafter 	3" × 0.148" nail (10d common)[c]	3
	3$^{1}/_{2}$" × 0.162" nail (16d common)	
	3$^{1}/_{4}$" × 0.131" nail	4
	3" × 0.131" nail	
	3$^{1}/_{4}$" × 0.120" nail	
	3" × 0.120" nail	
Jack rafter to hip, toe-nailed 	3" × 0.148" nail (10d common)[c]	3
	3$^{1}/_{2}$" × 0.162" nail (16d common)	
	3$^{1}/_{4}$" × 0.131" nail	4
	3" × 0.131" nail	
	3$^{1}/_{4}$" × 0.120" nail	
	3" × 0.120" nail	
Jack rafter to hip, face nailed 	3$^{1}/_{2}$" × 0.162" nail (16d common)[c]	2
	3" × 0.148" nail (10d common)	3
	3$^{1}/_{4}$" × 0.131" nail	
	3" × 0.131" nail	
	3$^{1}/_{4}$" × 0.120" nail	4
	3" x 0.120" nail	
Roof rafter to plate (toe-nailed) 	2$^{1}/_{2}$" × 0.131" nail (8d common)[c]	3
	3$^{1}/_{2}$" × 0.162" nail (16d common)	
	3" × 0.148" nail (10d common)	
	3$^{1}/_{4}$" × 0.131" nail	
	3" × 0.131" nail	
	3$^{1}/_{4}$" × 0.120" nail	4
	3" × 0.120" nail	
	2$^{3}/_{8}$" × 0.113" nail	5
	2" × 0.113" nail	
	2$^{1}/_{4}$" × 0.105" nail	
	2$^{1}/_{4}$" × 0.099" nail	6

(continued)

TABLE 602.3(1)-continued

CEILING AND ROOF FRAMING[a, e]

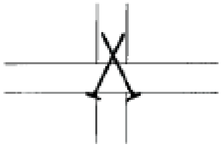
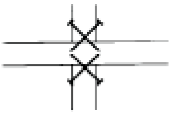
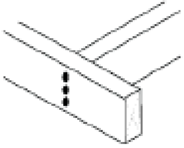
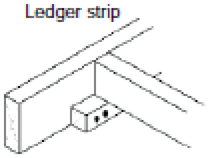
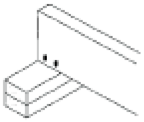
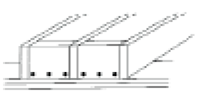
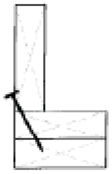
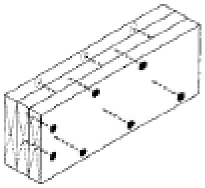
CONNECTION[b] (NAIL SIZE AND POSITION EXAGGERATED FOR ILLUSTRATIVE PURPOSES)	FASTENER MINIMUM NOMINAL LENGTH IN INCHES X MINIMUM NOMINAL NAIL DIAMETER IN INCHES	QUANTITY PER CONNECTION, OR SPACING BETWEEN FASTENERS (INCHES ON CENTER)[d]
Roof rafter to 2-by ridge beam, face nailed  (only the attachment of the top rafter is illustrated	$3^1/_2$" × 0.162" nail (16d common)[c]	2
	3" × 0.148 nail (10d common)	3
	$3^1/_4$" × 0.131" nail	
	3" × 0.131" nail	
	$3^1/_4$" × 0.120" nail	4
	3" × 0.120" nail	
Roof rafter to 2-by ridge beam, toe-nailed 	$3^1/_2$" × 0.162" nail (16d common)[c]	2
	3" × 0.148" nail (10d common)	3
	$3^1/_4$" × 0.131" nail	
	3" × 0.131" nail	
	$3^1/_4$" × 0.120" nail	4
	3" x 0.120" nail	

TABLE 602.3(1)-continued
FLOOR FRAMING[a, e]

CONNECTION[b] (NAIL SIZE AND POSITION EXAGGERATED FOR ILLUSTRATIVE PURPOSES)	FASTENER MINIMUM NOMINAL LENGTH IN INCHES X MINIMUM NOMINAL NAIL DIAMETER IN INCHES	QUANTITY PER CONNECTION, OR SPACING BETWEEN FASTENERS[d]
joist to band joist 	$3^{1}/_{2}$" × 0.162" nail (16d common)[c]	3
	3" × 0.148" nail (10d common)	5
	$3^{1}/_{4}$" × 0.131" nail	
	3" × 0.131" nail	
	$3^{1}/_{4}$" × 0.120" nail	6
	3" × 0.120" nail	
Ledger strip 	$3^{1}/_{2}$" × 0.162" nail (16d common)[c]	3
	3" × 0.148" nail (10d common)	4
	$3^{1}/_{4}$" × 0.131" nail	
	3" × 0.131" nail	
	$3^{1}/_{4}$" × 0.120" nail	
	3" × 0.120" nail	
Joist to sill or girder toe-nailed  Blocking between joist or rafter to top plate (toe-nailed) 	$2^{1}/_{2}$" × 0.131" nail (8d common)[c]	3
	3" × 0.148" nail (10d common)	
	$3^{1}/_{4}$" × 0.131" nail	
	3" × 0.131" nail	4
	$3^{1}/_{4}$" × 0.120" nail	
	3" × 0.120" nail	
Bridging to joist (listed number of fasteners at each end 	$2^{1}/_{2}$" × 0.131" nail (8d common)[c]	2
	$3^{1}/_{4}$" × 0.120" nail	3
	3" × 0.120" nail	
	$2^{3}/_{8}$" × 0.113" nail	
	2" × 0.113" nail (6d common)	4
	$2^{1}/_{4}$" × 0.105" nail	3
	$2^{1}/_{4}$" × 0.099" nail	4
Rim joist to top plate (toe-nailed) 	$2^{1}/_{2}$" × 0.113" (3d box)[c]	6" o.c.
	$3^{1}/_{2}$" × 0162" nail (16d common)	8" o.c.
	3" × 0.148" nail (10d common)	4" o.c.
	$3^{1}/_{4}$" × 0.131" nail	
	3" × 0.131" nail	
	$3^{1}/_{4}$" × 0.120" nail	
	3" × 0.120" nail	4" o.c.
	$2^{3}/_{8}$" × 0.113" nail	4" o.c.
	2" × 0.113" nail (6d common)	3" o.c.
	$2^{1}/_{4}$" × 0.105" nail	
	$2^{1}/_{4}$" x 0.099" nail	

Connection[b] (Nail size and position Exaggerated for illustrative purposes)	Fastner minimum nominal length in inches × minimum nominal nail diameter in inches	Spacing of fasteners along the top and bottom of beam, staggered on each side of each layer	Number of fasteners at each end and splice for each layer
Built-up girders and beams 	4" × 0.192" nail (20d common)[c]	32" o.c.	2
	$3^{1}/_{2}$" × 0.162" nail (16d common)	24" o.c.	3
	3" × 0.148" nail (10d common)		
	$3^{1}/_{4}$" × 0.131" nail		
	3" × 0.131" nail		
	$3^{1}/_{4}$" × 0.120" nail	16" o.c.	3
	3" × 0.120" nail		
	$2^{1}/_{2}$" × 0.131" nail (8d common)	16" o.c.	4

Change to 4” o.c.

Change to 6” o.c.

(continued)

TABLE 602.3(1)-continued
FLOOR FRAMING[a, e]

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.44 m/s, 1 foot = 304.8 mm.

a. This fastening schedule applies to framing members having an actual thickness of 11/2" (nominal “2-by” lumber).

b. Fastenings listed above may also be used for other connections that are not listed but that have the same configuration and the same code requirement for fastener quantity/spacing and fastener size (pennyweight and style, e.g., 8d common, “8-penny common nail”).

c. This fastener, in the quantity or spacing shown in the rightmost column, comprises the most stringent fastening of the connection listed in the International, National, *International One- and Two-family Dwelling*, Standard or Uniform Building Codes.

d. Fastening schedule only applies to buildings of conventional wood frame construction where wind or seismic analysis is not required by the applicable code. In areas where wind or seismic analysis is required, required fastening must be determined by structural analysis. The following are conditions for which codes require structural analysis:

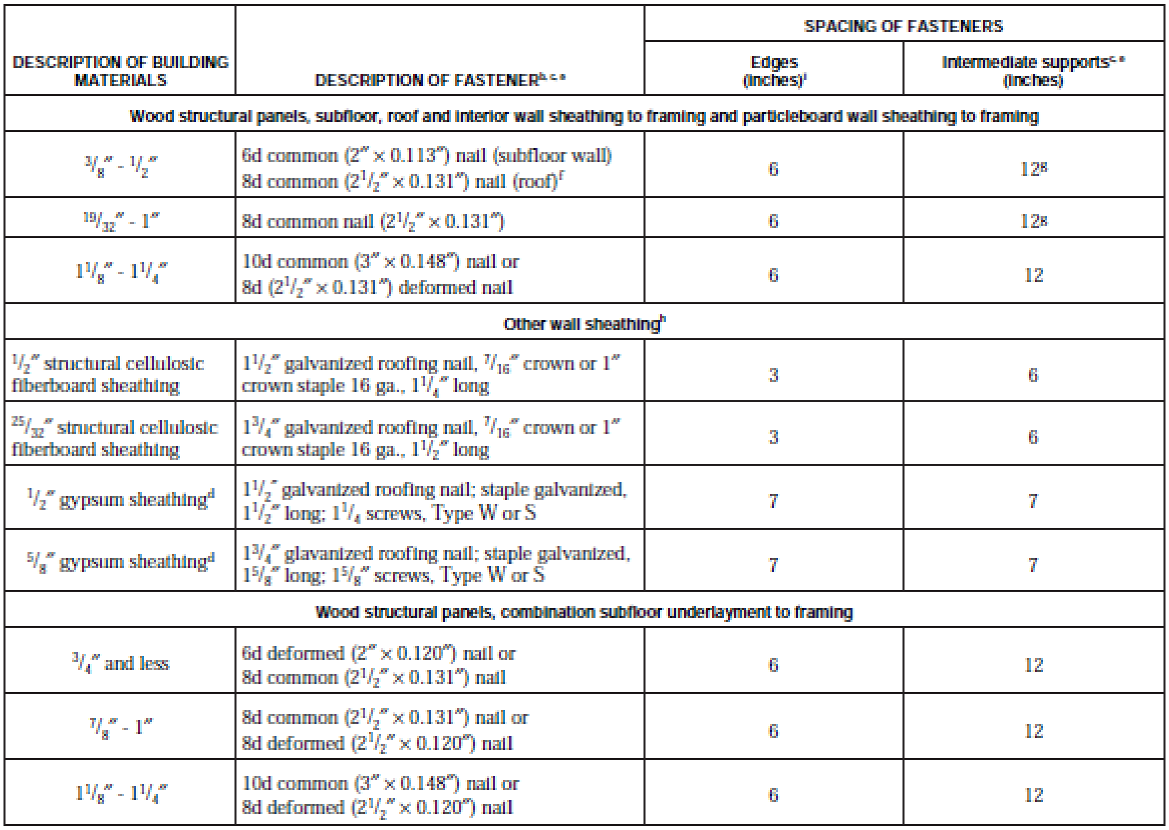
i. For nominal dimensions of nails see Table R602.3(1a)

ii. *North Carolina Residential Code* – buildings located in areas where the design wind speed equals or exceeds 130 mph (58 m/s) or townhouses assigned to seismic design category C.

e. Reprinted by permission of the ICC Evaluation Service, LLC from Evaluation Report ESR-1539-09. Use of ESR 1539-15 is permitted.

f. Nails and staples shall conform to the requirements of ASTM F1667.

TABLE 602.3(1)-continued
FASTENER SCHEDULE FOR STRUCTURAL MEMBERS[j,k]



DESCRIPTION OF BUILDING MATERIALS	DESCRIPTION OF FASTENER[b, c, e]	SPACING OF FASTENERS	
		Edges (inches)[i]	Intermediate supports[c, e] (inches)
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing			
3/8″ - 1/2″	6d common (2″ × 0.113″) nail (subfloor wall) 8d common (2 1/2″ × 0.131″) nail (roof)[f]	6	12[g]
19/32″ - 1″	8d common nail (2 1/2″ × 0.131″)	6	12[g]
1 1/8″ - 1 1/4″	10d common (3″ × 0.148″) nail or 8d (2 1/2″ × 0.131″) deformed nail	6	12
Other wall sheathing[h]			
1/2″ structural cellulosic fiberboard sheathing	1 1/2″ galvanized roofing nail, 7/16″ crown or 1″ crown staple 16 ga., 1 1/4″ long	3	6
25/32″ structural cellulosic fiberboard sheathing	1 3/4″ galvanized roofing nail, 7/16″ crown or 1″ crown staple 16 ga., 1 1/2″ long	3	6
1/2″ gypsum sheathing[d]	1 1/2″ galvanized roofing nail; staple galvanized, 1 1/2″ long; 1 1/4 screws, Type W or S	7	7
5/8″ gypsum sheathing[d]	1 3/4″ glavanized roofing nail; staple galvanized, 1 5/8″ long; 1 5/8″ screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing			
3/4″ and less	6d deformed (2″ × 0.120″) nail or 8d common (2 1/2″ × 0.131″) nail	6	12
7/8″ - 1″	8d common (2 1/2″ × 0.131″) nail or 8d deformed (2 1/2″ × 0.120″) nail	6	12
1 1/8″ - 1 1/4″	10d common (3″ × 0.148″) nail or 8d deformed (2 1/2″ × 0.120″) nail	6	12

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1ksi = 6.895 MPa.

a. Deleted.
b. Staples are 16 gage wire and have a minimum 7/16-inch on diameter crown width.
c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.
d. Four-foot-by-8-foot or 4-foot-by-9-foot panels shall be applied vertically.
e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).
f. For regions having ultimate wind speed of 130 mph or greater, 8d deformed (21/2" x 0.120) nails shall be used for attaching plywood and wood structural panel roof sheathing to framing within minimum 48-inch distance from gable end walls, if mean roof height is more than 25 feet, up to 35 feet maximum.
g. For regions having ultimate wind speed of 120 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. When basic wind speed is greater than 100 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.
h. Gypsum sheathing shall conform to ASTM C 79 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.
i. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at all floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking. Roof sheathing 7/16-inch or greater in thickness does not require perimeter blocking.
j. For nominal dimensions of nails see Table R602.3(1a).
k. Nails and staples shall conform to the requirements of ASTM F1667.

TABLE R602.3(1a)
NOMINAL DIMENSIONS OF NAILS LISTED IN TABLE R602.3(1)

NAILS DESCRIBED BY PENNYWEIGHT SYSTEM		
Pennyweight	Length (inches)	Shank diameter (inches)
Box		
6d	2	0.099
8d	$2^{1}/_{2}$	0.113
10d	3	0.128
Casing		
6d	$2^{1}/_{4}$	0.099
8d	$2^{1}/_{2}$	0.113
10d	3	0.128
Common		
6d	2	0.113
8d	$2^{1}/_{2}$	0.131
10d	3	0.148
16d	$3^{1}/_{2}$	0.162
20d	4	0.192
Cooler		
5d	$1^{5}/_{8}$	0.086
6d	$1^{7}/_{8}$	0.092
8d	$2^{3}/_{8}$	0.113
Deformed[a]		
3d	$1^{1}/_{4}$	0.099
4d	$1^{1}/_{2}$	0.099
6d	2	0.120
8d	$2^{1}/_{2}$	0.120
Finish		
8d	$2^{1}/_{2}$	0.099
10d	3	0.113
Siding		
6d	$1^{7}/_{8}$	0.106
8d	$2^{3}/_{8}$	0.128
Additional Recognized Nails		
Smooth shank nails	$2^{1}/_{4}$	0.092
	$2^{1}/_{4}$	0.105
	3	0.120
	$3^{1}/_{4}$	
	$1^{1}/_{2}$	0.131
	3	
	$3^{1}/_{4}$	
	$1^{1}/_{2}$	0.148
	$2^{1}/_{2}$	0.162
Deformed shank nails[a]	$2^{1}/_{4}$	0.099
	2	0.113
	$2^{3}/_{8}$	
	$2^{1}/_{2}$	0.131

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1ksi = 6.895 MPa.

a. A deformed shank nail must have either a helical (screw) shank or an annular (ring) shank.

TABLE R602.3(2)[i]
ALTERNATE ATTACHMENTS TO TABLE R602.3(1)

NOMINAL MATERIAL THICKNESS (inches)	**DESCRIPTION[a, b] OF FASTENER AND LENGTH (inches)**	**SPACING[c] OF FASTENERS**	
		Edges (inches)	**Intermediate supports (inches)**
Wood structural panels subfloor, roof[g] and wall sheathing to framing and particleboard wall sheathing to framing[f]			
Up to $^{1}/_{2}$	Staple 15 ga. 1$^{3}/_{4}$	4	8
	0.097 - 0.099 Nail 2$^{1}/_{4}$	3	6
	Staple 16 ga. 1$^{3}/_{4}$	3	6
$^{19}/_{32}$ and $^{5}/_{8}$	0.113 Nail 2	3	6
	Staple 15 and 16 ga. 2	4	8
	0.097 - 0.099 Nail 2$^{1}/_{4}$	4	8
$^{23}/_{32}$ and $^{3}/_{4}$	Staple 14 ga. 2	4	8
	Staple 15 ga. 1$^{3}/_{4}$	3	6
	0.097 - 0.099 Nail 2$^{1}/_{4}$	4	8
	Staple 16 ga. 2	4	8
1	Staple 14 ga. 2$^{1}/_{4}$	4	8
	0.113 Nail 2$^{1}/_{4}$	3	6
	Staple 15 ga. 2$^{1}/_{4}$	4	8
	0.097 - 0.099 Nail 2$^{1}/_{2}$	4	8
NOMINAL MATERIAL THICKNESS (inches)	DESCRIPTION[a, b] **OF FASTENER AND LENGTH (inches)**	SPACING[c] **OF FASTENERS**	
		Edges (inches)	Body of panel[d] **(inches)**
Floor underlayment; plywood-hardboard-particleboard[f]-fiber-cement[h]			
Fiber-cement			
	3d, corrosion-resistant, ring shank nails (finished flooring other than tile)	3	6

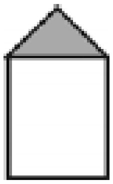
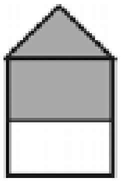
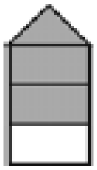
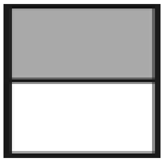
1/4	Staple 18 ga., 7/8 long, 1/4 crown (finished flooring other than tile)	3	6
	1 1/4 long × .121 shank × .375 head diameter corrosion-resistant (galvanized or stainless steel) roofing nails (for tile finish)	8	8
	1 1/4 long, No. 8 × .375 head diameter, ribbed wafer-head screws (for tile finish)	8	8
Plywood			
1/4 and 5/16	1 1/4 ring or screw shank nail-minimum 12 1/2 ga. (0.099″) shank diameter	3	6
	Staple 18 ga., 7/8, 3/16 crown width	2	5
11/32, 3/8, 15/32, and 1/2	1 1/4 ring or screw shank nail-minimum 12 1/2 ga. (0.099″) shank diameter	6	8[e]
19/32, 5/8, 23/32 and 3/4	1 1/2 ring or screw shank nail-minimum 12 1/2 ga. (0.099″) shank diameter	6	8
	Staple 16 ga. 1 1/2	6	8
Hardboard[f]			
0.200	1 1/2 long ring-grooved underlayment nail	6	6
	4d cement-coated sinker nail	6	6
	Staple 18 ga., 7/8 long (plastic coated)	3	6
Particleboard			
1/4	4d ring-grooved underlayment nail	3	6
	Staple 18 ga., 7/8 long, 3/16 crown	3	6
3/8	6d ring-grooved underlayment nail	6	10
	Staple 16 ga., 1 1/8 long, 3/8 crown	3	6
1/2, 5/8	6d ring-grooved underlayment nail	6	10
	Staple 16 ga., 1 5/8 long, 3/8 crown	3	6

For SI: 1 inch = 25.4 mm.

a. Nail is a general description and shall be permitted to be T-head, modified round head or round head.

b. Staples shall have a minimum crown width of $^{7}/_{16}$-inch on diameter except as noted.
c. Nails or staples shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater. Nails or staples shall be spaced at not more than 12 inches on center at intermediate supports for floors.
d. Fasteners shall be placed in a grid pattern throughout the body of the panel.
e. For 5-ply panels, intermediate nails shall be spaced not more than 12 inches on center each way.
f. Hardboard underlayment shall conform to CPA/ANSI A135.4
g. Specified alternate attachments for roof sheathing shall be permitted where the ultimate design wind speed is less than 130 mph. Fasteners attaching wood structural panel roof sheathing to gable end wall framing shall be installed using the spacing listed for panel edges.
h. Fiber-cement underlayment shall conform to ASTM C 1288 or ISO 8336, Category C.
i. Nails and staples shall conform to the requirements of ASTM F1667.

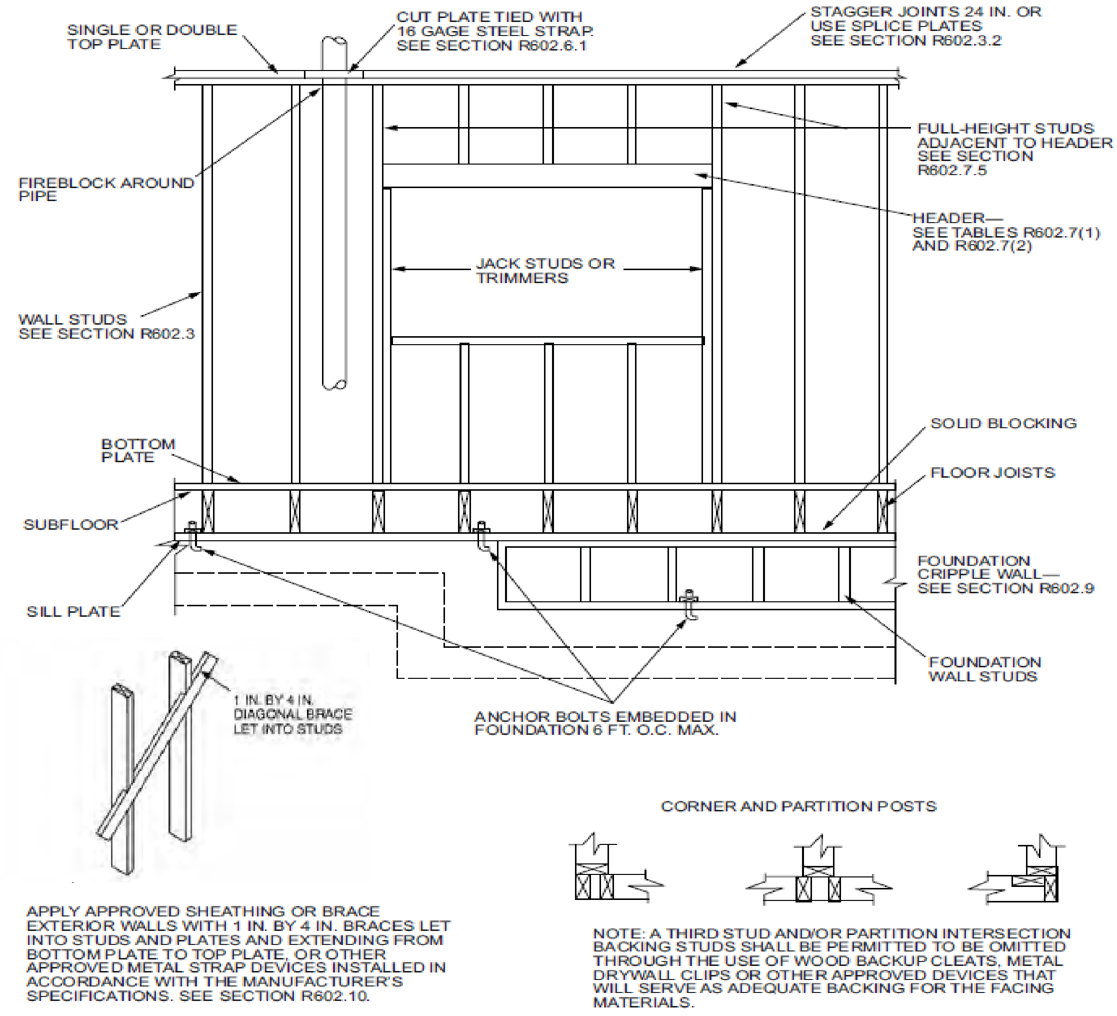
TABLE R602.3(5)
SIZE, HEIGHT AND SPACING OF WOOD STUDS[a, d]

STUD SIZE (inches)	BEARING WALLS					NONBEARING WALLS	
	Laterally unsupported stud height[a] (feet)	Maximum spacing when supporting a roof-ceiling assembly or a habitable attic assembly, only (inches)	Maximum spacing when supporting one floor, plus a roof-ceiling assembly or a habitable attic assembly (inches)	Maximum spacing when supporting two floors, plus a roof-ceiling assembly or a habitable attic assembly (inches)	Maximum spacing when supporting one floor height[a] (inches)	Laterally unsupported stud height[a] (feet)	Maximum spacing (inches)
							
2 × 3[b]	—	—	—	—	—	10	16
2 × 4	10	24[c]	16[c]	[e]	24	14	24
3 × 4	10	24	24	16	24	14	24
2 × 5	10	24	24	—	24	16	24
2 × 6	10	24	24	16	24	20	24

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.
a. Listed heights are distances between points of lateral support placed perpendicular to the plane of the wall. Bearing walls shall be sheathed on not less than one side or bridging shall be installed not greater than 4 feet apart measured vertically from either end of the stud. Increases in unsupported height are permitted where in compliance with Exception 2 of Section R602.3.1 or designed in accordance with accepted engineering practice.
b. Shall not be used in exterior walls.
c. A habitable attic assembly supported by 2 × 4 studs is limited to a roof span of 32 feet. Where the roof span exceeds 32 feet, the wall studs shall be increased to 2 × 6 or the studs shall be designed in accordance with accepted engineering practice.

d. One half of the studs interrupted by a wall opening shall be placed immediately outside the jack studs on each side of the opening as king studs to resist wind loads. King studs shall extend full height from sole plate to top plate of the wall.

e. 2x4 studs at 12 inches maximum spacing are permitted in accordance with Table R4505(b).



APPLY APPROVED SHEATHING OR BRACE EXTERIOR WALLS WITH 1 IN. BY 4 IN. BRACES LET INTO STUDS AND PLATES AND EXTENDING FROM BOTTOM PLATE TO TOP PLATE, OR OTHER APPROVED METAL STRAP DEVICES INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS. SEE SECTION R602.10.

NOTE: A THIRD STUD AND/OR PARTITION INTERSECTION BACKING STUDS SHALL BE PERMITTED TO BE OMITTED THROUGH THE USE OF WOOD BACKUP CLEATS, METAL DRYWALL CLIPS OR OTHER APPROVED DEVICES THAT WILL SERVE AS ADEQUATE BACKING FOR THE FACING MATERIALS.

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

FIGURE R602.3(2)
FRAMING DETAILS

R602.3.2 Top plate for bearing walls and braced wall lines.

Wood stud walls shall be capped with a double top plate installed to provide overlapping at corners and intersections with bearing partitions. End joints in top plates shall be offset not less than 24 inches (610 mm). Joints in plates need not occur over studs. Plates shall be not less than 2-inches (51 mm) nominal thickness and have a width not less than the width of the studs.

Exception: A single top plate used as an alternative to a double top plate shall comply with the following:

1. The single top plate shall be tied at corners, intersecting walls, and at in-line splices in straight wall lines in accordance with Table R602.3.2.
2. The rafters or joists shall be centered over the studs with a tolerance of not more than 1 inch (25 mm).
3. Omission of the top plate is permitted over headers where the headers are adequately tied to adjacent wall sections in accordance with Table R602.3.2.

TABLE R602.3.2
SINGLE TOP-PLATE SPLICE CONNECTION DETAILS FOR BEARING WALLS AND BRACED WALL LINES

CONDITION	TOP-PLATE SPLICE LOCATION			
	Corners and intersecting walls		Butt joints in straight walls	
	Splice plate size	Minimum nails each side of joint	Splice plate size	Minimum nails each side of joint
Structures in SDC A-C~~; and in SDC D$_0$, D$_1$ and D$_2$ with braced wall line spacing less than 25 feet~~	3″ × 6″ × 0.036″ galvanized steel plate or equivalent	(6) 8d box (2$^1/_2$″ × 0.113″) nails	3′ × 12″ ×0.036″ galvanized steel plate or equivalent	(12) 8d box (2$^1/_2$″ × 0.113″) nails
~~Structures in SDC D$_0$, D$_1$ and D$_2$, with braced wall line spacing greater than or equal to 25 feet~~	~~3″ × 8″ by 0.036″ galvanized steel plate or equivalent~~	~~(9) 8d box (2$^1/_2$″ × 0.113″) nails~~	~~3′ × 16″ × 0.036″ galvanized steel plate or equivalent~~	~~(18) 8d box (2$^1/_2$″ × 0.113″) nails~~

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

R602.6 Drilling and notching of studs.

Drilling and notching of studs shall be in accordance with the following:

1. Notching. Any stud in an exterior wall or bearing partition shall be permitted to be cut or notched to a depth not exceeding 25 percent of its width. Studs in nonbearing partitions shall be permitted to be notched to a depth not to exceed 40 percent of a single stud width. Notching of bearing studs shall be on one edge only and not to exceed one-fourth the height of the stud. Notching shall not occur in the bottom or top 6 inches (152 mm) of bearing studs.
2. Drilling. Any stud shall be permitted to be bored or drilled, provided that the diameter of the resulting hole is not more than 60 percent of the stud width, the edge of the hole is not more than $^5/_8$ inch (16 mm) to the edge of the stud, and the hole ~~is not located in the~~

~~same section as a cut or notch~~ shall not be closer than 6 inches (152 mm) from an adjacent hole or notch. Holes not exceeding 3/4 inch (19 mm) diameter can be as close as 1 ½ inches (38 mm) on center spacing. Studs located in exterior walls or bearing partitions drilled over 40 percent and up to 60 percent shall be doubled with not more than two successive doubled studs bored. See Figures R602.6(1) and R602.6(2).

> **Exception:** Use of *approved* stud shoes is permitted where they are installed in accordance with the manufacturer's recommendations.

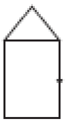
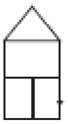
3. Cutting and notching of studs shall be permitted to be increased to 65 percent of the width of the stud in exterior and interior walls and bearing partitions, provided that one of the following conditions are met:

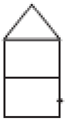
   (a) The wall section is reinforced with ½ inch (13 mm) exterior grade plywood or equivalent reinforcement on the notched side of the wall. Plywood, if used, shall reach from the floor to ceiling and at least one stud further on each side of the section that has been notched or cut.

   (b) The exterior walls of a kitchen may be reinforced by placing ½ inch (13 mm) plywood or equivalent reinforcement on the notched side of the wall. Plywood, if used, shall reach from the floor to counter-top height and at least one stud further on each side of the section that has been notched or cut.

TABLE R602.7(1)
GIRDER SPANS[a] AND HEADER SPANS[a] FOR EXTERIOR BEARING WALLS
(Maximum spans for Douglas fir-larch, hem-fir, southern pine and spruce-pine-fir[b] and required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[e]																	
		30						50						70					
		Building width[c] (feet)																	
		20		28		36		20		28		36		20		28		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
Roof and ceiling	1-2 × 8	4-6	1	3-10	1	3-5	1	3-9	1	3-2	1	2-10	2	—	—	—	—	—	—
	1-2 × 10	5-8	1	4-11	1	4-4	1	4-9	1	4-1	1	3-7	2	—	—	—	—	—	—
	1-2 × 12	6-11	1	5-11	2	5-3	2	5-9	2	4-8	2	3-8	2	—	—	—	—	—	—
	2-2 × 4	3-6	1	3-2	1	2-10	1	3-2	1	2-9	1	2-6	1	2-10	1	2-6	1	2-3	1
	2-2 × 6	5-5	1	4-8	1	4-2	1	4-8	1	4-1	1	3-8	2	4-2	1	3-8	2	3-3	2
	2-2 × 8	6-10	1	5-11	2	5-4	2	5-11	2	5-2	2	4-7	2	5-4	2	4-7	2	4-1	2
	2-2 × 10	8-5	2	+7-3	2	6-6	2	7-3	2	6-3	2	5-7	2	6-6	2	5-7	2	5-0	2

	2-2 × 12	9-9	2	8-5	2	7-6	2	8-5	2	7-3	2	6-6	2	7-6	2	6-6	2	5-10	3
	3-2 × 8	8-4	1	7-5	1	6-8	1	7-5	1	6-5	2	5-9	2	6-8	1	5-9	2	5-2	2
	3-2 × 10	10-6	1	9-1	2	8-2	2	9-1	2	7-10	2	7-0	2	8-2	2	7-0	2	6-4	2
	3-2 × 12	12-2	2	10-7	2	9-5	2	10-7	2	9-2	2	8-2	2	9-5	2	8-2	2	7-4	2
	4-2 × 8	9-2	1	8-4	1	7-8	1	8-4	1	7-5	1	6-8	1	7-8	1	6-8	1	5-11	2
	4-2 × 10	11-8	1	10-6	1	9-5	2	10-6	1	9-1	2	8-2	2	9-5	2	8-2	2	7-3	2
	4-2 × 12	14-1	1	12-2	2	10-11	2	12-2	2	10-7	2	9-5	2	10-11	2	9-5	2	8-5	2
Roof, ceiling and one center-bearing floor 	1-2 × 8	3-11	1	3-5	1	3-0	1	3-7	1	3-0	2	2-8	2	—	—	—	—	—	—
	1-2 × 10	5-0	2	4-4	2	3-10	2	4-6	2	3-11	2	3-4	2	—	—	—	—	—	—
	1-2 × 12	5-10	2	4-9	2	4-2	2	5-5	2	4-2	2	3-4	2	—	—	—	—	—	—
	2-2 × 4	3-1	1	2-9	1	2-5	1	2-9	1	2-5	1	2-2	1	2-7	1	2-3	1	2-0	1
	2-2 × 6	4-6	1	4-0	1	3-7	2	4-1	1	3-7	2	3-3	2	3-9	2	3-3	2	2-11	2
	2-2 × 8	5-9	2	5-0	2	4-6	2	5-2	2	4-6	2	4-1	2	4-9	2	4-2	2	3-9	2
	2-2 × 10	7-0	2	6-2	2	5-6	2	6-4	2	5-6	2	5-0	2	5-9	2	5-1	2	4-7	3
	2-2 × 12	8-1	2	7-1	2	6-5	2	7-4	2	6-5	2	5-9	3	6-8	2	5-10	3	5-3	3
	3-2 × 8	7-2	1	6-3	2	5-8	2	6-5	2	5-8	2	5-1	2	5-11	2	5-2	2	4-8	2
	3-2 × 10	8-9	2	7-8	2	6-11	2	7-11	2	6-11	2	6-3	2	7-3	2	6-4	2	5-8	2
	3-2 × 12	10-2	2	8-11	2	8-0	2	9-2	2	8-0	2	7-3	2	8-5	2	7-4	2	6-7	2
	4-2 × 8	8-1	1	7-3	1	6-7	1	7-5	1	6-6	1	5-11	2	6-10	1	6-0	2	5-5	2
	4-2 × 10	10-1	1	8-10	2	8-0	2	9-1	2	8-0	2	7-2	2	8-4	2	7-4	2	6-7	2
	4-2 × 12	11-9	2	10-3	2	9-3	2	10-7	2	9-3	2	8-4	2	9-8	2	8-6	2	7-7	2
Roof, ceiling and one clear span floor	1-2 × 8	3-6	1	3-0	1	2-8	1	3-5	1	2-11	1	2-7	2	—	—	—	—	—	—
	1-2 × 10	4-6	1	3-10	1	3-3	1	4-4	1	3-9	1	3-1	2	—	—	—	—	—	—
	1-2 × 12	5-6	1	4-2	2	3-3	2	5-4	2	3-11	2	3-1	2	—	—	—	—	—	—
	2-2 × 4	2-8	1	2-4	1	2-1	1	2-7	1	2-3	1	2-0	1	2-5	1	2-1	1	1-10	1
	2-2 × 6	3-11	1	3-5	2	3-0	2	3-10	2	3-4	2	3-0	2	3-6	2	3-1	2	2-9	2
	2-2 × 8	5-0	2	4-4	2	3-10	2	4-10	2	4-2	2	3-9	2	4-6	2	3-11	2	3-6	2

	2-2 × 10	6-1	2	5-3	2	4-8	2	5-11	2	5-1	2	4-7	3	5-6	2	4-9	2	4-3	3
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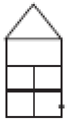
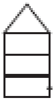
	3-2 × 8	6-3	2	5-5	2	4-10	2	6-1	2	5-3	2	4-8	2	5-7	2	4-11	2	4-5	2
	3-2 × 10	7-7	2	6-7	2	5-11	2	7-5	2	6-5	2	5-9	2	6-10	2	6-0	2	5-4	2
	3-2 × 12	8-10	2	7-8	2	6-10	2	8-7	2	7-5	2	6-8	2	7-11	2	6-11	2	6-3	2
	4-2 × 8	7-2	1	6-3	2	5-7	2	7-0	1	6-1	2	5-5	2	6-6	1	5-8	2	5-1	2
	4-2 × 10	8-9	2	7-7	2	6-10	2	8-7	2	7-5	2	6-7	2	7-11	2	6-11	2	6-2	2
	4-2 × 12	10-2	2	8-10	2	7-11	2	9-11	2	8-7	2	7-8	2	9-2	2	8-0	2	7-2	2

(continued)

TABLE R602.7(1)—continued
GIRDER SPANS[a] AND HEADER SPANS[a] FOR EXTERIOR BEARING WALLS
(Maximum spans for Douglas fir-larch, hem-fir, southern pine and spruce-pine-fir[b] and required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	**SIZE**	**GROUND SNOW LOAD (psf)[e]**																	
		30						**50**						**70**					
		Building width[c] (feet)																	
		20		**28**		**36**		**20**		**28**		**36**		**20**		**28**		**36**	
		Span	**NJ[d]**	**Span**	**NJ[d]**	**Span**	**NJ[d]**	**Span**	**NJ[d]**	**Span**	**NJ[d]**	**Span**	**NJ[d]**	**Span**	**NJ[d]**	**Span**	**NJ[d]**	**Span**	**NJ[d]**
Roof, ceiling and two center-bearing floors 	2-2 × 4	2-7	1	2-3	1	2-0	1	2-6	1	2-2	1	1-11	1	2-4	1	2-0	1	1-9	1
	2-2 × 6	3-9	2	3-3	2	2-11	2	3-8	2	3-2	2	2-10	2	3-5	2	3-0	2	2-8	2
	2-2 × 8	4-9	2	4-2	2	3-9	2	4-7	2	4-0	2	3-8	2	4-4	2	3-9	2	3-5	2
	2-2 × 10	5-9	2	5-1	2	4-7	3	5-8	2	4-11	2	4-5	3	5-3	2	4-7	3	4-2	3
	2-2 × 12	6-8	2	5-10	3	5-3	3	6-6	2	5-9	3	5-2	3	6-1	3	5-4	3	4-10	3
	3-2 × 8	5-11	2	5-2	2	4-8	2	5-9	2	5-1	2	4-7	2	5-5	2	4-9	2	4-3	2
	3-2 × 10	7-3	2	6-4	2	5-8	2	7-1	2	6-2	2	5-7	2	6-7	2	5-9	2	5-3	2
	3-2 × 12	8-5	2	7-4	2	6-7	2	8-2	2	7-2	2	6-5	3	7-8	2	6-9	2	6-1	3
	4-2 × 8	6-10	1	6-0	2	5-5	2	6-8	1	5-10	2	5-3	2	6-3	2	5-6	2	4-11	2
	4-2 × 10	8-4	2	7-4	2	6-7	2	8-2	2	7-2	2	6-5	2	7-7	2	6-8	2	6-0	2
	4-2 × 12	9-8	2	8-6	2	7-8	2	9-5	2	8-3	2	7-5	2	8-10	2	7-9	2	7-0	2

Roof, ceiling, and two clear-span floors 	2-2 × 4	2-1	1	1-8	1	1-6	2	2-0	1	1-8	1	1-5	2	2-0	1	1-8	1	1-5	2
	2-2 × 6	3-1	2	2-8	2	2-4	2	3-0	2	2-7	2	2-3	2	2-11	2	2-7	2	2-3	2
	2-2 × 8	3-10	2	3-4	2	3-0	3	3-10	2	3-4	2	2-11	3	3-9	2	3-3	2	2-11	3
	2-2 × 10	4-9	2	4-1	3	3-8	3	4-8	2	4-0	3	3-7	3	4-7	3	4-0	3	3-6	3
	2-2 × 12	5-6	3	4-9	3	4-3	3	5-5	3	4-8	3	4-2	3	5-4	3	4-7	3	4-1	4
	3-2 × 8	4-10	2	4-2	2	3-9	2	4-9	2	4-1	2	3-8	2	4-8	2	4-1	2	3-8	2
	3-2 × 10	5-11	2	5-1	2	4-7	3	5-10	2	5-0	2	4-6	3	5-9	2	4-11	2	4-5	3
	3-2 × 12	6-10	2	5-11	3	5-4	3	6-9	2	5-10	3	5-3	3	6-8	2	5-9	3	5-2	3
	4-2 × 8	5-7	2	4-10	2	4-4	2	5-6	2	4-9	2	4-3	2	5-5	2	4-8	2	4-2	2
	4-2 × 10	6-10	2	5-11	2	5-3	2	6-9	2	5-10	2	5-2	2	6-7	2	5-9	2	5-1	2
	4-2 × 12	7-11	2	6-10	2	6-2	3	7-9	2	6-9	2	6-0	3	7-8	2	6-8	2	5-11	3

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are given in feet and inches.

b. Tabulated values assume #2 grade lumber.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ = Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

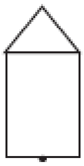
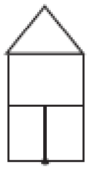
e. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.

TABLE R602.7(2)

GIRDER SPANS[a] AND HEADER SPANS[a] FOR INTERIOR BEARING WALLS

(Maximum spans for Douglas fir-larch, hem-fir, southern pine and spruce-pine-fir[b] and required number of jack studs)

HEADERS AND GIRDERS SUPPORTING	SIZE	BUILDING Width[c] (feet)					
		20		28		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
One floor only	2-2 × 4	3-1	1	2-8	1	2-5	1
	2-2 × 6	4-6	1	3-11	1	3-6	1
	2-2 × 8	5-9	1	5-0	2	4-5	2
	2-2 × 10	7-0	2	6-1	2	5-5	2
	2-2 × 12	8-1	2	7-0	2	6-3	2

	3-2 × 8	7-2	1	6-3	1	5-7	2
	3-2 × 10	8-9	1	7-7	2	6-9	2
	3-2 × 12	10-2	2	8-10	2	7-10	2
	4-2 × 8	9-0	1	7-8	1	6-9	1
	4-2 × 10	10-1	1	8-9	1	7-10	2
	4-2 × 12	11-9	1	10-2	2	9-1	2
Two floors 	2-2 × 4	2-2	1	1-10	1	1-7	1
	2-2 × 6	3-2	2	2-9	2	2-5	2
	2-2 × 8	4-1	2	3-6	2	3-2	2
	2-2 × 10	4-11	2	4-3	2	3-10	3
	2-2 × 12	5-9	2	5-0	3	4-5	3
	3-2 × 8	5-1	2	4-5	2	3-11	2
	3-2 × 10	6-2	2	5-4	2	4-10	2
	3-2 × 12	7-2	2	6-3	2	5-7	3
	4-2 × 8	6-1	1	5-3	2	4-8	2
	4-2 × 10	7-2	2	6-2	2	5-6	2
	4-2 × 12	8-4	2	7-2	2	6-5	2

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

a. Spans are given in feet and inches.

b. Tabulated values assume #2 grade lumber.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ = Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

~~R602.10 Wall bracing.~~

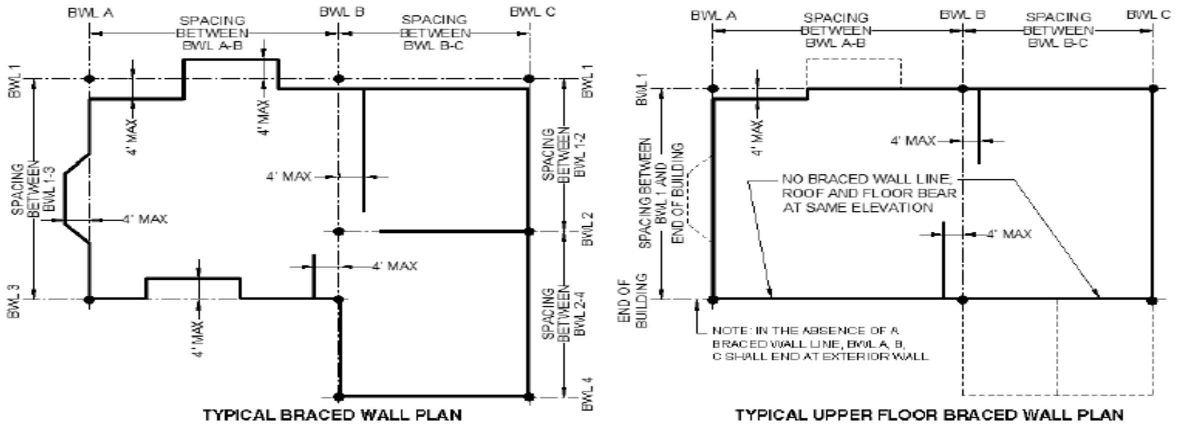
~~Buildings shall be braced in accordance with this section or, when applicable, Section R602.12. Where a building, or portion thereof, does not comply with one or more of the bracing requirements in this section, those portions shall be designed and constructed in accordance with Section R301.1.~~

~~R602.10.1 Braced wall lines.~~

~~For the purpose of determining the amount and location of bracing required in each story level of a building, *braced wall lines* shall be designated as straight lines in the building plan placed in accordance with this section.~~

~~R602.10.1.1 Length of a braced wall line.~~

~~The length of a *braced wall line* shall be the distance between its ends. The end of a *braced wall line* shall be the intersection with a perpendicular *braced wall line*, an angled *braced wall line* as permitted in Section R602.10.1.4 or an exterior wall as shown in Figure R602.10.1.1.~~



TYPICAL BRACED WALL PLAN **TYPICAL UPPER FLOOR BRACED WALL PLAN**

~~For SI: 1 foot = 304.8 mm.~~

~~FIGURE R602.10.1.1~~
~~BRACED WALL LINES~~

~~R602.10.1.2 Offsets along a braced wall line.~~

~~Exterior walls parallel to a *braced wall line* shall be offset not more than 4 feet (1219 mm) from the designated *braced wall line* location as shown in Figure R602.10.1.1. Interior walls used as bracing shall be offset not more than 4 feet (1219 mm) from a *braced wall line* through the interior of the building as shown in Figure R602.10.1.1.~~

~~R602.10.1.3 Spacing of braced wall lines.~~

~~The spacing between parallel *braced wall lines* shall be in accordance with Table R602.10.1.3. Intermediate *braced wall lines* through the interior of the building shall be permitted.~~

~~TABLE R602.10.1.3~~
~~BRACED WALL LINE SPACING~~

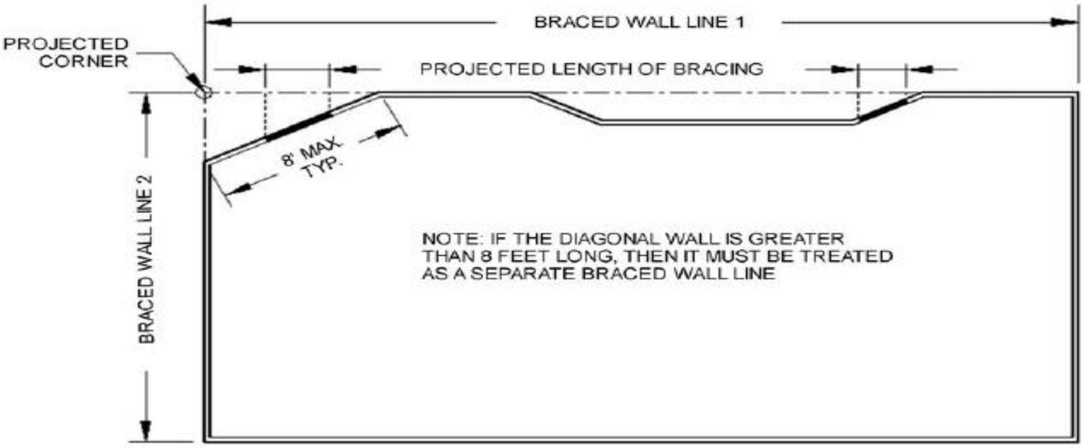
~~APPLICATION~~	**~~CONDITION~~**	**~~BUILDING TYPE~~**	**~~BRACED WALL LINE SPACING CRITERIA~~**	
			~~Maximum Spacing~~	**~~Exception to Maximum Spacing~~**
~~Wind bracing~~	~~Ultimate design wind speed 100 mph to < 140 mph~~	~~Detached, townhouse~~	~~60 feet~~	~~None~~
~~Seismic bracing~~	~~SDC A – C~~	~~Detached~~	~~Use wind bracing~~	
	~~SDC A – B~~	~~Townhouse~~	~~Use wind bracing~~	
	~~SDC C~~	~~Townhouse~~	~~35 feet~~	~~Up to 50 feet when length of required bracing per Table R602.10.3(3) is adjusted in accordance with Table R602.10.3(4).~~

	~~SDC D_0, D_1, D_2~~	~~Detached, townhouses, one- and two-story only~~	~~25 feet~~	~~Up to 35 feet to allow for a single room not to exceed 900 square feet. Spacing of all other braced wall lines shall not exceed 25 feet.~~
	~~SDC D_0, D_1, D_2~~	~~Detached, townhouse~~	~~25 feet~~	~~Up to 35 feet when length of required bracing per Table R602.10.3(3) is adjusted in accordance with Table R602.10.3(4).~~

~~For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2, 1 mile per hour = 0.447 m/s.~~

~~R602.10.1.4 Angled walls.~~

~~Any portion of a wall along a *braced wall line* shall be permitted to angle out of plane for a maximum diagonal length of 8 feet (2438 mm). Where the angled wall occurs at a corner, the length of the *braced wall line* shall be measured from the projected corner as shown in Figure R602.10.1.4. Where the diagonal length is greater than 8 feet (2438 mm), it shall be considered a separate *braced wall line* and shall be braced in accordance with Section R602.10.1.~~



~~For SI: 1 foot = 304.8 mm.~~

~~FIGURE R602.10.1.4~~
~~ANGLED WALLS~~

~~R602.10.2 Braced wall panels.~~

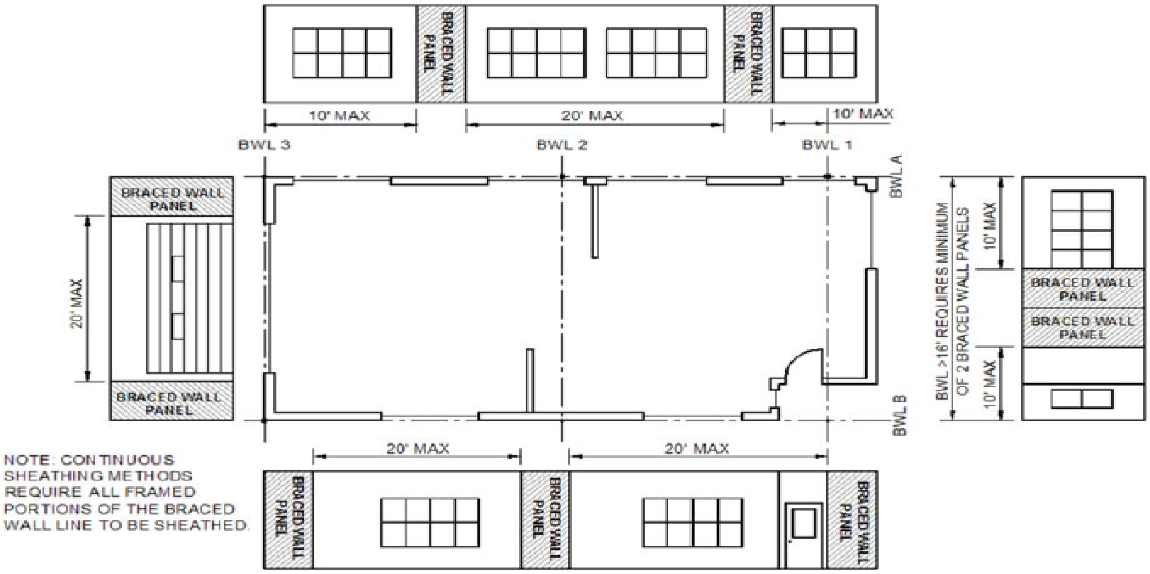
~~*Braced wall panels* shall be full-height sections of wall that shall not have vertical or horizontal offsets. *Braced wall panels* shall be constructed and placed along a *braced wall line* in accordance with this section and the bracing methods specified in Section R602.10.4.~~

~~R602.10.2.1 Braced wall panel uplift load path.~~

~~The bracing lengths in Table R602.10.3(1) apply only when uplift loads are resisted in accordance with Section R602.3.5.~~

~~**R602.10.2.2 Locations of braced wall panels.**~~

~~A *braced wall panel* shall begin within 10 feet (3810 mm) from each end of a *braced wall line* as determined in Section R602.10.1.1. The distance between adjacent edges of *braced wall panels* along a *braced wall line* shall be not greater than 20 feet (6096 mm) as shown in Figure R602.10.2.2.~~



NOTE: CONTINUOUS SHEATHING METHODS REQUIRE ALL FRAMED PORTIONS OF THE BRACED WALL LINE TO BE SHEATHED.

~~For SI: 1 foot = 304.8 mm.~~

~~**FIGURE R602.10.2.2**~~
~~**LOCATION OF BRACED WALL PANELS**~~

~~**R602.10.2.2.1 Location of braced wall panels in Seismic Design Categories D0, D1 and D2.**~~

~~Braced wall panels shall be located at each end of a braced wall line.~~

~~**Exception:** Braced wall panels constructed of Method WSP or BV-WSP and continuous sheathing methods as specified in Section R602.10.4 shall be permitted to begin not more than 10 feet (3048 mm) from each end of a braced wall line provided each end complies with one of the following:~~

1. ~~A minimum 24-inch-wide (610 mm) panel for Methods WSP, CS-WSP, CS-G and CS-PF is applied to each side of the building corner as shown in End Condition 4 of Figure R602.10.7.~~

2. ~~The end of each braced wall panel closest to the end of the braced wall line shall have an 1,800 lb (8 kN) hold-down device fastened to the stud at the edge of the braced wall panel closest to the corner and to the foundation or framing below as shown in End Condition 5 of Figure R602.10.7.~~

~~R602.10.2.3 Minimum number of braced wall panels.~~

~~*Braced wall lines* with a length of 16 feet (4877 mm) or less shall have not less than two *braced wall panels* of any length or one *braced wall panel* equal to 48 inches (1219 mm) or more. *Braced wall lines* greater than 16 feet (4877 mm) shall have not less than two *braced wall panels*.~~

~~R602.10.3 Required length of bracing.~~

~~The required length of bracing along each *braced wall line* shall be determined as follows:~~

1. ~~All buildings in Seismic Design Categories A and B shall use Table R602.10.3(1) and the applicable adjustment factors in Table R602.10.3(2).~~

2. ~~Detached buildings in Seismic Design Category C shall use Table R602.10.3(1) and the applicable adjustment factors in Table R602.10.3(2).~~

3. ~~Townhouses in Seismic Design Category C shall use the greater value determined from Table R602.10.3(1) or R602.10.3(3) and the applicable adjustment factors in Table R602.10.3(2) or R602.10.3(4), respectively.~~

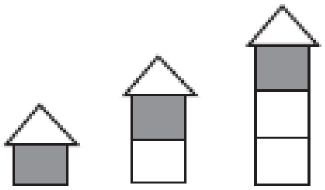
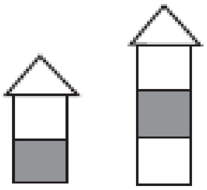
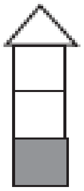
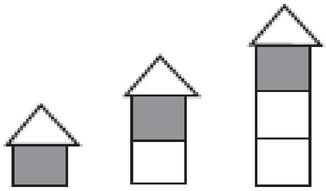
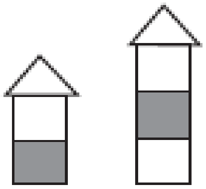
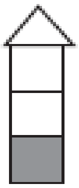
4. ~~All buildings in Seismic Design Categories D0, D1 and D2 shall use the greater value determined from Table R602.10.3(1) or R602.10.3(3) and the applicable adjustment factors in Table R602.10.3(2) or R602.10.3(4), respectively.~~

~~Only *braced wall panels* parallel to the *braced wall line* shall contribute toward the required length of bracing of that *braced wall line*. *Braced wall panels* along an angled wall meeting the minimum length requirements of Tables R602.10.5 and R602.10.5.2 shall be permitted to contribute its projected length toward the minimum required length of bracing for the *braced wall line* as shown in Figure R602.10.1.4. Any *braced wall panel* on an angled wall at the end of a *braced wall line* shall contribute its projected length for only one of the *braced wall lines* at the projected corner.~~

~~**Exception:** The length of wall bracing for dwellings in Seismic Design Categories D0, D1 and D2 with stone or masonry veneer installed in accordance with Section R703.8 and exceeding the first-story height shall be in accordance with Section R602.10.6.5.~~

~~TABLE R602.10.3(1)~~
~~BRACING REQUIREMENTS BASED ON WIND SPEED~~

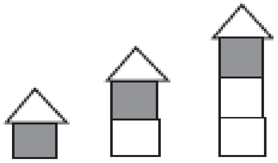
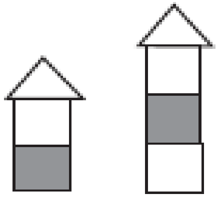
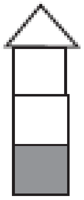
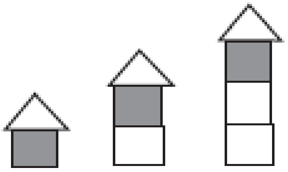
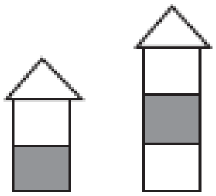
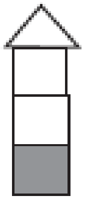
~~· EXPOSURE CATEGORY B~~ ~~· 30-FOOT MEAN ROOF HEIGHT~~ ~~· 10-FOOT WALL HEIGHT~~ ~~· 2 BRACED WALL LINES~~			~~MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE~~[a]			
~~Ultimate Design Wind Speed (mph)~~	~~Story Location~~	~~Braced Wall Line Spacing (feet)~~	~~Method LIB~~[b]	~~Method GB~~	~~Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFC, CS-SFB~~[c]	~~Methods CS-WSP, CS-G, CS-PF~~

~~≤ 110~~		~~10~~	~~3.5~~	~~3.5~~	~~2.0~~	~~1.5~~
		~~20~~	~~6.0~~	~~6.0~~	~~3.5~~	~~3.0~~
		~~30~~	~~8.5~~	~~8.5~~	~~5.0~~	~~4.5~~
		~~40~~	~~11.5~~	~~11.5~~	~~6.5~~	~~5.5~~
		~~50~~	~~14.0~~	~~14.0~~	~~8.0~~	~~7.0~~
		~~60~~	~~16.5~~	~~16.5~~	~~9.5~~	~~8.0~~
		~~10~~	~~6.5~~	~~6.5~~	~~3.5~~	~~3.0~~
		~~20~~	~~11.5~~	~~11.5~~	~~6.5~~	~~5.5~~
		~~30~~	~~16.5~~	~~16.5~~	~~9.5~~	~~8.0~~
		~~40~~	~~21.5~~	~~21.5~~	~~12.5~~	~~10.5~~
		~~50~~	~~26.5~~	~~26.5~~	~~15.5~~	~~13.0~~
		~~60~~	~~31.5~~	~~31.5~~	~~18.0~~	~~15.5~~
		~~10~~	~~NP~~	~~9.5~~	~~5.5~~	~~4.5~~
		~~20~~	~~NP~~	~~17.0~~	~~10.0~~	~~8.5~~
		~~30~~	~~NP~~	~~24.5~~	~~14.0~~	~~12.0~~
		~~40~~	~~NP~~	~~32.0~~	~~18.5~~	~~15.5~~
		~~50~~	~~NP~~	~~39.5~~	~~22.5~~	~~19.0~~
		~~60~~	~~NP~~	~~46.5~~	~~26.5~~	~~23.0~~
~~≤ 115~~		~~10~~	~~3.5~~	~~3.5~~	~~2.0~~	~~2.0~~
		~~20~~	~~6.5~~	~~6.5~~	~~3.5~~	~~3.5~~
		~~30~~	~~9.5~~	~~9.5~~	~~5.5~~	~~4.5~~
		~~40~~	~~12.5~~	~~12.5~~	~~7.0~~	~~6.0~~
		~~50~~	~~15.0~~	~~15.0~~	~~9.0~~	~~7.5~~
		~~60~~	~~18.0~~	~~18.0~~	~~10.5~~	~~9.0~~
		~~10~~	~~7.0~~	~~7.0~~	~~4.0~~	~~3.5~~
		~~20~~	~~12.5~~	~~12.5~~	~~7.5~~	~~6.5~~
		~~30~~	~~18.0~~	~~18.0~~	~~10.5~~	~~9.0~~
		~~40~~	~~23.5~~	~~23.5~~	~~13.5~~	~~11.5~~
		~~50~~	~~29.0~~	~~29.0~~	~~16.5~~	~~14.0~~
		~~60~~	~~34.5~~	~~34.5~~	~~20.0~~	~~17.0~~
		~~10~~	~~NP~~	~~10.0~~	~~6.0~~	~~5.0~~
		~~20~~	~~NP~~	~~18.5~~	~~11.0~~	~~9.0~~
		~~30~~	~~NP~~	~~27.0~~	~~15.5~~	~~13.0~~
		~~40~~	~~NP~~	~~35.0~~	~~20.0~~	~~17.0~~
		~~50~~	~~NP~~	~~43.0~~	~~24.5~~	~~21.0~~
		~~60~~	~~NP~~	~~51.0~~	~~29.0~~	~~25.0~~

~~(continued)~~

~~TABLE R602.10.3(1)—continued~~
~~BRACING REQUIREMENTS BASED ON WIND SPEED~~

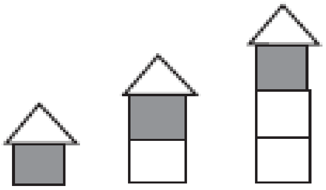
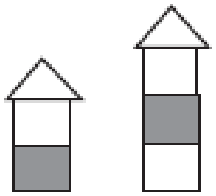
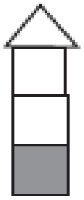
~~EXPOSURE CATEGORY B~~ **~~30-FOOT MEAN ROOF HEIGHT~~** **~~10-FOOT WALL HEIGHT~~** **~~2 BRACED WALL LINES~~**	**~~MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE~~**[a]

~~Ultimate Design Wind Speed (mph)~~	~~Story Location~~	~~Braced Wall Line Spacing (feet)~~	~~Method LIB~~[~~b~~]	~~Method GB~~	~~Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB~~[~~c~~]	~~Methods CS-WSP, CS-G, CS-PF~~
~~≤ 120~~		~~10~~	~~4.0~~	~~4.0~~	~~2.5~~	~~2.0~~
		~~20~~	~~7.0~~	~~7.0~~	~~4.0~~	~~3.5~~
		~~30~~	~~10.5~~	~~10.5~~	~~6.0~~	~~5.0~~
		~~40~~	~~13.5~~	~~13.5~~	~~8.0~~	~~6.5~~
		~~50~~	~~16.5~~	~~16.5~~	~~9.5~~	~~8.0~~
		~~60~~	~~19.5~~	~~19.5~~	~~11.5~~	~~9.5~~
		~~10~~	~~7.5~~	~~7.5~~	~~4.5~~	~~3.5~~
		~~20~~	~~14.0~~	~~14.0~~	~~8.0~~	~~7.0~~
		~~30~~	~~20.0~~	~~20.0~~	~~11.5~~	~~9.5~~
		~~40~~	~~25.5~~	~~25.5~~	~~15.0~~	~~12.5~~
		~~50~~	~~31.5~~	~~31.5~~	~~18.0~~	~~15.5~~
		~~60~~	~~37.5~~	~~37.5~~	~~21.5~~	~~18.5~~
		~~10~~	~~NP~~	~~11.0~~	~~6.5~~	~~5.5~~
		~~20~~	~~NP~~	~~20.5~~	~~11.5~~	~~10.0~~
		~~30~~	~~NP~~	~~29.0~~	~~17.0~~	~~14.5~~
		~~40~~	~~NP~~	~~38.0~~	~~22.0~~	~~18.5~~
		~~50~~	~~NP~~	~~47.0~~	~~27.0~~	~~23.0~~
		~~60~~	~~NP~~	~~55.5~~	~~32.0~~	~~27.0~~
~~≤ 130~~		~~10~~	~~4.5~~	~~4.5~~	~~2.5~~	~~2.5~~
		~~20~~	~~8.5~~	~~8.5~~	~~5.0~~	~~4.0~~
		~~30~~	~~12.0~~	~~12.0~~	~~7.0~~	~~6.0~~
		~~40~~	~~15.5~~	~~15.5~~	~~9.0~~	~~7.5~~
		~~50~~	~~19.5~~	~~19.5~~	~~11.0~~	~~9.5~~
		~~60~~	~~23.0~~	~~23.0~~	~~13.0~~	~~11.0~~
		~~10~~	~~8.5~~	~~8.5~~	~~5.0~~	~~4.5~~
		~~20~~	~~16.0~~	~~16.0~~	~~9.5~~	~~8.0~~
		~~30~~	~~23.0~~	~~23.0~~	~~13.5~~	~~11.5~~
		~~40~~	~~30.0~~	~~30.0~~	~~17.5~~	~~15.0~~
		~~50~~	~~37.0~~	~~37.0~~	~~21.5~~	~~18.0~~
		~~60~~	~~44.0~~	~~44.0~~	~~25.0~~	~~21.5~~
		~~10~~	~~NP~~	~~13.0~~	~~7.5~~	~~6.5~~
		~~20~~	~~NP~~	~~24.0~~	~~13.5~~	~~11.5~~
		~~30~~	~~NP~~	~~34.5~~	~~19.5~~	~~17.0~~
		~~40~~	~~NP~~	~~44.5~~	~~25.5~~	~~22.0~~
		~~50~~	~~NP~~	~~55.0~~	~~31.5~~	~~26.5~~
		~~60~~	~~NP~~	~~65.0~~	~~37.5~~	~~31.5~~

(continued)

~~TABLE R602.10.3(1)—continued~~

~~BRACING REQUIREMENTS BASED ON WIND SPEED~~

~~EXPOSURE CATEGORY B~~ ~~30-FOOT MEAN ROOF HEIGHT~~ ~~10-FOOT WALL HEIGHT~~ ~~2 BRACED WALL LINES~~			~~MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE~~[a]			
~~Ultimate Design Wind Speed (mph)~~	~~Story Location~~	~~Braced Wall Line Spacing (feet)~~	~~Method LIB~~[b]	~~Method GB~~	~~Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB~~[c]	~~Methods CS-WSP, CS-G, CS-PF~~
~~≤ 140~~		~~10~~	~~5.5~~	~~5.5~~	~~3.0~~	~~2.5~~
		~~20~~	~~10.0~~	~~10.0~~	~~5.5~~	~~5.0~~
		~~30~~	~~14.0~~	~~14.0~~	~~8.0~~	~~7.0~~
		~~40~~	~~18.0~~	~~18.0~~	~~10.5~~	~~9.0~~
		~~50~~	~~22.5~~	~~22.5~~	~~13.0~~	~~11.0~~
		~~60~~	~~26.5~~	~~26.5~~	~~15.0~~	~~13.0~~
		~~10~~	~~10.0~~	~~10.0~~	~~6.0~~	~~5.0~~
		~~20~~	~~18.5~~	~~18.5~~	~~11.0~~	~~9.0~~
		~~30~~	~~27.0~~	~~27.0~~	~~15.5~~	~~13.0~~
		~~40~~	~~35.0~~	~~35.0~~	~~20.0~~	~~17.0~~
		~~50~~	~~43.0~~	~~43.0~~	~~24.5~~	~~21.0~~
		~~60~~	~~51.0~~	~~51.0~~	~~29.0~~	~~25.0~~
		~~10~~	~~NP~~	~~15.0~~	~~8.5~~	~~7.5~~
		~~20~~	~~NP~~	~~27.5~~	~~16.0~~	~~13.5~~
		~~30~~	~~NP~~	~~39.5~~	~~23.0~~	~~19.5~~
		~~40~~	~~NP~~	~~51.5~~	~~29.5~~	~~25.0~~
		~~50~~	~~NP~~	~~63.5~~	~~36.5~~	~~31.0~~
		~~60~~	~~NP~~	~~75.5~~	~~43.0~~	~~36.5~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.~~

~~a. Linear interpolation shall be permitted.~~

~~b. Method LIB shall have gypsum board fastened to not less than one side with nails or screws in accordance with Table R602.3(1) for exterior sheathing or Table R702.3.5 for interior gypsum board. Spacing of fasteners at panel edges shall not exceed 8 inches.~~

~~c. Where a braced wall line has parallel braced wall lines on one or both sides of differing dimensions, the average dimension shall be permitted to be used for braced wall line spacing.~~

~~TABLE R602.10.3(2)~~
~~WIND ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING~~

~~ITEM NUMBER~~	~~ADJUSTMENT BASED ON~~	~~STORY/SUPPORTING~~	~~CONDITION~~	~~ADJUSTMENT FACTOR~~[a, b] ~~[multiply length from Table~~	~~APPLICABLE METHODS~~

				~~R602.10.3(1) by this factor]~~	
~~1~~	~~Exposure category~~	~~One-story structure~~	~~B~~ ~~C~~ ~~D~~	~~1.00~~ ~~1.20~~ ~~1.50~~	~~All methods~~
		~~Two-story structure~~	~~B~~ ~~C~~ ~~D~~	~~1.00~~ ~~1.30~~ ~~1.60~~	
		~~Three-story structure~~	~~B~~ ~~C~~ ~~D~~	~~1.00~~ ~~1.40~~ ~~1.70~~	
~~2~~	~~Roof eave-to-ridge height~~	~~Roof only~~	~~≤ 5 feet~~ ~~10 feet~~ ~~15 feet~~ ~~20 feet~~	~~0.70~~ ~~1.00~~ ~~1.30~~ ~~1.60~~	
		~~Roof + 1 floor~~	~~≤ 5 feet~~ ~~10 feet~~ ~~15 feet~~ ~~20 feet~~	~~0.85~~ ~~1.00~~ ~~1.15~~ ~~1.30~~	
		~~Roof + 2 floors~~	~~≤ 5 feet~~ ~~10 feet~~ ~~15 feet~~ ~~20 feet~~	~~0.90~~ ~~1.00~~ ~~1.10~~ ~~Not permitted~~	
~~3~~	~~Wall height adjustment~~	~~Any story~~	~~8 feet~~ ~~9 feet~~ ~~10 feet~~ ~~11 feet~~ ~~12 feet~~	~~0.90~~ ~~0.95~~ ~~1.00~~ ~~1.05~~ ~~1.10~~	
~~4~~	~~Number of braced wall lines (per plan direction)~~[c]	~~Any story~~	~~2~~ ~~3~~ ~~4~~ ~~≥ 5~~	~~1.00~~ ~~1.30~~ ~~1.45~~ ~~1.60~~	
~~5~~	~~Additional 800-pound hold-down device~~	~~Top story only~~	~~Fastened to the end studs of each braced wall panel and to the foundation or framing below~~	~~0.80~~	~~DWB, WSP, SFB, PBS, PCP, HPS~~
~~6~~	~~Interior gypsum board finish (or equivalent)~~	~~Any story~~	~~Omitted from inside face of braced wall panels~~	~~1.40~~	~~DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB~~

~~7~~	~~Gypsum board fastening~~	~~Any story~~	~~4 inches o.c. at panel edges, including top and bottom plates, and all horizontal joints blocked~~	~~0.7~~	~~GB~~

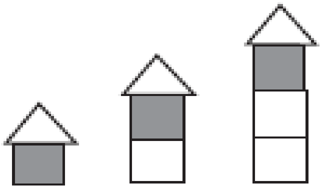
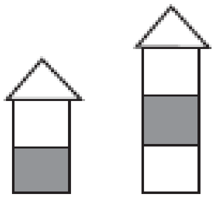
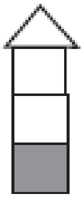
~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.48 N.~~

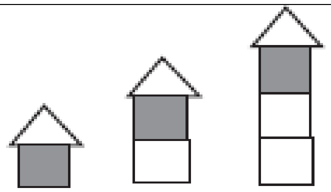
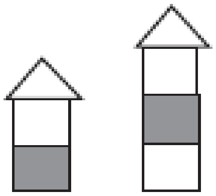
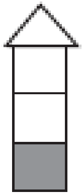
~~a. Linear interpolation shall be permitted.~~

~~b. The total adjustment factor is the product of all applicable adjustment factors.~~

~~c. The adjustment factor is permitted to be 1.0 when determining bracing amounts for intermediate braced wall lines provided the bracing amounts on adjacent braced wall lines are based on a spacing and number that neglects the intermediate braced wall line.~~

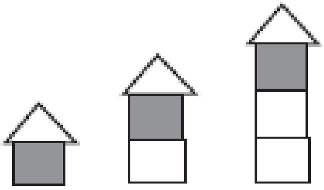
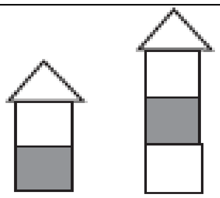
~~TABLE R602.10.3(3)~~
~~BRACING REQUIREMENTS BASED ON SEISMIC DESIGN CATEGORY~~

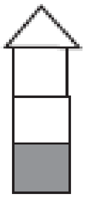
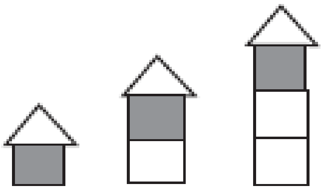
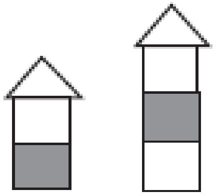
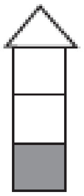
~~SOIL CLASS D~~[~~b~~] ~~WALL HEIGHT = 10 FEET~~ ~~10 PSF FLOOR DEAD LOAD~~ ~~15 PSF ROOF/CEILING DEAD LOAD~~ ~~BRACED WALL LINE SPACING ≤ 25 FEET~~			~~MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE~~[~~a~~]				
~~Seismic Design Category~~	**~~Story Location~~**	**~~Braced Wall Line Length (feet)~~**[~~c~~]	**~~Method LIB~~**[~~d~~]	**~~Method GB~~**	**~~Methods DWB, SFB, PBS, PCP, HPS, CS-SFB~~**[~~e~~]	**~~Method WSP~~**	**~~Methods CS-WSP, CS-G~~**
~~C (townhouses only)~~		~~10~~	~~2.5~~	~~2.5~~	~~2.5~~	~~1.6~~	~~1.4~~
		~~20~~	~~5.0~~	~~5.0~~	~~5.0~~	~~3.2~~	~~2.7~~
		~~30~~	~~7.5~~	~~7.5~~	~~7.5~~	~~4.8~~	~~4.1~~
		~~40~~	~~10.0~~	~~10.0~~	~~10.0~~	~~6.4~~	~~5.4~~
		~~50~~	~~12.5~~	~~12.5~~	~~12.5~~	~~8.0~~	~~6.8~~
		~~10~~	~~NP~~	~~4.5~~	~~4.5~~	~~3.0~~	~~2.6~~
		~~20~~	~~NP~~	~~9.0~~	~~9.0~~	~~6.0~~	~~5.1~~
		~~30~~	~~NP~~	~~13.5~~	~~13.5~~	~~9.0~~	~~7.7~~
		~~40~~	~~NP~~	~~18.0~~	~~18.0~~	~~12.0~~	~~10.2~~
		~~50~~	~~NP~~	~~22.5~~	~~22.5~~	~~15.0~~	~~12.8~~
		~~10~~	~~NP~~	~~6.0~~	~~6.0~~	~~4.5~~	~~3.8~~
		~~20~~	~~NP~~	~~12.0~~	~~12.0~~	~~9.0~~	~~7.7~~
		~~30~~	~~NP~~	~~18.0~~	~~18.0~~	~~13.5~~	~~11.5~~
		~~40~~	~~NP~~	~~24.0~~	~~24.0~~	~~18.0~~	~~15.3~~
		~~50~~	~~NP~~	~~30.0~~	~~30.0~~	~~22.5~~	~~19.1~~
		~~10~~	~~NP~~	~~2.8~~	~~2.8~~	~~1.8~~	~~1.6~~

~~D_0~~		~~20~~ ~~30~~ ~~40~~ ~~50~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~5.5~~ ~~8.3~~ ~~11.0~~ ~~13.8~~	~~5.5~~ ~~8.3~~ ~~11.0~~ ~~13.8~~	~~3.6~~ ~~5.4~~ ~~7.2~~ ~~9.0~~	~~3.1~~ ~~4.6~~ ~~6.1~~ ~~7.7~~
		~~10~~ ~~20~~ ~~30~~ ~~40~~ ~~50~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~5.3~~ ~~10.5~~ ~~15.8~~ ~~21.0~~ ~~26.3~~	~~5.3~~ ~~10.5~~ ~~15.8~~ ~~21.0~~ ~~26.3~~	~~3.8~~ ~~7.5~~ ~~11.3~~ ~~15.0~~ ~~18.8~~	~~3.2~~ ~~6.4~~ ~~9.6~~ ~~12.8~~ ~~16.0~~
		~~10~~ ~~20~~ ~~30~~ ~~40~~ ~~50~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~7.3~~ ~~14.5~~ ~~21.8~~ ~~29.0~~ ~~36.3~~	~~7.3~~ ~~14.5~~ ~~21.8~~ ~~29.0~~ ~~36.3~~	~~5.3~~ ~~10.5~~ ~~15.8~~ ~~21.0~~ ~~26.3~~	~~4.5~~ ~~9.0~~ ~~13.4~~ ~~17.9~~ ~~22.3~~

~~(continued)~~

~~TABLE R602.10.3(3)—continued~~
~~BRACING REQUIREMENTS BASED ON SEISMIC DESIGN CATEGORY~~

~~SOIL CLASS D~~[~~b~~] ~~WALL HEIGHT = 10 FEET~~ ~~10 PSF FLOOR DEAD LOAD~~ ~~15 PSF ROOF/CEILING DEAD LOAD~~ ~~BRACED WALL LINE SPACING ≤ 25 FEET~~			~~MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE~~[~~a~~]				
~~Seismic Design Category~~	**~~Story Location~~**	**~~Braced Wall Line Length (feet)~~**[~~c~~]	**~~Method LIB~~**[~~d~~]	**~~Method GB~~**	**~~Methods DWB, SFB, PBS, PCP, HPS, CS-SFB~~**[~~e~~]	**~~Method WSP~~**	**~~Methods CS-WSP, CS-G~~**
~~D_1~~		~~10~~ ~~20~~ ~~30~~ ~~40~~ ~~50~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~3.0~~ ~~6.0~~ ~~9.0~~ ~~12.0~~ ~~15.0~~	~~3.0~~ ~~6.0~~ ~~9.0~~ ~~12.0~~ ~~15.0~~	~~2.0~~ ~~4.0~~ ~~6.0~~ ~~8.0~~ ~~10.0~~	~~1.7~~ ~~3.4~~ ~~5.1~~ ~~6.8~~ ~~8.5~~
		~~10~~ ~~20~~ ~~30~~ ~~40~~ ~~50~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~6.0~~ ~~12.0~~ ~~18.0~~ ~~24.0~~ ~~30.0~~	~~6.0~~ ~~12.0~~ ~~18.0~~ ~~24.0~~ ~~30.0~~	~~4.5~~ ~~9.0~~ ~~13.5~~ ~~18.0~~ ~~22.5~~	~~3.8~~ ~~7.7~~ ~~11.5~~ ~~15.3~~ ~~19.1~~
		~~10~~	~~NP~~	~~8.5~~	~~8.5~~	~~6.0~~	~~5.1~~

		~~20~~ ~~30~~ ~~40~~ ~~50~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~17.0~~ ~~25.5~~ ~~34.0~~ ~~42.5~~	~~17.0~~ ~~25.5~~ ~~34.0~~ ~~42.5~~	~~12.0~~ ~~18.0~~ ~~24.0~~ ~~30.0~~	~~10.2~~ ~~15.3~~ ~~20.4~~ ~~25.5~~
~~D_2~~		~~10~~ ~~20~~ ~~30~~ ~~40~~ ~~50~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~4.0~~ ~~8.0~~ ~~12.0~~ ~~16.0~~ ~~20.0~~	~~4.0~~ ~~8.0~~ ~~12.0~~ ~~16.0~~ ~~20.0~~	~~2.5~~ ~~5.0~~ ~~7.5~~ ~~10.0~~ ~~12.5~~	~~2.1~~ ~~4.3~~ ~~6.4~~ ~~8.5~~ ~~10.6~~
		~~10~~ ~~20~~ ~~30~~ ~~40~~ ~~50~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~7.5~~ ~~15.0~~ ~~22.5~~ ~~30.0~~ ~~37.5~~	~~7.5~~ ~~15.0~~ ~~22.5~~ ~~30.0~~ ~~37.5~~	~~5.5~~ ~~11.0~~ ~~16.5~~ ~~22.0~~ ~~27.5~~	~~4.7~~ ~~9.4~~ ~~14.0~~ ~~18.7~~ ~~23.4~~
		~~10~~ ~~20~~ ~~30~~ ~~40~~ ~~50~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~
	~~Cripple wall below one- or two-story dwelling~~	~~10~~ ~~20~~ ~~30~~ ~~40~~ ~~50~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~ ~~NP~~	~~7.5~~ ~~15.0~~ ~~22.5~~ ~~30.0~~ ~~37.5~~	~~6.4~~ ~~12.8~~ ~~19.1~~ ~~25.5~~ ~~31.9~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.~~

~~a. Linear interpolation shall be permitted.~~

~~b. Wall bracing lengths are based on a soil site class "D." Interpolation of bracing length between the S_{ds} values associated with the seismic design categories shall be permitted when a site-specific S_{ds} value is determined in accordance with Section 1613.3 of the *International Building Code*.~~

~~c. Where the braced wall line length is greater than 50 feet, braced wall lines shall be permitted to be divided into shorter segments having lengths of 50 feet or less, and the amount of bracing within each segment shall be in accordance with this table.~~

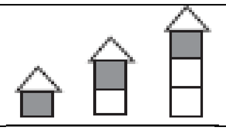
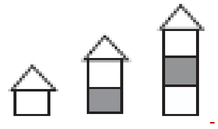
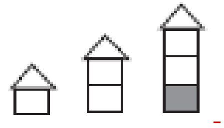
~~d. Method LIB shall have gypsum board fastened to not less than one side with nails or screws in accordance with Table R602.3(1) for exterior sheathing or Table R702.3.5 for interior gypsum board. Spacing of fasteners at panel edges shall not exceed 8 inches.~~

~~e. Method CS-SFB does not apply in Seismic Design Categories D_0, D_1 and D_2.~~

~~TABLE R602.10.3(4)~~

~~SEISMIC ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING~~

~~ITEM NUMBER~~	~~ADJUSTMENT BASED ON:~~	~~STORY~~	~~CONDITION~~	~~ADJUSTMENT FACTOR~~[~~a, b~~] ~~[Multiply length from Table~~	~~APPLICABLE METHODS~~

				~~R602.10.3(3) by this factor]~~	
~~1~~	~~Story height (Section 301.3)~~	~~Any story~~	~~≤ 10 feet~~ ~~> 10 feet and ≤ 12 feet~~	~~1.0~~ ~~1.2~~	~~All methods~~
~~2~~	~~Braced wall line spacing, townhouses in SDC C~~	~~Any story~~	~~≤ 35 feet~~ ~~> 35 feet and ≤ 50 feet~~	~~1.0~~ ~~1.43~~	
~~3~~	~~Braced wall line spacing, in SDC D_0, D_1, D_2~~[~~c~~]	~~Any story~~	~~> 25 feet and ≤ 30 feet~~ ~~> 30 feet and ≤ 35 feet~~	~~1.2~~ ~~1.4~~	
~~4~~	~~Wall dead load~~	~~Any story~~	~~> 8 psf and < 15 psf~~ ~~< 8 psf~~	~~1.0~~ ~~0.85~~	
~~5~~	~~Roof/ceiling dead load for wall supporting~~	~~1-, 2- or 3-story building~~	~~≤15 psf~~	~~1.0~~	
		~~2- or 3-story building~~	~~> 15 psf and ≤ 25 psf~~	~~1.1~~	
		~~1-story building~~	~~> 15 psf and ≤ 25 psf~~	~~1.2~~	
~~6~~	~~Walls with stone or masonry veneer, townhouses in SDC C~~[~~d, e~~]		~~1.0~~		~~All methods~~
			~~1.5~~		
			~~1.5~~		
~~7~~	~~Walls with stone or masonry veneer, detached one- and two-family dwellings in SDC D_0 — D_2~~[~~f~~]	~~Any story~~	~~See Table R602.10.6.5~~		~~BV-WSP~~

~~8~~	~~Interior gypsum board finish (or equivalent)~~	~~Any story~~	~~Omitted from inside face of braced wall panels~~	~~1.5~~	~~DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB~~

~~For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.~~

~~a. Linear interpolation shall be permitted.~~

~~b. The total length of bracing required for a given wall line is the product of all applicable adjustment factors.~~

~~c. The length-to-width ratio for the floor/roof *diaphragm* shall not exceed 3:1. The top plate lap splice nailing shall be in accordance with Table R602.3(1), Item 13.~~

~~d. Applies to stone or masonry veneer exceeding the first story height.~~

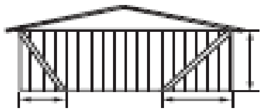
~~e. The adjustment factor for stone or masonry veneer shall be applied to all exterior *braced wall lines* and all *braced wall lines* on the interior of the building, backing or perpendicular to and laterally supported veneered walls.~~

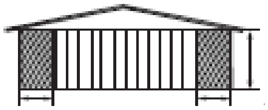
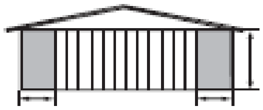
~~f. See Section R602.10.6.5 for requirements where stone or masonry veneer does not exceed the first-story height.~~

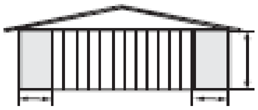
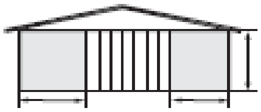
~~R602.10.4 Construction methods for braced wall panels.~~

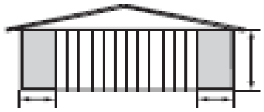
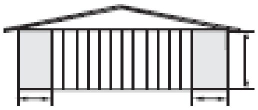
~~Intermittent and continuously sheathed *braced wall panels* shall be constructed in accordance with this section and the methods listed in Table R602.10.4.~~

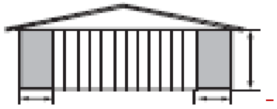
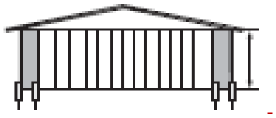
~~TABLE R602.10.4~~ ~~BRACING METHODS~~

~~METHODS, MATERIAL~~		~~MINIMUM THICKNESS~~	~~FIGURE~~	~~CONNECTION CRITERIA~~[a]	
		~~Fasteners~~			~~Spacing~~
~~Intermittent Bracing Method~~	~~**LIB**~~ ~~Let-in-bracing~~	~~1 × 4 wood or approved metal straps at 45° to 60° angles for maximum 16″ stud spacing~~	 -	~~Wood: 2-8d common nails or 3-8d (2 1/2″ long x 0.113″ dia.) nails~~	~~Wood: per stud and top and bottom plates~~
				~~Metal strap: per manufacturer~~	~~Metal: per manufacturer~~

	~~DWB~~ ~~Diagonal wood boards~~	~~3/4″(1″ nominal) for maximum 24″ stud spacing~~		~~2-8d (2 1/2″ long × 0.113″ dia.) nails or 2 - 1 3/4″ long staples~~	~~Per stud~~
	~~WSP~~ ~~Wood structural panel (See Section R604)~~	~~3/8″~~		~~Exterior sheathing per Table R602.3(3)~~	~~6″ edges 12″ field~~
				~~Interior sheathing per Table R602.3(1) or R602.3(2)~~	~~Varies by fastener~~
	~~BV-WSP~~[e] ~~Wood structural panels with stone or masonry veneer (See Section R602.10.6.5)~~	~~7/16″~~	~~See Figure R602.10.6.5~~	~~8d common (2 1/2″ × 0.131) nails~~	~~4″ at panel edges 12″ at intermediate supports 4″ at braced wall panel end posts~~

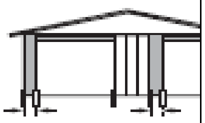
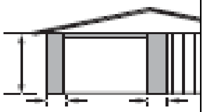
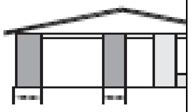
	~~**SFB**~~ ~~Structural fiberboard sheathing~~	~~1/2″ or 25/32″ for maximum 16″ stud spacing~~		~~1 1/2″ long × 0.12″ dia. (for 1/2″ thick sheathing) 1 3/4″ long × 0.12″ dia. (for 25/32″ thick sheathing) galvanized roofing nails or 8d common (2 1/2″ long × 0.131″ dia.) nails~~	~~3″ edges 6″ field~~
	~~**GB**~~ ~~Gypsum board~~	~~1/2″~~		~~Nails or screws per Table R602.3(1) for exterior locations~~	~~For all braced wall panel locations: 7″ edges (including top and bottom plates) 7″ field~~

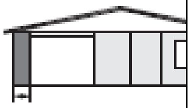
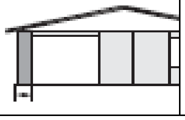
				~~Nails or screws per Table R702.3.5 for interior locations~~	
	~~**PBS** Particleboard sheathing (See Section R605)~~	~~3/8″ or 1/2″ for maximum 16″ stud spacing~~		~~For 3/8″, 6d common (2″ long × 0.113″ dia.) nails For 1/2″, 8d common (2 1/2″ long × 0.131″ dia.) nails~~	~~3″ edges 6″ field~~
	~~**PCP** Portland cement plaster~~	~~See Section R703.6 for maximum 16″ stud spacing~~		~~1 1/2″ long, 11 gage, 7/16″ dia. head nails or 7/8″ long, 16 gage staples~~	~~6″ o.c. on all framing members~~

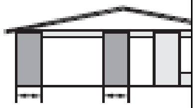
	~~**HPS**~~ ~~Hardboard panel siding~~	~~7/16″ for maximum 16″ stud spacing~~		~~0.092″ dia., 0.225″ dia. head nails with length to accommodate 1 1/2″ penetration into studs~~	~~4″ edges 8″ field~~
	~~**ABW**~~ ~~Alternate braced wall~~	~~3/8″~~		~~See Section R602.10.6.1~~	~~See Section R602.10.6.1~~

~~*(continued)*~~

~~TABLE R602.10.4—continued~~
~~BRACING METHODS~~

~~**METHODS, MATERIAL**~~		~~**MINIMUM THICKNESS**~~	~~**FIGURE**~~	~~**CONNECTION CRITERIA**~~[a]	
				~~**Fasteners**~~	~~**Spacing**~~
~~Intermittent Bracing Methods~~	~~**PFH**~~ ~~Portal frame with hold-downs~~	~~3/8″~~		~~See Section R602.10.6.2~~	~~See Section R602.10.6.2~~
	~~**PFG**~~ ~~Portal frame at garage~~	~~7/16″~~		~~See Section R602.10.6.3~~	~~See Section R602.10.6.3~~
~~Continuous Sheathing Methods~~	~~**CS-WSP**~~ ~~Continuously sheathed wood structural panel~~	~~3/8″~~		~~Exterior sheathing per Table R602.3(3)~~	~~6″ edges 12″ field~~

				~~Interior sheathing per Table R602.3(1) or R602.3(2)~~	~~Varies by fastener~~
	~~**CS-G**~~~~[b, c]~~ ~~Continuously sheathed wood structural panel adjacent to garage openings~~	~~3/8″~~		~~See Method CS-WSP~~	~~See Method CS-WSP~~
	~~**CS-PF**~~ ~~Continuously sheathed portal frame~~	~~7/16″~~		~~See Section R602.10.6.4~~	~~See Section R602.10.6.4~~

	~~**CS-SFB**~~[~~d~~] ~~Continuously sheathed structural fiberboard~~	~~1/2″ or 25/32″ for maximum 16″ stud spacing~~		~~1 1/2″ long × 0.12″ dia. (for 1/2″ thick sheathing) 1 3/4″ long × 0.12″ dia. (for 25/32″ thick sheathing) galvanized roofing nails or 8d common (2 1/2″ long × 0.131″ dia.) nails~~	~~3″ edges 6″ field~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad, 1 pound per square foot = 47.8 N/m~~^{2}~~, 1 mile per hour = 0.447 m/s.~~

~~a. Adhesive attachment of wall sheathing, including Method GB, shall not be permitted in Seismic Design Categories C,~~ D_0, D_1 ~~and~~ D_2.

~~b. Applies to panels next to garage door opening where supporting gable end wall or roof load only. Shall only be used on one wall of the garage. In Seismic Design Categories~~ D_0, D_1 ~~and~~ D_2, ~~roof covering dead load shall not exceed 3 psf.~~

~~c. Garage openings adjacent to a Method CS-G panel shall be provided with a header in accordance with Table R502.5(1). A full-height clear opening shall not be permitted adjacent to a Method CS-G panel.~~

~~d. Method CS-SFB does not apply in Seismic Design Categories~~ D_0, D_1 ~~and~~ D_2.

~~e. Method applies to detached one- and two-family dwellings in Seismic Design Categories~~ D_0 ~~through~~ D_2 ~~only.~~

~~**R602.10.4.1 Mixing methods.**~~

~~Mixing of bracing methods shall be permitted as follows:~~

1. ~~Mixing intermittent bracing and continuous sheathing methods from story to story shall be permitted.~~

2. ~~Mixing intermittent bracing methods from *braced wall line* to *braced wall line* within a story shall be permitted. In regions within Seismic Design Categories A, B and C or where the ultimate design wind speed is less than or equal to 130 mph (58m/s), mixing of intermittent bracing and continuous sheathing methods from braced wall line to braced wall line within a story shall be permitted.~~

3. ~~Mixing intermittent bracing methods along a *braced wall line* shall be permitted in Seismic Design Categories A and B, and detached dwellings in Seismic Design Category C, provided the length of required bracing in accordance with Table R602.10.3(1) or R602.10.3(3) is the highest value of all intermittent bracing methods used.~~

4. ~~Mixing of continuous sheathing methods CS-WSP, CS-G and CS-PF along a *braced wall line* shall be permitted. Intermittent methods ABW, PFH and PFG shall be permitted to be used along a *braced wall line* with continuous sheathed methods.~~

5. ~~In Seismic Design Categories A and B, and for detached one- and two-family dwellings in Seismic Design Category C, mixing of intermittent bracing methods along the interior portion of a *braced wall line* with continuous sheathing methods CS-WSP, CS-G and CS-PF along the exterior portion of the same braced wall line shall be permitted. The length of required bracing shall be the highest value of all intermittent bracing methods used in accordance with Table R602.10.3(1) or R602.10.3(3) as adjusted by Tables R602.10.3(2) and R602.10.3(4), respectively. The requirements of Section R602.10.7 shall apply to each end of the continuously sheathed portion of the braced wall line.~~

~~R602.10.4.2 Continuous sheathing methods.~~

~~Continuous sheathing methods require structural panel sheathing to be used on all sheathable surfaces on one side of a *braced wall line* including areas above and below openings and gable end walls and shall meet the requirements of Section R602.10.7.~~

~~R602.10.4.3 Braced wall panel interior finish material.~~

~~*Braced wall panels* shall have gypsum wall board installed on the side of the wall opposite the bracing material. Gypsum wall board shall be not less than $^1/_2$ inch (12.7 mm) in thickness and be fastened with nails or screws in accordance with Table R602.3(1) for exterior sheathing or Table R702.3.5 for interior gypsum wall board. Spacing of fasteners at panel edges for gypsum wall board opposite Method LIB bracing shall not exceed 8 inches (203 mm). Interior finish material shall not be glued in Seismic Design Categories D_0, D_1 and D_2.~~

~~**Exceptions:**~~

1. ~~Interior finish material is not required opposite wall panels that are braced in accordance with Methods GB, BV-WSP, ABW, PFH, PFG and CS-PF, unless otherwise required by Section R302.6.~~

~~2. An approved interior finish material with an in-plane shear resistance equivalent to gypsum board shall be permitted to be substituted, unless otherwise required by Section R302.6.~~

~~3. Except for Method LIB, gypsum wall board is permitted to be omitted provided the required length of bracing in Tables R602.10.3(1) and R602.10.3(3) is multiplied by the appropriate adjustment factor in Tables R602.10.3(2) and R602.10.3(4), respectively, unless otherwise required by Section R302.6.~~

~~R602.10.5 Minimum length of a braced wall panel.~~
~~The minimum length of a *braced wall panel* shall comply with Table R602.10.5. For Methods CS-WSP and CS-SFB, the minimum panel length shall be based on the adjacent clear opening height in accordance with Table R602.10.5 and Figure R602.10.5. Where a panel has an opening on either side of differing heights, the taller opening height shall be used to determine the panel length.~~

~~TABLE R602.10.5~~
~~MINIMUM LENGTH OF BRACED WALL PANELS~~

~~METHOD (See Table R602.10.4)~~		~~MINIMUM LENGTH~~[a] ~~(inches)~~					~~CONTRIBUTING LENGTH (inches)~~
		~~Wall Height~~					
		~~8 feet~~	~~9 feet~~	~~10 feet~~	~~11 feet~~	~~12 feet~~	
~~DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP~~		~~48~~	~~48~~	~~48~~	~~53~~	~~58~~	~~Actual~~[b]
~~GB~~		~~48~~	~~48~~	~~48~~	~~53~~	~~58~~	~~Double sided = Actual~~ ~~Single sided = 0.5 × Actual~~
~~LIB~~		~~55~~	~~62~~	~~69~~	~~NP~~	~~NP~~	~~Actual~~[b]
~~ABW~~	~~SDC A, B and C, ultimate design wind speed < 140 mph~~	~~28~~	~~32~~	~~34~~	~~38~~	~~42~~	~~48~~
	~~SDC D_0, D_1 and D_2, ultimate design wind speed < 140 mph~~	~~32~~	~~32~~	~~34~~	~~NP~~	~~NP~~	
~~PFH~~	~~Supporting roof only~~	~~16~~	~~16~~	~~16~~	~~18~~[c]	~~20~~[c]	~~48~~
	~~Supporting one story and roof~~	~~24~~	~~24~~	~~24~~	~~27~~[c]	~~29~~[c]	~~48~~
~~PFG~~		~~24~~	~~27~~	~~30~~	~~33~~[d]	~~36~~[d]	~~1.5 × Actual~~[b]
~~CS-G~~		~~24~~	~~27~~	~~30~~	~~33~~	~~36~~	~~Actual~~[b]
~~CS-PF~~	~~SDC A, B and C~~	~~16~~	~~18~~	~~20~~	~~22~~[e]	~~24~~[e]	~~1.5 × Actual~~[b]
	~~SDC D_0, D_1 and D_2~~	~~16~~	~~18~~	~~20~~	~~22~~[e]	~~24~~[e]	~~Actual~~[b]

~~CS-WSP, CS-SFB~~	~~Adjacent clear opening height (inches)~~						
	~~≤ 64~~	~~24~~	~~27~~	~~30~~	~~33~~	~~36~~	~~Actual[b]~~
	~~68~~	~~26~~	~~27~~	~~30~~	~~33~~	~~36~~	
	~~72~~	~~27~~	~~27~~	~~30~~	~~33~~	~~36~~	
	~~76~~	~~30~~	~~29~~	~~30~~	~~33~~	~~36~~	
	~~80~~	~~32~~	~~30~~	~~30~~	~~33~~	~~36~~	
	~~84~~	~~35~~	~~32~~	~~32~~	~~33~~	~~36~~	
	~~88~~	~~38~~	~~35~~	~~33~~	~~33~~	~~36~~	
	~~92~~	~~43~~	~~37~~	~~35~~	~~35~~	~~36~~	
	~~96~~	~~48~~	~~41~~	~~38~~	~~36~~	~~36~~	
	~~100~~	~~—~~	~~44~~	~~40~~	~~38~~	~~38~~	
	~~104~~	~~—~~	~~49~~	~~43~~	~~40~~	~~39~~	
	~~108~~	~~—~~	~~54~~	~~46~~	~~43~~	~~41~~	
	~~112~~	~~—~~	~~—~~	~~50~~	~~45~~	~~43~~	
	~~116~~	~~—~~	~~—~~	~~55~~	~~48~~	~~45~~	
	~~120~~	~~—~~	~~—~~	~~60~~	~~52~~	~~48~~	
	~~124~~	~~—~~	~~—~~	~~—~~	~~56~~	~~51~~	
	~~128~~	~~—~~	~~—~~	~~—~~	~~61~~	~~54~~	
	~~132~~	~~—~~	~~—~~	~~—~~	~~66~~	~~58~~	
	~~136~~	~~—~~	~~—~~	~~—~~	~~—~~	~~62~~	
	~~140~~	~~—~~	~~—~~	~~—~~	~~—~~	~~66~~	
	~~144~~	~~—~~	~~—~~	~~—~~	~~—~~	~~72~~	

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.~~

~~NP = Not Permitted.~~

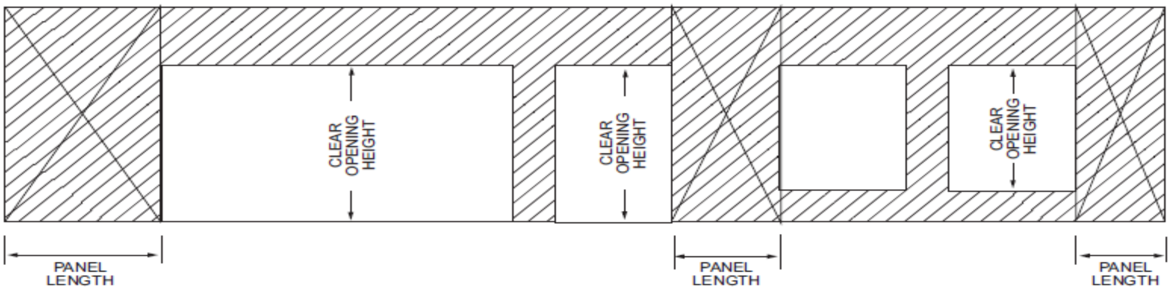
~~a. Linear interpolation shall be permitted.~~

~~b. Use the actual length where it is greater than or equal to the minimum length.~~

~~c. Maximum header height for PFH is 10 feet in accordance with Figure R602.10.6.2, but wall height shall be permitted to be increased to 12 feet with pony wall.~~

~~d. Maximum opening height for PFG is 10 feet in accordance with Figure R602.10.6.3, but wall height shall be permitted to be increased to 12 feet with pony wall.~~

~~e. Maximum opening height for CS-PF is 10 feet in accordance with Figure R602.10.6.4, but wall height shall be permitted to be increased to 12 feet with pony wall~~



~~FIGURE R602.10.5~~
~~BRACED WALL PANELS WITH CONTINUOUS SHEATHING~~

~~R602.10.5.1 Contributing length.~~

~~For purposes of computing the required length of bracing in Tables R602.10.3(1) and R602.10.3(3), the contributing length of each *braced wall panel* shall be as specified in Table R602.10.5.~~

~~R602.10.5.2 Partial credit.~~

~~For Methods DWB, WSP, SFB, PBS, PCP and HPS in Seismic Design Categories A, B and C, panels between 36 inches and 48 inches (914 mm and 1219 mm)) in length shall be considered a *braced wall panel* and shall be permitted to partially contribute toward the required length of bracing in Tables R602.10.3(1) and R602.10.3(3), and the contributing length shall be determined from Table R602.10.5.2.~~

~~TABLE R602.10.5.2~~

~~PARTIAL CREDIT FOR BRACED WALL PANELS LESS THAN 48 INCHES IN ACTUAL LENGTH~~

~~ACTUAL LENGTH OF BRACED WALL PANEL (inches)~~	**~~CONTRIBUTING LENGTH OF BRACED WALL PANEL (inches)~~[a]**	
	~~8-foot Wall Height~~	**~~9-foot Wall Height~~**
~~48~~	~~48~~	~~48~~
~~42~~	~~36~~	~~36~~
~~36~~	~~27~~	~~N/A~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.~~
~~N/A = Not Applicable.~~
~~a. Linear interpolation shall be permitted.~~

~~R602.10.6 Construction of Methods ABW, PFH, PFG, CS-PF and BV-WSP.~~

~~Methods ABW, PFH, PFG, CS-PF and BV-WSP shall be constructed as specified in Sections R602.10.6.1 through R602.10.6.5.~~

~~R602.10.6.1 Method ABW: Alternate braced wall panels.~~

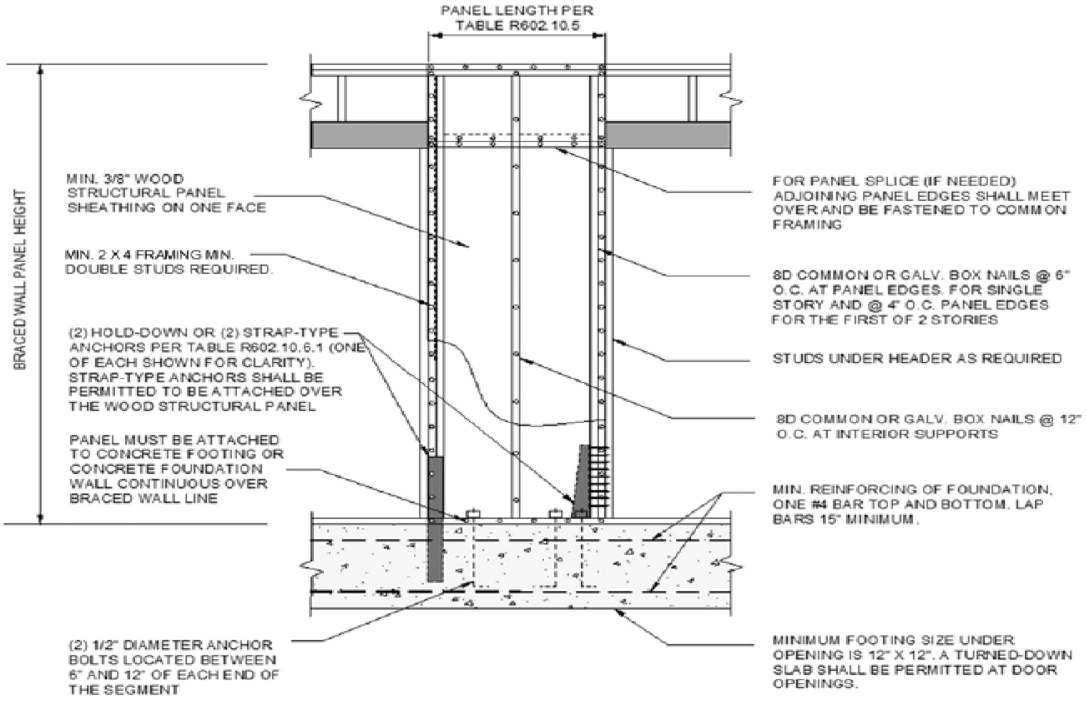
~~Method ABW *braced wall panels* shall be constructed in accordance with Figure R602.10.6.1. The hold-down force shall be in accordance with Table R602.10.6.1.~~

~~TABLE R602.10.6.1~~

~~MINIMUM HOLD-DOWN FORCES FOR METHOD ABW BRACED WALL PANELS~~

~~SEISMIC DESIGN CATEGORY AND WIND SPEED~~	**~~SUPPORTING/STORY~~**	**~~HOLD-DOWN FORCE (pounds)~~**				
		~~Height of Braced Wall Panel~~				
		~~8 feet~~	**~~9 feet~~**	**~~10 feet~~**	**~~11 feet~~**	**~~12 feet~~**
~~SDC A, B and C~~ ~~Ultimate design wind speed < 140 mph~~	~~One story~~	~~1,800~~	~~1,800~~	~~1,800~~	~~2,000~~	~~2,200~~
	~~First of two stories~~	~~3,000~~	~~3,000~~	~~3,000~~	~~3,300~~	~~3,600~~
~~SDC D_0, D_1 and D_2~~ ~~Ultimate design wind speed <140 mph~~	~~One story~~	~~1,800~~	~~1,800~~	~~1,800~~	~~NP~~	~~NP~~
	~~First of two stories~~	~~3,000~~	~~3,000~~	~~3,000~~	~~NP~~	~~NP~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.45 N, 1 mile per hour = 0.447 m/s.~~
~~NP = Not Permitted.~~

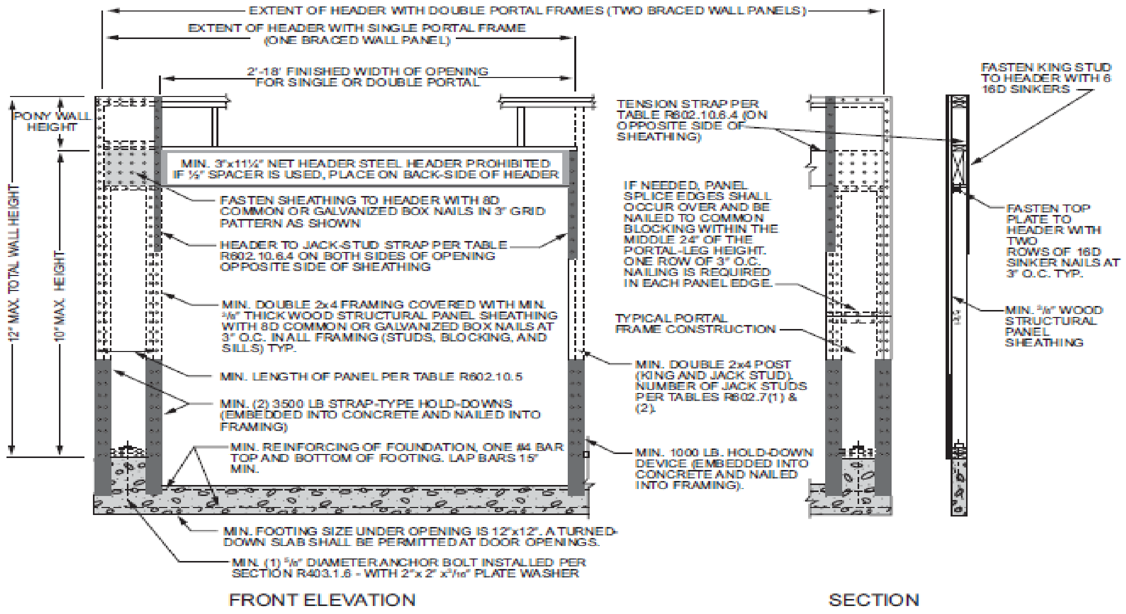


~~For SI: 1 inch = 25.4 mm.~~

~~**FIGURE R602.10.6.1**~~
~~**METHOD ABW—ALTERNATE BRACED WALL PANEL**~~

~~R602.10.6.2 Method PFH: Portal frame with hold-downs.~~

~~Method PFH *braced wall panels* shall be constructed in accordance with Figure R602.10.6.2.~~

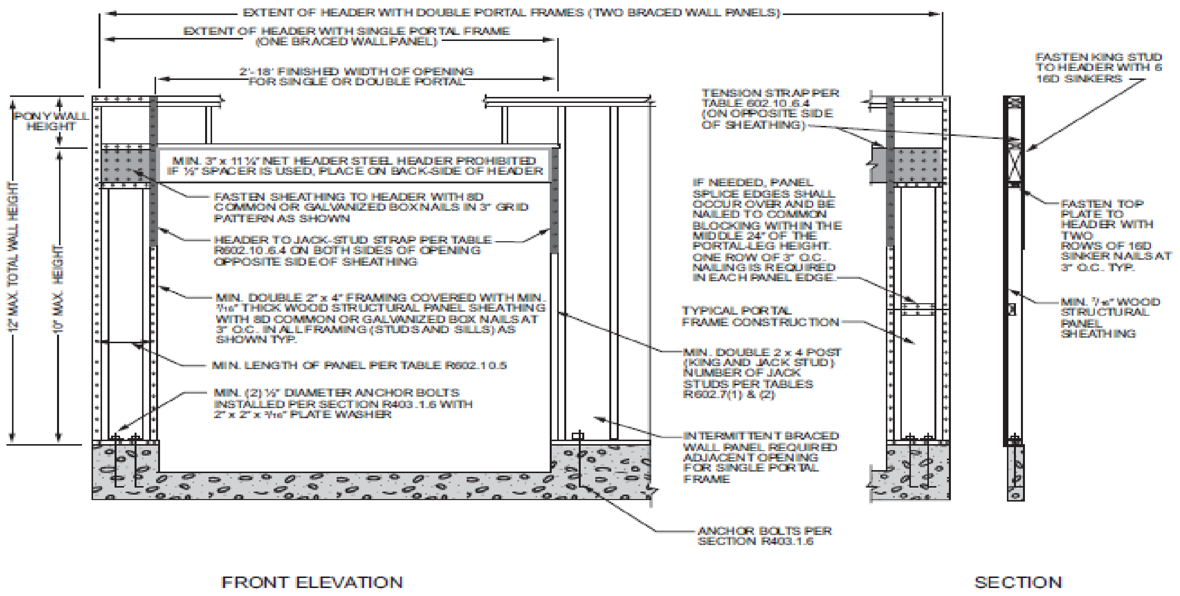


~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.~~

~~FIGURE R602.10.6.2~~
~~METHOD PFH—PORTAL FRAME WITH HOLD-DOWNS~~

~~R602.10.6.3 Method PFG: Portal frame at garage door openings in Seismic Design Categories A, B and C.~~

~~Where supporting a roof or one story and a roof, a Method PFG *braced wall panel* constructed in accordance with Figure R602.10.6.3 shall be permitted on either side of garage door openings.~~

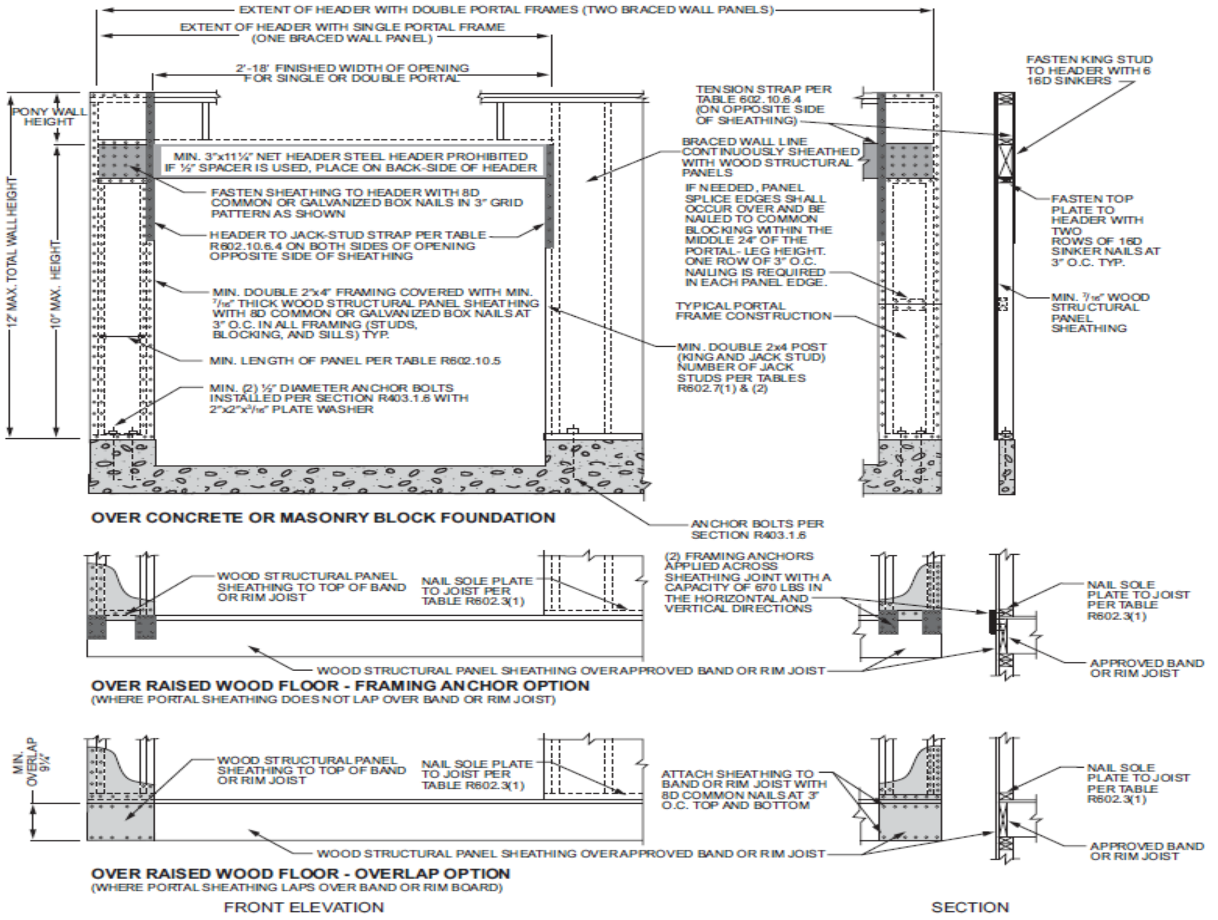


~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.~~

~~FIGURE R602.10.6.3~~
~~METHOD PFG—PORTAL FRAME AT GARAGE DOOR OPENINGS IN SEISMIC DESIGN CATEGORIES A, B AND C~~

~~R602.10.6.4 Method CS-PF: Continuously sheathed portal frame.~~

~~Continuously sheathed portal frame *braced wall panels* shall be constructed in accordance with Figure R602.10.6.4 and Table R602.10.6.4. The number of continuously sheathed portal frame panels in a single *braced wall line* shall not exceed four.~~



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

~~FIGURE R602.10.6.4~~
~~METHOD CS-PF—CONTINUOUSLY SHEATHED PORTAL FRAME PANEL CONSTRUCTION~~

~~TABLE R602.10.6.4~~
~~TENSION STRAP CAPACITY FOR RESISTING WIND PRESSURES PERPENDICULAR TO METHODS PFH, PFG AND CS-PF BRACED WALL PANELS~~

~~MINIMUM WALL STUD FRAMING NOMINAL SIZE AND GRADE~~	~~MAXIMUM PONY WALL HEIGHT (feet)~~	~~MAXIMUM TOTAL WALL HEIGHT (feet)~~	~~MAXIMUM OPENING WIDTH (feet)~~	~~TENSION STRAP CAPACITY REQUIRED (pounds)~~ ~~a, b~~					
				~~Ultimate Design Wind Speed V_{ult} (mph)~~					
				~~110~~	~~115~~	~~130~~	~~110~~	~~115~~	~~130~~
				~~Exposure B~~			~~Exposure C~~		
~~2 × 4 No. 2 Grade~~	~~0~~	~~10~~	~~18~~	~~1,000~~	~~1,000~~	~~1,000~~	~~1,000~~	~~1,000~~	~~1,050~~
	~~1~~	~~10~~	~~9~~	~~1,000~~	~~1,000~~	~~1,000~~	~~1,000~~	~~1,000~~	~~1,750~~
			~~16~~	~~1,000~~	~~1,025~~	~~2,050~~	~~2,075~~	~~2,500~~	~~3,950~~
			~~18~~	~~1,000~~	~~1,275~~	~~2,375~~	~~2,400~~	~~2,850~~	~~DR~~
	~~2~~	~~10~~	~~9~~	~~1,000~~	~~1,000~~	~~1,475~~	~~1,500~~	~~1,875~~	~~3,125~~
			~~16~~	~~1,775~~	~~2,175~~	~~3,525~~	~~3,550~~	~~4,125~~	~~DR~~

			~~18~~	~~2,075~~	~~2,500~~	~~3,950~~	~~3,975~~	~~DR~~	~~DR~~
	~~2~~	~~12~~	~~9~~	~~1,150~~	~~1,500~~	~~2,650~~	~~2,675~~	~~3,175~~	~~DR~~
			~~16~~	~~2,875~~	~~3,375~~	~~DR~~	~~DR~~	~~DR~~	~~DR~~
			~~18~~	~~3,425~~	~~3,975~~	~~DR~~	~~DR~~	~~DR~~	~~DR~~
	~~4~~	~~12~~	~~9~~	~~2,275~~	~~2,750~~	~~DR~~	~~DR~~	~~DR~~	~~DR~~
			~~12~~	~~3,225~~	~~3,775~~	~~DR~~	~~DR~~	~~DR~~	~~DR~~
~~2 × 6 Stud Grade~~	~~2~~	~~12~~	~~9~~	~~1,000~~	~~1,000~~	~~1,700~~	~~1,700~~	~~2,025~~	~~3,050~~
			~~16~~	~~1,825~~	~~2,150~~	~~3,225~~	~~3,225~~	~~3,675~~	~~DR~~
			~~18~~	~~2,200~~	~~2,550~~	~~3,725~~	~~3,750~~	~~DR~~	~~DR~~
	~~4~~	~~12~~	~~9~~	~~1,450~~	~~1,750~~	~~2,700~~	~~2,725~~	~~3,125~~	~~DR~~
			~~16~~	~~2,050~~	~~2,400~~	~~DR~~	~~DR~~	~~DR~~	~~DR~~
			~~18~~	~~3,350~~	~~3,800~~	~~DR~~	~~DR~~	~~DR~~	~~DR~~

~~For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.~~
~~a. DR = Design Required.~~
~~b. Straps shall be installed in accordance with manufacturer's recommendations.~~

~~R602.10.6.5 Wall bracing for dwellings with stone and masonry veneer in Seismic Design Categories D0, D1 and D2.~~

~~Where stone and masonry veneer are installed in accordance with Section R703.8, wall bracing on exterior *braced wall lines* and *braced wall lines* on the interior of the building, backing or perpendicular to and laterally supporting veneered walls shall comply with this section.~~

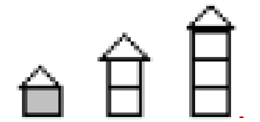
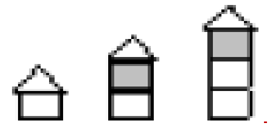
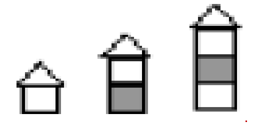
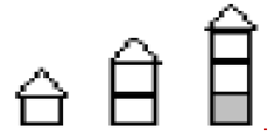
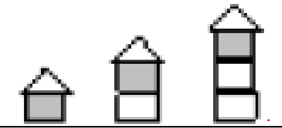
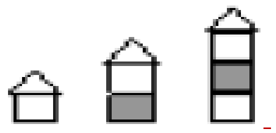
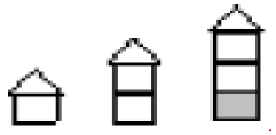
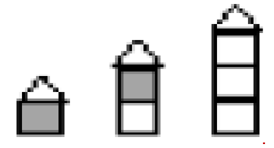
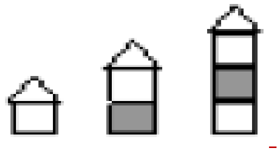
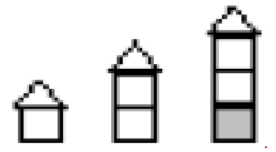
~~Where dwellings in Seismic Design Categories D_0, D_1 and D_2 have stone or masonry veneer installed in accordance with Section R703.7, and the veneer does not exceed the first-story height, wall bracing shall be in accordance with Section R602.10.3.~~

~~Where detached one- or two-family dwellings in Seismic Design Categories D_0, D_1 and D_2 have stone or masonry veneer installed in accordance with Section R703.7, and the veneer exceeds the first-*story height*, wall bracing at exterior *braced wall lines* and *braced wall lines* on the interior of the building shall be constructed using Method BV-WSP in accordance with this section and Figure R602.10.6.5. Cripple walls shall not be permitted, and required interior *braced wall lines* shall be supported on continuous foundations.~~

~~Townhouses in Seismic Design Categories D_0, D_1 and D_2 with stone or masonry veneer exceeding the first-story height shall be designed in accordance with accepted engineering practice.~~

~~TABLE R602.10.6.5~~
~~METHOD BV-WSP WALL BRACING REQUIREMENTS~~

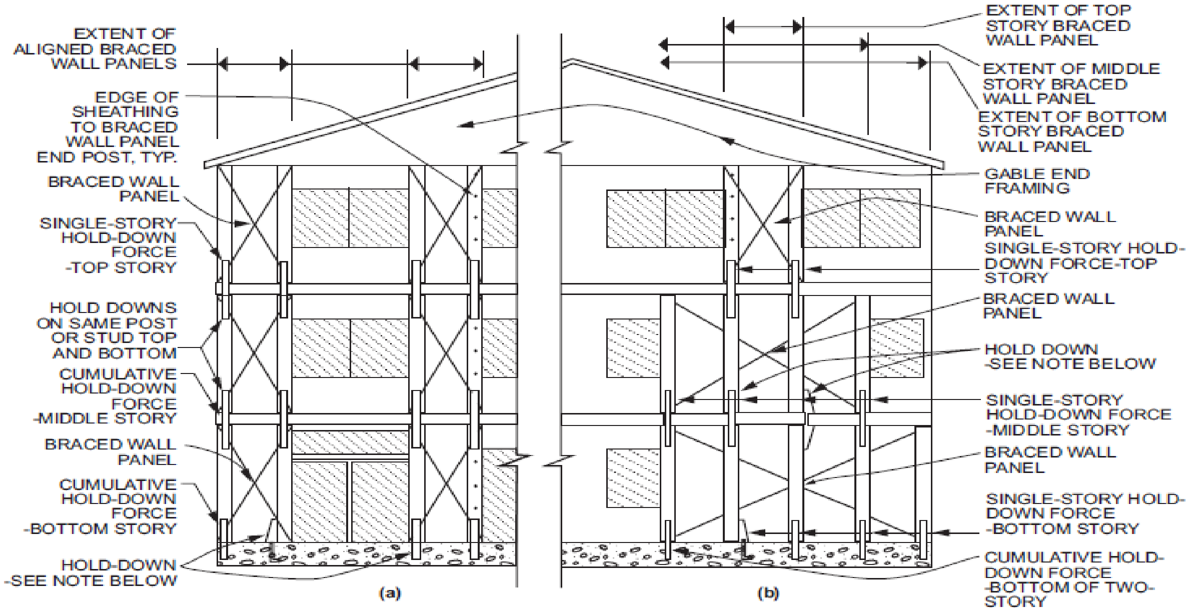
~~**SEISMIC DESIGN CATEGORY**~~	~~**STORY**~~	~~**BRACED WALL LINE LENGTH (FEET)**~~					~~**SINGLE-STORY HOLD-DOWN**~~	~~**CUMULATIVE HOLD-DOWN**~~
		~~**10**~~	~~**20**~~	~~**30**~~	~~**40**~~	~~**50**~~		

		~~Minimum Total Length (feet) of Braced Wall Panels Required Along each Braced Wall Line~~					~~FORCE (pounds)[a]~~	~~FORCE (pounds)[b]~~
~~D_0~~		~~4.0~~	~~7.0~~	~~10.5~~	~~14.0~~	~~17.5~~	~~N/A~~	~~—~~
		~~4.0~~	~~7.0~~	~~10.5~~	~~14.0~~	~~17.5~~	~~1900~~	~~—~~
		~~4.5~~	~~9.0~~	~~13.5~~	~~18.0~~	~~22.5~~	~~3500~~	~~5400~~
		~~6.0~~	~~12.0~~	~~18.0~~	~~24.0~~	~~30.0~~	~~3500~~	~~8900~~
~~D_1~~		~~4.5~~	~~9.0~~	~~13.5~~	~~18.0~~	~~22.5~~	~~2100~~	~~—~~
		~~4.5~~	~~9.0~~	~~13.5~~	~~18.0~~	~~22.5~~	~~3700~~	~~5800~~
		~~6.0~~	~~12.0~~	~~18.0~~	~~24.0~~	~~30.0~~	~~3700~~	~~9500~~
~~D_2~~		~~5.5~~	~~11.0~~	~~16.5~~	~~22.0~~	~~27.5~~	~~2300~~	~~—~~
		~~5.5~~	~~11.0~~	~~16.5~~	~~22.0~~	~~27.5~~	~~3900~~	~~6200~~
		~~NP~~	~~NP~~	~~NP~~	~~NP~~	~~NP~~	~~N/A~~	~~N/A~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.479 kPa, 1 pound-force = 4.448 N.~~
~~NP = Not Permitted.~~
~~N/A = Not Applicable.~~
~~a. Hold-down force is minimum allowable stress design load for connector providing uplift tie from wall framing at end of braced wall panel at the noted story to wall framing at end of braced wall panel at the story below, or to~~

~~foundation or foundation wall. Use single-story hold-down force where edges of braced wall panels do not align; a continuous load path to the foundation shall be maintained.~~

~~b. Where hold-down connectors from stories above align with stories below, use cumulative hold-down force to size middle- and bottom-story hold-down connectors.~~



(a) Braced wall panels stacked (aligned story to story). Use cumulative hold-down force.

Braced wall panels mixed stacked and not stacked. Use hold-down force as noted.

Note: Hold downs should be strap ties, tension ties, or other approved hold-down devices and shall be installed in accordance with the manufacturer's instructions.

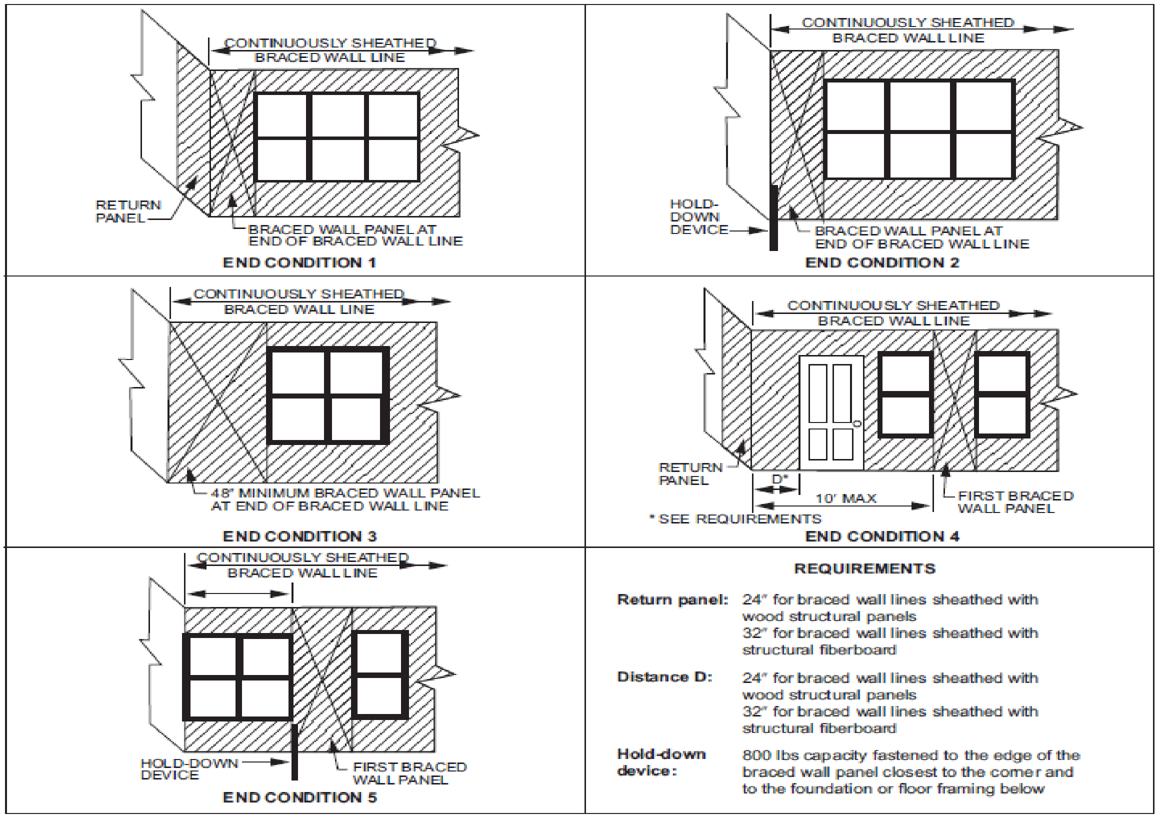
~~FIGURE R602.10.6.5~~
~~METHOD BV-WSP—WALL BRACING FOR DWELLINGS WITH STONE AND MASONRY VENEER IN SEISMIC DESIGN CATEGORIES D_0, D_1 and D_2~~

~~R602.10.6.5.1 Length of bracing.~~

~~The length of bracing along each *braced wall line* shall be the greater of that required by the ultimate design wind speed and *braced wall line* spacing in accordance with Table R602.10.3(1) as adjusted by the factors in Table R602.10.3(2) or the seismic design category and *braced wall line* length in accordance with Table R602.10.6.5. Angled walls shall be permitted to be counted in accordance with Section R602.10.1.4, and *braced wall panel* location shall be in accordance with Section R602.10.2.2. Spacing between *braced wall lines* shall be in accordance with Table R602.10.1.3. The seismic adjustment factors in Table R602.10.3(4) shall not be applied to the length of bracing determined using Table R602.10.6.5, except that the bracing amount increase for braced wall line spacing greater than 25 feet (7620 mm) in accordance with Table R602.10.1.3 shall be required. The minimum total length of bracing in a braced wall line, after all adjustments have been taken, shall not be less than 48 inches (1219 mm) total.~~

~~R602.10.7 Ends of braced wall lines with continuous sheathing.~~

~~Each end of a *braced wall line* with continuous sheathing shall have one of the conditions shown in Figure R602.10.7.~~



REQUIREMENTS

Return panel:	24" for braced wall lines sheathed with wood structural panels 32" for braced wall lines sheathed with structural fiberboard
Distance D:	24" for braced wall lines sheathed with wood structural panels 32" for braced wall lines sheathed with structural fiberboard
Hold-down device:	800 lbs capacity fastened to the edge of the braced wall panel closest to the corner and to the foundation or floor framing below

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.45 N.~~

~~FIGURE R602.10.7~~
~~END CONDITIONS FOR BRACED WALL LINES WITH CONTINUOUS SHEATHING~~

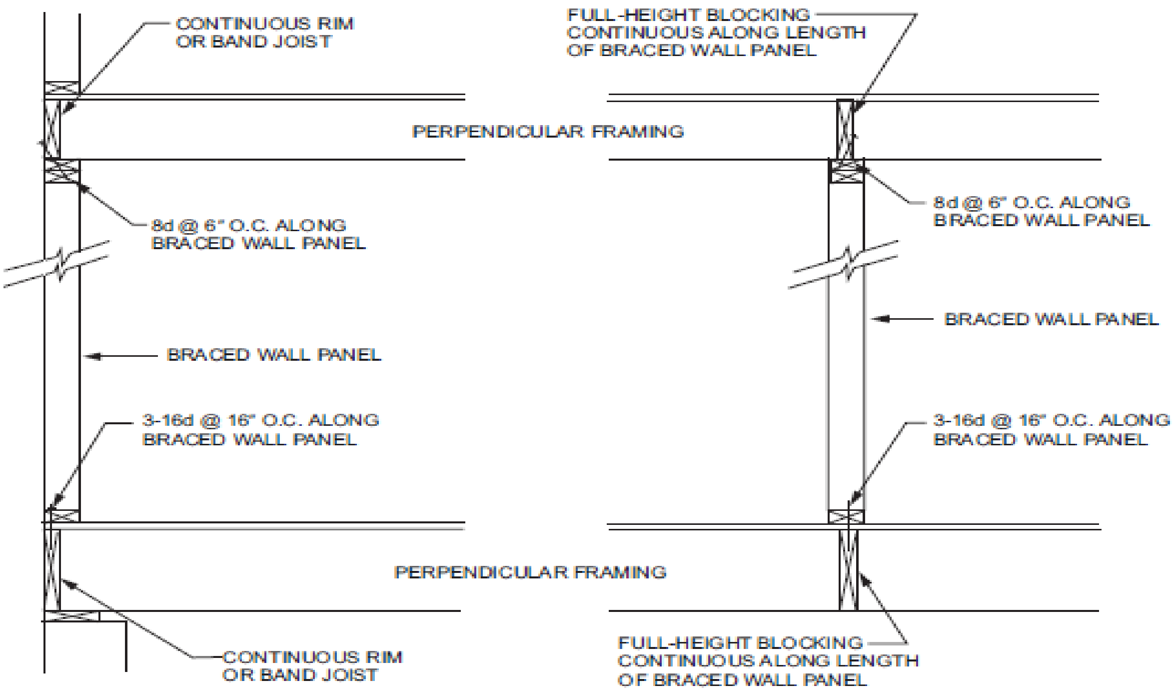
~~R602.10.8 Braced wall panel connections.~~

~~*Braced wall panels* shall be connected to floor framing or foundations as follows:~~

1. ~~Where joists are perpendicular to a *braced wall panel* above or below, a rim joist, band joist or blocking shall be provided along the entire length of the *braced wall panel* in accordance with Figure R602.10.8(1). Fastening of top and bottom wall plates to framing, rim joist, band joist and/or blocking shall be in accordance with Table R602.3(1).~~

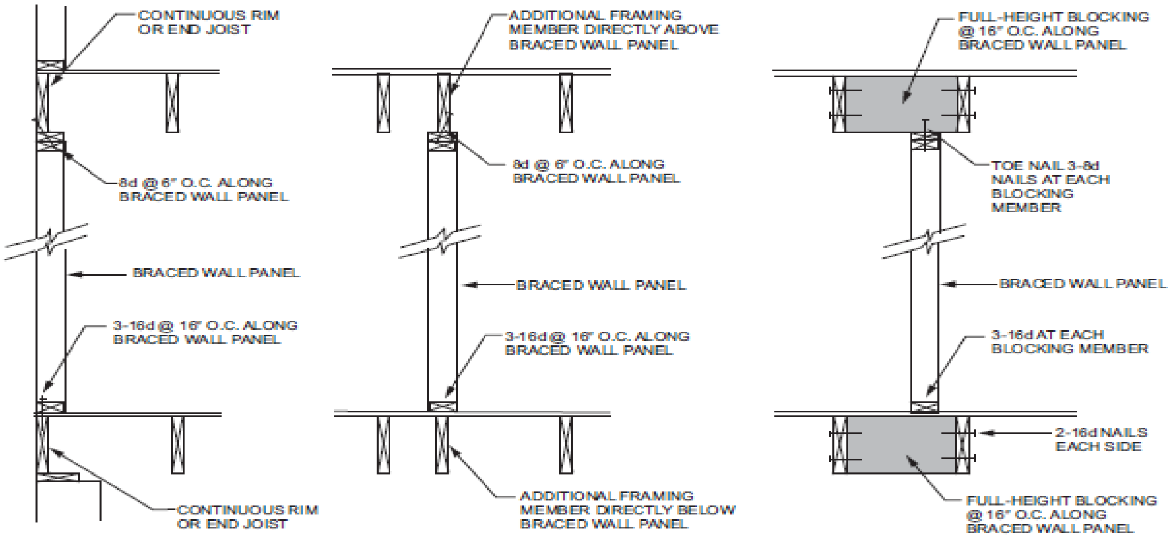
2. ~~Where joists are parallel to a *braced wall panel* above or below, a rim joist, end joist or other parallel framing member shall be provided directly above and below the *braced wall panel* in accordance with Figure R602.10.8(2). Where a parallel framing member cannot be located directly above and below the panel, full-depth blocking at 16-inch (406 mm) spacing shall be provided between the parallel framing members to each side of the *braced wall panel* in accordance with Figure R602.10.8(2). Fastening of blocking and wall plates shall be in accordance with Table R602.3(1) and Figure R602.10.8(2).~~

3. ~~Connections of *braced wall panels* to concrete or masonry shall be in accordance with Section R403.1.6.~~



~~For SI: 1 inch = 25.4 mm.~~

~~**FIGURE R602.10.8(1)**~~
~~**BRACED WALL PANEL CONNECTION WHEN PERPENDICULAR TO FLOOR/CEILING FRAMING**~~



~~For SI: 1 inch = 25.4 mm.~~

~~**FIGURE R602.10.8(2)**~~

~~BRACED WALL PANEL CONNECTION WHEN PARALLEL TO FLOOR/CEILING FRAMING~~

~~R602.10.8.1 Braced wall panel connections for Seismic Design Categories D0, D1and D2.~~

~~*Braced wall panels* shall be fastened to required foundations in accordance with Section R602.11.1, and top plate lap splices shall be face-nailed with not less than eight 16d nails on each side of the splice.~~

~~R602.10.8.2 Connections to roof framing.~~

~~Top plates of exterior *braced wall panels* shall be attached to rafters or roof trusses above in accordance with Table R602.3(1) and this section. Where required by this section, blocking between rafters or roof trusses shall be attached to top plates of *braced wall panels* and to rafters and roof trusses in accordance with Table R602.3(1). A continuous band, rim or header joist or roof truss parallel to the *braced wall panels* shall be permitted to replace the blocking required by this section. Blocking shall not be required over openings in continuously sheathed *braced wall lines*. In addition to the requirements of this section, lateral support shall be provided for rafters and ceiling joists in accordance with Section R802.8 and for trusses in accordance with Section R802.10.3. Roof ventilation shall be provided in accordance with Section R806.1.~~

1. ~~For Seismic Design Categories A, B and C where the distance from the top of the braced wall panel to the top of the rafters or roof trusses above is $9^{1}/_{4}$ inches (235 mm) or less, blocking between rafters or roof trusses shall not be required. Where the distance from the top of the braced wall panel to the top of the rafters or roof trusses above is between $9^{1}/_{4}$ inches (235 mm) and $15^{1}/_{4}$ inches (387 mm), blocking between rafters or roof trusses shall be provided above the braced wall panel in accordance with Figure R602.10.8.2(1).~~

    ~~**Exception:** Where the outside edge of truss vertical web members aligns with the outside face of the wall studs below, wood structural panel sheathing extending above the top plate as shown in Figure R602.10.8.2(3) shall be permitted to be fastened to each truss web with three-8d nails ($2^{1}/_{2}$ inches × 0.131 inch) and blocking between the trusses shall not be required.~~

2. ~~For Seismic Design Categories D_0, D_1 and, where the distance from the top of the braced wall panel to the top of the rafters or roof trusses is $15^{1}/_{4}$ inches (387 mm) or less, blocking between rafters or roof trusses shall be provided above the braced wall panel in accordance with Figure R602.10.8.2(1).~~

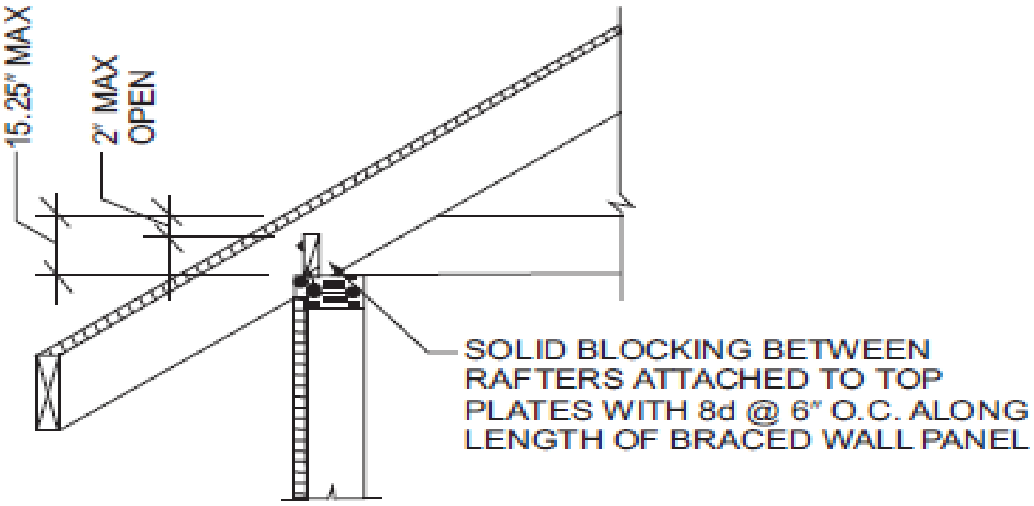
3. ~~Where the distance from the top of the braced wall panel to the top of rafters or roof trusses exceeds $15^{1}/_{4}$ inches (387 mm), the top plates of the braced wall panel shall be connected to perpendicular rafters or roof trusses above in accordance with one or more of the following methods:~~

~~3.1. Soffit blocking panels constructed in accordance with Figure R602.10.8.2(2).~~

~~3.2. Vertical blocking panels constructed in accordance with Figure R602.10.8.2(3).~~

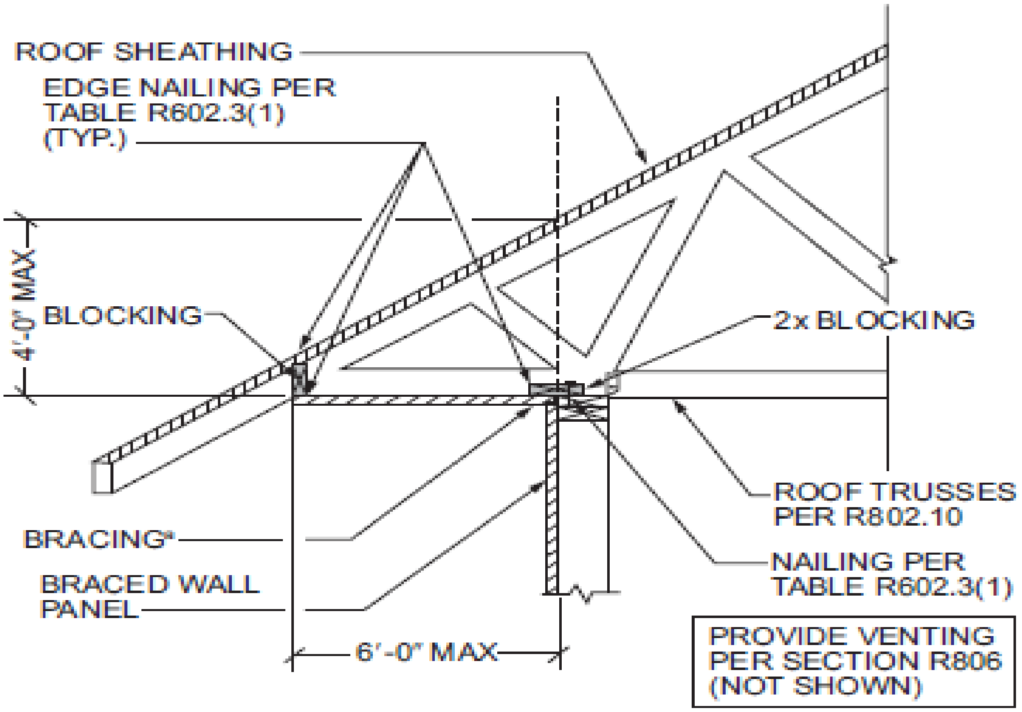
~~3.3. Blocking panels provided by the roof truss manufacturer and designed in accordance with Section R802.~~

~~3.4. Blocking, blocking panels or other methods of lateral load transfer designed in accordance with the AWC WFCM or accepted engineering practice.~~



~~For SI: 1 inch = 25.4 mm.~~

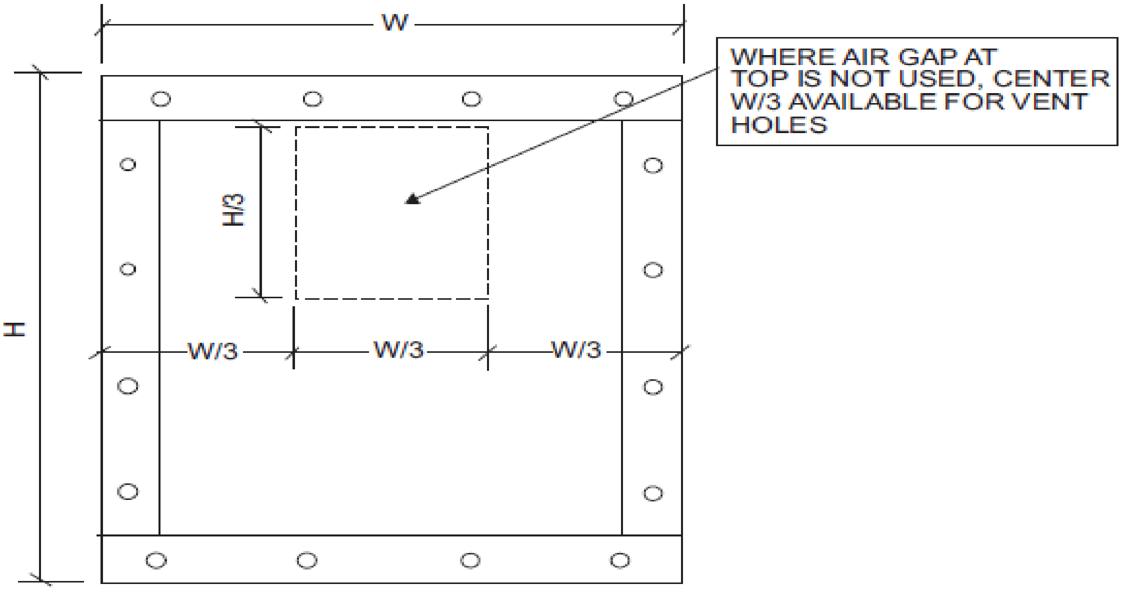
~~**FIGURE R602.10.8.2(1)**~~
~~**BRACED WALL PANEL CONNECTION**~~
~~**TO PERPENDICULAR RAFTERS**~~



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

~~a. Methods of bracing shall be as described in Section R602.10.4.~~

~~**FIGURE R602.10.8.2(2)**~~
~~**BRACED WALL PANEL CONNECTION OPTION TO PERPENDICULAR RAFTERS OR ROOF TRUSSES**~~



~~**FIGURE R602.10.8.2(3)**~~

~~BRACED WALL PANEL CONNECTION OPTION TO PERPENDICULAR RAFTERS OR ROOF TRUSSES~~

~~R602.10.9 Braced wall panel support.~~

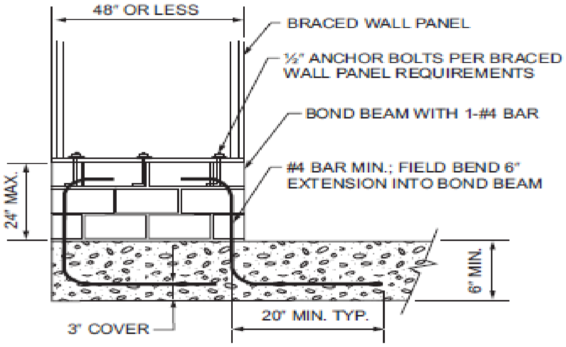
~~*Braced wall panel* support shall be provided as follows:~~

1. ~~Cantilevered floor joists complying with Section R502.3.3 shall be permitted to support *braced wall panels*.~~

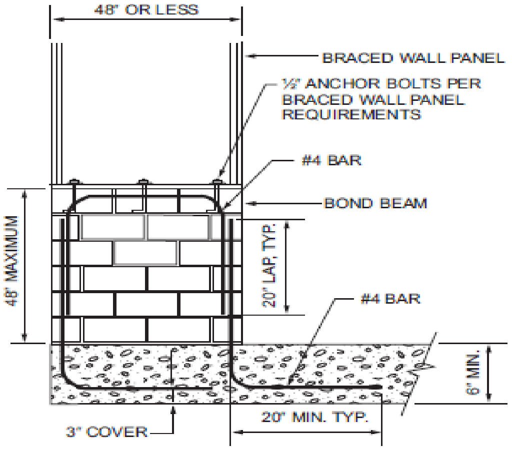
2. ~~Raised floor system post or pier foundations supporting *braced wall panels* shall be designed in accordance with accepted engineering practice.~~

3. ~~Masonry stem walls with a length of 48 inches (1219 mm) or less supporting *braced wall panels* shall be reinforced in accordance with Figure R602.10.9. Masonry stem walls with a length greater than 48 inches (1219 mm) supporting *braced wall panels* shall be constructed in accordance with Section R403.1 Methods ABW and PFH shall not be permitted to attach to masonry stem walls.~~

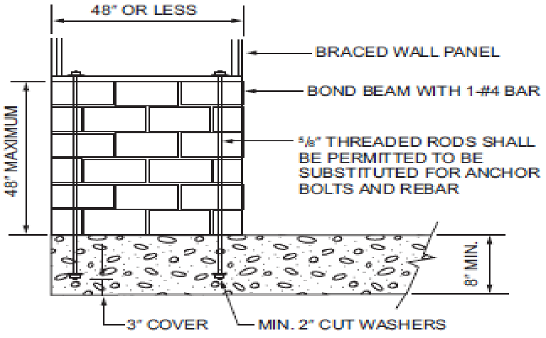
4. ~~Concrete stem walls with a length of 48 inches (1219 mm) or less, greater than 12 inches (305 mm) tall and less than 6 inches (152 mm) thick shall have reinforcement sized and located in accordance with Figure R602.10.9.~~



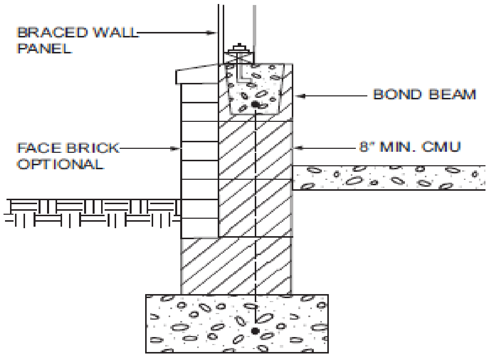
SHORT STEM WALL REINFORCEMENT



TALL STEM WALL REINFORCEMENT



OPTIONAL STEM WALL REINFORCEMENT



TYPICAL STEM WALL SECTION

NOTE: GROUT BOND BEAMS AND ALL CELLS THAT CONTAIN REBAR, THREADED RODS AND ANCHOR BOLTS.

~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R602.10.9~~
~~MASONRY STEM WALLS SUPPORTING BRACED WALL PANELS~~

~~R602.10.9.1 Braced wall panel support for Seismic Design Categories D0, D1and D2.~~

~~In Seismic Design Categories~~ ~~D_0, D_1~~ ~~and~~ ~~D_2~~~~, braced wall panel footings shall be as specified in Section R403.1.2.~~

~~R602.10.10 Panel joints.~~

~~Vertical joints of panel sheathing shall occur over, and be fastened to, common studs. Horizontal joints in *braced wall panels* shall occur over, and be fastened to, common blocking of a minimum~~ ~~$1^{1}/_{2}$~~ ~~inch (38 mm) thickness.~~

~~Exceptions:~~

1. ~~Vertical joints of panel sheathing shall be permitted to occur over double studs, where adjoining panel edges are attached to separate studs with the required panel edge fastening schedule, and the adjacent studs are attached together with two rows of 10d box nails [3 inches by 0.128 inch (76.2 mm by 3.25 mm)] at 10 inches o.c. (254 mm).~~

2. ~~Blocking at horizontal joints shall not be required in wall segments that are not counted as *braced wall panels*.~~

3. ~~Where the bracing length provided is not less than twice the minimum length required by Tables R602.10.3(1) and R602.10.3(3), blocking at horizontal joints shall not be required in *braced wall panels* constructed using Methods WSP, SFB, GB, PBS or HPS.~~

4. ~~Where Method GB panels are installed horizontally, blocking of horizontal joints is not required.~~

~~R602.10.11 Cripple wall bracing.~~

~~Cripple walls shall be constructed in accordance with Section R602.9 and braced in accordance with this section. Cripple walls shall be braced with the length and method of bracing used for the wall above in accordance with Tables R602.10.3(1) and R602.10.3(3), and the applicable adjustment factors in Table R602.10.3(2) or R602.10.3(4), respectively, except that the length of cripple wall bracing shall be multiplied by a factor of 1.15. Where gypsum wall board is not used on the inside of the cripple wall bracing, the length adjustments for the elimination of the gypsum wallboard, or equivalent, shall be applied as directed in Tables R602.10.3(2) and R602.10.3(4) to the length of cripple wall bracing required. This adjustment shall be taken in addition to the 1.15 increase.~~

~~R602.10.11.1 Cripple wall bracing for Seismic Design Categories D0 and D1 and townhouses in Seismic Design Category C.~~

~~In addition to the requirements in Section R602.10.11, the distance between adjacent~~

~~edges of *braced wall panels* for cripple walls along a *braced wall line* shall be 14 feet (4267 mm) maximum.~~

~~Where *braced wall lines* at interior walls are not supported on a continuous foundation below, the adjacent parallel cripple walls, where provided, shall be braced with Method WSP or Method CS-WSP in accordance with Section R602.10.4. The length of bracing required in accordance with Table R602.10.3(3) for the cripple walls shall be multiplied by 1.5. Where the cripple walls do not have sufficient length to provide the required bracing, the spacing of panel edge fasteners shall be reduced to 4 inches (102 mm) on center and the required bracing length adjusted by 0.7. If the required length can still not be provided, the cripple wall shall be designed in accordance with accepted engineering practice.~~

~~R602.10.11.2 Cripple wall bracing for Seismic Design Category D2.~~
~~In Seismic Design Category D_2, cripple walls shall be braced in accordance with Tables R602.10.3(3) and R602.10.3(4).~~

~~R602.10.11.3 Redesignation of cripple walls.~~
~~Where all cripple wall segments along a *braced wall line* do not exceed 48 inches (1219 mm) in height, the cripple walls shall be permitted to be redesignated as a first-*story* wall for purposes of determining wall bracing requirements. Where any cripple wall segment in a *braced wall line* exceeds 48 inches (1219 mm) in height, the entire cripple wall shall be counted as an additional *story*. If the cripple walls are redesignated, the stories above the redesignated *story* shall be counted as the second and third stories, respectively.~~

R602.10 Wall bracing.
Buildings, and portions thereof, shall be braced in accordance with one or more of the following sections using bracing materials and methods complying with Section R602.10.1 and load path detailing in accordance with Section R602.10.4:

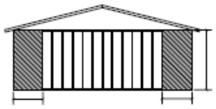
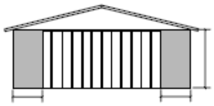
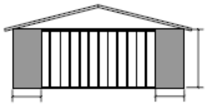
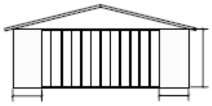
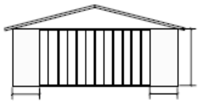
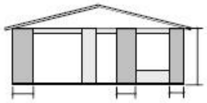
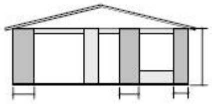
1. Isolated panel bracing in accordance with Section R602.10.2,
2. Continuous sheathing in accordance with Section R602.10.3,
3. Engineered design in accordance with Section R602.10.5, or
4. 2015 International Residential Code (IRC).
5. SR-102 as published by APA, The Engineered Wood Association with limitations indicated in this document.

Where a building, or portion thereof, does not comply with Section R602.10.2, Section R602.10.3, or Section R602.10.4, those portions shall be designed and constructed in accordance with Section R602.10.5.

R602.10.1 Bracing materials and methods.

Wall bracing materials and methods shall comply with Table R602.10.1.

TABLE R602.10.1
BRACING METHODS[1, 2]

Method	**Minimum Brace Material Thickness or Size**	**Minimum Brace Panel Length or Brace Angle**	**Connection Criteria**		**Figure of Bracing Method, not Necessarily Location**
			Fasteners	**Spacing**	
LIB Let-in Bracing	1x4 wood brace (or approved metal brace installed per manufacturer instructions)	45° angle for maximum 16”oc stud spacing[3]	2-8d common nails or 3-8d (2-1/2” long x 0.113” dia.) nails	Per stud and top and bottom plates	
DWB Diagonal wood boards	¾” (1” nominal)	48”	2-8d (2-1/2” long x 0.113” diameter) or 2 – 1-3/4” long staples	Per stud and top and bottom plates	
WSP Wood structural panel	3/8”	48”[4]	6d common nail or 8d (2-1/2” long x 0.113” diameter) nail (See Table R602.3(3)	6” edges 12” field	
SFB Structural Fiberboard Sheathing	½”	48”[4]	1-1/2” long x 0.120” dia. Galvanized roofing nails	3” edges 6” field	
GB Gypsum Board Installed on both sides of wall	½”	96” for use with R602.10.2 48” for use with R602.10.3	Min. 5d cooler nails or #6 screws	7” edges 7” field	
PCP Portland cement plaster	¾” (maximum 16”oc stud spacing)	48”	1-1/2” long, 11 gage, 7/16” diameter head nails or 7/8” long, 16 gage staples	6” o.c. on all framing members	
CS-WSP[5,9] Continuously sheathed WSP	3/8”	24” adjacent to window not more than 67% of wall height; 30” adjacent to door or window greater than 67% and less than 85% of wall height. 48” for taller	Same as WSP	Same as WSP	
CS-SFB[5,9] Continuously sheathed SFB	½”		Same as SFB	Same as SFB	

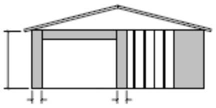
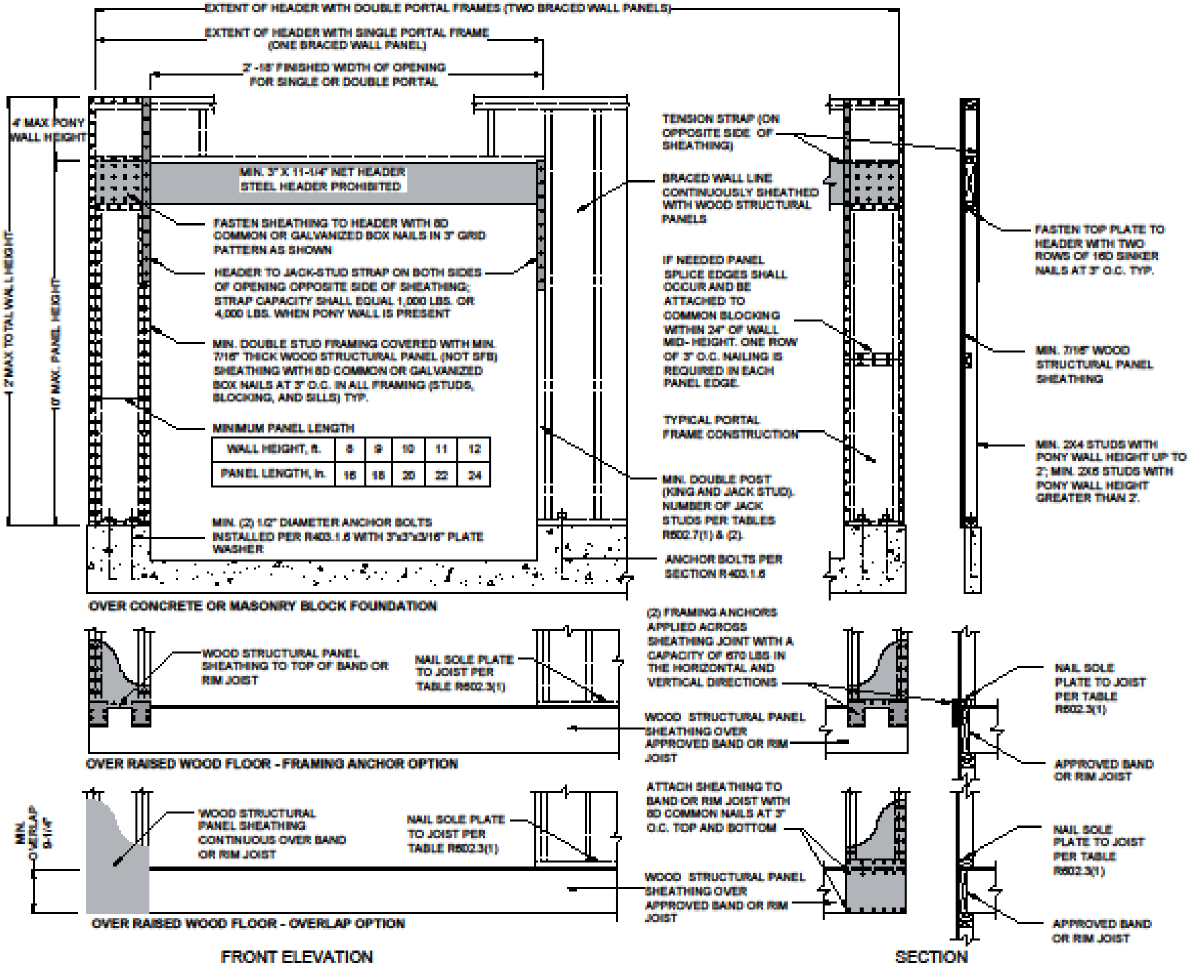
		openings.			
PF Portal Frame^{6,7,8}	7/16”	See Figure R602.10.1	See Figure R602.10.1	See Figure R602.10.1	

Table Notes:

1. Alternative bracing materials and methods shall comply with Section 105 of the North Carolina Administrative Code and Policies, and shall be permitted to be used as a substitute for any of the bracing materials listed in Table R602.10.1 provided at least equivalent performance is demonstrated. Where the tested bracing strength or stiffness differs from tabulated materials, the bracing amount required for the alternative material shall be permitted to be factored to achieve equivalence.
2. All edges of panel-type wall bracing required from Tables R602.10.1 and R602.10.3 shall be attached to framing or blocking, except GB bracing horizontal joints shall not be required to be blocked when joints are finished.
3. Two LIB braces installed at a 60º angle shall be permitted to be substituted for each 45º angle LIB brace.
4. For 8-foot (2483 mm) or 9-foot (2743 mm) wall height, brace panel minimum length shall be permitted to be reduced to 36-inch (914 mm) or 42-inch length (1067 mm), respectively, where not located adjacent to a door opening. A braced wall panel shall be permitted to be reduced to a 32-inch (813 mm) length when studs at each end of the braced wall panel are anchored to foundation or framing below using hold-down device with minimum 2,800 lbs. design tension capacity. For detached single story garages and attached garages supporting roof only, a minimum 24-inch (610 mm) brace panel length shall be permitted on one wall containing one or more garage door openings.
5. Bracing methods designated CS-WSP and CS-SFB shall have sheathing installed on all sheathable surfaces above, below, and between wall openings.
6. For purposes of bracing in accordance with Section R602.10.2, two portal frame brace panels with wood structural panel sheathing applied to the exterior face of each brace panel as shown in Figure R602.10.1 shall be considered equivalent to one braced wall panel.
7. Structural fiberboard (SFB) shall not be used in portal frame construction.
8. No more than three portal frames shall be used in a single building elevation.
9. CS-WSP and CS-SFB cannot be mixed on the same story. Gable ends shall match the panel type of the wall below.



WALL HEIGHT, ft.	8	9	10	11	12
PANEL LENGTH, in.	16	18	20	22	24

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 lb = 4.45 N

FIGURE R602.10.1
METHOD PF – PORTAL FRAME CONSTRUCTION

R602.10.2. Isolated Panel Bracing.

R602.10.2.1 Limitations.

The conventional bracing requirements of Section R602.10.2.2 shall be limited to the following conditions of use:

1. Ultimate design wind speed shall not exceed 120 mph (53 m/s), Exposure Category B.
2. Bracing methods shall be LIB, DWB, WSP, SFB, GB, PCP, and PF in accordance with Table R602.10.1.
3. Length of the house is limited to 75 feet (22.9 m). Overall plan length shall not exceed 3 times the overall plan width. The multiple circumscribed rectangle method from R602.10.3.2 may be applied to the method set forth in this section.

4. Wall height at each story level shall not exceed 10 feet (3048 mm).

5. Roof eave-to-ridge height shall not exceed 10 feet (3048 mm) unless the roof is considered as an additional story for the purpose of determining bracing amounts required.

6. Except when used for bracing method GB, the interior side of exterior walls and both sides of interior walls shall be sheathed continuously with minimum ½-inch (12.7 mm) thick gypsum wall board interior finish fastened in accordance with Table R702.3.5, or approved interior finish of equivalent or greater shear resistance.

7. Floors shall not cantilever more than 24 inches (610 mm) beyond the foundation or bearing wall below.

8. Townhouses shall be stabilized independently of adjacent units unless a design is provided to permit lateral load transfer between adjacent units.

9. Townhouses in Seismic Design Category C shall be designed in accordance with Section R602.10.5 or the 2015 *International Residential Code*.

R602.10.2.2 Requirements.

Braced wall panels shall be constructed of bracing methods, materials, and minimum braced panel lengths complying with Table R602.10.1. The number of braced wall panels required for each side of a building (elevation view) at each story level of the building shall comply with Table R602.10.2. The following additional requirements shall apply:

1. In no case shall the amount of bracing be less than two braced wall panels on exterior walls comprising each side of the floor plan (or plan elevation) for each story level of the building.

2. A braced wall panel shall be located within 12 feet (3658 mm) of both ends of each elevation view of the house. Braced wall panels on exterior walls shall be installed such that the edge-to-edge distance between braced wall panels does not exceed 21 feet (6401 mm). See Figures R602.10.2.2(1) and R602.10.2.2(2).

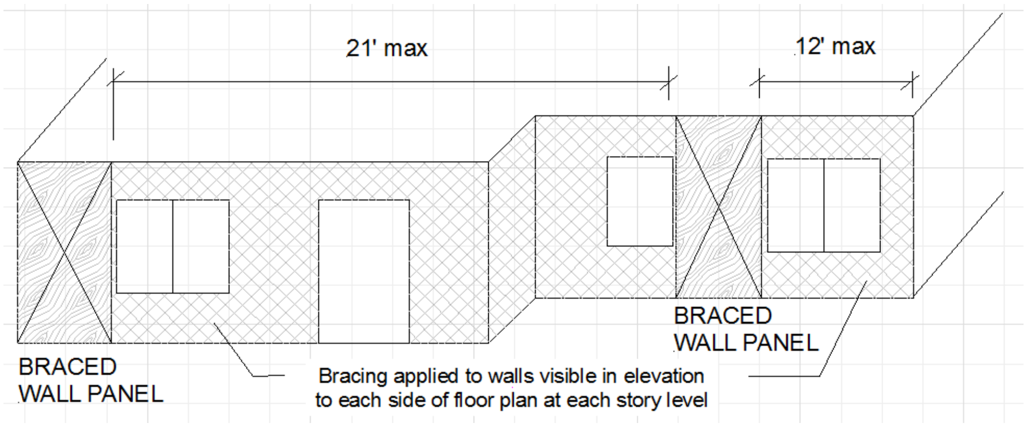


FIGURE R602.10.2.2(1)
LOCATION OF BRACED WALL PANELS

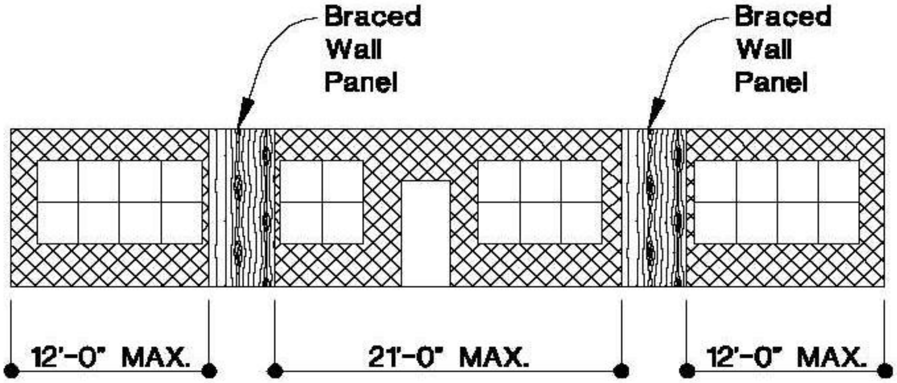


FIGURE R602.10.2.2(2)
PANELS INSET 12'-0"
FROM BOTH ENDS OF WALL ELEVATION

3. No more than one-half of bracing on parallel exterior walls shall be permitted to be relocated to interior walls oriented in the same plan direction and within one-half the floor plan dimension perpendicular to the exterior wall. See Figure R602.10.2.2(3).

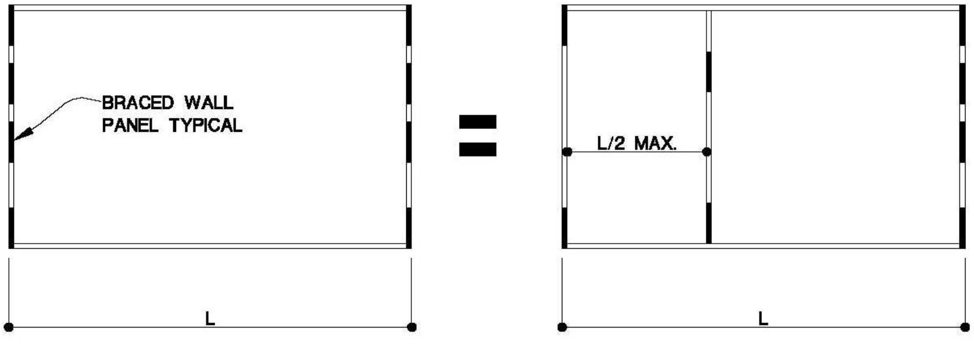

Note: Bracing shown in one direction only for clarity. Braced panel locations may be shifted along the walls to any location meeting the distribution rules in Figure R602.10.2.2 desired by the permit holder.

FIGURE R602.10.2.2(3)
PANELS SHIFTED TO INTERIOR WALLS

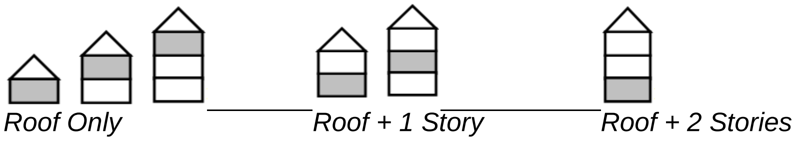
4. Use of multiple bracing methods and materials complying with Table R602.10.1 shall be permitted.

5. Detached garages or storage buildings connected to the house with a covered walk-way shall be considered separate buildings. Houses with skewed wings shall be designed in accordance with Section R602.10.3, Section R602.10.5, or the 2015 *International Residential Code*.

6. Garage door openings supporting a floor load above shall be braced using the portal frame method (PF) unless the building plan level containing the garage opening wall complies with all the bracing requirements of this section.

TABLE R602.10.2
NUMBER OF BRACED WALL PANELS REQUIRED FOR EACH HOUSE ELEVATION (BUILDING SIDE) AT EACH STORY LEVEL[1]

Wind Speed	**Story Level Supporting:**	**Longest Overall Dimension of Floor Plan for a Given Story Level**		
		25'	**50'**	**75'**
115 mph	**Roof Only**	1	2	3
	Roof + 1 Story	2	4	6
	Roof + 2 Stories	3	6	9
120 mph	**Roof Only**	2	3	4
	Roof + 1 Story	3	5	8
	Roof + 2 Stories	4	8	11



1. Interpolation between dimensions is permitted. Extrapolation is prohibited. Fractions of panels shall be rounded to the nearest whole panel.

R602.10.3 Continuous Sheathing.

R602.10.3.1 Limitations.

The continuous sheathing requirements of Section R602.10.3 shall be limited to bracing methods CS-WSP and CS-SFB in accordance with Table R602.10.1 with the following conditions of use:

1. Ultimate design wind speed shall not exceed 130 mph (58 m/s).

2. Wall height at each story level shall not exceed 12 feet (3658 mm).

3. Eave to ridge height shall not exceed 20 feet (6096 mm).

4. Exterior walls shall be sheathed on all sheathable surfaces including infill areas between braced wall panels, above and below wall openings, and on gable end walls.

5. Except when used for bracing method GB, the interior side of exterior walls and both sides of interior walls shall be sheathed continuously with minimum ½-inch (12.7 mm) thick gypsum wall board interior finish fastened in accordance with Table R702.3.5, or approved interior finish of equivalent or greater shear resistance Unless required for fire separation by Section R302.6, gypsum board shall be permitted to be omitted where the required length of bracing, as determined in Table R602.10.3, is multiplied by 1.40.

6. Floors shall not cantilever more than 24 inches (610 mm) beyond the foundation or bearing wall below.

7. Townhouses in Seismic Design Category C shall be designed in accordance with Section R602.10.5 or the 2015 *International Residential Code*.

8. Townhouses shall be stabilized independently of adjacent units, unless a design is provided to permit lateral load transfer between adjacent units.

9. CS-WSP and CS-SFB cannot be mixed on the same story. Gable ends shall match the panel type of the wall below.

R602.10.3.2 Requirements.
The required length of bracing for each side of a rectangle circumscribed around the plan or a portion of the plan at each story level shall be determined using Table R602.10.3 and Figure R602.10.3(1). The cumulative contributing length of braced wall panels assigned to a rectangle side shall be greater than or equal to the required length of bracing specified in Table R602.10.3. The following additional requirements shall apply.

1. Braced wall panels on exterior or interior walls shall be assigned to the nearest rectangle side as shown in Figure R602.10.3(2) for each story level floor plan.

2. Braced wall panels shall be distributed and installed in accordance with Figures R602.10.3(3), R602.10.3(4), and R602.10.3(5).

3. A minimum of one-half the required bracing amount for each rectangle side should be located on exterior walls within 8 feet (2438 mm) of the location of the rectangle side.

4. Interior braced wall panels using method GB shall be assigned to the closest parallel rectangle side and shall contribute 0.5 times their actual length.

5. The bracing amount provided on an upper story building side shall be deemed-to-comply where it equals or exceeds the amount of bracing required for the story immediately below.

6. Where the bracing amount provided on an upper story equals or exceeds the amount of bracing required for the story below, an analysis of bracing shall not be required for the upper story.

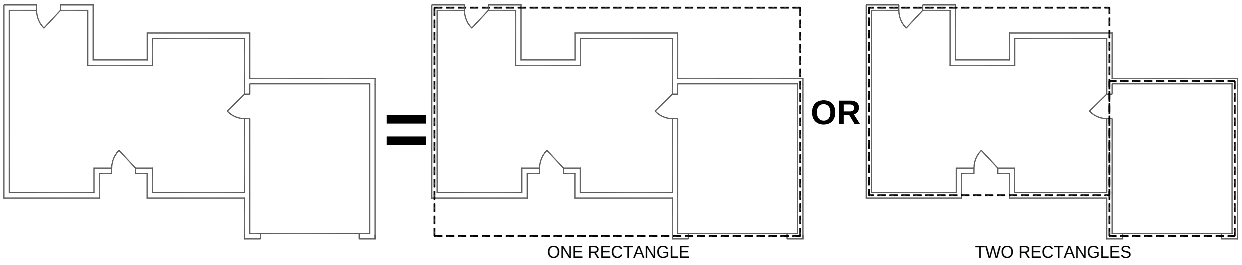


FIGURE R602.10.3(1)
CIRCUMSCRIBED RECTANGLES[1,2,3]

Figure Notes:

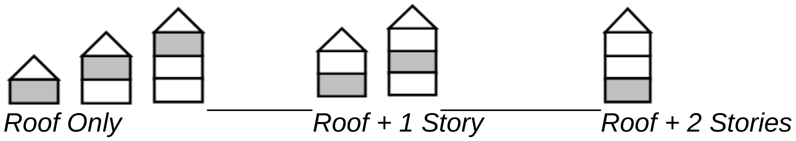
1. Each floor plan level shall be circumscribed with one or more rectangles around the floor plan or portions of the plan at the floor level under consideration as shown in Figure R602.10.3(1).
2. Rectangles shall surround all enclosed offsets and projections such as sunrooms and attached garages for a given story level floor plan. Chimneys, partial height projections, and open structures, such as carports and decks, shall be excluded from the rectangle.
3. Each rectangle shall have no side greater than 80 feet (24.4 m) with a maximum rectangle length-to-width ratio of 3:1. Rectangles shall be permitted to be skewed to accommodate diagonal walls.

TABLE R602.10.3
REQUIRED LENGTH OF BRACING ALONG EACH SIDE OF A CIRCUMSCRIBED RECTANGLE [a, b, c, d]

WIND SPEED	EAVE-TO RIDGE HEIGHT (FEET)	STORY LEVEL SUPPORTING:[e]	REQUIRED LENGTH OF BRACING ON ANY SIDE														
			Length of perpendicular side (ft)[f]														
			10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
115	10	Roof Only	2.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5
		Roof + 1 Story	3.0	4.0	5.5	6.5	8.0	9.0	10.0	11.0	12.5	13.5	14.5	16.0	17.0	18.0	19.0
		Roof + 2 Stories	4.5	6.5	8.5	10.5	12.0	14.0	16.0	17.5	19.5	21.0	23.0	24.5	26.5	28.5	30.0
	15	Roof Only	2.0	2.0	3.0	3.5	4.0	4.5	5.5	6.0	6.5	7.0	8.0	8.5	9.0	9.5	10.0
		Roof + 1 Story	3.5	4.5	6.0	7.0	8.5	9.5	11.0	12.0	13.5	15.0	16.0	17.5	18.5	20.0	21.0
		Roof + 2 Stories	5.0	7.0	9.0	11.0	13.0	15.0	16.5	18.5	20.5	22.5	24.5	26.0	28.0	30.0	32.0
	20	Roof Only	2.0	2.5	3.5	4.0	4.5	5.5	6.0	7.0	7.5	8.5	9.0	10.0	10.5	11.5	12.0
		Roof + 1 Story	3.5	5.0	6.5	8.0	9.0	10.5	12.0	13.5	14.5	16.0	17.5	18.5	20.0	21.5	23.0
		Roof + 2 Stories	5.0	7.5	9.5	11.5	13.5	15.5	17.5	19.5	21.5	23.5	25.5	27.5	29.5	31.5	33.5
120	10	Roof Only	2.0	2.0	2.5	3.0	3.5	4.0	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0
		Roof + 1 Story	3.0	4.5	6.0	7.0	8.5	9.5	11.0	12.0	13.5	14.5	16.0	17.0	18.5	19.5	21.0
		Roof + 2 Stories	5.0	7.0	9.5	11.5	13.0	15.0	17.0	19.0	21.0	23.0	25.0	27.0	29.0	31.0	32.5
	15	Roof Only	2.0	2.5	3.0	3.5	4.5	5.0	6.0	6.5	7.0	8.0	8.5	9.0	10.0	10.5	11.0

		Roof + 1 Story	3.5	5.0	6.5	8.0	9.0	10.5	12.0	13.5	14.5	16.0	17.5	19.0	20.0	21.5	23.0
		Roof + 2 Stories	5.5	7.5	10.0	12.0	14.0	16.0	18.0	20.0	22.5	24.5	26.5	28.5	30.5	32.5	34.5
	20	Roof Only	2.0	3.0	3.5	4.5	5.0	6.0	6.5	7.5	8.5	9.0	10.0	10.5	11.5	12.5	13.0
		Roof + 1 Story	4.0	5.5	7.0	8.5	10.0	11.5	13.0	14.5	16.0	17.5	19.0	20.5	22.0	23.5	25.0
		Roof + 2 Stories	5.5	8.0	10.5	12.5	14.5	17.0	19.0	21.5	23.5	25.5	28.0	30.0	32.0	34.5	36.5
130	10	Roof Only	2.0	2.5	3.0	3.5	4.5	5.0	5.5	6.5	7.0	7.5	8.0	9.0	9.5	10.0	11.0
		Roof + 1 Story	4.0	5.5	7.0	8.5	10.0	11.5	13.0	14.5	16.0	17.5	18.5	20.0	21.5	23.0	24.5
		Roof + 2 Stories	6.0	8.5	11.0	13.0	15.5	18.0	20.0	22.5	24.5	27.0	29.5	31.5	34.0	36.0	38.5
	15	Roof Only	2.0	3.0	3.5	4.5	5.0	6.0	7.0	7.5	8.5	9.0	10.0	10.5	11.5	12.5	13.0
		Roof + 1 Story	4.0	6.0	7.5	9.0	11.0	12.5	14.0	15.5	17.0	19.0	20.5	22.0	23.5	25.0	27.0
		Roof + 2 Stories	6.5	9.0	11.5	14.0	16.5	19.0	21.5	23.5	26.0	28.5	31.0	33.5	36.0	38.0	40.5
	20	Roof Only	2.5	3.5	4.5	5.0	6.0	7.0	8.0	9.0	10.0	10.5	11.5	12.5	13.5	14.5	15.5
		Roof + 1 Story	4.5	6.5	8.0	10.0	11.5	13.5	15.0	17.0	18.5	20.5	22.0	24.0	25.5	27.5	29.0
		Roof + 2 Stories	6.5	9.5	12.0	14.5	17.5	20.0	22.5	25.0	27.5	30.0	32.5	35.5	38.0	40.5	43.0

For SI: 1 ft = 304.8 mm



a. Interpolation shall be permitted; extrapolation shall be prohibited.

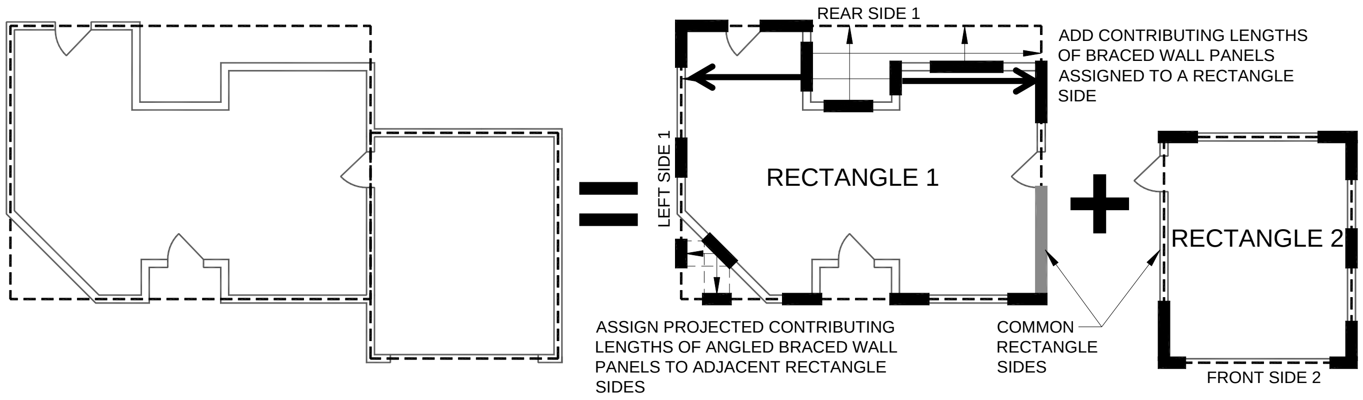
b. For Exposure Category C or D, multiply the required length of bracing by a factor of 1.3 or 1.6, respectively.

c. For wall heights other than 10 ft (3048 mm), multiply the required length of bracing by the following factors: 0.90 for 8 feet (2438 mm), 0.95 for 9 feet (2743 mm), 1.05 for 11 feet (3353 mm) and 1.10 for 12 feet (3658 mm).

d. Where minimum ½" gypsum wall board interior finish is not provided, the required bracing amount for the affected rectangle side shall be multiplied by 1.40.

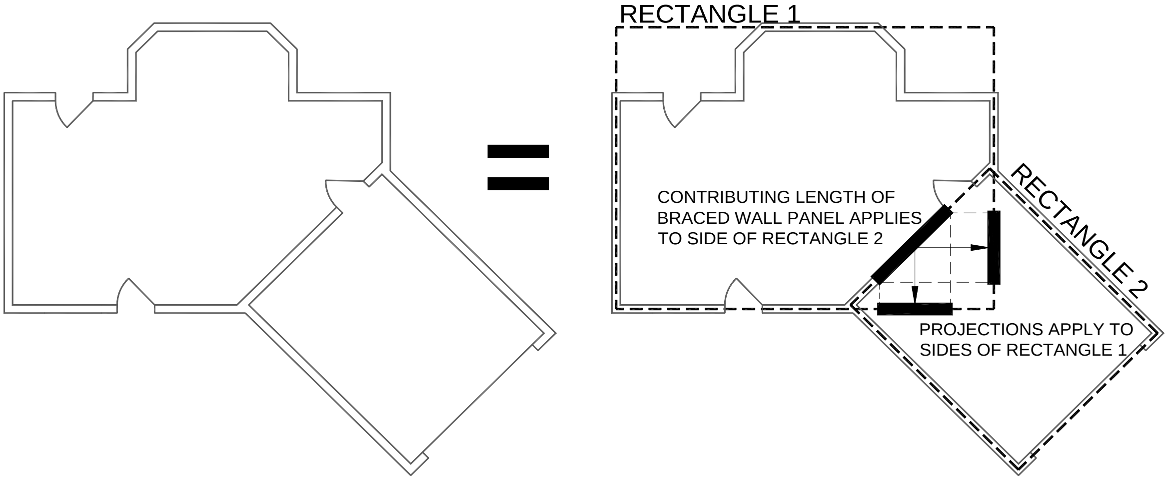
e. A floor, habitable or otherwise, contained wholly within the roof rafters or roof trusses need not be considered a story for purposes of determining wall bracing provided the eave to ridge height does not exceed 20 feet (6096 mm) and the openings in the roof do not exceed 48 inches (1219 mm) in width.

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.



(a) Regular Floor Plan

FIGURE R602.10.3(2)a



(b) Skewed Floor Plan

FIGURE R602.10.3(2)b

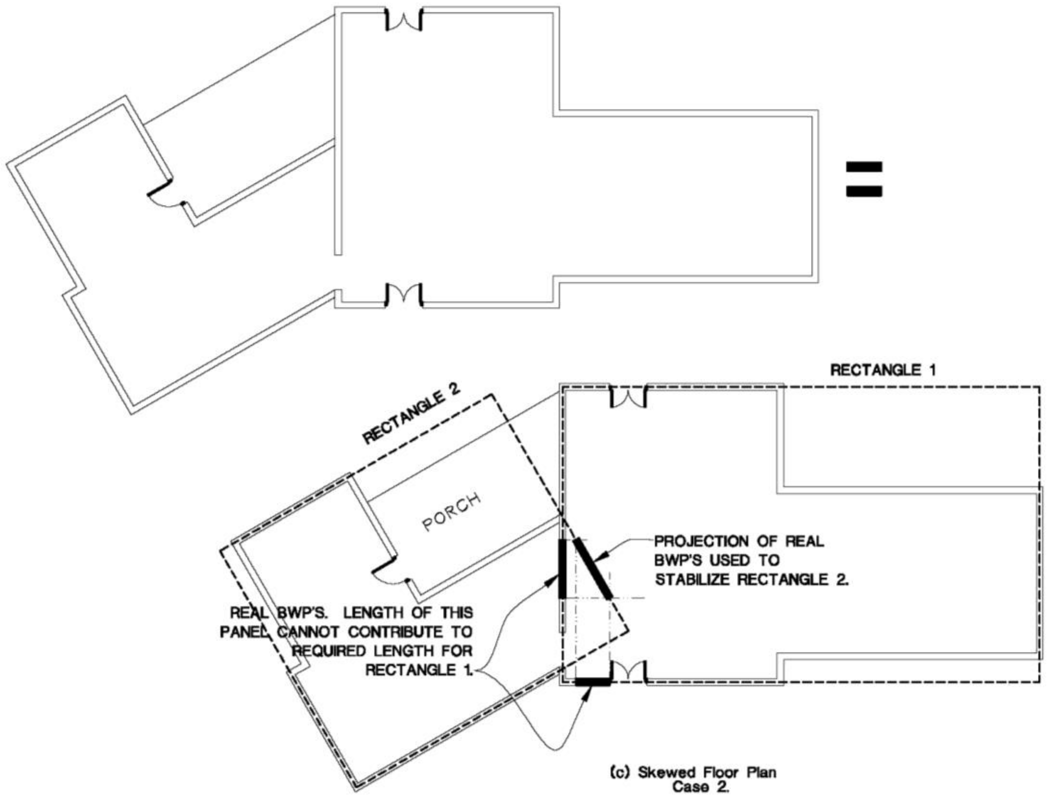
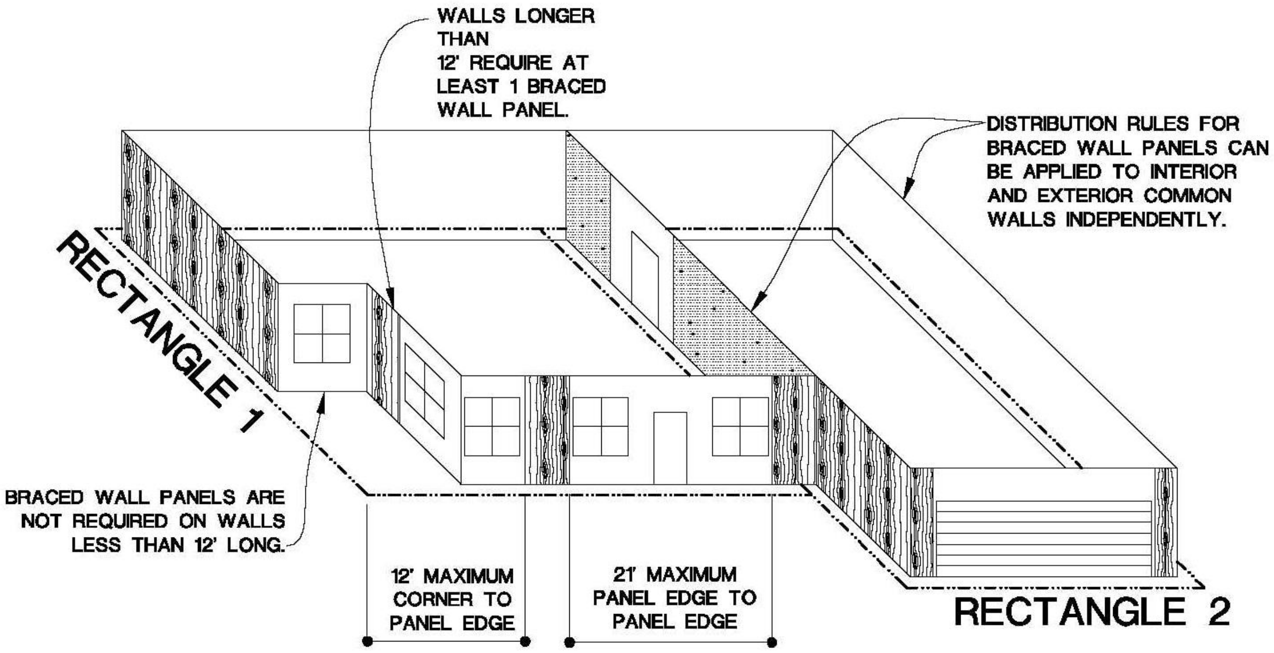


FIGURE R602.10.3(2)c

FIGURE R602.10.3(2)
ASSIGNMENT OF BRACED WALL PANELS TO CIRCUMSCRIBED RECTANGLE SIDES[1,2,3,4,5,6]

Figure Notes:

1. Exterior braced wall panels shall be assigned to the closest parallel rectangle side and shall contribute their actual length.
2. Interior braced wall panels using method GB shall be assigned to the closest parallel rectangle side and shall contribute 0.5 times their actual length.
3. Projected contributing lengths of angled braced wall panels shall be assigned to the closest rectangle sides.
4. Portal frame braced wall panels shall contribute 1.5 times their actual length to their assigned rectangle side.
5. Where multiple rectangles share a common side or sides, as shown in Figure R602.10.3(2)(a), the required length of bracing shall equal the sum of the required lengths from each of the shared rectangle sides.
6. Braced wall panels located on a common wall where skewed rectangles intersect, as shown in Figure R602.10.3(2)(b), 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 skewed rectangle sides. Where the common side of rectangle 2 as shown in Figure R602.10.3(2)c has no physical wall, the wall bracing required to stabilized this side of Rectangle 2 shall be determined from Table 602.10.3. This length of bracing shall be resolved into orthogonal projections, and the orthogonal projections shall be added to the length of bracing required for the walls of Rectangle 1 which connect to Rectangle 2 in the directions parallel to the projections.

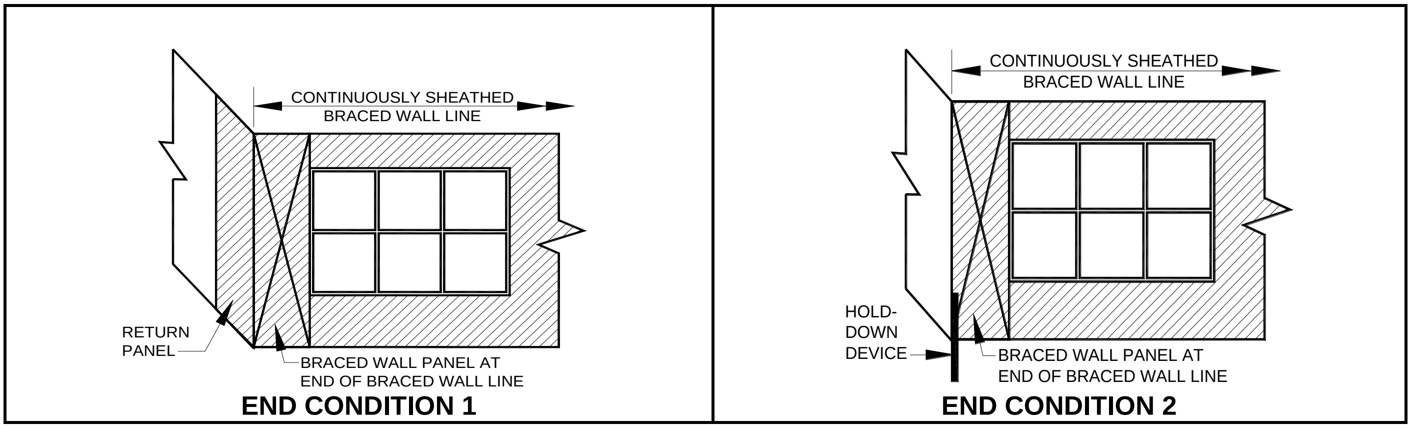


For SI: 1 ft = 304.8 mm

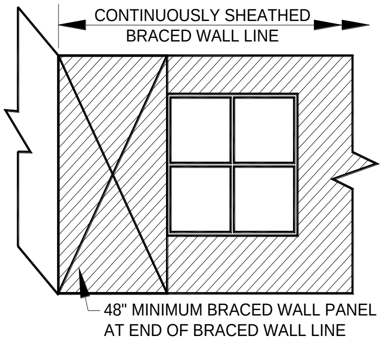
FIGURE R602.10.3(3)
DISTRIBUTION OF BRACED WALL PANELS[1,2,3,4,5.6]

Figure Notes:

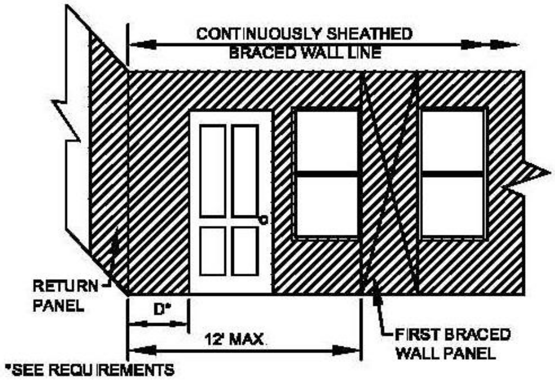
1. A braced wall panel shall be located on each elevation view within 12 feet (3658 mm) of the corners of circumscribed rectangles. Detached garages or storage buildings connected to the house with a covered walk-way shall be considered separate buildings.
2. The distance between adjacent edges of braced wall panels shall be no more than 21 feet (6401 mm).
3. Segments of exterior walls greater than 12 feet (3658 mm) in length shall have a minimum of one braced wall panel.
4. Segments of exterior wall 12 feet (3658 mm) or less in length shall be permitted to have no bracing provided a braced wall panel is located within 12 feet (3658 mm) from the rectangle corner.
5. Interior and exterior wall segments which contribute to the common sides of multiple rectangles shall be permitted to apply the distribution requirements given above to each wall segment independently.
6. See Figures R602.10.3(4) and R602.10.3(5) for end conditions for braced walls with continuous sheathing.



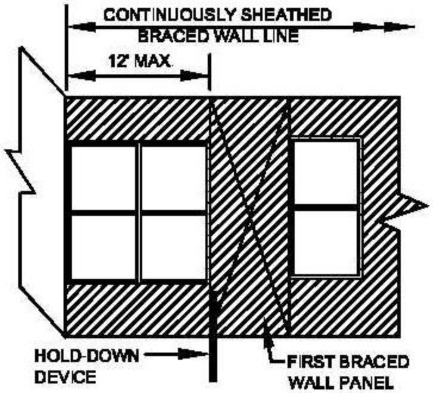
END CONDITION 1 **END CONDITION 2**



END CONDITION 3



END CONDITION 4

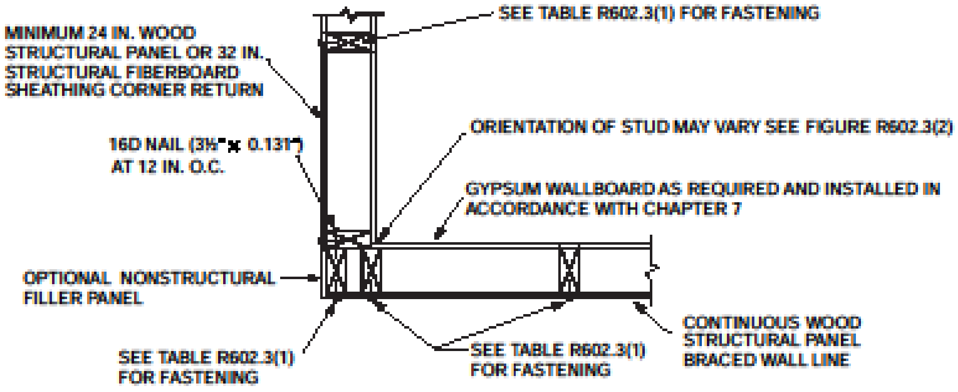


END CONDITION 5

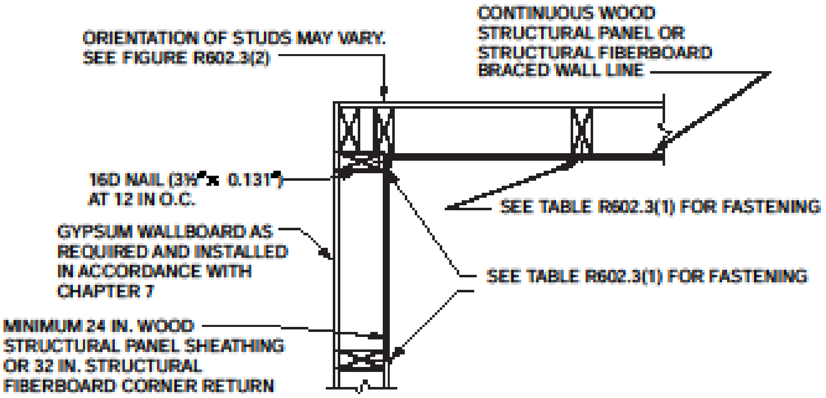
REQUIREMENTS

Return panel:	24" for braced wall lines sheathed with wood structural panels 32" for braced wall lines sheathed with structural fiberboard
Distance D:	24" for braced wall lines sheathed with wood structural panels 32" for braced wall lines sheathed with structural fiberboard
Hold-down device:	800 lbs capacity fastened to the edge of the braced wall panel closest to the corner and to the foundation or floor framing below

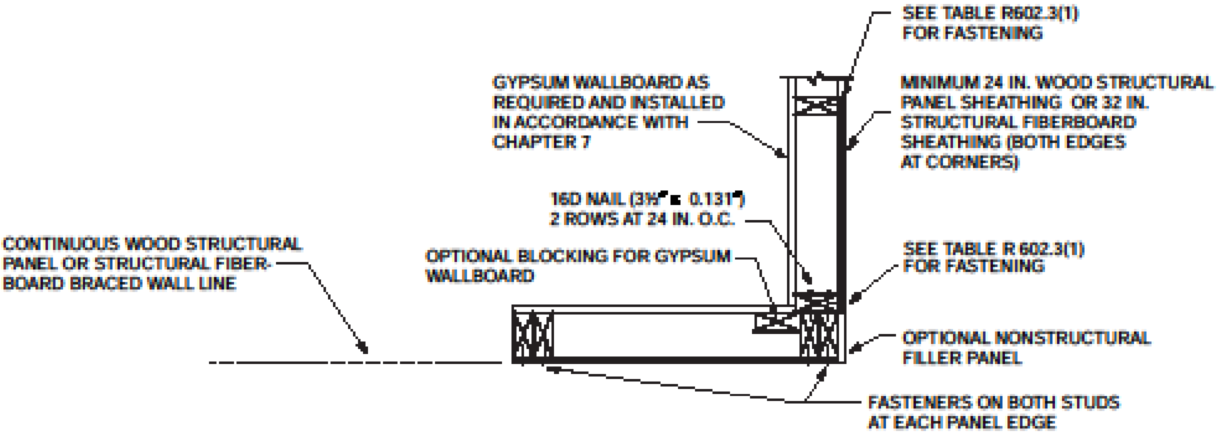
FIGURE R602.10.3(4)
END CONDITIONS FOR BRACED WALLS WITH CONTINUOUS SHEATHING



(a) OUTSIDE CORNER DETAIL



(b) INSIDE CORNER DETAIL



(c) GARAGE DOOR CORNER

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm.

FIGURE R602.10.3(5)
TYPICAL EXTERIOR CORNER FRAMING FOR CONTINUOUS SHEATHING

R602.10.4 Load path details.

Construction shall comply with applicable detailing requirements of this section to ensure an adequate continuous load path for transfer of bracing loads and uplift loads from the roof to the foundation.

R602.10.4.1 Wind uplift load path.

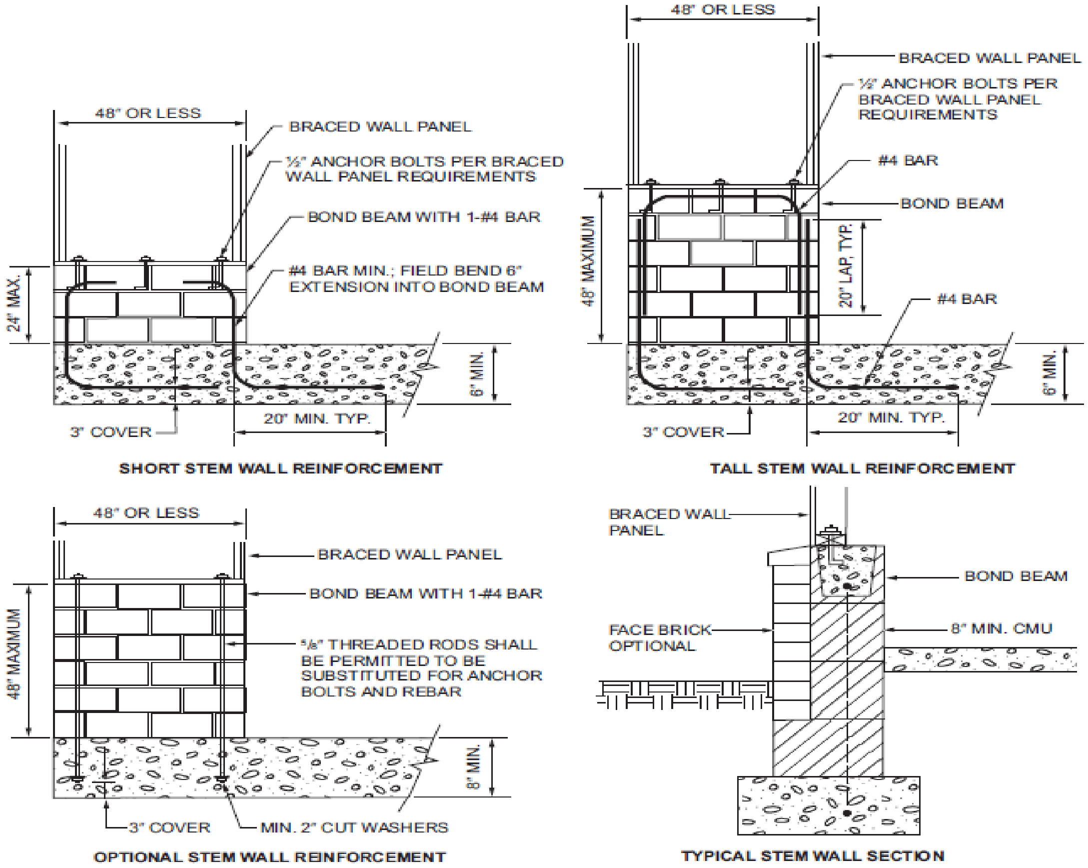
Framing connections to transfer roof uplift forces shall comply with Section R602.3.5 and Section R802.11. In the 130 mph (58 m/s) wind zone provide uplift anchorage in accordance with Section R4508 and Section R4504.1.

R602.10.4.2 Foundation anchorage.

Braced wall panels shall be connected to the foundation per Section R403.1.6, Section R602.11 and as required in Figure R602.10.1 for portal frames.

R602.10.4.3 Masonry or concrete pedestals.

Masonry or concrete stem walls with a length of 48 inches (1219 mm) or less supporting braced wall panels shall be reinforced in accordance with Figure R602.10.4.3. Concrete stem walls shall be 6 inches (152 mm) nominal minimum thickness. Continuous concrete stem walls shall be reinforced per Section R404.1.3.2.



NOTE: GROUT BOND BEAMS AND ALL CELLS THAT CONTAIN REBAR, THREADED RODS AND ANCHOR BOLTS.

FIGURE R602.10.4.3
MASONRY STEM WALLS SUPPORTING BRACED WALL PANELS

R602.10.4.4 Blocking of floor framing.

When perpendicular to floor framing, braced wall panels shall be connected to full-height solid blocking between floor framing in accordance with Figure R602.10.4.4(1). When parallel to floor framing, braced wall panels shall be connected to a band, rim or header joist, floor framing or perpendicular full-height solid blocking between floor framing at 16 inches (406 mm) on center in accordance with Figure R602.10.4.4(2). Attachments shall be in accordance with Table R602.3(1). Manufactured lumber or truss blocking panels shall be permitted to substitute for full-height solid blocking.

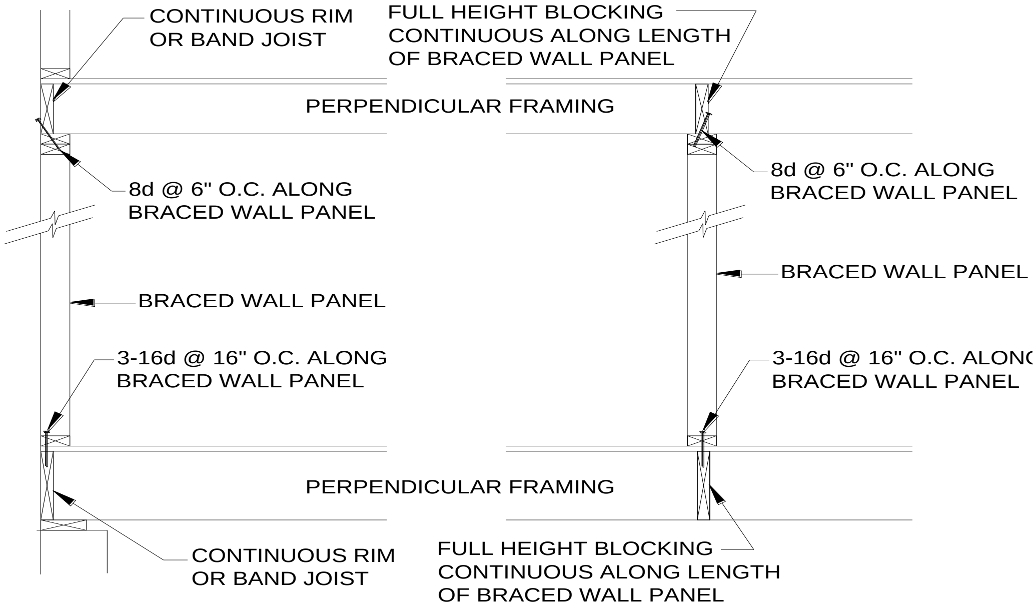


FIGURE R602.10.4.4(1)
BRACED WALL PANEL CONNECTION WHEN
PERPENDICULAR TO FLOOR/CEILING FRAMING

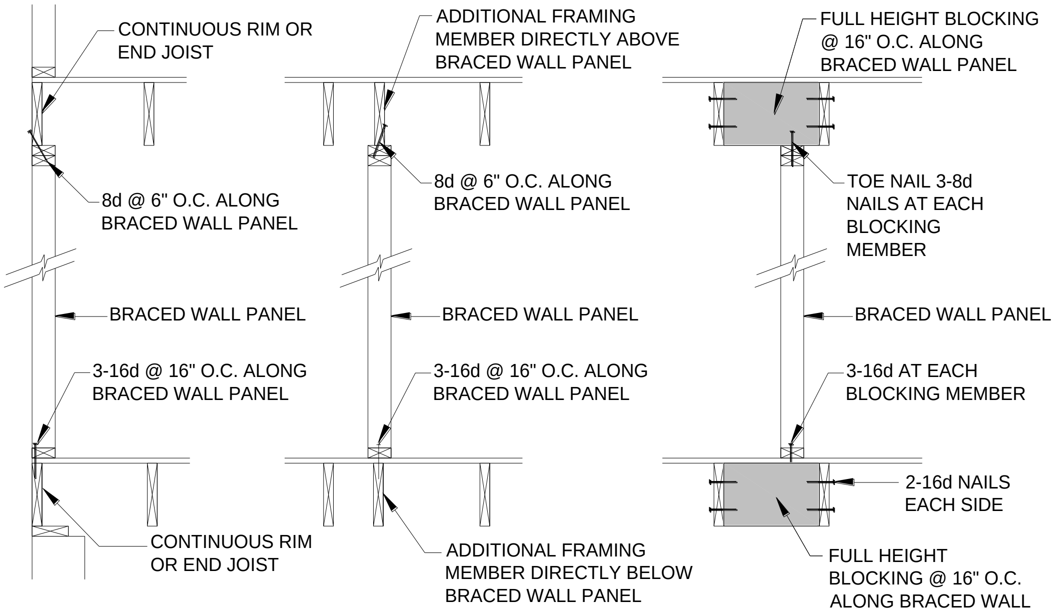


FIGURE R602.10.4.4(2)
BRACED WALL PANEL CONNECTION WHEN
PARALLEL TO FLOOR/CEILING FRAMING

R602.10.4.5 Blocking of roof framing.
When parallel to roof framing, braced wall panels shall be connected to a band, rim or header joist, or roof truss. When perpendicular to roof framing, the top plates of exterior

braced wall panels shall be connected to the rafters or roof trusses above in accordance with Table R602.10.4.5 and fastened in accordance with Table R602.3(1).

TABLE R602.10.4.5 BRACED WALL PANEL CONNECTIONS TO PERPENDICULAR ROOF FRAMING

DISTANCE FROM TOP OF BRACED WALL PANEL TO TOP OF RAFTER OR ROOF TRUSS, (in)	REQUIREMENT	REFERENCED FIGURE
≤ 9.25	No blocking required	NA
9.26 – 15.25	Solid 2x blocking between rafters or trusses	R602.10.4.5(1) or (2)
15.26 – 48	Vertical blocking panels	R602.10.4.5(2) or (3)
> 48	Designed in accordance with accepted engineering practice	NA

For SI: 1 inch = 25.4 mm

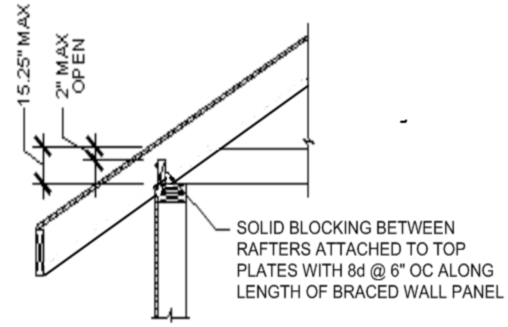


FIGURE R602.10.4.5(1) BRACED WALL PANEL CONNECTION TO PERPENDICULAR RAFTERS OR ROOF TRUSSES

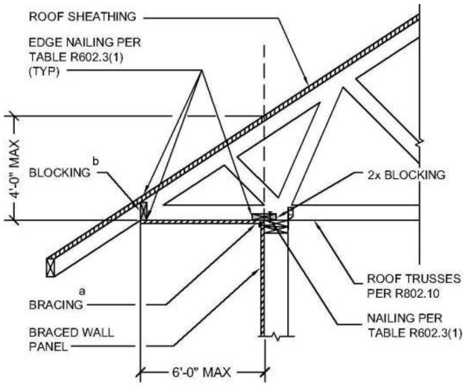
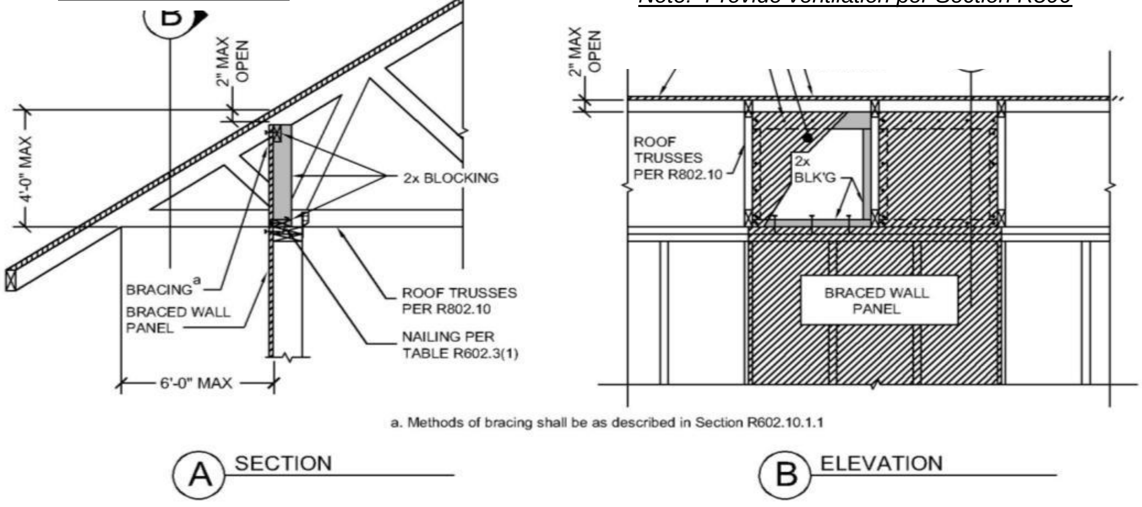


FIGURE R602.10.4.5(2) ALTERNATE TO FIGURE R602.10.4.5(1) OR FIGURE R602.10.4.5(3)

Note: Provide ventilation per Section R806



a. Methods of bracing shall be as described in Section R602.10.1.1

FIGURE R602.10.4.5(3)
BRACED WALL PANEL CONNECTION TO PERPENDICULAR RAFTERS OR TRUSSES

R602.10.4.6 Cripple walls and framed walls of walk-out basements.

The required length of bracing for cripple walls with a maximum height of 48 inches (1219 mm) or less along its entire length shall be equal to the bracing provided for the wall above. The required length of bracing for cripple walls with a height greater than 48 inches (1219 mm) at any location along its length and for framed walls of a walk-out basement shall be determined in accordance with Section R602.10.2 or R602.10.3, considering the cripple wall or walk-out basement as an additional story. As an alternative, the required length of bracing shall be permitted to equal to the bracing provided for the wall above multiplied by a factor of 1.15.

R602.10.4.7 Open elevated foundations.

Open elevated foundations, such as pile foundations, shall be constructed to transfer all lateral loads from the wall bracing system to the piles or open pier system, including shears, overturning, and uplift loads. Piles or open pier systems along with their foundations shall be sized and embedded to transfer all lateral loads imposed by the wall bracing system to the ground.

R602.10.4.8 Balloon frame wall bracing.

Balloon frame walls shall have a maximum height of two stories and a maximum length of 20 feet (6096 mm) unless constructed in accordance with an approved design. Wall framing shall be continuous from lowest floor to the wall top plate at the roof. Braced wall panels shall extend to the full-height of the balloon frame wall. All edges of sheathing shall be supported on and fastened to blocking or framing. The required brace wall panel length assigned to the balloon frame wall shall be based on the bracing required for the lowest floor level supporting the balloon frame wall as determined in accordance with Section R602.10.2 or R602.10.3. For balloon framed walls having a maximum height of two stories and a maximum length of 20 feet (6096 mm), braced wall panels shall be permitted to be placed both parallel and perpendicular to the balloon framed wall on each side and at each story adjacent to the balloon framed wall, and no bracing shall be required for the balloon frame wall portion. Bracing in the direction perpendicular to the balloon framed wall may be omitted when the opening dimension in the second floor perpendicular to the balloon framed wall created by the two story space is less than one half the least overall dimension of the house. See Figure R602.10.4.8.

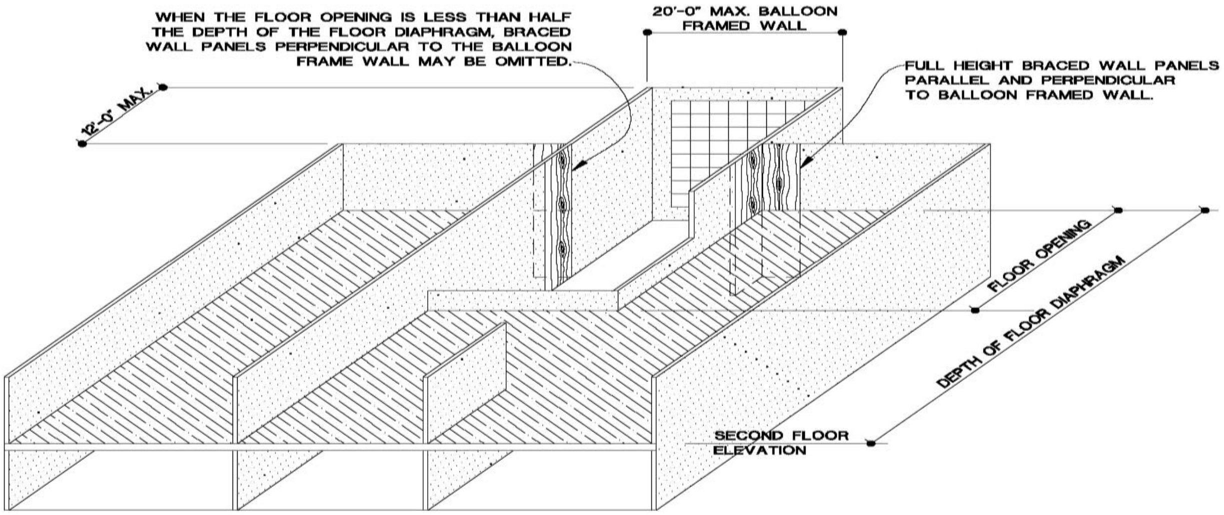


FIGURE R602.10.4.8
BALLOON FRAMED WALL

R602.10.5 Wall bracing by engineered design.

Design using bracing materials and methods listed in Table R602.10.1 or approved alternative materials and methods shall be permitted and shall comply with accepted engineering practice. Accepted engineering practice shall include the following:

1. Design in accordance with Section R301,
2. Design equivalent to the analysis basis of the provisions in Sections R602.10.2, R602.10.3, and R602.10.4, including determination of design loads, design unit shear values, and bracing amounts.

R602.11.1 Wall anchorage for ~~all buildings in Seismic Design Categories D0, D1and D2 and~~ townhouses in Seismic Design Category C.

Plate washers, not less than 0.229 inch by 3 inches by 3 inches (5.8 mm by 76 mm by 76 mm) in size, shall be provided between the foundation sill plate and the nut except where *approved* anchor straps are used. The hole in the plate washer is permitted to be diagonally slotted with a width of up to $^{3}/_{16}$ inch (5 mm) larger than the bolt diameter and a slot length not to exceed $1^{3}/_{4}$ inches (44 mm), provided a standard cut washer is placed between the plate washer and the nut.

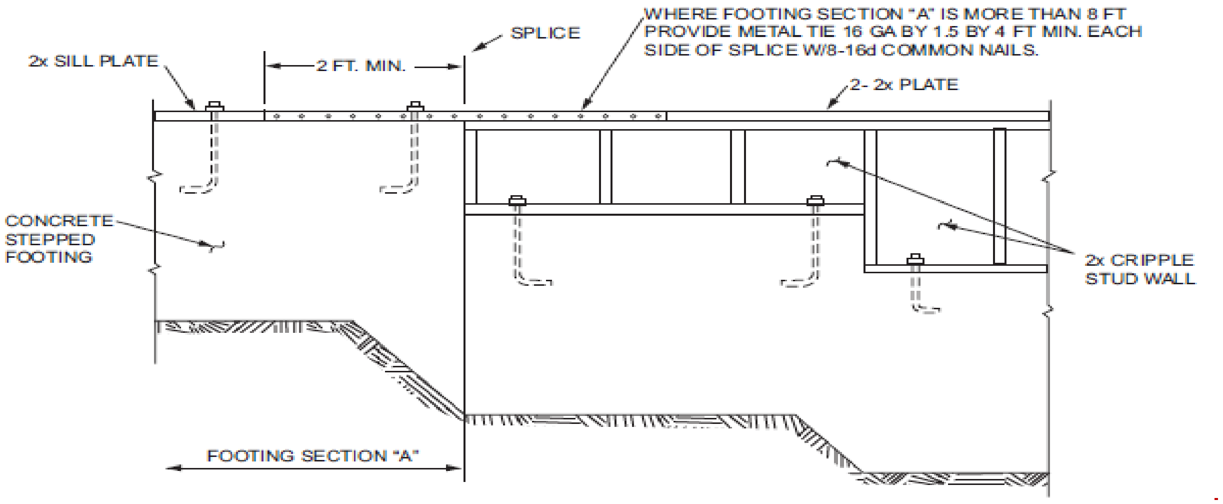
R602.11.2 Stepped foundations in Seismic Design Categories D0, D1and D2. Deleted. ~~In all buildings located in Seismic Design Categories D_0, D_1 and D_2, where the height of a required *braced wall line* that extends from foundation to floor above varies more than 4 feet (1219 mm), the *braced wall line* shall be constructed in accordance with the following:~~

1. ~~Where the lowest floor framing rests directly on a sill bolted to a foundation not less than 8 feet (2440 mm) in length along a line of bracing, the line shall be considered as braced. The double plate of the cripple stud wall beyond the segment of footing~~

~~that extends to the lowest framed floor shall be spliced by extending the upper top plate not less than 4 feet (1219 mm) along the foundation. Anchor bolts shall be located not more than 1 foot and 3 feet (305 and 914 mm) from the step in the foundation. See Figure R602.11.2.~~

2. ~~Where cripple walls occur between the top of the foundation and the lowest floor framing, the bracing requirements of Sections R602.10.11, R602.10.11.1 and R602.10.11.2 shall apply.~~

3. ~~Where only the bottom of the foundation is stepped and the lowest floor framing rests directly on a sill bolted to the foundations, the requirements of Sections R403.1.6 and R602.11.1 shall apply.~~



~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.~~
~~**Note:** Where footing Section "A" is less than 8 feet long in a 25-foot-long wall, install bracing at cripple stud wall.~~

~~FIGURE R602.11.2~~
~~STEPPED FOUNDATION CONSTRUCTION~~

R602.12 Simplified wall bracing. Deleted.
~~Buildings meeting all of the conditions listed below shall be permitted to be braced in accordance with this section as an alternate to the requirements of Section R602.10. The entire building shall be braced in accordance with this section; the use of other bracing provisions of Section R602.10, except as specified herein, shall not be permitted.~~

1. ~~There shall be not more than three stories above the top of a concrete or masonry foundation or basement wall. Permanent wood foundations shall not be permitted.~~

2. ~~Floors shall not cantilever more than 24 inches (607 mm) beyond the foundation or bearing wall below.~~

3. ~~Wall height shall not be greater than 10 feet (3048 mm).~~

4. ~~The building shall have a roof eave-to-ridge height of 15 feet (4572 mm) or less.~~

5. ~~Exterior walls shall have gypsum board with a minimum thickness of $^{1}/_{2}$ inch (12.7 mm) installed on the interior side fastened in accordance with Table R702.3.5.~~

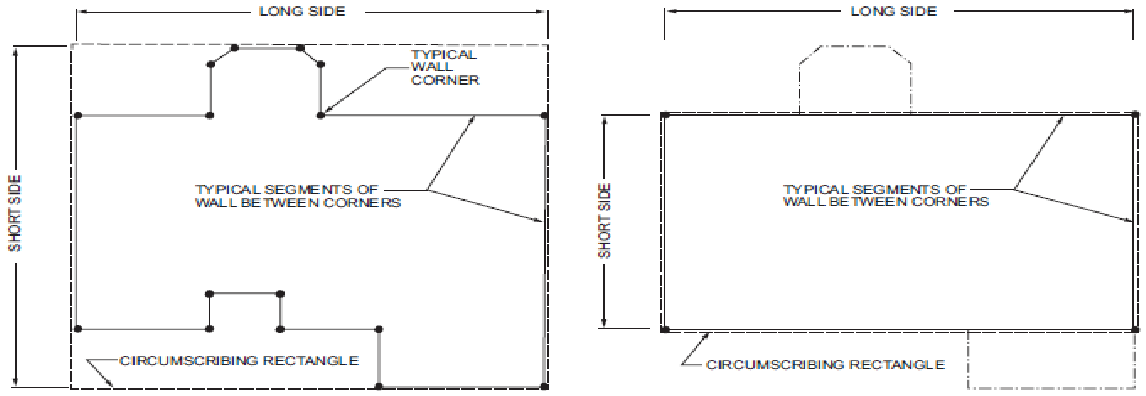
6. ~~The structure shall be located where the ultimate design wind speed is less than or equal to 130 mph (58 m/s), and the exposure category is B or C.~~

7. ~~The structure shall be located in Seismic Design Category A, B or C for detached one- and two-family dwellings or Seismic Design Category A or B for townhouses.~~

8. ~~Cripple walls shall not be permitted in three-story buildings.~~

~~R602.12.1 Circumscribed rectangle.~~

~~The bracing required for each building shall be determined by circumscribing a rectangle around the entire building on each floor as shown in Figure R602.12.1. The rectangle shall surround all enclosed offsets and projections such as sunrooms and attached garages. Open structures, such as carports and decks, shall be permitted to be excluded. The rectangle shall not have a side greater than 60 feet (18 288 mm), and the ratio between the long side and short side shall be not greater than 3:1.~~



FIRST FLOOR PLAN

SECOND FLOOR PLAN

~~FIGURE R602.12.1~~
~~RECTANGLE CIRCUMSCRIBING AN ENCLOSED BUILDING~~

~~R602.12.2 Sheathing materials.~~

~~The following sheathing materials installed on the exterior side of exterior walls shall be used to construct a bracing unit as defined in Section R602.12.3. Mixing materials is prohibited.~~

1. ~~Wood structural panels with a minimum thickness of $^{3}/_{8}$ inch (9.5 mm) fastened in accordance with Table R602.3(3).~~

2. ~~Structural fiberboard sheathing with a minimum thickness of $^1/_2$ inch (12.7 mm) fastened in accordance with Table R602.3(1).~~

~~R602.12.3 Bracing unit.~~

~~A bracing unit shall be a full-height sheathed segment of the exterior wall without openings or vertical or horizontal offsets and a minimum length as specified herein. Interior walls shall not contribute toward the amount of required bracing. Mixing of Items 1 and 2 is prohibited on the same story.~~

1. ~~Where all framed portions of all exterior walls are sheathed in accordance with Section R602.12.2, including wall areas between bracing units, above and below openings and on gable end walls, the minimum length of a bracing unit shall be 3 feet (914 mm).~~

2. ~~Where the exterior walls are braced with sheathing panels in accordance with Section R602.12.2 and areas between bracing units are covered with other materials, the minimum length of a bracing unit shall be 4 feet (1219 mm).~~

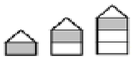
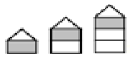
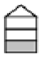
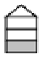
~~R602.12.3.1 Multiple bracing units.~~

~~Segments of wall compliant with Section R602.12.3 and longer than the minimum bracing unit length shall be considered as multiple bracing units. The number of bracing units shall be determined by dividing the wall segment length by the minimum bracing unit length. Full-height sheathed segments of wall narrower than the minimum bracing unit length shall not contribute toward a bracing unit except as specified in Section R602.12.6.~~

~~R602.12.4 Number of bracing units.~~

~~Each side of the circumscribed rectangle, as shown in Figure R602.12.1, shall have, at a minimum, the number of bracing units in accordance with Table R602.12.4 placed on the parallel exterior walls facing the side of the rectangle. Bracing units shall then be placed using the distribution requirements specified in Section R602.12.5.~~

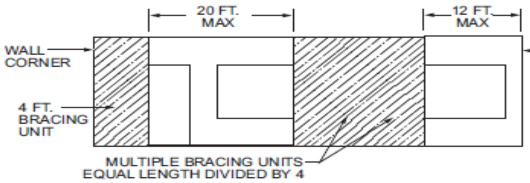
~~TABLE R602.12.4~~
~~MINIMUM NUMBER OF BRACING UNITS ON EACH SIDE OF THE CIRCUMSCRIBED RECTANGLE~~

ULTIMATE DESIGN WIND SPEED (mph)	STORY LEVEL	EAVE-TO-RIDGE HEIGHT (feet)	MINIMUM NUMBER OF BRACING UNITS ON EACH LONG SIDE[a, b, d]						MINIMUM NUMBER OF BRACING UNITS ON EACH SHORT SIDE[a, b, d]					
			Length of short side (feet)[c]						Length of long side (feet)[c]					
			10	20	30	40	50	60	10	20	30	40	50	60
115		10	1	2	2	2	3	3	1	2	2	2	3	3
			2	3	3	4	5	6	2	3	3	4	5	6
			2	3	4	6	7	8	2	3	4	6	7	8
		15	1	2	3	3	4	4	1	2	3	3	4	4
			2	3	4	5	6	7	2	3	4	5	6	7
			2	4	5	6	7	9	2	4	5	6	7	9
130		10	1	2	2	3	3	4	1	2	2	3	3	4
			2	3	4	5	6	7	2	3	4	5	6	7
			2	4	5	7	8	10	2	4	5	7	8	10
		15	2	3	3	4	4	6	2	3	3	4	4	6
			3	4	6	7	8	10	3	4	6	7	8	10
			3	6	7	10	11	13	3	6	7	10	11	13

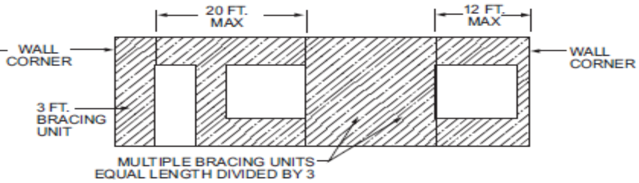
~~R602.12.5 Distribution of bracing units.~~

~~The placement of bracing units on exterior walls shall meet all of the following requirements as shown in Figure R602.12.5.~~

1. ~~A bracing unit shall begin not more than 12 feet (3658 mm) from any wall corner.~~
2. ~~The distance between adjacent edges of bracing units shall be not greater than 20 feet (6096 mm).~~
3. Segments of wall greater than 8 feet (2438 mm) in length shall have not less than one bracing unit.



BRACING WITH AREAS BETWEEN COVERED WITH OTHER MATERIALS



BRACING UNITS WITH ALL FRAMED PORTIONS OF WALL SHEATHED

~~For SI: 1 foot = 304.8 mm.~~

~~FIGURE R602.12.5~~
~~BRACING UNIT DISTRIBUTION~~

~~R602.12.6 Narrow panels.~~

~~The bracing methods referenced in Section R602.10 and specified in Sections R602.12.6.1 through R602.12.6.3 shall be permitted when using simplified wall bracing.~~

~~R602.12.6.1 Method CS-G.~~

~~*Braced wall panels* constructed as Method CS-G in accordance with Tables R602.10.4 and R602.10.5 shall be permitted for one-story garages where all framed portions of all exterior walls are sheathed with wood structural panels. Each CS-G panel shall be equivalent to 0.5 of a bracing unit. Segments of wall that include a Method CS-G panel shall meet the requirements of Section R602.10.4.2.~~

~~R602.12.6.2 Method CS-PF.~~

~~Braced wall panels constructed as Method CS-PF in accordance with Section R602.10.6.4 shall be permitted where all framed portions of all exterior walls are sheathed with wood structural panels. Each CS-PF panel shall equal 0.75 bracing units. Not more than four CS-PF panels shall be permitted on all segments of walls parallel to each side of the circumscribed rectangle. Segments of wall that include a Method CS-PF panel shall meet the requirements of Section R602.10.4.2.~~

~~R602.12.6.3 Methods ABW, PFH and PFG.~~

~~Braced wall panels constructed as Method ABW, PFH and PFG shall be permitted where bracing units are constructed using wood structural panels applied either continuously or intermittently. Each ABW and PFH panel shall equal one bracing unit and each PFG panel shall be equal to 0.75 bracing unit.~~

~~R602.12.7 Lateral support.~~

~~For bracing units located along the eaves, the vertical distance from the outside edge of the top wall plate to the roof sheathing above shall not exceed 9.25 inches (235 mm) at the location of a bracing unit unless lateral support is provided in accordance with Section R602.10.8.2.~~

~~R602.12.8 Stem walls.~~

~~Masonry stem walls with a height and length of 48 inches (1219 mm) or less supporting a bracing unit or a Method CS-G, CS-PF or PFG *braced wall panel* shall be constructed in accordance with Figure R602.10.9. Concrete stem walls with a length of 48 inches (1219 mm) or less, greater than 12 inches (305 mm) tall and less than 6 inches (152 mm) thick shall be reinforced sized and located in accordance with Figure R602.10.9.~~

SECTION R603
COLD-FORMED STEEL WALL FRAMING
Deleted

~~R603.1 General.~~

~~Elements shall be straight and free of any defects that would significantly affect structural~~

~~performance. Cold-formed steel wall framing members shall be in accordance with the requirements of this section.~~

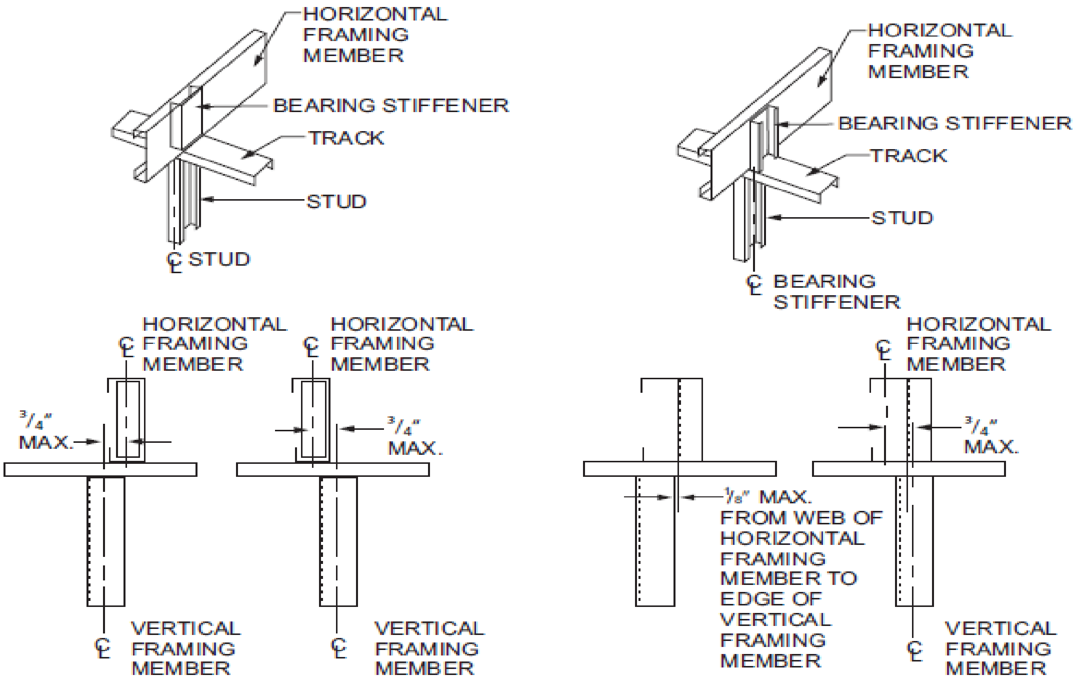
~~R603.1.1 Applicability limits.~~

~~The provisions of this section shall control the construction of exterior cold-formed steel wall framing and interior load-bearing cold-formed steel wall framing for buildings not more than 60 feet (18 288 mm) long perpendicular to the joist or truss span, not more than 40 feet (12 192 mm) wide parallel to the joist or truss span, and less than or equal to three stories above grade plane. Exterior walls installed in accordance with the provisions of this section shall be considered as load-bearing walls. Cold-formed steel walls constructed in accordance with the provisions of this section shall be limited to sites where the ultimate design wind speed is less than 139 miles per hour (62 m/s), Exposure Category B or C, and the ground snow load is less than or equal to 70 pounds per square foot (3.35 kPa).~~

~~R603.1.2 In-line framing.~~

~~Load-bearing cold-formed steel studs constructed in accordance with Section R603 shall be located in-line with joists, trusses and rafters in accordance with Figure R603.1.2 and the tolerances specified as follows:~~

1. ~~The maximum tolerance shall be $^{3}/_{4}$ inch (19 mm) between the centerline of the horizontal framing member and the centerline of the vertical framing member.~~
2. ~~Where the centerline of the horizontal framing member and bearing stiffener is located to one side of the centerline of the vertical framing member, the maximum tolerance shall be $^{1}/_{8}$ inch (3 mm) between the web of the horizontal framing member and the edge of the vertical framing member.~~



~~For SI: 1 inch = 25.4 mm,~~

~~FIGURE R603.1.2~~
~~IN-LINE FRAMING~~

~~R603.2 Structural framing.~~

~~Load-bearing cold-formed steel wall framing members shall be in accordance with this section.~~

~~R603.2.1 Material.~~

~~Load-bearing cold-formed steel framing members shall be cold formed to shape from structural- quality sheet steel complying with the requirements of ASTM A 1003: Structural Grades 33 Type H and 50 Type H.~~

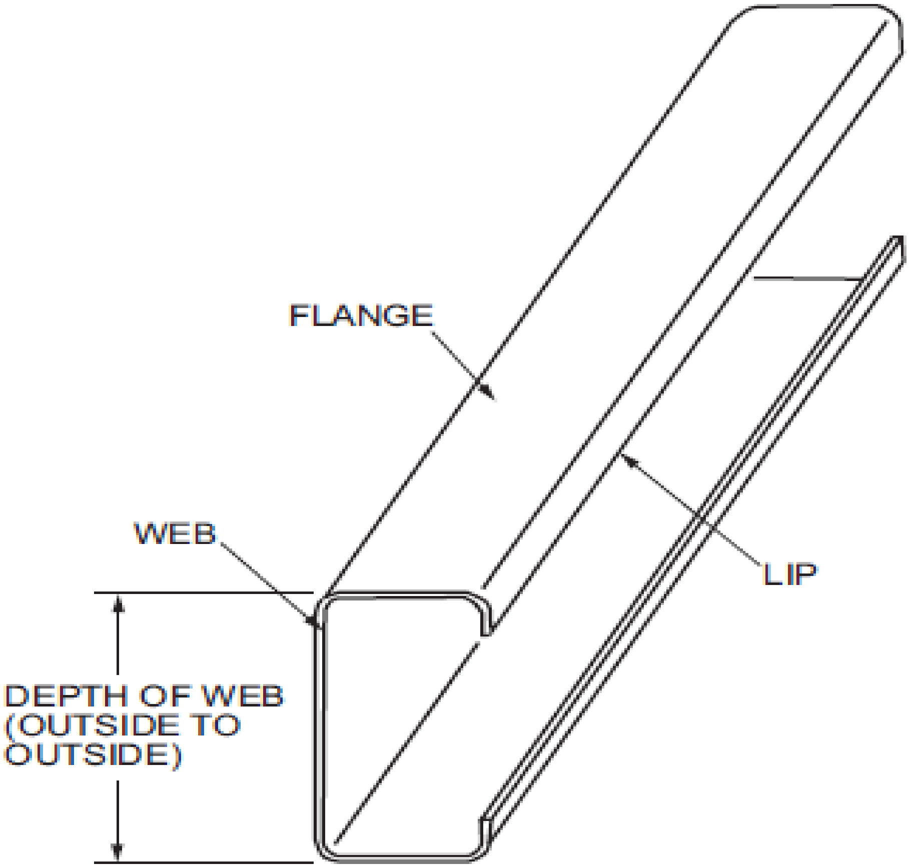
~~R603.2.2 Corrosion protection.~~

~~Load-bearing cold-formed steel framing shall have a metallic coating complying with ASTM A 1003 and one of the following:~~

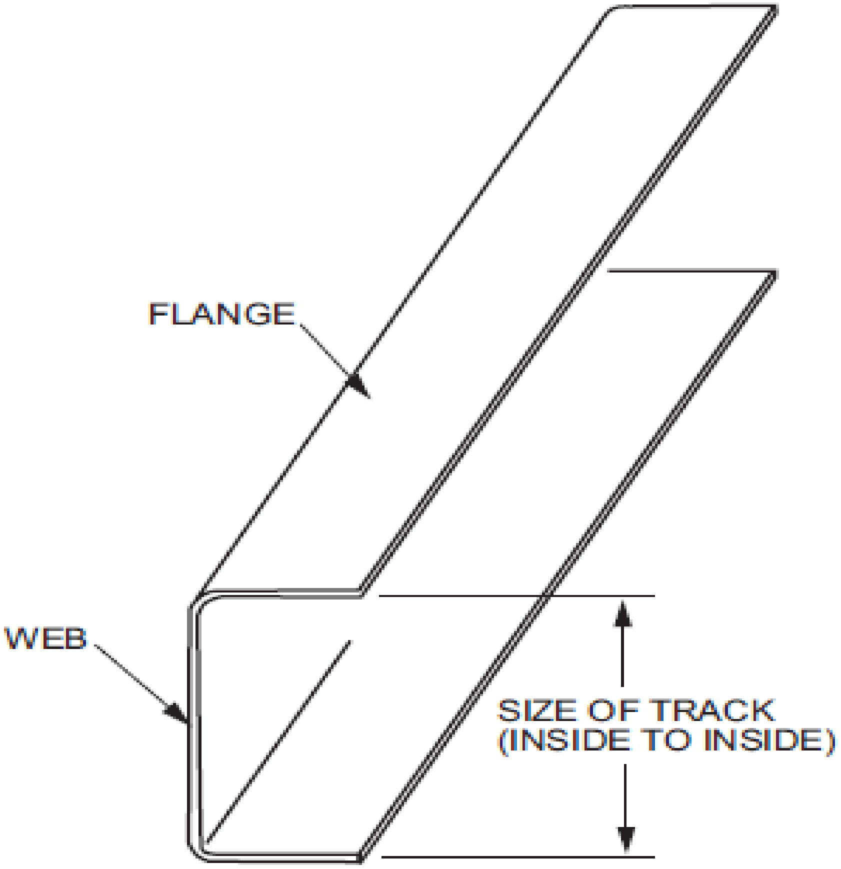
1. ~~A minimum of G 60 in accordance with ASTM A 653.~~
2. ~~A minimum of AZ 50 in accordance with ASTM A 792.~~

~~R603.2.3 Dimension, thickness and material grade.~~

~~Load-bearing cold-formed steel wall framing members shall comply with Figure R603.2.3(1) and with the dimensional and thickness requirements specified in Table R603.2.3. Additionally, C-shaped sections shall have a minimum flange width of 1~~ ~~$^5/_8$~~ ~~inches (41 mm) and a maximum flange width of 2 inches (51 mm). The minimum lip size for C-shaped sections shall be~~ ~~$^1/_2$~~ ~~inch (12.7 mm). Track sections shall comply with Figure R603.2.3(2) and shall have a minimum flange width of 1~~ ~~$^1/_4$~~ ~~inches (32 mm). Minimum Grade 33 ksi steel shall be used wherever 33 mil and 43 mil thicknesses are specified. Minimum Grade 50 ksi steel shall be used wherever 54 and 68 mil thicknesses are specified.~~



~~FIGURE R603.2.3(1)~~
~~C-SHAPED SECTION~~



~~FIGURE R603.2.3(2)~~
~~TRACK SECTION~~

~~TABLE R603.2.3~~
~~LOAD-BEARING COLD-FORMED STEEL STUD SIZES AND THICKNESSES~~

~~MEMBER DESIGNATION~~[a]	~~WEB DEPTH (inches)~~	~~MINIMUM BASE STEEL THICKNESS mil (inches)~~
~~350S162-t~~	~~3.5~~	~~33 (0.0329), 43 (0.0428), 54 (0.0538)~~
~~550S162-t~~	~~5.5~~	~~33 (0.0329), 43 (0.0428), 54 (0.0538), 68 (0.0677)~~

~~For SI: 1 inch = 25.4 mm; 1 mil = 0.0254 mm.~~

~~a. The member designation is defined by the first number representing the member depth in hundredths of an inch, "S" representing a stud or joist member, the second number representing the flange width in hundredths of an inch, and the letter "t" shall be a number representing the minimum base metal thickness in mils.~~

~~R603.2.4 Identification.~~

~~Load-bearing cold-formed steel framing members shall have a legible label, stencil, stamp or embossment with the following information as a minimum:~~

1. ~~Manufacturer's identification.~~
2. ~~Minimum base steel thickness in inches (mm).~~
3. ~~Minimum coating designation.~~
4. ~~Minimum yield strength, in kips per square inch (ksi) (MPa).~~

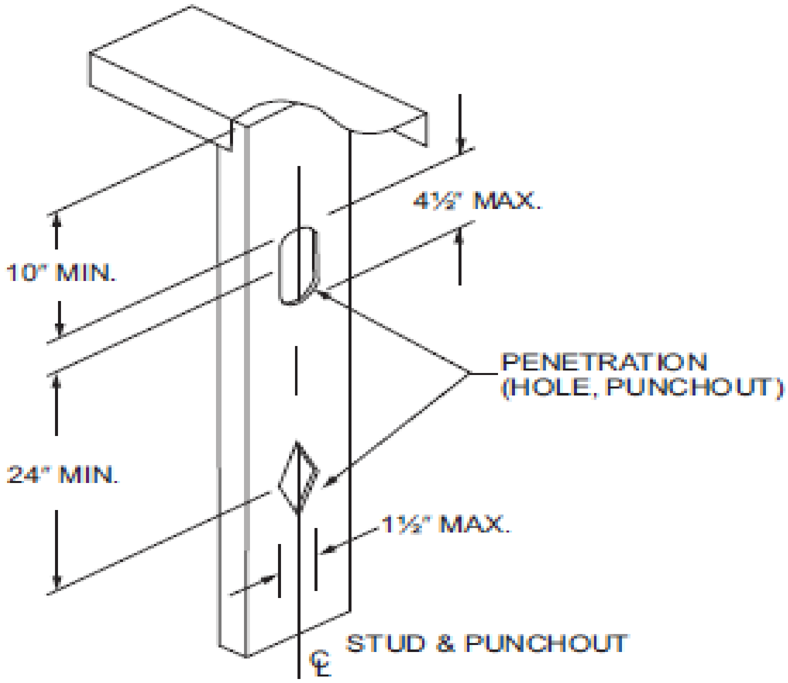
~~R603.2.5 Fastening.~~
~~Screws for steel-to-steel connections shall be installed with a minimum edge distance and center-to-center spacing of $^1/_2$ inch (12.7 mm), shall be self-drilling tapping and shall conform to ASTM C 1513. Structural sheathing shall be attached to cold-formed steel studs with minimum No. 8 self-drilling tapping screws that conform to ASTM C 1513. Screws for attaching structural sheathing to cold-formed steel wall framing shall have a minimum head diameter of 0.292 inch (7.4 mm) with countersunk heads and shall be installed with a minimum edge distance of $^3/_8$ inch (9.5 mm). Gypsum board shall be attached to cold-formed steel wall framing with minimum No. 6 screws conforming to ASTM C 954 or ASTM C 1513 with a bugle-head style and shall be installed in accordance with Section R702. For connections, screws shall extend through the steel a minimum of three exposed threads. Fasteners shall have rust-inhibitive coating suitable for the installation in which they are being used, or be manufactured from material not susceptible to corrosion.~~

~~R603.2.6 Web holes, web hole reinforcing and web hole patching.~~
~~Web holes, web hole reinforcing and web hole patching shall be in accordance with this section.~~

~~R603.2.6.1 Web holes.~~
~~Web holes in wall studs and other structural members shall comply with all of the following conditions:~~

1. ~~Holes shall conform to Figure R603.2.6.1.~~
2. ~~Holes shall be permitted only along the centerline of the web of the framing member.~~
3. ~~Holes shall have a center-to-center spacing of not less than 24 inches (610 mm).~~
4. ~~Holes shall have a web hole width not greater than 0.5 times the member depth, or 1$^1/_2$ inches (38 mm).~~
5. ~~Holes shall have a web hole length not exceeding 4$^1/_2$ inches (114 mm).~~
6. ~~Holes shall have a minimum distance between the edge of the bearing surface and the edge of the web hole of not less than 10 inches (254 mm).~~

~~Framing members with web holes not conforming to the above requirements shall be reinforced in accordance with Section R603.2.6.2, patched in accordance with Section R603.2.6.3 or designed in accordance with accepted engineering practice.~~



~~For SI: 1 inch = 25.4 mm.~~

~~**FIGURE R603.2.6.1**~~
~~**WALL STUD WEB HOLES**~~

~~R603.2.6.2 Web hole reinforcing.~~

~~Web holes in gable endwall studs not conforming to the requirements of Section R603.2.6.1 shall be permitted to be reinforced if the hole is located fully within the center 40 percent of the span and the depth and length of the hole does not exceed 65 percent of the flat width of the web. The reinforcing shall be a steel plate or C-shape section with a hole that does not exceed the web hole size limitations of Section R603.2.6.1 for the member being reinforced. The steel reinforcing shall be the same thickness as the receiving member and shall extend not less than 1 inch (25 mm) beyond all edges of the hole. The steel reinforcing shall be fastened to the web of the receiving member with No. 8 screws spaced not more than 1 inch (25 mm) center-to-center along the edges of the patch with minimum edge distance of $^1/_2$ inch (12.7 mm).~~

~~R603.2.6.3 Hole patching.~~

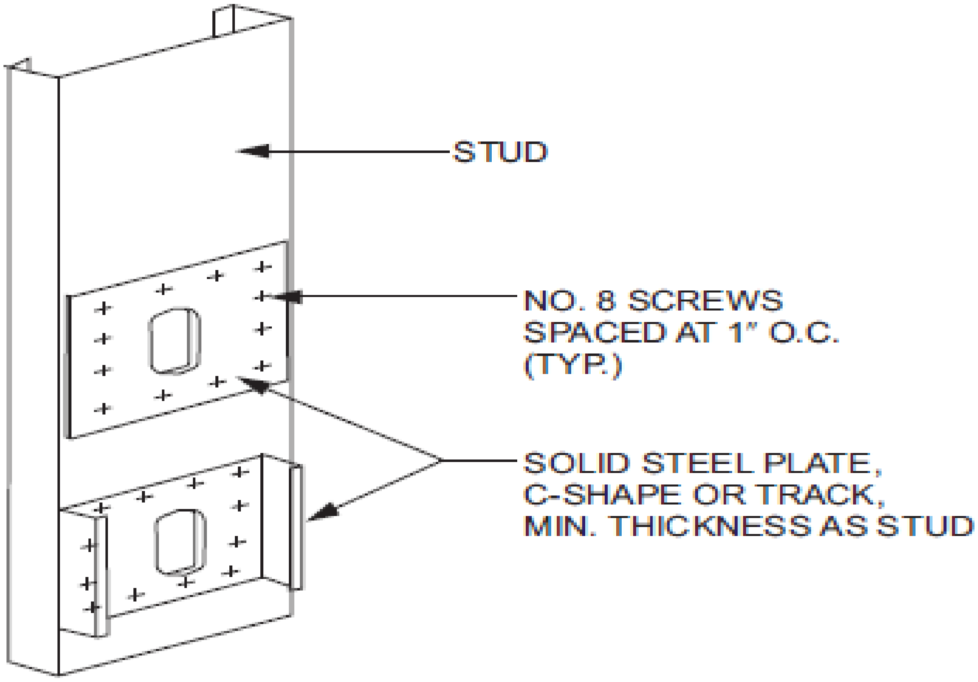
~~Web holes in wall studs and other structural members not conforming to the requirements in Section R603.2.6.1 shall be permitted to be patched in accordance with either of the following methods:~~

1. ~~Framing members shall be replaced or designed in accordance with accepted engineering practice where web holes exceed the following size limits:~~

    1.1. ~~The depth of the hole, measured across the web, exceeds 70 percent of the flat width of the web. or~~

    1.2. ~~The length of the hole measured along the web exceeds 10 inches (254 mm) or the depth of the web, whichever is greater.~~

2. ~~Web holes not exceeding the dimensional requirements in Section R603.2.6.3, Item 1, shall be patched with a solid steel plate, stud section or track section in accordance with Figure R603.2.6.3. The steel patch shall, as a minimum, be the same thickness as the receiving member and shall extend not less than1 inch (25 mm) beyond all edges of the hole. The steel patch shall be fastened to the web of the receiving member with No. 8 screws spaced not more than 1 inch (25 mm) center-to-center along the edges of the patch with a minimum edge distance of $^1/_2$ inch (12.7 mm).~~



~~For SI: 1 inch = 25.4 mm.~~

~~**FIGURE R603.2.6.3**~~
~~**WALL STUD WEB HOLE PATCH**~~

~~R603.3 Wall construction.~~

~~Exterior cold-formed steel framed walls and interior load-bearing cold-formed steel framed walls shall be constructed in accordance with the provisions of this section.~~

~~R603.3.1 Wall to foundation or floor connection.~~

~~Cold- formed steel framed walls shall be anchored to foundations or floors in accordance with Table R603.3.1 and Figure R603.3.1(1), R603.3.1(2), R603.3.1(3) or R603.3.1(4). Anchor bolts shall be located not more than 12 inches (305 mm) from corners or the termination of bottom tracks. Anchor bolts shall extend not less than 15 inches (381 mm) into masonry or 7 inches (178 mm) into concrete. Foundation anchor straps shall be permitted, in lieu of anchor bolts, if spaced as required to provide equivalent anchorage to the required anchor bolts and installed in accordance with manufacturer's requirements.~~

~~TABLE R603.3.1~~

~~WALL TO FOUNDATION OR FLOOR CONNECTION REQUIREMENTS~~[~~a, b~~]

~~FRAMING CONDITION~~			~~ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)~~				
			~~115 B~~	~~126 B or 110 C~~	~~< 139 B or 115 C~~	~~126 C~~	~~< 139 C~~
~~Wall bottom track to floor per Figure R603.3.1(1)~~			~~1-No. 8 screw at 12″ o.c.~~	~~1-No. 8 screw at 12″ o.c.~~	~~1-No. 8 screw at 12″ o.c.~~	~~2-No. 8 screws at 12″ o.c.~~	~~2-No. 8 screws at 12″ o.c.~~
~~Wall bottom track to foundation per Figure R603.3.1(2)~~[~~d~~]			~~1/2″ minimum diameter anchor bolt at 6′ o.c.~~	~~1/2″ minimum diameter anchor bolt at 4′ o.c.~~	~~1/2″ minimum diameter anchor bolt at 4′ o.c.~~	~~1/2″ minimum diameter anchor bolt at 4′ o.c.~~	~~1/2″ minimum diameter anchor bolt at 4′ o.c.~~
~~Wall bottom track to wood sill per Figure R603.3.1(3)~~			~~Steel plate spaced at 4′ o.c., with 4- No. 8 screws and 4-10d or 6-8d common nails~~	~~Steel plate spaced at 3′ o.c., with 4- No. 8 screws and 4-10d or 6-8d common nails~~	~~Steel plate spaced at 3′ o.c., with 4- No. 8 screws and 4-10d or 6-8d common nails~~	~~Steel plate spaced at 2′ o.c., with 4- No. 8 screws and 4-10d or 6-8d common nails~~	~~Steel plate spaced at 2′ o.c., with 4- No. 8 screws and 4-10d or 6-8d common nails~~
~~Wind uplift connector strength (lbs)~~[~~c, e~~]	~~Stud Spacing (inches)~~	~~Roof Span (feet)~~					
	~~16~~	~~24~~	~~NR~~	~~NR~~	~~NR~~	~~124~~	~~209~~
		~~28~~	~~NR~~	~~NR~~	~~62~~	~~151~~	~~249~~
		~~32~~	~~NR~~	~~NR~~	~~79~~	~~179~~	~~289~~
		~~36~~	~~NR~~	~~NR~~	~~94~~	~~206~~	~~329~~
		~~40~~	~~NR~~	~~61~~	~~117~~	~~239~~	~~374~~
	~~24~~	~~24~~	~~NR~~	~~NR~~	~~69~~	~~186~~	~~314~~
		~~28~~	~~NR~~	~~NR~~	~~93~~	~~227~~	~~374~~
		~~32~~	~~NR~~	~~NR~~	~~117~~	~~268~~	~~434~~
		~~36~~	~~NR~~	~~64~~	~~141~~	~~309~~	~~494~~
		~~40~~	~~NR~~	~~92~~	~~176~~	~~359~~	~~562~~

~~For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s, 1 foot = 304.8 mm, 1 pound = 4.45 N.~~

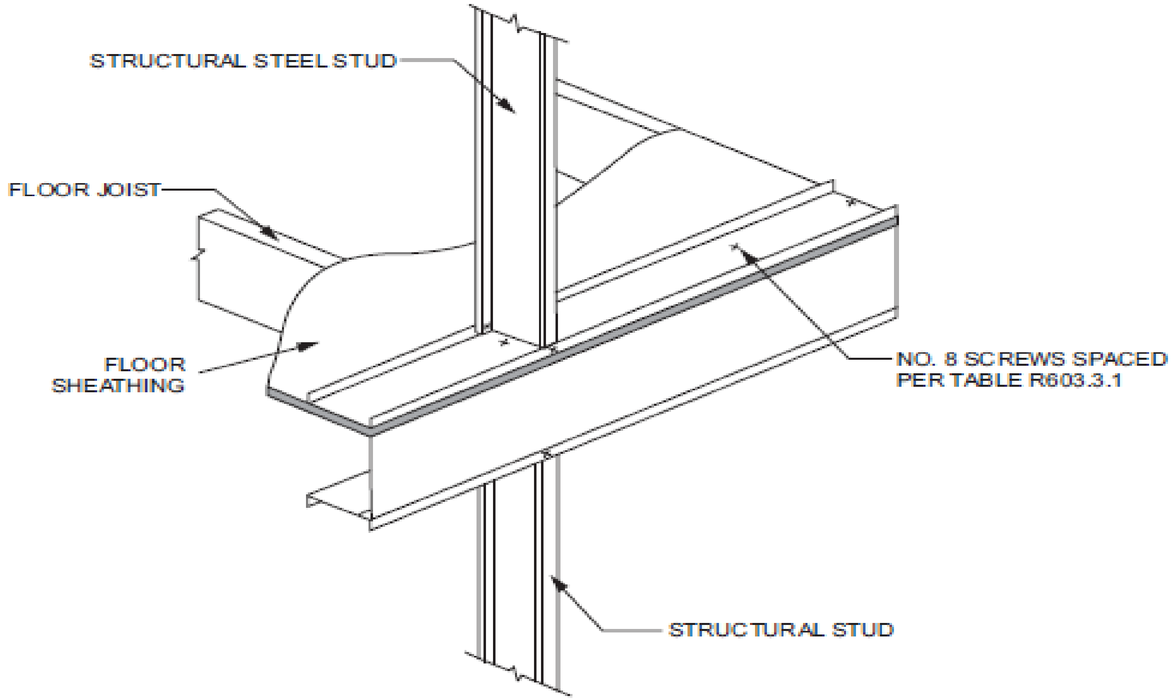
~~a. Anchor bolts are to be located not more than 12 inches from corners or the termination of bottom tracks such as, at door openings or corners. Bolts are to extend not less than 15 inches into masonry or 7 inches into concrete.~~

~~b. All screw sizes shown are minimum.~~

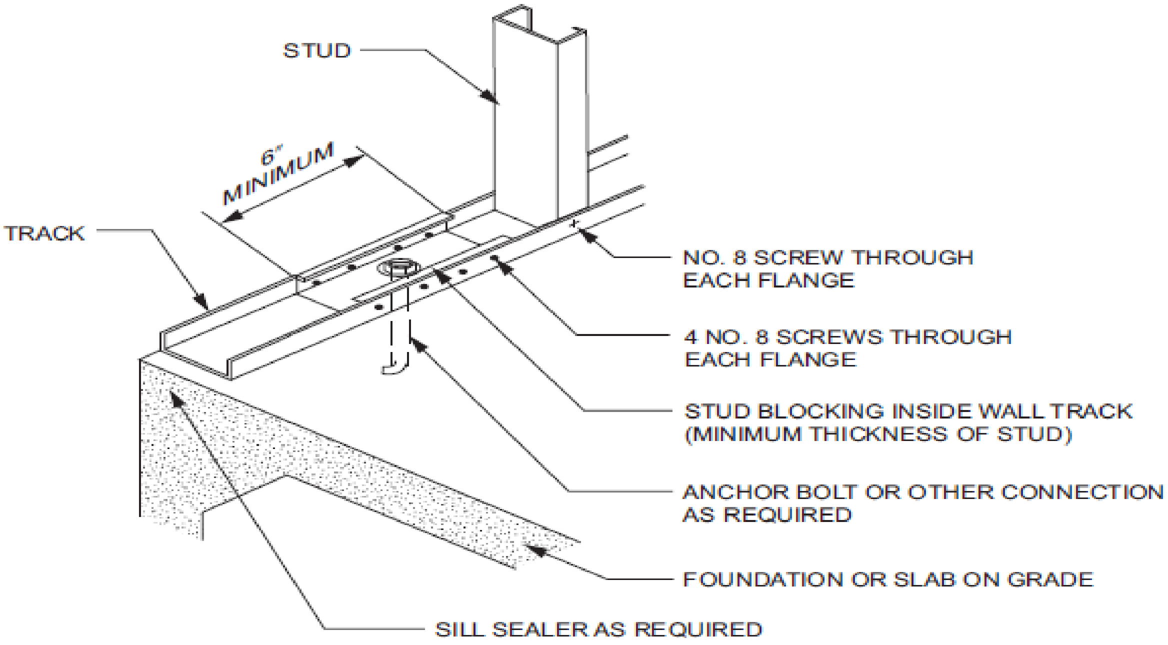
~~c. NR = Uplift connector not required.~~

~~d. Foundation anchor straps are permitted in place of anchor bolts, if spaced as required to provide equivalent anchorage to the required anchor bolts and installed in accordance with manufacturer's requirements.~~

~~e. See Figure R603.3.1(4) for details.~~

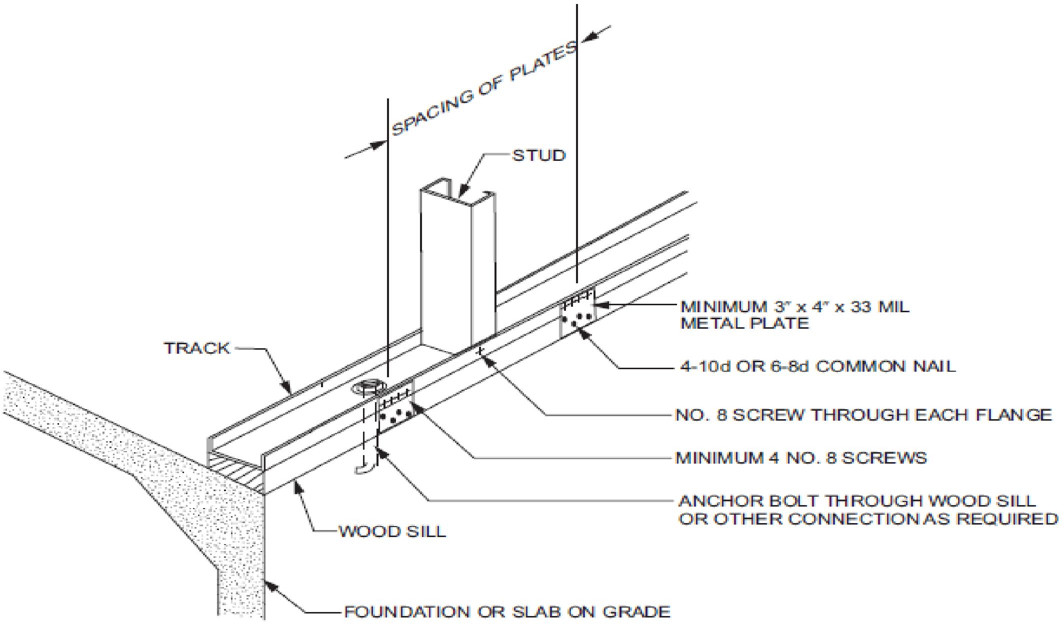


~~FIGURE R603.3.1(1)~~
~~WALL TO FLOOR CONNECTION~~



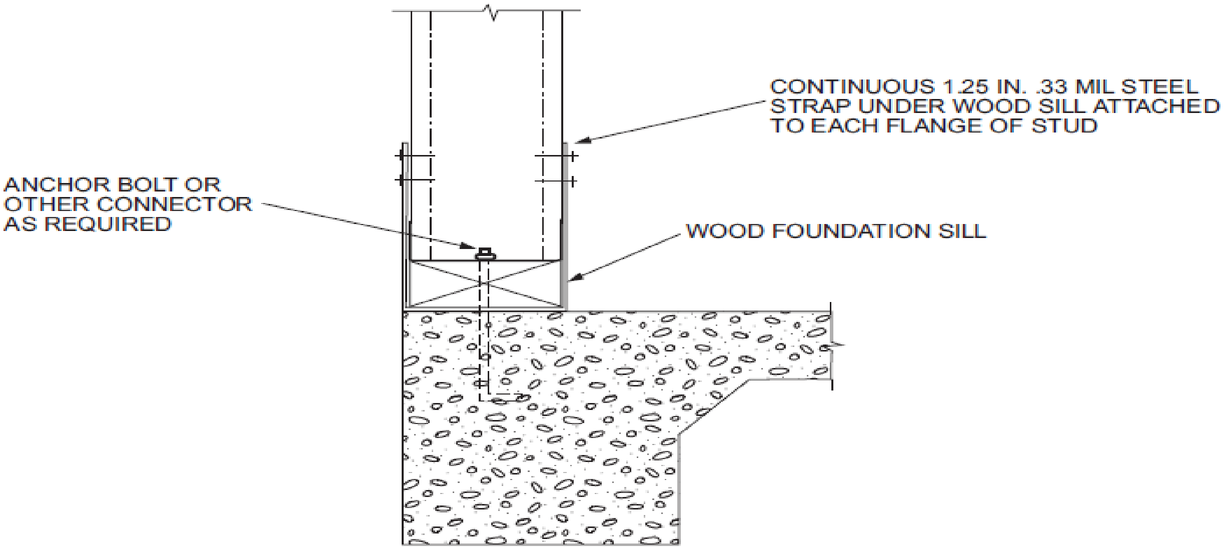
~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R603.3.1(2)~~
~~WALL TO FOUNDATION CONNECTION~~



~~For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.~~

~~FIGURE R603.3.1(3)~~
~~WALL TO WOOD SILL CONNECTION~~



~~FIGURE R603.3.1(4)~~
~~WIND UPLIFT CONNECTOR~~

~~R603.3.1.1 Gable endwalls.~~
~~Gable endwalls with heights greater than 10 feet (3048 mm) shall be anchored to foundations or floors in accordance with Table R603.3.1.1(1) or R603.3.1.1(2).~~

~~TABLE R603.3.1.1(1)~~
~~GABLE ENDWALL TO FLOOR CONNECTION REQUIREMENTS~~~~[a, b, c]~~

~~ULTIMATE WIND SPEED (mph)~~		~~WALL BOTTOM TRACK TO FLOOR JOIST OR TRACK CONNECTION~~		
~~Exposure Category~~		~~Stud height, *h* (feet)~~		
~~B~~	~~C~~	~~10 < *h* = 14~~	~~14 < *h* = 18~~	~~18 < *h* = 22~~
~~115~~	~~—~~	~~1-No. 8 screw @ 12″ o.c.~~	~~1-No. 8 screw @ 12″ o.c.~~	~~1-No. 8 screw @ 12″ o.c.~~
~~126~~	~~110~~	~~1-No. 8 screw @ 12″ o.c.~~	~~1-No. 8 screw @ 12″ o.c.~~	~~1-No. 8 screw @ 12″ o.c.~~
~~< 139~~	~~115~~	~~1-No. 8 screw @ 12″ o.c.~~	~~1-No. 8 screw @ 12″ o.c.~~	~~2-No. 8 screws @ 12″ o.c.~~
~~—~~	~~126~~	~~1-No. 8 screw @ 12″ o.c.~~	~~2-No. 8 screws @ 12″ o.c.~~	~~1-No. 8 screw @ 8″ o.c.~~
~~—~~	~~< 139~~	~~2-No. 8 screws @ 12″ o.c.~~	~~1-No. 8 screw @ 8″ o.c.~~	~~2-No. 8 screws @ 8″ o.c.~~

~~For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s, 1 foot = 304.8 mm.~~

~~a. Refer to Table R603.3.1.1(2) for gable endwall bottom track to foundation connections.~~

~~b. Where attachment is not given, special design is required.~~

~~c. Stud height, *h*, is measured from wall bottom track to wall top track or brace connection height.~~

~~TABLE R603.3.1.1(2)~~
~~GABLE ENDWALL BOTTOM TRACK TO FOUNDATION CONNECTION REQUIREMENTS~~~~[a, b, c]~~

~~ULTIMATE WIND SPEED (mph)~~		~~MINIMUM SPACING FOR $\frac{1}{2}$-INCH-DIAMETER ANCHOR BOLTS~~~~[d]~~		
~~Exposure Category~~		~~Stud height, *h* (feet)~~		
~~B~~	~~C~~	~~10 < *h* ≤ 14~~	~~14 < *h* ≤ 18~~	~~18 < *h* ≤ 22~~
~~115~~	~~—~~	~~6′- 0″ o.c.~~	~~5′- 7″ o.c.~~	~~6′- 0″ o.c.~~
~~126~~	~~110~~	~~5′- 10″ o.c.~~	~~6′- 0″ o.c.~~	~~6′- 0″ o.c.~~
~~< 139~~	~~115~~	~~4′- 10″ o.c.~~	~~5′- 6″ o.c.~~	~~6′- 0″ o.c.~~
~~—~~	~~126~~	~~4′- 1″ o.c.~~	~~6′- 0″ o.c.~~	~~6′- 0″ o.c.~~
~~—~~	~~< 139~~	~~5′- 1″ o.c.~~	~~6′- 0″ o.c.~~	~~5′- 2″ o.c.~~

~~For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s, 1 foot = 304.8 mm.~~

~~a. Refer to Table R603.3.1.1(1) for gable endwall bottom track to floor joist or track connection connections.~~

~~b. Where attachment is not given, special design is required.~~

~~c. Stud height, *h*, is measured from wall bottom track to wall top track or brace connection height.~~

~~d. Foundation anchor straps are permitted in place of anchor bolts if spaced as required to provide equivalent anchorage to the required anchor bolts and installed in accordance with manufacturer's requirements.~~

~~R603.3.2 Minimum stud sizes.~~
~~Cold-formed steel walls shall be constructed in accordance with Figure R603.3.1(1),~~

~~R603.3.1(2) or R603.3.1(3), as applicable. Exterior wall stud size and thickness shall be determined in accordance with the limits set forth in Tables R603.3.2(2) through R603.3.2(16). Interior load-bearing wall stud size and thickness shall be determined in accordance with the limits set forth in Tables R603.3.2(2) through R603.3.2(16) based upon an ultimate design wind speed of 115 miles per hour (51 m/s), Exposure Category B, and the building width, stud spacing and snow load, as appropriate. Fastening requirements shall be in accordance with Section R603.2.5 and Table R603.3.2(1). Top and bottom tracks shall have the same minimum thickness as the wall studs.~~

~~Exterior wall studs shall be permitted to be reduced to the next thinner size, as shown in Tables R603.3.2(2) through R603.3.2(16), but not less than 33 mils (0.84 mm), where both of the following conditions exist:~~

1. ~~Minimum of $^{1}/_{2}$-inch (12.7 mm) gypsum board is installed and fastened on the interior surface in accordance with Section R702.~~
2. ~~Wood structural sheathing panels of minimum $^{7}/_{16}$-inch-thick (11.1 mm) oriented strand board or $^{15}/_{32}$-inch-thick (12 mm) plywood are installed and fastened in accordance with Section R603.9.1 and Table R603.3.2(1) on the outside surface.~~

~~Interior load-bearing walls shall be permitted to be reduced to the next thinner size, as shown in Tables R603.3.2(2) through R603.3.2(16), but not less than 33 mils (0.84 mm), where not less than $^{1}/_{2}$-inch (12.7 mm) gypsum board is installed and fastened in accordance with Section R702 on both sides of the wall. The tabulated stud thickness for load-bearing walls shall be used when the attic load is 10 pounds per square foot (480 Pa) or less. A limited attic storage load of 20 pounds per square foot (960 Pa) shall be permitted provided that the next higher snow load column is used to select the stud size from Tables R603.3.2(2) through R603.3.2(16).~~

~~For two-story buildings, the tabulated stud thickness for walls supporting one floor, roof and ceiling shall be used when the second-floor live load is 30 pounds per square foot (1440 Pa). Second-floor live loads of 40 psf (1920 Pa) shall be permitted provided that the next higher snow load column is used to select the stud size from Tables R603.3.2(2) through R603.3.2(11).~~

~~For three-story buildings, the tabulated stud thickness for walls supporting one or two floors, roof and ceiling shall be used when the third-floor live load is 30 pounds per square foot (1440 Pa). Third-floor live loads of 40 pounds per square foot (1920 Pa) shall be permitted provided that the next higher snow load column is used to select the stud size from Tables R603.3.2(12) through R603.3.2(16).~~

~~TABLE R603.3.2(1)~~
~~WALL FASTENING SCHEDULE~~[a]

~~DESCRIPTION OF BUILDING ELEMENT~~	~~NUMBER AND SIZE OF FASTENERS~~[~~a~~]	~~SPACING OF FASTENERS~~
~~Wall stud to top or bottom track~~	~~2-No. 8 screws~~	~~Each end of stud, one per flange~~
~~Structural sheathing to wall studs~~	~~No. 8 screws~~[~~b~~]	~~6″ o.c. on edges and 12″ o.c. at intermediate supports~~
~~1/2″ gypsum board to framing~~	~~No. 6 screws~~	~~12″ o.c.~~

~~For SI: 1 inch = 25.4 mm.~~

~~a. All screw sizes shown are minimum.~~

~~b. Screws for attachment of structural sheathing panels are to be bugle-head, flat-head, or similar head styles with a minimum head diameter of 0.29 inch.~~

~~TABLE R603.3.2(2)~~

~~24-FOOT-WIDE BUILDING SUPPORTING ROOF AND CEILING ONLY~~[~~a, b, c, d~~]

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	33	33	43	43
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33
126	110	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	43	43	43	43
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	33	33	33	33	43
< 139	115	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	43	43	43	43	43	43	43	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	33	43	43	43	43
—	126	350S162	16	33	33	33	33	33	33	33	33	43	43	43	43
			24	43	43	43	43	43	43	43	43	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	43	43	43	43	43	43	43	43
—	< 139	350S162	16	33	33	33	33	43	43	43	43	43	43	43	43
			24	43	43	43	43	54	54	54	54	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	43	43	43	43	43	43	43	43	43	43	43

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: *L*/240.~~

~~b. Design load assumptions:~~
~~Second-floor dead load is 10 psf.~~
~~Second-floor live load is 30 psf.~~
~~Roof/ceiling dead load is 12 psf.~~

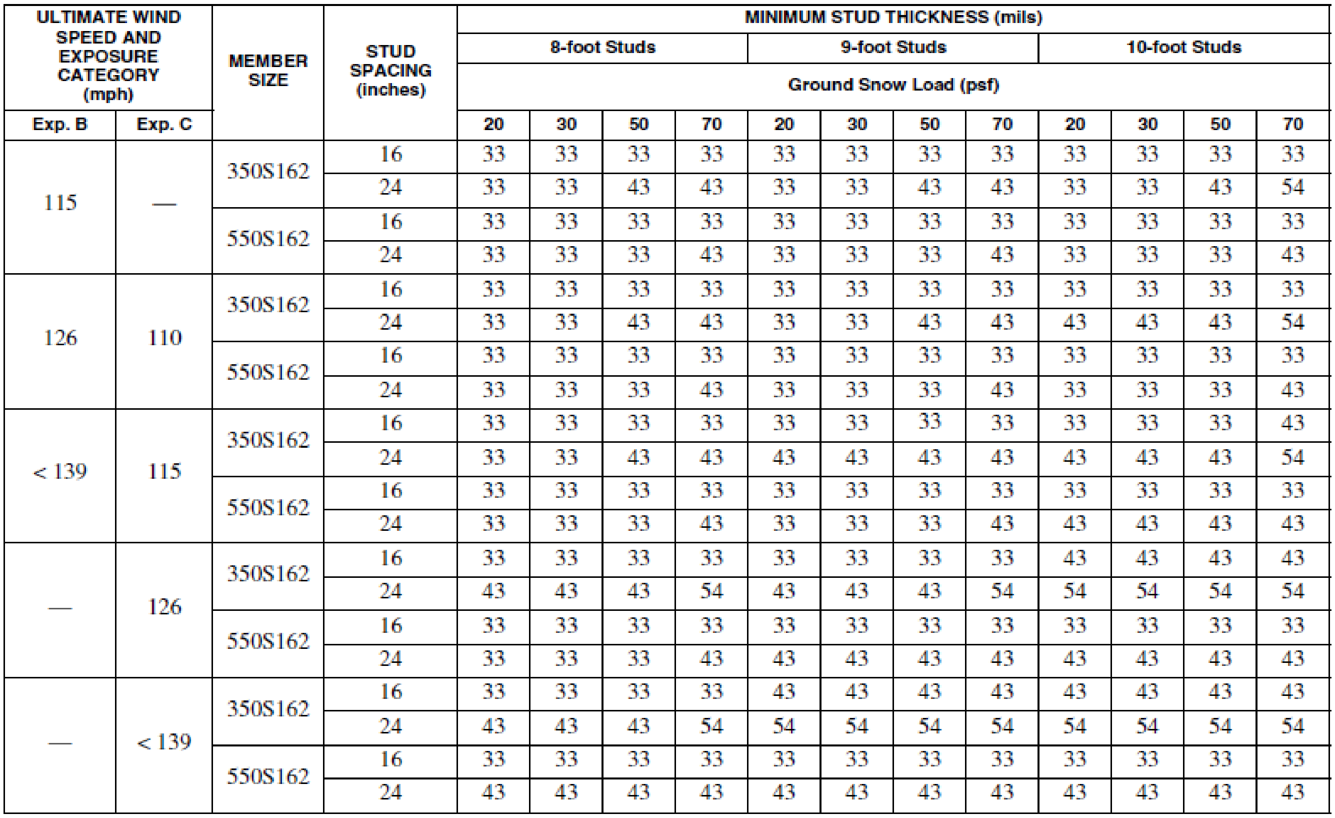
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2(3)~~

~~28-FOOT-WIDE BUILDING SUPPORTING ROOF AND CEILING ONLY[a, b, c, d]~~



ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	43	43	33	33	43	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	33	33	33	43
126	110	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	43	43	43	43	43	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	33	33	33	43
< 139	115	350S162	16	33	33	33	33	33	33	33	33	33	33	33	43
			24	33	33	43	43	43	43	43	43	43	43	43	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	43	43	43	43
—	126	350S162	16	33	33	33	33	33	33	33	33	43	43	43	43
			24	43	43	43	54	43	43	43	54	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	43	43	43	43	43	43	43	43
—	< 139	350S162	16	33	33	33	33	43	43	43	43	43	43	43	43
			24	43	43	43	54	54	54	54	54	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	43

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: *L*/240.~~

~~b. Design load assumptions:~~
~~Second-floor dead load is 10 psf.~~
~~Second-floor live load is 30 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2(4)~~

~~32-FOOT-WIDE BUILDING SUPPORTING ROOF AND CEILING ONLY[a, b, c, d]~~

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	33	33	33	33	33	33	33	33	33	33	33	43
			24	33	33	43	54	33	33	43	43	33	33	43	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	33	33	33	43
126	110	350S162	16	33	33	33	33	33	33	33	33	33	33	33	43
			24	33	33	43	54	33	33	43	54	43	43	43	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	33	33	33	43
< 139	115	350S162	16	33	33	33	43	33	33	33	33	33	33	33	43
			24	33	33	43	54	43	43	43	54	43	43	43	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	43	43	43	43
—	126	350S162	16	33	33	33	43	33	33	33	43	43	43	43	43
			24	43	43	43	54	43	43	43	54	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	43	43	43	43	43	43	43	43
—	< 139	350S162	16	33	33	33	43	43	43	43	43	43	43	43	43
			24	43	43	43	54	54	54	54	54	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	43

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: *L*/240.~~

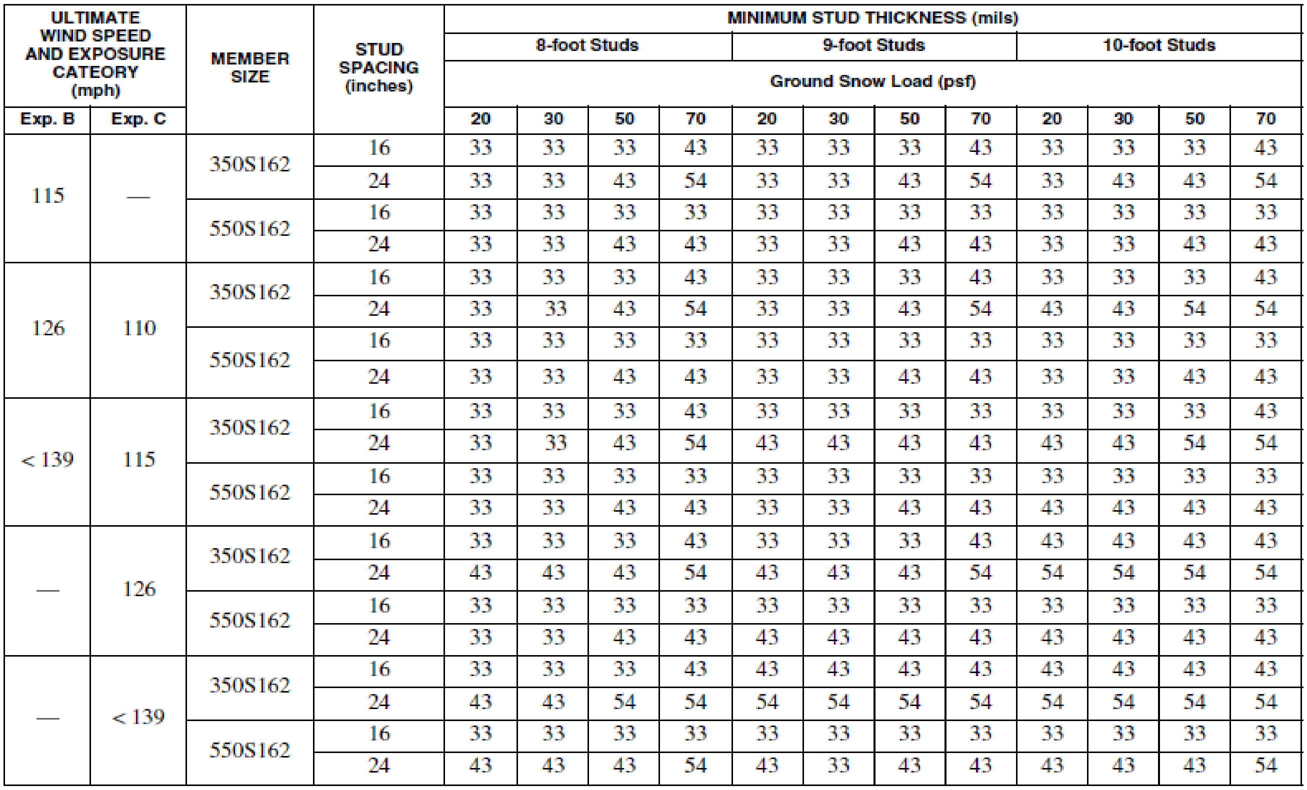
~~b. Design load assumptions:~~
~~Second-floor dead load is 10 psf.~~
~~Second-floor live load is 30 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2(5)~~

~~36-FOOT-WIDE BUILDING SUPPORTING ROOF AND CEILING ONLY~~[~~a, b, c, d~~]



ULTIMATE WIND SPEED AND EXPOSURE CATEORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	33	33	33	43	33	33	33	43	33	33	33	43
			24	33	33	43	54	33	33	43	54	33	43	43	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	43	43	33	33	43	43
126	110	350S162	16	33	33	33	43	33	33	33	43	33	33	33	43
			24	33	33	43	54	33	33	43	54	43	43	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	43	43	33	33	43	43
< 139	115	350S162	16	33	33	33	43	33	33	33	33	33	33	33	43
			24	33	33	43	54	43	43	43	43	43	43	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	43	43	43	43	43	43
—	126	350S162	16	33	33	33	43	33	33	33	43	43	43	43	43
			24	43	43	43	54	43	43	43	54	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	43	43	43	43	43	43	43	43
—	< 139	350S162	16	33	33	33	43	43	43	43	43	43	43	43	43
			24	43	43	54	54	54	54	54	54	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	54	43	33	43	43	43	43	43	54

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: *L*/240.~~

~~b. Design load assumptions:~~
~~Second-floor dead load is 10 psf.~~
~~Second-floor live load is 30 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2(6)~~

~~40-FOOT-WIDE BUILDING SUPPORTING ROOF AND CEILING ONLY[a, b, c, d]~~

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	33	33	33	43	33	33	33	43	33	33	33	43
			24	33	33	43	54	33	33	43	54	43	43	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	54	33	33	43	43	33	33	43	54
126	110	350S162	16	33	33	33	43	33	33	33	43	33	33	43	43
			24	33	43	43	54	33	43	43	54	43	43	54	54
		550S162	16	33	33	33	43	33	33	33	33	33	33	33	33
			24	33	33	43	54	33	33	43	43	33	33	43	54
< 139	115	350S162	16	33	33	33	43	33	33	33	43	33	33	43	43
			24	33	43	43	54	43	43	43	54	43	43	54	54
		550S162	16	33	33	33	43	33	33	33	33	33	33	33	43
			24	33	33	43	54	33	33	43	43	43	43	43	54
—	126	350S162	16	33	33	33	43	33	33	33	43	43	43	43	43
			24	43	43	54	54	43	43	54	54	54	54	54	54
		550S162	16	33	33	33	43	33	33	33	33	33	33	33	43
			24	33	33	43	54	43	43	43	54	43	43	43	54
—	< 139	350S162	16	33	33	43	43	43	43	43	43	43	43	43	54
			24	43	43	54	54	54	54	54	54	54	54	54	68
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43
			24	43	43	43	54	43	43	43	54	43	43	43	54

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: *L*/240.~~

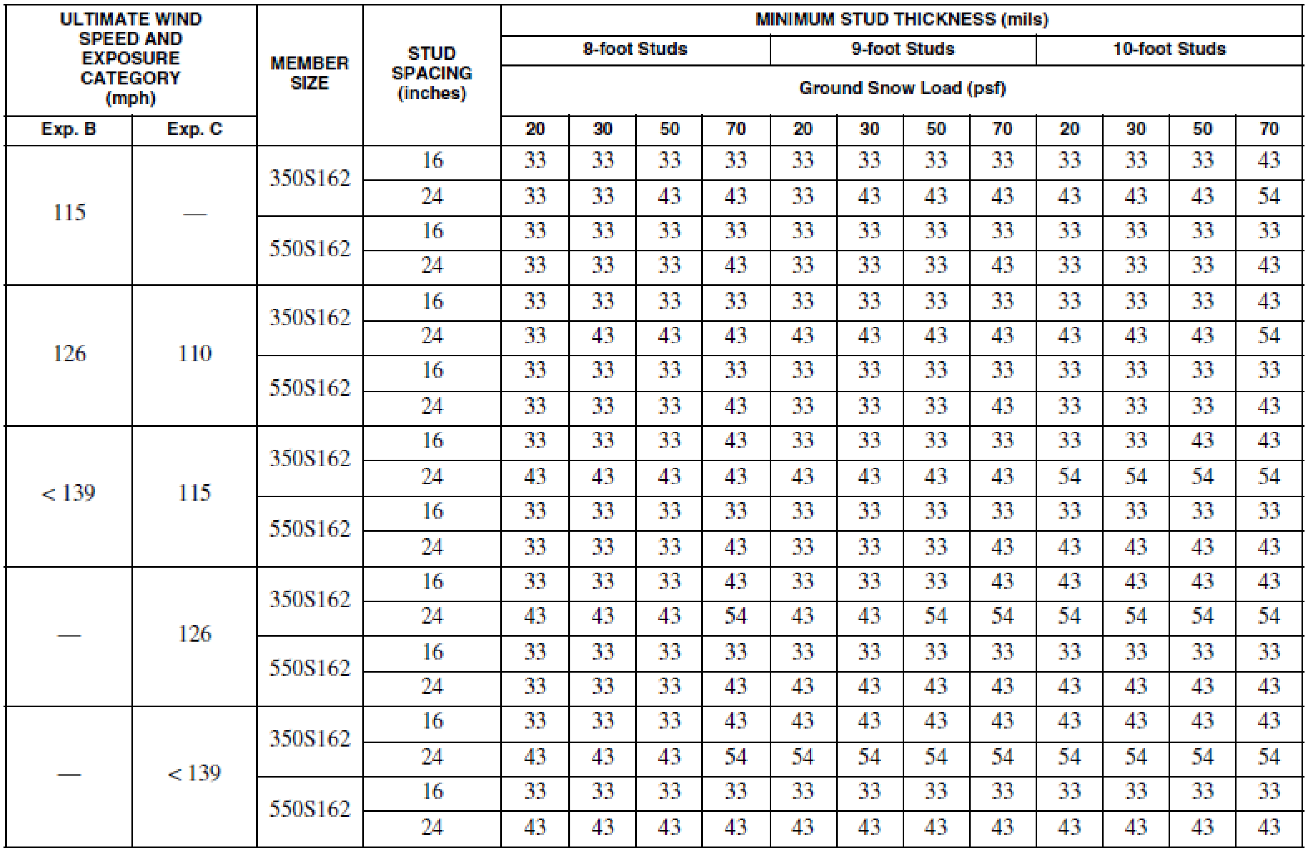
~~b. Design load assumptions:~~
~~Second-floor dead load is 10 psf.~~
~~Second-floor live load is 30 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2(7)~~

~~24-FOOT-WIDE BUILDING SUPPORTING ONE FLOOR, ROOF AND CEILING[a, b, c, d]~~



ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	33	33	33	33	33	33	33	33	33	33	33	43
			24	33	33	43	43	33	43	43	43	43	43	43	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	33	33	33	43
126	110	350S162	16	33	33	33	33	33	33	33	33	33	33	33	43
			24	33	43	43	43	43	43	43	43	43	43	43	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	33	33	33	43
< 139	115	350S162	16	33	33	33	43	33	33	33	33	33	33	43	43
			24	43	43	43	43	43	43	43	43	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	43	43	43	43
—	126	350S162	16	33	33	33	43	33	33	33	43	43	43	43	43
			24	43	43	43	54	43	43	54	54	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	43	43	43	43	43	43	43	43
—	< 139	350S162	16	33	33	33	43	43	43	43	43	43	43	43	43
			24	43	43	43	54	54	54	54	54	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	43

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: *L*/240.~~

~~b. Design load assumptions:~~
~~Second-floor dead load is 10 psf.~~
~~Second-floor live load is 30 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2(8)~~

~~28-FOOT-WIDE BUILDING SUPPORTING ONE FLOOR, ROOF AND CEILING~~ ~~[a, b, c, d]~~

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	33	33	33	43	33	33	33	43	33	33	33	43
			24	43	43	43	54	43	43	43	54	43	43	43	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	43	43	33	33	43	43
126	110	350S162	16	33	33	33	43	33	33	33	43	33	33	43	43
			24	43	43	43	54	43	43	43	54	43	43	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	43	43	33	33	43	43
< 139	115	350S162	16	33	33	33	43	33	33	33	43	43	43	43	43
			24	43	43	43	54	43	43	43	54	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	43	43	43	43	43	43
—	126	350S162	16	33	33	33	43	33	33	43	43	43	43	43	43
			24	43	43	43	54	54	54	54	54	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	43	43	43	43	43	43	43	43
—	< 139	350S162	16	33	33	43	43	43	43	43	43	43	43	43	54
			24	43	43	54	54	54	54	54	54	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	43

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: *L*/240.~~

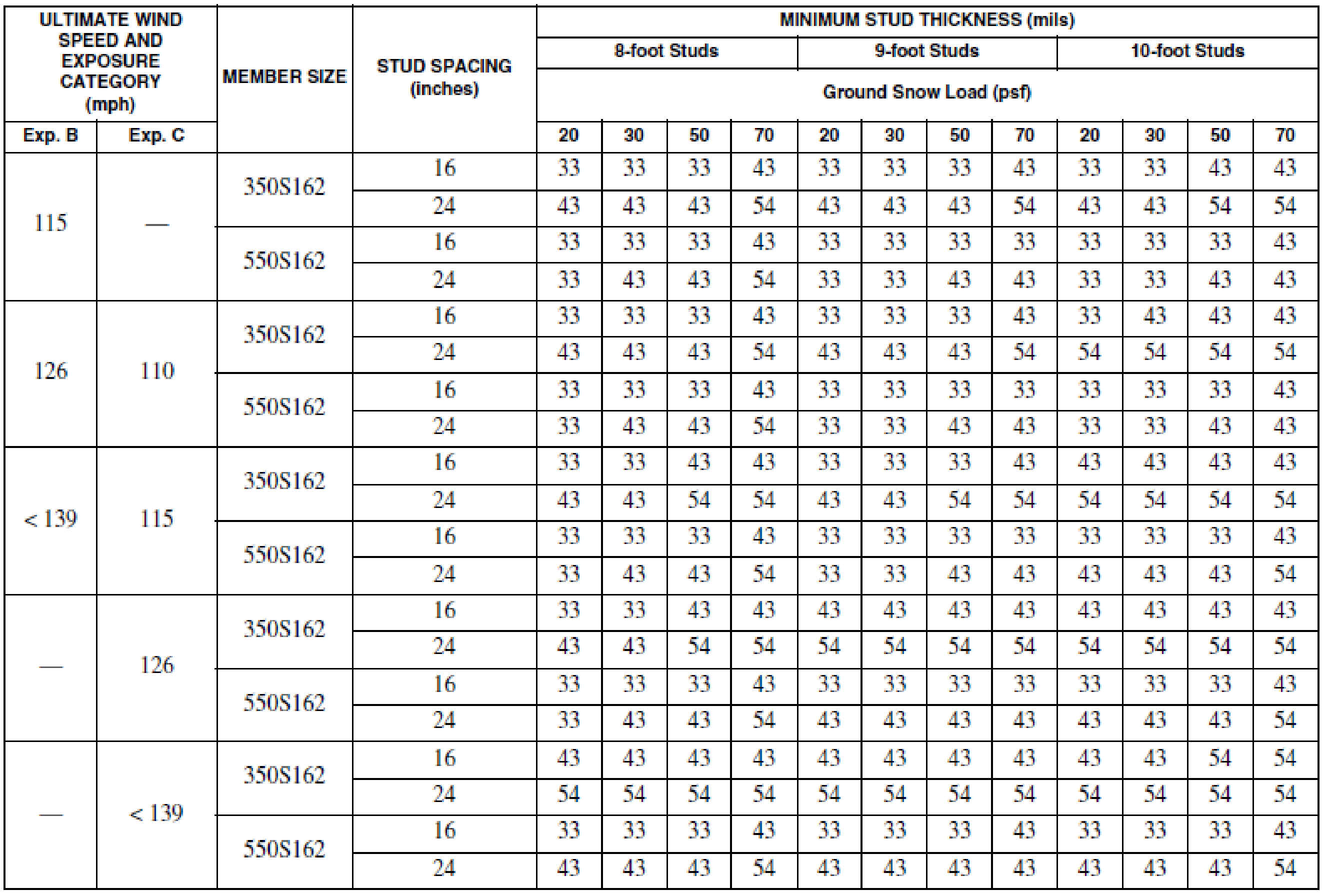
~~b. Design load assumptions:~~
~~Second-floor dead load is 10 psf.~~
~~Second-floor live load is 30 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2(9)~~

~~32-FOOT-WIDE BUILDING SUPPORTING ONE FLOOR, ROOF AND CEILING~~ ~~[a, b, c, d]~~



ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	33	33	33	43	33	33	33	43	33	33	43	43
			24	43	43	43	54	43	43	43	54	43	43	54	54
		550S162	16	33	33	33	43	33	33	33	33	33	33	33	43
			24	33	43	43	54	33	33	43	43	33	33	43	43
126	110	350S162	16	33	33	33	43	33	33	33	43	33	43	43	43
			24	43	43	43	54	43	43	43	54	54	54	54	54
		550S162	16	33	33	33	43	33	33	33	33	33	33	33	43
			24	33	43	43	54	33	33	43	43	33	33	43	43
< 139	115	350S162	16	33	33	43	43	33	33	33	43	43	43	43	43
			24	43	43	54	54	43	43	54	54	54	54	54	54
		550S162	16	33	33	33	43	33	33	33	33	33	33	33	43
			24	33	43	43	54	33	33	43	43	43	43	43	54
—	126	350S162	16	33	33	43	43	43	43	43	43	43	43	43	43
			24	43	43	54	54	54	54	54	54	54	54	54	54
		550S162	16	33	33	33	43	33	33	33	33	33	33	33	43
			24	33	43	43	54	43	43	43	43	43	43	43	54
—	< 139	350S162	16	43	43	43	43	43	43	43	43	43	43	54	54
			24	54	54	54	54	54	54	54	54	54	54	54	54
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43
			24	43	43	43	54	43	43	43	43	43	43	43	54

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: *L*/240.~~

~~b. Design load assumptions:~~
~~Second-floor dead load is 10 psf.~~
~~Second-floor live load is 30 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2(10)~~

~~36-FOOT-WIDE BUILDING SUPPORTING ONE FLOOR, ROOF AND CEILING~~ ~~[a, b, c, d]~~

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	33	33	43	43	33	33	43	43	33	33	43	43
			24	43	43	54	54	43	43	54	54	54	54	54	54
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43
			24	43	43	43	54	43	43	43	54	43	43	43	54
126	110	350S162	16	33	33	43	43	33	33	43	43	43	43	43	43
			24	43	43	54	54	43	43	54	54	54	54	54	54
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43
			24	43	43	43	54	43	43	43	54	43	43	43	54
< 139	115	350S162	16	33	33	43	43	33	33	43	43	43	43	43	54
			24	43	43	54	54	54	54	54	54	54	54	54	54
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43
			24	43	43	43	54	43	43	43	54	43	43	43	54
—	126	350S162	16	33	33	43	43	43	43	43	43	43	43	43	54
			24	54	54	54	54	54	54	54	54	54	54	54	68
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43
			24	43	43	43	54	43	43	43	54	43	43	43	54
—	< 139	350S162	16	43	43	43	43	43	43	43	43	43	54	54	54
			24	54	54	54	54	54	54	54	54	54	54	54	68
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43
			24	43	43	43	54	43	43	43	54	43	43	43	54

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: *L*/240.~~

~~b. Design load assumptions:~~
~~Second-floor dead load is 10 psf.~~
~~Second-floor live load is 30 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2(11)~~

~~40-FOOT-WIDE BUILDING SUPPORTING ONE FLOOR, ROOF AND CEILING~~ ~~[a, b, c, d]~~

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	33	33	43	43	33	33	43	43	43	43	43	54
			24	43	43	54	54	43	43	54	54	54	54	54	54
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43
			24	43	43	54	54	43	43	43	54	43	43	43	54
126	110	350S162	16	33	33	43	43	33	33	43	43	43	43	43	54
			24	43	43	54	54	43	43	54	54	54	54	54	54
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43
			24	43	43	54	54	43	43	43	54	43	43	43	54
< 139	115	350S162	16	33	33	43	43	43	43	43	43	43	43	43	54
			24	43	43	54	54	54	54	54	54	54	54	54	68
		550S162	16	33	33	43	43	33	33	33	43	33	33	33	43
			24	43	43	54	54	43	43	43	54	43	43	43	54
—	126	350S162	16	43	43	43	54	43	43	43	54	43	43	54	54
			24	54	54	54	54	54	54	54	54	54	54	54	68
		550S162	16	33	33	43	43	33	33	33	43	33	33	43	43
			24	43	43	54	54	43	43	43	54	43	43	54	54
—	< 139	350S162	16	43	43	43	54	43	43	43	54	54	54	54	54
			24	54	54	54	68	54	54	54	54	54	54	54	68
		550S162	16	33	33	43	43	33	33	33	43	33	33	43	43
			24	43	43	54	54	43	43	43	54	43	43	54	54

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: *L*/240.~~

~~b. Design load assumptions:~~
~~Second-floor dead load is 10 psf.~~
~~Second-floor live load is 30 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2(12)~~

~~24-FOOT-WIDE BUILDING SUPPORTING TWO FLOORS, ROOF AND CEILING~~~~[a, b, c, d]~~

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	43	43	43	43	33	33	33	43	43	43	43	43
			24	54	54	54	54	43	43	54	54	54	54	54	54
		550S162	16	33	33	43	43	33	33	33	33	33	33	33	43
			24	43	43	54	54	43	43	43	43	43	43	43	54
126	110	350S162	16	43	43	43	43	33	33	33	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
		550S162	16	33	33	43	43	33	33	33	33	33	33	33	43
			24	43	43	54	54	43	43	43	43	43	43	43	54
< 139	115	350S162	16	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
		550S162	16	33	33	43	43	33	33	33	33	33	33	33	43
			24	43	43	54	54	43	43	43	43	43	43	43	54
—	126	350S162	16	43	43	43	43	43	43	43	43	43	43	43	54
			24	54	54	54	54	54	54	54	54	54	54	54	54
		550S162	16	33	33	43	43	33	33	33	33	33	33	33	43
			24	43	43	54	54	43	43	43	43	43	43	43	54
—	< 139	350S162	16	43	43	43	43	43	43	43	43	54	54	54	54
			24	54	54	54	54	54	54	54	54	54	54	54	68
		550S162	16	33	33	43	43	33	33	33	33	33	33	33	43
			24	43	43	54	54	43	43	43	43	43	43	43	54

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: *L*/240.~~

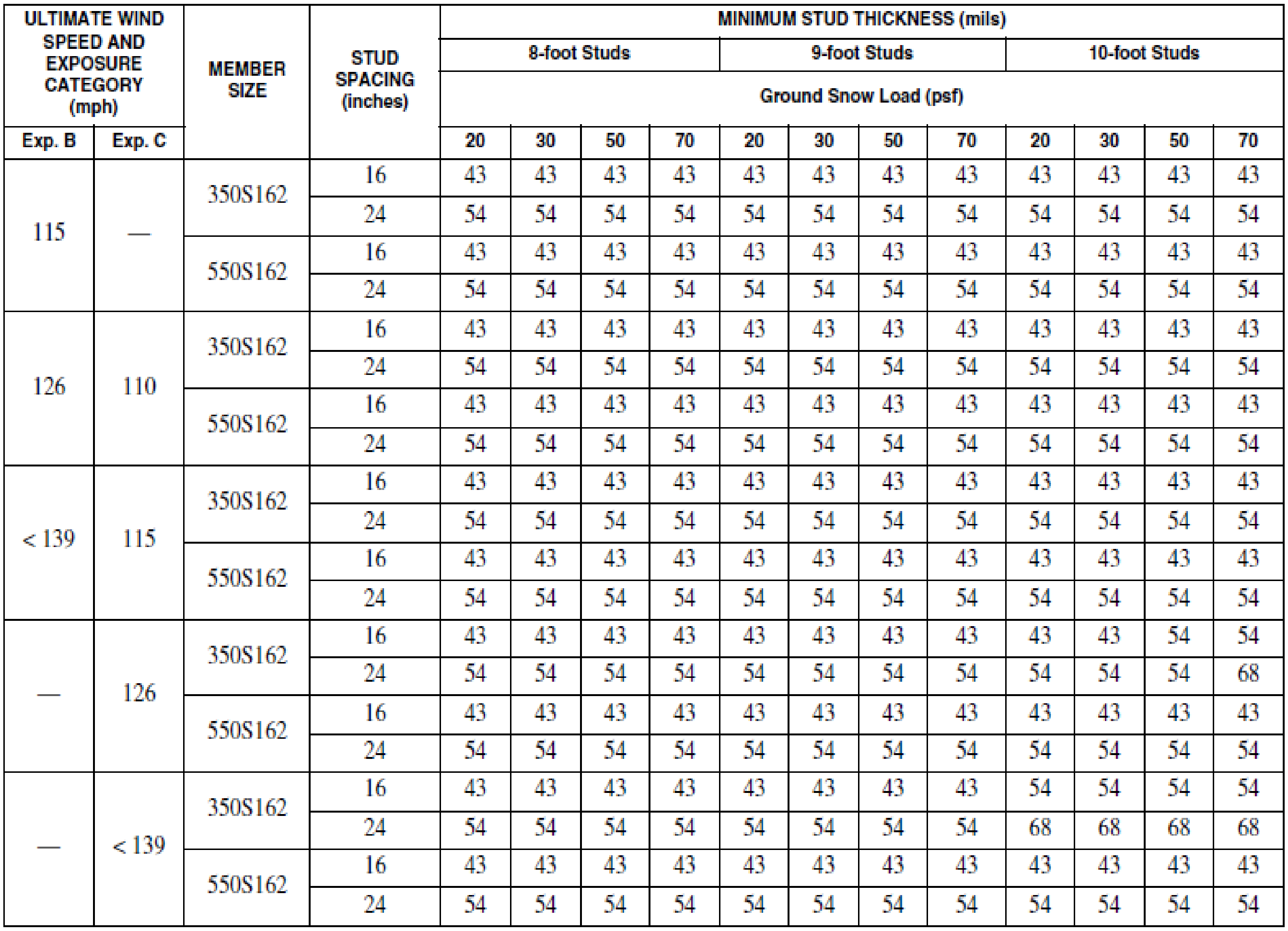
~~b. Design load assumptions:~~
~~Top- and middle-floor dead load is 10 psf.~~
~~Top-floor live load is 30 psf.~~
~~Middle-floor live load is 40 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2(13)~~

~~28-FOOT-WIDE BUILDING SUPPORTING TWO FLOORS, ROOF AND CEILING~~~~[a, b, c, d]~~



ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
126	110	350S162	16	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
< 139	115	350S162	16	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
—	126	350S162	16	43	43	43	43	43	43	43	43	43	43	54	54
			24	54	54	54	54	54	54	54	54	54	54	54	68
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
—	< 139	350S162	16	43	43	43	43	43	43	43	43	54	54	54	54
			24	54	54	54	54	54	54	54	54	68	68	68	68
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: L/240.~~

~~b. Design load assumptions:~~
~~Top- and middle-floor dead load is 10 psf.~~
~~Top-floor live load is 30 psf.~~
~~Middle-floor live load is 40 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2(14)~~

~~32-FOOT-WIDE BUILDING SUPPORTING TWO FLOORS, ROOF AND CEILING~~ [~~a, b, c, d~~]

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	43	43	43	54	43	43	43	43	43	43	43	54
			24	54	54	54	68	54	54	54	54	54	54	54	68
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
126	110	350S162	16	43	43	43	54	43	43	43	43	43	43	43	54
			24	54	54	54	68	54	54	54	54	54	54	54	68
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
< 139	115	350S162	16	43	43	43	54	43	43	43	43	43	43	54	54
			24	54	54	54	68	54	54	54	54	54	54	54	68
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
—	126	350S162	16	43	43	43	54	43	43	43	43	54	54	54	54
			24	54	54	54	68	54	54	54	54	68	68	68	68
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
—	< 139	350S162	16	43	43	43	54	43	43	54	54	54	54	54	54
			24	54	54	54	68	54	54	54	54	68	68	68	68
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: *L*/240.~~

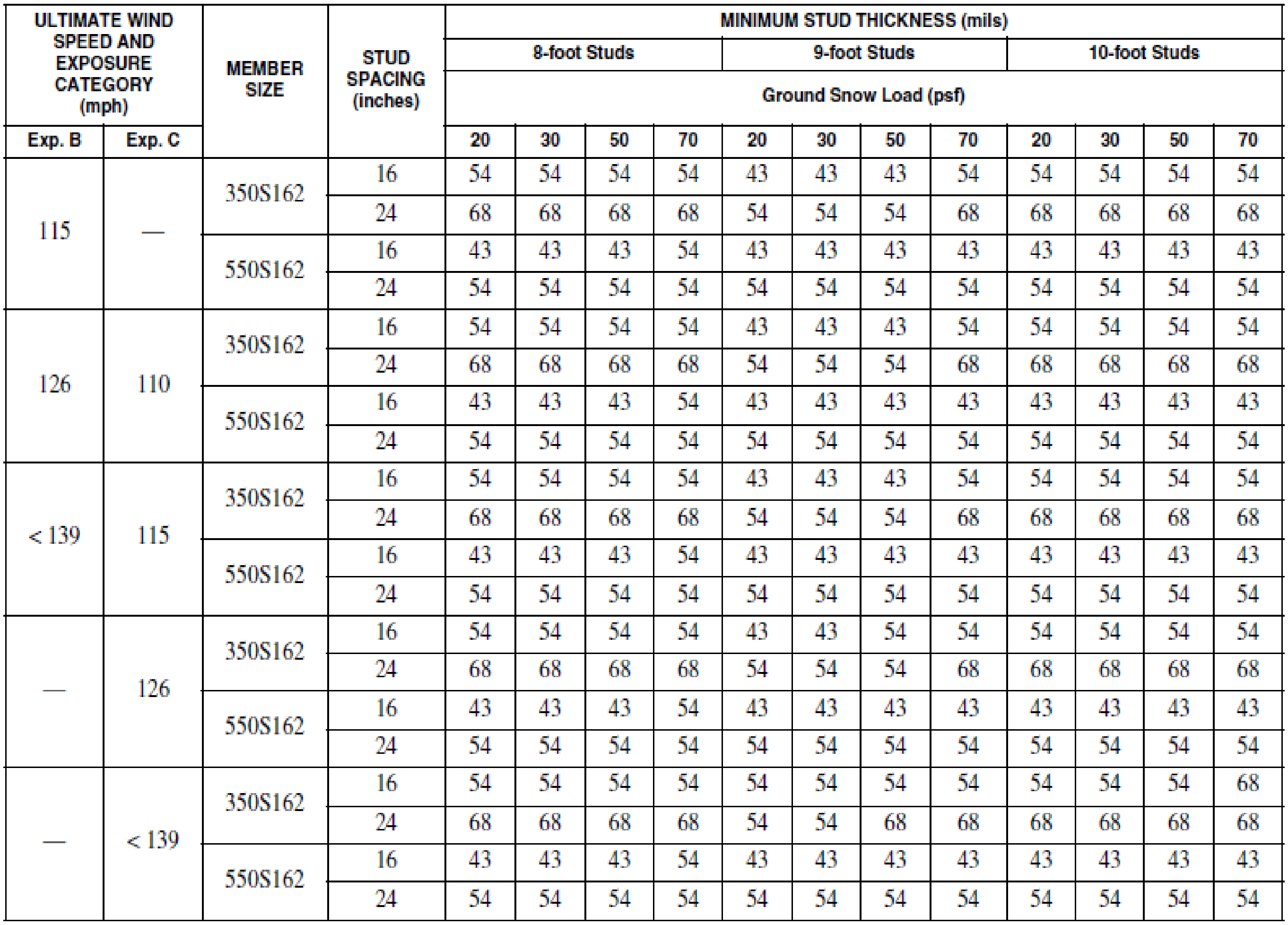
~~b. Design load assumptions:~~
~~Top- and middle-floor dead load is 10 psf.~~
~~Top-floor live load is 30 psf.~~
~~Middle-floor live load is 40 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2(15)~~

~~36-FOOT-WIDE BUILDING SUPPORTING TWO FLOORS, ROOF AND CEILING~~ ~~[a, b, c, d]~~



ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	54	54	54	54	43	43	43	54	54	54	54	54
			24	68	68	68	68	54	54	54	68	68	68	68	68
		550S162	16	43	43	43	54	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
126	110	350S162	16	54	54	54	54	43	43	43	54	54	54	54	54
			24	68	68	68	68	54	54	54	68	68	68	68	68
		550S162	16	43	43	43	54	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
< 139	115	350S162	16	54	54	54	54	43	43	43	54	54	54	54	54
			24	68	68	68	68	54	54	54	68	68	68	68	68
		550S162	16	43	43	43	54	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
—	126	350S162	16	54	54	54	54	43	43	54	54	54	54	54	54
			24	68	68	68	68	54	54	54	68	68	68	68	68
		550S162	16	43	43	43	54	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54
—	< 139	350S162	16	54	54	54	54	54	54	54	54	54	54	54	68
			24	68	68	68	68	54	54	68	68	68	68	68	68
		550S162	16	43	43	43	54	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: *L*/240.~~

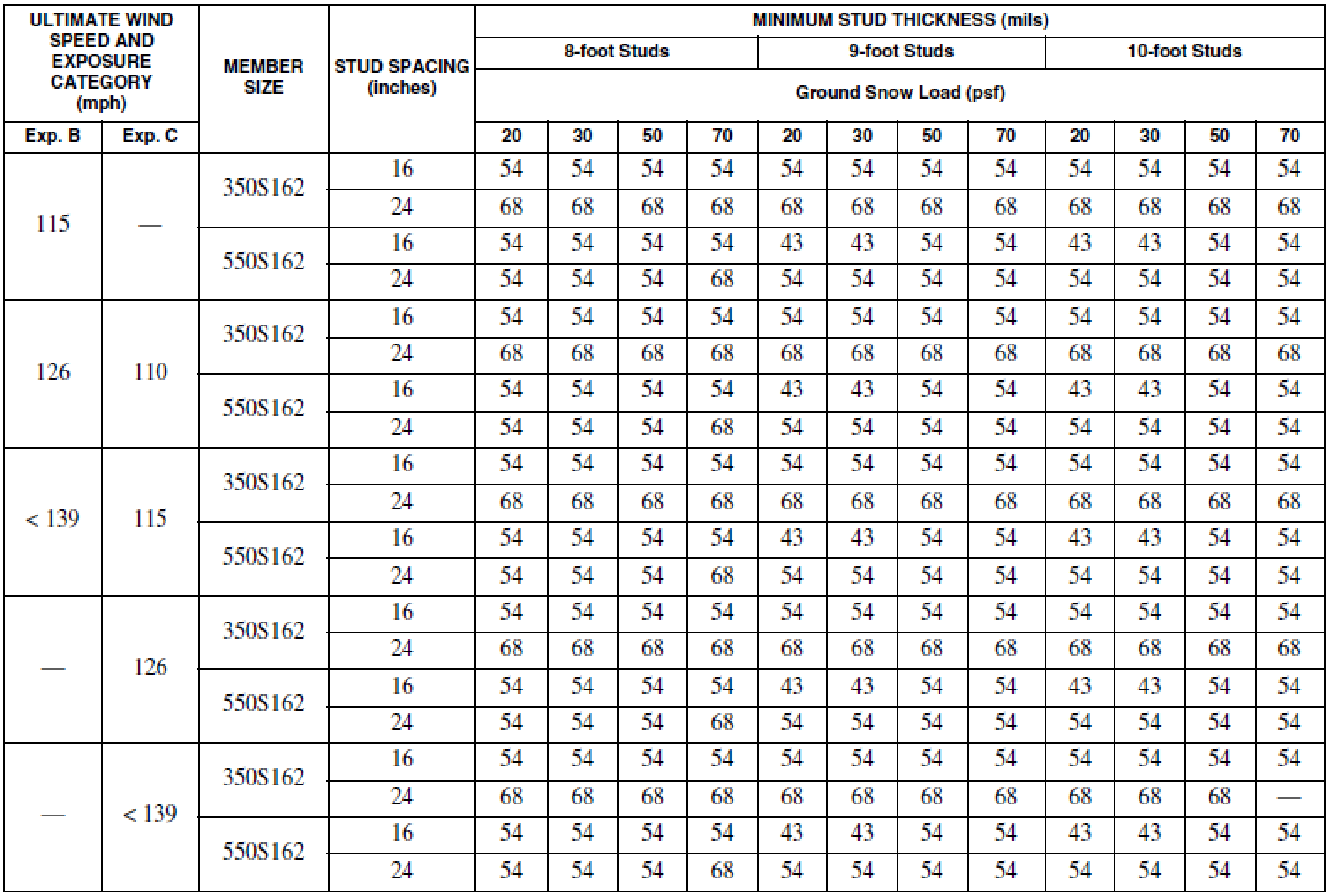
~~b. Design load assumptions:~~
~~Top- and middle-floor dead load is 10 psf.~~
~~Top-floor live load is 30 psf.~~
~~Middle-floor live load is 40 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2(16)~~

~~40-FOOT-WIDE BUILDING SUPPORTING TWO FLOORS, ROOF AND CEILING~~ ~~[a, b, c, d]~~



ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)											
				8-foot Studs				9-foot Studs				10-foot Studs			
				Ground Snow Load (psf)											
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70
115	—	350S162	16	54	54	54	54	54	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	68	68	68	68	68
		550S162	16	54	54	54	54	43	43	54	54	43	43	54	54
			24	54	54	54	68	54	54	54	54	54	54	54	54
126	110	350S162	16	54	54	54	54	54	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	68	68	68	68	68
		550S162	16	54	54	54	54	43	43	54	54	43	43	54	54
			24	54	54	54	68	54	54	54	54	54	54	54	54
< 139	115	350S162	16	54	54	54	54	54	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	68	68	68	68	68
		550S162	16	54	54	54	54	43	43	54	54	43	43	54	54
			24	54	54	54	68	54	54	54	54	54	54	54	54
—	126	350S162	16	54	54	54	54	54	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	68	68	68	68	68
		550S162	16	54	54	54	54	43	43	54	54	43	43	54	54
			24	54	54	54	68	54	54	54	54	54	54	54	54
—	< 139	350S162	16	54	54	54	54	54	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	68	68	68	68	—
		550S162	16	54	54	54	54	43	43	54	54	43	43	54	54
			24	54	54	54	68	54	54	54	54	54	54	54	54

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion: *L*/240.~~

~~b. Design load assumptions:~~
~~Top and middle floor dead load is 10 psf.~~
~~Top floor live load is 30 psf.~~
~~Middle floor live load is 40 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~R603.3.2.1 Gable endwalls.~~

~~The size and thickness of gable endwall studs with heights less than or equal to 10 feet (3048 mm) shall be permitted in accordance with the limits set forth in Table R603.3.2.1(1). The size and thickness of gable endwall studs with heights greater than 10 feet (3048 mm) shall be determined in accordance with the limits set forth in Table R603.3.2.1(2).~~

~~TABLE R603.3.2.1(1)~~

~~ALL BUILDING WIDTHS GABLE ENDWALLS 8, 9 OR 10 FEET IN HEIGHT[a, b, c, d]~~

~~**ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)**~~		~~**MEMBER SIZE**~~	~~**STUD SPACING (inches)**~~	~~**MINIMUM STUD THICKNESS (mils)**~~		
~~**Exp. B**~~	~~**Exp. C**~~			~~**8-foot Studs**~~	~~**9-foot Studs**~~	~~**10-foot Studs**~~
~~115~~	~~—~~	~~350S162~~	~~16~~	~~33~~	~~33~~	~~33~~
			~~24~~	~~33~~	~~33~~	~~33~~
		~~550S162~~	~~16~~	~~33~~	~~33~~	~~33~~
			~~24~~	~~33~~	~~33~~	~~33~~
~~126~~	~~110~~	~~350S162~~	~~16~~	~~33~~	~~33~~	~~33~~
			~~24~~	~~33~~	~~33~~	~~43~~
		~~550S162~~	~~16~~	~~33~~	~~33~~	~~33~~
			~~24~~	~~33~~	~~33~~	~~33~~
~~< 139~~	~~115~~	~~350S162~~	~~16~~	~~33~~	~~33~~	~~33~~
			~~24~~	~~33~~	~~33~~	~~43~~
		~~550S162~~	~~16~~	~~33~~	~~33~~	~~33~~
			~~24~~	~~33~~	~~33~~	~~33~~

~~—~~	~~126~~	~~350S162~~	~~16~~	~~33~~	~~33~~	~~43~~
			~~24~~	~~43~~	~~43~~	~~54~~
		~~550S162~~	~~16~~	~~33~~	~~33~~	~~33~~
			~~24~~	~~33~~	~~33~~	~~33~~
~~—~~	~~< 139~~	~~350S162~~	~~16~~	~~33~~	~~43~~	~~43~~
			~~24~~	~~43~~	~~54~~	~~54~~
		~~550S162~~	~~16~~	~~33~~	~~33~~	~~33~~
			~~24~~	~~33~~	~~33~~	~~43~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion *L*/240.~~

~~b. Design load assumptions:~~
~~Ground snow load is 70 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Floor dead load is 10 psf.~~
~~Floor live load is 40 psf.~~
~~Attic dead load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.3.2.1(2)~~

~~ALL BUILDING WIDTHS GABLE ENDWALLS OVER 10 FEET IN HEIGHT~~[~~a, b, c, d~~]

~~ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)~~		~~MEMBER SIZE~~	~~STUD SPACING (inches)~~	~~MINIMUM STUD THICKNESS (mils)~~					
		~~Stud Height, *h* (feet)~~							
~~Exp. B~~	~~Exp. C~~			~~10 < *h* ≤ 12~~	~~12 < *h* ≤ 14~~	~~14 < *h* ≤ 16~~	~~16 < *h* ≤ 18~~	~~18 < *h* ≤ 20~~	~~20 < *h* ≤ 22~~

~~115~~	~~—~~	~~350S162~~	~~16~~	~~33~~	~~43~~	~~68~~	~~—~~	~~—~~	~~—~~
			~~24~~	~~43~~	~~68~~	~~—~~	~~—~~	~~—~~	~~—~~
		~~550S162~~	~~16~~	~~33~~	~~33~~	~~33~~	~~43~~	~~54~~	~~54~~
			~~24~~	~~33~~	~~33~~	~~43~~	~~54~~	~~68~~	~~—~~
~~126~~	~~110~~	~~350S162~~	~~16~~	~~43~~	~~54~~	~~—~~	~~—~~	~~—~~	~~—~~
			~~24~~	~~54~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
		~~550S162~~	~~16~~	~~33~~	~~33~~	~~43~~	~~54~~	~~54~~	~~68~~
			~~24~~	~~33~~	~~43~~	~~54~~	~~54~~	~~—~~	~~—~~
~~< 139~~	~~115~~	~~350S162~~	~~16~~	~~43~~	~~68~~	~~—~~	~~—~~	~~—~~	~~—~~
			~~24~~	~~68~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
		~~550S162~~	~~16~~	~~33~~	~~43~~	~~43~~	~~54~~	~~68~~	~~—~~
			~~24~~	~~43~~	~~54~~	~~54~~	~~68~~	~~—~~	~~—~~
~~—~~	~~126~~	~~350S162~~	~~16~~	~~54~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
			~~24~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
		~~550S162~~	~~16~~	~~33~~	~~43~~	~~54~~	~~54~~	~~—~~	~~—~~
			~~24~~	~~43~~	~~54~~	~~54~~	~~—~~	~~—~~	~~—~~
~~—~~	~~< 139~~	~~350S162~~	~~16~~	~~54~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
			~~24~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
		~~550S162~~	~~16~~	~~43~~	~~54~~	~~54~~	~~68~~	~~—~~	~~—~~
			~~24~~	~~54~~	~~54~~	~~68~~	~~—~~	~~—~~	~~—~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,~~
~~1 ksi = 1,000 psi = 6.895 MPa.~~

~~a. Deflection criterion *L*/240.~~

~~b. Design load assumptions:~~
~~Ground snow load is 70 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Floor dead load is 10 psf.~~
~~Floor live load is 40 psf.~~
~~Attic dead load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

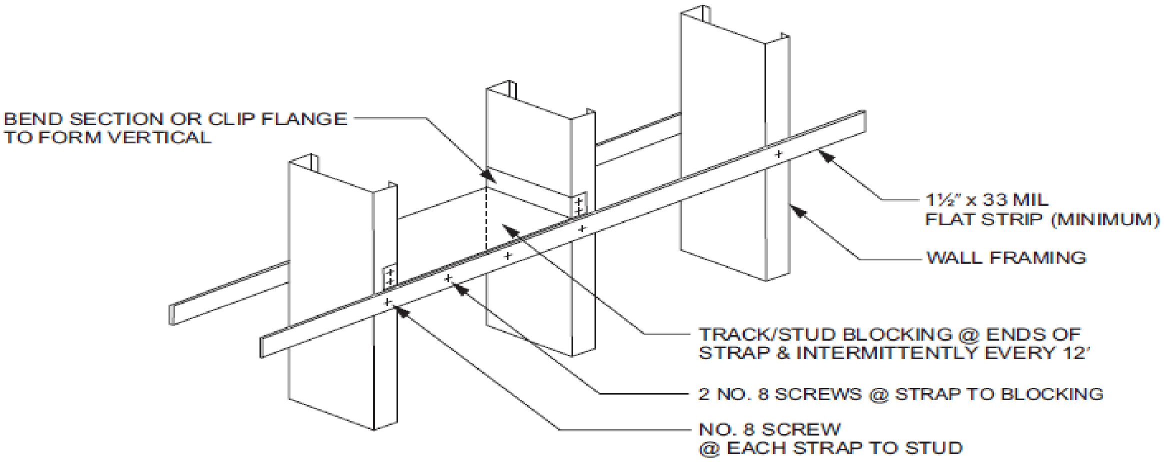
~~R603.3.3 Stud bracing.~~

~~The flanges of cold-formed steel studs shall be laterally braced in accordance with one of the following:~~

1. ~~Gypsum board on both sides, structural sheathing on both sides, or gypsum board on one side and structural sheathing on the other side of load-bearing walls with gypsum board installed with minimum No. 6 screws in accordance with Section R702 and structural sheathing installed in accordance with Section R603.9 and Table R603.3.2(1).~~

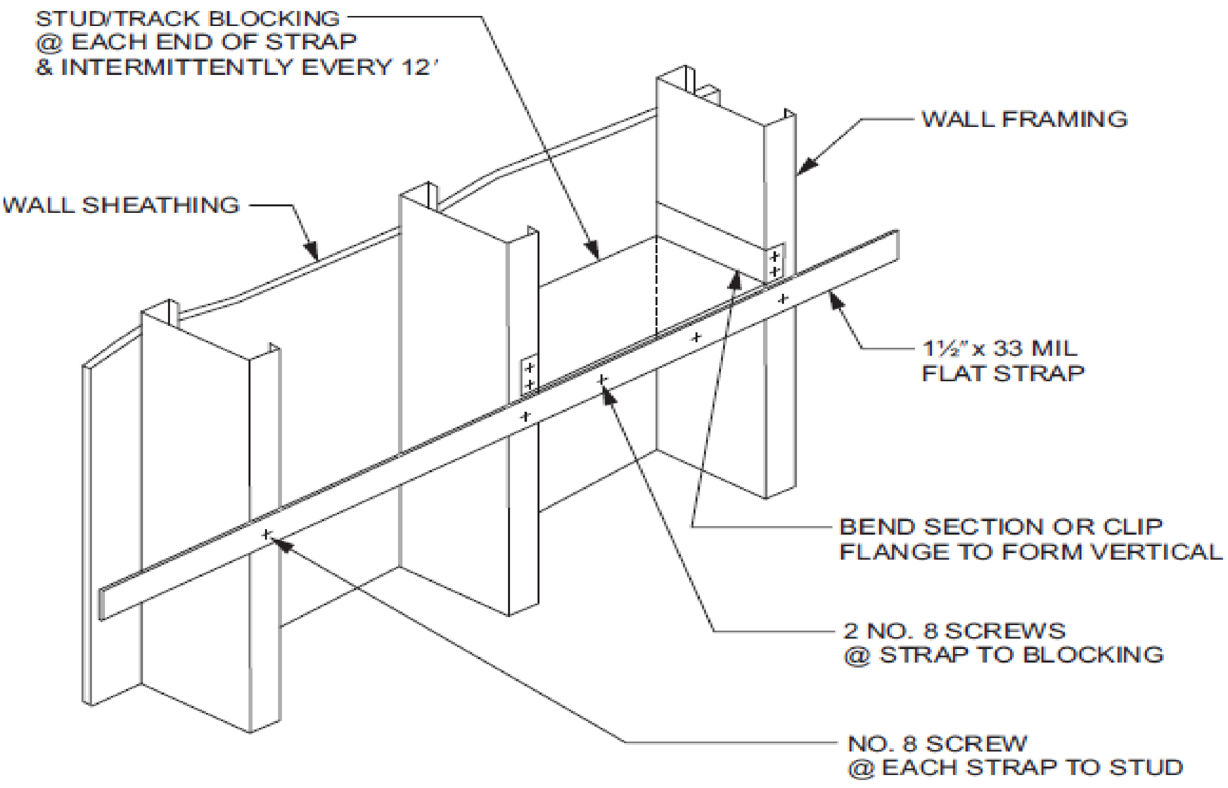
2. ~~Horizontal steel straps fastened in accordance with Figure R603.3.3(1) on both sides at mid-height for 8-foot (2438 mm) walls, and at one-third points for 9-foot and 10-foot (2743 mm and 3048 mm) walls. Horizontal steel straps shall be not less than 1 1/2 inches in width and 33 mils in thickness (38 mm by 0.84 mm). Straps shall be attached to the flanges of studs with one No. 8 screw. In-line blocking shall be installed between studs at the termination of straps and at 12-foot (3658 mm) intervals along the strap. Straps shall be fastened to the blocking with two No. 8 screws.~~

3. ~~Sheathing on one side and strapping on the other side fastened in accordance with Figure R603.3.3(2). Sheathing shall be installed in accordance with Item 1. Steel straps shall be installed in accordance with Item 2.~~



~~For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm.~~

~~FIGURE R603.3.3(1)~~
~~STUD BRACING WITH STRAPPING ONLY~~

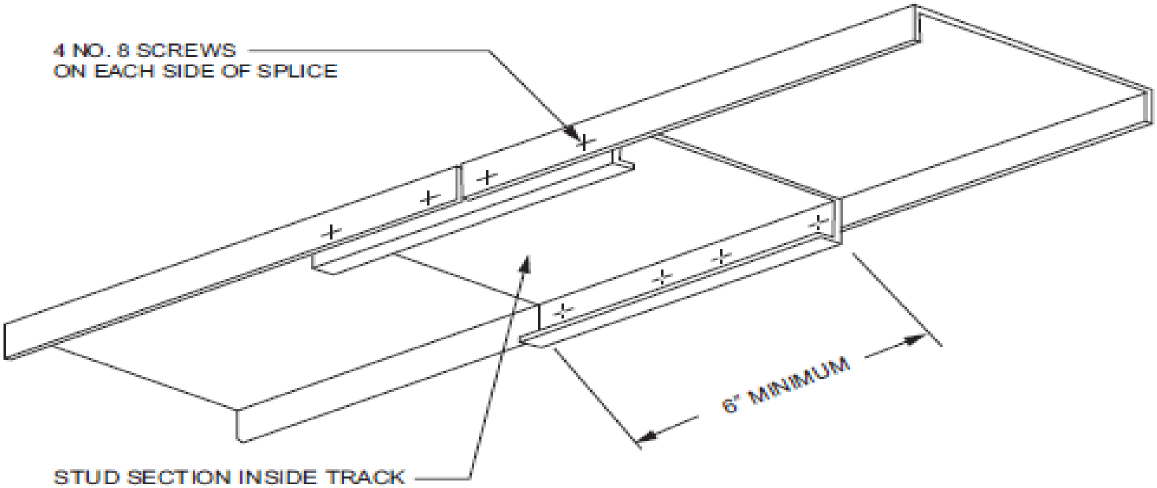


~~For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm.~~

~~FIGURE R603.3.3(2)~~
~~STUD BRACING WITH STRAPPING AND SHEATHING MATERIAL~~

~~R603.3.4 Cutting and notching.~~
~~Flanges and lips of cold-formed steel studs and headers shall not be cut or notched.~~

~~R603.3.5 Splicing.~~
~~Steel studs and other structural members shall not be spliced. Tracks shall be spliced in accordance with Figure R603.3.5.~~

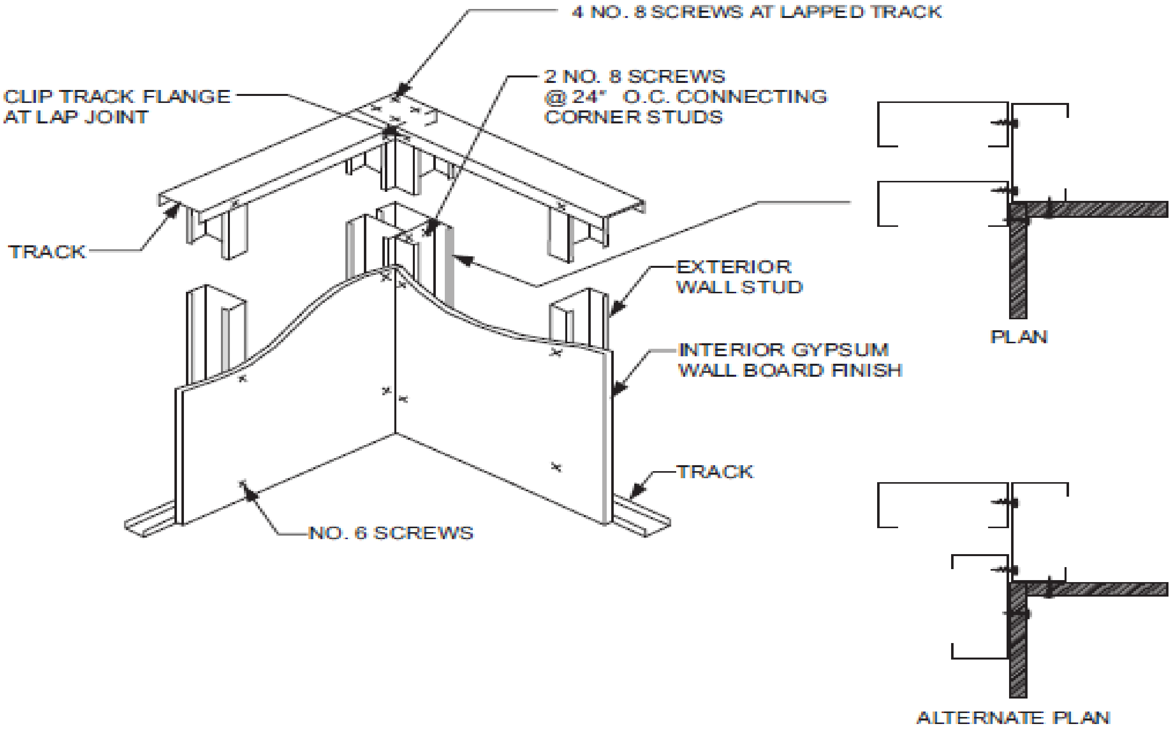


~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R603.3.5~~
~~TRACK SPLICE~~

~~R603.4 Corner framing.~~

~~In exterior walls, corner studs and the top tracks shall be installed in accordance with Figure R603.4.~~



~~For SI: 1 inch = 25.4 mm.~~

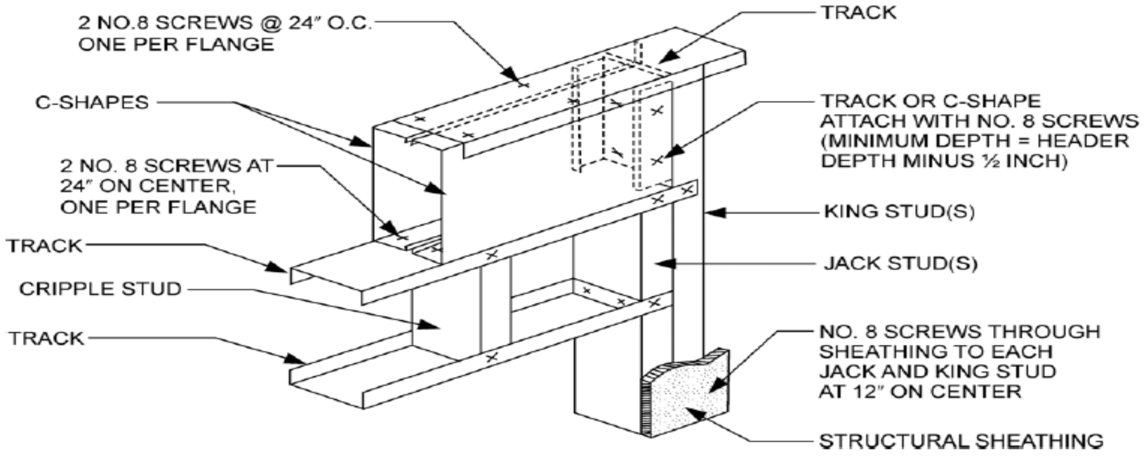
~~FIGURE R603.4~~
~~CORNER FRAMING~~

~~R603.5 Exterior wall covering.~~

~~The method of attachment of exterior wall covering materials to cold-formed steel stud wall framing shall conform to the manufacturer's installation instructions.~~

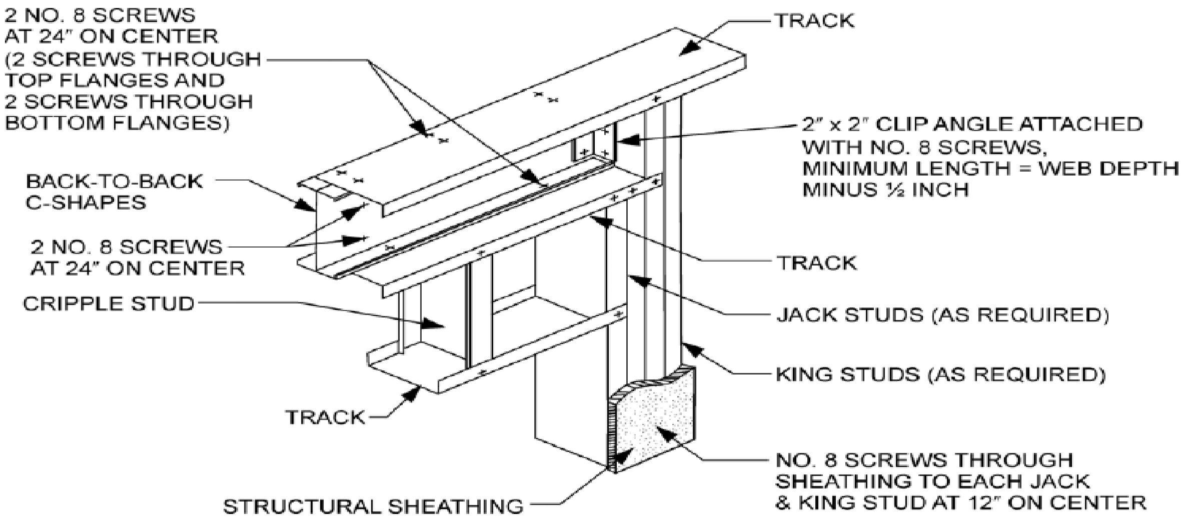
~~R603.6 Headers.~~

~~Headers shall be installed above all wall openings in exterior walls and interior load-bearing walls. Box beam headers and back-to-back headers each shall be formed from two equal sized C-shaped members in accordance with Figures R603.6(1) and R603.6(2), respectively, and Tables R603.6(1) through R603.6(6). L-shaped headers shall be permitted to be constructed in accordance with AISI S230. Alternately, headers shall be permitted to be designed and constructed in accordance with AISI S100, Section D4.~~



~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R603.6(1)~~
~~BOX BEAM HEADER~~



~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R603.6(2)~~
~~BACK-TO-BACK HEADER~~

~~TABLE R603.6(1)~~
~~BOX-BEAM AND BACK-TO-BACK HEADER SPANS~~
~~Headers Supporting Roof and Ceiling Only~~[~~a, b, d~~]

~~MEMBER DESIGNATION~~	**~~GROUND SNOW LOAD (20 psf)~~**					**~~GROUND SNOW LOAD (30 psf)~~**				
	~~Building width~~[~~c~~] **~~(feet)~~**					**~~Building width~~**[~~c~~] **~~(feet)~~**				
	~~24~~	**~~28~~**	**~~32~~**	**~~36~~**	**~~40~~**	**~~24~~**	**~~28~~**	**~~32~~**	**~~36~~**	**~~40~~**
~~2-350S162-33~~	~~3′-3″~~	~~2′-8″~~	~~2′-2″~~	~~—~~	~~—~~	~~2′-8″~~	~~2′-2″~~	~~—~~	~~—~~	~~—~~
~~2-350S162-43~~	~~4′-2″~~	~~3′-9″~~	~~3′-4″~~	~~2′-11″~~	~~2′-7″~~	~~3′-9″~~	~~3′-4″~~	~~2′-11″~~	~~2′-7″~~	~~2′-2″~~
~~2-350S162-54~~	~~6′-2″~~	~~5′-10″~~	~~5′-8″~~	~~5′-3″~~	~~4′-10″~~	~~5′-11″~~	~~5′-8″~~	~~5′-2″~~	~~4′-10″~~	~~4′-6″~~
~~2-350S162-68~~	~~6′-7″~~	~~6′-3″~~	~~6′-0″~~	~~5′-10″~~	~~5′-8″~~	~~6′-4″~~	~~6′-1″~~	~~5′-10″~~	~~5′-8″~~	~~5′-6″~~
~~2-550S162-33~~	~~4′-8″~~	~~4′-0″~~	~~3′-6″~~	~~3′-0″~~	~~2′-6″~~	~~4′-1″~~	~~3′-6″~~	~~3′-0″~~	~~2′-6″~~	~~—~~
~~2-550S162-43~~	~~6′-0″~~	~~5′-4″~~	~~4′-10″~~	~~4′-4″~~	~~3′-11″~~	~~5′-5″~~	~~4′-10″~~	~~4′-4″~~	~~3′-10″~~	~~3′-5″~~
~~2-550S162-54~~	~~8′-9″~~	~~8′-5″~~	~~8′-1″~~	~~7′-9″~~	~~7′-3″~~	~~8′-6″~~	~~8′-1″~~	~~7′-8″~~	~~7′-2″~~	~~6′-8″~~
~~2-550S162-68~~	~~9′-5″~~	~~9′-0″~~	~~8′-8″~~	~~8′-4″~~	~~8′-1″~~	~~9′-1″~~	~~8′-8″~~	~~8′-4″~~	~~8′-1″~~	~~7′-10″~~
~~2-800S162-33~~	~~4′-5″~~	~~3′-11″~~	~~3′-5″~~	~~3′-1″~~	~~2′-10″~~	~~3′-11″~~	~~3′-6″~~	~~3′-1″~~	~~2′-9″~~	~~2′-3″~~
~~2-800S162-43~~	~~7′-3″~~	~~6′-7″~~	~~5′-11″~~	~~5′-4″~~	~~4′-10″~~	~~6′-7″~~	~~5′-11″~~	~~5′-4″~~	~~4′-9″~~	~~4′-3″~~
~~2-800S162-54~~	~~10′-10″~~	~~10′-2″~~	~~9′-7″~~	~~9′-0″~~	~~8′-5″~~	~~10′-2″~~	~~9′-7″~~	~~8′-11″~~	~~8′-4″~~	~~7′-9″~~
~~2-800S162-68~~	~~12′-8″~~	~~11′-10″~~	~~11′-2″~~	~~10′-7″~~	~~10′-1″~~	~~11′-11″~~	~~11′-2″~~	~~10′-7″~~	~~10′-0″~~	~~9′-6″~~

~~2-1000S162-43~~	~~7′-10″~~	~~6′-10″~~	~~6′-1″~~	~~5′-6″~~	~~5′-0″~~	~~6′-11″~~	~~6′-1″~~	~~5′-5″~~	~~4′-11″~~	~~4′-6″~~
~~2-1000S162-54~~	~~12′-3″~~	~~11′-5″~~	~~10′-9″~~	~~10′-2″~~	~~9′-6″~~	~~11′-6″~~	~~10′-9″~~	~~10′-1″~~	~~9′-5″~~	~~8′-9″~~
~~2-1000S162-68~~	~~14′-5″~~	~~13′-5″~~	~~12′-8″~~	~~12′-0″~~	~~11′-6″~~	~~13′-6″~~	~~12′-8″~~	~~12′-0″~~	~~11′-5″~~	~~10′-10″~~
~~2-1200S162-54~~	~~12′-11″~~	~~11′-3″~~	~~10′-0″~~	~~9′-0″~~	~~8′-2″~~	~~11′-5″~~	~~10′-0″~~	~~9′-0″~~	~~8′-1″~~	~~7′-4″~~
~~2-1200S162-68~~	~~15′-11″~~	~~14′-10″~~	~~14′-0″~~	~~13′-4″~~	~~12′-8″~~	~~15′-0″~~	~~14′-0″~~	~~13′-3″~~	~~12′-7″~~	~~11′-11″~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa.~~

~~a. Deflection criteria: *L*/360 for live loads, *L*/240 for total loads.~~

~~b. Design load assumptions:~~

~~Roof/ceiling dead load is 12 psf.~~

~~Attic dead load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the header.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.6(2)~~
~~BOX-BEAM AND BACK-TO-BACK HEADER SPANS~~
~~Headers Supporting Roof and Ceiling Only~~[~~a, b, d~~]

~~MEMBER DESIGNATION~~	~~GROUND SNOW LOAD (50 psf)~~					~~GROUND SNOW LOAD (70 psf)~~				
	~~Building width~~[~~c~~] ~~(feet)~~					~~Building width~~[~~c~~] ~~(feet)~~				
	~~24~~	~~28~~	~~32~~	~~36~~	~~40~~	~~24~~	~~28~~	~~32~~	~~36~~	~~40~~
~~2-350S162-33~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-350S162-43~~	~~2′-4″~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-350S162-54~~	~~4′-8″~~	~~4′-2″~~	~~3′-9″~~	~~3′-5″~~	~~3′-1″~~	~~3′-7″~~	~~3′-2″~~	~~2′-9″~~	~~2′-5″~~	~~2′-0″~~
~~2-350S162-68~~	~~5′-7″~~	~~5′-2″~~	~~4′-9″~~	~~4′-4″~~	~~3′-11″~~	~~4′-7″~~	~~4′-1″~~	~~3′-7″~~	~~3′-2″~~	~~2′-10″~~
~~2-550S162-33~~	~~2′-2″~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-550S162-43~~	~~3′-8″~~	~~3′-1″~~	~~2′-6″~~	~~—~~	~~—~~	~~2′-3″~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-550S162-54~~	~~6′-11″~~	~~6′-3″~~	~~5′-9″~~	~~5′-3″~~	~~4′-9″~~	~~5′-6″~~	~~4′-11″~~	~~4′-5″~~	~~3′-11″~~	~~3′-5″~~
~~2-550S162-68~~	~~8′-0″~~	~~7′-6″~~	~~6′-11″~~	~~6′-5″~~	~~5′-11″~~	~~6′-9″~~	~~6′-1″~~	~~5′-6″~~	~~5′-0″~~	~~4′-7″~~
~~2-800S162-33~~	~~2′-7″~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-800S162-43~~	~~4′-6″~~	~~3′-9″~~	~~3′-1″~~	~~2′-5″~~	~~—~~	~~2′-10″~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-800S162-54~~	~~8′-0″~~	~~7′-3″~~	~~6′-8″~~	~~6′-1″~~	~~5′-7″~~	~~6′-5″~~	~~5′-9″~~	~~5′-1″~~	~~4′-7″~~	~~4′-0″~~
~~2-800S162-68~~	~~9′-9″~~	~~9′-0″~~	~~8′-3″~~	~~7′-8″~~	~~7′-1″~~	~~8′-0″~~	~~7′-3″~~	~~6′-7″~~	~~6′-0″~~	~~5′-6″~~
~~2-1000S162-43~~	~~4′-8″~~	~~4′-1″~~	~~3′-6″~~	~~2′-9″~~	~~—~~	~~3′-3″~~	~~2′-2″~~	~~—~~	~~—~~	~~—~~
~~2-1000S162-54~~	~~9′-1″~~	~~8′-2″~~	~~7′-3″~~	~~6′-7″~~	~~6′-0″~~	~~7′-0″~~	~~6′-2″~~	~~5′-6″~~	~~5′-0″~~	~~4′-6″~~
~~2-1000S162-68~~	~~11′-1″~~	~~10′-2″~~	~~9′-5″~~	~~8′-8″~~	~~8′-1″~~	~~9′-1″~~	~~8′-3″~~	~~7′-6″~~	~~6′-10″~~	~~6′-3″~~

~~2-1200S162-54~~	~~7′-8″~~	~~6′-9″~~	~~6′-1″~~	~~5′-6″~~	~~5′-0″~~	~~5′-10″~~	~~5′-1″~~	~~4′-7″~~	~~4′-1″~~	~~3′-9″~~
~~2-1200S162-68~~	~~12′-3″~~	~~11′-3″~~	~~10′-4″~~	~~9′-7″~~	~~8′-11″~~	~~10′-1″~~	~~9′-1″~~	~~8′-3″~~	~~7′-6″~~	~~6′-10″~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa.~~

~~a. Deflection criteria: *L*/360 for live loads, *L*/240 for total loads.~~

~~b. Design load assumptions:~~
~~Roof/ceiling dead load is 12 psf.~~
~~Attic dead load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the header.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.6(3)~~
~~BOX-BEAM AND BACK-TO-BACK HEADER SPANS~~
~~Headers Supporting One Floor, Roof and Ceiling~~ ~~[a, b, d]~~

~~MEMBER DESIGNATION~~	~~GROUND SNOW LOAD (20 psf)~~					~~GROUND SNOW LOAD (30 psf)~~				
	~~Building width[c] (feet)~~					~~Building width[c] (feet)~~				
	~~24~~	~~28~~	~~32~~	~~36~~	~~40~~	~~24~~	~~28~~	~~32~~	~~36~~	~~40~~
~~2-350S162-33~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-350S162-43~~	~~2′-2″~~	~~—~~	~~—~~	~~—~~	~~—~~	~~2′-1″~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-350S162-54~~	~~4′-4″~~	~~3′-10″~~	~~3′-5″~~	~~3′-1″~~	~~2′-9″~~	~~4′-3″~~	~~2′-9″~~	~~3′-4″~~	~~3′-0″~~	~~2′-8″~~
~~2-350S162-68~~	~~5′-0″~~	~~4′-9″~~	~~4′-7″~~	~~4′-2″~~	~~3′-9″~~	~~4′-11″~~	~~4″-8″~~	~~4′-6″~~	~~4′-1″~~	~~3′-9″~~
~~2-550S162-33~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-550S162-43~~	~~3′-5″~~	~~2′-9″~~	~~2′-1″~~	~~—~~	~~—~~	~~3′-3″~~	~~2″-7″~~	~~—~~	~~—~~	~~—~~
~~2-550S162-54~~	~~6′-6″~~	~~5′-10″~~	~~5′-3″~~	~~4′-9″~~	~~4′-4″~~	~~6′-4″~~	~~5′-9″~~	~~5′-2″~~	~~4′-8″~~	~~4′-3″~~
~~2-550S162-68~~	~~7′-2″~~	~~6′-10″~~	~~6′-5″~~	~~5′-11″~~	~~5′-6″~~	~~7′-0″~~	~~6′-9″~~	~~6′-4″~~	~~5′-10″~~	~~5′-4″~~
~~2-800S162-33~~	~~2′-1″~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-800S162-43~~	~~4′-2″~~	~~3′-4″~~	~~2′-7″~~	~~—~~	~~—~~	~~4′-0″~~	~~3′-3″~~	~~2′-5″~~	~~—~~	~~—~~
~~2-800S162-54~~	~~7′-6″~~	~~6′-9″~~	~~6′-2″~~	~~5′-7″~~	~~5′-0″~~	~~7′-5″~~	~~6′-8″~~	~~6′-0″~~	~~5′-5″~~	~~4′-11″~~
~~2-800S162-68~~	~~9′-3″~~	~~8′-5″~~	~~7′-8″~~	~~7′-1″~~	~~6′-6″~~	~~9′-1″~~	~~8′-3″~~	~~7′-7″~~	~~7′-0″~~	~~6′-5″~~
~~2-1000S162-43~~	~~4′-4″~~	~~3′-9″~~	~~2′-11″~~	~~—~~	~~—~~	~~4′-3″~~	~~3′-8″~~	~~2′-9″~~	~~—~~	~~—~~
~~2-1000S162-54~~	~~8′-6″~~	~~7′-6″~~	~~6′-8″~~	~~6′-0″~~	~~5′-5″~~	~~8′-4″~~	~~7′-4″~~	~~6′-6″~~	~~5′-10″~~	~~5′-4″~~
~~2-1000S162-68~~	~~10′-6″~~	~~9′-7″~~	~~8′-9″~~	~~8′-0″~~	~~7′-5″~~	~~10′-4″~~	~~9′-5″~~	~~8′-7″~~	~~7′-11″~~	~~7′-3″~~
~~2-1200S162-54~~	~~7′-1″~~	~~6′-2″~~	~~5′-6″~~	~~5′-0″~~	~~4′-6″~~	~~6′-11″~~	~~6′-1″~~	~~5′-5″~~	~~4′-10″~~	~~4′-5″~~
~~2-1200S162-68~~	~~11′-7″~~	~~10′-7″~~	~~9′-8″~~	~~8′-11″~~	~~8′-2″~~	~~11′-5″~~	~~10′-5″~~	~~9′-6″~~	~~8′-9″~~	~~8′-0″~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa.~~

~~a. Deflection criteria: *L*/360 for live loads, *L*/240 for total loads.~~

~~b. Design load assumptions:~~

~~Second-floor dead load is 10 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Second-floor live load is 30 psf.~~
~~Attic dead load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the header.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.6(4)~~
~~BOX-BEAM AND BACK-TO-BACK HEADER SPANS~~
~~Headers Supporting One Floor, Roof and Ceiling~~ ~~[a, b, d]~~

~~MEMBER DESIGNATION~~	~~GROUND SNOW LOAD (50 psf)~~					~~GROUND SNOW LOAD (70 psf)~~				
	~~Building width~~ ~~[c]~~ ~~(feet)~~					~~Building width~~ ~~[c]~~ ~~(feet)~~				
	~~24~~	~~28~~	~~32~~	~~36~~	~~40~~	~~24~~	~~28~~	~~32~~	~~36~~	~~40~~
~~2-350S162-33~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-350S162-43~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-350S162-54~~	~~3′-5″~~	~~3′-0″~~	~~2′-7″~~	~~2′-2″~~	~~—~~	~~2′-8″~~	~~2′-2″~~	~~—~~	~~—~~	~~—~~
~~2-350S162-68~~	~~4′-6″~~	~~4′-1″~~	~~3′-8″~~	~~3′-3″~~	~~2′-11″~~	~~3′-9″~~	~~3′-3″~~	~~2′-10″~~	~~2′-5″~~	~~2′-1″~~
~~2-550S162-33~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-550S162-43~~	~~2′-0″~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-550S162-54~~	~~5′-3″~~	~~3′-8″~~	~~4′-1″~~	~~3′-8″~~	~~3′-2″~~	~~4′-3″~~	~~3′-8″~~	~~3′-1″~~	~~2′-7″~~	~~2′-0″~~
~~2-550S162-68~~	~~6′-5″~~	~~5′-10″~~	~~5′-3″~~	~~4′-9″~~	~~4′-4″~~	~~5′-5″~~	~~4′-9″~~	~~4′-3″~~	~~3′-9″~~	~~3′-4″~~
~~2-800S162-33~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-800S162-43~~	~~2′-6″~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-800S162-54~~	~~6′-1″~~	~~5′-5″~~	~~4′-10″~~	~~4′-3″~~	~~3′-9″~~	~~4′-11″~~	~~4′-3″~~	~~3′-8″~~	~~3′-0″~~	~~2′-5″~~
~~2-800S162-68~~	~~7′-8″~~	~~6′-11″~~	~~6′-3″~~	~~5′-9″~~	~~5′-2″~~	~~6′-5″~~	~~5′-9″~~	~~5′-1″~~	~~4′-6″~~	~~4′-0″~~
~~2-1000S162-43~~	~~2′-10″~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-1000S162-54~~	~~6′-7″~~	~~5′-10″~~	~~5′-3″~~	~~4′-9″~~	~~4′-3″~~	~~5′-4″~~	~~4′-9″~~	~~4′-1″~~	~~3′-5″~~	~~2′-9″~~
~~2-1000S162-68~~	~~8′-8″~~	~~7′-10″~~	~~7′-2″~~	~~6′-6″~~	~~5′-11″~~	~~7′-4″~~	~~6′-6″~~	~~5′-9″~~	~~5′-1″~~	~~4′-6″~~
~~2-1200S162-54~~	~~5′-6″~~	~~4′-10″~~	~~4′-4″~~	~~3′-11″~~	~~3′-7″~~	~~4′-5″~~	~~3′-11″~~	~~3′-6″~~	~~3′-2″~~	~~2′-11″~~
~~2-1200S162-68~~	~~9′-7″~~	~~8′-8″~~	~~7′-11″~~	~~7′-2″~~	~~6′-6″~~	~~8′-1″~~	~~7′-2″~~	~~6′-4″~~	~~5′-8″~~	~~5′-0″~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa.~~

~~a. Deflection criteria: *L*/360 for live loads, *L*/240 for total loads.~~

~~b. Design load assumptions:~~

~~Second-floor dead load is 10 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Second-floor live load is 30 psf.~~

~~Attic dead load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the header.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.6(5)~~
~~BOX-BEAM AND BACK-TO-BACK HEADER SPANS~~
~~Headers Supporting Two Floors, Roof and Ceiling~~ ~~[a, b, d]~~

~~MEMBER DESIGNATION~~	~~GROUND SNOW LOAD (20 psf)~~					~~GROUND SNOW LOAD (30 psf)~~				
	~~Building width~~[~~c~~] ~~(feet)~~					~~Building width~~[~~c~~] ~~(feet)~~				
	~~24~~	~~28~~	~~32~~	~~36~~	~~40~~	~~24~~	~~28~~	~~32~~	~~36~~	~~40~~
~~2-350S162-33~~	—	—	—	—	—	—	—	—	—	—
~~2-350S162-43~~	—	—	—	—	—	—	—	—	—	—
~~2-350S162-54~~	~~2′-5″~~	—	—	—	—	~~2′-4″~~	—	—	—	—
~~2-350S162-68~~	~~3′-6″~~	~~3′-0″~~	~~2′-6″~~	~~2′-1″~~	—	~~3′-5″~~	~~2′-11″~~	~~2′-6″~~	~~2′-0″~~	—
~~2-550S162-33~~	—	—	—	—	—	—	—	—	—	—
~~2-550S162-43~~	—	—	—	—	—	—	—	—	—	—
~~2-550S162-54~~	~~3′-11″~~	~~3′-3″~~	~~2′-8″~~	~~2′-0″~~	—	~~3′-10″~~	~~3′-3″~~	~~2′-7″~~	—	—
~~2-550S162-68~~	~~5′-1″~~	~~4′-5″~~	~~3′-10″~~	~~3′-3″~~	~~2′-9″~~	~~5′-0″~~	~~4′-4″~~	~~3′-9″~~	~~3′-3″~~	~~2′-9″~~
~~2-800S162-33~~	—	—	—	—	—	—	—	—	—	—
~~2-800S162-43~~	—	—	—	—	—	—	—	—	—	—
~~2-800S162-54~~	~~4′-7″~~	~~3′-10″~~	~~3′-1″~~	~~2′-5″~~	—	~~4′-6″~~	~~3′-9″~~	~~3′-0″~~	~~2′-4″~~	—
~~2-800S162-68~~	~~6′-0″~~	~~5′-3″~~	~~4′-7″~~	~~3′-11″~~	~~3′-4″~~	~~6′-0″~~	~~5′-2″~~	~~4′-6″~~	~~3′-11″~~	~~3′-3″~~
~~2-1000S162-43~~	—	—	—	—	—	—	—	—	—	—
~~2-1000S162-54~~	~~5′-0″~~	~~4′-4″~~	~~3′-6″~~	~~2′-9″~~	—	~~4′-11″~~	~~4′-3″~~	~~3′-5″~~	~~2′-7″~~	—
~~2-1000S162-68~~	~~6′-10″~~	~~6′-0″~~	~~5′-3″~~	~~4′-6″~~	~~3′-10″~~	~~6′-9″~~	~~5′-11″~~	~~5′-2″~~	~~4′-5″~~	~~3′-9″~~
~~2-1200S162-54~~	~~4′-2″~~	~~3′-7″~~	~~3′-3″~~	~~2′-11″~~	—	~~4′-1″~~	~~3′-7″~~	~~3′-2″~~	~~2′-10″~~	—
~~2-1200S162-68~~	~~7′-7″~~	~~6′-7″~~	~~5′-9″~~	~~5′-0″~~	~~4′-2″~~	~~7′-6″~~	~~6′-6″~~	~~5′-8″~~	~~4′-10″~~	~~4′-1″~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa.~~

~~a. Deflection criteria: *L*/360 for live loads, *L*/240 for total loads.~~

~~b. Design load assumptions:~~
~~Second-floor dead load is 10 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Second-floor live load is 40 psf~~
~~Third-floor live load is 30 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the header.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R603.6(6)~~
~~BOX-BEAM AND BACK-TO-BACK HEADER SPANS~~
~~Headers Supporting Two Floors, Roof and Ceiling~~~~[a, b, d]~~

~~MEMBER DESIGNATION~~	~~GROUND SNOW LOAD (50 psf)~~					~~GROUND SNOW LOAD (70 psf)~~				
	~~Building width~~~~[c]~~ ~~(feet)~~					~~Building width~~~~[c]~~ ~~(feet)~~				
	~~24~~	~~28~~	~~32~~	~~36~~	~~40~~	~~24~~	~~28~~	~~32~~	~~36~~	~~40~~
~~2-350S162-33~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-350S162-43~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-350S162-54~~	~~2′-2″~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-350S162-68~~	~~3′-3″~~	~~2′-9″~~	~~2′-3″~~	~~—~~	~~—~~	~~2′-11″~~	~~2′-5″~~	~~—~~	~~—~~	~~—~~
~~2-550S162-33~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-550S162-43~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-550S162-54~~	~~3′-7″~~	~~2′-11″~~	~~2′-3″~~	~~—~~	~~—~~	~~3′-3″~~	~~2′-7″~~	~~—~~	~~—~~	~~—~~
~~2-550S162-68~~	~~4′-9″~~	~~2′-1″~~	~~3′-6″~~	~~3′-0″~~	~~2′-5″~~	~~4′-4″~~	~~3′-9″~~	~~3′-2″~~	~~2′-8″~~	~~2′-1″~~
~~2-800S162-33~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-800S162-43~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-800S162-54~~	~~4′-3″~~	~~3′-5″~~	~~2′-8″~~	~~—~~	~~—~~	~~3′-9″~~	~~3′-0″~~	~~2′-3″~~	~~—~~	~~—~~
~~2-800S162-68~~	~~5′-8″~~	~~4′-11″~~	~~4′-2″~~	~~3′-7″~~	~~2′-11″~~	~~5′-3″~~	~~4′-6″~~	~~3′-10″~~	~~3′-3″~~	~~2′-7″~~
~~2-1000S162-43~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~2-1000S162-54~~	~~4′-8″~~	~~3′-11″~~	~~3′-1″~~	~~2′-2″~~	~~—~~	~~4′-3″~~	~~3′-5″~~	~~2′-7″~~	~~—~~	~~—~~
~~2-1000S162-68~~	~~6′-5″~~	~~5′-7″~~	~~4′-9″~~	~~4′-1″~~	~~3′-4″~~	~~5′-11″~~	~~5′-1″~~	~~4′-5″~~	~~3′-8″~~	~~2′-11″~~
~~2-1200S162-54~~	~~3′-11″~~	~~3′-5″~~	~~3′-0″~~	~~2′-4″~~	~~—~~	~~3′-7″~~	~~3′-2″~~	~~2′-10″~~	~~—~~	~~—~~
~~2-1200S162-68~~	~~7′-1″~~	~~6′-2″~~	~~5′-3″~~	~~4′-6″~~	~~3′-8″~~	~~6′-6″~~	~~5′-8″~~	~~4′-10″~~	~~4′-0″~~	~~3′-3″~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa.~~

~~a. Deflection criteria: *L*/360 for live loads, *L*/240 for total loads.~~

~~b. Design load assumptions:~~
~~Second-floor dead load is 10 psf.~~
~~Roof/ceiling dead load is 12 psf.~~
~~Second-floor live load is 40 psf~~
~~Third-floor live load is 30 psf.~~
~~Attic live load is 10 psf.~~

~~c. Building width is in the direction of horizontal framing members supported by the header.~~

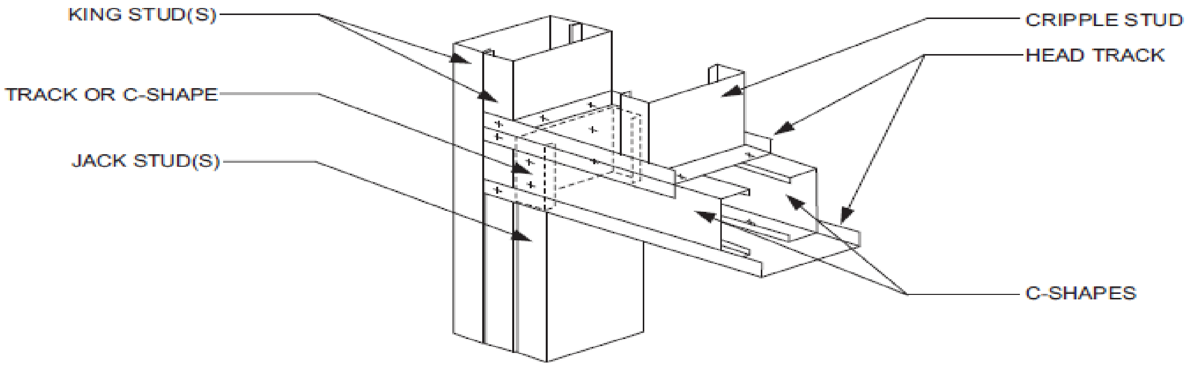
~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~R603.6.1 Headers in gable endwalls.~~

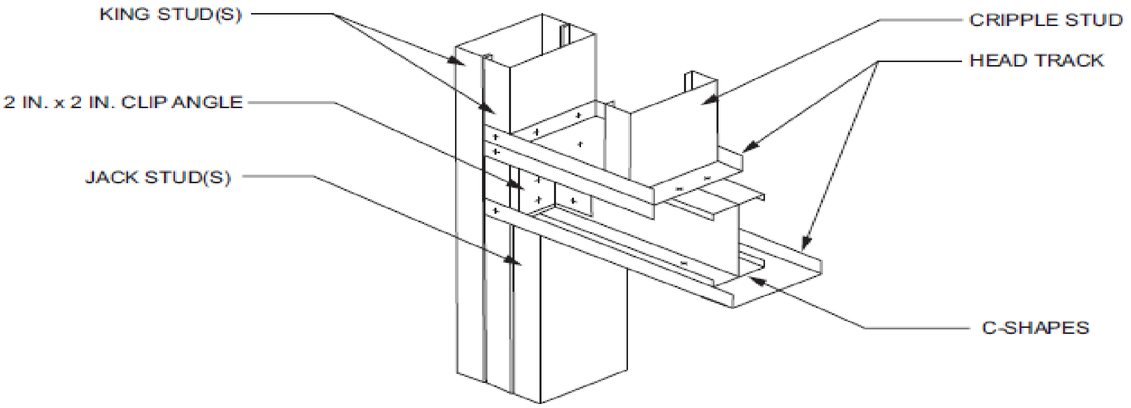
~~Box beam and back-to-back headers in gable endwalls shall be permitted to be constructed~~

~~in accordance with Section R603.6 or with the header directly above the opening in accordance with Figures R603.6.1(1) and R603.6.1(2) and the following provisions:~~

1. ~~Two 362S162-33 for openings less than or equal to 4 feet (1219 mm).~~
2. ~~Two 600S162-43 for openings greater than 4 feet (1219 mm) but less than or equal to 6 feet (1830 mm).~~
3. ~~Two 800S162-54 for openings greater than 6 feet (1829 mm) but less than or equal to 9 feet (2743 mm).~~



~~FIGURE R603.6.1(1)~~
~~BOX BEAM HEADER IN GABLE ENDWALL~~



~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R603.6.1(2)~~
~~BACK-TO-BACK HEADER IN GABLE ENDWALL~~

~~R603.7 Jack and king studs.~~

~~The number of jack and king studs installed on each side of a header shall comply with Table R603.7(1). King, jack and cripple studs shall be of the same dimension and thickness as the adjacent wall studs. Headers shall be connected to king studs in accordance with Table R603.7(2) and the following provisions:~~

1. ~~For box beam headers, one-half of the total number of required screws shall be applied to the header and one- half to the king stud by use of C-shaped or track member in accordance with Figure R603.6(1). The track or C-shaped sections shall extend the depth of the header minus 1/2 inch (12.7 mm) and shall have a minimum thickness not less than that of the wall studs.~~

2. ~~For back-to-back headers, one-half the total number of screws shall be applied to the header and one-half to the king stud by use of a minimum 2-inch by 2-inch (51 mm by 51 mm) clip angle in accordance with Figure R603.6(2). The clip angle shall extend the depth of the header minus 1/2 inch (12.7 mm) and shall have a minimum thickness not less than that of the wall studs. Jack and king studs shall be interconnected with structural sheathing in accordance with Figures R603.6(1) and R603.6(2).~~

~~TABLE R603.7(1)~~
~~TOTAL NUMBER OF JACK AND KING STUDS REQUIRED AT EACH END OF AN OPENING~~

~~SIZE OF OPENING (feet-inches)~~	~~24-INCH O.C. STUD SPACING~~		~~16-INCH O.C. STUD SPACING~~	
	~~No. of jack studs~~	~~No. of king studs~~	~~No. of jack studs~~	~~No. of king studs~~
~~Up to 3′-6″~~	~~1~~	~~1~~	~~1~~	~~1~~
~~> 3′-6″ to 5′-0″~~	~~1~~	~~2~~	~~1~~	~~2~~
~~> 5′-0″ to 5′-6″~~	~~1~~	~~2~~	~~2~~	~~2~~
~~> 5′-6″ to 8′-0″~~	~~1~~	~~2~~	~~2~~	~~2~~
~~> 8′-0″ to 10′-6″~~	~~2~~	~~2~~	~~2~~	~~3~~
~~> 10′-6″ to 12′-0″~~	~~2~~	~~2~~	~~3~~	~~3~~
~~> 12′-0″ to 13′-0″~~	~~2~~	~~3~~	~~3~~	~~3~~
~~> 13′-0″ to 14′-0″~~	~~2~~	~~3~~	~~3~~	~~4~~
~~> 14′-0″ to 16′-0″~~	~~2~~	~~3~~	~~3~~	~~4~~
~~> 16′-0″ to 18′-0″~~	~~3~~	~~3~~	~~4~~	~~4~~

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

~~TABLE R603.7(2)~~
~~HEADER TO KING STUD CONNECTION REQUIREMENTS~~~~[a, b, c, d]~~

~~HEADER SPAN (feet)~~	~~ULTIMATE WIND SPEED (mph), EXPOSURE CATEGORY~~	
	~~110, Exposure Category C or less than 139, Exposure Category B~~	~~Less than 139, Exposure Category C~~
~~≤ 4′~~	~~4-No. 8 screws~~	~~6-No. 8 screws~~
~~> 4″ to 8″~~	~~4-No. 8 screws~~	~~8-No. 8 screws~~
~~> 8″ to 12″~~	~~6-No. 8 screws~~	~~10-No. 8 screws~~
~~> 12″ to 16″~~	~~8-No. 8 screws~~	~~12-No. 8 screws~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound = 4.448 N.~~

~~a. All screw sizes shown are minimum.~~

~~b. For headers located on the first floor of a two-story building or the first or second floor of a three-story building, the total number of screws is permitted to be reduced by 2 screws, but the total number of screws shall not be less than four.~~

~~c. For roof slopes of 6:12 or greater, the required number of screws shall be permitted to be reduced by half, but the total number of screws shall not be less than four.~~

~~d. Screws can be replaced by an uplift connector that has a capacity of the number of screws multiplied by 164 pounds.~~

~~R603.8 Head and sill track.~~

~~Head track spans above door and window openings and sill track spans beneath window openings shall comply with Table R603.8. For openings less than 4 feet (1219 mm) in height that have both a head track and a sill track, multiplying the spans by 1.75 shall be permitted in Table R603.8. For openings less than or equal to 6 feet (1829 mm) in height that have both a head track and a sill track, multiplying the spans in Table R603.8 by 1.50 shall be permitted.~~

~~TABLE R603.8~~
~~HEAD AND SILL TRACK SPAN~~

~~ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)~~		**~~ALLOWABLE HEAD AND SILL TRACK SPAN~~**~~[a, b, c]~~ **~~(feet-inches)~~**					
		~~TRACK DESIGNATION~~~~[d]~~					
~~B~~	**~~C~~**	**~~350T125-33~~**	**~~350T125-43~~**	**~~350T125-54~~**	**~~550T125-33~~**	**~~550T125-43~~**	**~~550T125-54~~**
~~115~~	—	~~4′-10″~~	~~5′-5″~~	~~6′-0″~~	~~5′-8″~~	~~6′-3″~~	~~6′-10″~~
~~126~~	~~110~~	~~4′-6″~~	~~5′-1″~~	~~5′-8″~~	~~5′-4″~~	~~5′-11″~~	~~6′-5″~~
~~< 139~~	~~115~~	~~4′-2″~~	~~4′-9″~~	~~5′-4″~~	~~5′-1″~~	~~5′-7″~~	~~6′-1″~~
—	~~126~~	~~3′-11″~~	~~4′-6″~~	~~5′-0″~~	~~4′-10″~~	~~5′-4″~~	~~5′-10″~~
—	~~< 139~~	~~3′-8″~~	~~4′-2″~~	~~4′-9″~~	~~4′-1″~~	~~5′-1″~~	~~5′-7″~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.~~

~~a. Deflection limit: *L*/240.~~

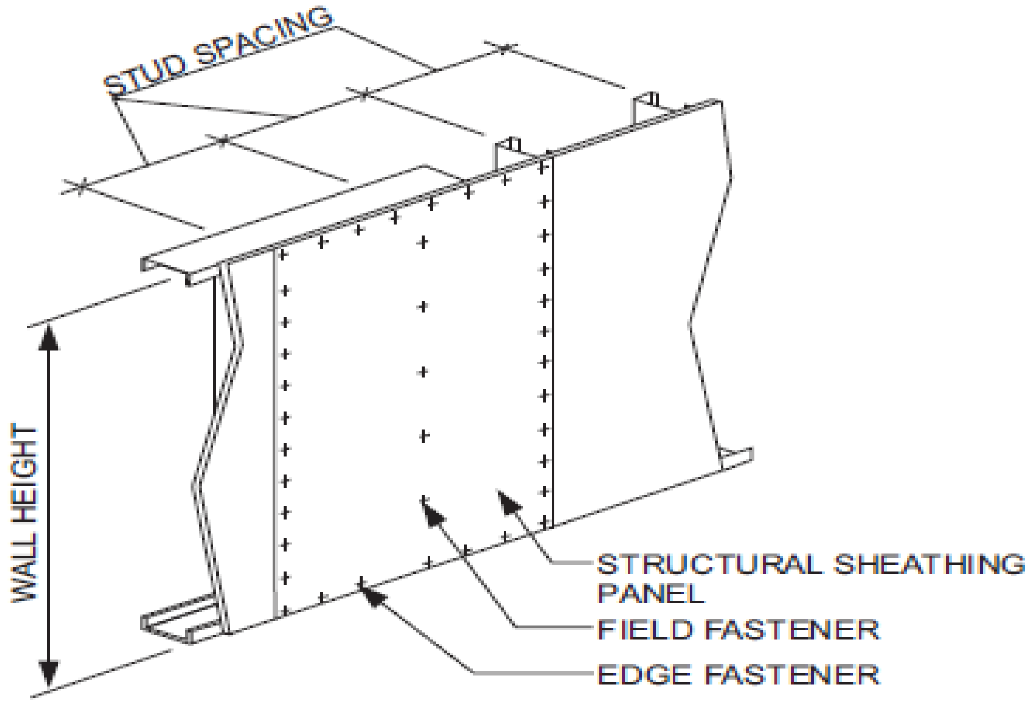
~~b. Head and sill track spans are based on components and cladding wind pressures and 48-inch tributary span.~~

~~c. For openings less than 4 feet in height that have both a head track and sill track, the spans are permitted to be multiplied by 1.75. For openings less than or equal to 6 feet in height that have both a head track and a sill track, the spans are permitted to be multiplied by a factor of 1.5.~~

~~d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~R603.9 Structural sheathing.~~

~~Structural sheathing shall be installed in accordance with Figure R603.9 and this section on all sheathable exterior wall surfaces, including areas above and below openings.~~



~~FIGURE R603.9~~
~~STRUCTURAL SHEATHING FASTENING PATTERN~~

~~R603.9.1 Sheathing materials.~~

~~Structural sheathing panels shall consist of minimum $^{7}/_{16}$-inch-thick (11 mm) oriented strand board or $^{15}/_{32}$-inch-thick (12 mm) plywood.~~

~~R603.9.2 Determination of minimum length of full- height sheathing.~~

~~The minimum length of full-height sheathing on each *braced wall line* shall be determined by multiplying the length of the *braced wall line* by the percentage obtained from Table R603.9.2(1) and by the plan aspect-ratio adjustment factors obtained from Table R603.9.2(2). The minimum length of full-height sheathing shall be not less than 20 percent of the *braced wall line* length.~~

~~To be considered full-height sheathing, structural sheathing shall extend from the bottom to the top of the wall without interruption by openings. Only sheathed, full- height wall sections, uninterrupted by openings, which are not less than 48 inches (1219 mm) wide, shall be counted toward meeting the minimum percentages in Table R603.9.2(1). In addition, structural sheathing shall comply with all of the following requirements:~~

1. ~~Be installed with the long dimension parallel to the stud framing and shall cover the full vertical height of wall from the bottom of the bottom track to the top of the top track of each *story*. Installing the long dimension perpendicular to the stud framing or using shorter segments shall be permitted provided that the horizontal joint is blocked as described in Item 2.~~

2. ~~Be blocked where the long dimension is installed perpendicular to the stud framing. Blocking shall be not less than 33 mil (0.84 mm) thickness. Each horizontal structural sheathing panel shall be fastened with No. 8 screws spaced at 6 inches (152 mm) on center to the blocking at the joint.~~

3. ~~Be applied to each end (corners) of each of the exterior walls with a minimum 48-inch-wide (1219 mm) panel.~~

~~**Exception:** Where stone or masonry veneer is installed, the required length of full-height sheathing and overturning anchorage required shall be determined in accordance with Section R603.9.5.~~

~~TABLE R603.9.2(1)~~
~~MINIMUM PERCENTAGE OF FULL-HEIGHT STRUCTURAL SHEATHING ON EXTERIOR WALLS[a, b]~~

~~WALL SUPPORTING~~	~~ROOF SLOPE~~	~~ULTIMATE WIND SPEED AND EXPOSURE (mph)~~				
		~~115 B~~	~~126 B~~ ~~110 C~~	~~< 139 B~~ ~~115 C~~	~~126 C~~	~~< 139 C~~
~~Roof and ceiling only (one story or top floor of two- or three-story building).~~	~~3:12~~	~~9~~	~~9~~	~~12~~	~~16~~	~~20~~
	~~6:12~~	~~13~~	~~15~~	~~20~~	~~26~~	~~35~~
	~~9:12~~	~~23~~	~~25~~	~~30~~	~~50~~	~~58~~
	~~12:12~~	~~33~~	~~35~~	~~40~~	~~66~~	~~75~~
~~One story, roof and ceiling (first floor of a two-story building or second floor of a three-story building).~~	~~3:12~~	~~27~~	~~30~~	~~35~~	~~50~~	~~66~~
	~~6:12~~	~~28~~	~~30~~	~~40~~	~~58~~	~~74~~
	~~9:12~~	~~38~~	~~40~~	~~55~~	~~74~~	~~91~~
	~~12:12~~	~~45~~	~~50~~	~~65~~	~~100~~	~~115~~
~~Two stories, roof and ceiling (first floor of a three-story building).~~	~~3:12~~	~~45~~	~~51~~	~~58~~	~~84~~	~~112~~
	~~6:12~~	~~43~~	~~45~~	~~60~~	~~90~~	~~113~~
	~~9:12~~	~~53~~	~~55~~	~~80~~	~~98~~	~~124~~
	~~12:12~~	~~57~~	~~65~~	~~90~~	~~134~~	~~155~~

~~For SI: 1 mph = 0.447 m/s.~~

~~a. Linear interpolation is permitted.~~

~~b. For hip-roofed homes the minimum percentage of full-height sheathing, based upon wind, is permitted to be multiplied by a factor of 0.95 for roof slopes not exceeding 7:12 and a factor of 0.9 for roof slopes greater than 7:12.~~

~~TABLE R603.9.2(2)~~
~~FULL-HEIGHT SHEATHING LENGTH ADJUSTMENT FACTORS~~

~~PLAN ASPECT RATIO~~	~~LENGTH ADJUSTMENT FACTORS~~	
	~~Short wall~~	~~Long wall~~
~~1:1~~	~~1.0~~	~~1.0~~
~~1.5:1~~	~~1.5~~	~~0.67~~
~~2:1~~	~~2.0~~	~~0.50~~
~~3:1~~	~~3.0~~	~~0.33~~
~~4:1~~	~~4.0~~	~~0.25~~

~~R603.9.2.1 Full height sheathing.~~

~~The minimum percentage of full-height structural sheathing shall be multiplied by 1.10 for 9-foot-high (2743 mm) walls and multiplied by 1.20 for 10-foot-high (3048 mm) walls.~~

~~R603.9.2.2 Full-height sheathing in lowest story.~~

~~In the lowest *story* of a *dwelling*, multiplying the percentage of full-height sheathing required in Table R603.9.2(1) by 0.6 shall be permitted provided hold-down anchors are provided in accordance with Section R603.9.4.2.~~

~~R603.9.3 Structural sheathing fastening.~~

~~Edges and interior areas of structural sheathing panels shall be fastened to framing members and tracks in accordance with Figure R603.9 and Table R603.3.2(1). Screws for attachment of structural sheathing panels shall be bugle-head, flat-head, or similar head style with a minimum head diameter of 0.29 inch (8 mm).~~

~~For continuously sheathed *braced wall lines* using wood structural panels installed with No. 8 screws spaced 4 inches (102 mm) on center at all panel edges and 12 inches (304.8 mm) on center on intermediate framing members, the following shall apply:~~

1. ~~Multiplying the percentages of full-height sheathing in Table R603.9.2(1) by 0.72 shall be permitted.~~
2. ~~For bottom track attached to foundations or framing below, the bottom track anchor or screw connection spacing in Tables R505.3.1(1) and R603.3.1 shall be multiplied by two-thirds~~

~~R603.9.4 Uplift connection requirements.~~

~~Uplift connections shall be provided in accordance with this section.~~

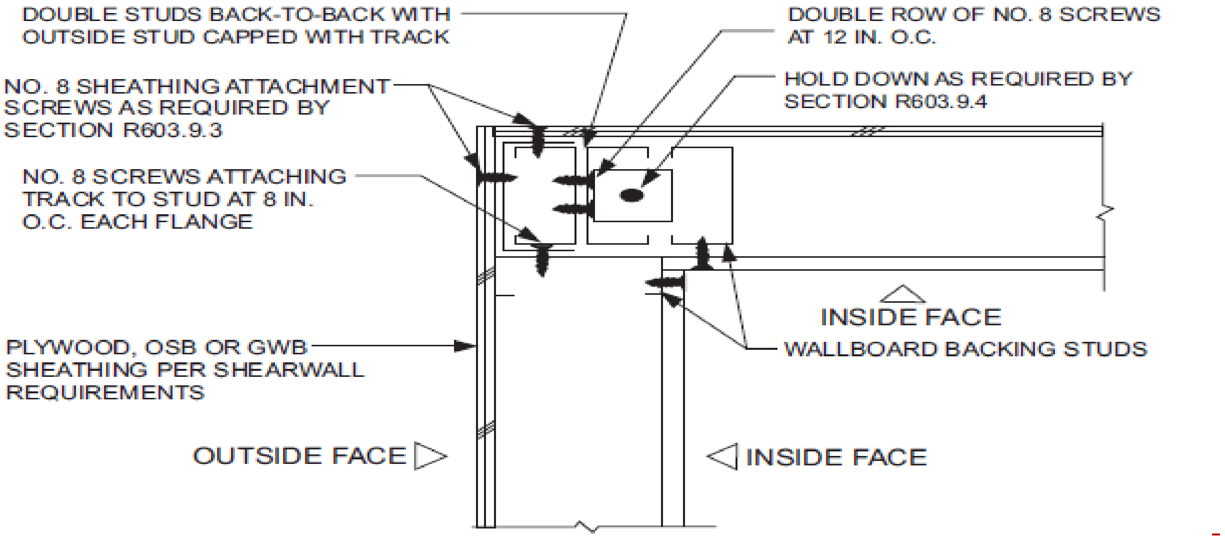
~~R603.9.4.1 Ultimate design wind speeds greater than 126 mph.~~

~~Where ultimate design wind speeds exceed 126 miles per hour (56 m/s), Exposure Category C walls shall be provided with direct uplift connections in accordance with AISI S230, Section E13.3, and AISI S230, Section F7.2, as required for 39 miles per hour (62 m/s), Exposure Category C.~~

~~R603.9.4.2 Hold-down anchor.~~

~~Where the percentage of full-height sheathing is adjusted in accordance with Section R603.9.2.2, a hold-down anchor, with a strength of 4,300 pounds (19 kN), shall be provided at each end of each full-height sheathed wall section used to meet the minimum percent sheathing requirements of Section R603.9.2. Hold-down anchors shall be attached to back-to-back studs; structural sheathing panels shall have edge fastening to the studs, in accordance with Section R603.9.3 and AISI S230, Table E11-1.~~

~~A single hold-down anchor, installed in accordance with Figure R603.9.4.2, shall be permitted at the corners of buildings.~~

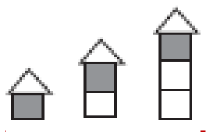
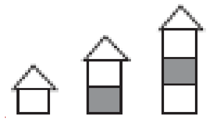


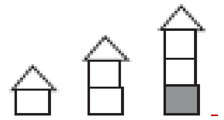
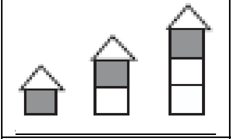
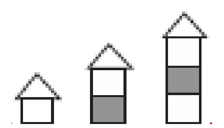
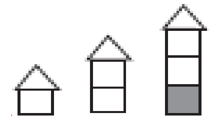
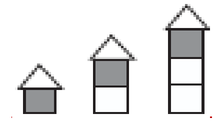
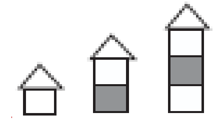
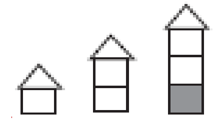
~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R603.9.4.2~~
~~CORNER STUD HOLD-DOWN DETAIL~~

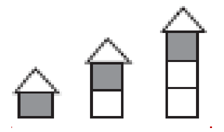
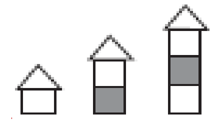
~~R603.9.5 Structural sheathing for stone and masonry veneer.~~ ~~Where stone and masonry veneer are installed in accordance with Section R703.8, the length of full-height sheathing for exterior and interior wall lines backing or perpendicular to and laterally supporting walls with veneer shall comply with this section.~~

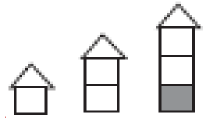
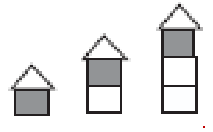
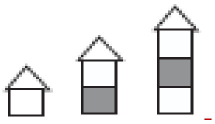
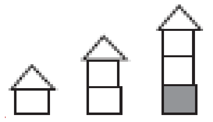
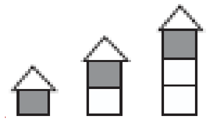
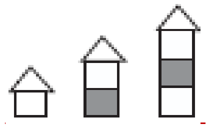
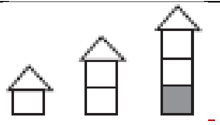
~~TABLE R603.9.5(1)~~
~~REQUIRED LENGTH OF FULL-HEIGHT SHEATHING AND ASSOCIATED OVERTURNING ANCHORAGE FOR WALLS SUPPORTING WALLS WITH STONE OR MASONRY VENEER AND USING 33-MIL COLD-FORMED STEEL FRAMING AND 6-INCH SCREW SPACING ON THE PERIMETER OF EACH PANEL OF STRUCTURAL SHEATHING~~

~~SEISMIC DESIGN CATEGORY~~	**~~STORY~~**	**~~BRACED WALL LINE LENGTH (feet)~~**						**~~SINGLE-STORY HOLD-DOWN FORCE (pounds)~~**	**~~CUMULATIVE HOLD-DOWN FORCE (pounds)~~**
		~~10~~	**~~20~~**	**~~30~~**	**~~40~~**	**~~50~~**	**~~60~~**		
		~~Minimum total length of braced wall panels required along each braced wall line (feet)~~							
~~D_0~~		~~3.3~~	~~4.7~~	~~6.1~~	~~7.4~~	~~8.8~~	~~10.2~~	~~3,360~~	~~—~~
		~~5.3~~	~~8.7~~	~~12.1~~	~~15.4~~	~~18.8~~	~~22.2~~	~~3,360~~	~~6,720~~

		~~7.3~~	~~12.7~~	~~18.0~~	~~23.4~~	~~28.8~~	~~34.2~~	~~3,360~~	~~10,080~~
~~D_1~~		~~4.1~~	~~5.8~~	~~7.5~~	~~9.2~~	~~10.9~~	~~12.7~~	~~3,360~~	~~—~~
		~~6.6~~	~~10.7~~	~~14.9~~	~~19.1~~	~~23.3~~	~~27.5~~	~~3,360~~	~~6,720~~
		~~9.0~~	~~15.7~~	~~22.4~~	~~29.0~~	~~35.7~~	~~42.2~~	~~3,360~~	~~10,080~~
~~D_2~~		~~5.7~~	~~8.2~~	~~10.6~~	~~13.0~~	~~15.4~~	~~17.8~~	~~3,360~~	~~—~~
		~~9.2~~	~~15.1~~	~~21.1~~	~~27.0~~	~~32.9~~	~~38.8~~	~~3,360~~	~~6,720~~
		~~12.7~~	~~22.1~~	~~31.5~~	~~40.9~~	~~50.3~~	~~59.7~~	~~3,360~~	~~10,080~~

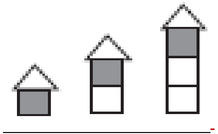
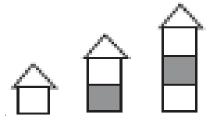
~~TABLE R603.9.5(2)~~
~~REQUIRED LENGTH OF FULL-HEIGHT SHEATHING AND ASSOCIATED OVERTURNING ANCHORAGE FOR WALLS SUPPORTING WALLS WITH STONE OR MASONRY VENEER AND USING 43-MIL COLD-FORMED STEEL FRAMING AND 6-INCH SCREW SPACING ON THE PERIMETER OF EACH PANEL OF STRUCTURAL SHEATHING~~

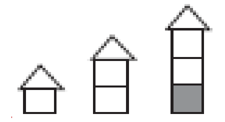
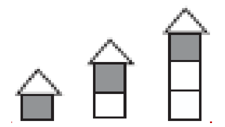
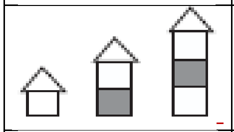
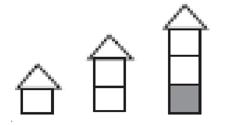
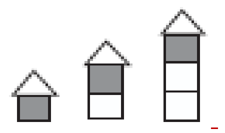
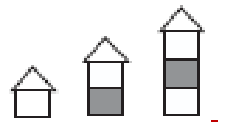
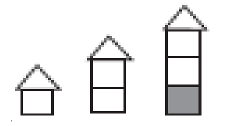
~~SEISMIC DESIGN CATEGORY~~	~~STORY~~	~~BRACED WALL LINE LENGTH (feet)~~						~~SINGLE-STORY HOLD-DOWN FORCE (pounds)~~	~~CUMULATIVE HOLD-DOWN FORCE (pounds)~~
		~~10~~	~~20~~	~~30~~	~~40~~	~~50~~	~~60~~		
		~~Minimum total length of braced wall panels required along each braced wall line (feet)~~							
~~D_0~~		~~2.8~~	~~4.0~~	~~5.1~~	~~6.3~~	~~7.5~~	~~8.7~~	~~3,960~~	~~—~~
		~~4.5~~	~~7.4~~	~~10.2~~	~~13.1~~	~~16.0~~	~~18.8~~	~~3,960~~	~~7,920~~

		~~6.2~~	~~10.7~~	~~15.3~~	~~19.9~~	~~24.4~~	~~29.0~~	~~3,960~~	~~11, 880~~
~~D_1~~		~~3.5~~	~~4.9~~	~~6.4~~	~~7.8~~	~~9.3~~	~~10.7~~	~~3,960~~	~~—~~
		~~5.6~~	~~9.1~~	~~12.7~~	~~16.2~~	~~19.8~~	~~23.3~~	~~3,960~~	~~7,920~~
		~~7.7~~	~~13.3~~	~~19.0~~	~~24.6~~	~~30.3~~	~~35.9~~	~~3,960~~	~~11, 880~~
~~D_2~~		~~4.9~~	~~6.9~~	~~9.0~~	~~11.0~~	~~13.1~~	~~15.1~~	~~3,960~~	~~—~~
		~~7.8~~	~~12.9~~	~~17.9~~	~~22.9~~	~~27.9~~	~~32.9~~	~~3,960~~	~~7,920~~
		~~10.8~~	~~18.8~~	~~26.7~~	~~34.7~~	~~42.7~~	~~50.7~~	~~3,960~~	~~11, 880~~

~~TABLE R603.9.5(3)~~

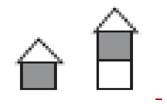
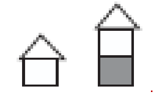
~~REQUIRED LENGTH OF FULL-HEIGHT SHEATHING AND ASSOCIATED OVERTURNING ANCHORAGE FOR WALLS SUPPORTING WALLS WITH STONE OR MASONRY VENEER AND USING 33-MIL COLD-FORMED STEEL FRAMING AND 4-INCH SCREW SPACING ON THE PERIMETER OF EACH PANEL OF STRUCTURAL SHEATHING~~

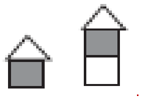
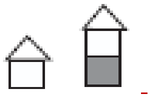
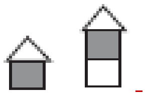
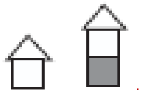
~~SEISMIC DESIGN CATEGORY~~	~~STORY~~	~~BRACED WALL LINE LENGTH (feet)~~						~~SINGLE-STORY HOLD-DOWN FORCE (pounds)~~	~~CUMULATIVE HOLD-DOWN FORCE (pounds)~~
		~~10~~	~~20~~	~~30~~	~~40~~	~~50~~	~~60~~		
		~~Minimum total length of braced wall panels required along each braced wall line (feet)~~							
~~D_0~~		~~2.5~~	~~3.6~~	~~4.6~~	~~5.7~~	~~6.8~~	~~7.8~~	~~4,392~~	~~—~~
		~~4.0~~	~~6.6~~	~~9.2~~	~~11.8~~	~~14.4~~	~~17.0~~	~~4,392~~	~~8,784~~

		~~5.6~~	~~9.7~~	~~13.8~~	~~17.9~~	~~22.0~~	~~26.2~~	~~4,392~~	~~13,176~~
~~D_1~~		~~3.1~~	~~4.4~~	~~5.7~~	~~7.1~~	~~8.4~~	~~9.7~~	~~4,392~~	~~—~~
		~~5.0~~	~~8.2~~	~~11.4~~	~~14.6~~	~~17.8~~	~~21.0~~	~~4,392~~	~~8,784~~
		~~6.9~~	~~12.0~~	~~17.1~~	~~22.2~~	~~27.3~~	~~32.4~~	~~4,392~~	~~13,176~~
~~D_2~~		~~4.4~~	~~6.2~~	~~8.1~~	~~10.0~~	~~11.8~~	~~13.7~~	~~4,392~~	~~—~~
		~~7.1~~	~~11.6~~	~~16.1~~	~~20.6~~	~~25.1~~	~~29.7~~	~~4,392~~	~~8,784~~
		~~9.7~~	~~16.9~~	~~24.1~~	~~31.3~~	~~38.5~~	~~45.7~~	~~4,392~~	~~13,176~~

~~TABLE R603.9.5(4)~~

~~REQUIRED LENGTH OF FULL-HEIGHT SHEATHING AND ASSOCIATED OVERTURNING ANCHORAGE FOR WALLS SUPPORTING WALLS WITH STONE OR MASONRY VENEER AND USING 43-MIL COLD-FORMED STEEL FRAMING AND 4-INCH SCREW SPACING ON THE PERIMETER OF EACH PANEL OF STRUCTURAL SHEATHING~~

~~SEISMIC DESIGN CATEGORY~~	~~STORY~~	~~BRACED WALL LINE LENGTH (feet)~~						~~SINGLE-STORY HOLD-DOWN FORCE (pounds)~~	~~CUMULATIVE HOLD-DOWN FORCE (pounds)~~
		~~10~~	~~20~~	~~30~~	~~40~~	~~50~~	~~60~~		
		~~Minimum total length of braced wall panels required along each braced wall line (feet)~~							
~~D_0~~		~~1.9~~	~~2.7~~	~~3.4~~	~~4.2~~	~~5.0~~	~~5.8~~	~~5,928~~	~~—~~
		~~3.0~~	~~4.9~~	~~6.8~~	~~8.8~~	~~10.7~~	~~12.6~~	~~5,928~~	~~11,856~~

~~D_1~~		~~2.3~~	~~3.3~~	~~4.3~~	~~5.2~~	~~6.2~~	~~7.2~~	~~5,928~~	~~—~~
		~~3.7~~	~~6.1~~	~~8.5~~	~~10.8~~	~~13.2~~	~~15.6~~	~~5,928~~	~~11,856~~
~~D_2~~		~~3.3~~	~~4.6~~	~~6.0~~	~~7.4~~	~~8.7~~	~~10.1~~	~~5,928~~	~~—~~
		~~5.2~~	~~8.6~~	~~11.9~~	~~15.3~~	~~18.6~~	~~22.0~~	~~5,928~~	~~11,856~~

~~R603.9.5.1 Seismic Design Category C.~~

~~In Seismic Design Category C, the length of structural sheathing for walls supporting one *story*, roof and ceiling shall be the greater of the amounts required by Section R603.9.2, except Section R603.9.2.2 shall be permitted.~~

~~R603.9.5.2 Seismic Design Categories D0, D1 and D2.~~

~~In Seismic Design Categories D_0, D_1 and D_2, the required length of structural sheathing and overturning anchorage shall be determined in accordance with Tables R603.9.5(1), R603.9.5(2), R603.9.5(3), and R603.9.5(4). Overturning anchorage shall be installed on the doubled studs at the end of each full-height wall segment.~~

SECTION R606
GENERAL MASONRY CONSTRUCTION

R606.1.1 Professional registration not required.

When the empirical design provisions of Appendix A of TMS 402/ACI 530/ASCE 5, the provisions of TMS 403, or the provisions of this section are used to design masonry, project drawings, typical details and specifications are not required to bear the seal of the ~~architect or engineer~~ *registered design professional* responsible for design, unless otherwise required by the state law of the *jurisdiction* having authority.

R606.2.6 Second hand units.

Second hand masonry units shall not be reused unless they conform to the requirements of new units. The units shall be of whole, sound materials and free from cracks and other defects that will interfere with proper laying or use. Old mortar shall be cleaned from the unit before reuse.

Exception: Second hand units are permitted to be used for interior nonbearing conditions.

R606.2.7.3 Masonry in Seismic Design Categories D0, D1 and D2. Deleted. ~~Mortar for masonry serving as the lateral-force-resisting system in Seismic Design Categories D_0, D_1 and D_2 shall be Type M or S Portland cement-lime or mortar cement mortar~~.

R606.3 Construction requirements.

R606.3.1 Bed and head joints.

Unless otherwise required or indicated on the project drawings, head and bed joints shall be $^{3}/_{8}$ inch (9.5 mm) thick, except that the thickness of the bed joint of the starting course placed over foundations shall be not less than $^{1}/_{4}$ inch (6.4 mm) and not more than 1 ½ ~~$^{3}/_{4}$~~ inch (~~19.1~~ 38 mm). Mortar joint thickness for load-bearing masonry shall be within the following tolerances from the specified dimensions:

1. Bed joint: + $^{1}/_{8}$ inch (3.2 mm).
2. Head joint: - $^{1}/_{4}$ inch (6.4 mm), + $^{3}/_{8}$ inch (9.5 mm).
3. Collar joints: - $^{1}/_{4}$ inch (6.4 mm), + $^{3}/_{8}$ inch (9.5 mm).

R606.3.7.2 Masonry laid in stack bond.

~~Where unit masonry is laid with less head joint offset than in Section R606.3.7.1, the minimum area of horizontal reinforcement placed in mortar bed joints or in bond beams spaced not more than 48 inches (1219 mm) apart shall be 0.0007 times the vertical cross-sectional area of the wall.~~ In unreinforced masonry where masonry units are laid in stack bond, longitudinal reinforcement consisting of not less than two continuous wires each with a minimum aggregate cross-sectional area of 0.017 square inch (11 mm^{2}) shall be provided in horizontal bed joints spaced not more than 16 inches (406 mm) on center vertically.

R606.4.4 Parapet walls.

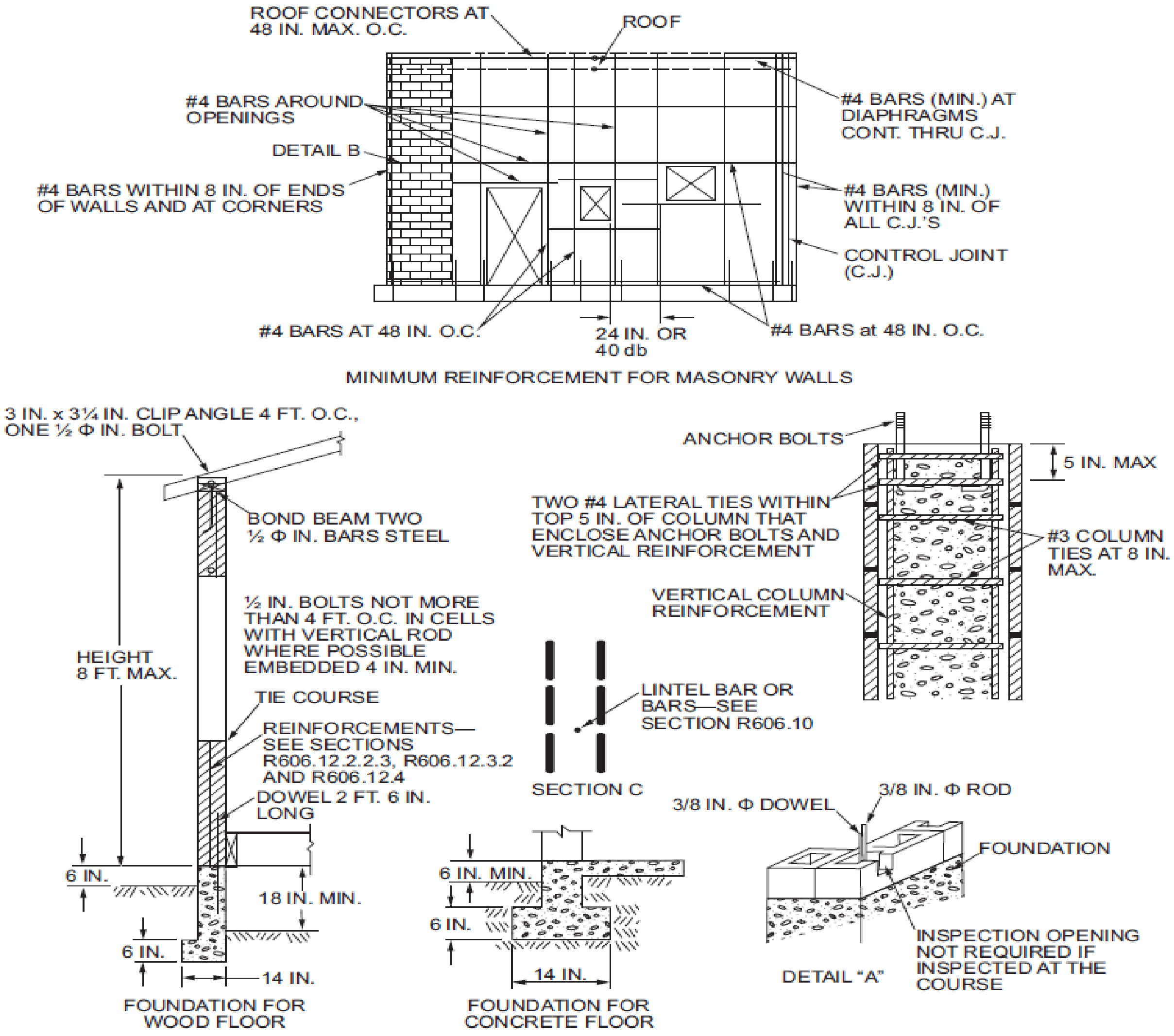
Unreinforced solid masonry parapet walls shall be not less than 8 inches (203 mm) thick and their height shall not exceed four times their thickness. Unreinforced hollow unit masonry parapet walls shall be not less than 8 inches (203 mm) thick, and their height shall not exceed three times their thickness. Masonry parapet walls in areas subject to wind loads of 30 pounds per square foot (1.44 kPa) ~~located in Seismic Design Category D_0, D_1 or D_2, or~~ on townhouses in Seismic Design Category C shall be reinforced in accordance with Section R606.12.

R606.7.1 Pier cap.

Hollow piers shall be capped with 4 inches (102 mm) of *solid masonry* or concrete~~, a masonry cap block, or shall have cavities of the top course filled with concrete or grout.~~ for one story and 8 inches (203 mm) of solid masonry or concrete for two story and two and one-half story or shall have cavities of the top course filled with concrete or grout or other *approved* methods.

R606.11 Anchorage.

Masonry walls shall be anchored to floor and roof systems in accordance with the details shown in Figure R606.11(1)~~,~~ or R606.11(2) ~~or R606.11(3)~~. Footings shall be permitted to be considered as points of lateral support.



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

Note:A full bed joint must be provided. Cells containing vertical bars are to be filled to the top of wall and provide inspection opening as shown on detail "A."

Horizontal bars are to be laid as shown on detail "B." Lintel bars are to be laid as shown on Section C.

~~**FIGURE R606.11(3)**~~

~~**REQUIREMENTS FOR REINFORCED MASONRY CONSTRUCTION IN SEISMIC DESIGN CATEGORY D_0, D_1 OR D_2**~~

R606.12 Seismic requirements.

~~The seismic requirements of this section shall apply to the design of masonry and the construction of masonry building elements located in Seismic Design Category D_0, D_1 or D_2.~~

Townhouses in Seismic Design Category C shall comply with the requirements of Section R606.12.2. These requirements shall not apply to glass unit masonry conforming to Section

~~R610~~ R607, anchored masonry veneer conforming to Section R703.8 or adhered masonry veneer conforming to Section R703.12.

R606.12.1 General.

Masonry structures and masonry elements shall comply with the requirements of Sections R606.12.2 ~~through R606.12.4~~ based on the seismic design category established in Table R301.2(1). Masonry structures and masonry elements shall comply with the requirements of Section R606.12 and Figures R606.11(1)~~,~~ and R606.11(2) ~~and R606.11(3)~~ or shall be designed in accordance with TMS 402/ACI 530/ASCE 5 or TMS 403.

R606.12.1.1 Floor and roof diaphragm construction.

Floor and roof *diaphragms* shall be constructed of wood structural panels attached to wood framing in accordance with Table R602.3(1) ~~or to cold-formed steel floor framing in accordance with Table R505.3.1(2) or to cold-formed steel roof framing in accordance with Table R804.3~~. Additionally, sheathing panel edges perpendicular to framing members shall be backed by blocking, and sheathing shall be connected to the blocking with fasteners at the edge spacing. For Seismic Design Category~~ies~~ C~~, D_0, D_1 and D_2,~~ where the width-to-thickness dimension of the *diaphragm* exceeds 2-to-1, edge spacing of fasteners shall be 4 inches (102 mm) on center.

TABLE R606.12.2.1
MINIMUM SOLID WALL LENGTH ALONG EXTERIOR WALL LINES

SESIMIC DESIGN CATEGORY	MINIMUM SOLID WALL LENGTH (percent)[a]		
	One story or top story of two story	Wall supporting light-framed second story and roof	Wall supporting masonry second story and roof
Townhouses in C	20	25	35
~~D_0 or D_1~~	~~25~~	~~NP~~	~~NP~~
~~D_2~~	~~30~~	~~NP~~	~~NP~~

NP = Not permitted, except with design in accordance with the *International Building Code*.

a. For all walls, the minimum required length of solid walls shall be based on the table percent multiplied by the dimension, parallel to the wall direction under consideration, of a rectangle inscribing the overall building plan.

R606.12.3 Seismic Design Category D0 or D1. Deleted.

~~Structures in Seismic Design Category D_0 or D_1 shall comply with the requirements of Seismic Design Category C and the additional requirements of this section. AAC masonry shall not be used for the design of masonry elements that are part of the lateral force-resisting system.~~

~~R606.12.3.1 Design requirements.~~

~~Masonry elements other than those covered by Section R606.12.2.2.2 shall be designed in accordance with the requirements of Chapters 1 through 7 and Sections 8.1 and 8.3 of TMS 402, ACI 530/ASCE 5 and shall meet the minimum reinforcement requirements~~

~~contained in Sections R606.12.3.2 and R606.12.3.2.1. Otherwise, masonry shall be designed in accordance with TMS 403.~~

> ~~**Exception:** Masonry walls limited to one *story* in height and 9 feet (2743 mm) between lateral supports need not be designed provided they comply with the minimum reinforcement requirements of Sections R606.12.3.2 and R606.12.3.2.1.~~

~~**R606.12.3.2 Minimum reinforcement requirements for masonry walls.**~~
~~Masonry walls other than those covered by Section R606.12.2.2.3 shall be reinforced in both the vertical and horizontal direction. The sum of the cross-sectional area of horizontal and vertical reinforcement shall be not less than 0.002 times the gross cross-sectional area of the wall, and the minimum cross-sectional area in each direction shall be not less than 0.0007 times the gross cross-sectional area of the wall. Reinforcement shall be uniformly distributed. Table R606.12.3.2 shows the minimum reinforcing bar sizes required for varying thicknesses of masonry walls. The maximum spacing of reinforcement shall be 48 inches (1219 mm) provided that the walls are solid grouted and constructed of hollow open-end units, hollow units laid with full head joints or two wythes of solid units. The maximum spacing of reinforcement shall be 24 inches (610 mm) for all other masonry.~~

~~TABLE R606.12.3.2~~
~~MINIMUM DISTRIBUTED WALL REINFORCEMENT FOR BUILDINGS ASSIGNED TO SEISMIC DESIGN CATEGORY D_0 or D_1~~

~~NOMINAL WALL THICKNESS (inches)~~	~~MINIMUM SUM OF THE VERTICAL AND HORIZONTAL REINFORCEMENT AREAS[a] (square inches per foot)~~	~~MINIMUM REINFORCEMENT AS DISTRIBUTED IN BOTH HORIZONTAL AND VERTICAL DIRECTIONS[b] (square inches per foot)~~	~~MINUMUM BAR SIZE FOR REINFORCEMENT SPACED AT 48 INCHES~~
~~6~~	~~0.135~~	~~0.047~~	~~#4~~
~~8~~	~~0.183~~	~~0.064~~	~~#5~~
~~10~~	~~0.231~~	~~0.081~~	~~#6~~
~~12~~	~~0.279~~	~~0.098~~	~~#6~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square inch per foot = 2064 mm^2/m.~~
~~a. Based on the minimum reinforcing ratio of 0.002 times the gross cross-sectional area of the wall.~~
~~b. Based on the minimum reinforcing ratio each direction of 0.0007 times the gross cross-sectional area of the wall.~~

> ~~**R606.12.3.2.1 Shear wall reinforcement requirements.**~~
> ~~The maximum spacing of vertical and horizontal reinforcement shall be the smaller of one-third the length of the shear wall, one-third the height of the shear wall, or 48 inches (1219 mm). The minimum cross-sectional area of vertical reinforcement shall be one-third of the required shear reinforcement. Shear reinforcement shall be anchored around vertical reinforcing bars with a standard hook.~~

~~R606.12.3.3 Minimum reinforcement for masonry columns.~~

~~Lateral ties in masonry columns shall be spaced not more than 8 inches (203 mm) on center and shall be not less than $^3/_8$-inch (9.5 mm) diameter. Lateral ties shall be embedded in grout.~~

~~R606.12.3.4 Material restrictions.~~

~~Type N mortar or masonry cement shall not be used as part of the lateral force-resisting system.~~

~~R606.12.3.5 Lateral tie anchorage.~~

~~Standard hooks for lateral tie anchorage shall be either a 135-degree (2.4 rad) standard hook or a 180-degree (3.2 rad) standard hook.~~

R606.12.4 Seismic Design Category D2. Deleted.

~~Structures in Seismic Design Category D_2 shall comply with the requirements of Seismic Design Category D_1 and to the additional requirements of this section.~~

~~R606.12.4.1 Design of elements not part of the lateral force-resisting system.~~

~~Stack bond masonry that is not part of the lateral force-resisting system shall have a horizontal cross-sectional area of reinforcement of not less than 0.0015 times the gross cross-sectional area of masonry. Table R606.12.4.1 shows minimum reinforcing bar sizes for masonry walls. The maximum spacing of horizontal reinforcement shall be 24 inches (610 mm). These elements shall be solidly grouted and shall be constructed of hollow open-end units or two wythes of solid units.~~

~~TABLE R606.12.4.1~~
~~MINIMUM REINFORCING FOR STACKED BONDED~~
~~MASONRY WALLS IN SEISMIC DESIGN CATEGORY D_2~~

~~NOMINAL WALL THICKNESS (inches)~~	~~MINIMUM BAR SIZE SPACED AT 24 INCHES~~
~~6~~	~~#4~~
~~8~~	~~#5~~
~~10~~	~~#5~~
~~12~~	~~#6~~

~~For SI: 1 inch = 25.4 mm.~~

~~R606.12.4.2 Design of elements part of the lateral force-resisting system.~~

~~Stack bond masonry that is part of the lateral force-resisting system shall have a horizontal cross-sectional area of reinforcement of not less than 0.0025 times the gross cross-sectional area of masonry. Table R606.12.4.2 shows minimum reinforcing bar sizes for masonry walls. The maximum spacing of horizontal reinforcement shall be 16 inches (406 mm). These elements shall be solidly grouted and shall be constructed of hollow open-end units or two wythes of solid units.~~

~~TABLE R606.12.4.2~~
~~MINIMUM REINFORCING FOR STACKED BONDED~~

~~MASONRY WALLS IN SEISMIC DESIGN CATEGORY D_2~~

~~NOMINAL WALL THICKNESS (inches)~~	~~MINIMUM BAR SIZE SPACED AT 16 INCHES~~
~~6~~	~~#4~~
~~8~~	~~#5~~
~~10~~	~~#5~~
~~12~~	~~#6~~

~~For SI: 1 inch = 25.4 mm.~~

R606.14 Anchored and adhered masonry veneer.

R606.14.1 Anchored veneer.
Anchored masonry veneer installed over a backing of wood ~~or cold-formed steel~~ shall meet the requirements of Section R703.8.

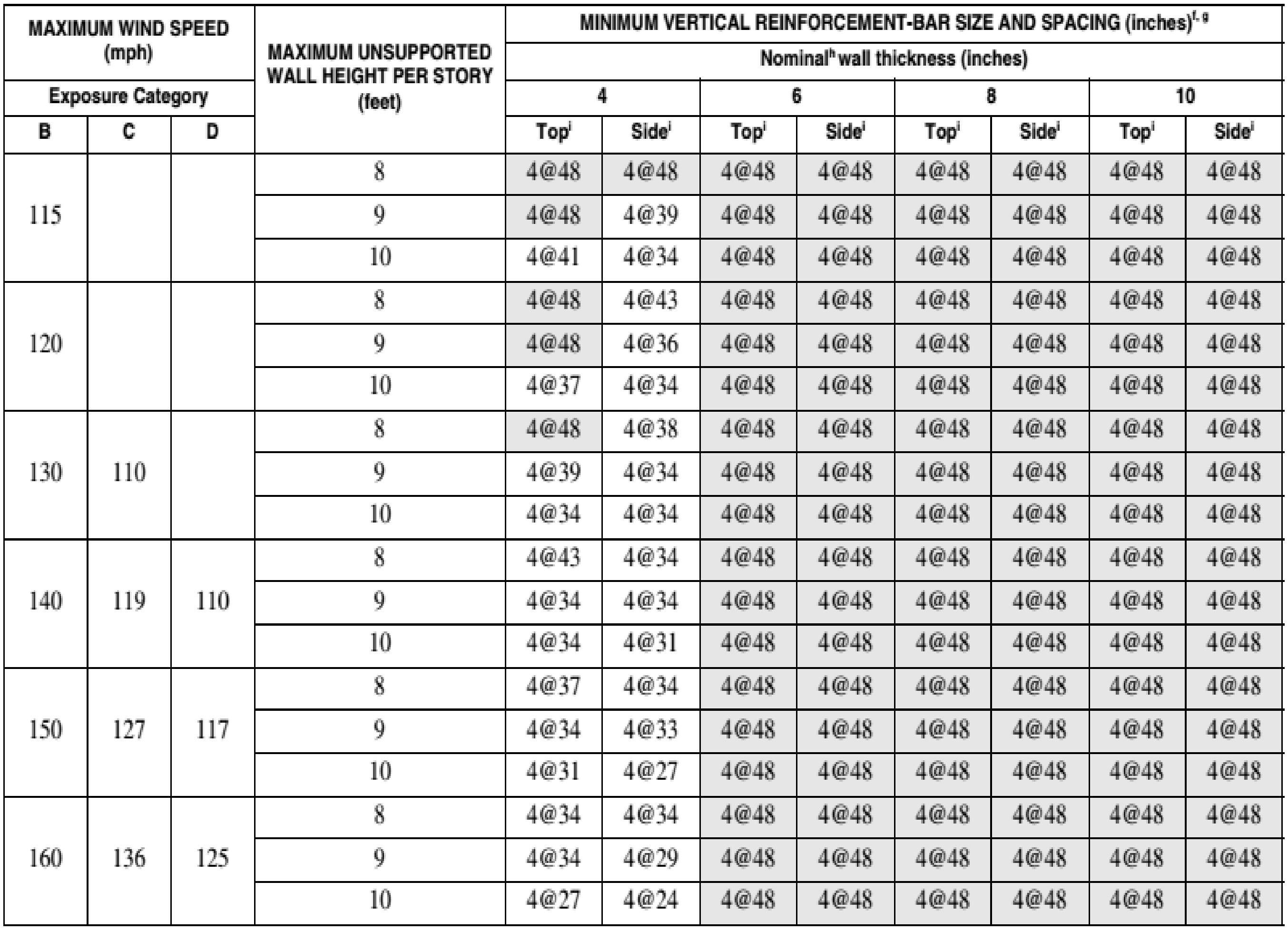
SECTION R608
EXTERIOR CONCRETE WALL CONSTRUCTION

R608.1 General.
Exterior concrete walls shall be designed and constructed in accordance with the provisions of this section or in accordance with the provisions of PCA 100 or ACI 318. Where PCA 100, ACI 318 or the provisions of this section are used to design concrete walls, project drawings, typical details and specifications are not required to bear the seal of the ~~architect or engineer responsible for design~~ *registered design professional*, unless otherwise required by the state law of the jurisdiction having authority.

R608.5.2.3 Sheet steel angles and tension tie straps.
Angles and tension tie straps for use with connection details in accordance with Figures R608.9(1) through R608.9(6) ~~R608.9(12)~~ shall be fabricated from sheet steel complying with ASTM A 653 SS, ASTM A 792 SS, or ASTM A 875 SS. The steel shall be minimum Grade 33 unless a higher grade is required by the applicable figure.

TABLE R608.6(1)

MINIMUM VERTICAL REINFORCEMENT FOR FLAT ABOVE-GRADE WALLS[a, b, c, d, e]



MAXIMUM WIND SPEED (mph)			MAXIMUM UNSUPPORTED WALL HEIGHT PER STORY (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)[f, g]							
				Nominal[h] wall thickness (inches)							
Exposure Category				4		6		8		10	
B	C	D		Top[i]	Side[i]	Top[i]	Side[i]	Top[i]	Side[i]	Top[i]	Side[i]
115			8	4@48	4@48	4@48	4@48	4@48	4@48	4@48	4@48
			9	4@48	4@39	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@41	4@34	4@48	4@48	4@48	4@48	4@48	4@48
120			8	4@48	4@43	4@48	4@48	4@48	4@48	4@48	4@48
			9	4@48	4@36	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@37	4@34	4@48	4@48	4@48	4@48	4@48	4@48
130	110		8	4@48	4@38	4@48	4@48	4@48	4@48	4@48	4@48
			9	4@39	4@34	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@34	4@34	4@48	4@48	4@48	4@48	4@48	4@48
140	119	110	8	4@43	4@34	4@48	4@48	4@48	4@48	4@48	4@48
			9	4@34	4@34	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@34	4@31	4@48	4@48	4@48	4@48	4@48	4@48
150	127	117	8	4@37	4@34	4@48	4@48	4@48	4@48	4@48	4@48
			9	4@34	4@33	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@31	4@27	4@48	4@48	4@48	4@48	4@48	4@48
160	136	125	8	4@34	4@34	4@48	4@48	4@48	4@48	4@48	4@48
			9	4@34	4@29	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@27	4@24	4@48	4@48	4@48	4@48	4@48	4@48

For SI: 61 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound per square inch = 1.895 kPa, 1 square foot = 0.0929 m^2.

a. Table is based on ASCE 7 components and cladding wind pressures for an enclosed building using a mean roof height of 35 feet, interior wall area 4, an effective wind area of 10 square feet, topographic factor, K_{zt}, equal to 1.0, and Risk Category II.

b. Table is based on concrete with a minimum specified compressive strength of 2,500 psi.

c. See Section R608.6.5 for location of reinforcement in wall.

d. Deflection criterion is *L*/240, where *L* is the unsupported height of the wall in inches.

e. Interpolation is not permitted.

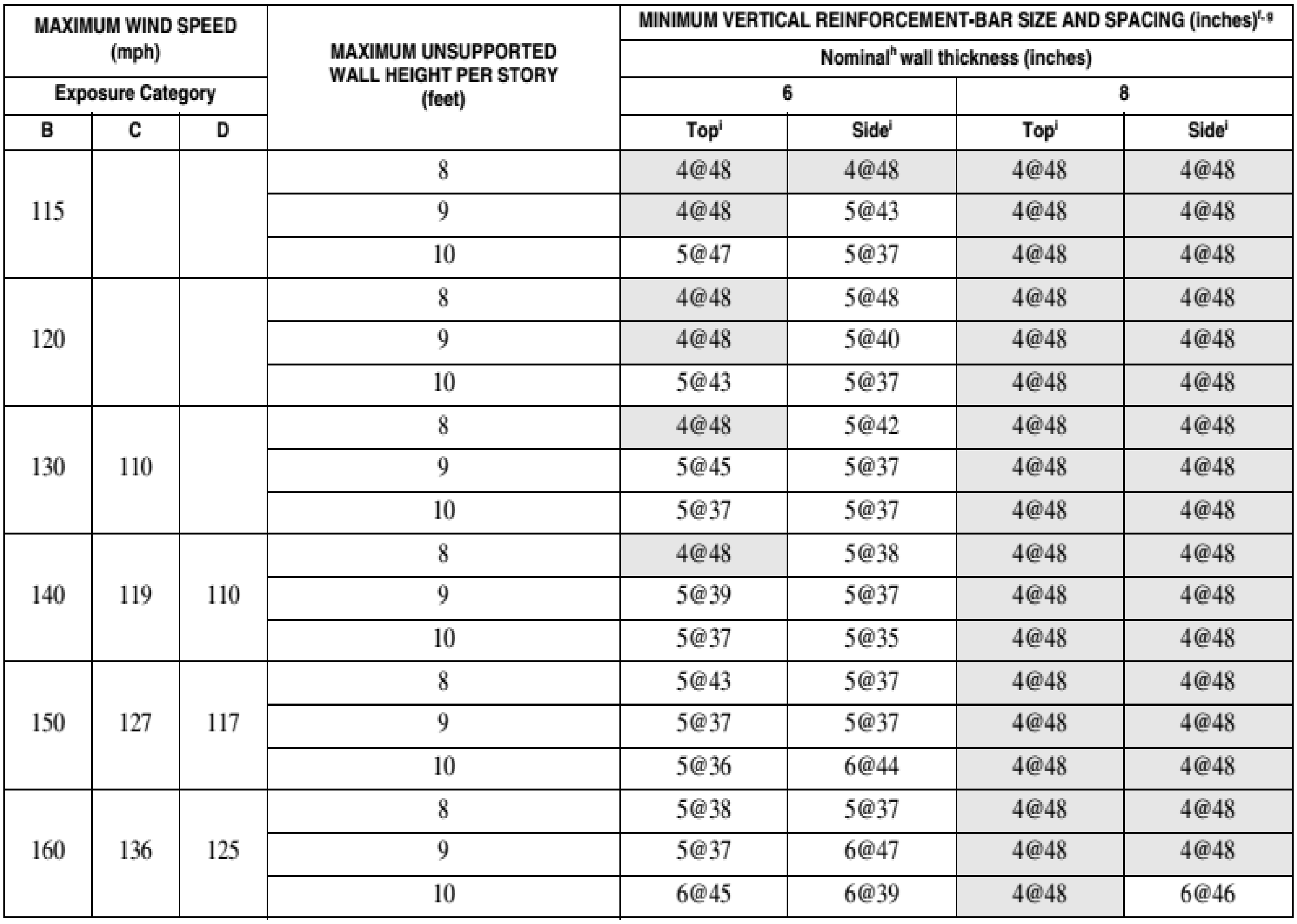
f. Where No. 4 reinforcing bars at a spacing of 48 inches are specified in the table as indicated by shaded cells, use of bars with a minimum yield strength of 40,000 psi or 60,000 psi is permitted.

g. Other than for No. 4 bars spaced at 48 inches on center, table values are based on reinforcing bars with a minimum yield strength of 60,000 psi. Vertical reinforcement with a yield strength of less than 60,000 psi or bars of a different size than specified in the table are permitted in accordance with Section R608.5.4.7 and Table R608.5.4(2).

h. See Table R608.3 for tolerances on nominal thicknesses.

i. “Top” means gravity load from roof or floor construction bears on top of wall. “Side” means gravity load from floor construction is transferred to wall from a wood ledger ~~or cold-formed steel track~~ bolted to side of wall. For nonload-bearing walls where floor framing members span parallel to the wall, use of the “Top” bearing condition is permitted.

TABLE R608.6(2)
MINIMUM VERTICAL REINFORCEMENT FOR WAFFLE-GRID ABOVE-GRADE WALLS[a, b, c, d, e]



MAXIMUM WIND SPEED (mph)			MAXIMUM UNSUPPORTED WALL HEIGHT PER STORY (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)[f, g]			
Exposure Category				Nominal[h] wall thickness (inches)			
				6		8	
B	C	D		Top[i]	Side[i]	Top[i]	Side[i]
115			8	4@48	4@48	4@48	4@48
			9	4@48	5@43	4@48	4@48
			10	5@47	5@37	4@48	4@48
120			8	4@48	5@48	4@48	4@48
			9	4@48	5@40	4@48	4@48
			10	5@43	5@37	4@48	4@48
130	110		8	4@48	5@42	4@48	4@48
			9	5@45	5@37	4@48	4@48
			10	5@37	5@37	4@48	4@48
140	119	110	8	4@48	5@38	4@48	4@48
			9	5@39	5@37	4@48	4@48
			10	5@37	5@35	4@48	4@48
150	127	117	8	5@43	5@37	4@48	4@48
			9	5@37	5@37	4@48	4@48
			10	5@36	6@44	4@48	4@48
160	136	125	8	5@38	5@37	4@48	4@48
			9	5@37	6@47	4@48	4@48
			10	6@45	6@39	4@48	6@46

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound per square inch = 6.895 kPa, 1 square foot = 0.0929 m2.

a. Table is based on ASCE 7 components and cladding wind pressures for an enclosed building using a mean roof height of 35 feet,interior wall area 4, an effective wind area of 10 square feet, topographic factor,Kzt , equal to 1.0, and Risk Category II.

b. Table is based on concrete with a minimum specified compressive strength of 2,500 psi.

c. See Section R608.6.5 for location of reinforcement in wall.

d. Deflection criterion is L/240, where Lis the unsupported height of the wall in inches.

e. Interpolation is not permitted.

f. Where No. 4 reinforcing bars at a spacing of 48 inches are specified in the table as indicated by shaded cells, use of bars with a minimum yield strength of 40,000 psi or 60,000 psi is permitted.

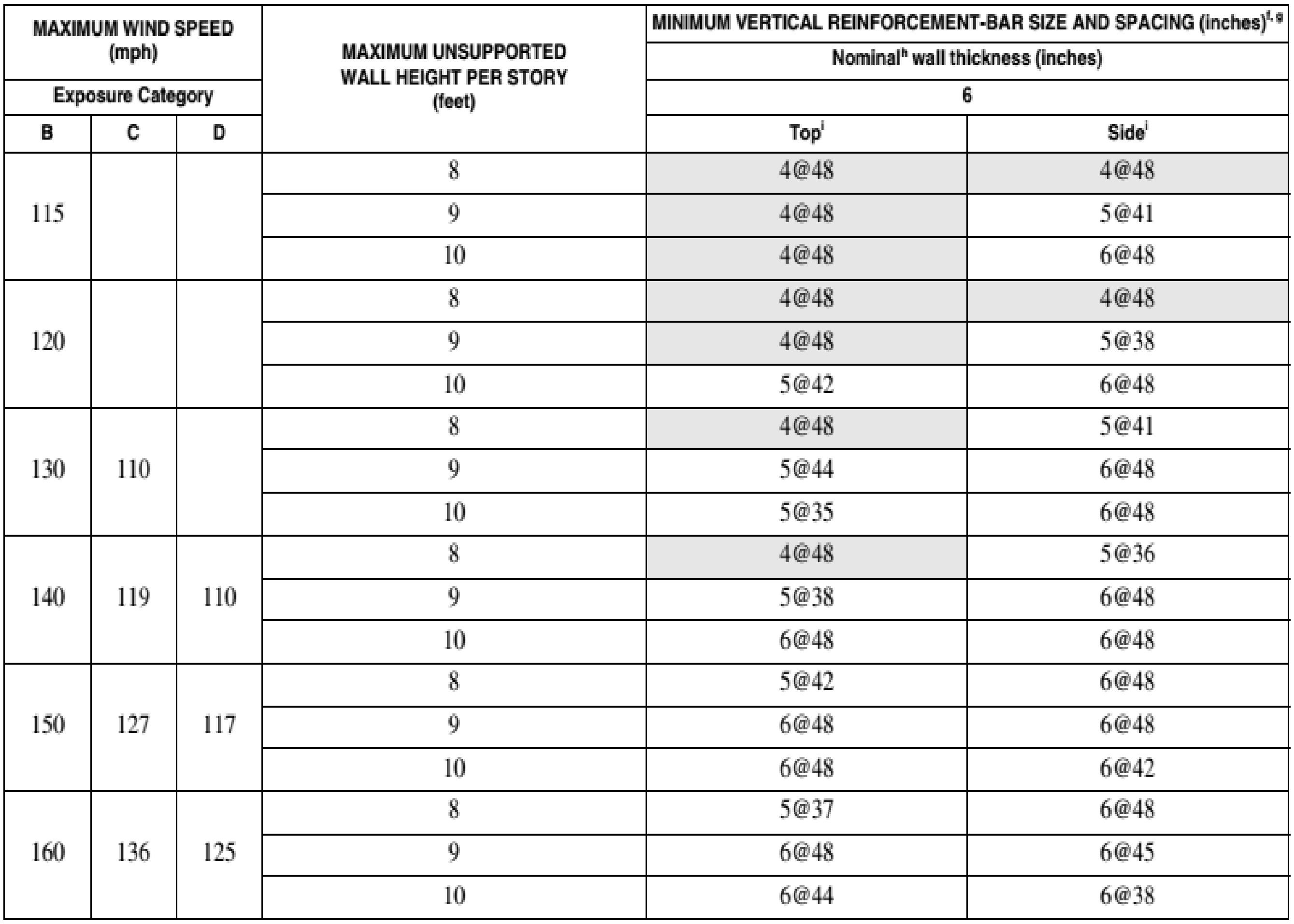
g. Other than for No. 4 bars spaced at 48 inches on center, table values are based on reinforcing bars with a minimum yield strength of 60,000 psi. Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches such as, 12, 24, 36 and 48, that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi or bars of a different size than specified in the table are permitted in accordance with Section R608.5.4.7 and Table R608.5.4(2).

h. See Table R608.3 for minimum core dimensions and maximum spacing of horizontal and vertical cores.

i. “Top” means gravity load from roof or floor construction bears on top of wall. “Side” means gravity load from floor construction is transferred to wall from a wood ledger ~~or cold-formed steel track~~ bolted to side of wall.

For nonload-bearing walls and where floor framing members span parallel to the wall, the “top” bearing condition is permitted to be used.

TABLE R608.6(3)
MINIMUM VERTICAL REINFORCEMENT FOR 6-INCH SCREEN-GRID ABOVE-GRADE WALLS[a, b, c, d, e]



MAXIMUM WIND SPEED (mph)			MAXIMUM UNSUPPORTED WALL HEIGHT PER STORY (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)[f, g]	
Exposure Category				Nominal[h] wall thickness (inches)	
				6	
B	C	D		Top[i]	Side[i]
115			8	4@48	4@48
			9	4@48	5@41
			10	4@48	6@48
120			8	4@48	4@48
			9	4@48	5@38
			10	5@42	6@48
130	110		8	4@48	5@41
			9	5@44	6@48
			10	5@35	6@48
140	119	110	8	4@48	5@36
			9	5@38	6@48
			10	6@48	6@48
150	127	117	8	5@42	6@48
			9	6@48	6@48
			10	6@48	6@42
160	136	125	8	5@37	6@48
			9	6@48	6@45
			10	6@44	6@38

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound per square inch = 6.895 kPa, 1 square foot = 0.0929 m^2.

a. Table is based on ASCE 7 components and cladding wind pressures for an enclosed building using a mean roof height of 35 feet, interior wall area 4, an effective wind area of 10 square feet, topographic factor, K_{zt}, equal to 1.0, and Risk Category II.

b. Table is based on concrete with a minimum specified compressive strength of 2,500 psi.

c. See Section R608.6.5 for location of reinforcement in wall.

d. Deflection criterion is *L*/240, where *L* is the unsupported height of the wall in inches.

e. Interpolation is not permitted.

f. Where No. 4 reinforcing bars at a spacing of 48 inches are specified in the table as indicated by shaded cells, use of bars with a minimum yield strength of 40,000 psi or 60,000 psi is permitted.

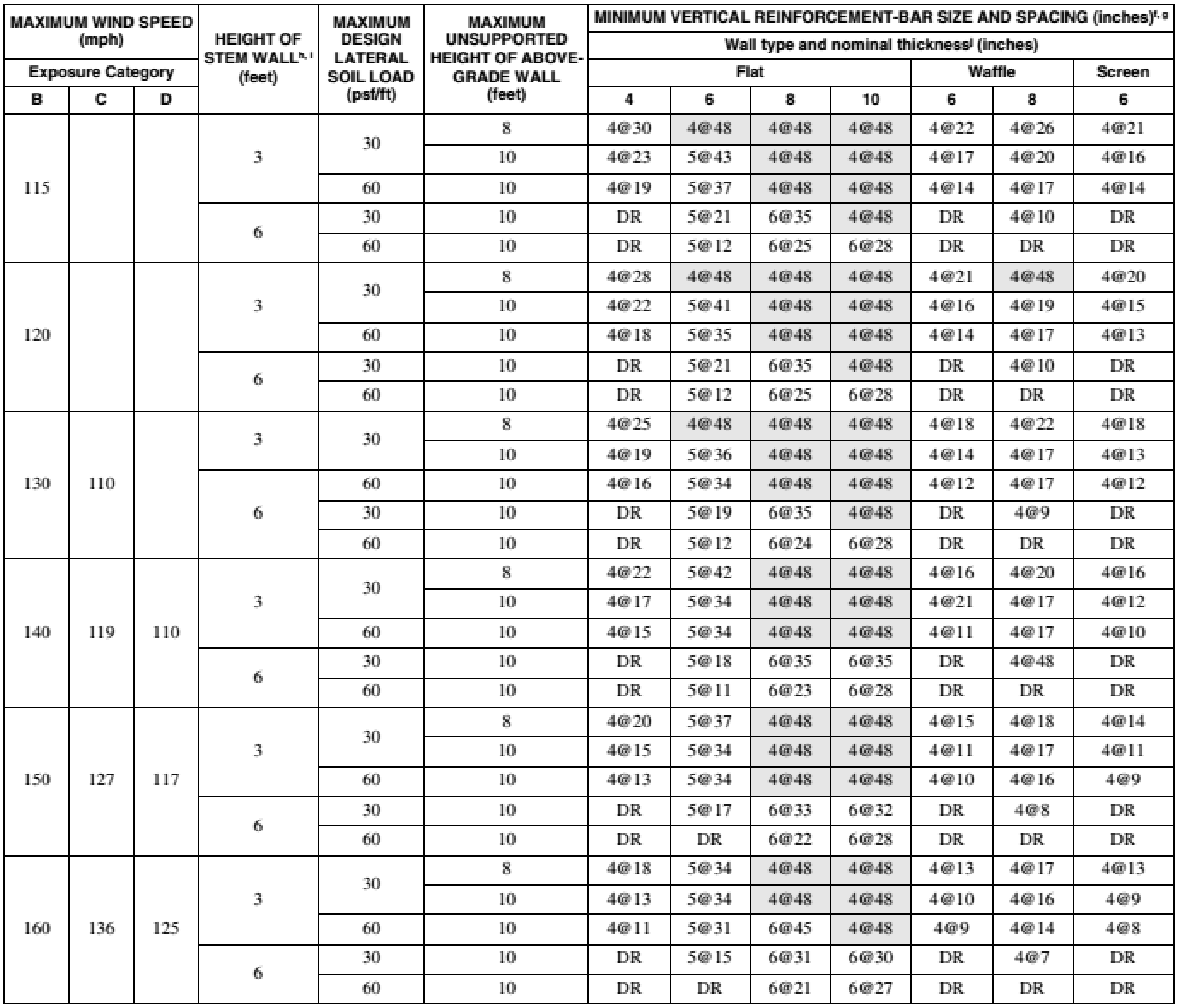
g. Other than for No. 4 bars spaced at 48 inches on center, table values are based on reinforcing bars with a minimum yield strength of 60,000 psi. Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches such as, 12, 24, 36 and 48, that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi or bars of a different size than specified in the table are permitted in accordance with Section R608.5.4.7 and Table R608.5.4(2).

h. See Table R608.3 for minimum core dimensions and maximum spacing of horizontal and vertical cores.

i. "Top" means gravity load from roof or floor construction bears on top of wall. "Side" means gravity load from floor construction is transferred to wall from a wood ledger ~~or cold-formed steel track~~ bolted to side of wall. For nonload-bearing wall and where floor framing members span parallel to the wall, use of the "Top" bearing condition is permitted.

TABLE R608.6(4)

MINIMUM VERTICAL REINFORCEMENT FOR FLAT, WAFFLE- AND SCREEN-GRID ABOVE-GRADE WALLS DESIGNED CONTINUOUS WITH FOUNDATION STEM WALLS[a, b, c, d, e, k, l]



MAXIMUM WIND SPEED (mph)			HEIGHT OF STEM WALL[h, i] (feet)	MAXIMUM DESIGN LATERAL SOIL LOAD (psf/ft)	MAXIMUM UNSUPPORTED HEIGHT OF ABOVE-GRADE WALL (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)[f, g]						
Exposure Category						Wall type and nominal thickness[j] (inches)						
						Flat				Waffle		Screen
B	C	D				4	6	8	10	6	8	6
115			3	30	8	4@30	4@48	4@48	4@48	4@22	4@26	4@21
					10	4@23	5@43	4@48	4@48	4@17	4@20	4@16
				60	10	4@19	5@37	4@48	4@48	4@14	4@17	4@14
			6	30	10	DR	5@21	6@35	4@48	DR	4@10	DR
				60	10	DR	5@12	6@25	6@28	DR	DR	DR
120			3	30	8	4@28	4@48	4@48	4@48	4@21	4@48	4@20
					10	4@22	5@41	4@48	4@48	4@16	4@19	4@15
				60	10	4@18	5@35	4@48	4@48	4@14	4@17	4@13
			6	30	10	DR	5@21	6@35	4@48	DR	4@10	DR
				60	10	DR	5@12	6@25	6@28	DR	DR	DR
130	110		3	30	8	4@25	4@48	4@48	4@48	4@18	4@22	4@18
					10	4@19	5@36	4@48	4@48	4@14	4@17	4@13
			6	60	10	4@16	5@34	4@48	4@48	4@12	4@17	4@12
				30	10	DR	5@19	6@35	4@48	DR	4@9	DR
				60	10	DR	5@12	6@24	6@28	DR	DR	DR
140	119	110	3	30	8	4@22	5@42	4@48	4@48	4@16	4@20	4@16
					10	4@17	5@34	4@48	4@48	4@21	4@17	4@12
				60	10	4@15	5@34	4@48	4@48	4@11	4@17	4@10
			6	30	10	DR	5@18	6@35	6@35	DR	4@48	DR
				60	10	DR	5@11	6@23	6@28	DR	DR	DR
150	127	117	3	30	8	4@20	5@37	4@48	4@48	4@15	4@18	4@14
					10	4@15	5@34	4@48	4@48	4@11	4@17	4@11
				60	10	4@13	5@34	4@48	4@48	4@10	4@16	4@9
			6	30	10	DR	5@17	6@33	6@32	DR	4@8	DR
				60	10	DR	DR	6@22	6@28	DR	DR	DR
160	136	125	3	30	8	4@18	5@34	4@48	4@48	4@13	4@17	4@13
					10	4@13	5@34	4@48	4@48	4@10	4@16	4@9
				60	10	4@11	5@31	6@45	4@48	4@9	4@14	4@8
			6	30	10	DR	5@15	6@31	6@30	DR	4@7	DR
				60	10	DR	DR	6@21	6@27	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound per square inch = 6.895 kPa, 1 square foot = 0.0929 m^2.

a. Table is based on ASCE 7 components and cladding wind pressures for an enclosed building using a mean roof height of 35 feet, interior wall area 4, an effective wind area of 10 square feet, topographic factor, K_{zt}, equal to 1.0, and Risk Category II.
b. Table is based on concrete with a minimum specified compressive strength of 2,500 psi.
c. See Section R608.6.5 for location of reinforcement in wall.
d. Deflection criterion is *L*/240, where *L* is the height of the wall in inches from the exterior finish ground level to the top of the above-grade wall.
e. Interpolation is not permitted. For intermediate values of basic wind speed, heights of stem wall and above-grade wall, and design lateral soil load, use next higher value.
f. Where No. 4 reinforcing bars at a spacing of 48 inches are specified in the table as indicated by shaded cells, use of bars with a minimum yield strength of 40,000 psi or 60,000 psi is permitted.
g. Other than for No. 4 bars spaced at 48 inches on center, table values are based on reinforcing bars with a minimum yield strength of 60,000 psi. Maximum spacings shown are the values calculated for the specified bar size. In waffle and screen-grid walls where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches such as, 12, 24, 36 and 48, that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and/or bars of a different size than specified in the table are permitted in accordance with Section R608.5.4.7 and Table R608.5.4(2).
h. Height of stem wall is the distance from the exterior finish ground level to the top of the slab-on-ground.
i. Where the distance from the exterior finish ground level to the top of the slab-on-ground is equal to or greater than 4 feet, the stem wall shall be laterally supported at the top and bottom before backfilling. Where the wall is designed and constructed to be continuous with the above-grade wall, temporary supports bracing the top of the stem wall shall remain in place until the above-grade wall is laterally supported at the top by floor or roof construction.
j. See Table R608.3 for tolerances on nominal thicknesses, and minimum core dimensions and maximum spacing of horizontal and vertical cores for waffle- and screen-grid walls.
k. Tabulated values are applicable to construction where gravity loads bear on top of wall, and conditions where gravity loads from floor construction are transferred to wall from a wood ledger ~~or cold-formed steel track~~ bolted to side of wall. See Tables R608.6(1), R608.6(2) and R608.6(3).
l. DR = Design Required.

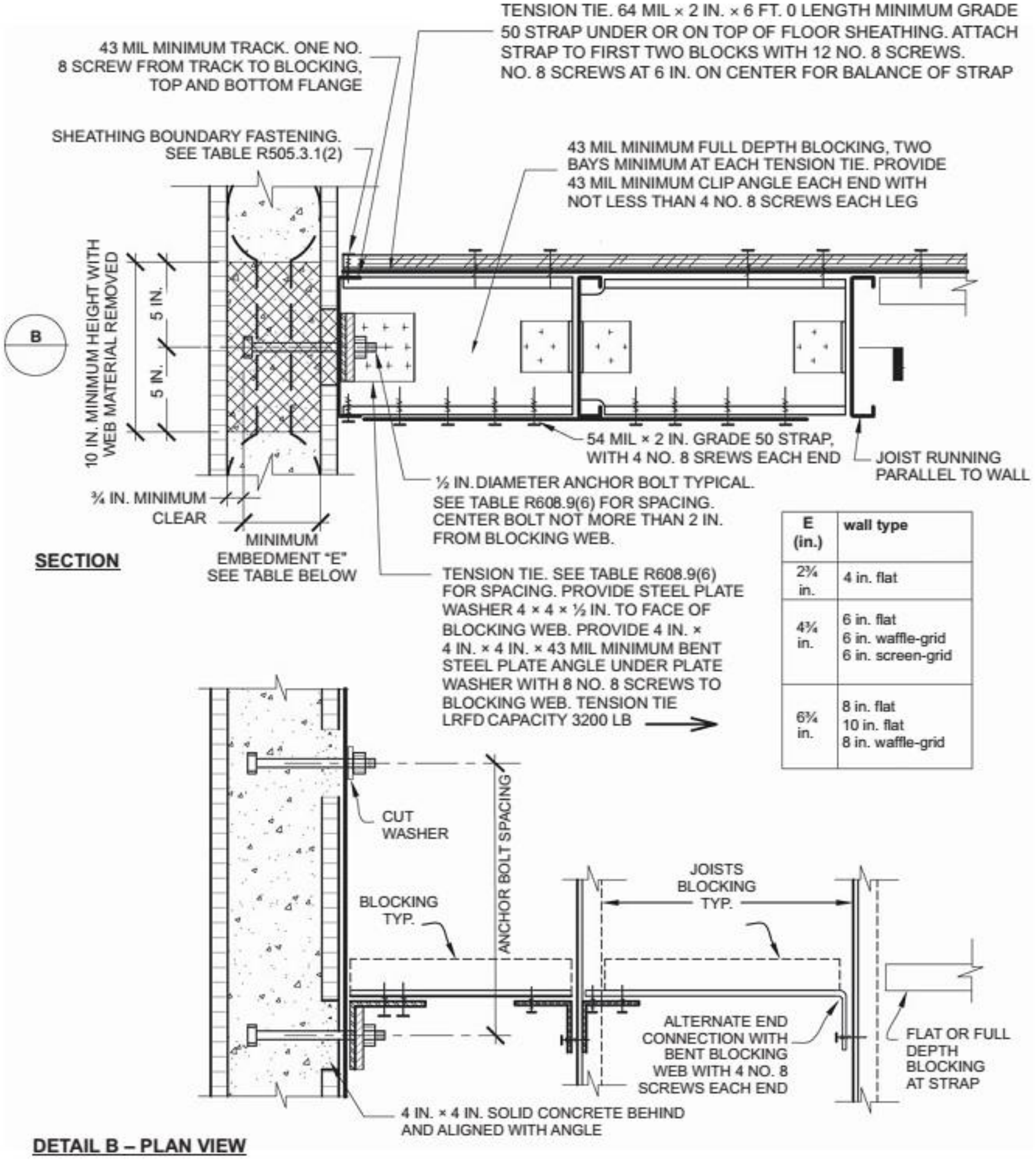
~~FIGURE R608.9(5)~~
~~COLD-FORMED STEEL FLOOR TO SIDE OF CONCRETE WALL, FRAMING PERPENDICULAR~~

~~TABLE R608.9(5)~~
~~COLD-FORMED STEEL-FRAMED FLOOR TO SIDEOF CONCRETE WALL, FRAMING PERPENDICULAR[a, b, c]~~

~~ANCHOR BOLT SPACING (inches)~~	~~TENSION TIE SPACING (inches)~~	~~BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY~~					
		~~115B~~	~~120B~~	~~130B~~	~~140B~~	~~150B~~	~~160B~~
		-	-	~~110C~~	~~119C~~	~~127C~~	~~136C~~
		-	-	-	~~110D~~	~~117D~~	~~125D~~
~~12~~	~~12~~	-	-	-	-	-	-
~~12~~	~~24~~	-	-	-	-	-	-
~~12~~	~~36~~	-	-	-	-		
~~12~~	~~48~~	-	-	-	-		
~~16~~	~~16~~	-	-	-	-		
~~16~~	~~32~~	-	-	-	-		
~~16~~	~~48~~	-	-	-	-		
~~19.2~~	~~19.2~~	-	-	-	-		
~~19.2~~	~~38.4~~	-	-	-	-		
~~24~~	~~24~~	-	-	-	-		
~~24~~	~~48~~	-	-	-	-		

~~For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.4470 m/s.~~
~~a. This table is for use with the detail in Figure R608.9(5). Use of this detail is permitted where a cell is not shaded.~~

~~b. Wall design per other provisions of Section R608 is required.~~
~~c. For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.~~



E (in.)	wall type
2¾ in.	4 in. flat
4¾ in.	6 in. flat 6 in. waffle-grid 6 in. screen-grid
6¾ in.	8 in. flat 10 in. flat 8 in. waffle-grid

~~For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.~~

~~**FIGURE R608.9(6)**~~
~~**COLD-FORMED STEEL FLOOR TO SIDE OF CONCRETE WALL, FRAMING PARALLEL**~~

~~TABLE R608.9(6)~~

~~COLD-FORMED STEEL-FRAMED FLOOR TO SIDE OF CONCRETE WALL, FRAMING PARALLEL~~ ~~[a, b, c]~~

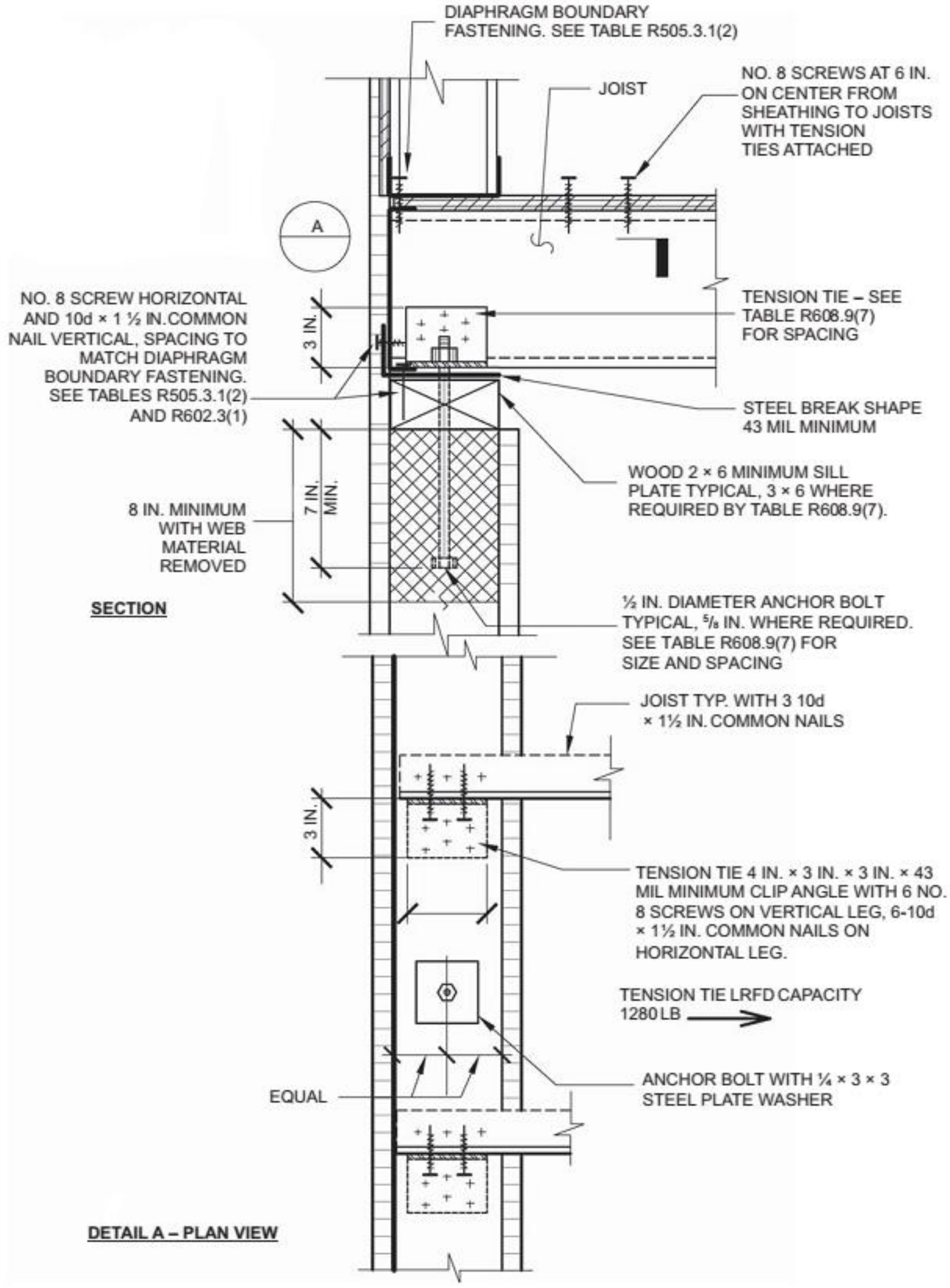
~~ANCHOR BOLT SPACING (inches)~~	~~TENSION TIE SPACING (inches)~~	~~BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY~~					
		~~115B~~	~~120B~~	~~130B~~	~~140B~~	~~150B~~	~~160B~~
				~~110C~~	~~119C~~	~~127C~~	~~136C~~
					~~110D~~	~~117D~~	~~125D~~
~~12~~	~~12~~						
~~12~~	~~24~~						
~~12~~	~~36~~						
~~12~~	~~48~~						
~~16~~	~~16~~						
~~16~~	~~32~~						
~~16~~	~~48~~						
~~19.2~~	~~19.2~~						
~~19.2~~	~~38.4~~						
~~24~~	~~24~~						
~~24~~	~~48~~						

~~For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.~~

~~a. This table is for use with the detail in Figure R608.9(6). Use of this detail is permitted where a cell is not shaded.~~

~~b. Wall design per other provisions of Section R608 is required.~~

~~c. For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.~~



~~For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.~~

~~FIGURE R608.9(7)~~
~~COLD-FORMED STEEL FLOOR TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR~~

~~TABLE R608.9(7)~~
~~COLD-FORMED STEEL-FRAMED FLOOR TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR~~[~~a, b, c, d, e~~]

~~ANCHOR BOLT SPACING (inches)~~	~~TENSION TIE SPACING (inches)~~	~~BASIC WIND SPEED AND WIND EXPOSURE CATEGORY (mph)~~					
		~~115B~~	~~120B~~	~~130B~~	~~140B~~	~~150B~~	~~160B~~
		-	-	~~110C~~	~~119C~~	~~127C~~	~~136C~~
		-	-	-	~~110D~~	~~117D~~	~~125D~~
~~12~~	~~12~~	-	-	-	-	-	~~6~~
~~12~~	~~24~~	-	-	-	-	~~6~~	~~6~~
~~16~~	~~16~~	-	-	-	-	~~6~~	~~6A~~
~~16~~	~~32~~	-	-	-	~~6~~	~~6~~	~~6A~~
~~19.2~~	~~19.2~~	-	-	-	~~6A~~	~~6A~~	~~6B~~
~~19.2~~	~~38.4~~	-	-	~~6~~	~~6A~~	~~6A~~	~~6B~~
~~24~~	~~24~~	-	-	~~6A~~	~~6B~~	~~6B~~	~~6B~~

~~For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.~~

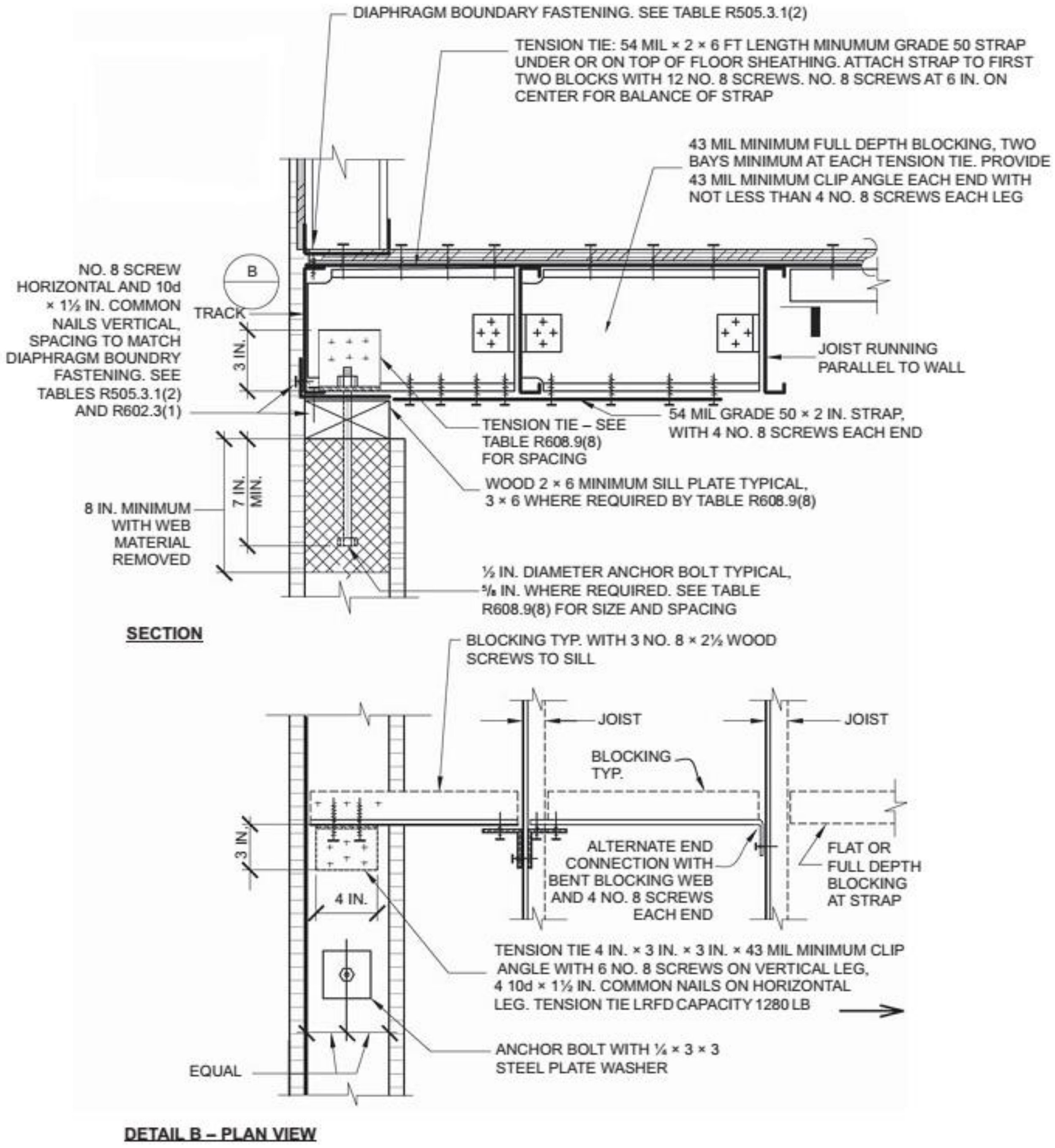
~~a. This table is for use with the detail in Figure R608.9(7). Use of this detail is permitted where a cell is not shaded.~~

~~b. Wall design per other provisions of Section R608 is required.~~

~~c. For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.~~

~~d. Number 6 indicates minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross-hatching in Figure R608.9(7). For the remainder of the wall, see Note b.~~

~~e. Letter "A" indicates that a minimum nominal 3 × 6 sill plate is required. Letter "B" indicates that a~~ $\frac{5}{8}$ ~~-inch-diameter anchor bolt and a minimum nominal 3 × 6 sill plate are required.~~



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

~~FIGURE R608.9(8)~~
~~COLD-FORMED STEEL FLOOR TO TOP OF CONCRETE WALL, FRAMING PARALLEL~~

~~TABLE R608.9(8)~~

~~COLD-FORMED STEEL-FRAMED FLOOR TO TOP OF CONCRETE WALL, FRAMING PARALLEL[a, b, c, d, e]~~

~~ANCHOR BOLT SPACING (inches)~~	~~TENSION TIE SPACING (inches)~~	~~BASIC WIND SPEED AND WIND EXPOSURE CATEGORY (mph)~~					
		~~115B~~	~~120B~~	~~130B~~	~~140B~~	~~150B~~	~~160B~~
				~~110C~~	~~119C~~	~~127C~~	~~136C~~
					~~110D~~	~~117D~~	~~125D~~
~~12~~	~~12~~						~~6~~
~~12~~	~~24~~					~~6~~	~~6~~
~~16~~	~~16~~					~~6~~	~~6A~~
~~16~~	~~32~~				~~6~~	~~6~~	~~6A~~
~~19.2~~	~~19.2~~				~~6A~~	~~6A~~	~~6B~~
~~19.2~~	~~38.4~~			~~6~~	~~6A~~	~~6A~~	~~6B~~
~~24~~	~~24~~			~~6A~~	~~6B~~	~~6B~~	~~6B~~

~~For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.~~

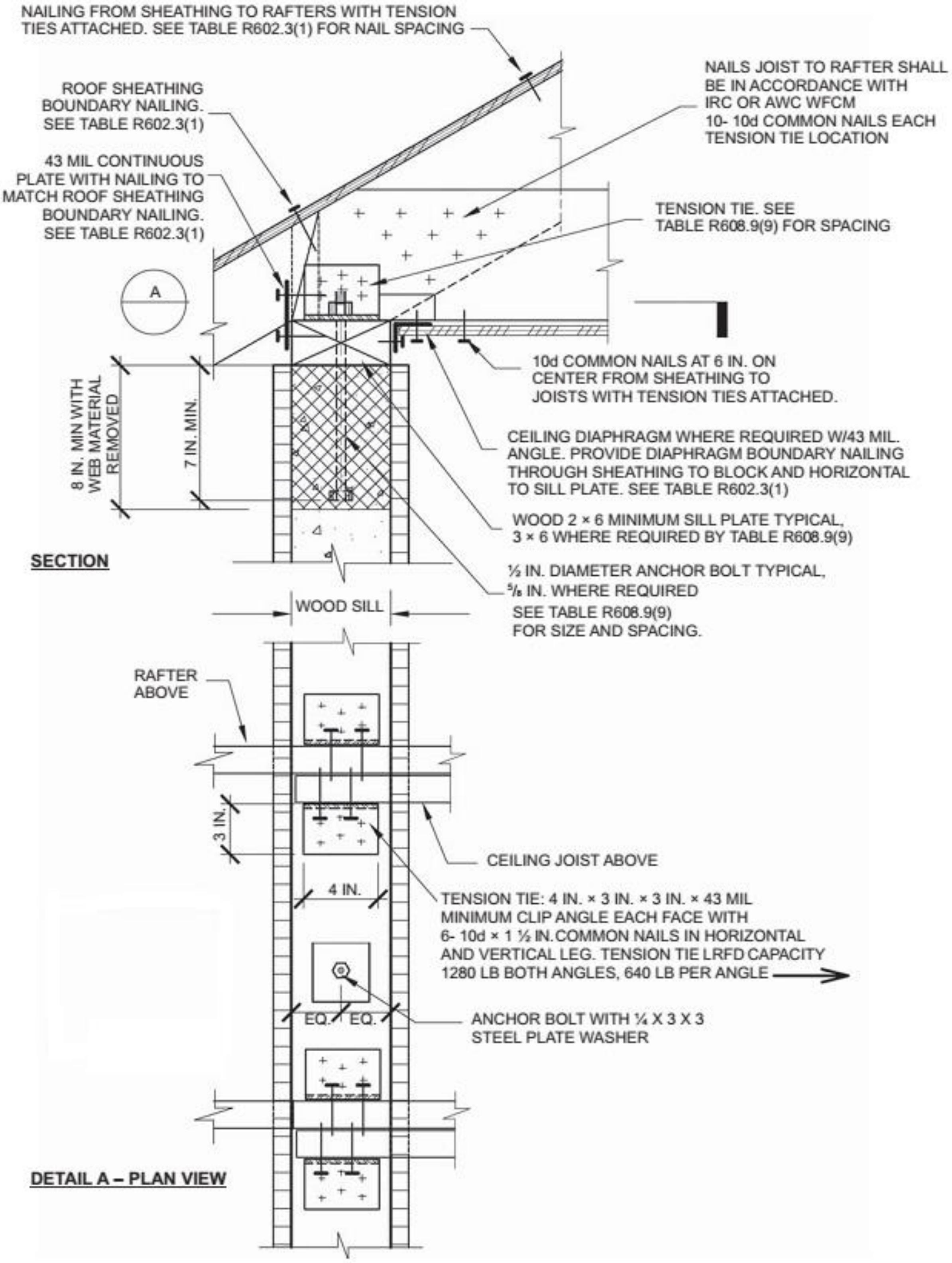
~~a. This table is for use with the detail in Figure R608.9(8). Use of this detail is permitted where a cell is not shaded.~~

~~b. Wall design per other provisions of Section R608 is required~~

~~c. For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.~~

~~d. Number 6 indicates minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross-hatching in Figure R608.9(8). For the remainder of the wall, see Note b~~

~~e. Letter “A” indicates that a minimum nominal 3 × 6 sill plate is required. Letter “B” indicates that a 5/8-inch-diameter anchor bolt and a minimum nominal 3 × 6 sill plate are required.~~



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

FIGURE R608.9(~~9~~5)
WOOD-FRAMED ROOF TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR

TABLE R608.9(~~9~~5)
WOOD-FRAMED ROOF TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR[a, b, c, d, e]

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
				110C	119C	127C	136C
					110D	117D	125D
12	12						6
12	24						6
12	36					6	6
12	48				6	6	6
16	16					6	6
16	32					6	6
16	48				6	6	6
19.2	19.2					6	6
19.2	38.4				6	6	▨
24	24				6	▨	▨
24	48			6	8B	▨	▨

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

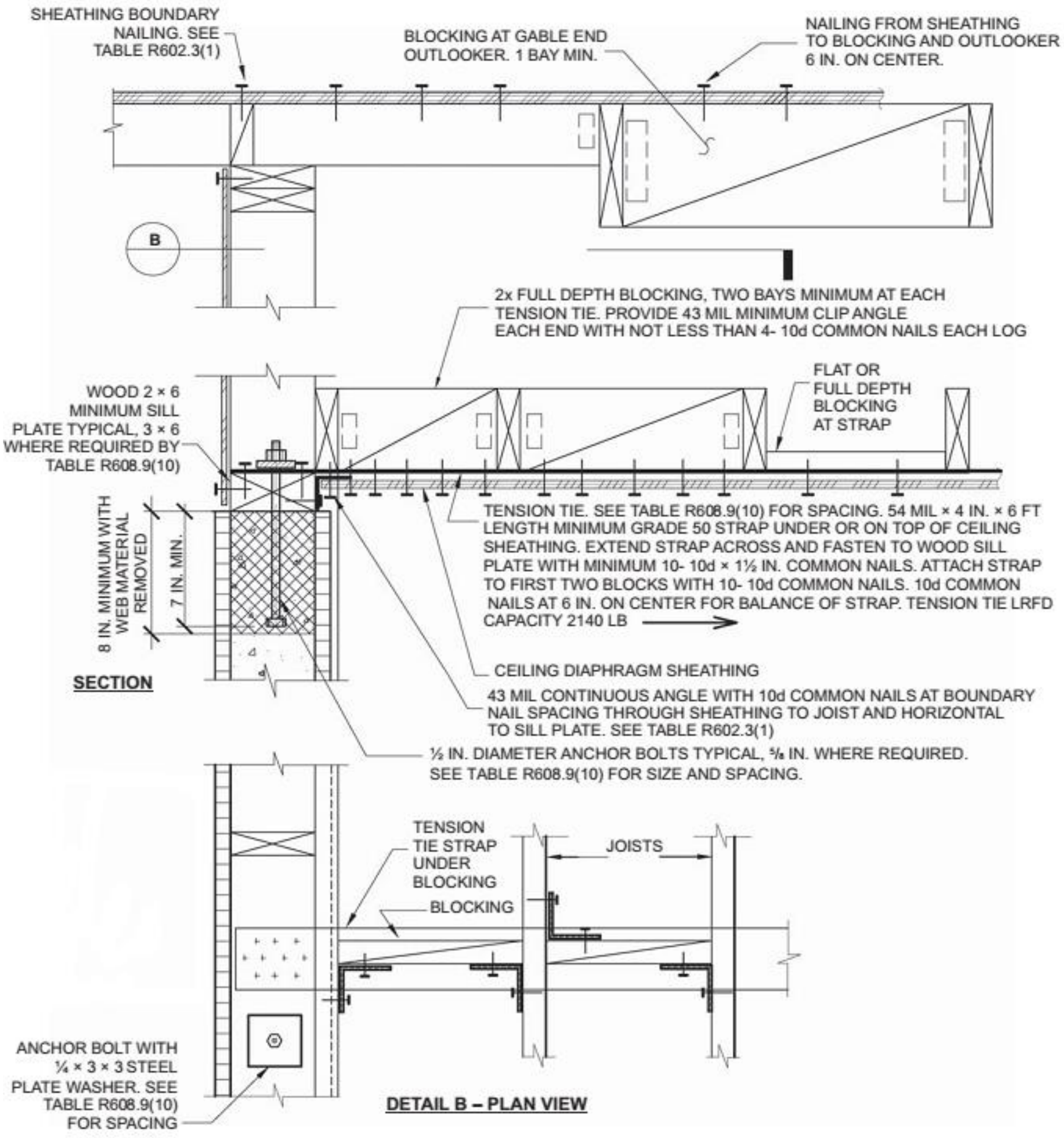
a. This table is for use with the detail in Figure R608.9(~~9~~5). Use of this detail is permitted where cell a is not shaded, prohibited where shaded.

b. Wall design per other provisions of Section R608 is required.

c. For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.

d. Numbers 6 and 8 indicate minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross-hatching in Figure R608.9(~~9~~5). For the remainder of the wall, see Note b.

e. Letter “B” indicates that a $^{5}/_{8}$-inch-diameter anchor bolt and a minimum nominal 3 × 6 sill plate are required.



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

FIGURE R608.9(~~10~~6)
WOOD-FRAMED ROOF TO TOP OF CONCRETE WALL, FRAMING PARALLEL

TABLE R608.9(~~10~~6)

WOOD-FRAMED ROOF TO TOP OF CONCRETE WALL, FRAMING PARALLEL[a, b, c, d, e]

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	**120B**	**130B**	**140B**	**150B**	**160B**
				110C	**119C**	**127C**	**136C**
					110D	**117D**	**125D**
12	12						6
12	24						6
12	36					6	6
12	48				6	6	6
16	16					6	6
16	32					6	6
16	48				6	6	6
19.2	19.2					6	6
19.2	38.4				6	6	
24	24				6		
24	48			6	8B		

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

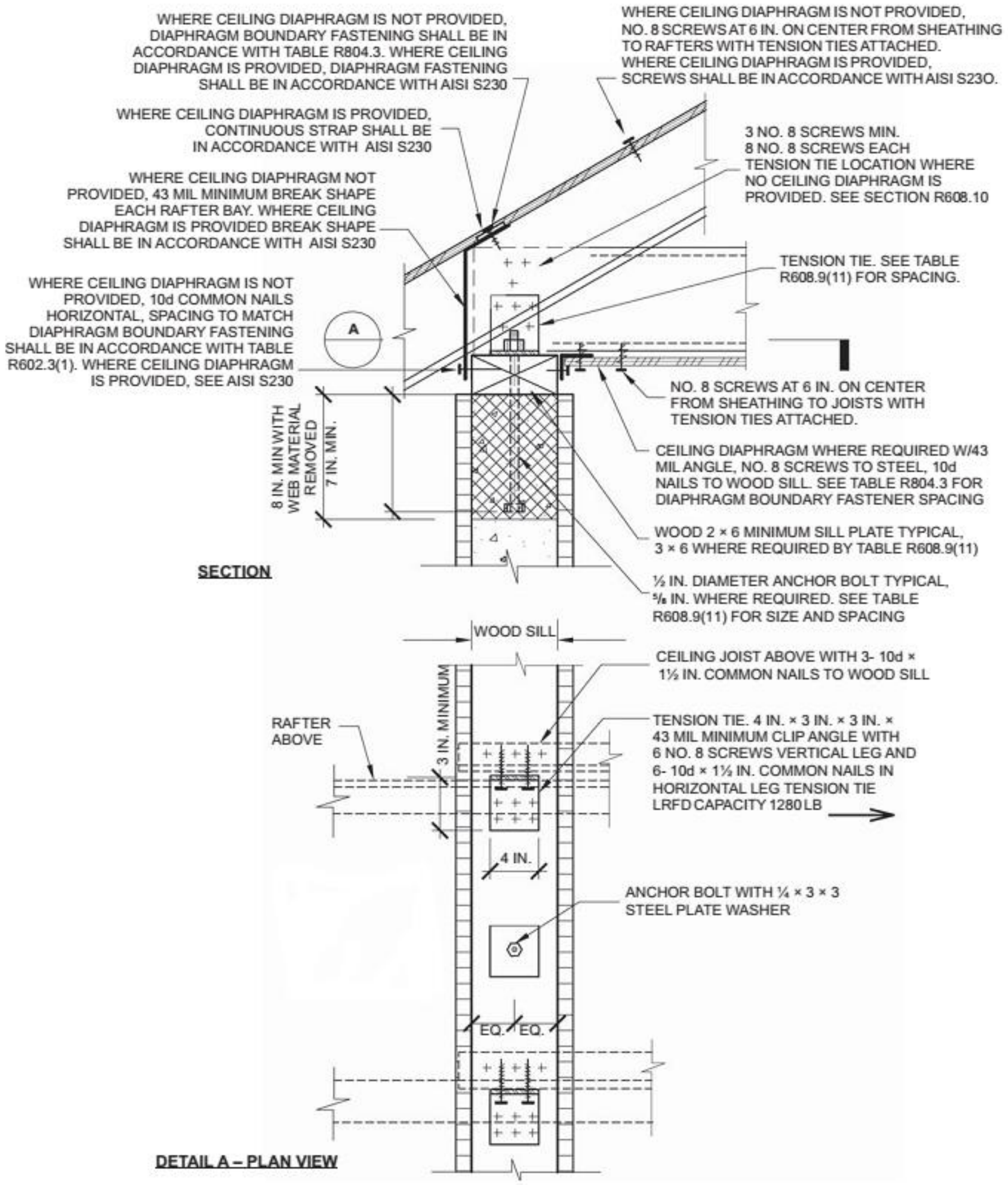
a. This table is for use with the detail in Figure R608.9(~~10~~6). Use of this detail is permitted where a cell is not shaded, prohibited where shaded.

b. Wall design per other provisions of Section R608 is required.

c. For wind design, minimum 4-inch-nominal wall is permitted in cells that do not contain a number.

d. Numbers 6 and 8 indicate minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross-hatching in Figure R608.9(~~10~~6). For the remainder of the wall, see Note b.

e. Letter “B” indicates that a ${}^{5}/_{8}$-inch-diameter anchor bolt and a minimum nominal 3 × 6 sill plate are required.



~~For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound-force = 4.448 N.~~

~~FIGURE R608.9(11)~~
~~COLD-FORMED STEEL ROOF TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR~~

~~TABLE R608.9(11)~~
~~COLD-FORMED STEEL ROOF TO TOP OF CONCRETE WALL, FRAMING~~

~~PERPENDICULAR[a, b, c, d, e]~~

~~ANCHOR BOLT SPACING (inches)~~	~~TENSION TIE SPACING (inches)~~	~~BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY~~					
		~~115B~~	~~120B~~	~~130B~~	~~140B~~	~~150B~~	~~160B~~
				~~110C~~	~~119C~~	~~127C~~	~~136C~~
					~~110D~~	~~117D~~	~~125D~~
~~12~~	~~12~~						~~6~~
~~12~~	~~24~~						~~6~~
~~16~~	~~16~~					~~6~~	~~6~~
~~16~~	~~32~~					~~6~~	~~6~~
~~19.2~~	~~19.2~~					~~6~~	~~6~~
~~19.2~~	~~38.4~~				~~6~~	~~6~~	~~6~~
~~24~~	~~24~~				~~6~~	~~6A~~	~~6B~~

~~For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.~~

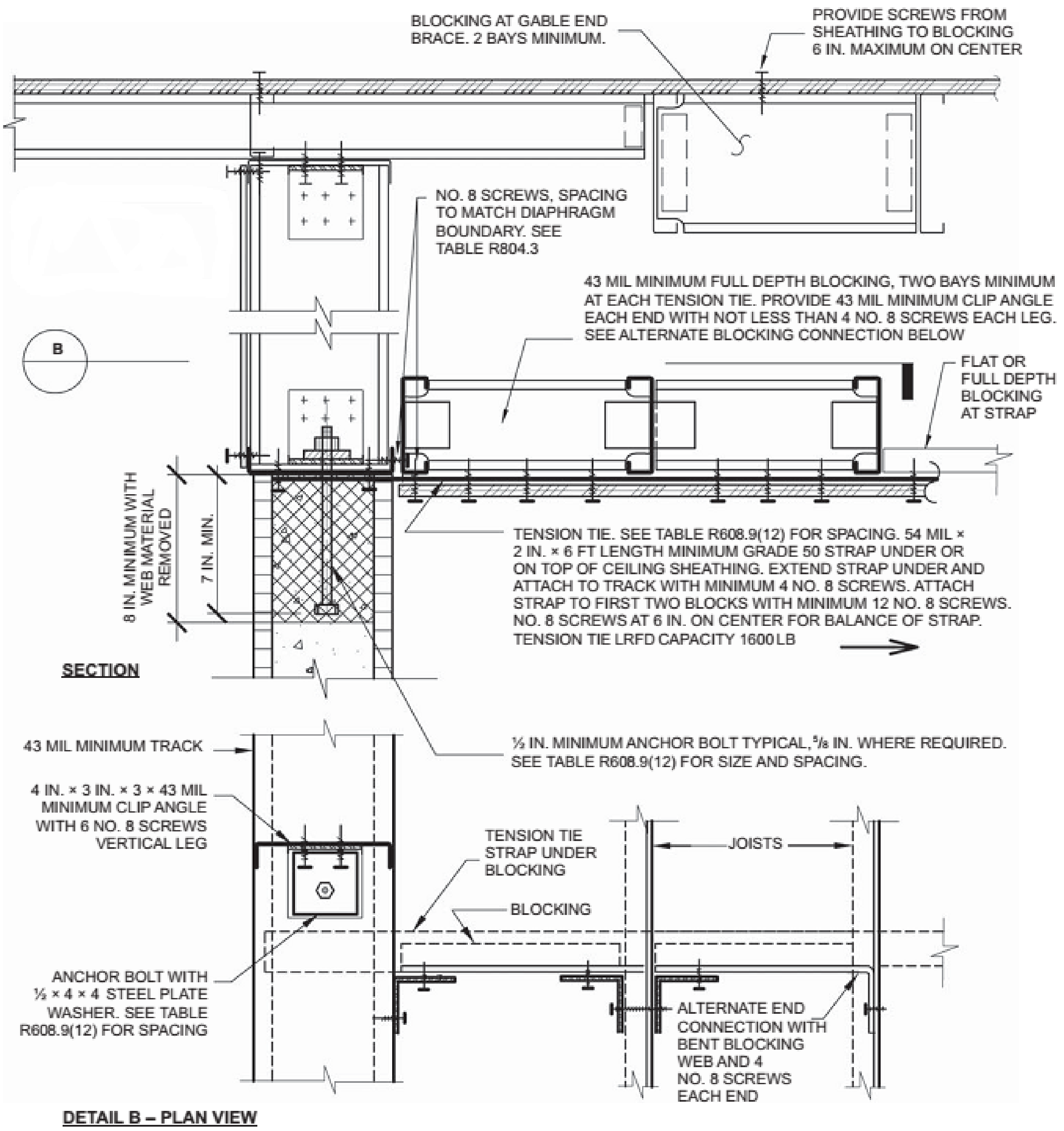
~~a. This table is for use with the detail in Figure R608.9(11). Use of this detail is permitted where a cell is not shaded.~~

~~b. Wall design per other provisions of Section R608 is required.~~

~~c. For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.~~

~~d. Number 6 indicates minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross-hatching in Figure R608.9(11). For the remainder of the wall, see Note b.~~

~~e. Letter “A” indicates that a minimum nominal 3 × 6 sill plate is required. Letter “B” indicates that a~~ ~~$^{5}/_{8}$~~ ~~-inch-diameter anchor bolt and a minimum nominal 3 × 6 sill plate are required.~~



~~For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.~~

~~FIGURE R608.9(12)~~
~~COLD-FORMED STEEL ROOF TO TOP OF CONCRETE WALL, FRAMING PARALLEL~~

~~TABLE R608.9(12)~~
~~COLD-FORMED STEEL ROOF TO TOP OF CONCRETE WALL, FRAMING PARALLEL~~[~~a, b, c, d, e~~]

~~ANCHOR BOLT SPACING (inches)~~	~~TENSION TIE SPACING (inches)~~	~~BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY~~					
		~~115B~~	~~120B~~	~~130B~~	~~140B~~	~~150B~~	~~160B~~
		~~-~~	~~-~~	~~110C~~	~~119C~~	~~127C~~	~~136C~~
		~~-~~	~~-~~	~~-~~	~~110D~~	~~117D~~	~~125D~~
~~12~~	~~12~~						~~6~~
~~12~~	~~24~~						~~6~~
~~16~~	~~16~~					~~6~~	~~6~~
~~16~~	~~32~~					~~6~~	~~6~~
~~19.2~~	~~19.2~~					~~6~~	~~6~~
~~19.2~~	~~38.4~~				~~6~~	~~6~~	~~6~~
~~24~~	~~24~~				~~6~~	~~6~~	~~6B~~

~~For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.~~

~~a. This table is for use with the detail in Figure R608.9(12). Use of this detail is permitted where a cell is not shaded.~~

~~b. Wall design per other provisions of Section R608 is required.~~

~~c. For wind design, minimum 4-inch-nominal wall is permitted in cells that do not contain a number.~~

~~d. Number 6 indicates minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross-hatching in Figure R608.9(12). For the remainder of the wall, see Note b.~~

~~e. Letter "B" indicates that a~~ $^{5}/_{8}$ ~~-inch-diameter anchor bolt is required.~~

R608.9.1 Connections between concrete walls and light-framed floor, ceiling and roof systems.

Connections between concrete walls and light-framed floor, ceiling and roof systems using the prescriptive details of Figures R608.9(1) through R608.9(6) ~~R608.9(12)~~ shall comply with this section and Sections R608.9.2 and R608.9.3.

R608.9.1.1 Anchor bolts.

Anchor bolts used to connect light-framed floor, ceiling and roof systems to concrete walls in accordance with Figures R608.9(1) through R608.9(6) ~~R608.9(12)~~ shall have heads, or shall be rods with threads on both ends with a hex or square nut on the end embedded in the concrete. Bolts and threaded rods shall comply with Section R608.5.2.2. Anchor bolts with J- or L-hooks shall not be used where the connection details in these figures are used.

R608.9.1.2 Removal of stay-in-place form material at bolts.

Holes in stay-in-place forms for installing bolts for attaching face-mounted wood ledger boards to the wall shall be not less than 4 inches (102 mm) in diameter for forms not greater than $1^{1}/_{2}$ inches (38 mm) in thickness, and increased 1 inch (25 mm) in diameter for each $^{1}/_{2}$-inch (12.7 mm) increase in form thickness. ~~Holes in stay-in-place forms for installing bolts for attaching face-mounted cold-formed steel tracks to the wall shall be not less than 4 inches (102 mm) square.~~ The wood ledger board ~~or steel track~~ shall be in direct contact with the concrete at each bolt location.

Exception: A vapor retarder or other material less than or equal to $^{1}/_{16}$ inch (1.6 mm) in thickness is permitted to be installed between the wood ledger ~~or cold-formed track~~ and the concrete.

R608.9.2 Connections between concrete walls and light-framed floor systems.

Connections between concrete walls and light-framed floor systems shall be in accordance with one of the following:

1. For floor systems of wood frame construction, the provisions of Section R608.9.1 and the prescriptive details of Figures R608.9(1) through R608.9(4), where permitted by the tables accompanying those figures. Portions of connections of wood-framed floor systems not noted in the figures shall be in accordance with Section R502, or AWC WFCM, if applicable. Wood framing members shall be of a species having a specific gravity equal to or greater than 0.42.

2. Deleted. ~~For floor systems of cold-formed steel construction, the provisions of Section R608.9.1 and the prescriptive details of Figures R608.9(5) through R608.9(8), where permitted by the tables accompanying those figures. Portions of connections of cold-formed-steel framed floor systems not noted in the figures shall be in accordance with Section R505, or AISI S230, if applicable.~~

3. Proprietary connectors selected to resist loads and load combinations in accordance with Appendix A (ASD) or Appendix B (LRFD) of PCA 100.

4. An engineered design using loads and load combinations in accordance with Appendix A (ASD) or Appendix B (LRFD) of PCA 100.

5. An engineered design using loads and material design provisions in accordance with this code, or in accordance with ASCE 7, ACI 318, and AWC NDS for wood frame construction ~~or AISI S100 for cold-formed steel frame construction~~.

R608.9.3 Connections between concrete walls and light-framed ceiling and roof systems.

Connections between concrete walls and light-framed ceiling and roof systems shall be in accordance with one of the following:

1. For ceiling and roof systems of wood frame construction, the provisions of Section R608.9.1 and the prescriptive details of Figures R608.9(~~9~~5) and R608.9(~~10~~6), where permitted by the tables accompanying those figures. Portions of connections of wood-framed ceiling and roof systems not noted in the figures shall be in accordance with Section R802, or AWC WFCM, if applicable. Wood framing members shall be of a species having a specific gravity equal to or greater than 0.42.

2. Deleted. ~~For ceiling and roof systems of cold-formed-steel construction, the provisions of Section R608.9.1 and the prescriptive details of Figures R608.9(11) and R608.9(12), where permitted by the tables accompanying those figures. Portions of connections of cold-formed-steel framed ceiling and roof systems not noted in the figures shall be in accordance with Section R804, or AISI S230, if applicable.~~

3. Proprietary connectors selected to resist loads and load combinations in accordance with Appendix A (ASD) or Appendix B (LRFD) of PCA 100.

4. An engineered design using loads and load combinations in accordance with Appendix A (ASD) or Appendix B (LRFD) of PCA 100.

5. An engineered design using loads and material design provisions in accordance with this code, or in accordance with ASCE 7, ACI 318, and AWC NDS for wood-frame construction ~~or AISI S100 for cold-formed-steel frame construction~~.

R608.10 Floor, roof and ceiling diaphragms.
Floors and roofs in buildings with exterior walls of concrete shall be designed and constructed as diaphragms. Where gable-end walls occur, ceilings shall be designed and constructed as diaphragms. The design and construction of floors, roofs and ceilings of wood ~~framing or cold-formed-steel framing~~ serving as diaphragms shall comply with the applicable requirements of this code, or AWC WFCM ~~or AISI S230,~~ if applicable. Wood framing members shall be of a species having a specific gravity equal to or greater than 0.42.

SECTION R609
EXTERIOR WINDOWS AND DOORS

R609.2 Performance.
Exterior windows and doors shall be designed to resist the design wind loads specified in Table R301.2(2) adjusted for height and exposure in accordance with Table R301.2(3) or determined in accordance with ASCE 7 using the allowable stress design load combinations of ASCE 7. Design wind loads for exterior glazing not part of a labeled assembly shall be permitted to be determined in accordance with Chapter 24 of the *International Building Code*.

> **Exception**: Openings for exterior balconies, decks, or porches under roofs enclosed with screen or removable vinyl or acrylic wind break panels shall not be required to be protected provided the spaces are separated from the building interior by a wall and all openings in the wall separating the unit from the balcony, deck or porch are protected in accordance with this section. Vinyl and acrylic glazed panels shall be removable. Removable panels shall be identified as removable by a decal. The identification decal shall state "Removable panel SHALL be removed when wind speeds exceed 75 mph (34 m/s)." Decals shall be placed such that the decal is visible when the panel is installed.

R609.7.2.1 Masonry, concrete or other structural substrate.
Where the wood shim or buck thickness is less than $1^1/_2$ inches (38 mm), window and glass door assemblies shall be anchored through the jamb, or by jamb clip and anchors shall be embedded directly into the masonry, concrete or other substantial substrate material. Anchors shall adequately transfer load from the window or door frame into the rough opening substrate [see Figures R609.7.2(1) and R609.7.2(2)]

Where the wood shim or buck thickness is $1^1/_2$ inches (38 mm) or more, the buck is securely fastened to the masonry, concrete or other substantial substrate, and the buck extends beyond the interior face of the window or door frame, window and glass door assemblies shall be anchored through the jamb, or by jamb clip, or through the flange to the secured wood buck. Anchors shall be embedded into the secured wood buck to adequately transfer load from the window or door frame assembly [see Figures R609.7.2(3), R6097.2(4) and R609.7.2(5)].

CHAPTER 7
WALL COVERING

SECTION R702
INTERIOR COVERING

R702.1 General.
Interior coverings or wall finishes shall be installed in accordance with this chapter and Table R702.1(1), Table R702.1(2), Table R702.1(3) and Table R702.3.5. Interior masonry veneer shall comply with the requirements of Section R703.~~7~~8.1 for support and Section R703.~~7~~8.4 for anchorage, except an airspace is not required. Interior finishes and materials shall conform to the flame spread and smoke-development requirements of Section R302.9.

R702.3.3 Cold-formed steel framing. Deleted.
~~Cold-formed steel framing supporting gypsum board and gypsum panel products shall be not less than $1^{1}/_{4}$ inches (32 mm) wide in the least dimension. Nonload-bearing cold-formed steel framing shall comply with AISI S220 and ASTM C645, Section 10. Load-bearing cold-formed steel framing shall comply with AISI S200 and ASTM C 955, Section 8.~~

TABLE R702.3.5
MINIMUM THICKNESS AND APPLICATION OF GYPSUM BOARD AND GYPSUM PANEL PRODUCTS

THICKNESS OF GYPSUM BOARD OR GYPSUM PANEL PRODUCTS (inches)	**APPLICATION**	**ORIENTATION OF GYPSUM BOARD OR GYPSUM PANEL PRODUCTS TO FRAMING**	**MAXIMUM SPACING OF FRAMING MEMBERS (inches o.c.)**	**MAXIMUM SPACING OF FASTENERS (inches)**		**SIZE OF NAILS FOR APPLICATION TO WOOD FRAMING[c]**
				Nails[a]	**Screws[b]**	
Application without adhesive						
$^{3}/_{8}$	Ceiling[d]	Perpendicular	16	7	12	13 gage, $1^{1}/_{4}$″ long, $^{19}/_{64}$″ head; 0.098″ diameter, $1^{1}/_{4}$″ long, annular-ringed; or 4d cooler nail, 0.080″ diameter, $1^{3}/_{8}$″ long, $^{7}/_{32}$″ head.
	Wall	Either direction	16	8	16	
$^{1}/_{2}$	Ceiling	Either direction	16	7	12	
	Ceiling[d]	Perpendicular	24	7	12	

	Wall	Either direction	24	8	12	13 gage, 1 3/8″ long, 19/64″ head; 0.098″ diameter, 1 1/4″ long, annular-ringed; 5d cooler nail, 0.086″ diameter, 1 5/8″ long, 15/64″ head; or gypsum board nail, 0.086″ diameter, 1 5/8″ long, 9/32″ head.
	Wall	Either direction	16	8	16	
5/8	Ceiling	Either direction	16	7	12	13 gage, 1 5/8″ long, 19/64″ head; 0.098″ diameter, 1 3/8″ long, annular-ringed; 6d cooler nail, 0.092″ diameter, 1 7/8″ long, 1/4″ head; or gypsum board nail, 0.0915″ diameter, 1 7/8″ long, 19/64″ head.
	Ceiling	Perpendicular	24	7	12	
	Type X at garage ceiling beneath habitable rooms	Perpendicular	24	6	6	1 7/8″ long 6d coated nails or equivalent drywall screws. Screws shall comply with Section R702.3.5.1
	Wall	Either direction	24	8	12	

	Wall	Either direction	16	8	16	13 gage, 1 5/8″ long, 19/64″ head; 0.098″ diameter, 1 3/8″ long, annular-ringed; 6d cooler nail, 0.092″ diameter, 1 7/8″ long, 1/4″ head; or gypsum board nail, 0.0915″ diameter, 1 7/8″ long, 19/64″ head.
Application with adhesive						
3/8	Ceiling[d]	Perpendicular	16	16	16	Same as above for 3/8″ gypsum board and gypsum panel products.
	Wall	Either direction	16	16	24	
1/2 or 5/8	Ceiling	Either direction	16	16	16	Same as above for 1/2″ and 5/8″ gypsum board and gypsum panel products, respectively.
	Ceiling[d]	Perpendicular	24	12	16	
	Wall	Either direction	24	16	24	
Two 3/8 layers	Ceiling	Perpendicular	16	16	16	Base ply nailed as above for 1/2″ gypsum board and gypsum panel products; face ply installed with adhesive.
	Wall	Either direction	24	24	24	

For SI: 1 inch = 25.4 mm.

a. For application without adhesive, a pair of nails spaced not less than 2 inches apart or more than 2 1/2 inches apart shall be permitted to be used with the pair of nails spaced 12 inches on center.

b. Screws shall be in accordance with Section ~~R702.3.6~~ R702.3.5.1. Screws for attaching gypsum board or gypsum panel products to structural insulated panels shall penetrate the wood structural panel facing not less than 7/16 inch.

c. ~~Where cold-formed steel framing is used with a clinching design to receive nails by two edges of metal, the nails shall be not less than 5/8 inch longer than the gypsum board or gypsum panel product~~

~~thickness and shall have ringed shanks. Where the cold-formed steel framing has a nailing groove formed to receive the nails, the nails shall have barbed shanks or be 5d, 13 $^{1}/_{2}$ gage, $^{15}/_{8}$ inches long, $^{15}/_{64}$-inch head for $^{1}/_{2}$-inch gypsum board or gypsum panel product; and 6d, 13 gage, 1 $^{7}/_{8}$ inches long, $^{15}/_{64}$-inch head for $^{5}/_{8}$-inch gypsum board or gypsum panel product.~~ Deleted.

d. Three-eighths-inch-thick single-ply gypsum board or gypsum panel product shall not be used on a ceiling where a water-based textured finish is to be applied, or where it will be required to support insulation above a ceiling. On ceiling applications to receive a water-based texture material, either hand or spray applied, the gypsum board or gypsum panel product shall be applied perpendicular to framing. Where applying a water-based texture material, the minimum gypsum board thickness shall be increased from $^{3}/_{8}$ inch to $^{1}/_{2}$ inch for 16-inch on center framing, and from $^{1}/_{2}$ inch to $^{5}/_{8}$ inch for 24-inch on center framing or $^{1}/_{2}$-inch sag-resistant gypsum ceiling board shall be used.

R702.3.5.1 Screw fastening.

Screws for attaching gypsum board and gypsum panel products to wood framing shall be Type W or Type S in accordance with ASTM C 1002 and shall penetrate the wood not less than $^{5}/_{8}$ inch (15.9 mm). ~~Gypsum board and gypsum panel products shall be attached to cold-formed steel framing with minimum No. 6 screws. Screws for attaching gypsum board and gypsum panel products to cold-formed steel framing less than 0.033 inch (1 mm) thick shall be Type S in accordance with ASTM C 1002 or bugle head style in accordance with ASTM C 1513 and shall penetrate the steel not less than $^{3}/_{8}$ inch (9.5 mm). Screws for attaching gypsum board and gypsum panel products to cold-formed steel framing 0.033 inch to 0.112 inch (1 mm to 3 mm) thick shall be in accordance with ASTM C 954 or bugle head style in accordance with ASTM C 1513.~~ Screws for attaching gypsum board and gypsum panel products to structural insulated panels shall penetrate the wood structural panel facing not less than $^{7}/_{16}$ inch (11.1 mm).

TABLE R702.3.6
SHEAR CAPACITY FOR HORIZONTAL WOOD-FRAMED GYPSUM BOARD DIAPHRAGM CEILING ASSEMBLIES

MATERIAL	THICKNESS OF MATERIAL (min.) (inch)	SPACING OF FRAMING MEMBERS (max.) (inch)	SHEAR VALUE[a, b] (plf of ceiling)	MINIMUM FASTENER SIZE[c, d]
Gypsum board or gypsum panel product	$^{1}/_{2}$	16 o.c.	90	5d cooler or wallboard nail; 1 $^{5}/_{8}$-inch long; 0.086-inch shank; $^{15}/_{64}$-inch head
Gypsum board or gypsum panel product	$^{1}/_{2}$	24 o.c.	70	5d cooler or wallboard nail;

				$1^{5}/_{8}$-inch long; 0.086-inch shank; $^{15}/_{64}$-inch head

For SI: 1 inch = 25.4 mm, 1 pound per linear foot = 1.488 kg/m.

a. Values are not cumulative with other horizontal diaphragm values and are for short-term loading caused by wind or seismic loading. Values shall be reduced 25 percent for normal loading.

b. ~~Values shall be reduced 50 percent in Seismic Design Categories D_0, D_1, D_2 and E.~~ Deleted.

c. $1^{1}/_{4}$-inch, No. 6 Type S or W screws shall be permitted to be substituted for the listed nails.

d. Fasteners shall be spaced not more than 7 inches on center at all supports, including perimeter blocking, and not less than $^{3}/_{8}$ inch from the edges and ends of the gypsum board.

R702.3.7 Water-resistant gypsum backing board.

Gypsum board used as the base or backer for adhesive application of ceramic tile or other required nonabsorbent finish material shall conform to ASTM C 1396, C 1178 or C 1278. Use of water-resistant gypsum backing board shall be permitted on ceilings. Use of water-resistant gypsum backing board shall be permitted on ceilings where framing spacing does not exceed 12 inches (305 mm) on center for 1/2-inch (12.7 mm) thick or 16 inches (406 mm) for 5/8-inch (16 mm) thick gypsum board. Water-resistant gypsum board shall not be installed over a Class I or II vapor retarder in a shower or tub compartment. Cut or exposed edges, including those at wall intersections, shall be sealed as recommended by the manufacturer.

R702.5 Other finishes.

Wood veneer paneling and hardboard paneling shall be placed on wood ~~or cold-formed steel~~ framing spaced not more than 16 inches (406 mm) on center. Wood veneer and hard board paneling less than $^{1}/_{4}$-inch (6 mm) nominal thickness shall not have less than a $^{3}/_{8}$-inch (10 mm) gypsum board or gypsum panel product backer. Wood veneer paneling not less than $^{1}/_{4}$-inch (6 mm) nominal thickness shall conform to ANSI/HPVA HP-1. Hardboard paneling shall conform to CPA/ANSI A135.5.

R702.6 Wood shakes and shingles.

Wood shakes and shingles shall conform to CSSB *Grading Rules for Wood Shakes and Shingles* and shall be permitted to be installed directly to the studs with maximum 24 inches (610 mm) on-center spacing.

SECTION R703
EXTERIOR COVERING

R703.3 Nominal thickness and attachments.

The nominal thickness and attachment of exterior wall coverings shall be in accordance with Table R703.3(1), the wall covering material requirements of this section, and the wall covering manufacturer’s installation instructions. Cladding attachment over foam sheathing shall comply with the additional requirements and limitations of Sections R703.15 ~~through~~ and R703.17. Nominal material thicknesses in Table R703.3(1) are based on a maximum stud spacing of 16 inches (406 mm) on center. Where specified by the siding manufacturer’s instructions and supported by a test report or other documentation, attachment to studs with greater spacing is permitted. Fasteners for exterior wall coverings attached to wood framing shall be in accordance with Section R703.3.2 and Table R703.3(1). ~~Exterior wall coverings shall be attached to cold-formed steel light frame construction in accordance with the cladding manufacturer’s installation instructions, the requirements of Table R703.3(1) using screw fasteners substituted for the nails specified in accordance with Table R703.3(2), or an approved design.~~

TABLE R703.3(1)
SIDING MINIMUM ATTACHMENT AND MINIMUM THICKNESS

SIDING MATERIAL		NOMINAL THICKNESS (inches)	JOINT TREATMENT	TYPE OF SUPPORTS FOR THE SIDING MATERIAL AND FASTENERS					
				Wood or wood structural panel sheathing into stud	Fiberboard sheathing into stud	Gypsum sheathing into stud	Foam plastic sheathing[l] into stud	Direct to studs	Number or spacing of fasteners
Anchored veneer: brick, concrete, masonry or stone (see Section R703.8)		2	Section R703.8	Section R703.8					
Adhered veneer: concrete, stone or masonry (see Section R703.12)		—	Section R703.12	Section R703.12					
Fiber cement siding	Panel siding (see Section R703.10.1)	5/16	Section R703.10.1	6d common (2″ × 0.113″)	6d common (2″ × 0.113″)	6d common (2″ × 0.113″)	6d common (2″ × 0.113″)	4d common (1 1/2″ × 0.099″)	6″ panel edges 12″ inter. sup.
	Lap siding (see Section R703.10.2)	5/16	Section R703.10.2	6d common (2″ × 0.113″)	6d common (2″ × 0.113″)	6d common (2″ × 0.113″)	6d common (2″ × 0.113″)	6d common (2″ × 0.113″) or 11 gage roofing nail	Note f
Hardboard panel siding (see Section ~~R703.3~~ R703.5)		7/16	—	0.120″ nail (shank) with 0.225″ head	0.120″ nail (shank) with 0.225″ head	0.120″ nail (shank) with 0.225″ head	0.120″ nail (shank) with 0.225″ head	0.120″ nail (shank) with 0.225″ head	6″ panel edges 12″ inter. sup.[d]
Hardboard lap siding (see Section ~~R703.3~~ R703.5)		7/16	Note e	0.099″ nail (shank) with 0.240″ head	0.099″ nail (shank) with 0.240″ head	0.099″ nail (shank) with 0.240″ head	0.099″ nail (shank) with 0.240″ head	0.099″ nail (shank) with 0.240″ head	Same as stud spacing 2 per bearing
Horizontal aluminum[a]	Without insulation	0.019[b]	Lap	Siding nail 1 1/2″ × 0.120″	Siding nail 2″ × 0.120″	Siding nail 2″ × 0.120″	Siding nail[h] 1 1/2″ × 0.120″	Not allowed	Same as stud spacing

		0.024	Lap	Siding nail 1 1/2″ × 0.120″	Siding nail 2″ × 0.120″	Siding nail 2″ × 0.120″	Siding nail[h] 1 1/2″ × 0.120″	Not allowed	
	With insulation	0.019	Lap	Siding nail 1 1/2″ × 0.120″	Siding nail 2 1/2″ × 0.120″	Siding nail 2 1/2″ × 0.120″	Siding nail[h] 1 1/2″ × 0.120″	Siding nail 1 1/2″ × 0.120″	
Insulated vinyl siding[j]		0.035 (vinyl siding layer only)	Lap	0.120 nail (shank) with a 0.313 head or 16-gage crown[h,i]	0.120 nail (shank) with a 0.313 head or 16-gage crown[h]	0.120 nail (shank) with a 0.313 head or 16-gage crown[h]	0.120 nail (shank) with a 0.313 head Section R703.11.2	Not allowed	16 inches on center or specified by manufacturer instructions, test report or other sections of this code
Particleboard panels		3/8	—	6d box nail (2″ × 0.099″)	6d box nail (2″ × 0.099″)	6d box nail (2″ × 0.099″)	6d box nail (2″ × 0.099″)	Not allowed	6″ panel edges 12″ inter. sup.
		1/2	—	6d box nail (2″ × 0.099″)	6d box nail (2″ × 0.099″)	6d box nail (2″ × 0.099″)	6d box nail (2″ × 0.099″)	6d box nail (2″ × 0.099″)	
		5/8	—	6d box nail (2″ × 0.099″)	8d box nail (2 1/2″ × 0.113″)	8d box nail (2 1/2″ × 0.113″)	6d box nail (2″ × 0.099″)	6d box nail (2″ × 0.099″)	
Polypropylene siding[k]		Not applicable	Lap	Section 703.14.1	Section 703.14.1	Section 703.14.1	Section 703.14.1	Not allowed	As specified by the manufacturer instructions, test report or other sections of this code

(continued)

TABLE R703.3(1)—continued
SIDING MINIMUM ATTACHMENT AND MINIMUM THICKNESS

SIDING MATERIAL		NOMINAL THICKNESS (inches)	JOINT TREATMENT	TYPE OF SUPPORTS FOR THE SIDING MATERIAL AND FASTENERS					
				Wood or wood structural panel sheathing into stud	**Fiberboard sheathing into stud**	**Gypsum sheathing into stud**	**Foam plastic sheathing into stud**	**Direct to studs**	**Number or spacing of fasteners**
Steel[c]		29 ga.	Lap	Siding nail (1 3/4″ × 0.113″) Staple–1 3/4″	Siding nail (2 3/4″ × 0.113″) Staple–2 1/2″	Siding nail (2 1/2″ × 0.113″) Staple–2 1/4″	Siding nail (1 3/4″ x 0.113″) Staple–1 3/4″	Not allowed	Same as stud spacing
Vinyl siding (see Section R703.11)		0.035	Lap	0.120″ nail (shank) with a 0.313″ head or 16-gage staple with 3/8- to 1/2-inch crown[h,i]	0.120″ nail (shank) with a 0.313″ head or 16-gage staple with 3/8- to 1/2-inch crown[h]	0.120″ nail (shank) with a 0.313″ head or 16- gage staple with 3/8- to 1/2-inch crown[h]	0.120″ nail (shank) with a 0.313 head Section R703.11.2	Not allowed	16 inches on center or as specified by the manufacturer instructions or test report
Wood siding (see Section ~~R703.3~~ R703.5)	Wood rustic, drop	3/8 min.	Lap	6d box or siding nail (2″ × 0.099″)	6d box or siding nail (2″ × 0.099″)	6d box or siding nail (2″ × 0.099″)	6d box or siding nail (2″ × 0.099″)	8d box or siding nail (2 1/2″ × 0.113″) Staple–2″	Face nailing up to 6″ widths, 1 nail per bearing; 8″ widths and over, 2 nails per bearing
	Shiplap	19/32 average	Lap						
	Bevel	7/16							
	Butt tip	3/16	Lap						
Wood structural panel ANSI/APA PRP-210 siding (exterior grade) (see Section ~~R703.3~~ R703.5)		3/8 – 1/2	Note e	2″ × 0.099″ siding nail	2 1/2″ × 0.113″ siding nail	2 1/2″ × 0.113″ siding nail	2 1/2″ × 0.113″ siding nail	2″ × 0.099″ siding nail	6″ panel edges 12″ inter. sup.
Wood structural panel lap siding (see Section ~~R703.3~~ R703.5)		3/8 – 1/2	Note e Note g	2″ × 0.099″ siding nail	2 1/2″ × 0.113″ siding nail	2 1/2″ × 0.113″ siding nail	2 1/2″ × 0.113″ siding nail	2″ × 0.099″ siding nail	8″ along bottom edge

For SI: 1 inch = 25.4 mm.

a. Aluminum nails shall be used to attach aluminum siding.

b. Aluminum (0.019 inch) shall be unbacked only where the maximum panel width is 10 inches and the maximum flat area is 8 inches. The tolerance for aluminum siding shall be +0.002 inch of the nominal dimension.

c. Shall be of approved type.

d. Where used to resist shear forces, the spacing must be 4 inches at panel edges and 8 inches on interior supports.

e. Vertical end joints shall occur at studs and shall be covered with a joint cover or shall be caulked.

f. Face nailing: one 6d common nail through the overlapping planks at each stud. Concealed nailing: one 11-gage $1^1/_2$ -inch-long galv. roofing nail through the top edge of each plank at each stud in accordance with the manufacturer's installation instructions.

g. Vertical joints, if staggered, shall be permitted to be away from studs if applied over wood structural panel sheathing.

h. Minimum fastener length must be sufficient to penetrate sheathing other nailable substrate and framing a total of a minimum of $1^1/_4$ inches or in accordance with the manufacturer's installation instructions.

i. Where specified by the manufacturer's instructions and supported by a test report, fasteners are permitted to penetrate into or fully through nailable sheathing or other nailable substrate of minimum thickness specified by the instructions or test report, without penetrating into framing.

j. Insulated vinyl siding shall comply with ASTM D 7793.

k. Polypropylene siding shall comply with ASTM D 7254.

l. Cladding attachment over foam sheathing shall comply with the additional requirements and limitations of Sections R703.15~~, R703.16~~ and R703.17.

~~TABLE R703.3(2)~~
~~SCREW FASTENER SUBSTITUTION FOR SIDING ATTACHMENT TO COLD-FORMED STEEL LIGHT FRAME CONSTRUCTION~~~~[a, b, c, d, e]~~

~~NAIL DIAMETER PER TABLE R703.3(1)~~	~~MINIMUM SCREW FASTENER SIZE~~
~~0.099″~~	~~No. 6~~
~~0.113″~~	~~No. 7~~
~~0.120″~~	~~No. 8~~

~~For SI: 1 inch = 25.4 mm~~

~~a. Screws shall comply with ASTM C 1513 and shall penetrate a minimum of three threads through minimum 33 mil (20 gage) cold-formed steel frame construction.~~

~~b. Screw head diameter shall be not less than the nail head diameter required by Table R703.3(1).~~

~~c. Number and spacing of screw fasteners shall comply with Table R703.3(1).~~

~~d. Pan head, hex washer head, modified truss head or other screw head types with a flat attachment surface under the head shall be used for vinyl siding attachment.~~

~~e. Aluminum siding shall not be fastened directly to cold-formed steel light frame construction.~~

R703.3.1 Wind limitations. Deleted.

~~Where the design wind pressure exceeds 30 psf or where the limits of Table R703.3.1 are exceeded, the attachment of wall coverings shall be designed to resist the component and cladding loads specified in Table R301.2(2), adjusted for height and exposure in accordance with Table R301.2(3). For the determination of wall covering attachment, component and cladding loads shall be determined using an effective wind area of 10 square feet (0.93 m~~~~^{2}~~~~).~~

~~TABLE R703.3.1~~
~~LIMITS FOR ATTACHMENT PER TABLE R703.3(1)~~

~~MAXIMUM MEAN ROOF HEIGHT~~			
~~Ultimate Wind Speed (mph 3-second gust)~~	~~Exposure~~		
	~~B~~	~~C~~	~~D~~
~~115~~	~~NL~~	~~50′~~	~~20′~~
~~120~~	~~NL~~	~~30′~~	~~DR~~
~~130~~	~~60′~~	~~15′~~	~~DR~~
~~140~~	~~35′~~	~~DR~~	~~DR~~

~~For SI: 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.~~
~~NL = Not limited by Table R703.3.1, DR = Design required.~~

R703.3.2 Fasteners.
Exterior wall coverings shall be securely fastened with aluminum, galvanized, stainless steel or rust-preventative coated nails or staples in accordance with Table R703.3(1) or with other approved corrosion-resistant fasteners in accordance with the wall covering manufacturer’s installation instructions. Nails and staples shall comply with ASTM F 1667. Nails shall be T-head, modified round head, or round head with smooth or deformed shanks. Staples shall have a minimum crown width of $^{7}/_{16}$ inch (11.1 mm) outside diameter and be manufactured of minimum 16-gage wire. Where fiberboard, gypsum, or foam plastic sheathing backing is used, nails or staples shall be driven into the studs. Where wood or wood structural panel sheathing is used, fasteners shall be driven into studs unless otherwise permitted to be driven into sheathing in accordance with either the siding manufacturer’s installation instructions or Table R703.3.2.

> **Exception:** Openings for exterior balconies, decks, or porches under roofs enclosed with screen or removable vinyl or acrylic wind break panels shall not be required to be protected provided the spaces are separated from the building interior by a wall and all openings in the wall separating the unit from the balcony, deck or porch are protected in accordance with this section. Vinyl and acrylic glazed panels shall be removable. Removable panels shall be identified as removable by a decal. The identification decal shall state "Removable panel SHALL be removed when wind speeds exceed 75 mph (34 m/s)." Decals shall be placed such that the decal is visible when the panel is installed.

TABLE R703.3.2
OPTIONAL SIDING ATTACHMENT SCHEDULE FOR FASTENERS WHERE NO STUD PENETRATION NECESSARY

APPLICATION	NUMBER AND TYPE OF FASTENER	SPACING OF FASTENERS[b]
Exterior wall covering (weighing 3 psf or less) attachment to wood structural panel sheathing, either direct or over foam sheathing a maximum of 2 inches thick.[a] Note: Does not apply to vertical siding.	Ring shank roofing nail (0.120″ min. dia.)	12″ o.c.
	Ring shank nail (0.148″ min. dia.)	15″ o.c.
	No. 6 screw (0.138″ min. dia.)	12″ o.c.
	No. 8 screw (0.164″ min. dia.)	16″ o.c.

For SI: 1 inch = 25.4 mm.

a. Fastener length shall be sufficient to penetrate back side of the wood structural panel sheathing by at least $^{1}/4$ inch. The wood structural panel sheathing shall be not less than $^{7}/_{16}$ inch in thickness.

b. Spacing of fasteners is per 12 inches of siding width. For other siding widths, multiply “Spacing of Fasteners” above by a factor of 12/s, where “s” is the siding width in inches. Fastener spacing shall never be greater than the manufacturer’s minimum recommendations.

R703.4 Flashing.

Approved corrosion-resistant flashing shall be applied shingle-fashion in a manner to prevent entry of water into the wall cavity or penetration of water to the building structural framing components. Self-adhered membranes used as flashing shall comply with AAMA 711. Fluid-applied membranes used as flashing in exterior walls shall comply with AAMA 714. The flashing shall extend to the surface of the exterior wall finish. Aluminum flashing shall not be used in contact with cementitious material, except at counter flashing. Approved corrosion-resistant flashings shall be installed at the following locations:

1. Exterior window and door openings. Flashing at exterior window and door openings shall extend to the surface of the exterior wall finish or to the water-resistive barrier complying with Section 703.2 for subsequent drainage. Mechanically attached flexible flashings shall comply with AAMA 712. Flashing at exterior window and door openings shall be installed in accordance with one or more of the following:
   - 1.1. The fenestration manufacturer’s installation and flashing instructions, or for applications not addressed in the fenestration manufacturer’s instructions, in accordance with the flashing manufacturer’s instructions. Where flashing instructions or details are not provided, pan flashing shall be installed at the sill of exterior window and door openings. Pan flashing shall be sealed or sloped in such a manner as to direct water to the surface of the exterior wall finish or to the water-resistive barrier for subsequent drainage. Openings using pan flashing shall incorporate flashing or protection at the head and sides.
   - 1.2. In accordance with the flashing design or method of a registered design professional.
   - 1.3. In accordance with other approved methods.
2. At the intersection of chimneys or other masonry construction with frame or stucco walls, with projecting lips on both sides under stucco copings.
3. Under and at the ends of masonry, wood or metal copings and sills.
4. Continuously above all projecting wood trim.
5. Where exterior 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.

R703.6.3 Attachment.

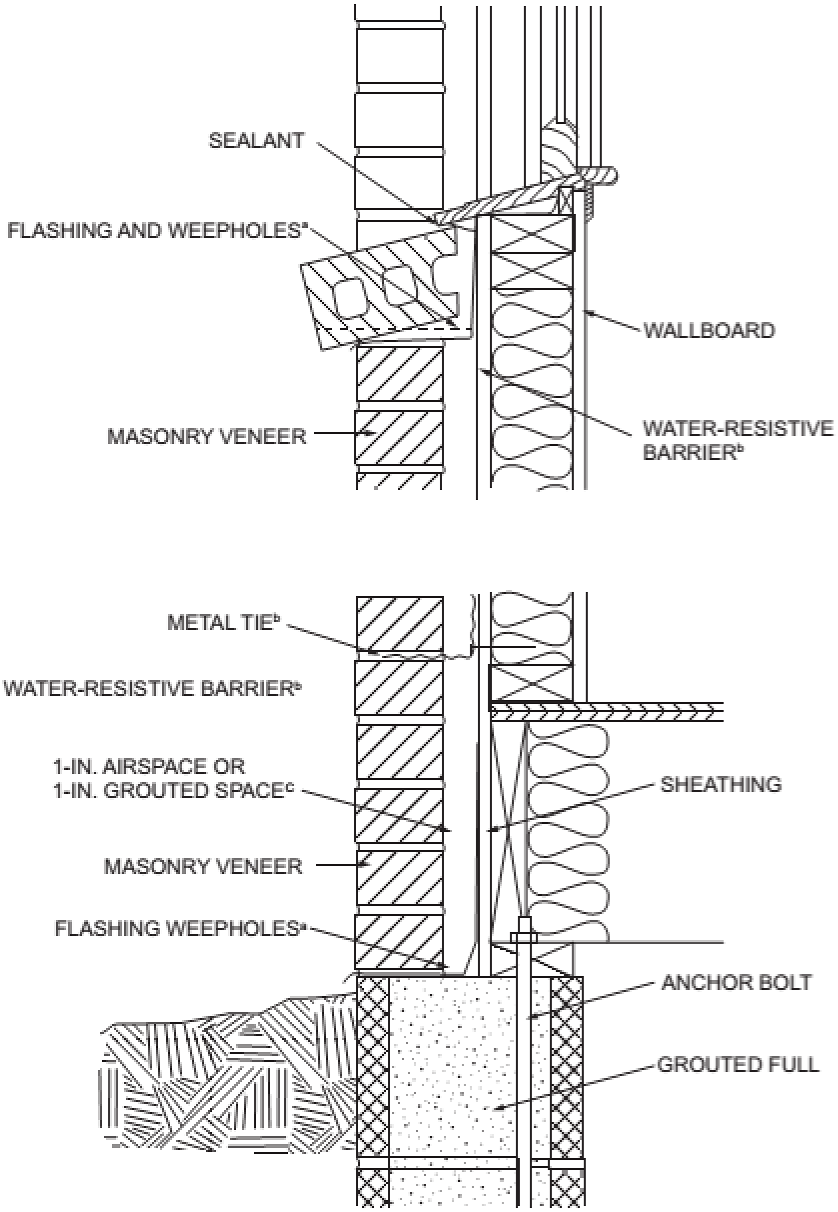
Wood shakes or shingles shall be installed according to this chapter and the manufacturer’s instructions. Each shake or shingle shall be held in place by two stainless steel Type 304, Type 316 or hot-dipped zinc-coated galvanized corrosion-resistant box nails in accordance with Table R703.6.3(1) or R703.6.3(2). The hot-dipped zinc-coated galvanizing shall conform to minimum standard ASTM A 153D, 1.0 ounce per square foot. Alternatively, 16-gage stainless steel Type 304 or Type 316 staples with crown widths $^{7}/_{16}$ inch (11 mm) minimum, $^{3}/_{4}$ inch (19 mm) maximum, shall be used and the crown of the staple shall be placed parallel with the butt of the shake or the shingle. In single-course application, the fasteners shall be concealed by the course above and shall be driven approximately 1 inch (25 mm) above the butt line of the succeeding course and $^{3}/_{4}$ inch (19 mm) from the edge. In double-course applications, the exposed shake or shingle shall be face-nailed with two fasteners, driven approximately 2 inches (51 mm) above the butt line and $^{3}/_{4}$ inch (19 mm) from each edge. ~~Fasteners installed within 15 miles (24 km) of salt water coastal areas shall be stainless steel Type 316.~~ Fasteners for fire-retardant-treated shakes or shingles in accordance with Section R902 or pressure-impregnated-preservative-treated shakes or shingles in accordance with AWPA U1 shall be stainless steel Type 316. The fasteners shall penetrate the sheathing or furring strips by not less than $^{1}/_{2}$ inch (13 mm) and shall not be overdriven. Fasteners for untreated (natural) and treated products shall comply with ASTM F 1667.

R703.8 Anchored stone and masonry veneer, general.

Anchored stone and masonry veneer shall be installed in accordance with this chapter~~,~~ and Table R703.3(1) ~~and Figure R703.8~~. These veneers installed over a backing of wood ~~or cold-formed steel~~ shall be limited to the first story above grade plane and shall not exceed 5 inches (127 mm) in thickness. See Section R602.10 for wall bracing requirements for masonry veneer for wood-framed construction ~~and Section R603.9.5 for wall bracing requirements for masonry veneer for cold-formed steel construction~~.

Exceptions:

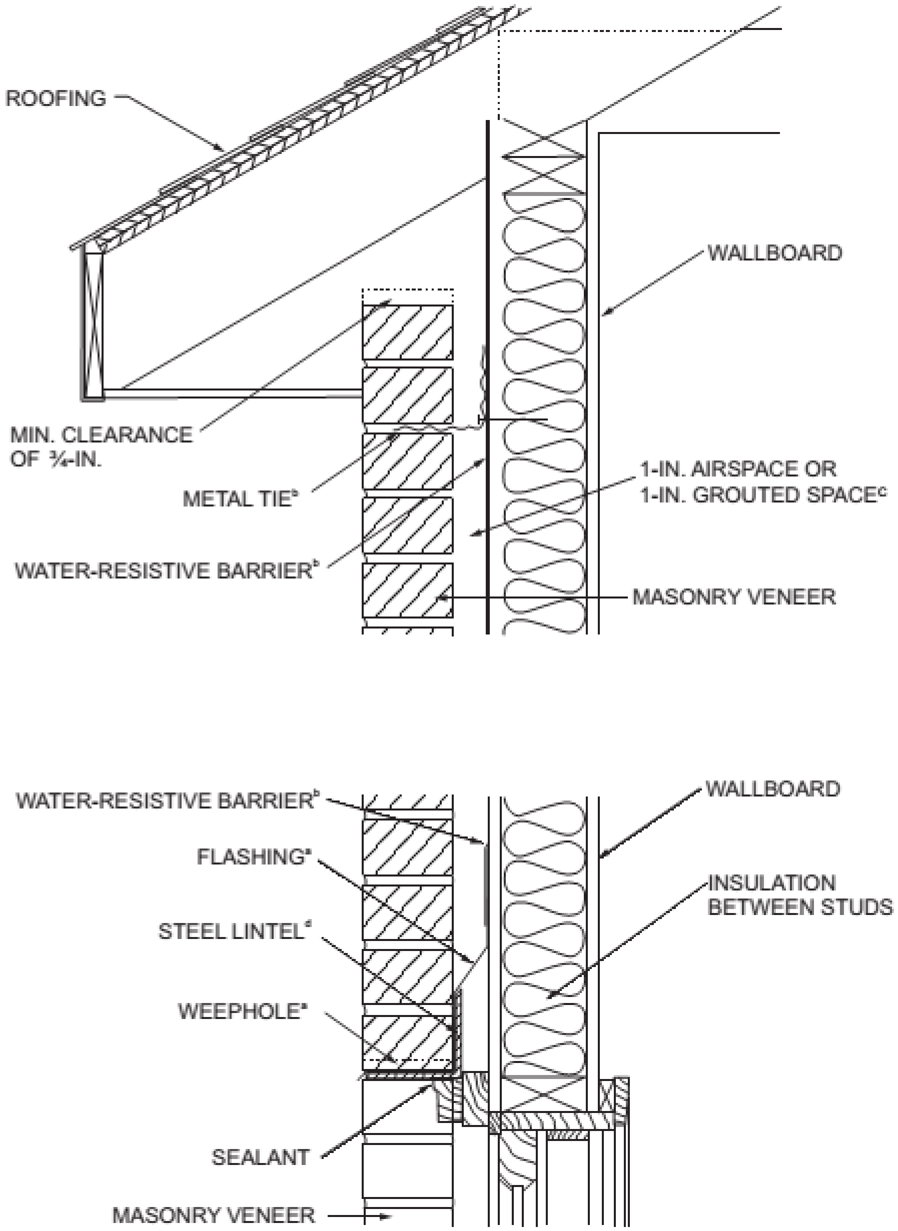
1. ~~For buildings in Seismic Design Categories A, B and C, e~~Exterior stone or masonry veneer, as specified in Table R703.8(1), with a backing of wood ~~or steel~~ framing shall be permitted to the height specified in Table R703.8(1) above a noncombustible foundation.
2. ~~For detached one- or two-family dwellings in Seismic Design Categories D_0, D_1 and D_2, exterior stone or masonry veneer, as specified in Table R703.8(2), with a backing of wood framing shall be permitted to the height specified in Table R703.8(2) above a noncombustible foundation.~~ Deleted.



For SI: 1 inch = 24.5 mm.

~~FIGURE R703.8~~
~~TYPICAL MASONRY VENEER WALL DETAILS~~

~~*(continued)*~~



~~For SI: 1 inch = 25.4 mm.~~

~~a. See Sections R703.8.5, R703.8.6 and R703.4.~~

~~b. See Sections R703.2 and R703.8.4.~~

~~c. See Section R703.8.4.2 and Table R703.8.4.~~

~~d. See Section R703.8.3.~~

~~e. Figure R703.8 illustrates typical construction details for a masonry veneer wall. For the actual mandatory requirements of this code, see the indicated sections of text. Other details of masonry veneer wall construction shall be permitted provided the requirements of the indicated sections of text are met.~~

~~FIGURE R703.8—continued~~

~~TYPICAL MASONRY VENEER WALL DETAILS[e]~~

TABLE R703.8(1)
STONE OR MASONRY VENEER LIMITATIONS AND REQUIREMENTS, WOOD ~~OR STEEL~~ FRAMING, SEISMIC DESIGN CATEGORIES A, B AND C

SEISMIC DESIGN CATEGORY	**NUMBER OF WOOD- ~~OR STEEL-~~ FRAMED STORIES**	**MAXIMUM HEIGHT OF VENEER ABOVE NONCOMBUSTIBLE FOUNDATION[a] (feet)**	**MAXIMUM NOMINAL THICKNESS OF VENEER (inches)**	**MAXIMUM WEIGHT OF VENEER (psf)[b]**	**WOOD- ~~OR STEEL-~~ FRAMED STORY**
A or B	~~Steel: 1 or 2~~ Wood: 1, 2 or 3	30	5	50	all
C	1	30	5	50	1 only
	2	30	5	50	top
					bottom
	Wood only: 3	30	5	50	top
					middle
					bottom

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.479 kPa.

a. An additional 8 feet is permitted for gable end walls. See also story height limitations of Section R301.3.

b. Maximum weight is installed weight and includes weight of mortar, grout, lath and other materials used for installation. Where veneer is placed on both faces of a wall, the combined weight shall not exceed that specified in this table.

~~TABLE R703.8(2)~~
~~STONE OR MASONRY VENEER LIMITATIONS AND REQUIREMENTS, ONE- AND TWO-FAMILY DETACHED DWELLINGS, SEISMIC DESIGN CATEGORIES D$_0$, D$_1$ AND D$_2$~~

~~SEISMIC DESIGN CATEGORY~~	~~NUMBER OF WOOD-FRAMED STORIES[a]~~	~~MAXIMUM HEIGHT OF VENEER ABOVE NONCOMBUSTIBLE FOUNDATION OR FOUNDATION WALL (feet)~~	~~MAXIMUM NOMINAL THICKNESS OF VENEER (inches)~~	~~MAXIMUM WEIGHT OF VENEER (psf)[b]~~
~~D$_0$~~	~~1~~	~~20[c]~~	~~4~~	~~40~~
	~~2~~	~~20[c]~~	~~4~~	~~40~~
	~~3~~	~~30[d]~~	~~4~~	~~40~~
~~D$_1$~~	~~1~~	~~20[c]~~	~~4~~	~~40~~
	~~2~~	~~20[c]~~	~~4~~	~~40~~

	~~3~~	~~20^c~~	~~4~~	~~40~~
~~D_2~~	~~1~~	~~20^c~~	~~3~~	~~30~~
	~~2~~	~~20^c~~	~~3~~	~~30~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.479 kPa, 1 pound-force = 4.448 N.~~

~~a. Cripple walls are not permitted in Seismic Design Categories D_0, D_1 and D_2.~~

~~b. Maximum weight is installed weight and includes weight of mortar, grout and lath, and other materials used for installation.~~

~~c. The veneer shall not exceed 20 feet in height above a noncombustible foundation, with an additional 8 feet permitted for gable end walls, or 30 feet in height with an additional 8 feet for gable end walls where the lower 10 feet have a backing of concrete or masonry wall. See story height limitations of Section R301.3.~~

~~d. The veneer shall not exceed 30 feet in height above a noncombustible foundation, with an additional 8 feet permitted for gable end walls. See story height limitations of Section R301.3.~~

R703.8.1 Interior veneer support.

Veneers used as interior wall finishes shall be permitted to be supported on wood ~~or cold-formed steel~~ floors that are designed to support the loads imposed.

R703.8.2 Exterior veneer support.

~~Except in Seismic Design Categories D_0, D_1 and D_2, e~~Exterior masonry veneers having an installed weight of 40 pounds per square foot (195 kg/m2) or less shall be permitted to be supported on wood ~~or cold-formed steel~~ construction. Where masonry veneer supported by wood ~~or cold-formed steel~~ construction adjoins masonry veneer supported by the foundation, there shall be a movement joint between the veneer supported by the wood ~~or cold-formed steel~~ construction and the veneer supported by the foundation. The wood ~~or cold-formed steel~~ construction supporting the masonry veneer shall be designed to limit the deflection to $^1/_{600}$ of the span for the supporting members. The design of the wood ~~or cold-formed steel~~ construction shall consider the weight of the veneer and any other loads.

R703.8.2.1 Support by steel angle.

A minimum 6-inch by 4-inch by $^5/_{16}$-inch (152 mm by 102 mm by 8 mm) steel angle, with the long leg placed vertically, shall be anchored to double 2-inch by 4-inch (51 mm by 102 mm) wood studs ~~or double 350S162 cold-formed steel studs~~ at a maximum on-center spacing of 16 inches (406 mm). Anchorage of the steel angle at every double stud spacing shall be not less than two $^7/_{16}$-inch-diameter (11 mm) by 4-inch (102 mm) lag screws for wood construction ~~or two $^7/_{16}$-inch (11.1 mm) bolts with washers for cold-formed steel construction~~. The steel angle shall have a minimum clearance to underlying construction of $^1/_{16}$ inch (1.6 mm). Not less than two-thirds the width of the masonry veneer thickness shall bear on the steel angle. Flashing and weep holes shall be located in the masonry veneer in accordance with Figure R703.8.2.1. The maximum height of masonry veneer above the steel angle support shall be 12 feet 8 inches (3861 mm). The airspace separating the masonry veneer from the wood backing shall be in accordance with Sections R703.8.4 and R703.8.4.2. The method of support for the masonry veneer on wood construction shall be constructed in accordance with Figure R703.8.2.1

The maximum slope of the roof construction without stops shall be 7:12. Roof construction with slopes greater than 7:12 but not more than 12:12 shall have stops of a minimum 3-inch by 3-inch by $^{1}/_{4}$-inch (76 mm by 76 mm by 6.4 mm) steel plate welded to the angle at 24 inches (610 mm) on center along the angle or as *approve*d by the *building official*.

R703.8.2.2 Support by roof construction.
A steel angle shall be placed directly on top of the roof construction. The roof supporting construction for the steel angle shall consist of not fewer than three 2-inch by 6-inch (51 mm by 152 mm) wood members for wood construction ~~or three 550S162 cold-formed steel members for cold-formed steel light frame construction~~. A wood member abutting the vertical wall stud construction shall be anchored with not fewer than three $^{5}/_{8}$-inch (15.9 mm) diameter by 5-inch (127 mm) lag screws to every wood stud spacing. Each additional wood roof member shall be anchored by the use of two 10d nails at every wood stud spacing. ~~A cold-formed steel member abutting the vertical wall stud shall be anchored with not fewer than nine No. 8 screws to every cold-formed steel stud. Each additional cold-formed steel roof member shall be anchored to the adjoining roof member using two No. 8 screws at every stud spacing.~~ Not less than two-thirds the width of the masonry veneer thickness shall bear on the steel angle. Flashing and weep holes shall be located in the masonry veneer wythe in accordance with Figure R703.8.2.2. The maximum height of the masonry veneer above the steel angle support shall be 12 feet 8 inches (38.61 mm). The airspace separating the masonry veneer from the wood backing shall be in accordance with Sections R703.8.4 and R703.8.4.2. The support for the masonry veneer shall be constructed in accordance with Figure R703.8.2.2.

The maximum slope of the roof construction without stops shall be 7:12. Roof construction with slopes greater than 7:12 but not more than 12:12 shall have stops of a minimum 3-inch by 3-inch by $^{1}/_{4}$-inch (76 mm by 76 mm by 6.4 mm) steel plate welded to the angle at 24 inches (610 mm) on center along the angle or as *approved* by the *building official*.

TABLE R703.8.3.1
ALLOWABLE SPANS FOR LINTELS SUPPORTING MASONRY VENEER[a, b, c, d, e]

SIZE OF STEEL ANGLE[a, c, d] (inches)	NO STORY ABOVE	ONE STORY ABOVE	TWO STORIES ABOVE	NO. OF $^{1}/_{2}$-INCH OR EQUIVALENT REINFORCING BARS IN REINFORCED LINTEL[b, d]
3 × 3 × $^{1}/_{4}$	6′-0″	4′-6″	3′-0″	1

4 × 3 × $^{1}/_{4}$	8′-0″	6′-0″	4′-6″	1
5 × 3$^{1}/_{2}$ × $^{5}/_{16}$	10′-0″	8′-0″	6′-0″	2
6 × 3$^{1}/_{2}$ × $^{5}/_{16}$	14′-0″	9′-6″	7′-0″	2
2-6 × 3$^{1}/_{2}$ × $^{5}/_{16}$	20′-0″	12′-0″	9′-6″	4

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

a. Long leg of the angle shall be placed in a vertical position.

b. 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.

c. Steel members indicated are adequate typical examples; other steel members meeting structural design requirements shall be permitted to be used.

d. Either steel angle or reinforced lintel shall span opening.

e. Spans over 4 feet (1219 mm) shall be shored up until cured.

TABLE R703.8.4
TIE ATTACHMENT AND AIRSPACE REQUIREMENTS

BACKING AND TIE	MINIMUM TIE	MINIMUM TIE FASTENER~~[a]~~	AIRSPACE[a]	
Wood stud backing with corrugated sheet metal	22 U.S. gage (0.0299 in.) × $^{7}/_{8}$ in. wide	8d common nail [b] (2$^{1}/_{2}$ in. × 0.131 in.)	Nominal 1 in. between sheathing and veneer	
Wood stud backing with metal strand wire	W1.7 (No. 9 U.S. gage; 0.148 in.) with hook embedded in mortar joint	8d common nail [b] (2$^{1}/_{2}$ in. × 0.131 in.)	Minimum nominal 1 in. between sheathing and veneer	Maximum 4$^{1}/_{2}$ in. between backing and veneer
~~Cold-formed steel stud backing with adjustable metal strand wire~~	~~W1.7 (No. 9 U.S. gage; 0.148 in.) with hook embedded in mortar joint~~	~~No. 10 screw extending through the steel framing a minimum of three exposed threads~~	~~Minimum nominal 1 in. between sheathing and veneer~~	~~Maximum 4$^{1}/_{2}$ in. between backing and veneer~~

For SI: 1 inch = 25.4 mm.

a. ~~In Seismic Design Category D_0, D_1 or D_2, the minimum tie fastener shall be an 8d ring-shank nail (2$^{1}/_{2}$ in. × 0.131 in.) or a No. 10 screw extending through the steel framing a minimum of three exposed threads.~~ An airspace that provides drainage and contains mortar from construction shall be permitted.

b. All fasteners shall have rust-inhibitive coating suitable for the installation in which they are being used, or be manufactured from material not susceptible to corrosion.

R703.8.4.1 Size and spacing.

Veneer ties, if strand wire, shall be not less in thickness than No. 9 U.S. gage [(0.148 inch) (4 mm)] wire and shall have a hook embedded in the mortar joint, or if sheet metal, shall be not less than No. 22 U.S. gage by [(0.0299 inch) (0.76 mm)] $^{7}/_{8}$ inch (22 mm) corrugated. Each tie shall support not more than 2.67 square feet (0.25 m^2) of wall area and shall be spaced not more than 32 inches (813 mm) on center horizontally and 24 inches (635 mm) on center vertically.

Exception: In ~~Seismic Design Category D_0, D_1 or D_2 or~~ townhouses in Seismic Design Category C or in wind areas of more than 30 pounds per square foot pressure (1.44 kPa), each tie shall support not more than 2 square feet (0.2 m^2) of wall area.

R703.8.5 Flashing.

Flashing of 6 mil (0.152 mm) poly or other corrosions resistive material shall be located beneath the first course of masonry above finished ground level above the foundation wall or slab and at other points of support, including structural floors, shelf angles and lintels where masonry veneers are designed in accordance with Section R703.8. Top of base flashing shall be installed with a minimum 2 inch (51 mm) lap behind building paper or water repellant sheathing. See Section R703.4 for additional requirements.

R703.8.6 Weepholes.

Weepholes shall be provided in the outside wythe of masonry walls at a maximum spacing of ~~33~~ 48 inches (~~838~~ 1219 mm) on center. Weepholes shall be not less than $^3/_{16}$ inch (5 mm) in diameter. Weepholes shall be located immediately above the flashing.

R703.9 Exterior insulation and finish system (EIFS)/EIFS with drainage.

Exterior insulation and finish systems (EIFS) shall comply with this chapter and Section R703.9.1. EIFS with drainage shall comply with this chapter and Section R703.9.2.

R703.9.1 Exterior insulation and finish systems (EIFS).

~~EIFS shall comply with the following:~~Non-drainable EIFS shall not be permitted.

1. ~~ASTM E 2568.~~
2. ~~EIFS shall be limited to applications over substrates of concrete or masonry wall assemblies.~~
3. ~~Flashing of EIFS shall be provided in accordance with the requirements of Section R703.8.~~
4. ~~EIFS shall be installed in accordance with the manufacturer's instructions.~~
5. ~~EIFS shall terminate not less than 6 inches (152 mm) above the finished ground level.~~
6. ~~Decorative trim shall not be face-nailed through the EIFS.~~

R703.9.2 Exterior insulation and finish system (EIFS) with drainage.

EIFS with drainage shall comply with the following:

1. ASTM E 2568.

2. EIFS with drainage shall be required over all wall assemblies with the exception of substrates of concrete or masonry wall assemblies.
3. EIFS with drainage shall have an average minimum drainage efficiency of 90 percent when tested in accordance with ASTM E 2273.
4. The water-resistive barrier shall comply with Section R703.2 or ASTM E 2570.
5. The water-resistive barrier shall be applied between the EIFS and the wall sheathing.
6. Flashing of EIFS with drainage shall be provided in accordance with the requirements of Section R703.8.
7. EIFS with drainage shall be installed in accordance with the manufacturer’s instructions.
8. EIFS with drainage shall terminate not less than 6 inches (152 mm) above the finished ground level.
9. Decorative trim shall not be face-nailed through the EIFS with drainage.

R703.11.1.1 Fasteners. Deleted.
~~Unless specified otherwise by the manufacturer’s instructions, fasteners for vinyl siding shall be 0.120-inch (3 mm) shank diameter nail with a 0.313-inch (8 mm) head or 16-gage staple with a $^{3}/_{8}$-inch (9.5 mm) to $^{1}/_{2}$-inch (12.7 mm) crown.~~

R703.11.1.2 Penetration depth. Deleted.
~~Unless specified otherwise by the manufacturer’s instructions, fasteners shall penetrate into building framing. The total penetration into sheathing, furring framing or other nailable substrate shall be a minimum 1$^{1}/_{4}$ inches (32 mm). Where specified by the manufacturer’s instructions and supported by a test report, fasteners are permitted to penetrate into or fully through nailable sheathing or other nailable substrate of minimum thickness specified by the instructions or test report without penetrating into framing. Where the fastener penetrates fully through the sheathing, the end of the fastener shall extend a minimum of $^{1}/_{4}$ inch (6.4 mm) beyond the opposite face of the sheathing or nailable substrate.~~

R703.11.1.3 Spacing. Deleted.
~~Unless specified otherwise by the manufacturer’s instructions, the maximum spacing between fasteners for horizontal siding shall be 16 inches (406 mm), and for vertical siding 12 inches (305 mm) both horizontally and vertically. Where specified by the manufacturer’s instructions and supported by a test report, greater fastener spacing is permitted~~.

R703.12.3 Water-resistive barrier.
A water-resistive barrier shall be installed as required by Section R703.2 and shall comply

with the requirements of Section ~~R703.6.3~~ R703.7.3. The water-resistive barrier shall lap over the exterior of the attachment flange of the screed or flashing provided in accordance with Section R703.12.2.

R703.16 Cladding attachment over foam sheathing to cold-formed steel framing. Deleted. ~~Cladding shall be specified and installed in accordance with Section R703, the cladding manufacturer's approved instructions, including any limitations for use over foam plastic sheathing, or an approved design. In addition, the cladding or furring attachments through foam sheathing to framing shall meet or exceed the minimum fastening requirements of Section R703.16.1, Section R703.16.2 or an approved design for support of cladding weight.~~

~~**Exceptions:**~~

1. ~~Where the cladding manufacturer has provided approved installation instructions for application over foam sheathing, those requirements shall apply.~~
2. ~~For exterior insulation and finish systems, refer to Section R703.9.~~
3. ~~For anchored masonry or stone veneer installed over foam sheathing, refer to Section R703.7.~~

~~**R703.16.1 Direct attachment.**~~

~~Where cladding is installed directly over foam sheathing without the use of furring, cladding minimum fastening requirements to support the cladding weight shall be as specified in Table R703.16.1.~~

~~**TABLE R703.16.1**~~
~~**CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT**~~[a]

~~CLADDING FASTENER THROUGH FOAM SHEATHING INTO:~~	~~CLADDING FASTENER TYPE AND MINIMUM SIZE~~[b]	~~CLADDING FASTENER VERTICAL SPACING (inches)~~	~~MAXIMUM THICKNESS OF FOAM SHEATHING~~[c] ~~(inches)~~					
			~~16″ o.c. Fastener Horizontal Spacing~~			~~24" o.c. Fastener Horizontal Spacing~~		
			~~Cladding Weight:~~			~~Cladding Weight:~~		
			~~3 psf~~	~~11 psf~~	~~25 psf~~	~~3 psf~~	~~11 psf~~	~~25 psf~~
~~Steel Framing (minimum penetration of steel thickness + 3 threads)~~	~~No. 8 screw into 33 mil steel or thicker~~	~~6~~	~~3~~	~~3~~	~~1.5~~	~~3~~	~~2~~	~~DR~~
		~~8~~	~~3~~	~~2~~	~~0.5~~	~~3~~	~~1.5~~	~~DR~~
		~~12~~	~~3~~	~~1.5~~	~~DR~~	~~3~~	~~0.75~~	~~DR~~
	~~No. 10 screw into 33 mil steel~~	~~6~~	~~4~~	~~3~~	~~2~~	~~4~~	~~3~~	~~0.5~~
		~~8~~	~~4~~	~~3~~	~~1~~	~~4~~	~~2~~	~~DR~~
		~~12~~	~~4~~	~~2~~	~~DR~~	~~3~~	~~1~~	~~DR~~
	~~No. 10 screw into 43 mil steel or thicker~~	~~6~~	~~4~~	~~4~~	~~3~~	~~4~~	~~4~~	~~2~~
		~~8~~	~~4~~	~~4~~	~~2~~	~~4~~	~~3~~	~~1.5~~
		~~12~~	~~4~~	~~3~~	~~1.5~~	~~4~~	~~3~~	~~DR~~

~~For SI: 1 inch = 25.4 mm, 1 mil = 0.0254 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa.~~

~~DR = Design required.~~
~~o.c. = on center.~~
~~a. Steel framing shall be minimum 33 ksi steel for 33 mil and 43 mil steel, and 50 ksi steel for 54 mil steel or thicker.~~
~~b. Screws shall comply with the requirements of ASTM C 1513.~~
~~c. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C 578 or ASTM C 1289.~~

~~R703.16.2 Furred cladding attachment.~~

~~Where steel or wood furring is used to attach cladding over foam sheathing, furring minimum fastening requirements to support the cladding weight shall be as specified in Table R703.16.2. Where placed horizontally, wood furring shall be preservative-treated wood in accordance with Section R317.1 or naturally durable wood and fasteners shall be corrosion resistant in accordance with Section R317.3. Steel furring shall have a minimum G60 galvanized coating.~~

~~TABLE R703.16.2~~
~~FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT~~[a]

~~FURRING MATERIAL~~	~~FRAMING MEMBER~~	~~FASTENER TYPE AND MINIMUM SIZE~~[b]	~~MINIMUM PENETRATION INTO WALL FRAMING (inches)~~	~~FASTENER SPACING IN FURRING (inches)~~	~~MAXIMUM THICKNESS OF FOAM SHEATHING~~[d] ~~(inches)~~					
					~~16″ o.c. Furring~~[e]			~~24″ o.c. Furring~~[e]		
					~~Cladding Weight:~~			~~Cladding Weight:~~		
					~~3 psf~~	~~11 psf~~	~~25 psf~~	~~3 psf~~	~~11 psf~~	~~25 psf~~
~~Minimum 33 mil Steel Furring or Minimum 1´ Wood Furring~~[c]	~~33 mil Steel Stud~~	~~No. 8 screw~~	~~Steel thickness + 3 threads~~	~~12~~	~~3~~	~~1.5~~	~~DR~~	~~3~~	~~0.5~~	~~DR~~
				~~16~~	~~3~~	~~1~~	~~DR~~	~~2~~	~~DR~~	~~DR~~
				~~24~~	~~2~~	~~DR~~	~~DR~~	~~2~~	~~DR~~	~~DR~~
		~~No. 10 screw~~	~~Steel thickness + 3 threads~~	~~12~~	~~4~~	~~2~~	~~DR~~	~~4~~	~~1~~	~~DR~~
				~~16~~	~~4~~	~~1.5~~	~~DR~~	~~3~~	~~DR~~	~~DR~~
				~~24~~	~~3~~	~~DR~~	~~DR~~	~~2~~	~~DR~~	~~DR~~
	~~43 mil or thicker Steel Stud~~	~~No. 8 Screw~~	~~Steel thickness + 3 threads~~	~~12~~	~~3~~	~~1.5~~	~~DR~~	~~3~~	~~0.5~~	~~DR~~
				~~16~~	~~3~~	~~1~~	~~DR~~	~~2~~	~~DR~~	~~DR~~
				~~24~~	~~2~~	~~DR~~	~~DR~~	~~2~~	~~DR~~	~~DR~~
		~~No. 10 screw~~	~~Steel thickness + 3 threads~~	~~12~~	~~4~~	~~3~~	~~1.5~~	~~4~~	~~3~~	~~DR~~
				~~16~~	~~4~~	~~3~~	~~0.5~~	~~4~~	~~2~~	~~DR~~
				~~24~~	~~4~~	~~2~~	~~DR~~	~~4~~	~~0.5~~	~~DR~~

~~For SI: 1 inch = 25.4 mm, 1 mil = 0.0254 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa.~~
~~DR = Design required.~~
~~o.c. = on center.~~
~~a. Wood furring shall be Spruce-pine-fir or any softwood species with a specific gravity of 0.42 or greater. Steel furring shall be minimum 33 ksi steel. Steel studs shall be minimum 33 ksi steel for 33mil and 43 mil thickness, and 50 ksi steel for 54 mil steel or thicker.~~
~~b. Screws shall comply with the requirements of ASTM C 1513.~~

~~c. Where the required cladding fastener penetration into wood material exceeds $^3/_4$ inch and is not more than 1 $^1/_2$ inches, a minimum 2-inch nominal wood furring or an approved design shall be used.~~

~~d. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C 578 or ASTM C 1289.~~

~~e. Furring shall be spaced not more than 24 inches (610 mm) on center, in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, the indicated 8-inch and 12-inch fastener spacing in furring shall be achieved by use of two fasteners into studs at 16 inches and 24 inches on center, respectively.~~

CHAPTER 8
ROOF-CEILING CONSTRUCTION

SECTION R802
WOOD ROOF FRAMING

R802.3 Framing details.

Rafters shall be framed ~~not more than 1$^{1}/_{2}$-inch (38 mm) offset from each other~~ to ridge board or ~~directly opposite from~~ to each other with a gusset plate as a tie. Ridge board shall be not less than 1-inch (25 mm) nominal thickness and not less in depth than the cut end of the rafter. Opposing rafters at the ridge must align within the thickness of the ridge member. Regularly spaced hip and valley rafters need not align. At valleys and hips there shall be a valley or hip rafter not less than 2-inch (51 mm) nominal thickness and not less in depth than the cut end of the rafter. Hip and valley rafters shall be supported at the ridge by a brace to a bearing partition or be designed to carry and distribute the specific load at that point. Where the roof pitch is less than three units vertical in 12 units horizontal (25-percent slope), structural members that support rafters and ceiling joists, such as ridge beams, hips and valleys, shall be designed as beams.

R802.3.1 Ceiling joist and rafter connections.

Ceiling joists and rafters shall be nailed to each other in accordance with Table R802.5.1(9), and the rafter shall be nailed to the top wall plate in accordance with Table R602.3(1). Ceiling joists shall be continuous or securely joined in accordance with Table R802.5.1(9) where they meet over interior partitions and are nailed to adjacent rafters to provide a continuous tie across the building where such joists are parallel to the rafters.

Where ceiling joists are not connected to the rafters at the top wall plate, joists connected higher in the *attic* shall be installed as rafter ties, or rafter ties shall be installed to provide a continuous tie. Where ceiling joists are not parallel to rafters, subflooring or metal straps attached to the ends of the rafters shall be installed in a manner to provide a continuous tie across the building or rafter ties shall be installed. Rafter ties shall be not less than 2 inches by 4 inches (51 mm by 102 mm) (nominal), installed in accordance with the connection requirements in Table R802.5.1(9), or connections of equivalent capacities shall be provided. Where ceiling joists or rafter ties are not provided, the ridge formed by these rafters shall be supported by a wall or girder designed in accordance with accepted engineering practice.

Rafter ties shall be spaced not more than 4 feet (1219 mm) on center.

Collar ties or ridge straps to resist wind uplift shall be connected in the upper third of the *attic* space in accordance with Table R602.3(1).

Collar ties shall be not less than 1 inch by 4 inches (25 mm by 102 mm) (nominal), spaced not more than 4 feet (1219 mm) on center.

TABLE R802.5.1(1)
RAFTER SPANS FOR COMMON LUMBER SPECIES

(Roof live load = 20 psf, ceiling not attached to rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
12	Douglas fir-larch	SS	11-6	18-0	23-9	Note b	Note b	11-6	18-0	23-9	Note b	Note b
	Douglas fir-larch	#1	11-1	17-4	22-5	Note b	Note b	10-6	15-4	19-5	23-9	Note b
	Douglas fir-larch	#2	10-10	16-10	21-4	26-0	Note b	10-0	14-7	18-5	22-6	26-0
	Douglas fir-larch	#3	8-9	12-10	16-3	19-10	23-0	7-7	11-1	14-1	17-2	19-11
	Hem-fir	SS	10-10	17-0	22-5	Note b	Note b	10-10	17-0	22-5	Note b	Note b
	Hem-fir	#1	10 -7	16-8	22-0	Note b	Note b	10-4	15-2	19-2	23-5	Note b
	Hem-fir	#2	10-1	15-11	20-8	25-3	Note b	9-8	14-2	17-11	21-11	25-5
	Hem-fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Southern pine	SS	11-3	17-8	23-4	Note b	Note b	11-3	17-8	23-4	Note b	Note b
	Southern pine	#1	10-10	17-0	22-5	Note b	Note b	10-6	15-8	19-10	23-2	Note b
	Southern pine	#2	10-4	15-7	19-8	23-5	Note b	9-0	13-6	17-1	20-3	23-10
	Southern pine	#3	8-0	11-9	14-10	18-0	21-4	6-11	10-2	12-10	15-7	18-6
	Spruce-pine-fir	SS	10-7	16-8	21-11	Note b	Note b	10-7	16-8	21-9	Note b	Note b
	Spruce-pine-fir	#1	10-4	16-3	21-0	25-8	Note b	9-10	14-4	18-2	22-3	25-9
	Spruce-pine-fir	#2	10-4	16-3	21-0	25-8	Note b	9-10	14-4	18-2	22-3	25-9
	Spruce-pine-fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
16	Douglas fir-larch	SS	10-5	16-4	21-7	Note b	Note b	10-5	16-3	20-7	25-2	Note b
	Douglas fir-larch	#1	10-0	15-4	19-5	23-9	Note b	9-1	13-3	16-10	20-7	23-10
	Douglas fir-larch	#2	9-10	14-7	18-5	22-6	26-0	8-7	12-7	16-0	19-6	22-7
	Douglas fir-larch	#3	7-7	11-1	14-1	17-2	19-11	6-7	9-8	12-12	14-11	17-3
	Hem-fir	SS	9-10	15-6	20-5	Note b	Note b	9-10	15-6	19-11	24-4	Note b
	Hem-fir	#1	9-8	15-2	19-2	23-5	Note b	9-0	13-1	16-7	20-4	23-7
	Hem-fir	#2	9-2	14-2	17-11	21-11	25-5	8-5	12-3	15-6	18-11	22-0
	Hem-fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
	Southern pine	SS	10-3	16-1	21-2	Note b	Note b	10-3	16-1	21-2	25-7	Note b
	Southern pine	#1	9-10	15-6	19-10	23-2	Note b	9-1	13-7	17-2	20-1	23-10
	Southern pine	#2	9-0	13-6	17-1	20-3	23-10	7-9	11-8	14-9	17-6	20-8

	Southern pine	#3	6-11	10-2	12-10	15-7	18-6	6-0	8-10	11-2	13-6	16-0
	Spruce-pine-fir	SS	9-8	15-2	19-11	25-5	Note b	9-8	14-10	18-10	23-0	Note b
	Spruce-pine-fir	#1	9-5	14-4	18-2	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-pine-fir	#2	9-5	14-4	18-2	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-pine-fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
19.2	Douglas fir-larch	SS	9-10	15-5	20-4	25-11	Note b	9-10	14-10	18-10	23-0	Note b
	Douglas fir-larch	#1	9-5	14-0	17-9	21-8	25-2	8-4	12-2	15-4	18-9	21-9
	Douglas fir-larch	#2	9-1	13-3	16-10	20-7	23-10	7-10	11-6	14-7	17-10	20-8
	Douglas fir-larch	#3	6-11	10-2	12-10	15-8	18-3	6-0	8-9	11-2	12-7	15-9
	Hem-fir	SS	9-3	14-7	19-2	24-6	Note b	9-3	14-4	18-2	22-3	25-9
	Hem-fir	#1	9-1	13-10	17-6	21-5	24-10	8-2	12-0	15-2	18-6	21-6
	Hem-fir	#2	8-8	12-11	16-4	20-0	23-2	7-8	11-2	14-2	17-4	20-1
	Hem-fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
	Southern pine	SS	9-8	15-2	19-11	25-5	Note b	9-8	15-2	19-7	23-4	Note b
	Southern pine	#1	9-3	14-3	18-1	21-2	25-2	8-4	12-4	15-8	18-4	21-9
	Southern pine	#2	8-2	12-3	15-7	18-6	21-9	7-1	10-8	13-6	16-0	18-10
	Southern pine	#3	6-4	9-4	11-9	14-3	16-10	5-6	8-1	10-2	12-4	14-7
	Spruce-pine-fir	SS	9-1	14-3	18-9	23-11	Note b	9-1	13-7	17-2	21-0	24-4
	Spruce-pine-fir	#1	8-10	13-1	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-pine-fir	#2	8-10	13-1	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-pine-fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5

(continued)

TABLE R802.5.1(1)—continued RAFTER SPANS FOR COMMON LUMBER SPECIES (Roof live load = 20 psf, ceiling not attached to rafters, L/Δ = 180)

RAFTER SPACING (inches)	**SPECIES AND GRADE**	**DEAD LOAD = 10 psf**					**DEAD LOAD = 20 psf**				
		2 × 4	**2 × 6**	**2 × 8**	**2 × 10**	**2 × 12**	**2 × 4**	**2 × 6**	**2 × 8**	**2 × 10**	**2 × 12**
		Maximum rafter spans[a]									
		(feet - inches)	**(feet - inches)**	**(feet - inches)**	**(feet - inches)**	**(feet - inches)**	**(feet - inches)**	**(feet - inches)**	**(feet - inches)**	**(feet - inches)**	**(feet - inches)**

24	Douglas fir-larch	SS	9-1	14-4	18-10	23-9	Note b	9-1	13-3	16-10	20-7	23-10
	Douglas fir-larch	#1	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Douglas fir-larch	#2	8-2	11-11	15-1	18-5	21-4	7-0	10-4	13-0	15-11	18-6
	Douglas fir-larch	#3	6-2	9-1	11-6	14-1	16-3	5-4	7-10	10-0	12-2	14-1
	Hem-fir	SS	8-7	13-6	17-10	22-9	Note b	8-7	12-10	16-3	19-10	23-0
	Hem-fir	#1	8-5	12-4	15-8	19-2	22-2	7-4	10-9	13-7	16-7	19-3
	Hem-fir	#2	7-11	11-7	14-8	17-10	20-9	6-10	10-0	12-8	15-6	17-11
	Hem-fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9
	Southern pine	SS	8-11	14-1	18-6	23-8	Note b	8-11	13-10	17-6	20-10	24-8
	Southern pine	#1	8-7	12-9	16-2	18-11	22-6	7-5	11-1	14-0	16-5	19-6
	Southern pine	#2	7-4	11-0	~~10’-11”~~ 13’-11”	16-6	19-6	6-4	9-6	12-1	14-4	16-10
	Southern pine	#3	5-8	8-4	10-6	12-9	15-1	4-11	7-3	9-1	11-0	13-1
	Spruce-pine-fir	SS	8-5	13-3	17-5	21-8	25-2	8-4	12-2	15-4	18-9	21-9
	Spruce-pine-fir	#1	8-0	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-pine-fir	#2	8-0	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-pine-fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9

Check sources for availability of lumber in lengths greater than 20 feet.
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the following factors:

H_C/H_R	**Rafter Span Adjustment Factor**
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.
H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

b. Span exceeds 26 feet in length.

TABLE R802.5.1(2)

RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof live load = 20 psf, ceiling attached to rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
12	Douglas fir-larch	SS	10-5	16-4	21-7	Note b	Note b	10-5	16-4	21-7	Note b	Note b
	Douglas fir-larch	#1	10-0	15-9	20-10	Note b	Note b	10-0	15-4	19-5	23-9	Note b
	Douglas fir-larch	#2	9-10	15-6	20-5	26-0	Note b	9-10	14-7	18-5	22-6	26-0
	Douglas fir-larch	#3	8-9	12-10	16-3	19-10	23-0	7-7	11-1	14-1	17-2	19-11
	Hem-fir	SS	9-10	15-6	20-5	Note b	Note b	9-10	15-6	20-5	Note b	Note b
	Hem-fir	#1	9-8	15-2	19-11	25-5	Note b	9-8	15-2	19-2	23-5	Note b
	Hem-fir	#2	9-2	14-5	19-0	24-3	Note b	9-2	14-2	17-11	21-11	25-5
	Hem-fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Southern pine	SS	10-3	16-1	21-2	Note b	Note b	10-3	16-1	21-2	Note b	Note b
	Southern pine	#1	9-10	15-6	20-5	Note b	Note b	9-10	15-6	19-10	23-2	Note b
	Southern pine	#2	9-5	14-9	19-6	23-5	Note b	9-0	13-6	17-1	20-3	23-10
	Southern pine	#3	8-0	11-9	14-10	18-0	21-4	6-11	10-2	12-10	15-7	18-6
	Spruce-pine-fir	SS	9-8	15-2	19-11	25-5	Note b	9-8	15-2	19-11	25-5	Note b
	Spruce-pine-fir	#1	9-5	14-9	19-6	24-10	Note b	9-5	14-4	18-2	22-3	25-9
	Spruce-pine-fir	#2	9-5	14-9	19-6	24-10	Note b	9-5	14-4	18-2	22-3	25-9
	Spruce-pine-fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
16	Douglas fir-larch	SS	9-6	14-11	19-7	25-0	Note b	9-6	14-11	19-7	25-0	Note b
	Douglas fir-larch	#1	9-1	14-4	18-11	23-9	Note b	9-1	13-3	16-10	20-7	23-10
	Douglas fir-larch	#2	8-11	14-1	18-5	22-6	26-0	8-7	12-7	16-0	19-6	22-7
	Douglas fir-larch	#3	7-7	11-1	14-1	17-2	19-11	6-7	9-8	12-2	14-11	17-3
	Hem-fir	SS	8-11	14-1	18-6	23-8	Note b	8-11	14-1	18-6	23-8	Note b
	Hem-fir	#1	8-9	13-9	18-1	23-1	Note b	8-9	13-1	16-7	20-4	23-7
	Hem-fir	#2	8-4	13-1	17-3	21-11	25-5	8-4	12-3	15-6	18-11	22-0
	Hem-fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
	Southern pine	SS	9-4	14-7	19-3	24-7	Note b	9-4	14-7	19-3	24-7	Note b
	Southern pine	#1	8-11	14-1	18-6	23-2	Note b	8-11	13-7	17-2	20-1	23-10

	Southern pine	#2	8-7	13-5	17-1	20-3	23-10	7-9	11-8	14-9	17-6	20-8
	Southern pine	#3	6-11	10-2	12-10	15-7	18-6	6-0	8-10	11-2	13-6	16-0
	Spruce-pine-fir	SS	8-9	13-9	18-1	23-1	Note b	8-9	13-9	18-1	23-0	Note b
	Spruce-pine-fir	#1	8-7	13-5	17-9	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-pine-fir	#2	8-7	13-5	17-9	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-pine-fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
19.2	Douglas fir-larch	SS	8-11	14-0	18-5	23-7	Note b	8-11	14-0	18-5	23-0	Note b
	Douglas fir-larch	#1	8-7	13-6	17-9	21-8	25-2	8-4	12-2	15-4	18-9	21-9
	Douglas fir-larch	#2	8-5	13-3	16-10	20-7	23-10	7-10	11-6	14-7	17-10	20-8
	Douglas fir-larch	#3	6-11	10-2	12-10	15-8	18-3	6-0	8-9	11-2	13-7	15-9
	Hem-fir	SS	8-5	13-3	17-5	22-3	Note b	8-5	13-3	17-5	22-3	25-9
	Hem-fir	#1	8-3	12-11	17-1	21-5	24-10	8-2	12-0	15-2	18-6	21-6
	Hem-fir	#2	7-10	12-4	16-3	20-0	23-2	7-8	11-2	14-2	17-4	20-1
	Hem-fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5

(continued)

TABLE R802.5.1(2)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof live load = 20 psf, ceiling attached to rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
19.2	Southern pine	SS	8-9	13-9	18-2	23-1	Note b	8-9	13-9	18-2	23-1	Note b
	Southern pine	#1	8-5	13-3	17-5	21-2	25-2	8-4	12-4	15-8	18-4	21-9
	Southern pine	#2	8-1	12-3	15-7	18-6	21-9	7-1	10-8	13-6	16-0	18-10
	Southern pine	#3	6-4	9-4	11-9	14-3	16-10	5-6	8-1	10-2	12-4	14-7
	Spruce-pine-fir	SS	8-3	12-11	17-1	21-9	Note b	8-3	12-11	17-1	21-0	24-4
	Spruce-pine-fir	#1	8-1	12-8	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-pine-fir	#2	8-1	12-8	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-pine-fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5

24	Douglas fir-larch	SS	8-3	13-0	17-2	21-10	Note b	8-3	13-0	16-10	20-7	23-10
	Douglas fir-larch	#1	8-0	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Douglas fir-larch	#2	7-10	11-11	15-1	18-5	21-4	7-0	10-4	13-0	15-11	18-6
	Douglas fir-larch	#3	6-2	9-1	11-6	14-1	16-3	5-4	7-10	10-0	12-2	14-1
	Hem-fir	SS	7-10	12-3	16-2	20-8	25-1	7-10	12-3	16-2	19-10	23-0
	Hem-fir	#1	7-8	12-0	15-8	19-2	22-2	7-4	10-9	13-7	16-7	19-3
	Hem-fir	#2	7-3	11-5	14-8	17-10	20-9	6-10	10-0	12-8	15-6	17-11
	Hem-fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9
	Southern pine	SS	8-1	12-9	16-10	21-6	Note b	8-1	12-9	16-10	20-10	24-8
	Southern pine	#1	7-10	12-3	16-2	18-11	22-6	7-5	11-1	14-0	16-5	19-6
	Southern pine	#2	7-4	11-0	13-11	16-6	19-6	6-4	9-6	12-1	14-4	16-10
	Southern pine	#3	5-8	8-4	10-6	12-9	15-1	4-11	7-3	9-1	11-0	13-1
	Spruce-pine-fir	SS	7-8	12-0	15-10	20-2	24-7	7-8	12-0	15-4	18-9	21-9
	Spruce-pine-fir	#1	7-6	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-pine-fir	#2	7-6	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-pine-fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the following factors:

H_C/H_R	**Rafter Span Adjustment Factor**
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

b. Span exceeds 26 feet in length.

TABLE R802.5.1(3)
RAFTER SPANS FOR COMMON LUMBER SPECIES

(Ground snow load = 30 psf, ceiling not attached to rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
12	Douglas fir-larch	SS	10-0	15-9	20-9	Note b	Note b	10-0	15-9	20-5	24-11	Note b
	Douglas fir-larch	#1	9-8	14-9	18-8	22-9	Note b	9-0	13-2	16-8	20-4	23-7
	Douglas fir-larch	#2	9-6	14-0	17-8	21-7	25-1	8-6	12-6	15-10	19-4	22-5
	Douglas fir-larch	#3	7-3	10-8	13-6	16-6	19-2	6-6	9-6	12-1	14-9	17-1
	Hem-fir	SS	9-6	14-10	19-7	25-0	Note b	9-6	14-10	19-7	24-1	Note b
	Hem-fir	#1	9-3	14-6	18-5	22-6	26-0	8-11	13-0	16-6	20-1	23-4
	Hem-fir	#2	8-10	13-7	17-2	21-0	24-4	8-4	12-2	15-4	18-9	21-9
	Hem-fir	#3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Southern pine	SS	9-10	15-6	20-5	Note b	Note b	9-10	15-6	20-5	25-4	Note b
	Southern pine	#1	9-6	14-10	19-0	22-3	Note b	9-0	13-5	17-0	19-11	23-7
	Southern pine	#2	8-7	12-11	16-4	19-5	22-10	7-8	11-7	14-8	17-4	20-5
	Southern pine	#3	6-7	9-9	12-4	15-0	17-9	5-11	8-9	11-0	13-5	15-10
	Spruce-pine-fir	SS	9-3	14-7	19-2	24-6	Note b	9-3	14-7	18-8	22-9	Note b
	Spruce-pine-fir	#1	9-1	13-9	17-5	21-4	24-8	8-5	12-4	15-7	19-1	22-1
	Spruce-pine-fir	#2	9-1	13-9	17-5	21-4	24-8	8-5	12-4	15-7	19-1	22-1
	Spruce-pine-fir	#3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
16	Douglas fir-larch	SS	9-1	14-4	18-10	24-1	Note b	9-1	14-0	17-8	21-7	25-1
	Douglas fir-larch	#1	8-9	12-9	16-2	19-9	22-10	7-10	11-5	14-5	17-8	20-5
	Douglas fir-larch	#2	8-3	12-1	15-4	18-9	21-8	7-5	10-10	13-8	16-9	19-5
	Douglas fir-larch	#3	6-4	9-3	11-8	14-3	16-7	5-8	8-3	10-6	12-9	14-10
	Hem-fir	SS	8-7	13-6	17-10	22-9	Note b	8-7	13-6	17-1	20-10	24-2
	Hem-fir	#1	8-5	12-7	15-11	19-6	22-7	7-8	11-3	14-3	17-5	20-2
	Hem-fir	#2	8-0	11-9	14-11	18-2	21-1	7-2	10-6	13-4	16-3	18-10
	Hem-fir	#3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6
	Southern pine	SS	8-11	14-1	18-6	23-8	Note b	8-11	14-1	18-5	~~1-11~~ 21’-11”	25-11
	Southern pine	#1	8-7	13-0	16-6	19-3	22-10	7-10	11-7	14-9	17-3	20-5
	Southern pine	#2	7-6	11-2	14-2	16-10	19-10	6-8	10-0	12-8	15-1	17-9

	Southern pine	#3	5-9	8-6	10-8	13-0	15-4	5-2	7-7	9-7	11-7	13-9
	Spruce-pine-fir	SS	8-5	13-3	17-5	22-1	25-7	8-5	12-9	16-2	19-9	22-10
	Spruce-pine-fir	#1	8-2	11-11	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Spruce-pine-fir	#2	8-2	11-11	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Spruce-pine-fir	#3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6
19.2	Douglas fir-larch	SS	8-7	13-6	17-9	22-1	25-7	8-7	12-9	16-2	19-9	22-10
	Douglas fir-larch	#1	7-11	11-8	14-9	18-0	20-11	7-1	10-5	13-2	16-1	18-8
	Douglas fir-larch	#2	7-7	11-0	14-0	17-1	19-10	6-9	9-10	12-6	15-3	17-9
	Douglas fir-larch	#3	5-9	8-5	10-8	13-1	15-2	5-2	7-7	9-7	11-8	13-6
	Hem-fir	SS	8-1	12-9	16-9	21-4	24-8	8-1	12-4	15-7	19-1	22-1
	Hem-fir	#1	7-10	11-6	14-7	17-9	20-7	7-0	10-3	13-0	15-11	18-5
	Hem-fir	#2	7-4	10-9	13-7	16-7	19-3	6-7	9-7	12-2	14-10	17-3
	Hem-fir	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2

(continued)

TABLE R802.5.1(3)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground snow load = 30 psf, ceiling not attached to rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
19.2	Southern pine	SS	8-5	13-3	17-5	22-3	Note b	8-5	13-3	16-10	20-0	23-7
	Southern pine	#1	8-0	11-10	15-1	17-7	20-11	7-1	10-7	13-5	15-9	18-8
	Southern pine	#2	6-10	10-2	12-11	15-4	18-1	6-1	9-2	11-7	13-9	16-2
	Southern pine	#3	5-3	7-9	9-9	11-10	14-0	4-8	6-11	8-9	10-7	12-6
	Spruce-pine-fir	SS	7-11	12-5	16-5	20-2	23-4	7-11	11-8	14-9	18-0	20-11
	Spruce-pine-fir	#1	7-5	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Spruce-pine-fir	#2	7-5	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Spruce-pine-fir	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2
24	Douglas fir-larch	SS	8-0	12-6	16-2	19-9	22-10	7-10	11-5	14-5	17-8	20-5

	Douglas fir-larch	#1	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Douglas fir-larch	#2	6-9	9-10	12-6	15-3	17-9	6-0	8-10	11-2	13-8	15-10
	Douglas fir-larch	#3	5-2	7-7	9-7	11-8	13-6	4-7	6-9	8-7	10-5	12-1
	Hem-fir	SS	7-6	11-10	15-7	19-1	22-1	7-6	11-0	13-11	17-0	19-9
	Hem-fir	#1	7-0	10-3	13-0	15-11	18-5	6-3	9-2	11-8	14-3	16-6
	Hem-fir	#2	6-7	9-7	12-2	14-10	17-3	5-10	8-7	10-10	13-3	15-5
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10
	Southern pine	SS	7-10	12-3	16-2	20-0	23-7	7-10	11-10	15-0	17-11	21-2
	Southern pine	#1	7-1	10-7	13-5	15-9	18-8	6-4	9-6	12-0	14-1	16-8
	Southern pine	#2	6-1	9-2	11-7	13-9	16-2	5-5	8-2	10-4	12-3	14-6
	Southern pine	#3	4-8	6-11	8-9	10-7	12-6	4-2	6-2	7-10	9-6	11-2
	Spruce-pine-fir	SS	7-4	11-7	14-9	18-0	20-11	7-1	10-5	13-2	16-1	18-8
	Spruce-pine-fir	#1	6-8	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-pine-fir	#2	6-8	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10

Check sources for availability of lumber in lengths greater than 20 feet.
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the following factors:

H_C/H_R	**Rafter Span Adjustment Factor**
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.
H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

b. Span exceeds 26 feet in length.

TABLE R802.5.1(4)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground snow load = 50 psf, ceiling not attached to rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
12	Douglas fir-larch	SS	8-5	13-3	17-6	22-4	26-0	8-5	13-3	17-3	21-1	24-5
	Douglas fir-larch	#1	8-2	12-0	15-3	18-7	21-7	7-7	11-2	14-1	17-3	20-0
	Douglas fir-larch	#2	7-10	11-5	14-5	17-8	20-5	7-3	10-7	13-4	16-4	18-11
	Douglas fir-larch	#3	6-0	8-9	11-0	13-6	15-7	5-6	8-1	10-3	12-6	14-6
	Hem-fir	SS	8-0	12-6	16-6	21-1	25-6	8-0	12-6	16-6	20-4	23-7
	Hem-fir	#1	7-10	11-10	15-0	18-4	21-3	7-6	11-0	13-11	17-0	19-9
	Hem-fir	#2	7-5	11-1	14-0	17-2	19-11	7-0	10-3	13-0	15-10	18-5
	Hem-fir	#3	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Southern pine	SS	8-4	13-1	17-2	21-11	Note b	8-4	13-1	17-2	21-5	25-3
	Southern pine	#1	8-0	12-3	15-6	18-2	21-7	7-7	11-4	14-5	16-10	20-0
	Southern pine	#2	7-0	10-6	13-4	15-10	18-8	6-6	9-9	12-4	14-8	17-3
	Southern pine	#3	5-5	8-0	10-1	12-3	14-6	5-0	7-5	9-4	11-4	13-5
	Spruce-pine-fir	SS	7-10	12-3	16-2	20-8	24-1	7-10	12-3	15-9	19-3	22-4
	Spruce-pine-fir	#1	7-8	11-3	14-3	17-5	20-2	7-1	10-5	13-2	16-1	18-8
	Spruce-pine-fir	#2	7-8	11-3	14-3	17-5	20-2	7-1	10-5	13-2	16-1	18-8
	Spruce-pine-fir	#3	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
16	Douglas fir-larch	SS	7-8	12-1	15-11	19-9	22-10	7-8	11-10	14-11	18-3	21-2
	Douglas fir-larch	#1	7-1	10-5	13-2	16-1	18-8	6-7	9-8	12-2	14-11	17-3
	Douglas fir-larch	#2	6-9	9-10	12-6	15-3	17-9	6-3	9-2	11-7	14-2	16-5
	Douglas fir-larch	#3	5-2	7-7	9-7	11-18	13-6	4-9	7-0	8-10	10-10	12-6
	Hem-fir	SS	7-3	11-5	15-0	19-1	22-1	7-3	11-5	14-5	17-8	20-5
	Hem-fir	#1	7-0	10-3	13-0	15-11	18-5	6-6	9-6	12-1	14-9	17-1
	Hem-fir	#2	6-7	9-7	12-2	14-10	17-3	6-1	8-11	11-3	13-9	15-11
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-8	6-10	8-8	10-6	12-3
	Southern pine	SS	7-6	11-10	15-7	19-11	23-7	7-6	11-10	15-7	18-6	21-10
	Southern pine	#1	7-1	10-7	13-5	15-9	18-8	6-7	9-10	12-5	14-7	17-3
	Southern pine	#2	6-1	9-2	11-7	13-9	16-2	5-8	8-5	10-9	12-9	15-0
	Southern pine	#3	4-8	6-11	8-9	10-7	12-6	4-4	6-5	8-1	9-10	11-7

	Spruce-pine-fir	SS	7-1	11-2	14-8	18-0	20-11	7-1	10-9	13-8	15-11	19-4
	Spruce-pine-fir	#1	6-8	9-9	12-4	15-1	17-6	6-2	9-0	11-5	13-11	16-2
	Spruce-pine-fir	#2	6-8	9-9	12-4	15-1	17-6	6-2	9-0	11-5	13-11	16-2
	Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-8	6-10	8-8	10-6	12-3
19.2	Douglas fir-larch	SS	7-3	11-4	14-9	18-0	20-11	7-3	10-9	13-8	16-8	19-4
	Douglas fir-larch	#1	6-6	9-6	12-0	14-8	17-1	6-0	8-10	11-2	13-7	15-9
	Douglas fir-larch	#2	6-2	9-0	11-5	13-11	16-2	5-8	8-4	10-9	12-11	15-0
	Douglas fir-larch	#3	4-8	6-11	8-9	10-8	12-4	4-4	6-4	8-1	9-10	11-5
	Hem-fir	SS	6-10	10-9	14-2	17-5	20-2	6-10	10-5	13-2	16-1	18-8
	Hem-fir	#1	6-5	9-5	11-11	14-6	16-10	~~8-11~~ 5'-10"	8-8	11-0	13-5	15-7
	Hem-fir	#2	6-0	8-9	11-1	13-7	15-9	5-7	8-1	10-3	12-7	14-7
	Hem-fir	#3	4-7	6-9	8-6	10-5	12-1	4-3	6-3	7-11	9-7	11-2

(continued)

TABLE R802.5.1(4)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground snow load = 50 psf, ceiling not attached to rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
19.2	Southern pine	SS	7-1	11-2	14-8	18-3	21-7	7-1	11-2	14-2	16-11	20-0
	Southern pine	#1	6-6	9-8	12-3	14-4	17-1	6-0	9-0	11-4	13-4	15-9
	Southern pine	#2	5-7	8-4	10-7	12-6	14-9	5-2	7-9	9-9	11-7	13-8
	Southern pine	#3	4-3	6-4	8-0	9-8	11-5	4-0	5-10	7-4	8-11	10-7
	Spruce-pine-fir	SS	6-8	10-6	13-5	16-5	19-1	6-8	9-10	12-5	15-3	17-8
	Spruce-pine-fir	#1	6-1	8-11	11-3	13-9	15-11	5-7	8-3	10-5	12-9	14-9
	Spruce-pine-fir	#2	6-1	8-11	11-3	13-9	15-11	5-7	8-3	10-5	12-9	14-9
	Spruce-pine-fir	#3	4-7	6-9	8-6	10-5	12-1	4-3	6-3	7-11	9-7	11-2
24	Douglas fir-larch	SS	6-8	10-5	13-2	16-1	18-8	6-7	9-8	12-2	14-11	17-3

	Douglas fir-larch	#1	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Douglas fir-larch	#2	5-6	8-1	10-3	12-6	14-6	5-1	7-6	9-5	11-7	13-5
	Douglas fir-larch	#3	4-3	6-2	7-10	9-6	11-1	3-11	5-8	7-3	8-10	10-3
	Hem-fir	SS	6-4	9-11	12-9	15-7	18-0	6-4	9-4	11-9	14-5	16-8
	Hem-fir	#1	5-9	8-5	10-8	13-0	15-1	~~8-4~~ 5’-3”	7-9	9-10	12-0	13-11
	Hem-fir	#2	5-4	7-10	9-11	12-1	14-1	4-11	7-3	9-2	11-3	13-0
	Hem-fir	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0
	Southern pine	SS	6-7	10-4	13-8	16-4	19-3	6-7	10-0	12-8	15-2	17-10
	Southern pine	#1	5-10	8-8	11-0	12-10	15-3	5-5	8-0	10-2	11-11	14-1
	Southern pine	#2	5-0	7-5	9-5	11-3	13-2	4-7	6-11	8-9	10-5	12-3
	Southern pine	#3	3-10	5-8	7-1	8-8	10-3	3-6	5-3	6-7	8-0	9-6
	Spruce-pine-fir	SS	6-2	9-6	12-0	14-8	17-1	6-0	8-10	11-2	13-7	15-9
	Spruce-pine-fir	#1	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Spruce-pine-fir	#2	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Spruce-pine-fir	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0

Check sources for availability of lumber in lengths greater than 20 feet.
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the following factors:

H_C/H_R	**Rafter Span Adjustment Factor**
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.
H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

b. Span exceeds 26 feet in length.

TABLE R802.5.1(5)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground snow load = 30 psf, ceiling attached to rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
12	Douglas fir-larch	SS	9-1	14-4	18-10	24-1	Note b	9-1	14-4	18-10	24-1	Note b
	Douglas fir-larch	#1	8-9	13-9	18-2	22-9	Note b	8-9	13-2	16-8	20-4	23-7
	Douglas fir-larch	#2	8-7	13-6	17-8	21-7	25-1	8-6	12-6	15-10	19-4	22-5
	Douglas fir-larch	#3	7-3	10-8	13-6	16-6	19-2	6-6	9-6	12-1	14-9	17-1
	Hem-fir	SS	8-7	13-6	17-10	22-9	Note b	8-7	13-6	17-10	22-9	Note b
	Hem-fir	#1	8-5	13-3	17-5	22-3	26-0	8-5	13-0	16-6	20-1	23-4
	Hem-fir	#2	8-0	12-7	16-7	21-0	24-4	8-0	12-2	15-4	18-9	21-9
	Hem-fir	#3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Southern pine	SS	8-11	14-1	18-6	23-8	Note b	8-11	14-1	18-6	23-8	Note b
	Southern pine	#1	8-7	13-6	17-10	22-3	Note b	8-7	13-5	17-0	19-11	23-7
	Southern pine	#2	8-3	12-11	16-4	19-5	22-10	7-8	11-7	14-8	17-4	20-5
	Southern pine	#3	6-7	9-9	12-4	15-0	17-9	5-11	8-9	11-0	13-5	15-10
	Spruce-pine-fir	SS	8-5	13-3	17-5	22-3	Note b	8-5	13-3	17-5	22-3	Note b
	Spruce-pine-fir	#1	8-3	12-11	17-0	21-4	24-8	8-3	12-4	15-7	19-1	22-1
	Spruce-pine-fir	#2	8-3	12-11	17-0	21-4	24-8	8-3	12-4	15-7	19-1	22-1
	Spruce-pine-fir	#3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
16	Douglas fir-larch	SS	8-3	13-0	17-2	21-10	Note b	8-3	13-0	17-2	21-7	25-1
	Douglas fir-larch	#1	8-0	12-6	16-2	19-9	22-10	7-10	11-5	14-5	17-8	20-5
	Douglas fir-larch	#2	7-10	12-1	15-4	18-9	21-8	7-5	10-10	13-8	16-9	19-5
	Douglas fir-larch	#3	6-4	9-3	11-8	14-3	16-7	5-8	8-3	10-6	12-9	14-10
	Hem-fir	SS	7-10	12-3	16-2	20-8	25-1	7-10	12-3	16-2	20-8	24-2
	Hem-fir	#1	7-8	12-0	15-10	19-6	22-7	7-8	11-3	14-3	17-5	20-2
	Hem-fir	#2	7-3	11-5	14-11	18-2	21-1	7-2	10-6	13-4	16-3	18-10
	Hem-fir	#3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6
	Southern pine	SS	8-1	12-9	16-10	21-6	Note b	8-1	12-9	16-10	21-6	25-11
	Southern pine	#1	7-10	12-3	16-2	19-3	22-10	7-10	11-7	14-9	17-3	20-5
	Southern pine	#2	7-6	11-2	14-2	16-10	19-10	6-8	10-0	12-8	15-1	17-9

	Southern pine	#3	5-9	8-6	10-8	13-0	15-4	5-2	7-7	9-7	11-7	13-9
	Spruce-pine-fir	SS	7-8	12-0	15-10	20-2	24-7	7-8	12-0	15-10	19-9	22-10
	Spruce-pine-fir	#1	7-6	11-9	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Spruce-pine-fir	#2	7-6	11-9	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Spruce-pine-fir	#3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6
19.2	Douglas fir-larch	SS	7-9	12-3	16-1	20-7	25-0	7-9	12-3	16-1	19-9	22-10
	Douglas fir-larch	#1	7-6	11-8	14-9	18-0	20-11	7-1	10-5	13-2	16-1	18-8
	Douglas fir-larch	#2	7-4	11-0	14-0	17-1	19-10	6-9	9-1	12-6	15-3	17-9
	Douglas fir-larch	#3	5-9	8-5	10-8	13-1	15-2	5-2	7-7	9-7	11-8	13-6
	Hem-fir	SS	7-4	11-7	15-3	19-5	23-7	7-4	11-7	15-3	19-1	22-1
	Hem-fir	#1	7-2	11-4	14-7	17-9	20-7	7-0	~~16-3~~ 10’-2”	13-0	15-11	18-5
	Hem-fir	#2	6-10	10-9	13-7	16-7	19-3	6-7	9-7	12-2	14-10	17-3
	Hem-fir	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2

(continued)

TABLE R802.5.1(5)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground snow load = 30 psf, ceiling attached to rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
19.2	Southern pine	SS	7-8	12-0	15-10	20-2	24-7	7-8	12-0	15-10	20-0	23-7
	Southern pine	#1	7-4	11-7	15-1	17-7	20-11	7-1	10-7	13-5	15-9	18-8
	Southern pine	#2	6-10	10-2	12-11	15-4	18-1	6-1	9-2	11-7	13-9	16-2
	Southern pine	#3	5-3	7-9	9-9	11-10	14-0	4-8	6-11	8-9	10-7	12-6
	Spruce-pine-fir	SS	7-2	11-4	14-11	19-0	23-1	7-2	11-4	14-9	18-0	20-11
	Spruce-pine-fir	#1	7-0	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Spruce-pine-fir	#2	7-0	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Spruce-pine-fir	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2

24	Douglas fir-larch	SS	7-3	11-4	15-0	19-1	22-10	7-3	11-4	14-5	17-8	20-5
	Douglas fir-larch	#1	7-0	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Douglas fir-larch	#2	6-9	9-10	12-6	15-3	17-9	6-0	8-10	11-2	13-8	15-10
	Douglas fir-larch	#3	5-2	7-7	9-7	11-8	13-6	4-7	6-9	8-7	10-5	12-1
	Hem-fir	SS	6-10	10-9	14-2	18-0	21-11	6-10	10-9	13-11	17-0	19-9
	Hem-fir	#1	6-8	10-3	13-0	15-11	18-5	6-3	9-2	11-8	14-3	16-6
	Hem-fir	#2	6-4	9-7	12-2	14-10	17-3	5-10	8-7	10-10	13-3	15-5
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10
	Southern pine	SS	7-1	11-2	14-8	18-9	22-10	7-1	11-2	14-8	17-11	21-2
	Southern pine	#1	6-10	10-7	13-5	15-9	18-8	6-4	9-6	12-0	14-1	16-8
	Southern pine	#2	6-1	9-2	11-7	13-9	16-2	5-5	8-2	10-4	12-3	14-6
	Southern pine	#3	4-8	6-11	8-9	10-7	12-6	4-2	6-2	7-10	9-6	11-2
	Spruce-pine-fir	SS	6-8	10-6	13-10	17-8	20-11	6-8	10-5	13-2	16-1	18-8
	Spruce-pine-fir	#1	6-6	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-pine-fir	#2	6-6	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the following factors:

H_C/H_R	**Rafter Span Adjustment Factor**
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

b. Span exceeds 26 feet in length.

TABLE R802.5.1(6)
RAFTER SPANS FOR COMMON LUMBER SPECIES

(Ground snow load = 50 psf, ceiling attached to rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
12	Douglas fir-larch	SS	7-8	12-1	15-11	20-3	24-8	7-8	12-1	15-11	20-3	24-5
	Douglas fir-larch	#1	7-5	11-7	15-3	18-7	21-7	7-5	11-2	14-1	17-3	20-0
	Douglas fir-larch	#2	7-3	11-5	14-5	17-8	20-5	7-3	10-7	13-4	16-4	18-11
	Douglas fir-larch	#3	6-0	8-9	11-0	13-6	15-7	5-6	8-1	10-3	12-6	14-6
	Hem-fir	SS	7-3	11-5	15-0	19-2	23-4	7-3	11-5	15-0	19-2	23-4
	Hem-fir	#1	7-1	11-2	14-8	18-4	21-3	7-1	11-0	13-11	17-0	19-9
	Hem-fir	#2	6-9	10-8	14-0	17-2	19-11	6-9	10-3	13-0	15-10	18-5
	Hem-fir	#3	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Southern pine	SS	7-6	11-10	15-7	19-11	24-3	7-6	11-10	15-7	19-11	24-3
	Southern pine	#1	7-3	11-5	15-0	18-2	21-7	7-3	11-4	14-5	16-10	20-0
	Southern pine	#2	6-11	10-6	13-4	15-10	18-8	6-6	9-9	12-4	14-8	17-3
	Southern pine	#3	5-5	8-0	10-1	12-3	14-6	5-0	7-5	9-4	11-4	13-5
	Spruce-pine-fir	SS	7-1	11-2	14-8	18-9	22-10	7-1	11-2	14-8	18-9	22-4
	Spruce-pine-fir	#1	6-11	10-11	14-3	17-5	20-2	6-11	10-5	13-2	16-1	18-8
	Spruce-pine-fir	#2	6-11	10-11	14-3	17-5	20-2	6-11	10-5	13-2	16-1	18-8
	Spruce-pine-fir	#3	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
16	Douglas fir-larch	SS	7-0	11-0	14-5	18-5	22-5	7-0	11-0	14-5	18-3	21-2
	Douglas fir-larch	#1	6-9	10-5	13-2	16-1	18-8	6-7	9-8	12-2	14-11	17-3
	Douglas fir-larch	#2	6-7	9-10	12-6	15-3	17-9	6-3	9-2	11-7	14-2	16-5
	Douglas fir-larch	#3	5-2	7-7	9-7	11-8	13-6	4-9	7-0	8-10	10-10	12-6
	Hem-fir	SS	6-7	10-4	13-8	17-5	21-2	6-7	10-4	13-8	17-5	20-5
	Hem-fir	#1	6-5	10-2	13-0	15-11	18-5	6-5	9-6	12-1	14-9	17-1
	Hem-fir	#2	6-2	9-7	12-2	14-10	17-3	6-1	8-11	11-3	13-9	15-11
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-8	6-10	8-8	10-6	12-3
	Southern pine	SS	6-10	10-9	14-2	18-1	22-0	6-10	10-9	14-2	18-1	21-10
	Southern pine	#1	6-7	10-4	13-5	15-9	18-8	6-7	9-10	12-5	14-7	17-3
	Southern pine	#2	6-1	9-2	11-7	13-9	16-2	5-8	8-5	10-9	12-9	15-0

	Southern pine	#3	4-8	6-11	8-9	10-7	12-6	4-4	6-5	8-1	9-10	11-7
	Spruce-pine-fir	SS	6-5	10-2	13-4	17-0	20-9	6-5	10-2	13-4	16-8	19-4
	Spruce-pine-fir	#1	6-4	9-9	12-4	15-1	17-6	6-2	9-0	11-5	13-11	16-2
	Spruce-pine-fir	#2	6-4	9-9	12-4	15-1	17-6	6-2	9-0	11-5	13-11	16-2
	Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-8	6-10	8-8	10-6	12-3
19.2	Douglas fir-larch	SS	6-7	10-4	13-7	17-4	20-11	6-7	10-4	13-7	16-8	19-4
	Douglas fir-larch	#1	6-4	9-6	12-0	14-8	17-1	6-0	8-10	11-2	13-7	15-9
	Douglas fir-larch	#2	6-2	9-0	11-5	13-11	16-2	5-8	8-4	10-7	12-11	15-0
	Douglas fir-larch	#3	4-8	6-11	8-9	10-8	12-4	4-4	6-4	8-1	9-10	11-5
	Hem-fir	SS	6-2	9-9	12-10	16-5	19-11	6-2	9-9	12-10	16-1	18-8
	Hem-fir	#1	6-1	9-5	11-11	14-6	16-10	5-11	8-8	11-0	13-5	15-7
	Hem-fir	#2	5-9	8-9	11-1	13-7	15-9	5-7	8-1	10-3	12-7	14-7
	Hem-fir	#3	4-7	6-9	8-6	10-5	12-1	4-3	6-3	7-11	9-7	11-2

(continued)

TABLE R802.5.1(6)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground snow load = 50 psf, ceiling attached to rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
19.2	Southern pine	SS	6-5	10-2	13-4	17-0	20-9	6-5	10-2	13-4	16-11	20-0
	Southern pine	#1	6-2	9-8	12-3	14-4	17-1	6-0	9-0	11-4	13-4	15-9
	Southern pine	#2	5-7	8-4	10-7	12-6	14-9	5-2	7-9	9-9	11-7	13-8
	Southern pine	#3	4-3	6-4	8-0	9-8	11-5	4-0	5-10	7-4	8-11	10-7
	Spruce-pine-fir	SS	6-1	9-6	12-7	16-0	19-1	6-1	9-6	12-5	15-3	17-8
	Spruce-pine-fir	#1	5-11	8-11	11-3	13-9	15-11	5-7	8-3	10-5	12-9	14-9
	Spruce-pine-fir	#2	5-11	8-11	11-3	13-9	15-11	5-7	8-3	10-5	12-9	14-9
	Spruce-pine-fir	#3	4-7	6-9	8-6	10-5	12-1	4-3	6-3	7-11	9-7	11-2
24	Douglas fir-larch	SS	6-1	9-7	12-7	16-1	18-8	6-1	9-7	12-2	14-11	17-3

	Douglas fir-larch	#1	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Douglas fir-larch	#2	5-6	8-1	10-3	12-6	14-6	5-1	7-6	9-5	11-7	13-5
	Douglas fir-larch	#3	4-3	6-2	7-10	9-6	11-1	3-11	5-8	7-3	8-10	10-3
	Hem-fir	SS	5-9	9-1	11-11	15-2	18-0	5-9	9-1	11-9	14-5	15-11
	Hem-fir	#1	5-8	8-5	10-8	13-0	15-1	5-4	7-9	9-10	12-0	13-11
	Hem-fir	#2	5-4	7-10	9-11	12-1	14-1	4-11	7-3	9-2	11-3	13-0
	Hem-fir	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0
	Southern pine	SS	6-0	9-5	12-5	15-10	19-3	6-0	9-5	12-5	15-2	17-10
	Southern pine	#1	5-9	8-8	11-0	12-10	15-3	5-5	8-0	10-2	11-11	14-1
	Southern pine	#2	5-0	7-5	9-5	11-3	13-2	4-7	6-11	8-9	10-5	12-3
	Southern pine	#3	3-10	5-8	7-1	8-8	10-3	3-6	5-3	6-7	8-0	9-6
	Spruce-pine-fir	SS	5-8	8-10	11-8	14-8	17-1	5-8	8-10	11-2	13-7	15-9
	Spruce-pine-fir	#1	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Spruce-pine-fir	#2	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Spruce-pine-fir	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0

Check sources for availability of lumber in lengths greater than 20 feet.
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the following factors:

H_C/H_R	**Rafter Span Adjustment Factor**
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.
H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

TABLE R802.5.1(7)
RAFTER SPANS FOR 70 PSF GROUND SNOW LOAD
(Ceiling not attached to rafters, L/Δ = 180)

	SPECIES AND GRADE	**DEAD LOAD = 10 psf**					**DEAD LOAD = 20 psf**				
		2 × 4	**2 × 6**	**2 × 8**	**2 × 10**	**2 × 12**	**2 × 4**	**2 × 6**	**2 × 8**	**2 × 10**	**2 × 12**

RAFTER SPACING (inches)			Maximum Rafter Spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
12	Douglas fir-larch	SS	7-7	11-10	15-8	19-9	22-10	7-7	11-10	15-3	18-7	21-7
	Douglas fir-larch	#1	7-1	10-5	13-2	16-1	18-8	6-8	9-10	12-5	15-2	17-7
	Douglas fir-larch	#2	6-9	9-10	12-6	15-3	17-9	6-4	9-4	11-9	14-5	16-8
	Douglas fir-larch	#3	5-2	7-7	9-7	11-8	13-6	4-10	7-1	9-0	11-0	12-9
	Hem-fir	SS	7-2	11-3	14-9	18-10	22-1	7-2	11-3	14-8	18-0	20-10
	Hem-fir	#1	7-0	10-3	13-0	15-11	18-5	6-7	9-8	12-3	15-0	17-5
	Hem-fir	#2	6-7	9-7	12-2	14-10	17-3	6-2	9-1	11-5	14-0	16-3
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
	Southern pine	SS	7-5	11-8	15-4	19-7	23-7	7-5	11-8	15-4	18-10	22-3
	Southern pine	#1	7-1	10-7	13-5	15-9	18-8	6-9	10-0	12-8	14-10	17-7
	Southern pine	#2	6-1	9-2	11-7	13-9	16-2	5-9	8-7	10-11	12-11	15-3
	Southern pine	#3	4-8	6-11	8-9	10-7	12-6	4-5	6-6	8-3	10-0	11-10
	Spruce-pine-fir	SS	7-0	11-0	14-6	18-0	20-11	7-0	11-0	13-11	17-0	19-8
	Spruce-pine-fir	#1	6-8	9-9	12-4	15-1	17-6	6-3	9-2	11-8	14-2	16-6
	Spruce-pine-fir	#2	6-8	9-9	12-4	15-1	17-6	6-3	9-2	11-8	14-2	16-6
	Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
16	Douglas fir-larch	SS	6-10	10-9	14-0	17-1	19-10	6-10	10-5	13-2	16-1	18-8
	Douglas fir-larch	#1	6-2	9-0	11-5	13-11	16-2	5-10	8-6	10-9	13-2	15-3
	Douglas fir-larch	#2	5-10	8-7	10-10	13-3	15-4	5-6	8-1	10-3	12-6	14-6
	Douglas fir-larch	#3	4-6	6-6	8-3	10-1	11-9	4-3	6-2	7-10	9-6	11-1
	Hem-fir	SS	6-6	10-2	13-5	16-6	19-2	6-6	10-1	12-9	15-7	18-0
	Hem-fir	#1	6-1	8-11	11-3	13-9	16-0	5-9	8-5	10-8	13-0	15-1
	Hem-fir	#2	5-8	8-4	10-6	12-10	14-11	5-4	7-10	9-11	12-1	14-1
	Hem-fir	#3	4-4	6-4	8-1	9-10	11-5	4-1	6-0	7-7	9-4	10-9
	Southern pine	SS	6-9	10-7	14-0	17-4	20-5	6-9	10-7	13-9	16-4	19-3
	Southern pine	#1	6-2	9-2	11-8	13-8	16-2	5-10	8-8	11-0	12-10	15-3
	Southern pine	#2	5-3	7-11	10-0	11-11	14-0	5-0	7-5	9-5	11-3	13-2
	Southern pine	#3	4-1	6-0	7-7	9-2	10-10	3-10	5-8	7-1	8-8	10-3
	Spruce-pine-fir	SS	6-4	10-0	12-9	15-7	18-1	6-4	9-6	12-0	14-8	17-1

	Spruce-pine-fir	#1	5-9	8-5	10-8	13-1	15-2	5-5	7-11	10-1	12-4	14-3
	Spruce-pine-fir	#2	5-9	8-5	10-8	13-1	15-2	5-5	7-11	10-1	12-4	14-3
	Spruce-pine-fir	#3	4-4	6-4	8-1	9-10	11-5	4-1	6-0	7-7	9-4	10-9
19.2	Douglas fir-larch	SS	6-6	10-1	12-9	15-7	18-1	6-6	9-6	12-0	14-8	17-1
	Douglas fir-larch	#1	5-7	8-3	10-5	12-9	14-9	5-4	7-9	9-10	12-0	13-11
	Douglas fir-larch	#2	5-4	7-10	9-11	12-1	14-0	5-0	7-4	9-4	11-5	13-2
	Douglas fir-larch	#3	4-1	6-0	7-7	9-3	10-8	3-10	5-7	7-1	8-8	10-1
	Hem-fir	SS	6-1	9-7	12-4	15-1	17-4	6-1	9-2	11-8	14-2	15-5
	Hem-fir	#1	5-7	8-2	10-3	12-7	14-7	5-3	7-8	9-8	11-10	13-9
	Hem-fir	#2	5-2	7-7	9-7	11-9	13-7	4-11	7-2	9-1	11-1	12-10
	Hem-fir	#3	4-0	5-10	7-4	9-0	10-5	3-9	5-6	6-11	8-6	9-10

(continued)

TABLE R802.5.1(7)—continued
RAFTER SPANS FOR 70 PSF GROUND SNOW LOAD
(Ceiling not attached to rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum Rafter Spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
19.2	Southern pine	SS	6-4	10-0	13-2	15-10	18-8	6-4	9-10	12-6	14-11	17-7
	Southern pine	#1	5-8	8-5	10-8	12-5	14-9	5-4	7-11	10-0	11-9	13-11
	Southern pine	#2	4-10	7-3	9-2	10-10	12-9	4-6	6-10	8-8	10-3	12-1
	Southern pine	#3	3-8	5-6	6-11	8-4	9-11	3-6	5-2	6-6	7-11	9-4
	Spruce-pine-fir	SS	6-0	9-2	11-8	14-3	16-6	5-11	8-8	11-0	13-5	15-7
	Spruce-pine-fir	#1	5-3	7-8	9-9	11-11	13-10	5-0	7-3	9-2	11-3	13-0
	Spruce-pine-fir	#2	5-3	7-8	9-9	11-11	13-10	5-0	7-3	9-2	11-3	13-0
	Spruce-pine-fir	#3	4-0	5-10	7-4	9-0	10-5	3-9	5-6	6-11	8-6	9-10
24	Douglas fir-larch	SS	6-0	9-0	11-5	13-11	16-2	5-10	8-6	10-9	13-2	15-3
	Douglas fir-larch	#1	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
	Douglas fir-larch	#2	4-9	7-0	8-10	10-10	12-6	4-6	6-7	8-4	10-2	11-10

	Douglas fir-larch	#3	3-8	5-4	6-9	8-3	9-7	3-5	5-0	6-4	7-9	9-10
	Hem-fir	SS	5-8	8-8	11-0	13-6	13-11	5-7	8-3	10-5	12-4	12-4
	Hem-fir	#1	5-0	7-3	9-2	11-3	13-0	4-8	6-10	8-8	10-7	12-4
	Hem-fir	#2	4-8	6-9	8-7	10-6	12-2	4-4	6-5	8-1	9-11	11-6
	Hem-fir	#3	3-7	5-2	6-7	8-1	9-4	3-4	4-11	6-3	7-7	8-10
	Southern pine	SS	5-11	9-3	11-11	14-2	16-8	5-11	8-10	11-2	13-4	15-9
	Southern pine	#1	5-0	7-6	9-6	11-1	13-2	4-9	7-1	9-0	10-6	12-5
	Southern pine	#2	4-4	6-5	8-2	9-9	11-5	4-1	6-1	7-9	9-2	10-9
	Southern pine	#3	3-4	4-11	6-2	7-6	8-10	3-1	4-7	5-10	7-1	8-4
	Spruce-pine-fir	SS	5-6	8-3	10-5	12-9	14-9	5-4	7-9	9-10	12-0	12-11
	Spruce-pine-fir	#1	4-8	6-11	8-9	10-8	12-4	4-5	6-6	8-3	10-0	11-8
	Spruce-pine-fir	#2	4-8	6-11	8-9	10-8	12-4	4-5	6-6	8-3	10-0	11-8
	Spruce-pine-fir	#3	3-7	5-2	6-7	8-1	9-4	3-4	4-11	6-3	7-7	8-10

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the following factors:

H_C/H_R	**Rafter Span Adjustment Factor**
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.
H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

TABLE R802.5.1(8)
RAFTER SPANS FOR 70 PSF GROUND SNOW LOAD
(Ceiling attached to rafters, L/Δ = 240)

RAFTER SPACING (inches)	**SPECIES AND GRADE**		**DEAD LOAD = 10 psf**					**DEAD LOAD = 20 psf**				
			2 × 4	**2 × 6**	**2 × 8**	**2 × 10**	**2 × 12**	**2 × 4**	**2 × 6**	**2 × 8**	**2 × 10**	**2 × 12**
			Maximum rafter spans[a]									
			(feet - inches)	**(feet - inches)**	**(feet - inches)**	**(feet - inches)**	**(feet - inches)**	**(feet - inches)**	**(feet - inches)**	**(feet - inches)**	**(feet - inches)**	**(feet - inches)**

12	Douglas fir-larch	SS	6-10	10-9	14-3	18-2	22-1	6-10	10-9	14-3	18-2	21-7
	Douglas fir-larch	#1	6-7	10-5	13-2	16-1	18-8	6-7	9-10	12-5	15-2	17-7
	Douglas fir-larch	#2	6-6	9-10	12-6	15-3	17-9	6-4	9-4	11-9	14-5	16-8
	Douglas fir-larch	#3	5-2	7-7	9-7	11-8	13-6	4-10	7-1	9-0	11-0	12-9
	Hem-fir	SS	6-6	10-2	13-5	17-2	20-10	6-6	10-2	13-5	17-2	20-10
	Hem-fir	#1	6-4	10-0	13-0	15-11	18-5	6-4	9-8	12-3	15-0	17-5
	Hem-fir	#2	6-1	9-6	12-2	14-10	17-3	6-1	9-1	11-5	14-0	16-3
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
	Southern pine	SS	6-9	10-7	14-0	17-10	21-8	6-9	10-7	14-0	17-10	21-8
	Southern pine	#1	6-6	10-2	13-5	15-9	18-8	6-6	10-0	12-8	14-10	17-7
	Southern pine	#2	6-1	9-2	11-7	13-9	16-2	5-9	8-7	10-11	12-11	15-3
	Southern pine	#3	4-8	6-11	8-9	10-7	12-6	4-5	6-6	8-3	10-0	11-10
	Spruce-pine-fir	SS	6-4	10-0	13-2	16-9	20-5	6-4	10-0	13-2	16-9	19-8
	Spruce-pine-fir	#1	6-2	9-9	12-4	15-1	17-6	6-2	9-2	11-8	14-2	16-6
	Spruce-pine-fir	#2	6-2	9-9	12-4	15-1	17-6	6-2	9-2	11-8	14-2	16-6
	Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
16	Douglas fir-larch	SS	6-3	9-10	12-11	16-6	19-10	6-3	9-10	12-11	16-1	18-8
	Douglas fir-larch	#1	6-0	9-0	11-5	13-11	16-2	5-10	8-6	10-9	13-2	15-3
	Douglas fir-larch	#2	5-10	8-7	10-10	13-3	15-4	5-6	8-1	10-3	12-6	14-6
	Douglas fir-larch	#3	4-6	6-6	8-3	10-1	11-9	4-3	6-2	7-10	9-6	11-1
	Hem-fir	SS	5-11	9-3	12-2	15-7	18-11	5-11	9-3	12-2	15-7	18-0
	Hem-fir	#1	5-9	8-11	11-3	13-9	16-0	5-9	8-5	10-8	13-0	15-1
	Hem-fir	#2	5-6	8-4	10-6	12-10	14-11	5-4	7-10	9-11	12-1	14-1
	Hem-fir	#3	4-4	6-4	8-1	9-10	11-5	4-1	6-0	7-7	9-4	10-9
	Southern pine	SS	6-1	9-7	12-8	16-2	19-8	6-1	9-7	12-8	16-2	19-3
	Southern pine	#1	5-11	9-2	11-8	13-8	16-2	5-10	8-8	11-0	12-10	15-3
	Southern pine	#2	5-3	7-11	10-0	11-11	14-0	5-0	7-5	9-5	11-3	13-2
	Southern pine	#3	4-1	6-0	7-7	9-2	10-10	3-10	5-8	7-1	8-8	10-3
	Spruce-pine-fir	SS	5-9	9-1	11-11	15-3	18-1	5-9	9-1	11-11	14-8	17-1
	Spruce-pine-fir	#1	5-8	8-5	10-8	13-1	15-2	5-5	7-11	10-1	12-4	14-3
	Spruce-pine-fir	#2	5-8	8-5	10-8	13-1	15-2	5-5	7-11	10-1	12-4	14-3

	Spruce-pine-fir	#3	4-4	6-4	8-1	9-10	11-5	4-1	6-0	7-7	9-4	10-9
19.2	Douglas fir-larch	SS	5-10	9-3	12-2	15-6	18-1	5-10	9-3	12-0	14-8	17-1
	Douglas fir-larch	#1	5-7	8-3	10-5	12-9	14-9	5-4	7-9	9-10	12-0	13-11
	Douglas fir-larch	#2	5-4	7-10	9-11	12-1	14-0	5-0	7-4	9-4	11-5	13-2
	Douglas fir-larch	#3	4-1	6-0	7-7	9-3	10-8	3-10	5-7	7-1	8-8	10-1
	Hem-fir	SS	5-6	8-8	11-6	14-8	17-4	5-6	8-8	11-6	14-2	15-5
	Hem-fir	#1	5-5	8-2	10-3	12-7	14-7	5-3	7-8	9-8	11-10	13-9
	Hem-fir	#2	5-2	7-7	9-7	11-9	13-7	4-11	7-2	9-1	11-1	12-10
	Hem-fir	#3	4-0	5-10	7-4	9-0	10-5	3-9	5-6	6-11	8-6	9-10

(continued)

TABLE R802.5.1(8)—continued
RAFTER SPANS FOR 70 PSF GROUND SNOW LOAD
(Ceiling attached to rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
19.2	Southern pine	SS	5-9	9-1	11-11	15-3	18-6	5-9	9-1	11-11	14-11	17-7
	Southern pine	#1	5-6	8-5	10-8	12-5	14-9	5-4	7-11	10-0	11-9	13-11
	Southern pine	#2	4-10	7-3	9-2	10-10	12-9	4-6	6-10	8-8	10-3	12-1
	Southern pine	#3	3-8	5-6	6-11	8-4	9-11	3-6	5-2	6-6	7-11	9-4
	Spruce-pine-fir	SS	5-5	8-6	11-3	14-3	16-6	5-5	8-6	11-0	13-5	15-7
	Spruce-pine-fir	#1	5-3	7-8	9-9	11-11	13-10	5-0	7-3	9-2	11-3	13-0
	Spruce-pine-fir	#2	5-3	7-8	9-9	11-11	13-10	5-0	7-3	9-2	11-3	13-0
	Spruce-pine-fir	#3	4-0	5-10	7-4	9-0	10-5	3-9	5-6	6-11	8-6	9-10
24	Douglas fir-larch	SS	5-5	8-7	11-3	13-11	16-2	5-5	8-6	10-9	13-2	15-3
	Douglas fir-larch	#1	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
	Douglas fir-larch	#2	4-9	7-0	8-10	10-10	12-6	4-6	6-7	8-4	10-2	11-10
	Douglas fir-larch	#3	3-8	5-4	6-9	8-3	9-7	3-5	5-0	6-4	7-9	9-0
	Hem-fir	SS	5-2	8-1	10-8	13-6	13-11	5-2	8-1	10-5	12-4	12-4
	Hem-fir	#1	5-0	7-3	9-2	11-3	13-0	4-8	6-10	8-8	10-7	12-4

	Hem-fir	#2	4-8	6-9	8-7	10-6	12-2	4-4	6-5	8-1	9-11	11-6
	Hem-fir	#3	3-7	5-2	6-7	8-1	9-4	3-4	4-11	6-3	7-7	8-10
	Southern pine	SS	5-4	8-5	11-1	14-2	16-8	5-4	8-5	11-1	13-4	15-9
	Southern pine	#1	5-0	7-6	9-6	11-1	13-2	4-9	7-1	9-0	10-6	12-5
	Southern pine	#2	4-4	6-5	8-2	9-9	11-5	4-1	6-1	7-9	9-2	10-9
	Southern pine	#3	3-4	4-11	6-2	7-6	8-10	3-1	4-7	5-10	7-1	8-4
	Spruce-pine-fir	SS	5-0	7-11	10-5	12-9	14-9	5-0	7-9	9-10	12-0	12-11
	Spruce-pine-fir	#1	4-8	6-11	8-9	10-8	12-4	4-5	6-6	8-3	10-0	11-8
	Spruce-pine-fir	#2	4-8	6-11	8-9	10-8	12-4	4-5	6-6	8-3	10-0	11-8
	Spruce-pine-fir	#3	3-7	5-2	6-7	8-1	9-4	3-4	4-11	6-3	7-7	8-10

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the following factors:

H_C/H_R	**Rafter Span Adjustment Factor**
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

TABLE R802.5.1(9)

RAFTER/CEILING JOIST HEEL JOINT CONNECTIONS[a, b, c, d, e, f, h]

RAFTER SLOPE	**RAFTER SPACING (inches)**	**GROUND SNOW LOAD (psf)**															
		20[g]				**30**				**50**				**70**			
		Roof span (feet)															
		12	**20**	**28**	**36**	**12**	**20**	**28**	**36**	**12**	**20**	**28**	**36**	**12**	**20**	**28**	**36**
		Required number of 16d common nails[a, b] per heel joint splices[c, d, e, f]															
3:12	12	4	6	8	10	4	6	8	11	5	8	12	15	6	11	15	20
	16	5	8	10	13	5	8	11	14	6	11	15	20	8	14	20	26
	24	7	11	15	19	7	11	16	21	9	16	23	30	12	21	30	39
4:12	12	3	5	6	8	3	5	6	8	4	6	9	11	5	8	12	15

	16	4	6	8	10	4	6	8	11	5	8	12	15	6	11	15	20
	24	5	8	12	15	5	9	12	16	7	12	17	22	9	16	23	29
5:12	12	3	4	5	6	3	4	5	7	3	5	7	9	4	7	9	12
	16	3	5	6	8	3	5	7	9	4	7	9	12	5	9	12	16
	24	4	7	9	12	4	7	10	13	6	10	14	18	7	13	18	23
7:12	12	3	4	4	5	3	3	4	5	3	4	5	7	3	5	7	9
	16	3	4	5	6	3	4	5	6	3	5	7	9	4	6	9	11
	24	3	5	7	9	3	5	7	9	4	7	10	13	5	9	13	17
9:12	12	3	3	4	4	3	3	3	4	3	3	4	5	3	4	5	7
	16	3	4	4	5	3	3	4	5	3	4	5	7	3	5	7	9
	24	3	4	6	7	3	4	6	7	3	6	8	10	4	7	10	13
12:12	12	3	3	3	3	3	3	3	3	3	3	3	4	3	3	4	5
	16	3	3	4	4	3	3	3	4	3	3	4	5	3	4	5	7
	24	3	4	4	5	3	3	4	6	3	4	6	8	3	6	8	10

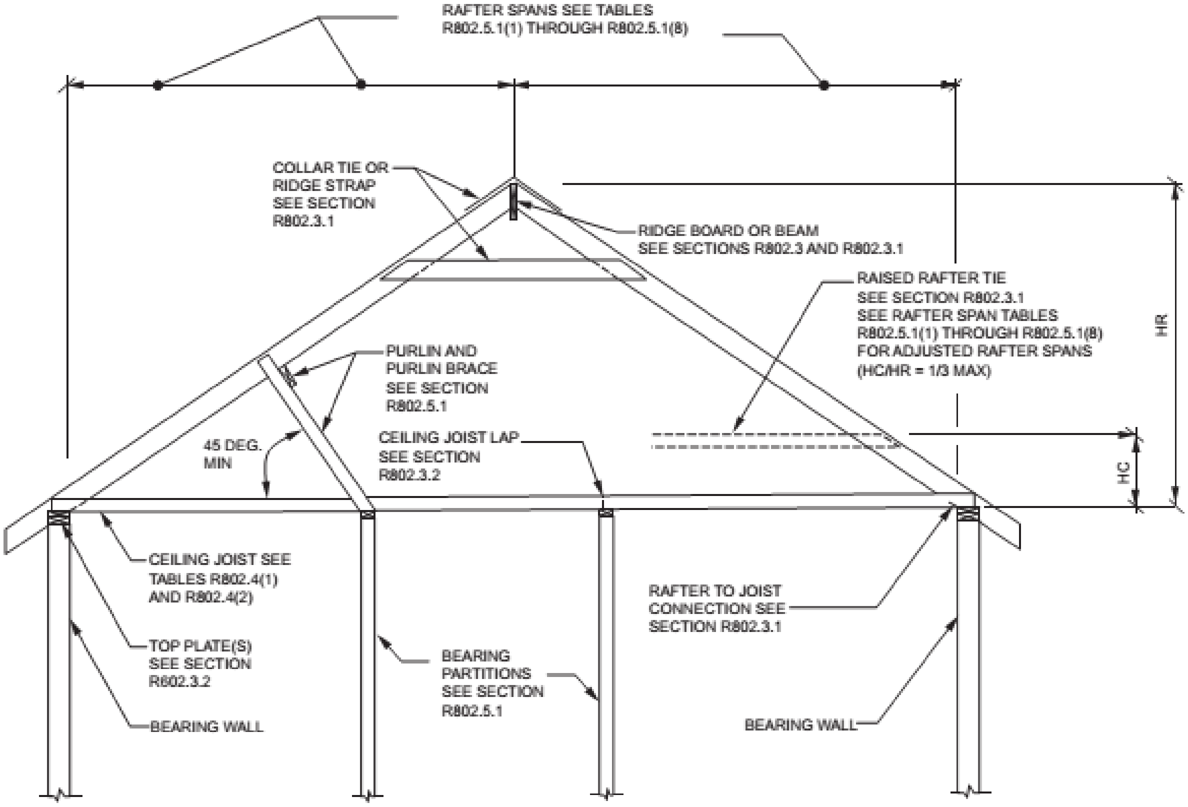
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. 40d box nails shall be permitted to be substituted for 16d common nails.
b. Nailing requirements shall be permitted to be reduced 25 percent if nails are clinched.
c. Heel joint connections are not required where the ridge is supported by a load-bearing wall, header or ridge beam.
d. Where intermediate support of the rafter is provided by vertical struts or purlins to a load-bearing wall, the tabulated heel joint connection requirements shall be permitted to be reduced proportionally to the reduction in span.
e. Equivalent nailing patterns are required for ceiling joist to ceiling joist lap splices.
f. Where rafter ties are substituted for ceiling joists, the heel joint connection requirement shall be taken as the tabulated heel joint connection requirement for two-thirds of the actual rafter slope.
g. Applies to roof live load of 20 psf or less.
h. Tabulated heel joint connection requirements assume that ceiling joists or rafter ties are located at the bottom of the attic space. Where ceiling joists or rafter ties are located higher in the attic, heel joint connection requirements shall be increased by the following factors:

H_C/H_R	**Heel Joint Connection Adjustment Factor**
1/3	1.5
1/4	1.33
1/5	1.25
1/6	1.2
1/10 or less	1.11

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.
H_R = Height of roof ridge measured vertically above the top of the rafter support walls.



For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 degree = 0.018 rad.

Note: Where ceiling joists run perpendicular to the rafter, rafter ties shall be installed in accordance with Section R802.3.1. (Note: Break rafter span on left side.)

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

FIGURE R802.5.1
BRACED RAFTER CONSTRUCTION

R802.10.2 Design.

Wood trusses shall be designed in accordance with accepted engineering practice. The design and manufacture of metal-plate-connected wood trusses shall comply with ANSI/TPI 1. The truss design drawings shall be prepared by a registered professional ~~where required by the statutes of the *jurisdiction* in which the project is to be constructed in accordance with Section R106.1~~.

R802.11.1.1 Truss uplift resistance.

Trusses shall be attached to supporting wall assemblies by connections capable of resisting uplift forces as specified on the Truss Design Drawings for the ultimate design wind speed as determined by ~~Figure R301.2(4)A~~ Table R301.2(4) and listed in Table R301.2(1) or as shown on the construction documents. Uplift forces shall be permitted to be determined as specified by Table R802.11, if applicable, or as determined by accepted engineering practice.

SECTION R803
ROOF SHEATHING

R803.1 Lumber sheathing.

Allowable spans for lumber used as roof sheathing shall conform to Table R803.1. Spaced lumber sheathing for wood shingle and shake roofing shall conform to the requirements of Sections R905.7 and R905.8. ~~Spaced lumber sheathing is not allowed in Seismic Design Category D$_2$.~~

R803.2.3 Installation.

Wood structural panel used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing ~~or with Table R804.3 for cold-formed steel roof framing~~.

SECTION R804
COLD-FORMED STEEL ROOF FRAMING
Deleted

~~R804.1 General.~~

~~Elements shall be straight and free of any defects that would significantly affect their structural performance. Cold-formed steel roof framing members shall be in accordance with the requirements of this section.~~

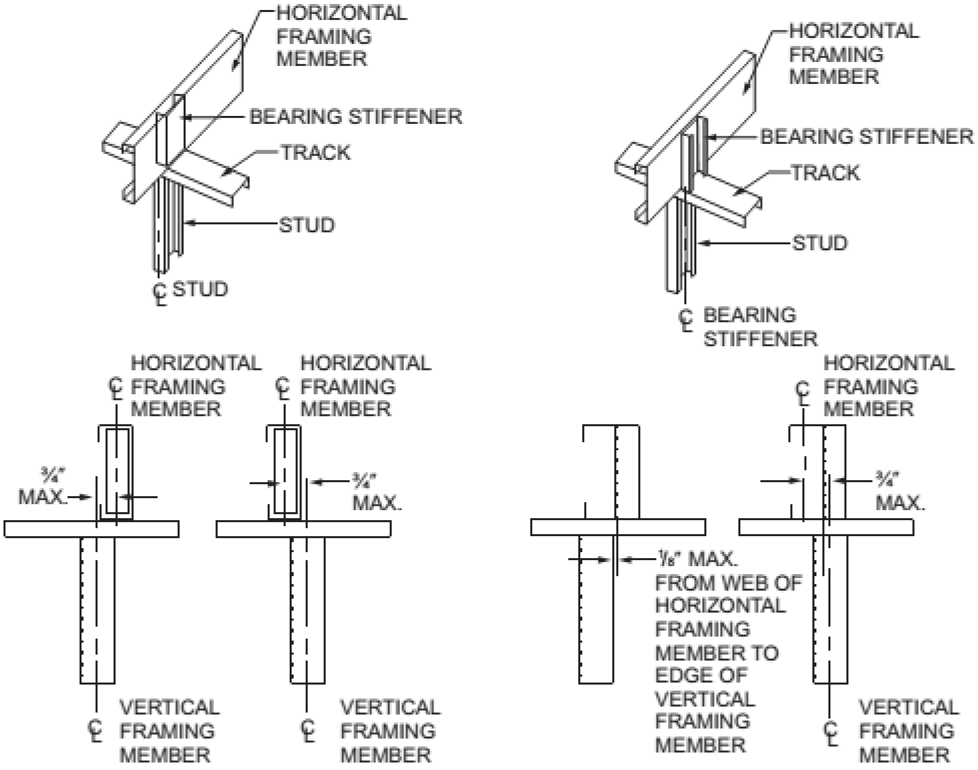
~~R804.1.1 Applicability limits.~~

~~The provisions of this section shall control the construction of cold-formed steel roof framing for buildings not greater than 60 feet (18 288 mm) perpendicular to the joist, rafter or truss span, not greater than 40 feet (12 192 mm) in width parallel to the joist span or truss, less than or equal to three stories above *grade* plane and with roof slopes not less than 3:12 (25-percent slope) or greater than 12:12 (100-percent slope). Cold-formed steel roof framing constructed in accordance with the provisions of this section shall be limited to sites where the ultimate design wind speed is less than 139 miles per hour (62 m/s), Exposure Category B or C, and the ground snow load is less than or equal to 70 pounds per square foot (3350 Pa).~~

~~R804.1.2 In-line framing.~~

~~Cold-formed steel roof framing constructed in accordance with Section R804 shall be located in line with load-bearing studs in accordance with Figure R804.1.2 and the tolerances specified as follows:~~

1. ~~The maximum tolerance shall be $^{3}/_{4}$ inch (19.1 mm) between the centerline of the horizontal framing member and the centerline of the vertical framing member.~~
2. ~~Where the centerline of the horizontal framing member and bearing stiffener are located to one side of the centerline of the vertical framing member, the maximum tolerance shall be $^{1}/_{8}$ inch (3.2 mm) between the web of the horizontal framing member and the edge of the vertical framing member.~~



~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R804.1.2~~
~~IN-LINE FRAMING~~

~~R804.2 Structural framing.~~

~~Load-bearing, cold-formed steel roof framing members shall be in accordance with this section.~~

~~R804.2.1 Material.~~

~~Load-bearing, cold-formed steel framing members shall be cold formed to shape from structural quality sheet steel complying with the requirements of ASTM A 1003, Structural Grades 33 Type H and 50 Type H.~~

~~R804.2.2 Corrosion protection.~~

~~Load-bearing, cold-formed steel framing shall have a metallic coating complying with ASTM A 1003 and one of the following:~~

1. ~~A minimum of G 60 in accordance with ASTM A 653.~~
2. ~~A minimum of AZ 50 in accordance with ASTM A 792.~~

~~R804.2.3 Dimension, thickness and material grade.~~

~~Load-bearing, cold-formed steel roof framing members shall comply with Figure R804.2.3(1) and with the dimensional and thickness requirements specified in Table R804.2.3. Additionally, C-shaped sections shall have a minimum flange width of 1.625 inches (41 mm)~~

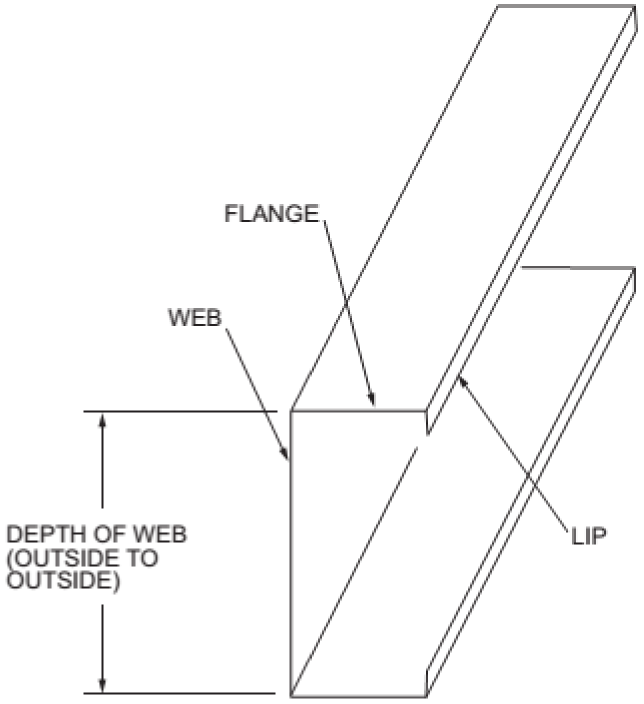
~~and a maximum flange width of 2 inches (51 mm). The minimum lip size for C-shaped sections shall be 1/2 inch (12.7 mm). Tracks shall comply with Figure R804.2.3(2) and shall have a minimum flange width of 1 1/4 inches (32 mm). Minimum Grade 33 ksi steel shall be used wherever 33 mil and 43 mil thicknesses are specified. Minimum Grade 50 ksi steel shall be used wherever 54 and 68 mil thicknesses are specified.~~

~~TABLE R804.2.3~~
~~LOAD-BEARING COLD-FORMED STEEL ROOF FRAMING MEMBER SIZES AND THICKNESSES~~

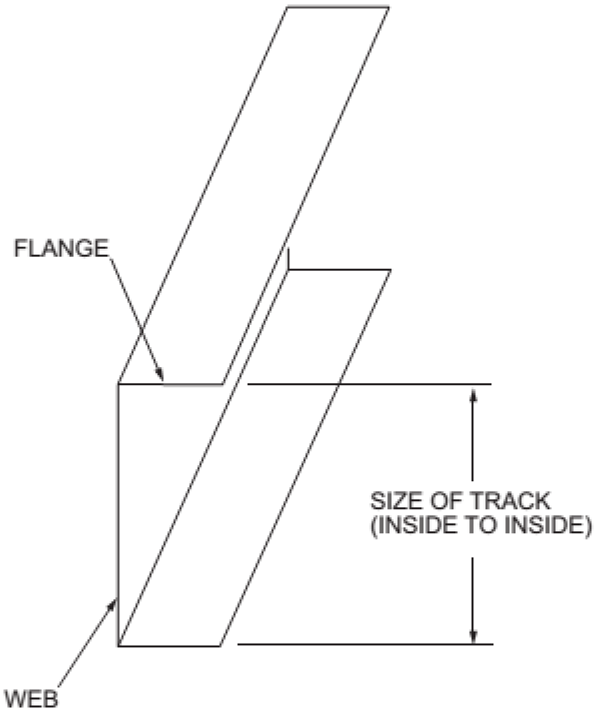
~~MEMBER DESIGNATION~~[a]	~~WEB DEPTH (inches)~~	~~MINIMUM BASE STEEL THICKNESS mil (inches)~~
~~350S162-t~~	~~3.5~~	~~33 (0.0329), 43 (0.0428), 54 (0.0538)~~
~~550S162-t~~	~~5.5~~	~~33 (0.0329), 43 (0.0428), 54 (0.0538), 68 (0.0677)~~
~~800S162-t~~	~~8~~	~~33 (0.0329), 43 (0.0428), 54 (0.0538), 68 (0.0677)~~
~~1000S162-t~~	~~10~~	~~43 (0.0428), 54 (0.0538), 68 (0.0677)~~
~~1200S162-t~~	~~12~~	~~43 (0.0428), 54 (0.0538), 68 (0.0677)~~

~~For SI: 1 inch = 25.4 mm~~

~~a. The member designation is defined by the first number representing the member depth in hundredths of an inch, the letter “s” representing a stud or joist member, the second number representing the flange width in hundredths of an inch and the letter “t” shall be a number representing the minimum base metal thickness in mils.~~



~~FIGURE R804.2.3(1)~~
~~C-SHAPED SECTION~~



~~FIGURE R804.2.3(2)~~
~~TRACK SECTION~~

~~R804.2.4 Identification.~~

~~Load-bearing, cold-formed steel framing members shall have a legible *label,* stencil, stamp or embossment with the following information as a minimum:~~

1. ~~Manufacturer's identification.~~
2. ~~Minimum base steel thickness in inches (mm).~~
3. ~~Minimum coating designation.~~
4. ~~Minimum yield strength, in kips per square inch (ksi) (MPa).~~

~~R804.2.5 Fastening requirements.~~

~~Screws for steel-to-steel connections shall be installed with a minimum edge distance and center-to-center spacing of $^{1}/_{2}$ inch (12.7 mm), shall be self-drilling tapping and shall conform to ASTM C 1513. Structural sheathing shall be attached to cold-formed steel roof rafters with minimum No. 8 self-drilling tapping screws that conform to ASTM C 1513. Screws for attaching structural sheathing to cold-formed steel roof framing shall have a minimum head diameter of 0.292 inch (7.4 mm) with countersunk heads and shall be installed with a~~

~~minimum edge distance of 3/8 inch (9.5 mm). Gypsum board ceilings shall be attached to cold-formed steel joists with minimum No. 6 screws conforming to ASTM C 954 or ASTM C 1513 with a bugle-head style and shall be installed in accordance with Section R805. For all connections, screws shall extend through the steel a minimum of three exposed threads. Fasteners shall have rust-inhibitive coating suitable for the installation in which they are being used, or be manufactured from material not susceptible to corrosion.~~

~~R804.2.6 Web holes, web hole reinforcing and web hole patching.~~

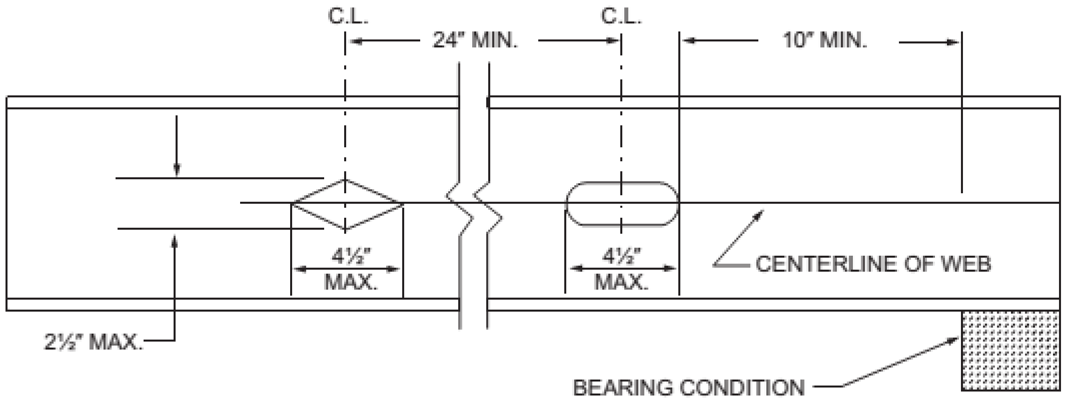
~~Web holes, web hole reinforcing and web hole patching shall be in accordance with this section.~~

~~R804.2.6.1 Web holes.~~

~~Web holes in roof framing members shall comply with all of the following conditions:~~

1. ~~Holes shall conform to Figure R804.2.6.1.~~
2. ~~Holes shall be permitted only along the centerline of the web of the framing member.~~
3. ~~Center-to-center spacing of holes shall not be less than 24 inches (610 mm).~~
4. ~~The web hole width shall be not greater than one-half the member depth, or 2 1/2 inches (64 mm).~~
5. ~~Holes shall have a web hole length not exceeding 4 1/2 inches (114 mm).~~
6. ~~The minimum distance between the edge of the bearing surface and the edge of the web hole shall be not less than 10 inches (254 mm).~~

~~Framing members with web holes not conforming to Items 1 though 6 shall be reinforced in accordance with Section R804.2.6.2, patched in accordance with Section R804.2.6.3 or designed in accordance with accepted engineering practices.~~



~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R804.2.6.1~~
~~ROOF FRAMING MEMBER WEB HOLES~~

~~R804.2.6.2 Web hole reinforcing.~~

~~Reinforcement of web holes in ceiling joists not conforming to the requirements of Section R804.2.6.1 shall be permitted if the hole is located fully within the center 40 percent of the span and the depth and length of the hole do not exceed 65 percent of the flat width of the web. The reinforcing shall be a steel plate or C-shaped section with a hole that does not exceed the web hole size limitations of Section R804.2.6.1 for the member being reinforced. The steel reinforcing shall be the same thickness as the receiving member and shall extend not less than 1 inch (25 mm) beyond all edges of the hole. The steel reinforcing shall be fastened to the web of the receiving member with No. 8 screws spaced not greater than 1 inch (25 mm) center to center along the edges of the patch with minimum edge distance of $^1/_2$ inch (12.7 mm).~~

~~R804.2.6.3 Hole patching.~~

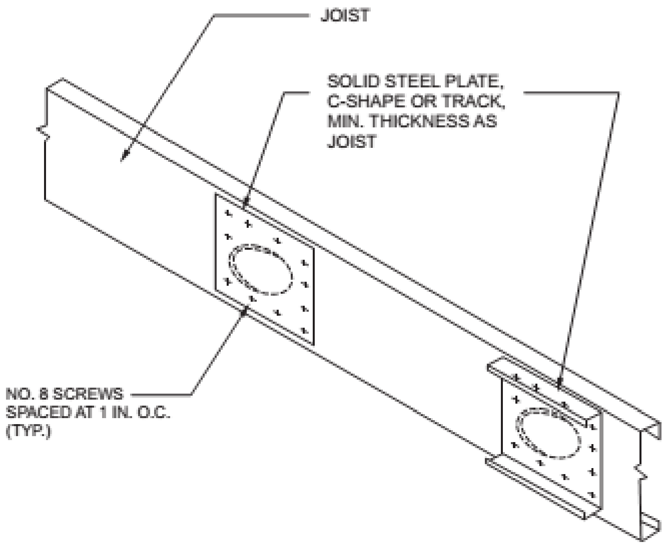
~~Patching of web holes in roof framing members not conforming to the requirements in Section R804.2.6.1 shall be permitted in accordance with either of the following methods:~~

1. ~~Framing members shall be replaced or designed in accordance with accepted engineering practices where web holes exceed either of the following size limits:~~

    ~~1.1. The depth of the hole, measured across the web, exceeds 70 percent of the flat width of the web.~~

    ~~1.2. The length of the hole measured along the web, exceeds 10 inches (254 mm) or the depth of the web, whichever is greater.~~

2. ~~Web holes not exceeding the dimensional requirements in Section R804.2.6.3, Item 1, shall be patched with a solid steel plate, stud section or track section in accordance with Figure R804.2.6.3. The steel patch shall, as a minimum, be the same thickness as the receiving member and shall extend not less than 1 inch (25 mm) beyond all edges of the hole. The steel patch shall be fastened to the web of the receiving member with No. 8 screws spaced not greater than 1 inch (25 mm) center-to-center along the edges of the patch with minimum edge distance of $^1/_2$ inch (12.7 mm).~~

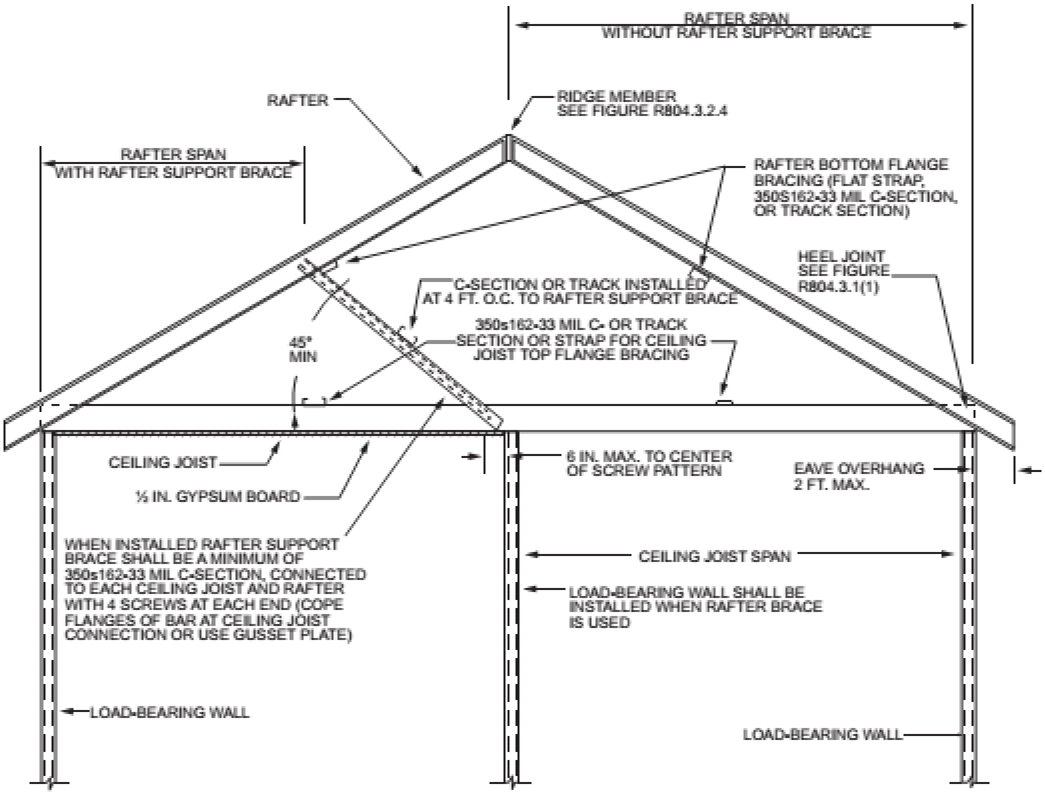


~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R804.2.6.3~~
~~ROOF FRAMING MEMBER WEB HOLE PATCH~~

~~R804.3 Roof construction.~~

~~Cold-formed steel roof systems constructed in accordance with the provisions of this section shall consist of both ceiling joists and rafters in accordance with Figure R804.3 and fastened in accordance with Table R804.3.~~



~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm.~~

~~**FIGURE R804.3**~~
~~**COLD-FORMED STEEL ROOF CONSTRUCTION**~~

~~TABLE R804.3~~
~~ROOF FRAMING FASTENING SCHEDULE~~~~[a, b]~~

~~DESCRIPTION OF BUILDING ELEMENTS~~			~~NUMBER AND SIZE OF FASTENERS~~~~[a]~~				~~SPACING OF FASTENERS~~
~~Roof sheathing (oriented strand board or plywood) to rafter~~			~~No. 8 screws~~				~~6″ o.c. on edges and 12″ o.c. at interior supports. 6″ o.c. at gable end truss~~
~~Gable end truss to end wall top track~~			~~No. 10 screws~~				~~12″ o.c.~~
~~Rafter to ceiling joist~~			~~Minimum No. 10 screws, in accordance with Table R804.3.1.1(3)~~				~~Evenly spaced, not less than 1/2″ from all edges.~~
~~Ceiling joist or roof truss to top track of bearing wall~~~~[b]~~	~~Ceiling Joist Spacing (in.)~~	~~Roof Span (ft)~~	~~Ultimate Design Wind Speed (mph) and Exposure Category~~				~~Each ceiling joist or roof truss~~
			~~126 B 110 C~~	~~<139 B 115 C~~	~~126 C~~	~~<139 C~~	
	~~16~~	~~24~~	~~2~~	~~2~~	~~2~~	~~3~~	

		~~28~~	~~2~~	~~2~~	~~3~~	~~3~~	
		~~32~~	~~2~~	~~2~~	~~3~~	~~4~~	
		~~36~~	~~2~~	~~2~~	~~3~~	~~4~~	
		~~40~~	~~2~~	~~2~~	~~3~~	~~4~~	
	~~24~~	~~24~~	~~2~~	~~2~~	~~3~~	~~4~~	
		~~28~~	~~2~~	~~2~~	~~4~~	~~5~~	
		~~32~~	~~2~~	~~3~~	~~4~~	~~5~~	
		~~36~~	~~2~~	~~3~~	~~4~~	~~6~~	
		~~40~~	~~2~~	~~3~~	~~5~~	~~6~~	

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 mil = 0.0254 mm.~~

~~a. Screws are a minimum No. 10 unless noted otherwise.~~

~~b. Indicated number of screws shall be applied through the flanges of the truss or ceiling joist or through each leg of a 54 mil clip angle. See Section R804.3.8 for additional requirements to resist uplift forces.~~

~~R804.3.1 Ceiling joists.~~

~~Cold-formed steel ceiling joists shall be in accordance with this section.~~

~~R804.3.1.1 Minimum ceiling joist size.~~

~~Ceiling joist size and thickness shall be determined in accordance with the limits set forth in Tables R804.3.1.1(1) and R804.3.1.1(2). When determining the size of ceiling joists, the lateral support of the top flange shall be classified as unbraced, braced at midspan or braced at third points in accordance with Section R804.3.1.4. Where sheathing material is attached to the top flange of ceiling joists or where the bracing is spaced closer than third point of the joists, the "third point" values from Tables R804.3.1.1(1) and R804.3.1.1(2) shall be used.~~

~~Ceiling joists shall have a bearing support length of not less than 1 $^{1}/_{2}$ inches (38 mm) and shall be connected to roof rafters (heel joint) with No. 10 screws in accordance with Figure R804.3.1.1 and Table 804.3.1.1(3).~~

~~Where continuous joists are framed across interior bearing supports, the interior bearing supports shall be located within 24 inches (610 mm) of midspan of the ceiling joist, and the individual spans shall not exceed the applicable spans in Tables R804.3.1.1(1) and R804.3.1.1(2).~~

~~Where the *attic* is to be used as an occupied space, the ceiling joists shall be designed in accordance with Section R505.~~

~~TABLE R804.3.1.1(1)~~
~~CEILING JOIST SPANS~~
~~10 PSF LIVE LOAD (NO ATTIC STORAGE)~~[~~a, b, c~~]

~~MEMBER DESIGNATION~~	**~~ALLOWABLE SPAN (feet - inches)~~**					
	~~Lateral Support of Top (Compression) Flange~~					
	~~Unbraced~~		**~~Midspan Bracing~~**		**~~Third-point Bracing~~**	
	~~Ceiling Joist Spacing (inches)~~					
	~~16~~	~~24~~	~~16~~	~~24~~	~~16~~	~~24~~
~~350S162-33~~	~~9′-5″~~	~~8′-6″~~	~~12′-2″~~	~~10′-4″~~	~~12′-2″~~	~~10′-7″~~

~~350S162-43~~	~~10′-3″~~	~~9′-12″~~	~~13′-2″~~	~~11′-6″~~	~~13′-2″~~	~~11′-6″~~
~~350S162-54~~	~~11′-1″~~	~~9′-11″~~	~~13′-9″~~	~~12′-0″~~	~~13′-9″~~	~~12′-0″~~
~~350S162-68~~	~~12′-1″~~	~~10′-9″~~	~~14′-8″~~	~~12′-10″~~	~~14′-8″~~	~~12′-10″~~
~~550S162-33~~	~~10′-7″~~	~~9′-6″~~	~~14′-10″~~	~~12′-10″~~	~~15′-11″~~	~~13′-4″~~
~~550S162-43~~	~~11′-8″~~	~~10′-6″~~	~~16′-4″~~	~~14′-3″~~	~~17′-10″~~	~~15′-3″~~
~~550S162-54~~	~~12′-6″~~	~~11′-2″~~	~~17′-7″~~	~~15′-7″~~	~~19′-5″~~	~~16′-10″~~
~~550S162-68~~	~~13′-6″~~	~~12′-1″~~	~~19′-2″~~	~~17′-0″~~	~~21′-0″~~	~~18′-4″~~
~~800S162-33~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~800S162-43~~	~~13′-0″~~	~~11′-9″~~	~~18′-10″~~	~~17′-0″~~	~~21′-6″~~	~~19′-0″~~
~~800S162-54~~	~~13′-10″~~	~~12′-5″~~	~~20′-0″~~	~~18′-0″~~	~~22′-9″~~	~~20′-4″~~
~~800S162-68~~	~~14′-11″~~	~~13′-4″~~	~~21′-3″~~	~~19′-1″~~	~~24′-1″~~	~~21′-8″~~
~~1000S162-43~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~1000S162-54~~	~~14′-9″~~	~~13′-3″~~	~~21′-4″~~	~~19′-3″~~	~~24′-4″~~	~~22′-0″~~
~~1000S162-68~~	~~15′-10″~~	~~14′-2″~~	~~22′-8″~~	~~20′-5″~~	~~25′-9″~~	~~23′-2″~~
~~1200S162-43~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~1200S162-54~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~1200S162-68~~	~~16′-8″~~	~~14′-11″~~	~~23′-11″~~	~~21′-6″~~	~~27′-2″~~	~~24′-6″~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 pound per square foot = 0.0479 kPa.~~

~~a. Deflection criterion: *L*/240 for total loads.~~

~~b. Ceiling dead load = 5 psf.~~

~~c. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R804.3.1.1(2)~~

~~CEILING JOIST SPANS~~

~~20 PSF LIVE LOAD (LIMITED ATTIC STORAGE)~~~~[a, b, c]~~

~~**MEMBER DESIGNATION**~~	~~**ALLOWABLE SPAN (feet - inches)**~~					
	~~**Lateral Support of Top (Compression) Flange**~~					
	~~**Unbraced**~~		~~**Midspan Bracing**~~		~~**Third-point Bracing**~~	
	~~**Ceiling Joist Spacing (inches)**~~					
	~~**16**~~	~~24~~	~~16~~	~~24~~	~~16~~	~~24~~
~~350S162-33~~	~~8′-2″~~	~~6′-10″~~	~~9′-9″~~	~~6′-10″~~	~~9′-11″~~	~~6′-10″~~
~~350S162-43~~	~~8′-10″~~	~~7′-10″~~	~~11′-0″~~	~~9′-5″~~	~~11′-0″~~	~~9′-7″~~
~~350S162-54~~	~~9′-6″~~	~~8′-6″~~	~~11′-9″~~	~~10′-3″~~	~~11′-9″~~	~~10′-3″~~
~~350S162-68~~	~~10′-4″~~	~~9′-2″~~	~~12′-7″~~	~~11′-0″~~	~~12′-7″~~	~~11′-0″~~
~~550S162-33~~	~~9′-2″~~	~~8′-3″~~	~~12′-2″~~	~~8′-5″~~	~~12′-6″~~	~~8′-5″~~
~~550S162-43~~	~~10′-1″~~	~~9′-1″~~	~~13′-7″~~	~~11′-8″~~	~~14′-5″~~	~~12′-2″~~
~~550S162-54~~	~~10′-9″~~	~~9′-8″~~	~~14′-10″~~	~~12′-10″~~	~~15′-11″~~	~~13′-6″~~
~~550S162-68~~	~~11′-7″~~	~~10′-4″~~	~~16′-4″~~	~~14′-0″~~	~~17′-5″~~	~~14′-11″~~
~~800S162-33~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~800S162-43~~	~~11′-4″~~	~~10′-1″~~	~~16′-5″~~	~~13′-6″~~	~~18′-1″~~	~~13′-6″~~
~~800S162-54~~	~~20′-0″~~	~~10′-9″~~	~~17′-4″~~	~~15′-6″~~	~~19′-6″~~	~~27′-0″~~
~~800S162-68~~	~~12′-10″~~	~~11′-6″~~	~~18′-5″~~	~~16′-6″~~	~~20′-10″~~	~~18′-3″~~
~~1000S162-43~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~1000S162-54~~	~~12′-10″~~	~~11′-6″~~	~~18′-7″~~	~~16′-9″~~	~~21′-2″~~	~~15′-5″~~
~~1000S162-68~~	~~13′-8″~~	~~12′-3″~~	~~19′-8″~~	~~17′-8″~~	~~22′-4″~~	~~20′-1″~~
~~1200S162-43~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~
~~1200S162-54~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~	~~—~~

~~1200S162-68~~	~~14′-4″~~	~~12′-11″~~	~~20′-9″~~	~~18′-8″~~	~~23′-7″~~	~~21′-3″~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 pound per square foot = 0.0479 kPa.~~

~~a. Deflection criterion: L/240 for total loads.~~

~~b. Ceiling deal load = 5 psf.~~

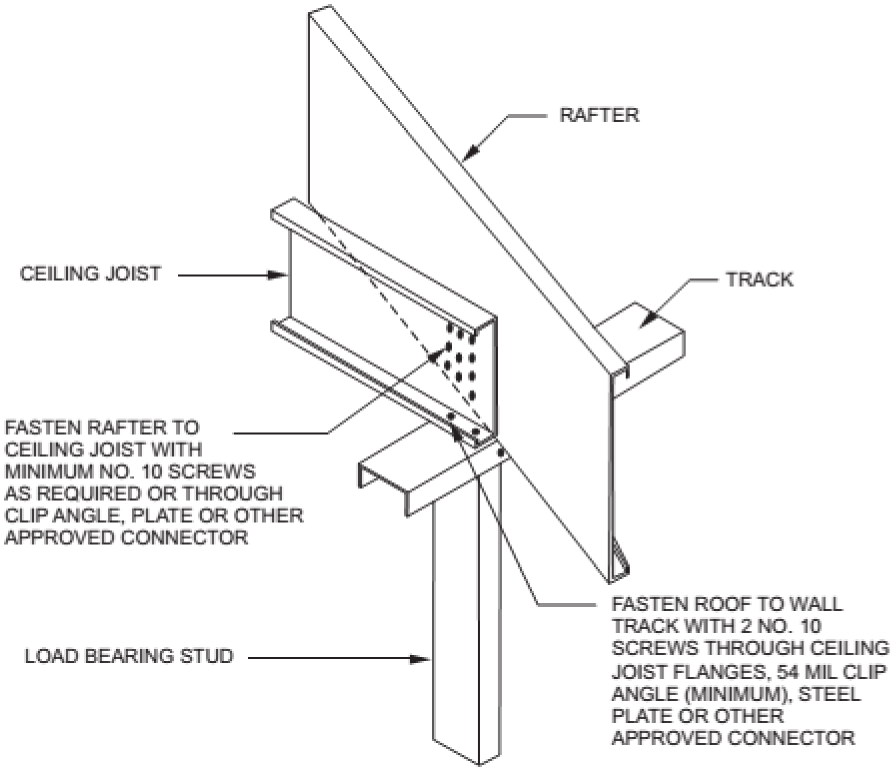
~~c. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

~~TABLE R804.3.1.1(3)~~
~~NUMBER OF SCREWS REQUIRED FOR CEILING JOIST TO ROOF RAFTER CONNECTION~~[a]

~~ROOF SLOPE~~	**~~NUMBER OF SCREWS~~**																			
	~~Building width (feet)~~																			
	~~24~~				**~~28~~**				**~~32~~**				**~~36~~**				**~~40~~**			
	~~Ground snow load (psf)~~																			
	~~20~~	**~~30~~**	**~~50~~**	**~~70~~**	**~~20~~**	**~~30~~**	**~~50~~**	**~~70~~**	**~~20~~**	**~~30~~**	**~~50~~**	**~~70~~**	**~~20~~**	**~~30~~**	**~~50~~**	**~~70~~**	**~~20~~**	**~~30~~**	**~~50~~**	**~~70~~**
~~3/12~~	~~5~~	~~6~~	~~9~~	~~11~~	~~5~~	~~7~~	~~10~~	~~13~~	~~6~~	~~8~~	~~11~~	~~15~~	~~7~~	~~8~~	~~13~~	~~17~~	~~8~~	~~9~~	~~14~~	~~19~~
~~4/12~~	~~4~~	~~5~~	~~7~~	~~9~~	~~4~~	~~5~~	~~8~~	~~10~~	~~5~~	~~6~~	~~9~~	~~12~~	~~5~~	~~7~~	~~10~~	~~13~~	~~6~~	~~7~~	~~11~~	~~14~~
~~5/12~~	~~3~~	~~4~~	~~6~~	~~7~~	~~4~~	~~4~~	~~6~~	~~8~~	~~4~~	~~5~~	~~7~~	~~10~~	~~5~~	~~5~~	~~8~~	~~11~~	~~5~~	~~6~~	~~9~~	~~12~~
~~6/12~~	~~3~~	~~3~~	~~5~~	~~6~~	~~3~~	~~4~~	~~6~~	~~7~~	~~4~~	~~4~~	~~6~~	~~8~~	~~4~~	~~5~~	~~7~~	~~9~~	~~4~~	~~5~~	~~8~~	~~10~~
~~7/12~~	~~3~~	~~3~~	~~4~~	~~6~~	~~3~~	~~3~~	~~5~~	~~7~~	~~3~~	~~4~~	~~6~~	~~7~~	~~4~~	~~4~~	~~6~~	~~8~~	~~4~~	~~5~~	~~7~~	~~9~~
~~8/12~~	~~2~~	~~3~~	~~4~~	~~5~~	~~3~~	~~3~~	~~5~~	~~6~~	~~3~~	~~4~~	~~5~~	~~7~~	~~3~~	~~4~~	~~6~~	~~8~~	~~4~~	~~4~~	~~6~~	~~8~~
~~9/12~~	~~2~~	~~3~~	~~4~~	~~5~~	~~3~~	~~3~~	~~4~~	~~6~~	~~3~~	~~3~~	~~5~~	~~6~~	~~3~~	~~4~~	~~5~~	~~7~~	~~3~~	~~4~~	~~6~~	~~8~~
~~10/12~~	~~2~~	~~2~~	~~4~~	~~5~~	~~2~~	~~3~~	~~4~~	~~5~~	~~3~~	~~3~~	~~5~~	~~6~~	~~3~~	~~3~~	~~5~~	~~7~~	~~3~~	~~4~~	~~6~~	~~7~~
~~11/12~~	~~2~~	~~2~~	~~3~~	~~4~~	~~2~~	~~3~~	~~4~~	~~5~~	~~3~~	~~3~~	~~4~~	~~6~~	~~3~~	~~3~~	~~5~~	~~6~~	~~3~~	~~4~~	~~5~~	~~7~~
~~12/12~~	~~2~~	~~2~~	~~3~~	~~4~~	~~2~~	~~3~~	~~4~~	~~5~~	~~2~~	~~3~~	~~4~~	~~5~~	~~3~~	~~3~~	~~5~~	~~6~~	~~3~~	~~4~~	~~5~~	~~7~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479kPa.~~

~~a. Screws shall be No. 10.~~



~~For SI: 1 mil = 0.0254 mm.~~

~~FIGURE R804.3.1.1~~
~~JOIST TO RAFTER CONNECTION~~

~~R804.3.1.2 Ceiling joist bottom flange bracing.~~
~~The bottom flanges of ceiling joists shall be laterally braced by the application of gypsum board or continuous steel straps installed perpendicular to the joist run in accordance with one of the following:~~

1. ~~Gypsum board shall be fastened with No. 6 screws in accordance with Section R702.~~

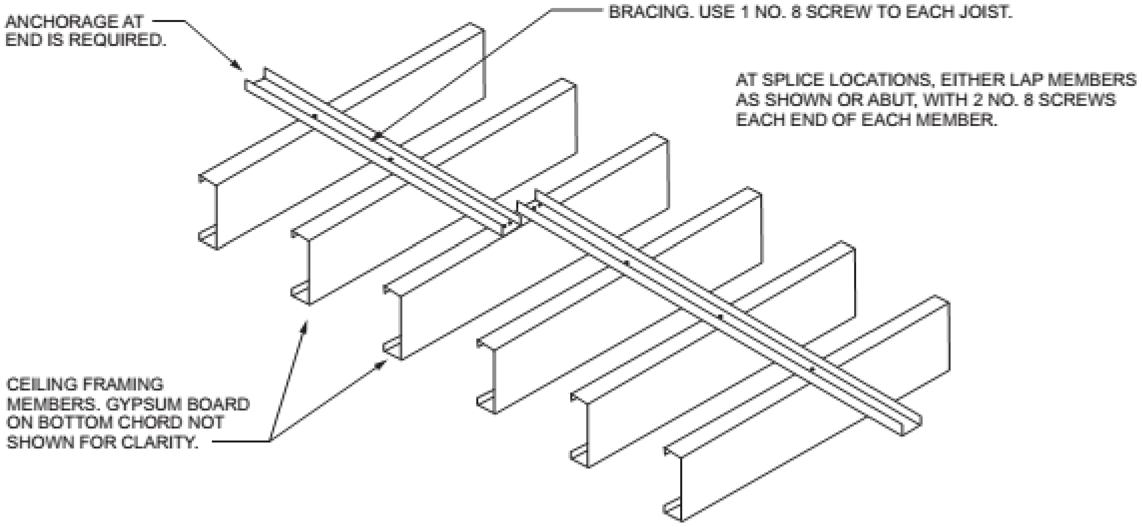
2. ~~Steel straps with a minimum size of 1$^1/_2$ inches by 33 mils (38 mm by 0.84 mm) shall be installed at a maximum spacing of 4 feet (1219 mm). Straps shall be fastened to the bottom flange at each joist with one No. 8 screw and shall be fastened to blocking with two No. 8 screws. Blocking shall be installed between joists at a maximum spacing of 12 feet (3658 mm) measured along a line of continuous strapping (perpendicular to the joist run). Blocking shall also be located at the termination of all straps.~~

~~R804.3.1.3 Ceiling joist top flange bracing.~~

~~The top flanges of ceiling joists shall be laterally braced as required by Tables R804.3.1.1(1) and R804.3.1.1(2), in accordance with one of the following:~~

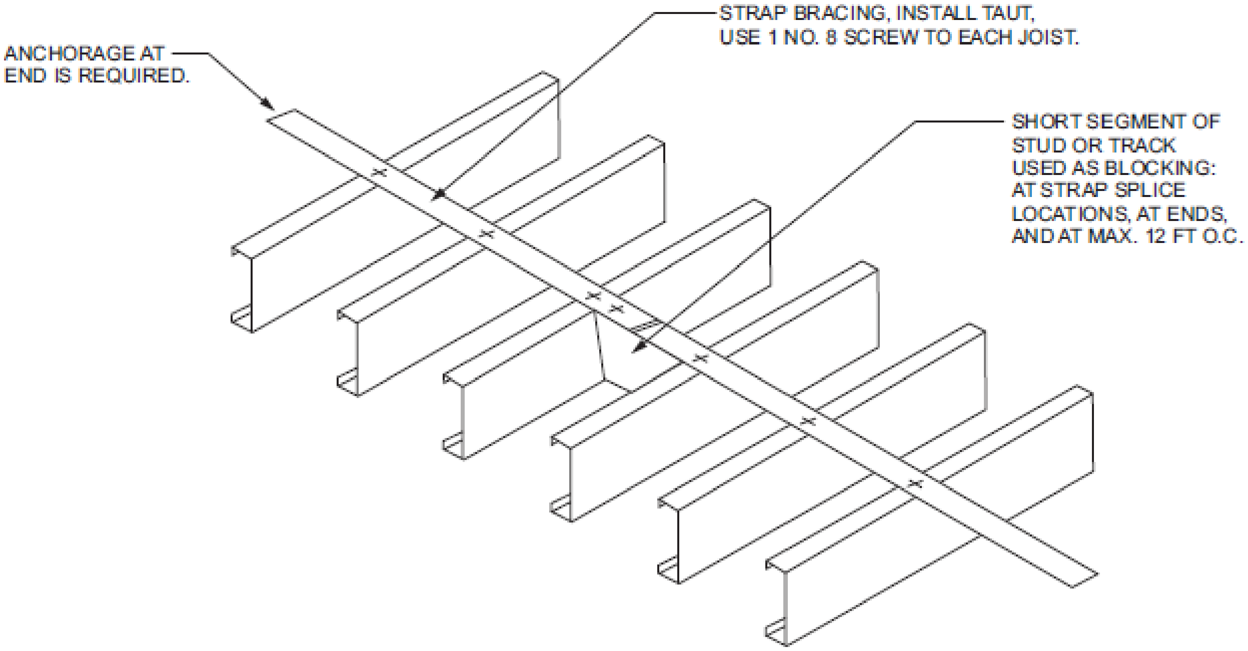
1. ~~Minimum 33-mil (0.84 mm) C-shaped member in accordance with Figure R804.3.1.3(1).~~
2. ~~Minimum 33-mil (0.84 mm) track section in accordance with Figure R804.3.1.3(1).~~
3. ~~Minimum 33-mil (0.84 mm) hat section in accordance with Figure R804.3.1.3(1).~~
4. ~~Minimum 54-mil (1.37 mm) 1$^{1}/_{2}$-inch (38 mm) cold-rolled channel section in accordance with Figure R804.3.1.3(1).~~
5. ~~Minimum 1$^{1}/_{2}$-inch by 33-mil (38 mm by 0.84 mm) continuous steel strap in accordance with Figure R804.3.1.3(2).~~

~~Lateral bracing shall be installed perpendicular to the ceiling joists and shall be fastened to the top flange of each joist with one No. 8 screw. Blocking shall be installed between joists in line with bracing at a maximum spacing of 12 feet (3658 mm) measured perpendicular to the joists. Ends of lateral bracing shall be attached to blocking or anchored to a stable building component with two No. 8 screws.~~



~~FIGURE R804.3.1.3(1)~~

~~CEILING JOIST TOP FLANGE BRACING WITH C-SHAPED, TRACK OR COLD-ROLLED CHANNEL~~

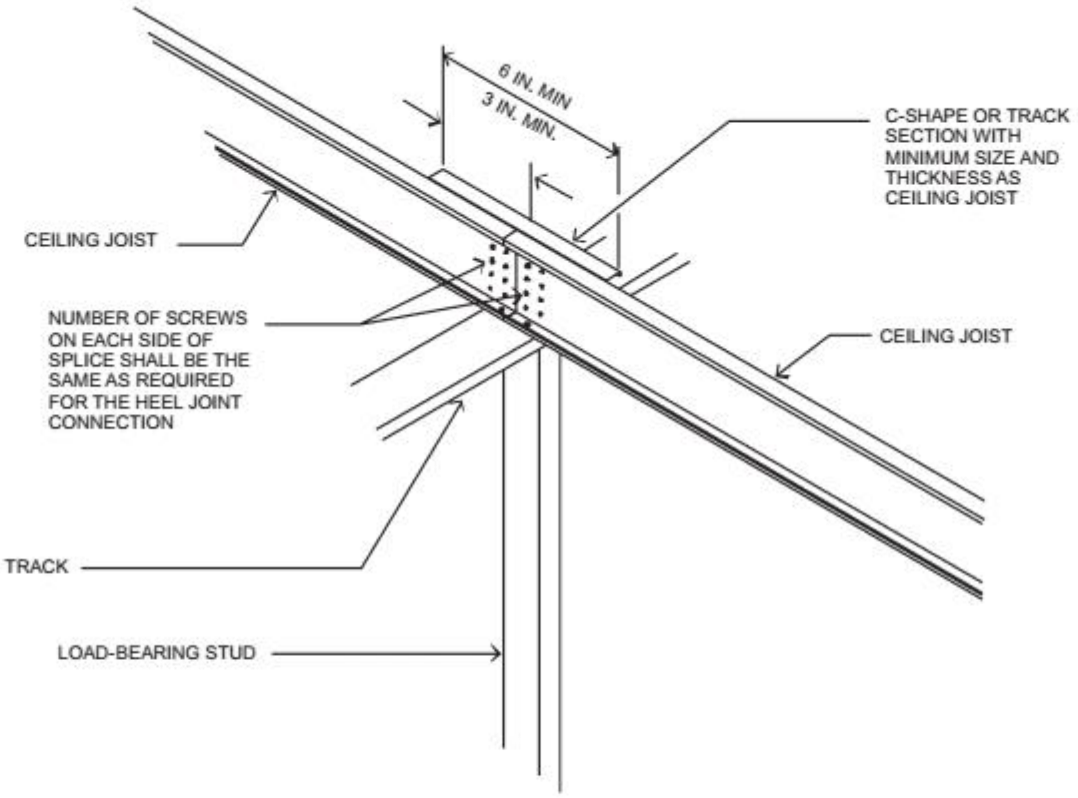


~~For SI: 1 foot = 304.8 mm.~~

~~FIGURE R804.3.1.3(2)~~
~~CEILING JOIST TOP FLANGE BRACING WITH CONTINUOUS STEEL STRAP AND BLOCKING~~

~~R804.3.1.4 Ceiling joist splicing.~~

~~Splices in ceiling joists shall be permitted, if ceiling joist splices are supported at interior bearing points and are constructed in accordance with Figure R804.3.1.4. The number of screws on each side of the splice shall be the same as required for the heel joint connection in Table R804.3.1.1(3).~~



~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R804.3.1.4~~
~~SPLICED CEILING JOISTS~~

~~R804.3.2 Roof rafters.~~

~~Cold-formed steel roof rafters shall be in accordance with this section.~~

~~R804.3.2.1 Minimum roof rafter sizes.~~

~~Roof rafter size and thickness shall be determined in accordance with the limits set forth in Table R804.3.2.1(1) based on the horizontal projection of the roof rafter span. For determination of roof rafter sizes, reduction of roof spans shall be permitted where a roof rafter support brace is installed in accordance with Section R804.3.2.2. The reduced roof rafter span shall be taken as the larger of the distances from the roof rafter support brace to the ridge or to the heel measured horizontally.~~

~~For the purpose of determining roof rafter sizes in Table R804.3.2.1(1), ultimate design wind speeds shall be converted to equivalent ground snow loads in accordance with Table R804.3.2.1(2). Roof rafter sizes shall be based on the higher of the ground snow load or the equivalent snow load converted from the ultimate design wind speed.~~

~~TABLE R804.3.2.1(1)~~
~~ROOF RAFTER SPANS~~[~~a, b, c, d~~]

~~**MEMBER DESIGNATION**~~	~~**ALLOWABLE SPAN MEASURED HORIZONTALLY (feet - inches)**~~							
	~~**Ground snow load (psf)**~~							
	~~**20**~~		~~**30**~~		~~**50**~~		~~**70**~~	
	~~**Rafter spacing (inches)**~~							
	~~**16**~~	~~**24**~~	~~**16**~~	~~**24**~~	~~**16**~~	~~**24**~~	~~**16**~~	~~**24**~~
~~550S162-33~~	~~14′-0″~~	~~11′-6″~~	~~11′-11″~~	~~9′-7″~~	~~9′-6″~~	~~7′-9″~~	~~8′-2″~~	~~6′-8″~~
~~550S162-43~~	~~16′-8″~~	~~13′-11″~~	~~14′-5″~~	~~11′-9″~~	~~11′-6″~~	~~9′-5″~~	~~9′-10″~~	~~8′-0″~~
~~550S162-54~~	~~17′-11″~~	~~15′-7″~~	~~15′-7″~~	~~13′-8″~~	~~13′-2″~~	~~11′-6″~~	~~11′-9″~~	~~10′-3″~~
~~550S162-68~~	~~19′-2″~~	~~16′-9″~~	~~16′-9″~~	~~14′-7″~~	~~14′-1″~~	~~12′-4″~~	~~12′-7″~~	~~11′-0″~~
~~800S162-33~~	~~16′-5″~~	~~13′-5″~~	~~13′-11″~~	~~11′-4″~~	~~11′-1″~~	~~8′-2″~~	~~9′-0″~~	~~6′-0″~~
~~800S162-43~~	~~19′-9″~~	~~16′-1″~~	~~16′-8″~~	~~13′-7″~~	~~13′-4″~~	~~10′-10″~~	~~11′-5″~~	~~9′-4″~~
~~800S162-54~~	~~24′-2″~~	~~21′-2″~~	~~21′-1″~~	~~18′-5″~~	~~17′-10″~~	~~14′-8″~~	~~15′-5″~~	~~12′-7″~~
~~800S162-68~~	~~25′-11″~~	~~22′-8″~~	~~22′-8″~~	~~19′-9″~~	~~19′-1″~~	~~16′-8″~~	~~17′-1″~~	~~14′-9″~~
~~1000S162-43~~	~~22′-3″~~	~~18′-2″~~	~~18′-9″~~	~~15′-8″~~	~~15′-0″~~	~~12′-3″~~	~~12′-10″~~	~~10′-6″~~
~~1000S162-54~~	~~29′-0″~~	~~24′-6″~~	~~25′-4″~~	~~20′-9″~~	~~20′-3″~~	~~16′-7″~~	~~17′-5″~~	~~14′-2″~~
~~1000S162-68~~	~~31′-2″~~	~~27′-3″~~	~~27′-3″~~	~~23′-9″~~	~~20′-0″~~	~~19′-6″~~	~~20′-6″~~	~~16′-8″~~
~~1200S162-54~~	~~33′-2″~~	~~27′-1″~~	~~28′-1″~~	~~22′-11″~~	~~22′-5″~~	~~18′-4″~~	~~19′-3″~~	~~15′-8″~~
~~1200S162-68~~	~~36′-4″~~	~~31′-9″~~	~~31′-9″~~	~~27′-0″~~	~~26′-5″~~	~~21′-6″~~	~~22′-6″~~	~~18′-6″~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.~~

~~a. Table provides maximum horizontal rafter spans in feet and inches for slopes between 3:12 and 12:12.~~

~~b. Deflection criteria: L/240 for live loads and L/180 for total loads.~~

~~c. Roof dead load = 12 psf.~~

~~d. Grade 33 ksi steel is permitted to be used for 33 mil and 43 mil thicknesses. Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.~~

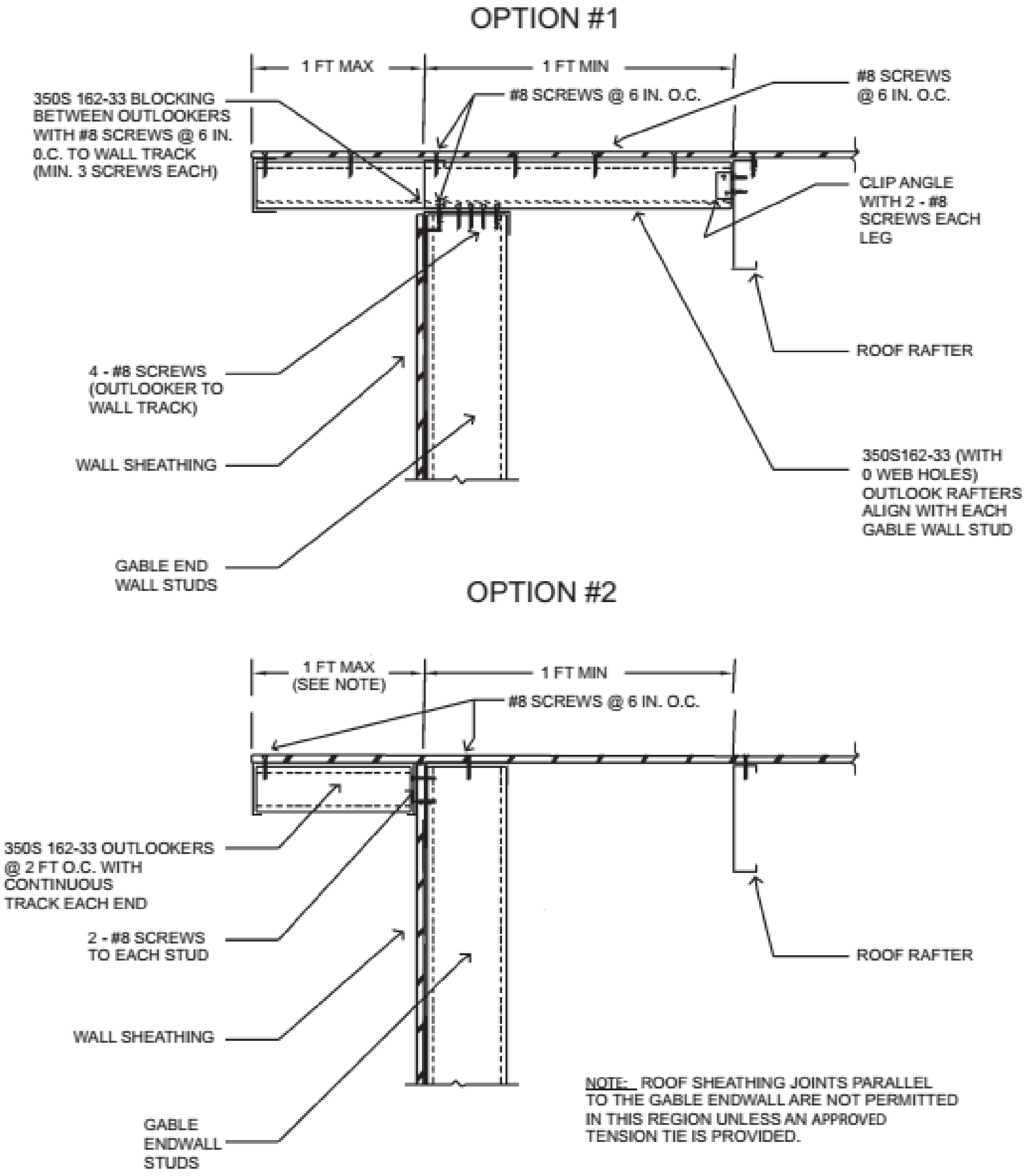
~~TABLE R804.3.2.1(2)~~
~~ULTIMATE DESIGN WIND SPEED TO EQUIVALENT SNOW LOAD CONVERSION~~

~~**BASIC WIND SPEED AND EXPOSURE**~~		~~**EQUIVALENT GROUND SNOW LOAD (psf)**~~									
		~~**Roof slope**~~									
~~**Exp. B**~~	~~**Exp. C**~~	~~**3:12**~~	~~**4:12**~~	~~**5:12**~~	~~**6:12**~~	~~**7:12**~~	~~**8:12**~~	~~**9:12**~~	~~**10:12**~~	~~**11:12**~~	~~**12:12**~~
~~85 mph~~	~~—~~	~~20~~	~~20~~	~~20~~	~~20~~	~~20~~	~~20~~	~~30~~	~~30~~	~~30~~	~~30~~
~~100 mph~~	~~85 mph~~	~~20~~	~~20~~	~~20~~	~~20~~	~~30~~	~~30~~	~~30~~	~~30~~	~~50~~	~~50~~
~~110 mph~~	~~100 mph~~	~~20~~	~~20~~	~~20~~	~~20~~	~~30~~	~~50~~	~~50~~	~~50~~	~~50~~	~~50~~
~~—~~	~~110 mph~~	~~30~~	~~30~~	~~30~~	~~50~~	~~50~~	~~50~~	~~70~~	~~70~~	~~70~~	~~—~~

~~For SI: 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa.~~

~~R804.3.2.1.1 Eave overhang.~~
~~Eave overhangs shall not exceed 24 inches (610 mm) measured horizontally.~~

~~R804.3.2.1.2 Rake overhangs.~~
~~Rake overhangs shall not exceed 12 inches (305 mm) measured horizontally. Outlookers at gable endwalls shall be installed in accordance with Figure R804.3.2.1.2.~~



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

~~FIGURE R804.3.2.1.2~~
~~GABLE ENDWALL OVERHANG DETAILS~~

~~R804.3.2.2 Roof rafter support brace.~~

~~When used to reduce roof rafter spans in determining roof rafter sizes, a roof rafter support brace shall meet all of the following conditions:~~

1. ~~Minimum 350S162-33 C-shaped brace member with maximum length of 8 feet (2438 mm).~~

2. ~~Minimum brace member slope of 45 degrees (0.785 rad) to the horizontal.~~

3. ~~Minimum connection of brace to a roof rafter and ceiling joist with four No.10 screws at each end.~~

4. ~~Maximum 6 inches (152 mm) between brace/ceiling joist connection and load-bearing wall below.~~

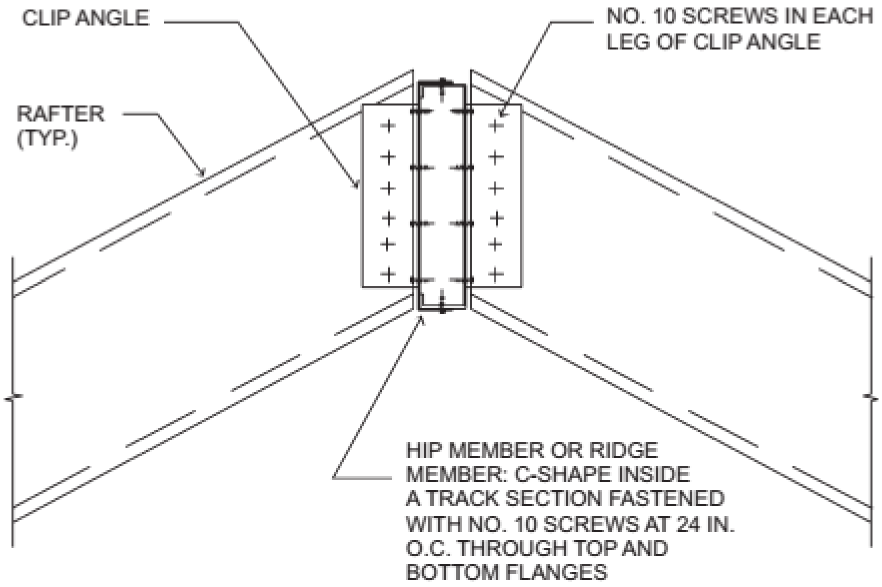
5. ~~Each roof rafter support brace greater than 4 feet (1219 mm) in length, shall be braced with a supplemental brace having a minimum size of 350S162-33 or 350T162-33 such that the maximum unsupported length of the roof rafter support brace is 4 feet (1219 mm). The supplemental brace shall be continuous and shall be connected to each roof rafter support brace using two No. 8 screws.~~

~~R804.3.2.3 Roof rafter splice.~~

~~Roof rafters shall not be spliced.~~

~~R804.3.2.4 Roof rafter to ceiling joist and ridge member connection.~~

~~Roof rafters shall be connected to a parallel ceiling joist to form a continuous tie between exterior walls in accordance with Figure R804.3.1.1 and Table R804.3.1.1(3). Ceiling joists shall be connected to the top track of the load-bearing wall in accordance with Table R804.3, either with the required number of No. 10 screws applied through the flange of the ceiling joist or by using a 54-mil (1.37 mm) clip angle with the required number of No.10 screws in each leg. Roof rafters shall be connected to a ridge member with a minimum 2-inch by 2-inch (51 mm by 51 mm) clip angle fastened with No. 10 screws to the ridge member in accordance with Figure R804.3.2.4 and Table R804.3.2.4. The clip angle shall have a steel thickness equivalent to or greater than the roof rafter thickness and shall extend the depth of the roof rafter member to the extent possible. The ridge member shall be fabricated from a C-shaped member and a track section that shall have a minimum size and steel thickness equivalent to or greater than that of adjacent roof rafters and shall be installed in accordance with Figure R804.3.2.4. The ridge member shall extend the full depth of the sloped roof rafter cut.~~



~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R804.3.2.4~~
~~RIDGE MEMBER CONNECTION~~

~~TABLE R804.3.2.4~~
~~SCREWS REQUIRED AT EACH LEG OF CLIP ANGLE FOR ROOF RAFTER TO RIDGE MEMBER CONNECTION~~[a]

~~BUILDING WIDTH (feet)~~	~~NUMBER OF SCREWS~~			
	~~Ground snow load (psf)~~			
	~~0 to 20~~	~~21 to 30~~	~~31 to 50~~	~~51 to 70~~
~~24~~	~~2~~	~~2~~	~~3~~	~~4~~
~~28~~	~~2~~	~~3~~	~~4~~	~~5~~
~~32~~	~~2~~	~~3~~	~~4~~	~~5~~
~~36~~	~~3~~	~~3~~	~~5~~	~~6~~
~~40~~	~~3~~	~~4~~	~~5~~	~~7~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.~~

~~a. Screws shall be No. 10 minimum.~~

~~R804.3.2.5 Roof rafter bottom flange bracing.~~

~~The bottom flanges of roof rafters shall be continuously braced, at a maximum spacing of 8 feet (2440 mm) as measured parallel to the roof rafters, with one of the following members:~~

1. ~~Minimum 33-mil (0.84 mm) C-shaped member.~~
2. ~~Minimum 33-mil (0.84 mm) track section.~~
3. ~~Minimum $1^{1}/_{2}$-inch by 33-mil (38 mm by 0.84 mm) steel strap.~~

~~The bracing element shall be fastened to the bottom flange of each roof rafter with one No. 8 screw and shall be fastened to blocking with two No. 8 screws. Blocking shall be installed between roof rafters in-line with the continuous bracing at a maximum spacing of 12 feet (3658 mm) measured perpendicular to the roof rafters. The ends of continuous bracing shall be fastened to blocking or anchored to a stable building component with two No. 8 screws.~~

~~R804.3.3 Cutting and notching.~~

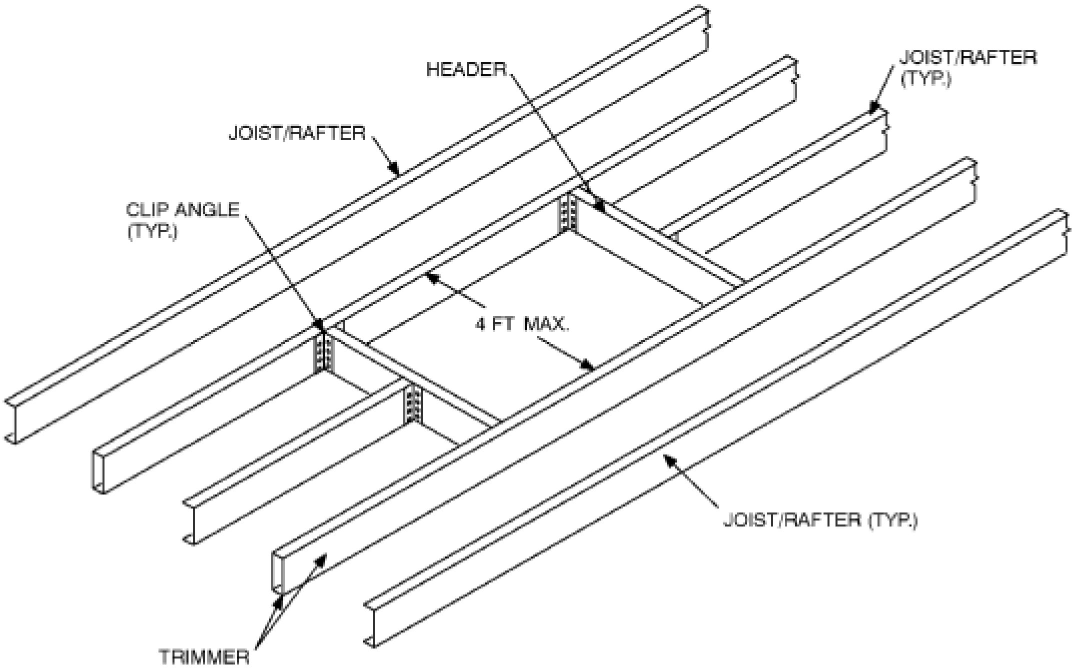
~~Flanges and lips of load-bearing, cold-formed steel roof framing members shall not be cut or notched.~~

~~R804.3.4 Headers.~~

~~Roof-ceiling framing above wall openings shall be supported on headers. The allowable spans for headers in load-bearing walls shall not exceed the values set forth in Section R603.6 and Tables R603.6(1) through R603.6(6).~~

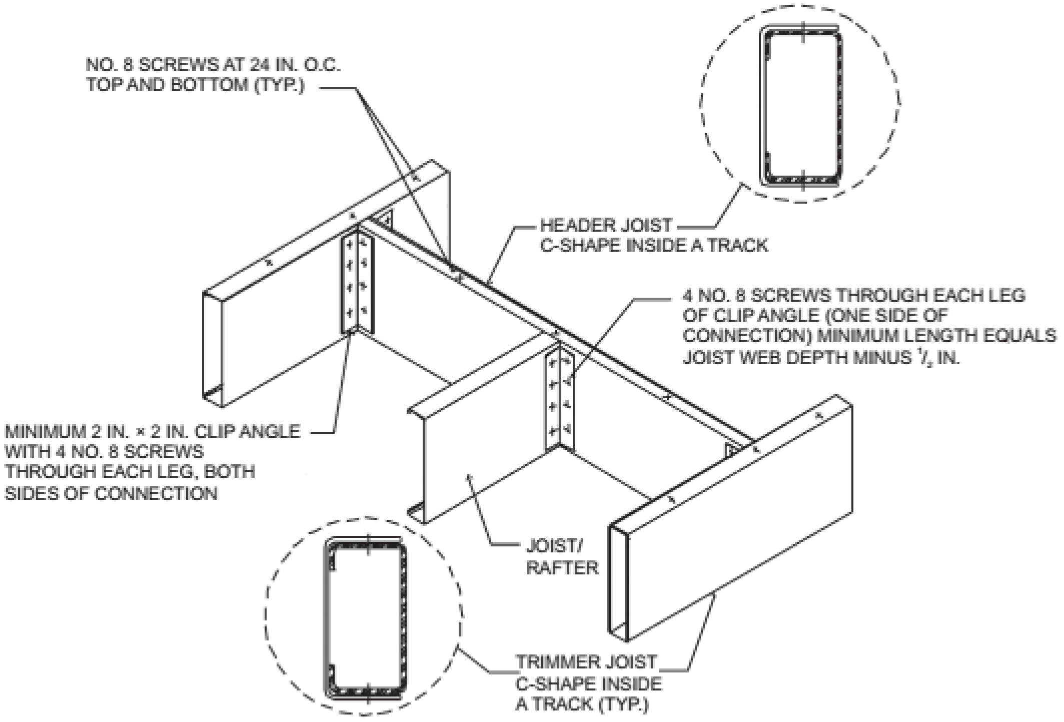
~~R804.3.5 Framing of openings in roofs and ceilings.~~

~~Openings in roofs and ceilings shall be framed with header and trimmer joists. Header joist spans shall not exceed 4 feet (1219 mm) in length. Header and trimmer joists shall be fabricated from joist and track members having a minimum size and thickness equivalent to the adjacent ceiling joists or roof rafters and shall be installed in accordance with Figures R804.3.5(1) and R804.3.5(2). Each header joist shall be connected to trimmer joists with not less than four 2-inch by 2-inch (51 by 51 mm) clip angles. Each clip angle shall be fastened to both the header and trimmer joists with four No. 8 screws, evenly spaced, through each leg of the clip angle. The steel thickness of the clip angles shall be not less than that of the ceiling joist or roof rafter. Each track section for a built-up header or trimmer joist shall extend the full length of the joist (continuous).~~



~~For SI: 1 foot = 304.8 mm.~~

~~FIGURE R804.3.5(1)~~
~~ROOF OR CEILING OPENING~~



~~For SI: 1 inch = 25.4 mm.~~

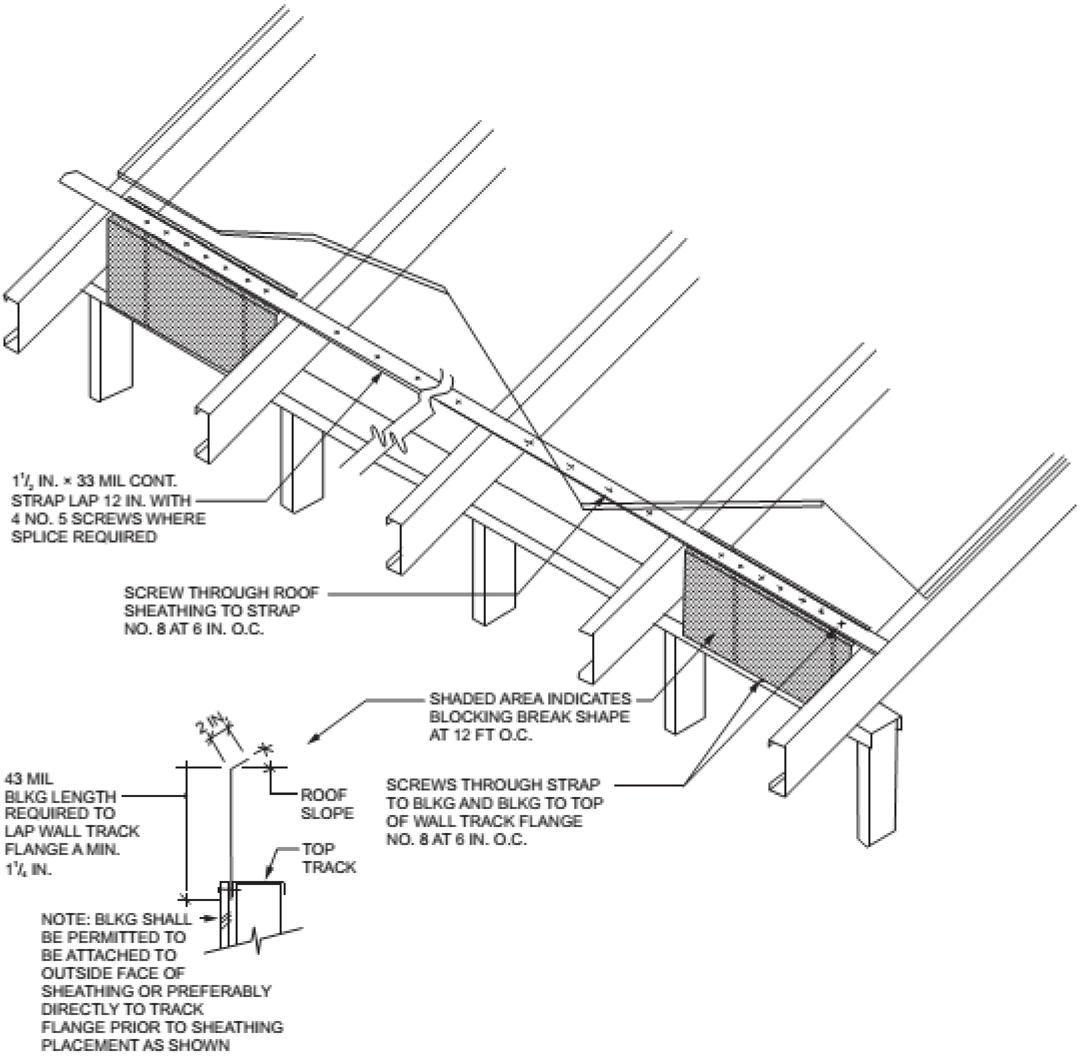
~~FIGURE R804.3.5(2)~~
~~HEADER TO TRIMMER CONNECTION~~

~~R804.3.6 Roof trusses.~~

~~Cold-formed steel trusses shall be designed and installed in accordance with AISI S100, Section D4. In the absence of specific bracing requirements, trusses shall be braced in accordance with accepted industry practices, such as the SBCA~~ ~~*Cold-Formed Steel Building Component Safety Information (CFSBCSI) Guide to Good Practice for Handling, Installing & Bracing of Cold-Formed Steel Trusses*~~~~. Trusses shall be connected to the top track of the load-bearing wall in accordance with Table R804.3, either with two No. 10 screws applied through the flange of the truss or by using a 54-mil (1.37 mm) clip angle with two No. 10 screws in each leg.~~

~~R804.3.7 Ceiling and roof diaphragms.~~

~~Ceiling and roof diaphragms shall be in accordance with this section.~~



~~For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.~~

~~FIGURE R804.3.7(2)~~
~~ROOF BLOCKING DETAIL~~

~~R804.3.7.1 Ceiling diaphragms.~~

~~At gable endwalls a ceiling *diaphragm* shall be provided by attaching a minimum $\frac{1}{2}$-inch (12.7 mm) gypsum board or a minimum $\frac{3}{8}$-inch (9.5 mm) wood structural panel sheathing, that complies with Section R803, to the bottom of ceiling joists or roof trusses and connected to wall framing in accordance with Figures R804.3.7.1(1) and R804.3.7.1(2), unless studs are designed as full height without bracing at the ceiling. Flat blocking shall consist of C-shaped or track section with a minimum thickness of 33 mils (0.84 mm). For a gypsum board sheathed ceiling, the diaphragm length shall be in accordance with Table R804.3.7.1. For a wood structural panel sheathed ceiling, the diaphragm length shall be not less than 12 feet (3658 mm) for building widths less than~~

~~36 feet (10 973 mm), or not less than 14 feet (4267 mm) for building widths greater than or equal to 36 feet (10 973 mm).~~

~~The ceiling diaphragm shall be secured with screws spaced at a maximum 6 inches (152 mm) o.c. at panel edges and a maximum 12 inches (305 mm) o.c. in the field. The required lengths in Table R804.3.7.1 for gypsum board sheathed ceiling diaphragms shall be permitted to be multiplied by 0.35 if all panel edges are blocked. Multiplying the required lengths in Table R804.3.7.1 for gypsum board sheathed ceiling diaphragms by 0.9 shall be permitted if all panel edges are secured with screws spaced at 4 inches (102 mm) o.c.~~

~~TABLE R804.3.7.1~~
~~REQUIRED LENGTHS FOR CEILING DIAPHRAGMS AT GABLE ENDWALLS GYPSUM BOARD SHEATHED, CEILING HEIGHT = 8 FEET~~[a, b, c, d, e, f, g]

~~EXPOSURE CATEGORY~~		~~ULTIMATE DESIGN WIND SPEED (mph)~~			
~~B~~		~~126~~	~~< 139~~	—	—
~~C~~		~~110~~	—	~~126~~	~~< 139~~
~~Roof pitch~~	~~Building endwall width (feet)~~	~~Minimum diaphragm length (feet)~~			
~~3:12 to 6:12~~	~~24 - 28~~	~~20~~	~~22~~	~~28~~	~~32~~
	~~> 28 - 32~~	~~22~~	~~28~~	~~32~~	~~38~~
	~~> 32 - 36~~	~~26~~	~~32~~	~~38~~	~~44~~
	~~> 36 - 40~~	~~30~~	~~36~~	~~44~~	~~50~~
~~6:12 to 9:12~~	~~> 24 - 28~~	~~22~~	~~26~~	~~32~~	~~36~~
	~~> 28 - 32~~	~~26~~	~~32~~	~~38~~	~~44~~
	~~> 32 - 36~~	~~32~~	~~38~~	~~44~~	~~52~~
	~~> 36 - 40~~	~~36~~	~~44~~	~~52~~	~~60~~
~~9:12 to 12:12~~	~~> 24 - 28~~	~~26~~	~~30~~	~~36~~	~~42~~
	~~> 28 - 32~~	~~30~~	~~36~~	~~42~~	~~50~~
	~~> 32 - 36~~	~~36~~	~~42~~	~~50~~	~~60~~
	~~> 36 - 40~~	~~42~~	~~50~~	~~60~~	~~70~~

~~For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa, 1 mile per hour = 0.447 m/s, 1 foot = 304.8 mm, 1 mil = 0.0254 mm.~~

~~a. Ceiling diaphragm is composed of $^1/_2$-inch gypsum board (min. thickness) secured with screws spaced at 6 inches o.c. at panel edges and 12 inches o.c. infield. Use No. 8 screws (min.) where framing members have a designation thickness of 54 mils or less and No. 10 screws (min.) where framing members have a designation thickness greater than 54 mils.~~

~~b. Maximum aspect ratio (length/width) of diaphragms is 2:1.~~

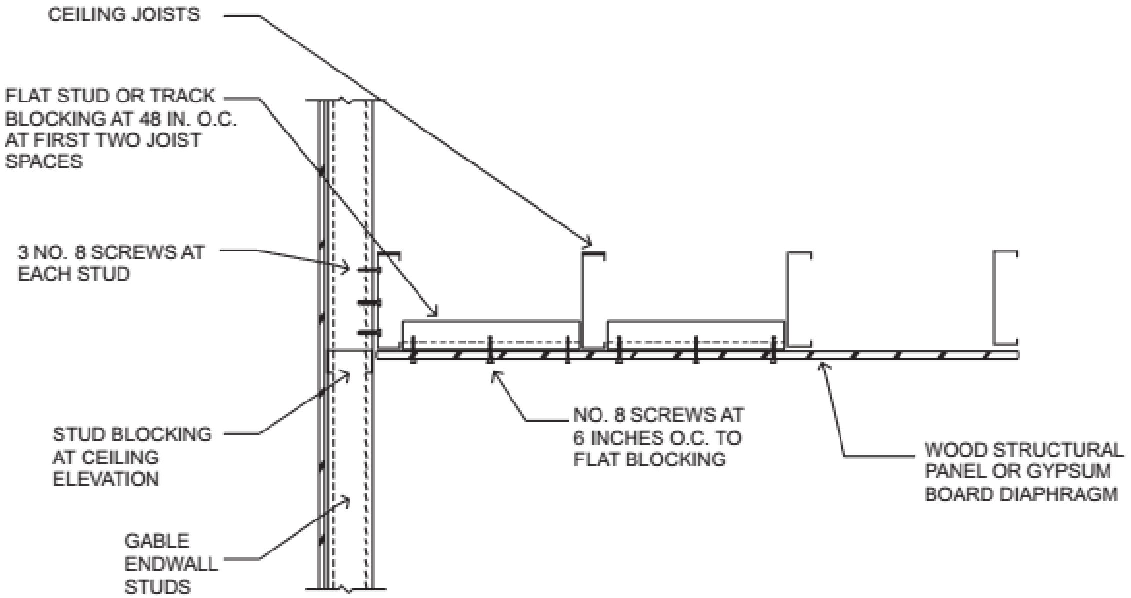
~~c. Building width is in the direction of horizontal framing members supported by the wall studs.~~

~~d. Required diaphragm lengths are to be provided at each end of the structure.~~

~~e. Multiplying required diaphragm lengths by 0.35 is permitted if all panel edges are blocked.~~

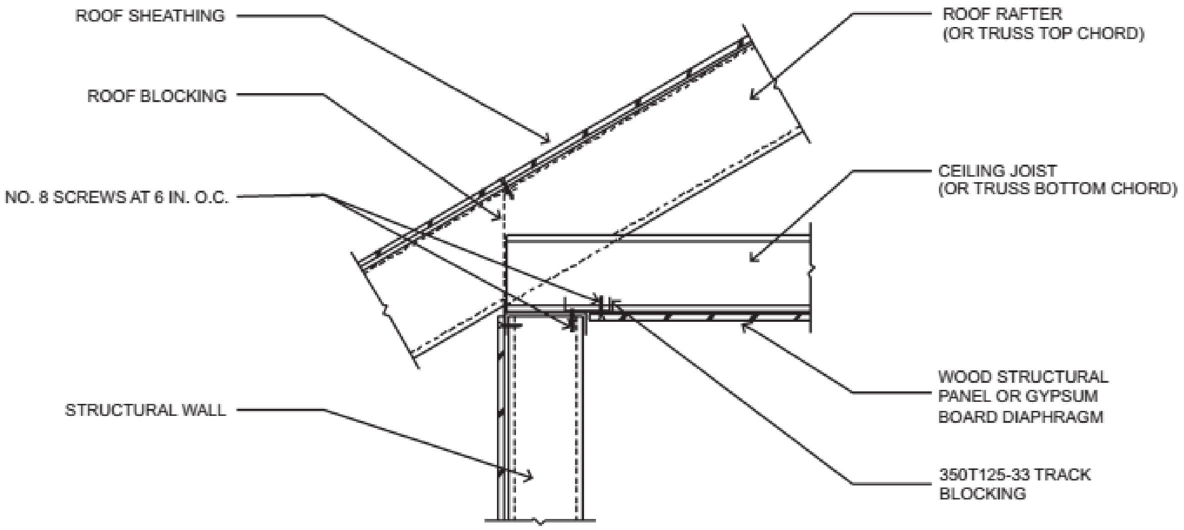
~~f. Multiplying required diaphragm lengths by 0.9 is permitted if all panel edges are secured with screws spaced at 4 inches o.c.~~

~~g. To determine the minimum diaphragm length for buildings with ceiling heights of 9 feet or 10 feet values in the table above shall be multiplied by 1.15.~~



~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R804.3.7.1(1)~~
~~CEILING DIAPHRAGM TO GABLE ENDWALL DETAIL~~



~~For SI: 1 inch = 25.4 mm.~~

~~FIGURE R804.3.7.1(2)~~
~~CEILING DIAPHRAGM TO SIDEWALL DETAIL~~

~~R804.3.7.2 Roof diaphragm.~~

~~A roof *diaphragm* shall be provided by attaching a minimum of $^{3}/_{8}$-inch (9.5 mm) wood structural panel which complies with Section R803 to roof rafters or truss top chords in accordance with Table R804.3. Buildings with 3:1 or larger plan *aspect ratio* and with roof rafter slope (pitch) of 9:12 or larger shall have the roof rafters and ceiling joists blocked in accordance with Figure R804.3.7(2).~~

~~R804.3.8 Roof tie-down.~~

~~Roof assemblies shall be connected to walls below in accordance with Table R804.3. A continuous load path shall be provided to transfer uplift loads to the foundation.~~

SECTION R806
ROOF VENTILATION

R806.2 Minimum vent area.

~~The minimum net free ventilating area shall be $^{1}/_{150}$ of the area of the vented space.~~

~~**Exception:** The minimum net free ventilation area shall be $^{1}/_{300}$ of the vented space provided one or more of the following conditions are met:~~

1. ~~In Climate Zones 6, 7 and 8, a Class I or II vapor retarder is installed on the warm-in-winter side of the ceiling.~~
2. ~~Not less than 40 percent and not more than 50 percent of the required ventilating area is provided by ventilators located in the upper portion of the attic or rafter space. Upper ventilators shall be located not more than 3 feet (914 mm) below the ridge or highest point of the space, measured vertically, with the balance of the required ventilation provided by eave or cornice vents. Where the location of wall or roof framing members conflicts with the installation of upper ventilators, installation more than 3 feet (914 mm) below the ridge or highest point of the space shall be permitted.~~

The total net free ventilating area shall not be less than 1/150 of the area of the space ventilated except that reduction of the total area to 1/300 is permitted provided that at least 50 percent and not more than 80 percent of the required ventilating area is provided by ventilators located in the upper portion of the space to be ventilated at least 3 feet (914 mm) above the eave or cornice vents with the balance of the required ventilation provided by eave or cornice vents. As an alternative, the net free cross-ventilation area may be reduced to 1/300 when a Class I or II vapor retarder is installed on the warm-in-winter side of the ceiling.

Exceptions:

1. Enclosed attic/rafter spaces requiring less than 1 square foot (0.0929 m^2) of ventilation may be vented with continuous soffit ventilation only.
2. Enclosed attic/rafter spaces over unconditioned space may be vented with continuous soffit vent only.

R806.4 Installation and weather protection. Deleted.
~~Ventilators shall be installed in accordance with manufacturer's instructions. Installation of ventilators in roof systems shall be in accordance with the requirements of Section R903. Installation of ventilators in wall systems shall be in accordance with the requirements of Section R703.1.~~

R806.5 Unvented attic and unvented enclosed rafter assemblies.
Unvented *attics* and unvented enclosed roof framing assemblies created by ceilings that are applied directly to the underside of the roof framing members and structural roof sheathing applied directly to the top of the roof framing members/rafters, shall be permitted where all the following conditions are met:

1. The unvented *attic* space is completely within the *building thermal envelope*.

2. No interior Class I vapor retarders are installed on the ceiling side (*attic* floor) of the unvented *attic* assembly or on the ceiling side of the unvented enclosed roof framing assembly.

3. Where wood shingles or shakes are used, a minimum $^1/_4$-inch (6.4 mm) vented airspace separates the shingles or shakes and the roofing underlayment above the structural sheathing.

4. ~~In Climate Zones 5, 6, 7 and 8, any *air-impermeable insulation* shall be a Class II vapor retarder, or shall have a Class II vapor retarder coating or covering in direct contact with the underside of the insulation.~~ Deleted.

5. Insulation shall be located in accordance with the following:

    5.1. Item 5.1.1, 5.1.2, 5.1.3 or 5.1.4 shall be met, depending on the air permeability of the insulation directly under the structural roof sheathing.

        5.1.1. Where only *air-impermeable insulation* is provided, it shall be applied in direct contact with the underside of the structural roof sheathing.

        5.1.2. Where *air-permeable insulation* is provided inside the building thermal envelope, it shall be installed in accordance with Section 5.1. In addition to the *air-permeable insulation* installed directly below the structural sheathing, rigid board or sheet insulation shall be installed directly above the structural roof sheathing in accordance with the *R*-values in Table R806.5 for condensation control.

        5.1.3. Where both *air-impermeable* and *air-permeable insulation* are provided, the *air-impermeable insulation* shall be applied in direct contact with the underside of the structural roof sheathing in accordance with Item 5.1.1 and shall be in accordance with the *R*-values in Table R806.5 for condensation control. The *air-permeable insulation* shall be installed directly under the *air-impermeable insulation*.

5.1.4. Alternatively, sufficient rigid board or sheet insulation shall be installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside of the structural roof sheathing above 45°F (7°C). For calculation purposes, an interior air temperature of 68°F (20°C) is assumed and the exterior air temperature is assumed to be the monthly average outside air temperature of the three coldest months.

5.2. Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.

SECTION R807
ATTIC ACCESS

R807.1 Attic access.
~~Buildings with combustible ceiling or roof construction shall have an *attic* access opening to *attic* areas that have a vertical height of 30 inches (762 mm) or greater over an area of not less than 30 square feet (2.8 m^2). The vertical height shall be measured from the top of the ceiling framing members to the underside of the roof framing members.~~

~~The rough-framed opening shall be not less than 22 inches by 30 inches (559 mm by 762 mm) and shall be located in a hallway or other readily accessible location. Where located in a wall, the opening shall be not less than 22 inches wide by 30 inches high (559 mm wide by 762 mm high). Where the access is located in a ceiling, minimum unobstructed headroom in the *attic* space shall be 30 inches (762 mm) at some point above the access measured vertically from the bottom of ceiling framing members. See Section M1305.1.3 for access requirements where mechanical *equipment* is located in *attics*.~~

An attic access opening shall be provided to attic areas that exceed 400 square feet (37.16 m^2) and have a vertical height of 60 inches (1524 mm) or greater. The net clear opening shall not be less than 20 inches by 30 inches (508 mm by 762 mm) and shall be located in a hallway or other readily accessible location. A 30-inch (762 mm) minimum unobstructed headroom in the attic space shall be provided at some point above the access opening. See Section M1305.1.3 for access requirements where mechanical equipment is located in attics.

Exceptions:

1. Concealed areas not located over the main structure including porches, areas behind knee walls, dormers, bay windows, etc. are not required to have access.
2. Pull down stair treads, stringers, handrails, and hardware may protrude into the net clear opening.

CHAPTER 9
ROOF ASSEMBLIES

SECTION R902
FIRE CLASSIFICATION

R902.1 Roofing covering materials.
Roofs shall be covered with materials as set forth in Sections R904 and R905. Class A, B or C roofing shall be installed ~~in jurisdictions designated by law as requiring their use or~~ where the edge of the roof is less than 3 feet (914 mm) from a lot line. Class A, B and C roofing required by this section to be listed shall be tested in accordance with UL 790 or ASTM E 108.

Exceptions:

1. Class A roof assemblies include those with coverings of brick, masonry and exposed concrete roof deck.
2. Class A roof assemblies include ferrous or copper shingles or sheets, metal sheets and shingles, clay or concrete roof tile, or slate installed on noncombustible decks.
3. Class A roof assemblies include minimum 16 ounces per square foot copper sheets installed over combustible decks.
4. Class A roof assemblies include slate installed over underlayment over combustible decks.

R902.4 Rooftop-mounted photovoltaic panels and modules.
Rooftop-mounted photovoltaic panels and modules installed on or above the roof covering shall be tested, listed and identified with a fire classification in accordance with UL 1703. Class A, B or C photovoltaic panels and modules shall be installed ~~in jurisdictions designated by law as requiring their use or~~ where the edge of the roof is less than 3 feet (914 mm) from a lot line.

SECTION R903
WEATHER PROTECTION

R903.3 Coping.
Parapet walls shall be properly coped with noncombustible, weatherproof materials of a width not less than the thickness of the parapet wall. Parapet coping shall extend 2 inches (51 mm) minimum down the faces of the parapet.

SECTION R904
MATERIALS

R904.4 Product identification.
Roof covering materials shall be delivered in packages bearing the manufacturer’s identifying

marks and *approved* testing agency *labels* when required. Bulk shipments of materials shall be accompanied by the same information issued in the form of a certificate or on a bill of lading by the manufacturer.

SECTION R905

REQUIREMENTS FOR ROOF COVERINGS

R905.1.2 Ice barriers.

In areas where ~~there has been a history of ice forming along the eaves causing a backup of water as designated in Table R301.2(1~~)the average daily temperature in January is 25° F (-4° C) or less or when Table R301.2(1) criteria so designates, an ice barrier shall be installed for asphalt shingles, metal roof shingles, mineral-surfaced roll roofing, slate and slate-type shingles, wood shingles and wood shakes. The ice barrier shall consist of not fewer than two layers of underlayment cemented together, or a self-adhering polymer-modified bitumen sheet shall be used in place of normal underlayment and extend from the lowest edges of all roof surfaces to a point not less than 24 inches (610 mm) inside the exterior wall line of the building. On roofs with slope equal to or greater than 8 units vertical in 12 units horizontal, the ice barrier shall also be applied not less than 36 inches (914 mm) measured along the roof slope from the eave edge of the building.

R905.2.6 Attachment.

Asphalt shingles shall have the minimum number of fasteners required by the manufacturer, but not less than four fasteners per strip shingle or two fasteners per individual shingle. Where the roof slope exceeds 21 units vertical in 12 units horizontal (21:12, 175-percent slope), shingles shall be installed as required by the manufacturer.

Exception: Asphalt strip shingles shall have a minimum of six fasteners per shingle where the roof is in one of the following categories:

1. The ultimate wind speed in accordance with Table R301.2(4) is 130 miles per hour (58 m/s) or greater and the eave is 20 feet (6096 mm) or higher above grade.

2. The ultimate wind speed in accordance with Table R301.2(4) is 140 miles per hour (63 m/s) or greater.

3. Special mountain regions in accordance with Table R301.2(5) that meet items 1 or 2 above.

R905.2.8.3 Sidewall flashing.

Base flashing against a vertical sidewall shall be continuous at horizontal surfaces or step flashing at sloped surfaces and shall be not less than 4 inches (102 mm) in height and 4 inches (102 mm) in width and shall direct water away from the vertical sidewall onto the roof or into the gutter. ~~Where siding is provided on the vertical sidewall, the vertical leg of the flashing shall be continuous under the siding.~~ Where anchored masonry veneer is provided on the vertical sidewall, the base flashing shall be provided in accordance with this section and counterflashing shall be provided in accordance with Section R703.~~7.2.2.~~8.5. ~~Where exterior plaster or adhered masonry veneer is provided on the vertical sidewall, the base flashing shall be provided in accordance with this section and Section R703.6.3.~~

R905.2.8.5 Drip edge. Deleted.

~~A drip edge shall be provided at eaves and rake edges of shingle roofs. Adjacent segments of drip edge shall be overlapped not less than 2 inches (51 mm). Drip edges shall extend not less than $^{1}/_{4}$ inch (6.4 mm) below the roof sheathing and extend up back onto the roof deck not less than 2 inches (51 mm). Drip edges shall be mechanically fastened to the roof deck at not more than 12 inches (305 mm) o.c. with fasteners as specified in Section R905.2.5. Underlayment shall be installed over the drip edge along eaves and under the underlayment along rake edges~~.

R905.16 Photovoltaic shingles. Deleted.

~~The installation of photovoltaic shingles shall comply with the provisions of this section, Section R324 and NFPA 70.~~

~~**R905.16.1 Deck requirements.**~~

~~Photovoltaic shingles shall be applied to a solid or closely-fitted deck, except where the roof covering is specifically designed to be applied over spaced sheathing.~~

~~**R905.16.2 Deck slope.**~~

~~Photovoltaic shingles shall be used only on roof slopes of two units vertical in 12 units horizontal (2:12) or greater.~~

~~**R905.16.3 Underlayment.**~~

~~Unless otherwise noted, required underlayment shall conform to ASTM D 4869 or ASTM D6757.~~

~~**R905.16.4 Underlayment application.**~~

~~Underlayment shall be applied shingle fashion, parallel to and starting from the eave, lapped 2 inches (51 mm) and fastened sufficiently to hold in place.~~

~~**R905.16.4.1 Ice barrier.**~~

~~In areas where there has been a history of ice forming along the eaves causing a backup of water, as designated in Table R301.2(1), an ice barrier that consists of not less than two layers of underlayment cemented together or of a self-adhering polymer modified bitumen sheet shall be used in lieu of normal underlayment and extend from the lowest edges of all roof surfaces to a point not less than 24 inches (610 mm) inside the exterior wall line of the building.~~

~~**Exception:** Detached accessory structures that contain no conditioned floor area.~~

~~**R905.16.4.2 Underlayment and high winds.**~~

~~Underlayment applied in areas subject to high winds [above 140 mph (63 m/s), in accordance with Figure R301.2(4)A] shall be applied with corrosion-resistant fasteners in accordance with the manufacturer’s installation instructions. Fasteners are to be applied along the overlap not farther apart than 36 inches (914 mm) on center.~~

~~Underlayment installed where the ultimate design wind speed equals or exceeds 150 mph (67 m/s) shall comply with ASTM D 4869 Type IV, or ASTM D 6757. The underlayment shall be attached in a grid pattern of 12 inches (305 mm) between side laps with a 6-inch (152 mm) spacing at the side laps. Underlayment shall be applied as required for asphalt shingles in accordance with Table R905.1.1(2). Underlayment shall~~

~~be attached using metal or plastic cap nails with a head diameter of not less than 1 inch (25 mm) with a thickness of not less than 32-gage sheet metal. The cap-nail shank shall be not less than 12 gage (0.105 inches) with a length to penetrate through the roof sheathing or not less than $^3/_4$ inch (19 mm) into the roof sheathing.~~

> ~~**Exception:** As an alternative, adhered underlayment complying with ASTM D 1970 shall be permitted.~~

~~**R905.16.5 Material standards.**~~
~~Photovoltaic shingles shall be listed and labeled in accordance with UL 1703.~~

~~**R905.16.6 Attachment.**~~
~~Photovoltaic shingles shall be attached in accordance with the manufacturer's installation instructions.~~

~~**R905.16.7 Wind resistance.**~~
~~Photovoltaic shingles shall be tested in accordance with procedures and acceptance criteria in ASTM D 3161. Photovoltaic shingles shall comply with the classification requirements of Table R905.2.4.1 for the appropriate maximum basic wind speed. Photovoltaic shingle packaging shall bear a label to indicate compliance with the procedures in ASTM D 3161 and the required classification from Table R905.2.4.1.~~

SECTION R907

ROOFTOP-MOUNTED PHOTOVOLTAIC SYSTEMS

Deleted

~~**R907.1 Rooftop-mounted photovoltaic systems.**~~
~~Rooftop-mounted photovoltaic panels or modules shall be installed in accordance with this section, Section R324 and NFPA 70.~~

~~**R907.2 Wind resistance.**~~
~~Rooftop-mounted photovoltaic panel or modules systems shall be installed to resist the component and cladding loads specified in Table R301.2(2), adjusted for height and exposure in accordance with Table R301.2(3).~~

~~**R907.3 Fire classification.**~~
~~Rooftop-mounted photovoltaic panels or modules shall have the same fire classification as the roof assembly required in Section R902.~~

~~**R907.4 Installation.**~~
~~Rooftop-mounted photovoltaic panels or modules shall be installed in accordance with the manufacturer's instructions.~~

~~**R907.5 Photovoltaic panels and modules.**~~
~~Rooftop-mounted photovoltaic panels and modules shall be listed and labeled in accordance with UL 1703 and shall be installed in accordance with the manufacturer's printed instructions.~~

SECTION R909

ROOFTOP-MOUNTED PHOTOVOLTAIC PANEL SYSTEMS

Deleted

~~R909.1 General.~~

~~The installation of photovoltaic panel systems that are mounted on or above the roof covering shall comply with this section, Section R324 and NFPA 70.~~

~~R909.2 Structural requirements.~~

~~Rooftop-mounted photovoltaic panel systems shall be designed to structurally support the system and withstand applicable gravity loads in accordance with Chapter 3. The roof upon which these systems are installed shall be designed and constructed to support the loads imposed by such systems in accordance with Chapter 8.~~

~~R909.3 Installation.~~

~~Rooftop-mounted photovoltaic systems shall be installed in accordance with the manufacturer's instructions. Roof penetrations shall be flashed and sealed in accordance with this chapter.~~

CHAPTER 10

CHIMNEYS AND FIREPLACES

SECTION R1001

MASONRY FIREPLACES

TABLE R1001.1
SUMMARY OF REQUIREMENTS FOR MASONRY FIREPLACES AND CHIMNEYS

ITEM	LETTER[a]	REQUIREMENTS
Hearth slab thickness	A	4″
Hearth extension (each side of opening)	B	8″ fireplace opening < 6 square foot. 12″ fireplace opening ≥ 6 square foot.
Hearth extension (front of opening)	C	16″ fireplace opening < 6 square foot. 20″ fireplace opening ≥ 6 square foot.
Hearth ~~slab~~ reinforcing	D	Reinforced to carry its own weight and all imposed loads.
Thickness of wall of firebox	E	10″ solid brick or 8″ where a firebrick lining is used. Joints in firebrick $^{1}/_{4}$″ maximum.
Distance from top of opening to throat	F	8″
Smoke chamber wall thickness Unlined walls	G	6″ 8″
Chimney Vertical reinforcing[b]	H	Four No. 4 full-length bars for chimney up to 40^{2} wide. Add two No. 4 bars for each additional 40^{2} or fraction of width or each additional flue.
Horizontal reinforcing[b]	J	$^{1}/_{4}$” ties at 18” and two ties at each bend in vertical steel.
Bond beams[b]	K	No specified requirements.
Fireplace lintel	L	Noncombustible material.
Chimney walls with flue lining	M	Solid masonry units or hollow masonry units grouted solid with not less than 4-inch nominal thickness.
Distances between adjacent flues	—	See Section R1003.13.
Effective flue area (based on area of fireplace opening)	P	See Section R1003.15.
Clearances Combustible material Mantel and trim Above roof	R	See Sections R1001.11 and R1003.18. See Section R1001.11, Exception 4. 3 at roofline and 2′ at 10′.
Anchorage[b] Strap Number	S	$^{3}/_{16}$″ × 1″ Two

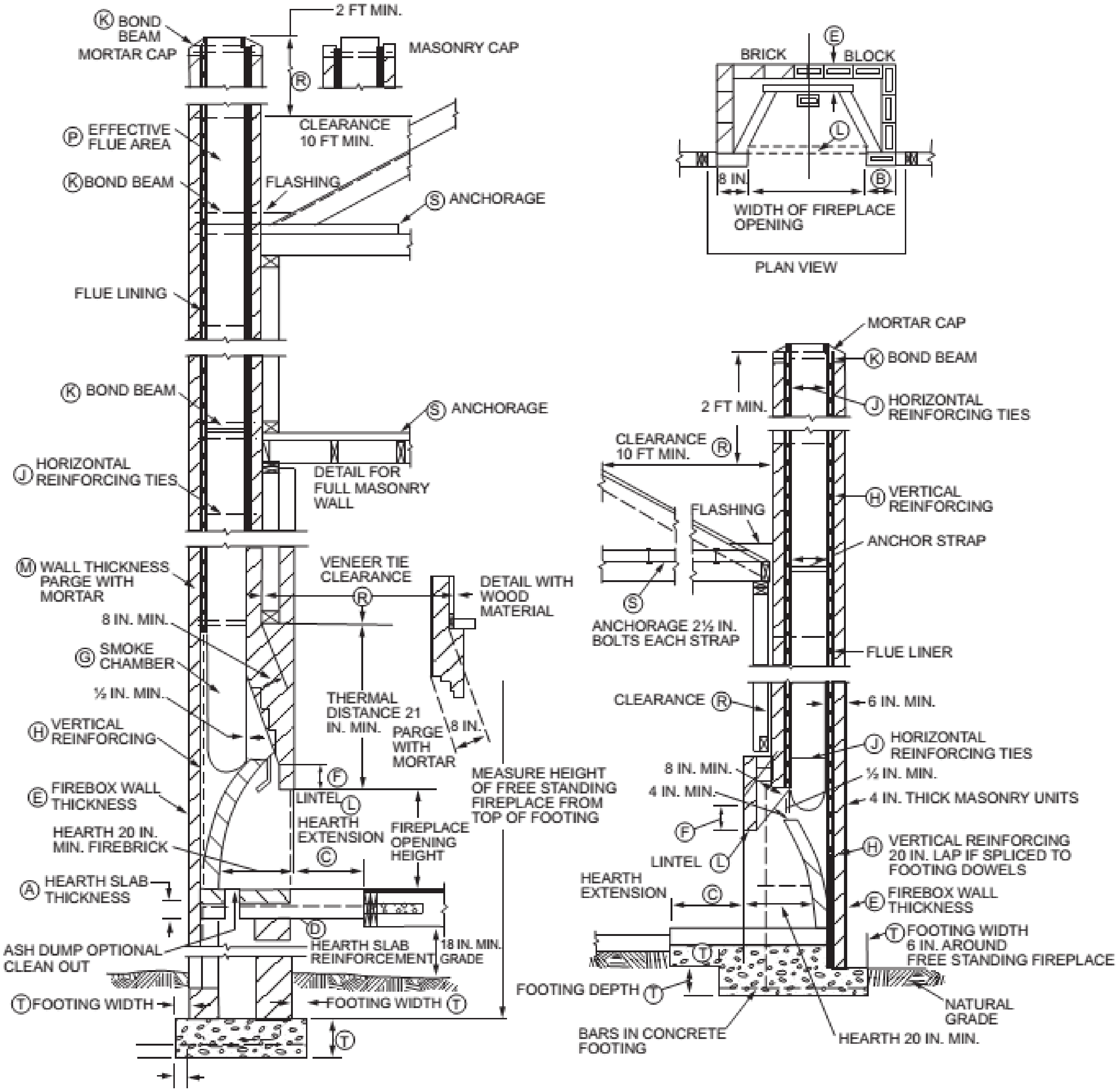
Embedment into chimney Fasten to Bolts		12″ hooked around outer bar with 6” extension. 4 joists ~~Two~~Three $^1/_2$″ diameter.
Footing Thickness Width	T	12″ min. ~~6~~12″ each side of fireplace wall.

For SI:1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2.

Note: This table provides a summary of major requirements for the construction of masonry chimneys and fireplaces. Letter references are to Figure R1001.1, which shows examples of typical construction. This table does not cover all requirements, nor does it cover all aspects of the indicated requirements. For the actual mandatory requirements of the code, see the indicated section of text.

a. The letters refer to Figure R1001.1.

b. Not required in Seismic Design Category A, B or C.



BRICK FIREBOX AND CHIMNEY—
SECTIONAL SIDE VIEW ON WOOD FLOOR

BRICK FIREBOX AND BLOCK CHIMNEY—
SECTIONAL SIDE VIEW ON CONCRETE SLAB

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

FIGURE R1001.1
FIREPLACE AND CHIMNEY DETAILS
**(Remove rebar from figures)

R1001.2 Footings and foundations.

Footings for masonry fireplaces and their chimneys shall be constructed of concrete or *solid masonry* not less than 12 inches (305 mm) thick and shall extend not less than ~~6~~12 inches (~~152~~ 305 mm) beyond the face of the fireplace or foundation wall on all sides. Footings shall be founded on natural, undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be not less than 12 inches (305 mm) below finished *grade*.

R1001.3 Seismic reinforcing. Deleted.
~~Masonry or concrete chimneys in Seismic Design Category D_0, D_1 or D_2 shall be reinforced. Reinforcing shall conform to the requirements set forth in Table R1001.1 and Section R606.~~

~~**R1001.3.1 Vertical reinforcing.**~~
~~For chimneys up to 40 inches (1016 mm) wide, four No. 4 continuous vertical bars shall be placed between wythes of *solid masonry* or within the cells of hollow unit masonry and grouted in accordance with Section R606. Grout shall be prevented from bonding with the flue liner so that the flue liner is free to move with thermal expansion. For chimneys more than 40 inches (1016 mm) wide, two additional No. 4 vertical bars shall be provided for each additional flue incorporated into the chimney or for each additional 40 inches (1016 mm) in width or fraction thereof.~~

~~**R1001.3.2 Horizontal reinforcing.**~~
~~Vertical reinforcement shall be placed within 1/4-inch (6.4 mm) ties, or other reinforcing of equivalent net cross-sectional area, placed in the bed joints in accordance with Section R606 at not less than every 18 inches (457 mm) of vertical height. Two such ties shall be installed at each bend in the vertical bars.~~

R1001.4 Seismic anchorage. Deleted.
~~Masonry or concrete chimneys in Seismic Design Category D_0, D_1 or D_2 shall be anchored at each floor, ceiling or roof line more than 6 feet (1829 mm) above *grade*, except where constructed completely within the exterior walls. Anchorage shall conform to the requirements of Section R1001.4.1.~~

~~**R1001.4.1 Anchorage.**~~
~~Two 3/16-inch by 1-inch (5 mm by 25 mm) straps shall be embedded not less than 12 inches (305 mm) into the chimney. Straps shall be hooked around the outer bars and extend 6 inches (152 mm) beyond the bend. Each strap shall be fastened to not less than four floor ceiling or floor joists or rafters with two 1/2-inch (12.7 mm) bolts.~~

~~**R1001.4.1.1 Cold-formed steel framing.**~~
~~Where cold-formed steel framing is used, the location where the 1/2-inch (12.7 mm) bolts are used to attach the straps to the framing shall be reinforced with not less than a 3-inch × 3-inch × 0.229-inch (76 mm × 76 mm × 5.8 mm) steel plate on top of the strap that is screwed to the framing with not fewer than seven No. 6 screws for each bolt.~~

SECTION R1002

MASONRY HEATERS

R1002.4 Seismic reinforcing. Deleted.
~~In Seismic Design Categories D_0, D_1 and D_2, masonry heaters shall be anchored to the masonry foundation in accordance with Section R1003.3. Seismic reinforcing shall not be~~

~~required within the body of a masonry heater whose height is equal to or less than 3.5 times its body width and where the masonry chimney serving the heater is not supported by the body of the heater. Where the masonry chimney shares a common wall with the facing of the masonry heater, the chimney portion of the structure shall be reinforced in accordance with Section R1003.~~

SECTION R1003

MASONRY CHIMNEYS

R1003.2 Footings and foundations.

Footings for masonry chimneys shall be constructed of concrete or *solid masonry* not less than 12 inches (305 mm) thick and shall extend not less than ~~6~~12 inches (~~152~~ 305 mm) beyond the face of the foundation or support wall on all sides. Footings shall be founded on natural undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be not less than 12 inches (305 mm) below finished *grade*.

R1003.3 Seismic reinforcing. Deleted.

~~Masonry or concrete chimneys shall be constructed, anchored, supported and reinforced as required in this chapter. In Seismic Design Category D_0, D_1 or D_2 masonry and concrete chimneys shall be reinforced and anchored as detailed in Sections R1003.3.1, R1003.3.2 and R1003.4. In Seismic Design Category A, B or C, reinforcement and seismic anchorage are not required.~~

~~R1003.3.1 Vertical reinforcing.~~

~~For chimneys up to 40 inches (1016 mm) wide, four No. 4 continuous vertical bars, anchored in the foundation, shall be placed in the concrete, or between wythes of *solid masonry*, or within the cells of hollow unit masonry, and grouted in accordance with Section R609.1.1. Grout shall be prevented from bonding with the flue liner so that the flue liner is free to move with thermal expansion. For chimneys more than 40 inches (1016 mm) wide, two additional No. 4 vertical bars shall be installed for each additional 40 inches (1016 mm) in width or fraction thereof.~~

~~R1003.3.2 Horizontal reinforcing.~~

~~Vertical reinforcement shall be placed enclosed within $^1/_4$-inch (6.4 mm) ties, or other reinforcing of equivalent net cross-sectional area, spaced not to exceed 18 inches (457 mm) on center in concrete, or placed in the bed joints of unit masonry, at not less than every 18 inches (457 mm) of vertical height. Two such ties shall be installed at each bend in the vertical bars.~~

R1003.4 Seismic anchorage. Deleted.

~~Masonry and concrete chimneys and foundations in Seismic Design Category D_0, D_1 or D_2 shall be anchored at each floor, ceiling or roof line more than 6 feet (1829 mm) above *grade*, except where constructed completely within the exterior walls. Anchorage shall conform to the requirements in Section R1003.4.1.~~

~~R1003.4.1 Anchorage.~~

~~Two $^{3}/_{16}$-inch by 1-inch (5 mm by 25 mm) straps shall be embedded not less than 12 inches (305 mm) into the chimney. Straps shall be hooked around the outer bars and extend 6 inches (152 mm) beyond the bend. Each strap shall be fastened to not less than four floor joists with two $^{1}/_{2}$-inch (12.7 mm) bolts.~~

~~R1003.4.1.1 Cold-formed steel framing.~~

~~Where cold-formed steel framing is used, the location where the $^{1}/_{2}$-inch (12.7 mm) bolts are used to attach the straps to the framing shall be reinforced with not less than a 3-inch × 3-inch × 0.229-inch (76 mm × 76 mm × 5.8 mm) steel plate on top of a strap that is screwed to the framing with not fewer than seven No. 6 screws for each bolt.~~

R1003.12 Clay flue lining (installation).

Clay flue liners shall be installed in accordance with ASTM C 1283 and extend from a point not less than 8 inches (203 mm) below the lowest inlet or, in the case of fireplaces, from the top of the smoke chamber to a point above the enclosing walls. The lining shall be carried up vertically, with a maximum slope not greater than 30 degrees (0.52 rad) from the vertical.

Clay flue liners shall be laid in medium-duty water insoluble refractory mortar conforming to ASTM C 199 (Types M and S) with tight mortar joints left smooth on the inside and installed to maintain an airspace or insulation not to exceed the thickness of the flue liner separating the flue liners from the interior face of the chimney masonry walls. Flue liners shall be supported on all sides. Only enough mortar shall be placed to make the joint and hold the liners in position.

Part IV—Energy Conservation

CHAPTER 11 [RE]

ENERGY EFFICIENCY

SECTION N1101
GENERAL

N1101.1 Scope.
This chapter regulates the energy efficiency for the design and construction of buildings regulated by this code.

Note: *The text of the following Sections N1101.2 through N1105 is extracted from the ~~2012~~ 2018 edition of the ~~International~~ North Carolina Energy Conservation* Code—Residential Provisions *and has been editorially revised to conform to the scope and application of this code*. *The section numbers appearing in parenthesis after each section number are the section numbers of the corresponding text in the ~~International~~ North Carolina Energy Conservation Code—Residential Provisions.*

N1101.4 (R102.1.1) Above code programs. Deleted.
~~The *building official* or other authority having jurisdiction shall be permitted to deem a national, state or local energy-efficiency program to exceed the energy efficiency required by this code. Buildings *approved* in writing by such an energy-efficiency program shall be considered in compliance with this code. The requirements identified as "mandatory" in this chapter, as applicable, shall be met.~~

N1101.5 (R103.2) Information on construction documents. Deleted.
~~Construction documents shall be drawn to scale upon suitable material. Electronic media documents are permitted to be submitted when *approved* by the *building official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, as applicable:~~

1. ~~Insulation materials and their *R*-values.~~

2. ~~Fenestration *U*-factors and SHGCs.~~

3. ~~Area-weighted *U*-factor and SHGC calculations.~~

4. ~~Mechanical system design criteria.~~

5. ~~Mechanical and service water heating system and equipment types, sizes and efficiencies.~~

~~6. Equipment and system controls.~~

~~7. Duct sealing, duct and pipe insulation and location.~~

~~8. Air sealing details.~~

N1101.5.1 (R103.2.1) Thermal envelope depiction. Deleted.
~~The building's thermal envelope shall be represented on the construction drawings.~~

N1101.6 (R202) Defined terms. Deleted. See Chapter 2.
~~The following words and terms shall, for the purposes of this chapter, have the meanings shown herein.~~

~~**ABOVE-GRADE WALL.** A wall more than 50 percent above grade and enclosing *conditioned space*. This includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.~~

~~**ACCESSIBLE.** Admitting close approach as a result of not being guarded by locked doors, elevation or other effective means (see "Readily *accessible*").~~

~~**ADDITION.** An extension or increase in the *conditioned space* floor area or height of a building or structure.~~

~~**AIR BARRIER.** Material(s) assembled and joined together to provide a barrier to air leakage through the building envelope. An air barrier may be a single material or a combination of materials.~~

~~**ALTERATION.** Any construction, retrofit or renovation to an existing structure other than repair or addition that requires a permit. Also, a change in a building, electrical, gas, mechanical or plumbing system that involves an extension, addition or change to the arrangement, type or purpose of the original installation that requires a permit.~~

~~**AUTOMATIC.** Self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength, pressure, temperature or mechanical configuration (see "Manual").~~

~~**BASEMENT WALL.** A wall 50 percent or more below grade and enclosing *conditioned space*.~~

~~**BUILDING.** Any structure used or intended for supporting or sheltering any use or occupancy, including any mechanical systems, service water heating systems and electric power and lighting systems located on the building site and supporting the building.~~

~~**BUILDING SITE.** A continguous area of land that is under the ownership or control of one entity.~~

~~**BUILDING THERMAL ENVELOPE.** The basement walls, exterior walls, floor, roof and any other building elements that enclose *conditioned space* or provide a boundary between *conditioned space* and exempt or unconditioned space.~~

~~**C-FACTOR (THERMAL CONDUCTANCE).** The coefficient of heat transmission (surface to surface) through a building component or assembly, equal to the time rate of heat flow per unit~~

~~area and the unit temperature difference between the warm side and cold side surfaces (Btu/h-ft^2·°F)[W/(m^2·K)].~~

~~**CIRCULATING HOT WATER SYSTEM.** A specifically designed water distribution system where one or more pumps are operated in the service hot water piping to circulate heated water from the water-heating equipment to fixtures and back to the water-heating equipment.~~

~~**CLIMATE ZONE.** A geographical region based on climatic criteria as specified in this code.~~

~~**CONDITIONED FLOOR AREA.** The horizontal projection of the floors associated with the *conditioned space*.~~

~~**CONDITIONED SPACE.** An area, room or space that is enclosed within the building thermal envelope and that is directly heated or cooled or indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate through openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings, or where they contain uninsulated ducts, piping or other sources of heating or cooling.~~

~~**CONTINUOUS AIR BARRIER.** A combination of materials and assemblies that restrict or prevent the passage of air through the building thermal envelope.~~

~~**CONTINUOUS INSULATION (ci).** Insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior, or is integral to any opaque surface, of the building envelope.~~

~~**CRAWL SPACE WALL.** The opaque portion of a wall that encloses a crawl space and is partially or totally below grade.~~

~~**CURTAIN WALL.** Fenestration products used to create an external nonload-bearing wall that is designed to separate the exterior and interior environments.~~

~~**DEMAND RECIRCULATION WATER SYSTEM.** A water distribution system where pump(s) prime the service hot water piping with heated water upon demand for hot water.~~

~~**DUCT.** A tube or conduit utilized for conveying air. The air passages of self-contained systems are not to be construed as air ducts.~~

~~**DUCT SYSTEM.** A continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, plenums, fans and accessory air-handling equipment and appliances.~~

~~**ENERGY ANALYSIS.** A method for estimating the annual energy use of the *proposed design* and *standard reference design* based on estimates of energy use.~~

~~**ENERGY COST.** The total estimated annual cost for purchased energy for the building functions regulated by this code, including applicable demand charges.~~

~~**ENERGY SIMULATION TOOL.** An *approved* software program or calculation-based methodology that projects the annual energy use of a building.~~

~~**ERI REFERENCE DESIGN.** A version of the rated design that meets the minimum requirements of the 2006 *International Energy Conservation Code.*~~

~~**EXTERIOR WALL.** Walls including both above-grade walls and basement walls.~~

~~**FENESTRATION.** Products classified as either *vertical fenestration* or *skylights*.~~

~~**FENESTRATION PRODUCT, SITE-BUILT.** A fenestration designed to be made up of field-glazed or field-assembled units using specific factory cut or otherwise factory- formed framing and glazing units. Examples of site-built fenestration include storefront systems, curtain walls, and atrium roof systems.~~

~~**FENESTRATION, VERTICAL.** Windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of a least 60 degrees (1.05 rad) from horizontal.~~

~~**HEATED SLAB.** Slab-on-grade construction in which the heating elements, hydronic tubing, or hot air distribution system is in contact with, or placed within or under, the slab.~~

~~**HIGH-EFFICACY LAMPS.** Compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps, or lamps with a minimum efficacy of:~~

1. ~~60 lumens per watt for lamps over 40 watts;~~

2. ~~50 lumens per watt for lamps over 15 watts to 40 watts; and~~

3. ~~40 lumens per watt for lamps 15 watts or less.~~

~~**HISTORIC BUILDING.** Buildings that are listed in or eligible for listing in the National Register of Historic Places, or designated as historic under an appropriate state or local law.~~

~~**INFILTRATION.** The uncontrolled inward air leakage into a building caused by the pressure effects of wind or the effect of differences in the indoor and outdoor air density or both.~~

~~**INSULATED SIDING.** A type of continuous insulation with manufacturer-installed insulating material as an integral part of the cladding product having a minimum *R*-value of R-2.~~

~~**INSULATING SHEATHING.** An insulating board with a core material having a minimum *R*-value of R-2.~~

~~**LOW-VOLTAGE LIGHTING.** Lighting equipment powered through a transformer such as a cable conductor, a rail conductor and track lighting.~~

~~**MANUAL.** Capable of being operated by personal intervention (see “Automatic”).~~

~~**PROPOSED DESIGN.** A description of the proposed building used to estimate annual energy use for determining compliance based on total building performance.~~

~~**RATED DESIGN.** A description of the proposed *building* used to determine the energy rating index.~~

~~**READILY ACCESSIBLE.** Capable of being reached quickly for operation, renewal or inspection without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders or access equipment (see "*Accessible*").~~

~~**REPAIR.** The reconstruction or renewal of any part of an existing building for the purpose of its maintenance or to correct damage. For definitions applicable in Chapter 11, see Section N1101.9.~~

~~**REROOFING.** The process of recovering or replacing an existing *roof covering*. See "Roof recover" and "Roof replacement."~~

~~**RESIDENTIAL BUILDING.** For this chapter, includes detached one- and two-family dwellings and multiple single-family dwellings (townhouses) as well as Group R-2, R-3 and R-4 buildings three stories or less in height above grade plane.~~

~~**ROOF RECOVER.** The process of installing an additional *roof covering* over a prepared existing *roof covering* without removing the existing *roof covering*.~~

~~**ROOF REPAIR.** Reconstruction or renewal of any part of an existing roof for the purposes of its maintenance.~~

~~**ROOF REPLACEMENT.** The process of removing the existing *roof covering*, repairing any damaged substrate and installing a new *roof covering*.~~

~~**R-VALUE (THERMAL RESISTANCE).** The inverse of the time rate of heat flow through a body from one of its bounding surfaces to the other surface for a unit temperature difference between the two surfaces, under steady state conditions, per unit area ($h \cdot ft^2 \cdot °F/Btu$)[($m^2 \cdot K$)/W].~~

~~**SERVICE WATER HEATING.** Supply of hot water for purposes other than comfort heating.~~

~~**SKYLIGHT.** Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal. Glazing material in skylights, including unit skylights, solariums, sunrooms, roofs and sloped walls is included in this definition.~~

~~**SOLAR HEAT GAIN COEFFICIENT (SHGC).** The ratio of the solar heat gain entering the space through the fenestration assembly to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation that is then reradiated, conducted or convected into the space.~~

~~**STANDARD REFERENCE DESIGN.** A version of the *proposed design* that meets the minimum requirements of this code and is used to determine the maximum annual energy use requirement for compliance based on total building performance.~~

~~**SUNROOM.** A one-story structure attached to a dwelling with a glazing area in excess of 40 percent of the gross area of the structure's exterior walls and roof.~~

~~**THERMAL ISOLATION.** Physical and space conditioning separation from *conditioned space(s)*. The *conditioned space*(s) shall be controlled as separate zones for heating and cooling or conditioned by separate equipment.~~

~~**THERMOSTAT.** An automatic control device used to maintain temperature at a fixed or adjustable set point.~~

~~**U-FACTOR (THERMAL TRANSMITTANCE).** The coefficient of heat transmission (air to air) through a building component or assembly, equal to the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films (Btu/h·ft^2·°F)[W/(m^2·K)].~~

~~**VENTILATION AIR.** That portion of supply air that comes from outside (outdoors) plus any recirculated air that has been treated to maintain the desired quality of air within a designated space.~~

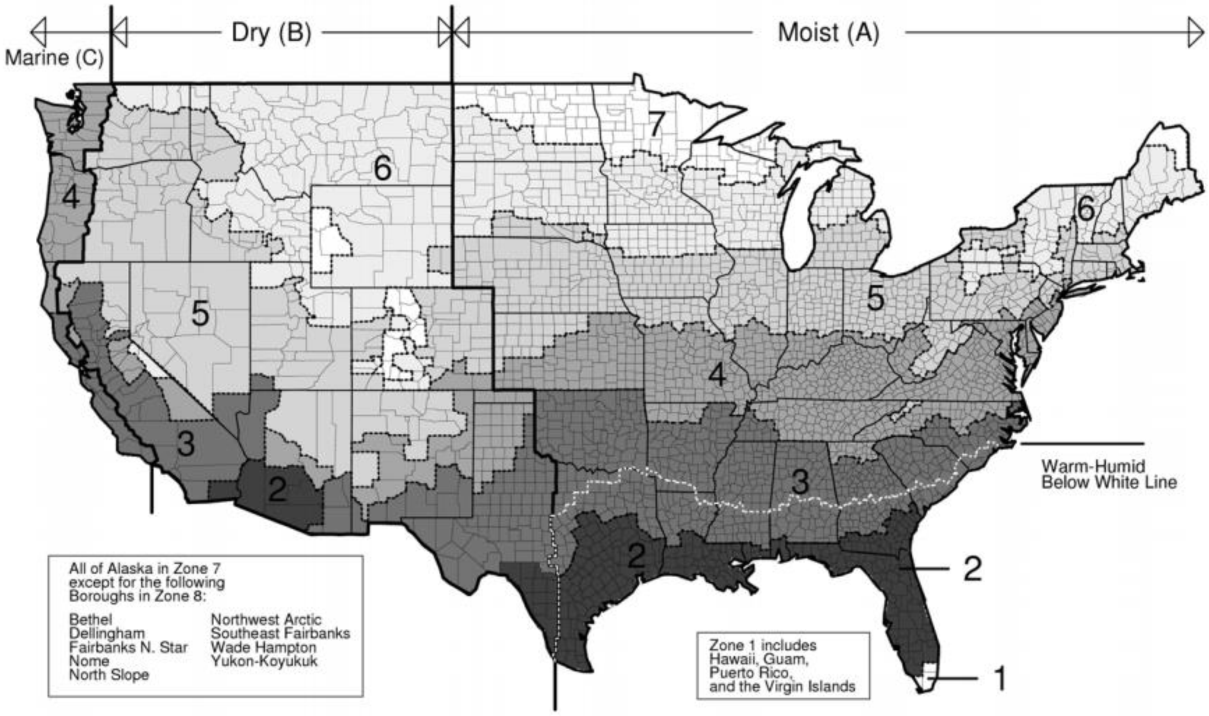
~~**VISIBLE TRANSMITTANCE [VT].** The ratio of visible light entering the space through the fenestration product assembly to the incident visible light, Visible Transmittance, includes the effects of glazing material and frame and is expressed as a number between 0 and 1.~~

~~**WHOLE HOUSE MECHANICAL VENTILATION SYSTEM.** An exhaust system, supply system, or combination thereof that is designed to mechanically exchange indoor air with outdoor air when operating continuously or through a programmed intermittent schedule to satisfy the whole house ventilation rates.~~

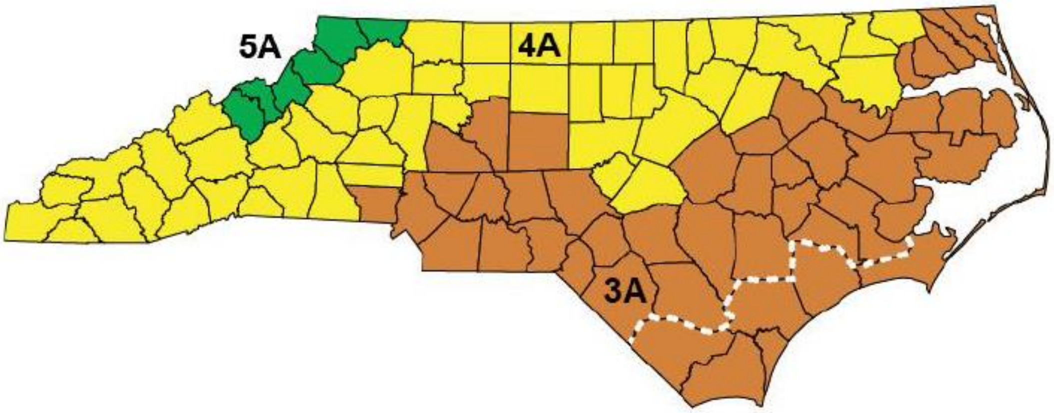
~~**ZONE.** A space or group of spaces within a building with heating or cooling requirements that are sufficiently similar so that desired conditions can be maintained throughout using a single controlling device.~~

N1101.7 (R301.1) Climate zones.

Climate zones from Figure N1101.7 or Table N1101.7 shall be used in determining the applicable requirements in Sections N1101 through N1111. ~~Locations not in Table N1101.7 (outside the United States) shall be assigned a climate zone based on Section N101.10.2.~~



~~FIGURE N1101.7 (R301.1)~~
~~CLIMATE ZONES~~



Warm and humid counties are below the dashed line.

FIGURE N1101.7 (R301.1)
CLIMATE ZONES

TABLE N1101.7 (R301.1)
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID

DESIGNATIONS BY STATE, COUNTY AND TERRITORY

Key: A – Moist, ~~B – Dry, C – Marine. Absence of moisture designation indicates moisture regime is irrelevant.~~
Asterisk (*) indicates a warm-humid location.

~~US STATES~~ BY COUNTY

~~ALABAMA~~

~~3A Autauga*~~
~~2A Baldwin*~~
~~3A Barbour*~~
~~3A Bibb~~
~~3A Blount~~
~~3A Bullock*~~
~~3A Butler*~~
~~3A Calhoun~~
~~3A Chambers~~
~~3A Cherokee~~
~~3A Chilton~~
~~3A Choctaw*~~
~~3A Clarke*~~
~~3A Clay~~
~~3A Cleburne~~
~~3A Coffee*~~
~~3A Colbert~~
~~3A Conecuh*~~
~~3A Coosa~~
~~3A Covington*~~
~~3A Crenshaw*~~
~~3A Cullman~~
~~3A Dale*~~
~~3A Dallas*~~
~~3A DeKalb~~
~~3A Elmore*~~
~~3A Escambia*~~
~~3A Etowah~~
~~3A Lee~~
~~3A Limestone~~
~~3A Lowndes*~~
~~3A Macon*~~
~~3A Madison~~
~~3A Marengo*~~
~~3A Marion~~
~~3A Marshall~~
~~2A Mobile*~~
~~3A Monroe*~~
~~3A Montgomery*~~
~~3A Morgan~~
~~3A Perry*~~
~~3A Pickens~~
~~3A Pike*~~
~~3A Randolph~~
~~3A Russell*~~
~~3A Shelby~~
~~3A St. Clair~~
~~3A Sumter~~
~~3A Talladega~~
~~3A Tallapoosa~~
~~3A Tuscaloosa~~
~~3A Walker~~
~~3A Washington*~~
~~3A Wilcox*~~
~~3A Winston~~

~~ALASKA~~

~~7 Aleutians East~~
~~7 Kodiak Island~~
~~7 Lake and Peninsula~~
~~7 Matanuska-Susitna~~
~~8 Nome~~
~~8 North Slope~~
~~8 Northwest Arctic~~
~~7 Prince of Wales Outer Ketchikan~~
~~7 Sitka~~
~~7 Skagway-Hoonah-Angoon~~
~~8 Southeast Fairbanks~~
~~7 Valdez-Cordova~~
~~8 Wade Hampton~~
~~7 Wrangell Petersburg~~
~~7 Yakutat~~
~~8 Yukon-Koyukuk~~

~~ARIZONA~~

~~5B Apache~~
~~3B Cochise~~
~~5B Coconino~~
~~4B Gila~~
~~3B Graham~~
~~3B Greenlee~~
~~2B La Paz~~
~~4A Boone~~
~~3A Bradley~~
~~3A Calhoun~~
~~4A Carroll~~
~~3A Chicot~~
~~3A Clark~~
~~3A Clay~~
~~3A Cleburne~~
~~3A Cleveland~~
~~3A Columbia*~~
~~3A Conway~~
~~3A Craighead~~
~~3A Crawford~~
~~3A Crittenden~~
~~3A Cross~~
~~3A Dallas~~
~~3A Desha~~
~~3A Drew~~
~~3A Faulkner~~
~~3A Franklin~~
~~4A Fulton~~
~~3A Garland~~
~~3A Grant~~
~~3A Greene~~
~~3A Hempstead*~~
~~3A Hot Spring~~
~~3A Howard~~
~~3A Independence~~
~~4A Izard~~
~~3A Jackson~~
~~3A Mississippi~~
~~3A Monroe~~
~~3A Montgomery~~
~~3A Nevada~~
~~4A Newton~~
~~3A Ouachita~~
~~3A Perry~~
~~3A Phillips~~
~~3A Pike~~
~~3A Poinsett~~
~~3A Polk~~
~~3A Pope~~
~~3A Prairie~~
~~3A Pulaski~~
~~3A Randolph~~
~~3A Saline~~
~~3A Scott~~
~~4A Searcy~~
~~3A Sebastian~~
~~3A Sevier*~~
~~3A Sharp~~
~~3A St. Francis~~
~~4A Stone~~
~~3A Union*~~
~~3A Van Buren~~
~~4A Washington~~
~~3A White~~
~~3A Woodruff~~
~~3A Yell~~

~~CALIFORNIA~~

~~3A Fayette~~
~~3A Franklin~~
~~3A Geneva*~~
~~3A Greene~~
~~3A Hale~~
~~3A Henry*~~
~~3A Houston*~~
~~3A Jackson~~
~~3A Jefferson~~
~~3A Lamar~~
~~3A Lauderdale~~
~~3A Lawrence~~

~~7 Aleutians West~~
~~7 Anchorage~~
~~8 Bethel~~
~~7 Bristol Bay~~
~~7 Denali~~
~~8 Dillingham~~
~~8 Fairbanks North Star~~
~~7 Haines~~
~~7 Juneau~~
~~7 Kenai Peninsula~~
~~7 Ketchikan Gateway~~

~~2B Maricopa~~
~~3B Mohave~~
~~5B Navajo~~
~~2B Pima~~
~~2B Pinal~~
~~3B Santa Cruz~~
~~4B Yavapai~~
~~2B Yuma~~

~~ARKANSAS~~

~~3A Arkansas~~
~~3A Ashley~~
~~4A Baxter~~
~~4A Benton~~

~~3A Jefferson~~
~~3A Johnson~~
~~3A Lafayette*~~
~~3A Lawrence~~
~~3A Lee~~
~~3A Lincoln~~
~~3A Little River*~~
~~3A Logan~~
~~3A Lonoke~~
~~4A Madison~~
~~4A Marion~~
~~3A Miller*~~

~~3C Alameda~~
~~6B Alpine~~
~~4B Amador~~
~~3B Butte~~
~~4B Calaveras~~
~~3B Colusa~~
~~3B Contra Costa~~
~~4C Del Norte~~
~~4B El Dorado~~
~~3B Fresno~~
~~3B Glenn~~

~~(continued)~~

~~TABLE N1101.7 (R301.1)—continued~~
~~CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY~~

~~4C Humboldt~~
~~2B Imperial~~
~~4B Inyo~~
~~3B Kern~~
~~3B Kings~~
~~4B Lake~~
~~5B Lassen~~
~~3B Los Angeles~~
~~3B Madera~~
~~3C Marin~~
~~4B Mariposa~~
~~3C Mendocino~~
~~3B Merced~~
~~5B Modoc~~
~~6B Mono~~
~~3C Monterey~~
~~3C Napa~~
~~5B Nevada~~
~~3B Orange~~
~~3B Placer~~
~~5B Plumas~~

~~3B Yuba~~

~~COLORADO~~

~~5B Adams~~
~~6B Alamosa~~
~~5B Arapahoe~~
~~6B Archuleta~~
~~4B Baca~~
~~5B Bent~~
~~5B Boulder~~
~~5B Broomfield~~
~~6B Chaffee~~
~~5B Cheyenne~~
~~7 Clear Creek~~
~~6B Conejos~~
~~6B Costilla~~
~~5B Crowley~~
~~6B Custer~~
~~5B Delta~~
~~5B Denver~~
~~6B Dolores~~

~~5B Morgan~~
~~4B Otero~~
~~6B Ouray~~
~~7 Park~~
~~5B Phillips~~
~~7 Pitkin~~
~~5B Prowers~~
~~5B Pueblo~~
~~6B Rio Blanco~~
~~7 Rio Grande~~
~~7 Routt~~
~~6B Saguache~~
~~7 San Juan~~
~~6B San Miguel~~
~~5B Sedgwick~~
~~7 Summit~~
~~5B Teller~~
~~5B Washington~~
~~5B Weld~~
~~5B Yuma~~

~~CONNECTICUT~~

~~2A Flagler*~~
~~2A Franklin*~~
~~2A Gadsden*~~
~~2A Gilchrist*~~
~~2A Glades*~~
~~2A Gulf*~~
~~2A Hamilton*~~
~~2A Hardee*~~
~~2A Hendry*~~
~~2A Hernando*~~
~~2A Highlands*~~
~~2A Hillsborough*~~
~~2A Holmes*~~
~~2A Indian River*~~
~~2A Jackson*~~
~~2A Jefferson*~~
~~2A Lafayette*~~
~~2A Lake*~~
~~2A Lee*~~
~~2A Leon*~~
~~2A Levy*~~

~~2A Union*~~
~~2A Volusia*~~
~~2A Wakulla*~~
~~2A Walton*~~
~~2A Washington*~~

~~GEORGIA~~

~~2A Appling*~~
~~2A Atkinson*~~
~~2A Bacon*~~
~~2A Baker*~~
~~3A Baldwin~~
~~4A Banks~~
~~3A Barrow~~
~~3A Bartow~~
~~3A Ben Hill*~~
~~2A Berrien*~~
~~3A Bibb~~
~~3A Bleckley*~~
~~2A Brantley*~~
~~2A Brooks*~~

~~3B Riverside~~
~~3B Sacramento~~
~~3C San Benito~~
~~3B San Bernardino~~
~~3B San Diego~~
~~3C San Francisco~~
~~3B San Joaquin~~
~~3C San Luis Obispo~~
~~3C San Mateo~~
~~3C Santa Barbara~~
~~3C Santa Clara~~
~~3C Santa Cruz~~
~~3B Shasta~~
~~5B Sierra~~
~~5B Siskiyou~~
~~3B Solano~~
~~3C Sonoma~~
~~3B Stanislaus~~
~~3B Sutter~~
~~3B Tehama~~
~~4B Trinity~~
~~3B Tulare~~
~~4B Tuolumne~~
~~3C Ventura~~
~~3B Yolo~~

~~5B Douglas~~
~~6B Eagle~~
~~5B Elbert~~
~~5B El Paso~~
~~5B Fremont~~
~~5B Garfield~~
~~5B Gilpin~~
~~7 Grand~~
~~7 Gunnison~~
~~7 Hinsdale~~
~~5B Huerfano~~
~~7 Jackson~~
~~5B Jefferson~~
~~5B Kiowa~~
~~5B Kit Carson~~
~~7 Lake~~
~~5B La Plata~~
~~5B Larimer~~
~~4B Las Animas~~
~~5B Lincoln~~
~~5B Logan~~
~~5B Mesa~~
~~7 Mineral~~
~~6B Moffat~~
~~5B Montezuma~~
~~5B Montrose~~

~~5A (all)~~

~~DELAWARE~~

~~4A (all)~~

~~DISTRICT OF COLUMBIA~~

~~4A (all)~~

~~FLORIDA~~

~~2A Alachua*~~
~~2A Baker*~~
~~2A Bay*~~
~~2A Bradford*~~
~~2A Brevard*~~
~~1A Broward*~~
~~2A Calhoun*~~
~~2A Charlotte*~~
~~2A Citrus*~~
~~2A Clay*~~
~~2A Collier*~~
~~2A Columbia*~~
~~2A DeSoto*~~
~~2A Dixie*~~
~~2A Duval*~~
~~2A Escambia*~~

~~2A Liberty*~~
~~2A Madison*~~
~~2A Manatee*~~
~~2A Marion*~~
~~2A Martin*~~
~~1A Miami-Dade*~~
~~1A Monroe*~~
~~2A Nassau*~~
~~2A Okaloosa*~~
~~2A Okeechobee*~~
~~2A Orange*~~
~~2A Osceola*~~
~~2A Palm Beach*~~
~~2A Pasco*~~
~~2A Pinellas*~~
~~2A Polk*~~
~~2A Putnam*~~
~~2A Santa Rosa*~~
~~2A Sarasota*~~
~~2A Seminole*~~
~~2A St. Johns*~~
~~2A St. Lucie*~~
~~2A Sumter*~~
~~2A Suwannee*~~
~~2A Taylor*~~

~~2A Bryan*~~
~~3A Bulloch*~~
~~3A Burke~~
~~3A Butts~~
~~3A Calhoun*~~
~~2A Camden*~~
~~3A Candler*~~
~~3A Carroll~~
~~4A Catoosa~~
~~2A Charlton*~~
~~2A Chatham*~~
~~3A Chattahoochee*~~
~~4A Chattooga~~
~~3A Cherokee~~
~~3A Clarke~~
~~3A Clay*~~
~~3A Clayton~~
~~2A Clinch*~~
~~3A Cobb~~
~~3A Coffee*~~
~~2A Colquitt*~~
~~3A Columbia~~
~~2A Cook*~~
~~3A Coweta~~

~~(continued)~~

~~TABLE N1101.7 (R301.1)—continued~~
~~CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY~~

~~3A Crawford~~
~~3A Crisp*~~
~~4A Dade~~
~~4A Dawson~~
~~2A Decatur*~~
~~3A DeKalb~~
~~3A Dodge*~~
~~3A Dooly*~~

~~2A Lanier*~~
~~3A Laurens*~~
~~3A Lee*~~
~~2A Liberty*~~
~~3A Lincoln~~
~~2A Long*~~
~~2A Lowndes*~~
~~4A Lumpkin~~

~~3A Taylor*~~
~~3A Telfair*~~
~~3A Terrell*~~
~~2A Thomas*~~
~~3A Tift*~~
~~2A Toombs*~~
~~4A Towns~~
~~3A Treutlen*~~

~~5B Cassia~~
~~6B Clark~~
~~5B Clearwater~~
~~6B Custer~~
~~5B Elmore~~
~~6B Franklin~~
~~6B Fremont~~
~~5B Gem~~

~~4A Crawford~~
~~5A Cumberland~~
~~5A DeKalb~~
~~5A De Witt~~
~~5A Douglas~~
~~5A DuPage~~
~~5A Edgar~~
~~4A Edwards~~

~~3A Dougherty*~~
~~3A Douglas~~
~~3A Early*~~
~~2A Echols*~~
~~2A Effingham*~~
~~3A Elbert~~
~~3A Emanuel*~~
~~2A Evans*~~
~~4A Fannin~~
~~3A Fayette~~
~~4A Floyd~~
~~3A Forsyth~~
~~4A Franklin~~
~~3A Fulton~~
~~4A Gilmer~~
~~3A Glascock~~
~~2A Glynn*~~
~~4A Gordon~~
~~2A Grady*~~
~~3A Greene~~
~~3A Gwinnett~~
~~4A Habersham~~
~~4A Hall~~
~~3A Hancock~~
~~3A Haralson~~
~~3A Harris~~
~~3A Hart~~
~~3A Heard~~
~~3A Henry~~
~~3A Houston*~~
~~3A Irwin*~~
~~3A Jackson~~
~~3A Jasper~~
~~2A Jeff Davis*~~
~~3A Jefferson~~
~~3A Jenkins*~~
~~3A Johnson*~~
~~3A Jones~~
~~3A Lamar~~

~~3A Macon*~~
~~3A Madison~~
~~3A Marion*~~
~~3A McDuffie~~
~~2A McIntosh*~~
~~3A Meriwether~~
~~2A Miller*~~
~~2A Mitchell*~~
~~3A Monroe~~
~~3A Montgomery*~~
~~3A Morgan~~
~~4A Murray~~
~~3A Muscogee~~
~~3A Newton~~
~~3A Oconee~~
~~3A Oglethorpe~~
~~3A Paulding~~
~~3A Peach*~~
~~4A Pickens~~
~~2A Pierce*~~
~~3A Pike~~
~~3A Polk~~
~~3A Pulaski*~~
~~3A Putnam~~
~~3A Quitman*~~
~~4A Rabun~~
~~3A Randolph*~~
~~3A Richmond~~
~~3A Rockdale~~
~~3A Schley*~~
~~3A Screven*~~
~~2A Seminole*~~
~~3A Spalding~~
~~4A Stephens~~
~~3A Stewart*~~
~~3A Sumter*~~
~~3A Talbot~~
~~3A Taliaferro~~
~~2A Tattnall*~~

~~3A Troup~~
~~3A Turner*~~
~~3A Twiggs*~~
~~4A Union~~
~~3A Upson~~
~~4A Walker~~
~~3A Walton~~
~~2A Ware*~~
~~3A Warren~~
~~3A Washington~~
~~2A Wayne*~~
~~3A Webster*~~
~~3A Wheeler*~~
~~4A White~~
~~4A Whitfield~~
~~3A Wilcox*~~
~~3A Wilkes~~
~~3A Wilkinson~~
~~3A Worth*~~

~~HAWAII~~

~~1A (all)*~~

~~IDAHO~~

~~5B Ada~~
~~6B Adams~~
~~6B Bannock~~
~~6B Bear Lake~~
~~5B Benewah~~
~~6B Bingham~~
~~6B Blaine~~
~~6B Boise~~
~~6B Bonner~~
~~6B Bonneville~~
~~6B Boundary~~
~~6B Butte~~
~~6B Camas~~
~~5B Canyon~~
~~6B Caribou~~

~~5B Gooding~~
~~5B Idaho~~
~~6B Jefferson~~
~~5B Jerome~~
~~5B Kootenai~~
~~5B Latah~~
~~6B Lemhi~~
~~5B Lewis~~
~~5B Lincoln~~
~~6B Madison~~
~~5B Minidoka~~
~~5B Nez Perce~~
~~6B Oneida~~
~~5B Owyhee~~
~~5B Payette~~
~~5B Power~~
~~5B Shoshone~~
~~6B Teton~~
~~5B Twin Falls~~
~~6B Valley~~
~~5B Washington~~

~~ILLINOIS~~

~~5A Adams~~
~~4A Alexander~~
~~4A Bond~~
~~5A Boone~~
~~5A Brown~~
~~5A Bureau~~
~~5A Calhoun~~
~~5A Carroll~~
~~5A Cass~~
~~5A Champaign~~
~~4A Christian~~
~~5A Clark~~
~~4A Clay~~
~~4A Clinton~~
~~5A Coles~~
~~5A Cook~~

~~4A Effingham~~
~~4A Fayette~~
~~5A Ford~~
~~4A Franklin~~
~~5A Fulton~~
~~4A Gallatin~~
~~5A Greene~~
~~5A Grundy~~
~~4A Hamilton~~
~~5A Hancock~~
~~4A Hardin~~
~~5A Henderson~~
~~5A Henry~~
~~5A Iroquois~~
~~4A Jackson~~
~~4A Jasper~~
~~4A Jefferson~~
~~5A Jersey~~
~~5A Jo Daviess~~
~~4A Johnson~~
~~5A Kane~~
~~5A Kankakee~~
~~5A Kendall~~
~~5A Knox~~
~~5A Lake~~
~~5A La Salle~~
~~4A Lawrence~~
~~5A Lee~~
~~5A Livingston~~
~~5A Logan~~
~~5A Macon~~
~~4A Macoupin~~
~~4A Madison~~
~~4A Marion~~
~~5A Marshall~~
~~5A Mason~~
~~4A Massac~~
~~5A McDonough~~
~~5A McHenry~~

~~(continued)~~

~~TABLE N1101.7 (R301.1)—continued~~
~~CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY~~

~~5A McLean~~ ~~5A Boone~~ ~~5A Miami~~ ~~5A Appanoose~~ ~~5A Jasper~~

~~5A Menard~~
~~5A Mercer~~
~~4A Monroe~~
~~4A Montgomery~~
~~5A Morgan~~
~~5A Moultrie~~
~~5A Ogle~~
~~5A Peoria~~
~~4A Perry~~
~~5A Piatt~~
~~5A Pike~~
~~4A Pope~~
~~4A Pulaski~~
~~5A Putnam~~
~~4A Randolph~~
~~4A Richland~~
~~5A Rock Island~~
~~4A Saline~~
~~5A Sangamon~~
~~5A Schuyler~~
~~5A Scott~~
~~4A Shelby~~
~~5A Stark~~
~~4A St. Clair~~
~~5A Stephenson~~
~~5A Tazewell~~
~~4A Union~~
~~5A Vermilion~~
~~4A Wabash~~
~~5A Warren~~
~~4A Washington~~
~~4A Wayne~~
~~4A White~~
~~5A Whiteside~~
~~5A Will~~
~~4A Williamson~~
~~5A Winnebago~~
~~5A Woodford~~

~~INDIANA~~

~~5A Adams~~
~~5A Allen~~
~~5A Bartholomew~~
~~5A Benton~~
~~5A Blackford~~
~~4A Brown~~
~~5A Carroll~~
~~5A Cass~~
~~4A Clark~~
~~5A Clay~~
~~5A Clinton~~
~~4A Crawford~~
~~4A Daviess~~
~~4A Dearborn~~
~~5A Decatur~~
~~5A De Kalb~~
~~5A Delaware~~
~~4A Dubois~~
~~5A Elkhart~~
~~5A Fayette~~
~~4A Floyd~~
~~5A Fountain~~
~~5A Franklin~~
~~5A Fulton~~
~~4A Gibson~~
~~5A Grant~~
~~4A Greene~~
~~5A Hamilton~~
~~5A Hancock~~
~~4A Harrison~~
~~5A Hendricks~~
~~5A Henry~~
~~5A Howard~~
~~5A Huntington~~
~~4A Jackson~~
~~5A Jasper~~
~~5A Jay~~
~~4A Jefferson~~
~~4A Jennings~~
~~5A Johnson~~
~~4A Knox~~
~~5A Kosciusko~~
~~5A LaGrange~~
~~5A Lake~~
~~5A LaPorte~~
~~4A Lawrence~~
~~5A Madison~~
~~5A Marion~~
~~5A Marshall~~
~~4A Martin~~
~~4A Monroe~~
~~5A Montgomery~~
~~5A Morgan~~
~~5A Newton~~
~~5A Noble~~
~~4A Ohio~~
~~4A Orange~~
~~5A Owen~~
~~5A Parke~~
~~4A Perry~~
~~4A Pike~~
~~5A Porter~~
~~4A Posey~~
~~5A Pulaski~~
~~5A Putnam~~
~~5A Randolph~~
~~4A Ripley~~
~~5A Rush~~
~~4A Scott~~
~~5A Shelby~~
~~4A Spencer~~
~~5A Starke~~
~~5A Steuben~~
~~5A St. Joseph~~
~~4A Sullivan~~
~~4A Switzerland~~
~~5A Tippecanoe~~
~~5A Tipton~~
~~5A Union~~
~~4A Vanderburgh~~
~~5A Vermillion~~
~~5A Vigo~~
~~5A Wabash~~
~~5A Warren~~
~~4A Warrick~~
~~4A Washington~~
~~5A Wayne~~
~~5A Wells~~
~~5A White~~
~~5A Whitley~~

~~IOWA~~

~~5A Adair~~
~~5A Adams~~
~~6A Allamakee~~
~~5A Audubon~~
~~5A Benton~~
~~6A Black Hawk~~
~~5A Boone~~
~~6A Bremer~~
~~6A Buchanan~~
~~6A Buena Vista~~
~~6A Butler~~
~~6A Calhoun~~
~~5A Carroll~~
~~5A Cass~~
~~5A Cedar~~
~~6A Cerro Gordo~~
~~6A Cherokee~~
~~6A Chickasaw~~
~~5A Clarke~~
~~6A Clay~~
~~6A Clayton~~
~~5A Clinton~~
~~5A Crawford~~
~~5A Dallas~~
~~5A Davis~~
~~5A Decatur~~
~~6A Delaware~~
~~5A Des Moines~~
~~6A Dickinson~~
~~5A Dubuque~~
~~6A Emmet~~
~~6A Fayette~~
~~6A Floyd~~
~~6A Franklin~~
~~5A Fremont~~
~~5A Greene~~
~~6A Grundy~~
~~5A Guthrie~~
~~6A Hamilton~~
~~6A Hancock~~
~~6A Hardin~~
~~5A Harrison~~
~~5A Henry~~
~~6A Howard~~
~~6A Humboldt~~
~~6A Ida~~
~~5A Iowa~~
~~5A Jackson~~
~~5A Jefferson~~
~~5A Johnson~~
~~5A Jones~~
~~5A Keokuk~~
~~6A Kossuth~~
~~5A Lee~~
~~5A Linn~~
~~5A Louisa~~
~~5A Lucas~~
~~6A Lyon~~
~~5A Madison~~
~~5A Mahaska~~
~~5A Marion~~
~~5A Marshall~~
~~5A Mills~~
~~6A Mitchell~~
~~5A Monona~~
~~5A Monroe~~
~~5A Montgomery~~
~~5A Muscatine~~
~~6A O'Brien~~
~~6A Osceola~~
~~5A Page~~
~~6A Palo Alto~~
~~6A Plymouth~~
~~6A Pocahontas~~
~~5A Polk~~
~~5A Pottawattamie~~
~~5A Poweshiek~~
~~5A Ringgold~~
~~6A Sac~~
~~5A Scott~~
~~5A Shelby~~
~~6A Sioux~~
~~5A Story~~
~~5A Tama~~
~~5A Taylor~~
~~5A Union~~
~~5A Van Buren~~
~~5A Wapello~~
~~5A Warren~~
~~5A Washington~~
~~5A Wayne~~
~~6A Webster~~
~~6A Winnebago~~

~~(continued)~~

~~TABLE N1101.7 (R301.1)—continued~~
~~CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY~~

~~6A Winneshiek~~
~~5A Woodbury~~
~~6A Worth~~
~~6A Wright~~

~~KANSAS~~

~~4A Allen~~
~~4A Anderson~~
~~4A Atchison~~
~~4A Barber~~
~~4A Barton~~
~~4A Bourbon~~
~~4A Brown~~
~~4A Butler~~
~~4A Chase~~
~~4A Chautauqua~~
~~4A Cherokee~~
~~5A Cheyenne~~
~~4A Clark~~
~~4A Clay~~
~~5A Cloud~~
~~4A Coffey~~
~~4A Comanche~~
~~4A Cowley~~
~~4A Crawford~~
~~5A Decatur~~
~~4A Dickinson~~
~~4A Doniphan~~
~~4A Edwards~~
~~4A Elk~~
~~5A Ellis~~
~~4A Ellsworth~~
~~4A Finney~~
~~4A Haskell~~
~~4A Hodgeman~~
~~4A Jackson~~
~~4A Jefferson~~
~~5A Jewell~~
~~4A Johnson~~
~~4A Kearny~~
~~4A Kingman~~
~~4A Kiowa~~
~~4A Labette~~
~~5A Lane~~
~~4A Leavenworth~~
~~4A Lincoln~~
~~4A Linn~~
~~5A Logan~~
~~4A Lyon~~
~~4A Marion~~
~~4A Marshall~~
~~4A McPherson~~
~~4A Meade~~
~~4A Miami~~
~~5A Mitchell~~
~~4A Montgomery~~
~~4A Morris~~
~~4A Morton~~
~~4A Nemaha~~
~~4A Neosho~~
~~5A Ness~~
~~5A Norton~~
~~4A Osage~~
~~5A Osborne~~
~~4A Ottawa~~
~~4A Pawnee~~
~~4A Sedgwick~~
~~4A Seward~~
~~4A Shawnee~~
~~5A Sheridan~~
~~5A Sherman~~
~~5A Smith~~
~~4A Stafford~~
~~4A Stanton~~
~~4A Stevens~~
~~4A Sumner~~
~~5A Thomas~~
~~5A Trego~~
~~4A Wabaunsee~~
~~5A Wallace~~
~~4A Washington~~
~~5A Wichita~~
~~4A Wilson~~
~~4A Woodson~~
~~4A Wyandotte~~

~~KENTUCKY~~

~~4A (all)~~

~~LOUISIANA~~

~~2A Acadia*~~
~~2A Allen*~~
~~2A Ascension*~~
~~2A Assumption*~~
~~2A Avoyelles*~~
~~2A Beauregard*~~
~~3A Bienville*~~
~~3A Bossier*~~
~~3A Caddo*~~
~~2A Iberville*~~
~~3A Jackson*~~
~~2A Jefferson*~~
~~2A Jefferson Davis*~~
~~2A Lafayette*~~
~~2A Lafourche*~~
~~3A La Salle*~~
~~3A Lincoln*~~
~~2A Livingston*~~
~~3A Madison*~~
~~3A Morehouse~~
~~3A Natchitoches*~~
~~2A Orleans*~~
~~3A Ouachita*~~
~~2A Plaquemines*~~
~~2A Pointe Coupee*~~
~~2A Rapides*~~
~~3A Red River*~~
~~3A Richland*~~
~~3A Sabine*~~
~~2A St. Bernard*~~
~~2A St. Charles*~~
~~2A St. Helena*~~
~~2A St. James*~~
~~2A St. John the Baptist*~~
~~2A St. Landry*~~
~~2A St. Martin*~~
~~2A St. Mary*~~
~~2A St. Tammany*~~
~~2A Tangipahoa*~~
~~3A Tensas*~~
~~2A Terrebonne*~~
~~6A Cumberland~~
~~6A Franklin~~
~~6A Hancock~~
~~6A Kennebec~~
~~6A Knox~~
~~6A Lincoln~~
~~6A Oxford~~
~~6A Penobscot~~
~~6A Piscataquis~~
~~6A Sagadahoc~~
~~6A Somerset~~
~~6A Waldo~~
~~6A Washington~~
~~6A York~~

~~MARYLAND~~

~~4A Allegany~~
~~4A Anne Arundel~~
~~4A Baltimore~~
~~4A Baltimore (city)~~
~~4A Calvert~~
~~4A Caroline~~
~~4A Carroll~~
~~4A Cecil~~
~~4A Charles~~
~~4A Dorchester~~
~~4A Frederick~~
~~5A Garrett~~
~~4A Harford~~
~~4A Howard~~
~~4A Kent~~
~~4A Montgomery~~
~~4A Prince George's~~

~~4A Ford~~
~~4A Franklin~~
~~4A Geary~~
~~5A Gove~~
~~5A Graham~~
~~4A Grant~~
~~4A Gray~~
~~5A Greeley~~
~~4A Greenwood~~
~~5A Hamilton~~
~~4A Harper~~
~~4A Harvey~~
~~4A Haskell~~

~~5A Phillips~~
~~4A Pottawatomie~~
~~4A Pratt~~
~~5A Rawlins~~
~~4A Reno~~
~~5A Republic~~
~~4A Rice~~
~~4A Riley~~
~~5A Rooks~~
~~4A Rush~~
~~4A Russell~~
~~4A Saline~~
~~5A Scott~~
~~4A Sedgwick~~

~~2A Calcasieu*~~
~~3A Caldwell*~~
~~2A Cameron*~~
~~3A Catahoula*~~
~~3A Claiborne*~~
~~3A Concordia*~~
~~3A De Soto*~~
~~2A East Baton Rouge*~~
~~3A East Carroll~~
~~2A East Feliciana*~~
~~2A Evangeline*~~
~~3A Franklin*~~
~~3A Grant*~~
~~2A Iberia*~~

~~3A Union*~~
~~2A Vermilion*~~
~~3A Vernon*~~
~~2A Washington*~~
~~3A Webster*~~
~~2A West Baton Rouge~~
~~3A West Carroll~~
~~2A West Feliciana*~~
~~3A Winn*~~

~~MAINE~~

~~6A Androscoggin~~
~~7 Aroostook~~

~~4A Queen Anne's~~
~~4A Somerset~~
~~4A St. Mary's~~
~~4A Talbot~~
~~4A Washington~~
~~4A Wicomico~~
~~4A Worcester~~

~~MASSACHSETTS~~

~~5A (all)~~

~~MICHIGAN~~

~~6A Alcona~~
~~6A Alger~~

~~(continued)~~

~~TABLE N1101.7 (R301.1)—continued~~
~~CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY~~

~~5A Allegan~~
~~6A Alpena~~
~~6A Antrim~~
~~6A Arenac~~
~~7 Baraga~~
~~5A Barry~~
~~5A Bay~~
~~6A Benzie~~
~~5A Berrien~~
~~5A Branch~~
~~5A Calhoun~~
~~5A Cass~~
~~6A Charlevoix~~
~~6A Cheboygan~~
~~7 Chippewa~~
~~6A Clare~~
~~5A Clinton~~
~~6A Crawford~~
~~6A Delta~~
~~6A Dickinson~~
~~5A Eaton~~

~~7 Mackinac~~
~~5A Macomb~~
~~6A Manistee~~
~~6A Marquette~~
~~6A Mason~~
~~6A Mecosta~~
~~6A Menominee~~
~~5A Midland~~
~~6A Missaukee~~
~~5A Monroe~~
~~5A Montcalm~~
~~6A Montmorency~~
~~5A Muskegon~~
~~6A Newaygo~~
~~5A Oakland~~
~~6A Oceana~~
~~6A Ogemaw~~
~~7 Ontonagon~~
~~6A Osceola~~
~~6A Oscoda~~
~~6A Otsego~~

~~6A Carver~~
~~7 Cass~~
~~6A Chippewa~~
~~6A Chisago~~
~~7 Clay~~
~~7 Clearwater~~
~~7 Cook~~
~~6A Cottonwood~~
~~7 Crow Wing~~
~~6A Dakota~~
~~6A Dodge~~
~~6A Douglas~~
~~6A Faribault~~
~~6A Fillmore~~
~~6A Freeborn~~
~~6A Goodhue~~
~~7 Grant~~
~~6A Hennepin~~
~~6A Houston~~
~~7 Hubbard~~
~~6A Isanti~~

~~7 Otter Tail~~
~~7 Pennington~~
~~7 Pine~~
~~6A Pipestone~~
~~7 Polk~~
~~6A Pope~~
~~6A Ramsey~~
~~7 Red Lake~~
~~6A Redwood~~
~~6A Renville~~
~~6A Rice~~
~~6A Rock~~
~~7 Roseau~~
~~6A Scott~~
~~6A Sherburne~~
~~6A Sibley~~
~~6A Stearns~~
~~6A Steele~~
~~6A Stevens~~
~~7 St. Louis~~
~~6A Swift~~

~~3A Clarke~~
~~3A Clay~~
~~3A Coahoma~~
~~3A Copiah*~~
~~3A Covington*~~
~~3A DeSoto~~
~~3A Forrest*~~
~~3A Franklin*~~
~~3A George*~~
~~3A Greene*~~
~~3A Grenada~~
~~2A Hancock*~~
~~2A Harrison*~~
~~3A Hinds*~~
~~3A Holmes~~
~~3A Humphreys~~
~~3A Issaquena~~
~~3A Itawamba~~
~~2A Jackson*~~
~~3A Jasper~~
~~3A Jefferson*~~

~~6A Emmet~~
~~5A Genesee~~
~~6A Gladwin~~
~~7 Gogebic~~
~~6A Grand Traverse~~
~~5A Gratiot~~
~~5A Hillsdale~~
~~7 Houghton~~
~~6A Huron~~
~~5A Ingham~~
~~5A Ionia~~
~~6A Iosco~~
~~7 Iron~~
~~6A Isabella~~
~~5A Jackson~~
~~5A Kalamazoo~~
~~6A Kalkaska~~
~~5A Kent~~
~~7 Keweenaw~~
~~6A Lake~~
~~5A Lapeer~~
~~6A Leelanau~~
~~5A Lenawee~~
~~5A Livingston~~
~~7 Luce~~

~~5A Ottawa~~
~~6A Presque Isle~~
~~6A Roscommon~~
~~5A Saginaw~~
~~6A Sanilac~~
~~7 Schoolcraft~~
~~5A Shiawassee~~
~~5A St. Clair~~
~~5A St. Joseph~~
~~5A Tuscola~~
~~5A Van Buren~~
~~5A Washtenaw~~
~~5A Wayne~~
~~6A Wexford~~

~~MINNESOTA~~

~~7 Aitkin~~
~~6A Anoka~~
~~7 Becker~~
~~7 Beltrami~~
~~6A Benton~~
~~6A Big Stone~~
~~6A Blue Earth~~
~~6A Brown~~
~~7 Carlton~~

~~7 Itasca~~
~~6A Jackson~~
~~7 Kanabec~~
~~6A Kandiyohi~~
~~7 Kittson~~
~~7 Koochiching~~
~~6A Lac qui Parle~~
~~7 Lake~~
~~7 Lake of the Woods~~
~~6A Le Sueur~~
~~6A Lincoln~~
~~6A Lyon~~
~~7 Mahnomen~~
~~7 Marshall~~
~~6A Martin~~
~~6A McLeod~~
~~6A Meeker~~
~~7 Mille Lacs~~
~~6A Morrison~~
~~6A Mower~~
~~6A Murray~~
~~6A Nicollet~~
~~6A Nobles~~
~~7 Norman~~
~~6A Olmsted~~

~~6A Todd~~
~~6A Traverse~~
~~6A Wabasha~~
~~7 Wadena~~
~~6A Waseca~~
~~6A Washington~~
~~6A Watonwan~~
~~7 Wilkin~~
~~6A Winona~~
~~6A Wright~~
~~6A Yellow Medicine~~

~~MISSISSIPPI~~

~~3A Adams*~~
~~3A Alcorn~~
~~3A Amite*~~
~~3A Attala~~
~~3A Benton~~
~~3A Bolivar~~
~~3A Calhoun~~
~~3A Carroll~~
~~3A Chickasaw~~
~~3A Choctaw~~
~~3A Claiborne*~~
~~3A Clarke~~

~~3A Jefferson Davis*~~
~~3A Jones*~~
~~3A Kemper~~
~~3A Lafayette~~
~~3A Lamar*~~
~~3A Lauderdale~~
~~3A Lawrence*~~
~~3A Leake~~
~~3A Lee~~
~~3A Leflore~~
~~3A Lincoln*~~
~~3A Lowndes~~
~~3A Madison~~
~~3A Marion*~~
~~3A Marshall~~
~~3A Monroe~~
~~3A Montgomery~~
~~3A Neshoba~~
~~3A Newton~~
~~3A Noxubee~~
~~3A Oktibbeha~~
~~3A Panola~~
~~2A Pearl River*~~
~~3A Perry*~~
~~3A Pike*~~

~~(continued)~~

~~TABLE N1101.7 (R301.1)—continued~~
~~CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY~~

~~3A Pontotoc~~
~~3A Prentiss~~
~~3A Quitman~~
~~3A Rankin*~~
~~3A Scott~~
~~3A Sharkey~~
~~3A Simpson*~~
~~3A Smith*~~
~~2A Stone*~~
~~3A Sunflower~~
~~3A Tallahatchie~~

~~5A Chariton~~
~~4A Christian~~
~~5A Clark~~
~~4A Clay~~
~~5A Clinton~~
~~4A Cole~~
~~4A Cooper~~
~~4A Crawford~~
~~4A Dade~~
~~4A Dallas~~
~~5A Daviess~~

~~4A Mississippi~~
~~4A Moniteau~~
~~4A Monroe~~
~~4A Montgomery~~
~~4A Morgan~~
~~4A New Madrid~~
~~4A Newton~~
~~5A Nodaway~~
~~4A Oregon~~
~~4A Osage~~
~~4A Ozark~~

~~4A Webster~~
~~5A Worth~~
~~4A Wright~~

~~MONTANA~~

~~6B (all)~~

~~NEBRASKA~~

~~5A (all)~~

~~NEVADA~~

~~4A Cumberland~~
~~4A Essex~~
~~4A Gloucester~~
~~4A Hudson~~
~~5A Hunterdon~~
~~5A Mercer~~
~~4A Middlesex~~
~~4A Monmouth~~
~~5A Morris~~
~~4A Ocean~~
~~5A Passaic~~

~~3A Tate~~
~~3A Tippah~~
~~3A Tishomingo~~
~~3A Tunica~~
~~3A Union~~
~~3A Walthall*~~
~~3A Warren*~~
~~3A Washington~~
~~3A Wayne*~~
~~3A Webster~~
~~3A Wilkinson*~~
~~3A Winston~~
~~3A Yalobusha~~
~~3A Yazoo~~

~~MISSOURI~~

~~5A Adair~~
~~5A Andrew~~
~~5A Atchison~~
~~4A Audrain~~
~~4A Barry~~
~~4A Barton~~
~~4A Bates~~
~~4A Benton~~
~~4A Bollinger~~
~~4A Boone~~
~~5A Buchanan~~
~~4A Butler~~
~~5A Caldwell~~
~~4A Callaway~~
~~4A Camden~~
~~4A Cape Girardeau~~
~~4A Carroll~~
~~4A Carter~~
~~4A Cass~~
~~4A Cedar~~
~~5A DeKalb~~
~~4A Dent~~
~~4A Douglas~~
~~4A Dunklin~~
~~4A Franklin~~
~~4A Gasconade~~
~~5A Gentry~~
~~4A Greene~~
~~5A Grundy~~
~~5A Harrison~~
~~4A Henry~~
~~4A Hickory~~
~~5A Holt~~
~~4A Howard~~
~~4A Howell~~
~~4A Iron~~
~~4A Jackson~~
~~4A Jasper~~
~~4A Jefferson~~
~~4A Johnson~~
~~5A Knox~~
~~4A Laclede~~
~~4A Lafayette~~
~~4A Lawrence~~
~~5A Lewis~~
~~4A Lincoln~~
~~5A Linn~~
~~5A Livingston~~
~~5A Macon~~
~~4A Madison~~
~~4A Maries~~
~~5A Marion~~
~~4A McDonald~~
~~5A Mercer~~
~~4A Miller~~
~~4A Pemiscot~~
~~4A Perry~~
~~4A Pettis~~
~~4A Phelps~~
~~5A Pike~~
~~4A Platte~~
~~4A Polk~~
~~4A Pulaski~~
~~5A Putnam~~
~~5A Ralls~~
~~4A Randolph~~
~~4A Ray~~
~~4A Reynolds~~
~~4A Ripley~~
~~4A Saline~~
~~5A Schuyler~~
~~5A Scotland~~
~~4A Scott~~
~~4A Shannon~~
~~5A Shelby~~
~~4A St. Charles~~
~~4A St. Clair~~
~~4A St. Francois~~
~~4A St. Louis~~
~~4A St. Louis (city)~~
~~4A Ste. Genevieve~~
~~4A Stoddard~~
~~4A Stone~~
~~5A Sullivan~~
~~4A Taney~~
~~4A Texas~~
~~4A Vernon~~
~~4A Warren~~
~~4A Washington~~
~~4A Wayne~~
~~5B Carson City (city)~~
~~5B Churchill~~
~~3B Clark~~
~~5B Douglas~~
~~5B Elko~~
~~5B Esmeralda~~
~~5B Eureka~~
~~5B Humboldt~~
~~5B Lander~~
~~5B Lincoln~~
~~5B Lyon~~
~~5B Mineral~~
~~5B Nye~~
~~5B Pershing~~
~~5B Storey~~
~~5B Washoe~~
~~5B White Pine~~

~~NEW HAMPSHIRE~~

~~6A Belknap~~
~~6A Carroll~~
~~5A Cheshire~~
~~6A Coos~~
~~6A Grafton~~
~~5A Hillsborough~~
~~6A Merrimack~~
~~5A Rockingham~~
~~5A Strafford~~
~~6A Sullivan~~

~~NEW JERSEY~~

~~4A Atlantic~~
~~5A Bergen~~
~~4A Burlington~~
~~4A Camden~~
~~4A Cape May~~
~~4A Salem~~
~~5A Somerset~~
~~5A Sussex~~
~~4A Union~~
~~5A Warren~~

~~NEW MEXICO~~

~~4B Bernalillo~~
~~5B Catron~~
~~3B Chaves~~
~~4B Cibola~~
~~5B Colfax~~
~~4B Curry~~
~~4B DeBaca~~
~~3B Dona Ana~~
~~3B Eddy~~
~~4B Grant~~
~~4B Guadalupe~~
~~5B Harding~~
~~3B Hidalgo~~
~~3B Lea~~
~~4B Lincoln~~
~~5B Los Alamos~~
~~3B Luna~~
~~5B McKinley~~
~~5B Mora~~
~~3B Otero~~
~~4B Quay~~
~~5B Rio Arriba~~
~~4B Roosevelt~~
~~5B Sandoval~~
~~5B San Juan~~
~~5B San Miguel~~
~~5B Santa Fe~~
~~4B Sierra~~
~~4B Socorro~~

~~(continued)~~

~~TABLE N1101.7 (R301.1)—continued~~
~~CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY~~

~~5B Taos~~
~~5B Torrance~~
~~4B Union~~
~~4B Valencia~~

~~NEW YORK~~

~~5A Albany~~
~~6A Allegany~~
~~4A Bronx~~
~~6A Broome~~
~~6A Cattaraugus~~
~~5A Cayuga~~
~~5A Chautauqua~~
~~5A Chemung~~
~~6A Chenango~~
~~6A Clinton~~
~~5A Columbia~~
~~5A Cortland~~
~~6A Delaware~~
~~5A Dutchess~~
~~5A Erie~~
~~6A Essex~~
~~6A Franklin~~
~~6A Fulton~~
~~5A Genesee~~
~~5A Greene~~
~~6A Hamilton~~
~~6A Herkimer~~
~~6A Jefferson~~
~~4A Kings~~
~~6A Lewis~~
~~5A Livingston~~
~~6A Madison~~
~~5A Monroe~~
~~6A Montgomery~~
~~4A Nassau~~
~~4A New York~~
~~5A Niagara~~
~~6A Oneida~~
~~5A Onondaga~~
~~5A Ontario~~
~~5A Orange~~
~~5A Orleans~~
~~5A Oswego~~
~~4A Queens~~
~~5A Rensselaer~~
~~4A Richmond~~
~~5A Rockland~~
~~5A Saratoga~~
~~5A Schenectady~~
~~6A Schoharie~~
~~6A Schuyler~~
~~5A Seneca~~
~~6A Steuben~~
~~6A St. Lawrence~~
~~4A Suffolk~~
~~6A Sullivan~~
~~5A Tioga~~
~~6A Tompkins~~
~~6A Ulster~~
~~6A Warren~~
~~5A Washington~~
~~5A Wayne~~
~~4A Westchester~~
~~6A Wyoming~~
~~5A Yates~~

NORTH CAROLINA

4A Alamance
4A Alexander
5A Alleghany
3A Anson
5A Ashe
5A Avery
3A Beaufort
4A Bertie
3A Bladen
3A Brunswick*
4A Buncombe
4A Burke
3A Cabarrus
4A Caldwell
3A Camden
3A Carteret*
4A Caswell
4A Catawba
4A Chatham
4A Clay
4A Cleveland
3A Columbus*
3A Craven
3A Cumberland
3A Currituck
3A Dare
3A Davidson
4A Davie
3A Duplin
4A Durham
3A Edgecombe
4A Forsyth
4A Franklin
3A Gaston
4A Gates
4A Graham
4A Granville
3A Greene
4A Guilford
4A Halifax
4A Harnett
4A Haywood
4A Henderson
4A Hertford
3A Hoke
3A Hyde
4A Iredell
4A Jackson
3A Johnston
3A Jones
4A Lee
3A Lenoir
4A Lincoln
4A Macon
4A Madison
3A Martin
4A McDowell
3A Mecklenburg
5A Mitchell
3A Montgomery
3A Moore
4A Nash
3A New Hanover*
4A Orange
3A Pamlico
3A Pasquotank
3A Pender*
3A Perquimans
4A Person
3A Pitt
4A Polk
3A Randolph
3A Richmond
3A Robeson
4A Rockingham
3A Rowan
4A Rutherford
3A Sampson
3A Scotland
3A Stanly
4A Stokes
4A Surry
4A Swain
4A Transylvania
3A Tyrrell
3A Union
4A Vance
4A Wake
4A Warren
3A Washington
5A Watauga
3A Wayne
4A Wilkes
3A Wilson
4A Yadkin
5A Yancey

~~NORTH DAKOTA~~

~~6A Adams~~
~~7 Barnes~~
~~7 Benson~~
~~6A Billings~~
~~7 Bottineau~~
~~6A Bowman~~
~~7 Burke~~
~~6A Burleigh~~
~~7 Cass~~
~~7 Divide~~
~~6A Dunn~~
~~7 Eddy~~
~~6A Emmons~~
~~7 Foster~~
~~6A Golden Valley~~
~~7 Grand Forks~~
~~6A Grant~~
~~7 Griggs~~
~~6A Hettinger~~
~~7 Kidder~~
~~6A LaMoure~~
~~6A Logan~~
~~7 McHenry~~
~~6A McIntosh~~
~~6A McKenzie~~
~~7 McLean~~
~~6A Mercer~~
~~6A Morton~~
~~7 Mountrail~~
~~7 Nelson~~
~~6A Oliver~~
~~7 Pembina~~
~~7 Pierce~~
~~7 Ramsey~~
~~6A Ransom~~
~~7 Renville~~
~~6A Richland~~
~~7 Rolette~~
~~6A Sargent~~
~~7 Sheridan~~
~~6A Sioux~~
~~6A Slope~~
~~6A Stark~~
~~7 Steele~~
~~7 Stutsman~~
~~7 Towner~~
~~7 Traill~~
~~7 Walsh~~
~~7 Ward~~
~~7 Wells~~
~~7 Williams~~

~~OHIO~~

~~6A Otsego~~
~~5A Putnam~~

4A Cherokee
3A Chowan

4A Northampton
3A Onslow*

~~7 Cavalier~~
~~6A Dickey~~

~~4A Adams~~
~~5A Allen~~

~~(continued)~~

~~TABLE N1101.7 (R301.1)—continued~~
~~CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY~~

~~5A Ashland~~
~~5A Ashtabula~~
~~5A Athens~~
~~5A Auglaize~~
~~5A Belmont~~
~~4A Brown~~
~~5A Butler~~
~~5A Carroll~~
~~5A Champaign~~
~~5A Clark~~
~~4A Clermont~~
~~5A Clinton~~
~~5A Columbiana~~
~~5A Coshocton~~
~~5A Crawford~~
~~5A Cuyahoga~~
~~5A Darke~~
~~5A Defiance~~
~~5A Delaware~~
~~5A Erie~~
~~5A Fairfield~~
~~5A Fayette~~
~~5A Franklin~~
~~5A Fulton~~
~~4A Gallia~~
~~5A Geauga~~
~~5A Greene~~
~~5A Guernsey~~
~~4A Hamilton~~
~~5A Hancock~~
~~5A Hardin~~
~~5A Harrison~~
~~5A Henry~~
~~5A Highland~~
~~5A Hocking~~
~~5A Holmes~~
~~5A Huron~~

~~5A Mahoning~~
~~5A Marion~~
~~5A Medina~~
~~5A Meigs~~
~~5A Mercer~~
~~5A Miami~~
~~5A Monroe~~
~~5A Montgomery~~
~~5A Morgan~~
~~5A Morrow~~
~~5A Muskingum~~
~~5A Noble~~
~~5A Ottawa~~
~~5A Paulding~~
~~5A Perry~~
~~5A Pickaway~~
~~4A Pike~~
~~5A Portage~~
~~5A Preble~~
~~5A Putnam~~
~~5A Richland~~
~~5A Ross~~
~~5A Sandusky~~
~~4A Scioto~~
~~5A Seneca~~
~~5A Shelby~~
~~5A Stark~~
~~5A Summit~~
~~5A Trumbull~~
~~5A Tuscarawas~~
~~5A Union~~
~~5A Van Wert~~
~~5A Vinton~~
~~5A Warren~~
~~4A Washington~~
~~5A Wayne~~
~~5A Williams~~

~~3A Bryan~~
~~3A Caddo~~
~~3A Canadian~~
~~3A Carter~~
~~3A Cherokee~~
~~3A Choctaw~~
~~4B Cimarron~~
~~3A Cleveland~~
~~3A Coal~~
~~3A Comanche~~
~~3A Cotton~~
~~3A Craig~~
~~3A Creek~~
~~3A Custer~~
~~3A Delaware~~
~~3A Dewey~~
~~3A Ellis~~
~~3A Garfield~~
~~3A Garvin~~
~~3A Grady~~
~~3A Grant~~
~~3A Greer~~
~~3A Harmon~~
~~3A Harper~~
~~3A Haskell~~
~~3A Hughes~~
~~3A Jackson~~
~~3A Jefferson~~
~~3A Johnston~~
~~3A Kay~~
~~3A Kingfisher~~
~~3A Kiowa~~
~~3A Latimer~~
~~3A Le Flore~~
~~3A Lincoln~~
~~3A Logan~~
~~3A Love~~

~~3A Okfuskee~~
~~3A Oklahoma~~
~~3A Okmulgee~~
~~3A Osage~~
~~3A Ottawa~~
~~3A Pawnee~~
~~3A Payne~~
~~3A Pittsburg~~
~~3A Pontotoc~~
~~3A Pottawatomie~~
~~3A Pushmataha~~
~~3A Roger Mills~~
~~3A Rogers~~
~~3A Seminole~~
~~3A Sequoyah~~
~~3A Stephens~~
~~4B Texas~~
~~3A Tillman~~
~~3A Tulsa~~
~~3A Wagoner~~
~~3A Washington~~
~~3A Washita~~
~~3A Woods~~
~~3A Woodward~~

~~OREGON~~

~~5B Baker~~
~~4C Benton~~
~~4C Clackamas~~
~~4C Clatsop~~
~~4C Columbia~~
~~4C Coos~~
~~5B Crook~~
~~4C Curry~~
~~5B Deschutes~~
~~4C Douglas~~
~~5B Gilliam~~

~~4C Linn~~
~~5B Malheur~~
~~4C Marion~~
~~5B Morrow~~
~~4C Multnomah~~
~~4C Polk~~
~~5B Sherman~~
~~4C Tillamook~~
~~5B Umatilla~~
~~5B Union~~
~~5B Wallowa~~
~~5B Wasco~~
~~4C Washington~~
~~5B Wheeler~~
~~4C Yamhill~~

~~PENNSYLVANIA~~

~~5A Adams~~
~~5A Allegheny~~
~~5A Armstrong~~
~~5A Beaver~~
~~5A Bedford~~
~~5A Berks~~
~~5A Blair~~
~~5A Bradford~~
~~4A Bucks~~
~~5A Butler~~
~~5A Cambria~~
~~6A Cameron~~
~~5A Carbon~~
~~5A Centre~~
~~4A Chester~~
~~5A Clarion~~
~~6A Clearfield~~
~~5A Clinton~~
~~5A Columbia~~
~~5A Crawford~~

~~5A Jackson~~
~~5A Jefferson~~
~~5A Knox~~
~~5A Lake~~
~~4A Lawrence~~
~~5A Licking~~
~~5A Logan~~
~~5A Lorain~~
~~5A Lucas~~
~~5A Madison~~

~~5A Wood~~
~~5A Wyandot~~

~~OKLAHOMA~~

~~3A Adair~~
~~3A Alfalfa~~
~~3A Atoka~~
~~4B Beaver~~
~~3A Beckham~~
~~3A Blaine~~

~~3A Major~~
~~3A Marshall~~
~~3A Mayes~~
~~3A McClain~~
~~3A McCurtain~~
~~3A McIntosh~~
~~3A Murray~~
~~3A Muskogee~~
~~3A Noble~~
~~3A Nowata~~

~~5B Grant~~
~~5B Harney~~
~~5B Hood River~~
~~4C Jackson~~
~~5B Jefferson~~
~~4C Josephine~~
~~5B Klamath~~
~~5B Lake~~
~~4C Lane~~
~~4C Lincoln~~

~~5A Cumberland~~
~~5A Dauphin~~
~~4A Delaware~~
~~6A Elk~~
~~5A Erie~~
~~5A Fayette~~
~~5A Forest~~
~~5A Franklin~~
~~5A Fulton~~
~~5A Greene~~

~~(continued)~~

~~TABLE N1101.7 (R301.1)—continued~~
~~CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY~~

~~5A Huntingdon~~
~~5A Indiana~~
~~5A Jefferson~~
~~5A Juniata~~
~~5A Lackawanna~~
~~5A Lancaster~~
~~5A Lawrence~~
~~5A Lebanon~~
~~5A Lehigh~~
~~5A Luzerne~~
~~5A Lycoming~~
~~6A McKean~~
~~5A Mercer~~
~~5A Mifflin~~
~~5A Monroe~~
~~4A Montgomery~~
~~5A Montour~~
~~5A Northampton~~
~~5A Northumberland~~
~~5A Perry~~
~~4A Philadelphia~~
~~5A Pike~~
~~6A Potter~~
~~5A Schuylkill~~
~~5A Snyder~~
~~5A Somerset~~
~~5A Sullivan~~
~~6A Susquehanna~~
~~6A Tioga~~
~~5A Union~~

~~3A Bamberg*~~
~~3A Barnwell*~~
~~3A Beaufort*~~
~~3A Berkeley*~~
~~3A Calhoun~~
~~3A Charleston*~~
~~3A Cherokee~~
~~3A Chester~~
~~3A Chesterfield~~
~~3A Clarendon~~
~~3A Colleton*~~
~~3A Darlington~~
~~3A Dillon~~
~~3A Dorchester*~~
~~3A Edgefield~~
~~3A Fairfield~~
~~3A Florence~~
~~3A Georgetown*~~
~~3A Greenville~~
~~3A Greenwood~~
~~3A Hampton*~~
~~3A Horry*~~
~~3A Jasper*~~
~~3A Kershaw~~
~~3A Lancaster~~
~~3A Laurens~~
~~3A Lee~~
~~3A Lexington~~
~~3A Marion~~
~~3A Marlboro~~

~~5A Bennett~~
~~5A Bon Homme~~
~~6A Brookings~~
~~6A Brown~~
~~6A Brule~~
~~6A Buffalo~~
~~6A Butte~~
~~6A Campbell~~
~~5A Charles Mix~~
~~6A Clark~~
~~5A Clay~~
~~6A Codington~~
~~6A Corson~~
~~6A Custer~~
~~6A Davison~~
~~6A Day~~
~~6A Deuel~~
~~6A Dewey~~
~~5A Douglas~~
~~6A Edmunds~~
~~6A Fall River~~
~~6A Faulk~~
~~6A Grant~~
~~5A Gregory~~
~~6A Haakon~~
~~6A Hamlin~~
~~6A Hand~~
~~6A Hanson~~
~~6A Harding~~
~~6A Hughes~~

~~6A Minnehaha~~
~~6A Moody~~
~~6A Pennington~~
~~6A Perkins~~
~~6A Potter~~
~~6A Roberts~~
~~6A Sanborn~~
~~6A Shannon~~
~~6A Spink~~
~~6A Stanley~~
~~6A Sully~~
~~5A Todd~~
~~5A Tripp~~
~~6A Turner~~
~~5A Union~~
~~6A Walworth~~
~~5A Yankton~~
~~6A Ziebach~~

~~TENNESSEE~~

~~4A Anderson~~
~~4A Bedford~~
~~4A Benton~~
~~4A Bledsoe~~
~~4A Blount~~
~~4A Bradley~~
~~4A Campbell~~
~~4A Cannon~~
~~4A Carroll~~
~~4A Carter~~

~~4A Gibson~~
~~4A Giles~~
~~4A Grainger~~
~~4A Greene~~
~~4A Grundy~~
~~4A Hamblen~~
~~4A Hamilton~~
~~4A Hancock~~
~~3A Hardeman~~
~~3A Hardin~~
~~4A Hawkins~~
~~3A Haywood~~
~~3A Henderson~~
~~4A Henry~~
~~4A Hickman~~
~~4A Houston~~
~~4A Humphreys~~
~~4A Jackson~~
~~4A Jefferson~~
~~4A Johnson~~
~~4A Knox~~
~~3A Lake~~
~~3A Lauderdale~~
~~4A Lawrence~~
~~4A Lewis~~
~~4A Lincoln~~
~~4A Loudon~~
~~4A Macon~~
~~3A Madison~~
~~4A Marion~~

~~5A Venango~~
~~5A Warren~~
~~5A Washington~~
~~6A Wayne~~
~~5A Westmoreland~~
~~5A Wyoming~~
~~4A York~~

~~RHODE ISLAND~~

~~5A (all)~~

~~SOUTH CAROLINA~~

~~3A Abbeville~~
~~3A Aiken~~
~~3A Allendale*~~
~~3A Anderson~~
~~3A McCormick~~
~~3A Newberry~~
~~3A Oconee~~
~~3A Orangeburg~~
~~3A Pickens~~
~~3A Richland~~
~~3A Saluda~~
~~3A Spartanburg~~
~~3A Sumter~~
~~3A Union~~
~~3A Williamsburg~~
~~3A York~~

~~SOUTH DAKOTA~~

~~6A Aurora~~
~~6A Beadle~~
~~5A Hutchinson~~
~~6A Hyde~~
~~5A Jackson~~
~~6A Jerauld~~
~~6A Jones~~
~~6A Kingsbury~~
~~6A Lake~~
~~6A Lawrence~~
~~6A Lincoln~~
~~6A Lyman~~
~~6A Marshall~~
~~6A McCook~~
~~6A McPherson~~
~~6A Meade~~
~~5A Mellette~~
~~6A Miner~~
~~4A Cheatham~~
~~3A Chester~~
~~4A Claiborne~~
~~4A Clay~~
~~4A Cocke~~
~~4A Coffee~~
~~3A Crockett~~
~~4A Cumberland~~
~~4A Davidson~~
~~4A Decatur~~
~~4A DeKalb~~
~~4A Dickson~~
~~3A Dyer~~
~~3A Fayette~~
~~4A Fentress~~
~~4A Franklin~~
~~4A Marshall~~
~~4A Maury~~
~~4A McMinn~~
~~3A McNairy~~
~~4A Meigs~~
~~4A Monroe~~
~~4A Montgomery~~
~~4A Moore~~
~~4A Morgan~~
~~4A Obion~~
~~4A Overton~~
~~4A Perry~~
~~4A Pickett~~
~~4A Polk~~
~~4A Putnam~~
~~4A Rhea~~

~~TABLE N1101.7 (R301.1)—continued~~
~~CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY~~

~~4A Roane~~
~~4A Robertson~~
~~4A Rutherford~~
~~4A Scott~~
~~4A Sequatchie~~
~~4A Sevier~~
~~3A Shelby~~
~~4A Smith~~
~~4A Stewart~~
~~4A Sullivan~~
~~4A Sumner~~
~~3A Tipton~~
~~4A Trousdale~~
~~4A Unicoi~~
~~4A Union~~
~~4A Van Buren~~
~~4A Warren~~
~~4A Washington~~
~~4A Wayne~~
~~4A Weakley~~
~~4A White~~
~~4A Williamson~~
~~4A Wilson~~

~~TEXAS~~

~~3B Brewster~~
~~4B Briscoe~~
~~2A Brooks*~~
~~3A Brown*~~
~~2A Burleson*~~
~~3A Burnet*~~
~~2A Caldwell*~~
~~2A Calhoun*~~
~~3B Callahan~~
~~2A Cameron*~~
~~3A Camp*~~
~~4B Carson~~
~~3A Cass*~~
~~4B Castro~~
~~2A Chambers*~~
~~2A Cherokee*~~
~~3B Childress~~
~~3A Clay~~
~~4B Cochran~~
~~3B Coke~~
~~3B Coleman~~
~~3A Collin*~~
~~3B Collingsworth~~
~~2A Colorado*~~
~~3B Ector~~
~~2B Edwards~~
~~3A Ellis*~~
~~3B El Paso~~
~~3A Erath*~~
~~2A Falls*~~
~~3A Fannin~~
~~2A Fayette*~~
~~3B Fisher~~
~~4B Floyd~~
~~3B Foard~~
~~2A Fort Bend*~~
~~3A Franklin*~~
~~2A Freestone*~~
~~2B Frio~~
~~3B Gaines~~
~~2A Galveston*~~
~~3B Garza~~
~~3A Gillespie*~~
~~3B Glasscock~~
~~2A Goliad*~~
~~2A Gonzales*~~
~~4B Gray~~
~~3A Grayson~~
~~3B Howard~~
~~3B Hudspeth~~
~~3A Hunt*~~
~~4B Hutchinson~~
~~3B Irion~~
~~3A Jack~~
~~2A Jackson*~~
~~2A Jasper*~~
~~3B Jeff Davis~~
~~2A Jefferson*~~
~~2A Jim Hogg*~~
~~2A Jim Wells*~~
~~3A Johnson*~~
~~3B Jones~~
~~2A Karnes*~~
~~3A Kaufman*~~
~~3A Kendall*~~
~~2A Kenedy*~~
~~3B Kent~~
~~3B Kerr~~
~~3B Kimble~~
~~3B King~~
~~2B Kinney~~
~~2A Kleberg*~~
~~3B McCulloch~~
~~2A McLennan*~~
~~2A McMullen*~~
~~2B Medina~~
~~3B Menard~~
~~3B Midland~~
~~2A Milam*~~
~~3A Mills*~~
~~3B Mitchell~~
~~3A Montague~~
~~2A Montgomery*~~
~~4B Moore~~
~~3A Morris*~~
~~3B Motley~~
~~3A Nacogdoches*~~
~~3A Navarro*~~
~~2A Newton*~~
~~3B Nolan~~
~~2A Nueces*~~
~~4B Ochiltree~~
~~4B Oldham~~
~~2A Orange*~~
~~3A Palo Pinto*~~
~~3A Panola*~~

~~2A Anderson*~~
~~3B Andrews~~
~~2A Angelina*~~
~~2A Aransas*~~
~~3A Archer~~
~~4B Armstrong~~
~~2A Atascosa*~~
~~2A Austin*~~
~~4B Bailey~~
~~2B Bandera~~
~~2A Bastrop*~~
~~3B Baylor~~
~~2A Bee*~~
~~2A Bell*~~
~~2A Bexar*~~
~~3A Blanco*~~
~~3B Borden~~
~~2A Bosque*~~
~~3A Bowie*~~
~~2A Brazoria*~~
~~2A Brazos*~~

~~2A Comal*~~
~~3A Comanche*~~
~~3B Concho~~
~~3A Cooke~~
~~2A Coryell*~~
~~3B Cottle~~
~~3B Crane~~
~~3B Crockett~~
~~3B Crosby~~
~~3B Culberson~~
~~4B Dallam~~
~~3A Dallas*~~
~~3B Dawson~~
~~4B Deaf Smith~~
~~3A Delta~~
~~3A Denton*~~
~~2A DeWitt*~~
~~3B Dickens~~
~~2B Dimmit~~
~~4B Donley~~
~~2A Duval*~~
~~3A Eastland~~

~~3A Gregg*~~
~~2A Grimes*~~
~~2A Guadalupe*~~
~~4B Hale~~
~~3B Hall~~
~~3A Hamilton*~~
~~4B Hansford~~
~~3B Hardeman~~
~~2A Hardin*~~
~~2A Harris*~~
~~3A Harrison*~~
~~4B Hartley~~
~~3B Haskell~~
~~2A Hays*~~
~~3B Hemphill~~
~~3A Henderson*~~
~~2A Hidalgo*~~
~~2A Hill*~~
~~4B Hockley~~
~~3A Hood*~~
~~3A Hopkins*~~
~~2A Houston*~~

~~3B Knox~~
~~3A Lamar*~~
~~4B Lamb~~
~~3A Lampasas*~~
~~2B La Salle~~
~~2A Lavaca*~~
~~2A Lee*~~
~~2A Leon*~~
~~2A Liberty*~~
~~2A Limestone*~~
~~4B Lipscomb~~
~~2A Live Oak*~~
~~3A Llano*~~
~~3B Loving~~
~~3B Lubbock~~
~~3B Lynn~~
~~2A Madison*~~
~~3A Marion*~~
~~3B Martin~~
~~3B Mason~~
~~2A Matagorda*~~
~~2B Maverick~~

~~3A Parker*~~
~~4B Parmer~~
~~3B Pecos~~
~~2A Polk*~~
~~4B Potter~~
~~3B Presidio~~
~~3A Rains*~~
~~4B Randall~~
~~3B Reagan~~
~~2B Real~~
~~3A Red River*~~
~~3B Reeves~~
~~2A Refugio*~~
~~4B Roberts~~
~~2A Robertson*~~
~~3A Rockwall*~~
~~3B Runnels~~
~~3A Rusk*~~
~~3A Sabine*~~
~~3A San Augustine*~~
~~2A San Jacinto*~~
~~2A San Patricio*~~

~~(continued)~~

~~TABLE N1101.7 (R301.1)—continued~~
~~CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY~~

~~3A San Saba*~~
~~3B Schleicher~~
~~3B Scurry~~
~~3B Shackelford~~
~~3A Shelby*~~
~~4B Sherman~~
~~3A Smith*~~
~~3A Somervell*~~
~~2A Starr*~~
~~3A Stephens~~
~~3B Sterling~~
~~3B Stonewall~~
~~3B Sutton~~
~~4B Swisher~~
~~3A Tarrant*~~
~~3B Taylor~~

~~3A Young~~
~~2B Zapata~~
~~2B Zavala~~

~~UTAH~~

~~5B Beaver~~
~~6B Box Elder~~
~~6B Cache~~
~~6B Carbon~~
~~6B Daggett~~
~~5B Davis~~
~~6B Duchesne~~
~~5B Emery~~
~~5B Garfield~~
~~5B Grand~~
~~5B Iron~~

~~4C Clark~~
~~5B Columbia~~
~~4C Cowlitz~~
~~5B Douglas~~
~~6B Ferry~~
~~5B Franklin~~
~~5B Garfield~~
~~5B Grant~~
~~4C Grays Harbor~~
~~4C Island~~
~~4C Jefferson~~
~~4C King~~
~~4C Kitsap~~
~~5B Kittitas~~
~~5B Klickitat~~
~~4C Lewis~~

~~4A Gilmer~~
~~5A Grant~~
~~5A Greenbrier~~
~~5A Hampshire~~
~~5A Hancock~~
~~5A Hardy~~
~~5A Harrison~~
~~4A Jackson~~
~~4A Jefferson~~
~~4A Kanawha~~
~~5A Lewis~~
~~4A Lincoln~~
~~4A Logan~~
~~5A Marion~~
~~5A Marshall~~
~~4A Mason~~

~~WISCONSIN~~

~~6A Adams~~
~~7 Ashland~~
~~6A Barron~~
~~7 Bayfield~~
~~6A Brown~~
~~6A Buffalo~~
~~7 Burnett~~
~~6A Calumet~~
~~6A Chippewa~~
~~6A Clark~~
~~6A Columbia~~
~~6A Crawford~~
~~6A Dane~~
~~6A Dodge~~

~~3B Terrell~~
~~3B Terry~~
~~3B Throckmorton~~
~~3A Titus*~~
~~3B Tom Green~~
~~2A Travis*~~
~~2A Trinity*~~
~~2A Tyler*~~
~~3A Upshur*~~
~~3B Upton~~
~~2B Uvalde~~
~~2B Val Verde~~
~~3A Van Zandt*~~
~~2A Victoria*~~
~~2A Walker*~~
~~2A Waller*~~
~~3B Ward~~
~~2A Washington*~~
~~2B Webb~~
~~2A Wharton*~~
~~3B Wheeler~~
~~3A Wichita~~
~~3B Wilbarger~~
~~2A Willacy*~~
~~2A Williamson*~~
~~2A Wilson*~~
~~3B Winkler~~
~~3A Wise~~
~~3A Wood*~~
~~4B Yoakum~~

~~5B Juab~~
~~5B Kane~~
~~5B Millard~~
~~6B Morgan~~
~~5B Piute~~
~~6B Rich~~
~~5B Salt Lake~~
~~5B San Juan~~
~~5B Sanpete~~
~~5B Sevier~~
~~6B Summit~~
~~5B Tooele~~
~~6B Uintah~~
~~5B Utah~~
~~6B Wasatch~~
~~3B Washington~~
~~5B Wayne~~
~~5B Weber~~

~~VERMONT~~

~~6A (all)~~

~~VIRGINIA~~

~~4A (all)~~

~~WASHINGTON~~

~~5B Adams~~
~~5B Asotin~~
~~5B Benton~~
~~5B Chelan~~
~~4C Clallam~~
~~5B Lincoln~~
~~4C Mason~~
~~6B Okanogan~~
~~4C Pacific~~
~~6B Pend Oreille~~
~~4C Pierce~~
~~4C San Juan~~
~~4C Skagit~~
~~5B Skamania~~
~~4C Snohomish~~
~~5B Spokane~~
~~6B Stevens~~
~~4C Thurston~~
~~4C Wahkiakum~~
~~5B Walla Walla~~
~~4C Whatcom~~
~~5B Whitman~~
~~5B Yakima~~

~~WEST VIRGINIA~~

~~5A Barbour~~
~~4A Berkeley~~
~~4A Boone~~
~~4A Braxton~~
~~5A Brooke~~
~~4A Cabell~~
~~4A Calhoun~~
~~4A Clay~~
~~5A Doddridge~~
~~5A Fayette~~
~~4A McDowell~~
~~4A Mercer~~
~~5A Mineral~~
~~4A Mingo~~
~~5A Monongalia~~
~~4A Monroe~~
~~4A Morgan~~
~~5A Nicholas~~
~~5A Ohio~~
~~5A Pendleton~~
~~4A Pleasants~~
~~5A Pocahontas~~
~~5A Preston~~
~~4A Putnam~~
~~5A Raleigh~~
~~5A Randolph~~
~~4A Ritchie~~
~~4A Roane~~
~~5A Summers~~
~~5A Taylor~~
~~5A Tucker~~
~~4A Tyler~~
~~5A Upshur~~
~~4A Wayne~~
~~5A Webster~~
~~5A Wetzel~~
~~4A Wirt~~
~~4A Wood~~
~~4A Wyoming~~

~~6A Door~~
~~7 Douglas~~
~~6A Dunn~~
~~6A Eau Claire~~
~~7 Florence~~
~~6A Fond du Lac~~
~~7 Forest~~
~~6A Grant~~
~~6A Green~~
~~6A Green Lake~~
~~6A Iowa~~
~~7 Iron~~
~~6A Jackson~~
~~6A Jefferson~~
~~6A Juneau~~
~~6A Kenosha~~
~~6A Kewaunee~~
~~6A La Crosse~~
~~6A Lafayette~~
~~7 Langlade~~
~~7 Lincoln~~
~~6A Manitowoc~~
~~6A Marathon~~
~~6A Marinette~~
~~6A Marquette~~
~~6A Menominee~~
~~6A Milwaukee~~
~~6A Monroe~~
~~6A Oconto~~
~~7 Oneida~~
~~6A Outagamie~~

~~(continued)~~

~~TABLE N1101.7 (R301.1)—continued~~
~~CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY~~

~~6A Ozaukee~~
~~6A Pepin~~
~~6A Pierce~~
~~6A Polk~~
~~6A Portage~~
~~7 Price~~
~~6A Racine~~
~~6A Richland~~
~~6A Rock~~
~~7 Taylor~~
~~6A Trempealeau~~
~~6A Vernon~~
~~7 Vilas~~
~~6A Walworth~~
~~7 Washburn~~
~~6A Washington~~
~~6A Waukesha~~
~~6A Waupaca~~
~~6B Big Horn~~
~~6B Campbell~~
~~6B Carbon~~
~~6B Converse~~
~~6B Crook~~
~~6B Fremont~~
~~5B Goshen~~
~~6B Hot Springs~~
~~6B Johnson~~
~~6B Sheridan~~
~~7 Sublette~~
~~6B Sweetwater~~
~~7 Teton~~
~~6B Uinta~~
~~6B Washakie~~
~~6B Weston~~

~~US TERRITORIES~~

~~NORTHERN MARIANA ISLANDS~~

~~1A (all)*~~

~~PUERTO RICO~~

~~1A (all)*~~

~~VIRGIN ISLANDS~~

~~6A Rusk~~
~~6A Sauk~~
~~7 Sawyer~~
~~6A Shawano~~
~~6A Sheboygan~~
~~6A St. Croix~~
~~6A Waushara~~
~~6A Winnebago~~
~~6A Wood~~

~~**WYOMING**~~

~~6B Albany~~
~~6B Laramie~~
~~7 Lincoln~~
~~6B Natrona~~
~~6B Niobrara~~
~~6B Park~~
~~5B Platte~~

~~**AMERICAN SAMOA**~~

~~1A (all)*~~

~~**GUAM**~~

~~1A (all)*~~

~~1A (all)*~~

N1101.7.2 (R301.3) International climate zones. Deleted.
~~The climate zone for any location outside the United States shall be determined by applying Table N1101.7.2(1) and then Table N1101.7.2(2).~~

~~TABLE N1101.7.2(1)[R302.3(1)]~~
~~INTERNATIONAL CLIMATE ZONE DEFINITIONS~~

~~**MAJOR CLIMATE TYPE DEFINITIONS**~~
~~Marine (C) Definition—Locations meeting all four criteria:~~ ~~1. Mean temperature of coldest month between -3°C (27°F) and 18°C (65°F).~~ ~~2. Warmest month mean < 22°C (72°F).~~ ~~3. At least four months with mean temperatures over 10°C (50°F).~~ ~~4. Dry season in summer. The month with the heaviest precipitation in the cold season has at least three times as much precipitation as the month with the least precipitation in the rest of the year. The cold season is October through March in the Northern Hemisphere and April through September in the Southern Hemisphere.~~
~~Dry (B) Definition—Locations meeting the following criteria:~~ ~~Not marine and $P_{in} < 0.44 \times (TF - 19.5)$ [$P_{cm} < 2.0 \times (TC + 7)$ in SI units]~~ ~~where:~~ ~~P_{in}=Annual precipitation in inches (cm)~~ ~~T=Annual mean temperature in °F (°C)~~
~~Moist (A) Definition—Locations that are not marine and not dry.~~
~~Warm-humid Definition—Moist (A) locations where either of the following wet-bulb temperature conditions shall occur during the warmest six consecutive months of the year:~~ ~~1. 67°F (19.4°C) or higher for 3,000 or more hours; or~~ ~~2. 73°F (22.8°C) or higher for 1,500 or more hours.~~

~~For SI: °C =[(°F)-32]/1.8, 1 inch = 2.54 cm.~~

~~TABLE N1101.7.2(2)[R301.3(2)]~~
~~INTERNATIONAL CLIMATE ZONE DEFINITIONS~~

~~**ZONE NUMBER**~~	~~**THERMAL CRITERIA**~~	
	~~**IP Units**~~	~~**SI Units**~~
~~1~~	~~9000 < CDD50°F~~	~~5000 < CDD10°C~~
~~2~~	~~6300 < CDD50°F ≤ 9000~~	~~3500 < CDD10°C ≤ 5000~~
~~3A and 3B~~	~~4500 < CDD50°F ≤ 6300 AND HDD65°F ≤ 5400~~	~~2500 < CDD10°C ≤ 3500 AND HDD18°C ≤ 3000~~
~~4A and 4B~~	~~CDD50°F ≤ 4500 AND HDD65°F ≤ 5400~~	~~CDD10°C ≤ 2500 AND HDD18°C ≤ 3000~~
~~3C~~	~~HDD65°F ≤ 3600~~	~~HDD18°C ≤ 2000~~
~~4C~~	~~3600 < HDD65°F ≤ 5400~~	~~2000 < HDD18°C ≤ 3000~~
~~5~~	~~5400 < HDD65°F ≤ 7200~~	~~3000 < HDD18°C ≤ 4000~~

~~6~~	~~7200 < HDD65°F ≤ 9000~~	~~4000 < HDD18°C ≤ 5000~~
~~7~~	~~9000 < HDD65°F ≤ 12600~~	~~5000 < HDD18°C ≤ 7000~~
~~8~~	~~12600 < HDD65°F~~	~~7000 < HDD18°C~~

~~For SI:°C =[(°F)-32]/1.8.~~

N1101.8 (R301.4) Tropical climate zone. Deleted.
~~The tropical climate zone shall be defined as:~~

1. ~~Hawaii, Puerto Rico, Guam, American Samoa, US Virgin Islands, Commonwealth of Northern Mariana Islands; and~~
2. ~~Islands in the area between the Tropic of Cancer and the Tropic of Capricorn.~~

N1101.10.3 (R303.1.3) Fenestration product rating.
~~*U*-factors of fenestration products (windows, doors and skylights) shall be determined in accordance with NFRC 100.~~

> ~~**Exception:** Where required, garage door *U*-factors shall be determined in accordance with either NFRC 100 or ANSI/DASMA 105.~~

~~*U*-factors shall be determined by an accredited, independent laboratory, and labeled and certified by the manufacturer.~~

~~Products lacking such a labeled U-factor shall be assigned a default *U*-factor from Table N1101.10.3(1) or N1101.10.3(2). The solar heat gain coefficient (SHGC) and visible transmittance (VT) of glazed fenestration products (windows, glazed doors and skylights) shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled SHGC or VT shall be assigned a default SHGC or VT from Table N1101.10.3(3).~~
U-factors of fenestration products (windows, doors and skylights) shall be determined in accordance with NFRC 100. *U*-factors shall be determined by an accredited, independent laboratory, and *labeled* and certified by the manufacturer. Products lacking such a *labeled* *U*-factor shall be assigned a default *U*-factor from Tables N1101.10.3(1) or N1101.10.3(2). The solar heat gain coefficient (SHGC) and *visible transmittance* (VT) of glazed fenestration products (windows, glazed doors and skylights) shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and *labeled* and certified by the manufacturer. Products lacking such a *labeled* SHGC or VT shall be assigned a default SHGC or VT from Table N1101.10.3(3).

> **Exception:** When a garage door is a part of the building thermal envelope garage door *U*-factors shall be determined in accordance with either NFRC 100 or ANSI/DASMA 105.

N1101.11.1 (R303.2.1) Protection of exposed foundation insulation.
Insulation applied to the exterior of basement walls, crawlspace walls and the perimeter of slab-on-grade floors shall have an ~~rigid,~~ opaque and weather-resistant protective covering to prevent the degradation of the insulation's thermal performance. The protective covering shall cover the exposed exterior insulation and extend not less than 6 inches (153 mm) below grade.

N1101.12 (R303.3) Maintenance information.
Maintenance instructions shall be furnished for equipment and systems that require preventive maintenance. ~~Required regular maintenance actions shall be clearly stated and incorporated on a readily accessible label. The label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product.~~

N1101.13 (R401.2) Compliance.
Projects shall comply with one of the following:

1. Sections N1101.14 through N1104.
2. Section N1105 and the provisions of Sections N1101.14 through N1104 labeled "Mandatory."
3. An energy rating index (ERI) approach in Section N1106.
4. North Carolina specific REScheck shall be permitted to demonstrate compliance with this code. Envelope requirements may not be traded off against the use of high efficiency heating or cooling equipment. No trade-off calculations are needed for required termite inspection and treatment gaps.

N1101.13.1 (R401.2.1) Tropical zone. Deleted.
~~*Residential buildings* in the tropical zone at elevations below 2,400 feet (731.5 m) above sea level shall be deemed to comply with this chapter where the following conditions are met:~~

~~1. Not more than one-half of the *occupied* space is air conditioned.~~

~~2. The *occupied* space is not heated.~~

~~3. Solar, wind or other renewable energy source supplies not less than 80 percent of the energy for service water heating.~~

~~4. Glazing in *conditioned* space has a *solar heat gain coefficient* of less than or equal to 0.40, or has an overhang with a projection factor equal to or greater than 0.30.~~

~~5. Permanently installed lighting is in accordance with Section N1104.~~

~~6. The exterior roof surface complies with one of the options in Table C402.2.1.1 of the International Energy Conservation Code, or the roof/ceiling has insulation with an *R*-value of R-15 or greater. If present, attics above the insulation are vented and attics below the insulation are unvented.~~

~~7. Roof surfaces have a minimum slope of $^1/_4$ inch (6.4 mm) per foot of run. The finished roof does not have water accumulation areas.~~

~~8. Operable fenestration provides ventilation area equal to not less than 14 percent of the floor area in each room. Alternatively, equivalent ventilation is provided by a ventilation fan.~~

9. ~~Bedrooms with exterior walls facing two different directions have operable fenestration or exterior walls facing two directions.~~

10. ~~Interior doors to bedrooms are capable of being secured in the open position.~~

11. ~~A ceiling fan or ceiling fan rough-in is provided for bedrooms and the largest space that is not used as a bedroom.~~

N1101.14 (R401.3) Certificate (Mandatory).

~~A permanent certificate shall be completed by the builder or registered design professional and posted on a wall in the space where the furnace is located, a utility room or an approved location inside the building. Where located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. The certificate shall list the predominant *R*-values of insulation installed in or on ceiling/roof, walls, foundation (slab, *basement wall,* crawl space wall and/or floor) and ducts outside conditioned spaces; *U*-factors for fenestration and the solar heat gain coefficient (SHGC) of fenestration, and the results from any required duct system and building envelope air leakage testing done on the building. Where there is more than one value for each component, the certificate shall list the value covering the largest area. The certificate shall list the types and efficiencies of heating, cooling and service water heating equipment. Where a gas-fired unvented room heater, electric furnace, or baseboard electric heater is installed in the residence, the certificate shall list "gas-fired unvented room heater,""electric furnace" or "baseboard electric heater," as appropriate. An efficiency shall not be *listed* for gas-fired unvented room heaters, electric furnaces or electric baseboard heaters.~~ A permanent certificate shall be posted on or in the electrical distribution panel, in the attic next to the attic insulation card, or inside a kitchen cabinet or other approved location. The certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. The builder, permit holder, or registered design professional shall be responsible for completing the certificate. The certificate shall list the predominant *R*-values of insulation installed in or on ceiling/roof, walls, foundation (slab, *basement wall*, crawlspace wall and floor) and ducts outside conditioned spaces; *U*-factors for fenestration and the solar heat gain coefficient (SHGC) of fenestration. Where there is more than one value for each component, the certificate shall list the value covering the largest area. The certificate shall indicate whether the building air leakage was visually inspected as required in Section N1102.4.2.1 or provide results of the air leakage testing required in Section N1102.4.2.2. The certificate shall provide results of duct leakage test required in Section N1103.3.3. Appendix E-1 contains a sample certificate.

N1101.15 (R401.4) Additional Voluntary Criteria for Increasing Residential Energy Efficiency.

Appendix E-4 contains additional voluntary measures for increasing residential energy efficiency beyond code minimums. Implementation of the increased energy efficiency measures is strictly voluntary at the option of the permit holder. The sole purpose of the appendix is to provide guidance for achieving additional residential energy efficiency improvements that have been evaluated to be those that are most cost effective for achieving an additional 10-15 percent improvement in energy efficiency beyond code minimums.

SECTION N1102 (R402)

BUILDING THERMAL ENVELOPE

N1102.1 (R402.1) General (Prescriptive).
The *building thermal envelope* shall meet the requirements of Sections N1102.1.1 through N1102.1.~~4~~5.

> **Exception:** The following low energy buildings, or portions thereof, separated from the remainder of the building by *building thermal envelope* assemblies complying with this section shall be exempt from the *building thermal envelope* provisions of Section N1102.
>
> 1. Those with a peak design rate of energy usage less than 3.4 Btu/h · ft^2 (10.7 W/m^2) or 1.0 watt/ft^2 of floor area for space conditioning purposes.
> 2. Those that do not contain *conditioned space*.

N1102.1.1 (R402.1.1) Vapor retarder. Deleted.
~~Wall assemblies in the *building thermal envelope* shall comply with the vapor retarder requirements of Section R702.7.~~

TABLE N1102.1.2 (R402.1.2)
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b, i]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e, k]	CEILING *R*-VALUE[m]	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c, o] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
~~1~~	~~NR~~	~~0.75~~	~~0.25~~	~~30~~	~~13~~	~~3/4~~	~~13~~	~~0~~	~~0~~	~~0~~
~~2~~	~~0.40~~	~~0.65~~	~~0.25~~	~~38~~	~~13~~	~~4/6~~	~~13~~	~~0~~	~~0~~	~~0~~
3	0.35	0.55	~~0.25~~ 0.30	38 or 30ci[l]	~~20~~ 15 or 13 + 2.5~~5~~[h]	~~8~~5/13 or 5/10ci	19	5/13[f]	0	5/13
4 ~~except Marine~~	0.35	0.55	~~0.40~~ 0.30	49 38 or 30ci[l]	~~20~~ 15 or 13 + 2.5~~5~~[h]	~~8~~5/13 or 5/10ci	19	10 /~~13~~15	10~~, 2 ft~~	10/~~13~~15
5 ~~and Marine 4~~	~~0.32~~ 0.35	0.55	NR	~~49~~ 38 or 30ci[l]	~~20~~ 19[n] or 13 + 5[h] or 15+3[h]	13/17 or 13/12.5 ci	30[g]	~~15/19~~10/15	10~~, 2 ft~~	~~15~~10/19
~~6~~	~~0.32~~	~~0.55~~	~~NR~~	~~49~~	~~20 + 5 or 13 + 10~~[h]	~~15/20~~	~~30~~[g]	~~15/19~~	~~10, 4 ft~~	~~15/19~~

~~7 and 8~~	~~0.32~~	~~0.55~~	~~NR~~	~~49~~	~~20 + 5 or 13 + 10[h]~~	~~19/21~~	~~38[g]~~	~~15/19~~	~~10, 4 ft~~	~~15/19~~

For SI:1 foot = 304.8 mm.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall not be less than the *R*-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration. ~~**Exception:** Skylights may be excluded from glazed fenestration SHGC requirements in Climate Zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.~~

c. ~~“15/19” means R-15 continuous insulation 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 insulation on the interior or exterior of the home.“10/13” means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.~~ “10/15” means R-10 continuous insulated sheathing on the interior or exterior of the home or R-15 cavity insulation at the interior of the basement wall or crawl space wall.

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. ~~Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Zones 1 through 3 for heated slabs.~~ For monolithic slabs, insulation shall be applied from the inspection gap downward to the bottom of the footing or a maximum of 24 inches below grade whichever is less. For floating slabs, insulation shall extend to the bottom of the foundation wall or 24 inches, whichever is less. (See Appendix O.)

e. ~~There are no SHGC requirements in the Marine Zone.~~ Deleted.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure N1101.10 and Table N1101.10.

g. Or insulation sufficient to fill the framing cavity, R-19 minimum.

h. The first value is cavity insulation, the second value is continuous insulation, so “13+5” means R-13 cavity insulation plus R-5 continuous insulation. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

j. In addition to the exemption in Section N1102.3.3, a maximum of two glazed fenestration product assemblies having a U-factor no greater than 0.55 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.

k. In addition to the exemption in Section N1102.3.3, a maximum of two glazed fenestration product assemblies having a SHGC no greater than 0.70 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.

l. R-30 shall be deemed to satisfy the ceiling insulation requirement wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Otherwise R-38 insulation is required where adequate clearance exists or insulation must extend to either the insulation baffle or within 1” of the attic roof deck.

m. Table value required except for roof edge where the space is limited by the pitch of the roof, there the insulation must fill the space up to the air baffle.

n. R -19 fiberglass batts compressed and installed in a nominal 2 × 6 framing cavity is deemed to comply. Fiberglass batts rated R-19 or higher compressed and installed in a 2x4 wall is not deemed to comply.

o. Basement wall meeting the minimum mass wall specific heat content requirement may use the mass wall R-value as the minimum requirement.

TABLE N1102.1.4 (R402.1.4)
EQUIVALENT *U*-FACTORS[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[d]	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
~~1~~	~~0.50~~	~~0.75~~	~~0.035~~	~~0.084~~	~~0.197~~	~~0.064~~	~~0.360~~	~~0.477~~
~~2~~	~~0.40~~	~~0.65~~	~~0.030~~	~~0.084~~	~~0.165~~	~~0.064~~	~~0.360~~	~~0.477~~

3	0.35	0.55	0.030	~~0.060~~ 0.077	~~0.098~~ 0.141	0.047	0.091[c]	0.136
4 ~~except Marine~~	0.35	0.55	~~0.026~~ 0.030	~~0.060~~ 0.077	~~0.098~~ 0.141	0.047	0.059	0.065
5 ~~and Marine 4~~	~~0.32~~ 0.35	0.55	~~0.026~~ 0.030	~~0.060~~ 0.061	0.082	0.033	~~0.050~~ 0.059	~~0.055~~ 0.065
~~6~~	~~0.32~~	~~0.55~~	~~0.026~~	~~0.045~~	~~0.060~~	~~0.033~~	~~0.050~~	~~0.055~~
~~7 and 8~~	~~0.32~~	~~0.55~~	~~0.026~~	~~0.045~~	~~0.057~~	~~0.028~~	~~0.050~~	~~0.055~~

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

b. When more than half the insulation is on the interior, the mass wall *U*-factors shall be a maximum of ~~0.17 in Zone 1, 0.14 in Zone 2~~, ~~0.12~~ 0.07 in Zone 3, ~~0.087~~ 0.07 in Zone 4 ~~except Marine~~, and ~~0.065~~ 0.054 in Zone 5 ~~and Marine~~ 4, and 0.057 in Zones 6 through 8.

c. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure N1101.10 (R301.1) and Table N1101.10 (R301.1).

d. A maximum of two glazed fenestration product assemblies having a U-factor no greater than 0.55 and a SHGC no greater than 0.70 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty. When applying this note and using the REScheck "UA Trade-off" compliance method to allow continued use of the software, the applicable fenestration products shall be modeled as meeting the U-factor of 0.35 and the SHGC of 0.30, as applicable, but the fenestration products actual U-factor and actual SHGC shall be noted in the comments section of the software for documentation of application of this note to the applicable products. Compliance for these substitute products shall be verified compared to the allowed substituted maximum U-value requirement and maximum SHGC requirement, as applicable.

N1102.2 (R402.2) Specific insulation requirements (Prescriptive).

In addition to the requirements of Section N1102.1, insulation shall meet the specific requirements of Sections N1102.2.1 through ~~N1102.2.13~~ N1102.2.15.

N1102.2.1 (R402.2.1) Ceilings with attic spaces.

Where Section R1102.1.2 would require R-38 insulation in the ceiling, installing R-30 over 100 percent of the ceiling area requiring insulation shall be deemed to satisfy the requirement for R-38 wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. ~~Similarly, where Section R1102.1.2 would require R-49 insulation in the ceiling, installing R-38 over 100 percent of the ceiling area requiring insulation shall be deemed to satisfy the requirement for R-49 insulation wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves.~~ This reduction shall not apply to the *U*-factor alternative approach in Section R1102.1.4 and the total UA alternative in Section R1102.1.5.

Exceptions:

1. When insulation is installed in a fully *enclosed attic floor system*, as described in Appendix E-2.1, R-30 shall be deemed compliant.

2. In roof edge and other details such as bay windows, dormers, and similar areas where the space is limited, the insulation must fill the space up to the air baffle.

N1102.2.2 (R402.2.2) Ceilings without attic spaces.

Where Section N1102.1.2 would require R-38 insulation ~~levels above R-30~~ and the design of the roof/ceiling assembly, including cathedral ceilings, bay windows and other similar areas, does not allow sufficient space for the required insulation, the minimum required insulation for such roof/ceiling assemblies shall be R-30. This reduction of insulation from the requirements of Section N1102.1.2 shall be limited to 500 square feet (46 m^2) ~~or 20~~

~~percent~~ of the total insulated ceiling area~~, whichever is less~~. This reduction shall not apply to the *U*-factor alternative approach in Section N1102.1.4 and the total UA alternative in Section N1102.1.5.

N1102.2.3 (R402.2.3) ~~Eave~~ Soffit baffle.

For air-permeable insulations in vented attics, a baffle shall be installed adjacent to soffit ~~and eave~~ vents. ~~Baffles shall maintain an opening equal or greater than the size of the vent~~. The baffle shall extend over the top of the attic insulation. The baffle shall be permitted to be any solid material.

N1102.2.4 (R402.2.4) Access hatches and doors.

Horizontal access ~~doors~~ hatches from conditioned spaces to unconditioned spaces such as attics and crawl spaces shall be weatherstripped and insulated to an R-10 minimum value and vertical doors to such spaces shall be weatherstripped and insulated to R-5 ~~a level equivalent to the insulation on the surrounding surfaces~~. Access shall be provided to all equipment that prevents damaging or compressing the insulation. 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 the 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.

Exceptions:

1. Vertical doors that provide access from conditioned to unconditioned spaces shall be permitted to meet the fenestration requirements of Table ~~R~~N1102.1.2 based on the applicable climate zone specified in ~~Chapter 3~~ N1101.7.

2. Pull down stair systems shall be weatherstripped and insulated to a minimum R-5 insulation value such that the insulation does not interfere with proper operation of the stair. Non-rigid insulation materials are not allowed. Additional insulation systems that enclose the stair system from above are allowed. Exposed foam plastic must meet the provisions of Section R318.

N1102.2.5 (R402.2.5) Mass walls.

Mass walls for the purposes of this chapter shall be considered ~~above-grade~~ walls of concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth (adobe, compressed earth block, rammed earth) and solid timber/logs, or any other walls meeting the specification immediately following ~~having a heat capacity greater than or equal to 6 Btu/ft^2 ×°F (123 kJ/m^2 × K)~~. Masonry or concrete walls having a mass greater than or equal to 30 pounds per square foot (146 kg/m$_2$). Solid wood walls having a mass greater than 20 pounds per square foot (98 kg/m^2), and any walls having a heat capacity greater than or equal to 6 Btu/ft$_2$ *°F[266 J/(m^2*K)].

N1102.2.7 (R402.2.7) Walls with partial structural sheathing.

~~Where Section R1102.1.2 would require continuous insulation on exterior walls and structural sheathing covers 40 percent or less of the gross area of all exterior walls, the continuous insulation *R*-value shall be permitted to be reduced by an amount necessary to result in a consistent total sheathing thickness, but not more than R-3, on areas of the walls covered by structural sheathing.~~ If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2. This reduction shall not apply to the *U*-factor alternative approach in Section ~~R~~N1102.1.4 and the total UA alternative in Section ~~R~~N1102.1.5.

N1102.2.8 (R402.2.8) Floors.

Floor framing-cavity insulation shall be installed to maintain permanent contact with the underside of the subfloor decking. The distance between tension support wires or other devices that hold the floor insulation in place against the subfloor shall be no more than 18 inches (457 mm). In addition, supports shall be located no further than 6 inches (152 mm) from each end of the insulation.

Exception: ~~The floor framing-cavity insulation shall be permitted to be in contact with the topside of sheathing or continuous insulation installed on the bottom side of floor framing where combined with insulation that meets or exceeds the minimum wood frame wall *R*-value in Table 1102.1.2 and that extends from the bottom to the top of all perimeter floor framing members.~~ Enclosed floor cavity such as garage ceilings, cantilevers or buildings on pilings with enclosed floor cavity with the insulation fully in contact with the lower air barrier. In this case, the band boards shall be insulated to maintain thermal envelope continuity.

N1102.2.9 (R402.2.9) Basement walls.

Walls associated with conditioned basements shall be insulated from the top of the *basement wall* down to 10 feet (3048 mm) below grade or to the basement floor, whichever is less. Walls associated with unconditioned basements shall meet this requirement unless the floor overhead is insulated in accordance with Sections N1102.1.2 and N1102.2.8. Foam plastic insulation applied to exterior of basement walls shall be provided with termite inspection and treatment gaps in accordance with Appendix O.

N1102.2.10 (R402.2.10) Slab-on-grade floors.

~~Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade shall be insulated in accordance with Table N1102.1.2. The insulation shall extend downward from the top of the slab on the outside or inside of the foundation wall. Insulation located below grade shall be extended the distance provided in Table N1102.1.2 by any combination of vertical insulation, insulation extending under the slab or insulation extending out from the building. Insulation extending away from the building shall be protected by pavement or by not less than 10 inches (254 mm) of soil. The top edge of the insulation installed between the *exterior wall* and the edge of the interior slab shall be permitted to be cut at a 45-degree (0.79 rad) angle away from the *exterior wall.* Slab-edge insulation is not required in jurisdictions designated by the *building official* as having a very heavy termite infestation.~~ Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade shall be insulated in accordance with Table N1102.1.2. The top edge of the insulation installed between the *exterior wall* and the edge of the interior slab shall be permitted to be cut at a 45-degree (0.79 rad) angle away from the *exterior wall*. Slab edge insulation shall have 2 inch (51 mm) termite inspection gap consistent with Appendix O of this code.

N1102.2.11 (R402.2.11) Closed crawl space walls.

~~As an alternative to insulating floors over crawl spaces, crawl space walls shall be permitted to be insulated when the crawl space is not vented to the outside. Crawl space wall insulation shall be permanently fastened to the wall and extend downward from the floor to the finished grade~~

~~level and then vertically and/or horizontally for at least an additional 24 inches (610 mm). Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with this code. All joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (153 mm) up the stem wall and shall be attached to the stem wall.~~
Where the floor above a closed crawl space is not insulated, the exterior crawlspace walls shall be insulated in accordance with Table N1102.1.2.

Wall insulation may be located in any combination of the outside and inside wall surfaces and within the structural cavities or materials of the wall system.

Wall insulation requires that the exterior wall band joist area of the floor frame be insulated. Wall insulation shall begin 3 inches (76 mm) below the top of the masonry foundation wall and shall extend down to 3 inches (76 mm) above the top of the footing or concrete floor, 3 inches (76 mm) above the interior ground surface or 24 inches (610 mm) below the outside finished ground level, whichever is less. (See Appendix E-2.2 details.)

Termite inspection, clearance, and wicking gaps are allowed in wall insulation systems. Insulation may be omitted in the gap area without energy penalty. The allowable insulation gap widths are listed in Table N1102.2.11. If gap width exceeds the allowances, one of the following energy compliance options shall be met:

1. Wall insulation is not allowed and the required insulation value shall be provided in the floor system.

2. Compliance shall be demonstrated with energy trade-off methods provided by a North Carolina-specific version of RESCHECK or the UA Alternative method or Section N1105.

TABLE N1102.2.11
WALL INSULATION ALLOWANCES FOR TERMITE TREATMENT AND INSULATION GAPS

Gap Width (inches)		Insulation Location	Gap Description
Minimum	Maximum		
2	3	Outside	Above grade inspection between top of insulation and bottom of siding
4	6	Outside	Below grade treatment
3[a]	4[a]	Inside	Wall inspection between top of insulation and bottom of sill
3[a]	4[a]	Inside	Clearance / wicking space between bottom of insulation and top of ground surface, footing, or concrete floor

For SI 1 inch = 25.4 mm
a. No insulation shall be required on masonry walls of 9 inches in height or less.

N1102.2.13 (R402.2.13) Sunroom insulation.

Sunrooms enclosing conditioned spaces shall meet the insulation requirements of this code.

> **Exception:** For *sunrooms* with *thermal isolation*, and enclosing conditioned spaces, the following exceptions to the insulation *requirements* of this code shall apply:
>
> 1. The minimum ceiling insulation *R*-values shall be R-19 in Zones ~~1 through~~ 3 and 4 and R-24 in Zone~~s~~ 5 ~~through 8~~.
>
> 2. The minimum wall *R*-value shall be R-13 in all *climate zones*. New walls separating a *sunroom* with a *thermal isolation* from *conditioned space* shall meet the *building thermal envelope* requirements of this code.

N1102.2.14 (R402.2.14) Framed cavity walls.

The exterior thermal envelope wall insulation shall be installed in contact and continuous alignment with the building envelope air barrier. Insulation shall be free from installation gaps, voids, or compression. For framed walls, the cavity insulation shall be enclosed on all sides with solid rigid material or an air barrier material. Polyethylene shall not be allowed. Rim joists are not required to be enclosed on all sides. Wall insulation shall be enclosed at the following locations when installed on exterior walls prior to being covered by subsequent construction, consistent with Appendix E-2.3 of this code:

1. Tubs

2. Showers

3. Stairs

4. Fireplace units (Enclose with rigid material only)

N1102.2.15 (R402.2.15) Attic knee walls.

Enclosure of wall cavity insulation also applies to walls that adjoin attic spaces by placing a rigid material or air barrier material on the attic space side of the wall on the attic space side of the wall consistent with Appendix E-2.3 of this code. Joints shall be air sealed. Non-insulating class I vapor retarders, such as polyethylene, shall not be allowed.

N1102.3 (R402.3) Fenestration (Prescriptive).

In addition to the requirements of Section N1102, fenestration shall comply with Sections N1102.3.1 through ~~N1102.4.5~~ N1102.3.5.

N1102.3.3 (R402.3.3) Glazed fenestration exemption.

~~Up to 15~~ Either two glazed fenestration assemblies or up to 24 square feet (~~1.4~~ 2.2 m^2) of glazed fenestration per dwelling unit shall be permitted to be exempt from *U*-factor and SHGC requirements in Section N1102.1.2. This exemption shall not apply to the *U*-factor alternative approach in Section N1102.1.4 and the total UA alternative in Section N1102.1.5.

N1102.3.4 (R402.3.4) Opaque door ~~exemption~~.

Opaque doors separating conditioned from unconditioned space shall have a maximum *U*-factor of 0.35.

Exception: One side-hinged opaque door assembly ~~up to 24 square feet (2.22 m^2) in area~~ is exempted from the *U*-factor requirement in Section N1102.1.2. This exemption shall not apply to the *U*-factor alternative approach in Section N1102.1.4 and the total UA alternative in Section N1102.1.5.

N1102.3.5 (R402.3.5) Sunroom fenestration.

Sunrooms enclosing *conditioned space* shall meet the fenestration requirements of this code.

Exceptions:

1. For *sunrooms* with *thermal isolation* and enclosing *conditioned space* in *Climate Zones* ~~2~~ 3 through ~~8~~ 5, the maximum fenestration *U*-factor shall be 0.45 and the maximum skylight *U*-factor shall be ~~0.70~~ 0.75. Sunrooms with cooling systems shall have a maximum fenestration SHGC of 0.40 for all glazing.

2. A maximum of two glazed fenestration product assemblies having a U-factor no greater than 0.55 and, when cooling is provided, a SHGC no greater than 0.70 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.

New fenestration separating the *sunroom* with *thermal isolation* from *conditioned space* shall meet the *building thermal envelope* requirements of this code.

N1102.4 (R402.4) Air leakage control (Mandatory).

The building thermal envelope shall be constructed to limit air leakage in accordance with the requirements of Sections R1102.4.1 through R1102.4.~~4~~6.

N1102.4.1 (R402.4.1) Building thermal envelope.

~~The *building thermal envelope* shall comply with Sections N1102.4.1.1 and N1102.4.1.2. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.~~ The *building thermal envelope* shall be durably sealed to limit infiltration. The sealing methods between dissimilar materials shall allow for differential expansion and contraction. For all homes, where present, the following shall be caulked, gasketed, weatherstripped or otherwise sealed with an air barrier material, or solid material consistent with Appendix E-2.4 of this code:

1. Blocking and sealing floor/ceiling systems and under knee walls open to unconditioned or exterior space.

2. Capping and sealing shafts or chases, including flue shafts.

3. Capping and sealing soffit or dropped ceiling areas.

4. Sealing HVAC register boots and return boxes to subfloor or drywall.

5. Seal exterior house wrap material joints and seams per manufacturer’s instructions or, if house wrap joints are not sealed, seal exterior sheathing and exposed band joist joints including perimeter joints and edges of these materials.

Exceptions:

1. Spray foam in building thermal envelope wall systems.
2. Wall sheathing joints where wall sheathing is fully glued to framing.

~~**N1102.4.1.1 (R402.4.1.1) Installation.**~~
~~The components of the *building thermal envelope* as listed in Table N1102.4.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria listed in Table N1102.4.1.1, as applicable to the method of construction. Where required by the *building official*, an *approved* third party shall inspect all components and verify compliance.~~

~~TABLE N1102.4.1.1 (402.4.1.1)~~
~~AIR BARRIER AND INSULATION INSTALLATION~~

~~COMPONENT~~	~~AIR BARRIER CRITERIA~~	~~INSULATION INSTALLATION CRITERIA~~
~~General requirements~~	~~A continuous air barrier shall be installed in the building envelope.~~ ~~The exterior thermal envelope contains a continuous air barrier.~~ ~~Breaks or joints in the air barrier shall be sealed.~~	~~Air-permeable insulation shall not be used as a sealing material.~~
~~Ceiling/attic~~	~~The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier sealed.~~ ~~Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.~~	~~The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.~~
~~Walls~~	~~The junction of the foundation and sill plate shall be sealed.~~ ~~The junction of the top plate and the top of exterior walls shall be sealed.~~ ~~Knee walls shall be sealed.~~	~~Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of R-3 per inch minimum.~~ ~~Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.~~
~~Windows, skylights and doors~~	~~The space between window/door jambs and framing, and skylights and framing shall be sealed.~~	
~~Rim joists~~	~~Rim joists shall include the air barrier.~~	~~Rim joists shall be insulated.~~
~~Floors (including above garage and cantilevered floors)~~	~~The air barrier shall be installed at any exposed edge of insulation.~~	~~Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking, or floor framing cavity insulation shall be permitted to be in contact~~

		~~with the top side of sheathing, or continuous insulation installed on the underside of floor framing; and extends from the bottom to the top of all perimeter floor framing members.~~
~~Crawl space walls~~	~~Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.~~	~~Where provided instead of floor insulation, insulation shall be permanently attached to the crawl space walls.~~
~~Shafts, penetrations~~	~~Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.~~	
~~Narrow cavities~~		~~Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.~~
~~Garage separation~~	~~Air sealing shall be provided between the garage and conditioned spaces.~~	
~~Recessed lighting~~	~~Recessed light fixtures installed in the building thermal envelope shall be sealed to the drywall.~~	~~Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated.~~
~~Plumbing and wiring~~		~~Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.~~
~~Shower/tub on exterior wall~~	~~The air barrier installed at exterior walls adjacent to showers and tubs shall separate them from the showers and tubs.~~	~~Exterior walls adjacent to showers and tubs shall be insulated.~~
~~Electrical/phone box on exterior walls~~	~~The air barrier shall be installed behind electrical or communication boxes or air-sealed boxes shall be installed.~~	
~~HVAC register boots~~	~~HVAC register boots that penetrate building thermal envelope shall be sealed to the subfloor or drywall.~~	
~~Concealed sprinklers~~	~~When required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.~~	

~~a. In addition, inspection of log walls shall be in accordance with the provisions of ICC 400.~~

~~N1102.4.1.2 (R402.4.1.2) Testing.~~
~~The building or dwelling unit shall be tested and verified as having an air leakage rate of~~

~~not exceeding five air changes per hour in Climate Zones 1 and 2, and three air changes per hour in Climate Zones 3 through 8. Testing shall be conducted in accordance with ASTM E 779 or ASTM E 1827 and reported at a pressure of 0.2 inches w.g. (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope*.~~

~~During testing:~~

1. ~~Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.~~

2. ~~Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.~~

3. ~~Interior doors, if installed at the time of the test, shall be open.~~

4. ~~Exterior doors for continuous ventilation systems and heat recovery ventilators shall be closed and sealed.~~

5. ~~Heating and cooling systems, if installed at the time of the test, shall be turned off.~~

6. ~~Supply and return registers, if installed at the time of the test, shall be fully open.~~

N1102.4.2 Air sealing.

Building envelope air tightness shall be demonstrated by compliance with Sections N1102.4.2.1 or N1102.4.2.2. Appendix E-3 contains optional sample worksheets for visual inspection or testing for the permit holder’s use only.

N1102.4.2.1 Visual inspection option.

Building envelope tightness shall be considered acceptable when items providing insulation enclosure in Section N1102.2.14 and enclosure and air sealing in Section N1102.2.15 and air sealing in Section N1102.4.1 are addressed and when the items listed in Table N1102.4.2, applicable to the method of construction, are certified by the builder, permit holder or *registered design professional* via the certificate in Appendix E-1.

N1102.4.2.2 Testing option.

Building envelope tightness shall be considered acceptable when items providing insulation enclosure in Section N1102.2.14 and enclosure and air sealing in Section N1102.2.15 and air sealing in Section N1102.4.1 are addressed and when tested air leakage is less than or equal to one of the two following performance measurements:

1. 0.30 CFM50/Square Foot of Surface Area (SFSA) or

2. Five (5) air changes per hour (ACH50) when tested with a blower door fan assembly, at a pressure of 33.5 psf (50 Pa). A single point depressurization, not

temperature corrected, test is sufficient to comply with this provision, provided that the blower door fan assembly has been certified by the manufacturer to be capable of conducting tests in accordance with ASTM E779 or ASTM E 1827. 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. Testing shall be reported by the permit holder, a North Carolina licensed general contractor, a North Carolina licensed HVAC contractor, a North Carolina licensed home inspector, a *registered design professional*, a *certified BPI envelope professional* or a *certified HERS rater.*

During testing:

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, backdraft, and flue dampers;

3. Interior doors shall be open;

4. Exterior openings for continuous ventilation systems, air intake ducted to the return side of the conditioning system, and energy or heat recovery ventilators shall be closed and sealed;

5. Heating and cooling system(s) shall be turned off; and

6. Supply and return registers shall not be sealed.

The air leakage information, building air leakage result, tester name, date, and contact information, shall be included on the certificate described in Section N1101.14.

For Test Criteria 1 above, the report shall be produced in the following manner: perform the blower door test and record the *CFM50*. Calculate the total square feet of surface area for the building thermal envelope (all floors, ceilings, and walls including windows and doors, bounding conditioned space) and record the area. Divide *CFM50* by the total square feet and record the result. If the result is less than or equal to [0.30 CFM50/SFSA] the envelope tightness is acceptable; or

For Test Criteria 2 above, the report shall be produced in the following manner: Perform a blower door test and record the *CFM50*. Multiply the CFM50 by 60 minutes to create CFHour50 and record. Then calculate the total conditioned volume of the home and record. Divide the CFH50 by the total volume and record the result. If the result is less than or equal to 5 ACH50 the envelope tightness is acceptable.

TABLE N1102.4.2
AIR BARRIER INSPECTION

COMPONENT	CRITERIA

Ceiling/attic	Sealants or gaskets provide a continuous air barrier system joining the top plate of framed walls with either the ceiling drywall or the top edge of wall drywall to prevent air leakage. Top plate penetrations are sealed. For ceiling finishes that are not air barrier systems such as tongue-and-groove planks, air barrier systems,(for example, taped house wrap), shall be used above the finish Note: It is acceptable that sealants or gaskets applied as part of the application of the drywall will not be observable by the code official.
Walls	Sill plate is gasketed or sealed to subfloor or slab.
Windows and doors	Space between window and exterior door jambs and framing is sealed.
Floors (including above-garage and cantilevered floors)	Air barrier system is installed at any exposed edge of insulation.
Penetrations	Utility penetrations through the building thermal envelope, including those for plumbing, electrical wiring, ductwork, security and fire alarm wiring, and control wiring, shall be sealed.
Garage separation	Air sealing is provided between the garage and conditioned spaces. An air barrier system shall be installed between the ceiling system above the garage and the ceiling system of interior spaces.
Ceiling penetrations	Ceiling electrical box penetrations and ceiling mechanical box penetrations shall be caulked, gasketed, or sealed at the penetration of the ceiling finish. See Appendix E-2.4. Exception: Ceiling electrical boxes and ceiling mechanical boxes not penetrating the building thermal envelope.
Recessed lighting	Recessed light fixtures are air tight, IC rated, and sealed to drywall. Exception: Fixtures in conditioned space.

N1102.4.~~2~~3 (R402.4.~~2~~3) Fireplaces.
~~New wood-burning fireplaces shall have tight-fitting flue dampers or doors, and outdoor combustion air. Where using tight-fitting doors on factory-built fireplaces listed and labeled in accordance with UL 127, the doors shall be tested and listed for the fireplace. Where using tight-fitting doors on masonry fireplaces, the doors shall be listed and labeled in accordance with UL 907.~~ Site-built masonry fireplaces shall have dampers and comply with Section R1006 for combustion air.

N1102.4.~~3~~4 (R402.4.~~3~~4) Fenestration air leakage.
Windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cfm per square foot (1.5 L/s/m^2), and swinging doors no more than 0.5 cfm per square

foot (2.6 L/s/m^2), 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.

Exception: Site-built windows, skylights and doors.

N1102.4.~~4~~5 (R402.4.~~4~~5) Rooms containing fuel-burning appliances. Deleted.

~~In Climate Zones 3 through 8, where open combustion air ducts provide combustion air to open combustion fuel-burning appliances, the appliances and combustion air opening shall be located outside the building thermal envelope or enclosed in a room, isolated from inside the thermal envelope. Such rooms shall be sealed and insulated in accordance with the envelope requirements of Table N1102.1.2, where the walls, floors and ceilings shall meet a minimum of the basement wall *R*-value requirement. The door into the room shall be fully gasketed and any water lines and ducts in the room insulated in accordance with Section N1103. The combustion air duct shall be insulated where it passes through conditioned space to a minimum of R-8.~~

~~**Exceptions:**~~

1. ~~Direct vent appliances with both intake and exhaust pipes installed continuous to the outside.~~
2. ~~Fireplaces and stoves complying with Sections N1102.4.2 and R1006.~~

N1102.4.~~5~~6 (R402.4.~~5~~6) Recessed lighting.

Recessed luminaires installed in the *building thermal envelope* shall be sealed to limit air leakage between conditioned and unconditioned spaces. All recessed luminaires shall be IC-rated and *labeled* as having an air leakage rate not more than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E 283 at a 1.57 psf (75 Pa) pressure differential. All recessed luminaires shall be sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.

N1102.5 (R402.5) Maximum fenestration U-factor and SHGC (Mandatory).

~~The area-weighted average maximum fenestration *U*-factor permitted using tradeoffs from Section N1102.1.5 or N1105 shall be 0.48 in climate zones 4 and 5 and 0.40 in climate zones 6 through 8 for vertical fenestration, and 0.75 in climate zones 4 through 8 for skylights. The area-weighted average maximum fenestration SHGC permitted using tradeoffs from Section N1105 in climate zones 1 through 3 shall be 0.50~~. The area-weighted average maximum fenestration *U*-factor permitted using trade-offs from Section N1102.1.5 shall be 0.48. Maximum skylight *U*-factors shall be 0.65 in Zones 4 and 5 and 0.60 in Zone 3. The area-weighted average maximum fenestration SHGC permitted using trade-offs from Section N1105 in Zone 3 shall be 0.50.

Exception: A maximum of two glazed fenestration product assemblies having a U-factor no greater than 0.55 and a SHGC no greater than 0.70 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.

SECTION N1103 (R403)

SYSTEMS

N1103.1.1 (R403.1.1) Programmable thermostat.

When the primary heating system is a forced air furnace or heat pump, the thermostat controlling the primary heating or cooling system of the dwelling unit shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain *zone* temperatures down to 55°F (13°C) or up to 85°F (29°C). The thermostat shall initially be programmed by the manufacturer with a heating temperature set point no higher than 70°F (21°C) and a cooling temperature set point no lower than 78°F (26°C).

N1103.1.2 (R403.1.2) Heat pump supplementary heat (Mandatory).

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.

A heat strip outdoor temperature lockout thermostat shall be provided to prevent supplemental heat operation in response to the thermostat being changed to a warmer setting. The lockout shall be set no lower than 35°F (2°C) and no higher than 40°F (4°C).

Exceptions:

1. In lieu of a heat strip outdoor temperature lockout thermostat, the following time and temperature electric-resistance control may be used. After six minutes of compressor run time in heat mode, supplemental electric heat shall energize only if the leaving air temperature from the indoor coil is below 90°F (32°C). If the indoor coil leaving air temperature exceeds 100°F (38°C), supplemental heat shall automatically de-energize, but allow the compressor to continue to operate until the call is satisfied. No thermostat shall initiate supplemental electric heat at any time. Thermostat controlled emergency heat shall not be limited by outdoor temperature. Electric resistance supplemental heat during defrost shall operate normally without limitation.

2. In lieu of a heat strip outdoor temperature lockout thermostat, a programmable indoor thermostat with the capability to minimize the use of supplementary electrical resistance heat using an automatic temperature ramp up control feature shall be acceptable.

N1103.3 (R403.3) Ducts.

Ducts and air handlers shall be in accordance with Sections N1103.3.1 through N1103.3.~~5~~4.

N1103.3.1 (R403.3.1) Insulation (~~Prescriptive~~ Mandatory).

~~Supply and return ducts in attics shall be insulated to a minimum of R-8 where 3 inches (76.2 mm) in diameter and greater and R-6 where less than 3 inches (76.2 mm) in diameter. Supply and return ducts in other portions of the building shall be insulated to a minimum of R-6 where 3 inches (76.2 mm) in diameter or greater and R-4.2 where less than 3 inches (76.2 mm) in diameter.~~ Supply and return ducts in unconditioned space and outdoors shall be insulated to a minimum R-8. Supply ducts inside semi-conditioned space shall be insulated to a minimum R-4; return ducts inside conditioned and semi-conditioned space are not required to be insulated. Ducts located inside conditioned space are not required to be insulated other than as may be necessary for preventing the formation of condensation on the exterior of cooling ducts.

> ~~**Exception:** Ducts or portions thereof located completely inside the *building thermal envelope.*~~

N1103.3.2 (R403.3.2) Sealing (Mandatory).

Ducts, air handlers, ~~and~~ filter boxes and building cavities used as ducts shall be sealed. Joints and seams shall comply with either the *International Mechanical Code* or Section M1601.4.1 of this code, as applicable.

Exceptions:

1. Air-impermeable spray foam products shall be permitted to be applied without additional joint seals.
2. ~~For ducts having a static pressure classification of less than 2 inches of water column (500 Pa), additional closure systems shall not be required for continuously welded joints and seams, and locking-type joints and seams of other than the snap-lock and button-lock types.~~ Deleted.

N1103.3.2.1 (R403.3.2.1) Sealed air handler. Deleted.

~~Air handlers shall have a manufacturer's designation for an air leakage of no more than 2 percent of the design air flow rate when tested in accordance with ASHRAE 193.~~

N1103.3.3 (R403.3.3) ~~Duct testing (Mandatory)~~ Duct leakage (Prescriptive) and duct testing (Mandatory).

~~Ducts shall be pressure tested to determine air leakage by one of the following methods:~~

1. ~~Rough-in test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the system, including the manufacturer's air handler enclosure if installed at the time of the test. All registers shall be taped or otherwise sealed during the test.~~
2. ~~Postconstruction test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. Registers shall be taped or otherwise sealed during the test.~~

> ~~**Exception:** A duct air leakage test shall not be required where the ducts and air handlers are located entirely within the building thermal envelope.~~

~~A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*.~~

~~N1103.3.4 (R403.3.4) Duct leakage (Prescriptive).~~

~~The total leakage of the ducts, where measured in accordance with Section R403.3.3, shall be as follows:~~

1. ~~Rough-in test: The total leakage shall be less than or equal to 4 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of conditioned floor area where the air handler is installed at the time of the test. Where the air handler is not installed at the time of the test, the total leakage shall be less than or equal to 3 cubic feet per minute (85 L/min) per 100 square feet (9.29 m^2) of conditioned floor area.~~

2. ~~Postconstruction test: Total leakage shall be less than or equal to 4 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of conditioned floor area.~~

Duct testing and duct leakage shall be verified by compliance with either Section N1103.3.3.1 or N1103.3.3.2. Duct testing shall be performed and reported by the permit holder, a North Carolina licensed general contractor, a North Carolina licensed HVAC contractor, a North Carolina licensed home inspector, a *registered design professional*, a certified BPI envelope professional or a certified HERS rater. A single point depressurization, not temperature corrected, test is sufficient to comply with this provision, provided that the duct testing fan assembly(s) has been certified by the manufacturer to be capable of conducting tests in accordance with ASTM E1554-07.

The duct leakage information, including duct leakage test selected and result, tester name, date, and contact information, shall be included on the certificate described in Section N1101.14.

For the Test Criteria, the report shall be produced in the following manner: perform the HVAC system air leakage test and record the CFM25. Calculate the total square feet of Conditioned Floor Area (CFA) served by that system. Multiply CFM25 by 100, divide the result by the CFA and record the result. If the result is less than or equal to 5 CFM25/100SF for the “Total duct leakage test or less than or equal to 4 CFM25/100SF for the “Duct leakage to the outside” test, then the HVAC system air tightness is acceptable. Appendix E-3C contains optional sample worksheets for duct testing for the permit holder’s use only.

Exceptions:

1. Duct systems or portions thereof inside the building thermal envelope shall not be required to be leak tested.

2. Installation of a partial system as part of replacement, renovation or addition does not require a duct leakage test.

N1103.3.3.1 Total duct leakage.

Total duct leakage less than or equal to 5 CFM (12 L/min) per 100 ft^2 (9.29 m^2) of conditioned floor area served by that system 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.

During testing:

1. Block, if present, ventilation air duct(s) connected to the conditioning system.

2. The duct air leakage testing equipment shall be attached to the largest return in the system or to the air handler.

3. The filter shall be removed and the air handler power shall be turned off.

4. Supply boots or registers and return boxes or grilles shall be taped, plugged, or otherwise sealed air tight.

5. The hose for measuring the 25 Pascals of pressure differential shall be inserted into the boot of the supply that is nominally closest to the air handler.

6. Specific instructions from the duct testing equipment manufacturer shall be followed to reach duct test pressure and measure duct air leakage.

N1103.3.3.2 Duct Leakage to the Outside.

Conduct the test using fan pressurization of distribution system and building at a fixed reference pressure for combined supply and return leak. Duct leakage to the outside shall be less than or equal to 4 CFM (12 L/min) per 100 ft^2 (9.29 m^2) of conditioned floor area served by that system when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the entire system, relative to the outside, including the manufacturer’s air handler enclosure.

During testing:

1. Block, if present, the ventilation air duct(s) connected to the conditioning system.

2. The duct air leakage testing equipment shall be attached to the largest return in the system or to the air handler.

3. The filter shall be removed and the air handler power shall be turned off.
4. Supply boots or registers and return boxes or grilles shall be taped, plugged, or otherwise sealed air tight or as tight as possible.

5. The hose for measuring the 25 Pascals of pressure differential shall be inserted into the boot of the supply that is nominally closest to the air handler.

6. Open all interconnecting doors in the building, close dampers for fireplaces and other operable dampers.

7. Set up an envelope air moving/ flow-regulating/ flow measurement assembly, such as a blower door, following the manufacturer’s prescribed procedure.

8. Specific instructions from the duct testing equipment manufacturer shall be followed to reach duct test pressure and measure duct air leakage used in combination with a blower door. Typical steps are as follows:

    a. Depressurize the ductwork system to 25 Pa using the measurement hose in Step 5 above.

    b. Depressurize the house to 25 Pa using an envelope air moving/ flow-regulating/ flow measurement assembly, such as a blower door.

c. Correct the duct pressure to measure 0 Pa of pressure differential between the house and the ductwork system.

d. Read the CFM of duct leakage using the procedures for the specific equipment being used. (Note that most automatically calculating pressure gauges cannot compute the CFM25 automatically with a duct-to-house difference in pressure of 0 Pa, so the gauge setting should be set to read CFM instead of CFM25).

N1103.3.~~5~~4 (R403.3.~~5~~4) Building cavities (Mandatory).

Building framing cavities shall not be used as supply ducts or supply plenums.

N1103.4.1 (R403.4.1) Protection of piping insulation. Deleted.

~~Piping insulation exposed to weather shall be protected from damage, including that caused by sunlight, moisture, equipment maintenance and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be permitted.~~

N1103.5 (R403.5) Service hot water systems.

~~Energy conservation measures for service hot water systems shall be in accordance with Sections N1103.5.1 and N1103.5.4~~. 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 hot water circulating pump when the system is not in use.

N1103.5.1 (R403.5.1) Heated water circulation and temperature maintenance systems (Mandatory). Deleted.

~~Heated water circulation systems shall be in accordance with Section R1103.5.1.1. Heat trace temperature maintenance systems shall be in accordance with Section R1103.5.1.2. Automatic controls, temperature sensors and pumps shall be accessible. Manual controls shall be readily *accessible*.~~

~~N1103.5.1.1 (R403.5.1.1) Circulation systems.~~

~~Heated water circulation systems shall be provided with a circulation pump. The system return pipe shall be a dedicated return pipe or a cold water supply pipe. Gravity and thermo-syphon circulation systems shall be prohibited. Controls for circulating hot water system pumps shall start the pump based on the identification of a demand for hot water within the occupancy. The controls shall automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is no demand for hot water.~~

~~N1103.5.1.2 (R403.5.1.2) Heat trace systems.~~

~~Electric heat trace systems shall comply with IEEE 515.1 or UL 515. Controls for such systems shall automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping in accordance with the times when heated water is used in the occupancy.~~

N1103.5.2 (R403.5.2) Demand recirculation systems. Deleted.

~~A water distribution system having one or more recirculation pumps that pump water from a heated water supply pipe back to the heated water source through a cold water supply pipe~~

~~shall be a *demand recirculation water system*. Pumps shall have controls that comply with both of the following:~~

1. ~~The control shall start the pump upon receiving a signal from the action of a user of a fixture or appliance, sensing the presence of a user of a fixture or sensing the flow of hot or tempered water to a fixture fitting or appliance.~~
2. ~~The control shall limit the temperature of the water entering the cold water piping to 104ºF (40ºC).~~

N1103.5.3 (R403.5.3) Hot water pipe insulation (Prescriptive). Deleted.
~~Insulation for hot water pipe with a minimum thermal resistance (*R*-value) of R-3 shall be applied to the following:~~

1. ~~Piping $^3/_4$ inch (19 mm) and larger in nominal diameter.~~
2. ~~Piping serving more than one dwelling unit.~~
3. ~~Piping located outside the conditioned space.~~
4. ~~Piping from the water heater to a distribution manifold.~~
5. ~~Piping located under a floor slab.~~
6. ~~Buried in piping.~~
7. ~~Supply and return piping in recirculation systems other than demand recirculation systems.~~

N1103.5.4 (R403.5.4) Drain water heat recovery units. Deleted.
~~Drain water heat recovery units shall comply with CSA 55.2. Drain water heat recovery units shall be tested in accordance with CSA 55.1. Potable water-side pressure loss of drain water heat recovery units shall be less than 3 psi (20.7 kPa) for individual units connected to one or two showers. Potable water-side pressure loss of drain water heat recovery units shall be less than 2 psi (13.8 kPa) for individual units connected to three or more showers.~~

N1103.6.1 (R403.6.1) Whole-house mechanical ventilation system fan efficacy. Deleted.
~~Mechanical ventilation system fans shall meet the efficacy requirements of Table N1103.6.1.~~

> ~~**Exception:** Where mechanical ventilation fans are integral to tested and listed HVAC equipment, they shall be powered by an electronically commutated motor.~~

~~TABLE N1103.6.1 (R403.6.1)~~
~~MECHANICAL VENTILATION SYSTEM FAN EFFICACY~~

~~FAN LOCATION~~	~~AIR FLOW RATE MINIMUM (CFM)~~	~~MINIMUM EFFICACY (CFM/WATT)~~	~~AIR FLOW RATE MAXIMUM (CFM)~~

~~Range hoods~~	~~Any~~	~~2.8 cfm/watt~~	~~Any~~
~~In-line fan~~	~~Any~~	~~2.8 cfm/watt~~	~~Any~~
~~Bathroom, utility room~~	~~10~~	~~1.4 cfm/watt~~	~~< 90~~
~~Bathroom, utility room~~	~~90~~	~~2.8 cfm/watt~~	~~Any~~

~~For SI:1 cubic foot per minute = 28.3 L/min.~~

N1103.7 (R403.7) Equipment sizing and efficiency rating (Mandatory).
Heating and cooling equipment shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other *approved* heating and cooling calculation methodologies. New ~~or replacement~~ heating and cooling equipment shall have an efficiency rating equal to or greater than the minimum required by federal law for the geographic location where the equipment is installed.

N1103.8 (R403.8) Systems serving multiple dwelling units (Mandatory).
Building mechanical systems and service water heating systems serving multiple dwelling units shall comply with Sections C403 and C404 of the IECC—Commercial Provisions in lieu of Section N1103.

N1103.9 (R403.9) Snow melt system controls (Mandatory).
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 (10°C)~~, and no precipitation is falling and an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F (4.8°C)~~.

N1103.10.2 (R403.10.2) Heaters.
~~The electric power to heaters shall be controlled by a readily *accessible* on-off switch that is an integral part of the heater mounted on the exterior of the heater, or external to and within 3 feet (914 mm) of the heater. Operation of such switch shall not change the setting of the heater thermostat. Such switches shall be in addition to a circuit breaker for the power to the heater. Gas-fired heaters shall not be equipped with continuously burning ignition pilots.~~ All heaters shall be equipped with a readily accessible on-off switch that is mounted outside of the heater to allow shutting off the heater without adjusting the thermostat setting. Gas-fired heaters shall not be equipped with constant burning pilot lights.

N1103.10.4 (R403.10.4) Covers.
Outdoor heated pools and outdoor permanent spas shall be provided with a vapor retardant cover ~~or other *approved* vapor-retardant means~~.

Exception: ~~Where more than 70 percent of the energy for heating, computed over an operation season, is from site-recovered energy, such as from a heat pump or solar energy source, covers or other vapor-retardant means shall not be required~~ Pools deriving over 70 percent of the energy from heating from site-recovered or solar energy source.

N1103.11 (R403.11) Portable spas (Mandatory). Deleted.
~~The energy consumption of electric-powered portable spas shall be controlled by the requirements of APSP-14.~~

SECTION N1105 (R405)

SIMULATED PERFORMANCE ALTERNATIVE
(PERFORMANCE)

N1105.1 (R405.1) Scope.

This section establishes criteria for compliance using simulated energy performance analysis. Such analysis shall include ~~heating, cooling and service water heating energy only~~ those items identified in Table N1105.5.2(1), as applicable. A *registered design professional* is required to perform the analysis if required by North Carolina licensure laws.

N1105.2 (R405.2) Mandatory requirements.

Compliance with this section requires that the mandatory provisions identified in Section N1101.13(2) be met. ~~All supply and return ducts not completely inside the *building thermal envelope* shall be insulated to a minimum of R-6.~~

N1105.4.2 (R405.4.2) Compliance report.

Compliance software tools shall generate a report that documents that the *proposed design* complies with Section N1105.3. A compliance report on the *proposed design* shall be submitted ~~with the application for the building permit. Upon completion of the building, a compliance report based on the as-built condition of the building shall be submitted to the *code official* before a certificate of occupancy is issued. Batch sampling of buildings to determine energy code compliance for all buildings in the batch shall be prohibited~~.

~~Compliance reports shall include information in accordance with Sections N1105.4.2.1 and N1105.4.2.2. Where the *proposed design* of a building could be built on different sites where the cardinal orientation of the building on each site is different, compliance of the *proposed design* for the purposes of the application for the building permit shall be based on the worst-case orientation, worst-case configuration, worst-case building air leakage and worst-case duct leakage. Such worst-case parameters shall be used as inputs to the compliance software for energy analysis.~~

~~N1105.4.2.1 (R405.4.2.1) Compliance report for permit application.~~

A compliance report ~~submitted with the application for building permit~~ shall include the following:

1. Building street address, or other building site identification.
2. A statement indicating that the *proposed design* complies with Section N1105.3.
3. An inspection checklist documenting the building component characteristics of the *proposed design* as indicated in Table N1105.5.2(1). The inspection checklist shall show results for both the *standard reference design* and the *proposed design* with user inputs to the compliance software to generate the results.
4. A site-specific energy analysis report that is in compliance with Section N1105.3.
5. The name of the individual performing the analysis and generating the report.
6. The name and version of the compliance software tool.

~~**N1105.4.2.2 (R405.4.2.2) Compliance report for certificate of occupancy.**~~
~~A compliance report submitted for obtaining the certificate of occupancy shall include the following:~~

1. ~~Building street address, or other building site identification.~~
2. ~~A statement indicating that the as-built building complies with Section N1105.3.~~
3. ~~A certificate indicating that the building passes the performance matrix for code compliance and listing the energy saving features of the buildings.~~
4. ~~A site-specific energy analysis report that is in compliance with Section N1105.3.~~
5. ~~The name of the individual performing the analysis and generating the report.~~
6. ~~The name and version of the compliance software tool.~~

TABLE N1105.5.2(1)[R405.5.2(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: as specified in Table N1102.1.4	As proposed
	Solar absorptance = 0.75	As proposed
	Remittance = 0.90	As proposed
Basement and crawl space walls	Type: same as proposed	As proposed
	Gross area: same as proposed	As proposed
	U-factor: from Table N1102.1.4, 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: as specified in Table N1102.1.4	As proposed
Ceilings	Type: wood frame	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table N1102.1.4	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
	Foundation wall area above and below grade and soil characteristics: same as proposed	As proposed
Opaque doors	Area: 40 ft^2	As proposed
	Orientation: North	As proposed

	U-factor: same as fenestration from Table N1102.1.4	As proposed
Vertical fenestration other than opaque doors	Total area^b = (a) The proposed glazing area, where the proposed glazing area is less than 15 percent of the conditioned floor area (b) 15 percent of the conditioned floor area, where the proposed glazing area is 15 percent or more of the conditioned floor area	As proposed
	Orientation: equally distributed to four cardinal compass orientations (N, E, S & W).	As proposed
	U-factor: as specified in Table N1102.1.4	As proposed
	SHGC: as specified in Table N1102.1.2 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed
	Interior shade fraction: 0.92-(0.21 × SHGC for the standard reference design)	0.92-(0.21 × SHGC as proposed)
	External shading: none	As proposed
Skylights	None	As proposed
Thermally isolated sunrooms	None	As proposed
Air exchange rate	Air leakage rate of 5 air changes per hour~~ in Climate Zones 1 and 2, and 3 air changes per hour~~ in Climate Zones 3 through ~~8~~ 5 at a pressure of 0.2 inches w.g (50 Pa). The mechanical ventilation rate shall be in addition to the air leakage rate and the same as in the proposed design, but no greater than $0.01 \times CFA + 7.5 \times (N_{br} + 1)$ where: *CFA* = conditioned floor area N_{br} = number of bedrooms Energy recovery shall not be assumed for mechanical ventilation.	For residences that are not tested, the same air leakage rate as the standard reference design. For tested residences, the measured air exchange rate^a. The mechanical ventilation rate^b shall be in addition to the air leakage rate and shall be as proposed.

(continued)

TABLE N1105.5.2(1)[R405.5.2(1)]—continued
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Mechanical ventilation	None, except where mechanical ventilation is specified by the proposed design, in which case: Annual vent fan energy use: $\text{kWh/yr} = 0.03942 \times CFA + 29.565 \times (N_{br} + 1)$ where: *CFA* = conditioned floor area N_{br} = number of bedrooms	As proposed

Internal gains	IGain = 17,900 + 23.8 × *CFA* + 4104 × 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[c] but not integral to the building envelope or structure.
Structural mass	For masonry floor slabs, 80 percent of floor area covered by R-2 carpet and pad, and 20 percent of floor directly exposed to room air.	As proposed
	For masonry basement walls, as proposed, but with insulation required by Table R402.1.4 located on the interior side of the walls	As proposed
	For other walls, for ceilings, floors, and interior walls, wood frame construction	As proposed
Heating systems[d,e]	As proposed for other than electric heating without a heat pump, where the proposed design utilizes electric heating without a heat pump the standard reference design shall be an air source heat pump meeting the requirements of Section C403 of the IECC-Commercial Provisions. Capacity: sized in accordance with Section N1103.7	As proposed
Cooling systems[d,f]	As proposed Capacity: sized in accordance with Section N1103.7.	As proposed
Service water heating[d,e,f]	As proposed Use: same as proposed design	As proposed gal/day = 30 +(10 × N_{br})
Thermal distribution systems	Duct insulation: From Section ~~N1103.2.1~~ N1103.3.1 A thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems. For tested duct systems, the leakage rate shall be 4 cfm (113.3 L/min) per 100 ft^2 (9.29 m^2) of *conditioned floor* area at a pressure of differential of 0.1 inches w.g. (25 Pa).	As tested or as specified in Table ~~R405.5.2(2)~~ N1105.5.2(2) if not tested. Duct insulation shall be ~~as proposed~~ the same as standard reference design.
Thermostat	Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F	Same as standard reference

For SI:1 square foot = 0.93 m^2, 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m^2, 1 gallon (US)= 3.785 L,°C =(°F-32)/1.8, 1 degree = 0.79 rad.

a. Where required by the *code official*, testing shall be conducted by an *approved* party. Hourly calculations as specified in the ASHRAE *Handbook of Fundamentals*, or the equivalent shall be used to determine the energy loads resulting from infiltration.

b. The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2001 ASHRAE *Handbook of Fundamentals*, page 26.24 and the “Whole-house Ventilation” provisions of 2001 ASHRAE *Handbook of Fundamentals*, page 26.19 for intermittent mechanical ventilation.
c. Thermal storage element shall mean 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 (0.26 rad) of true south, or must be connected to such a room with pipes or ducts that allow the element to be actively charged.
d. 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.
e. For a proposed design without a proposed heating system, a heating system with the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.
f. 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.
g. For a proposed design with a nonstorage-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.

SECTION N1106 (R406)

ENERGY RATING INDEX COMPLIANCE ALTERNATIVE

N1106.2 (R406.2) Mandatory requirements.

Compliance with this section requires that the ~~mandatory~~ provisions identified in Sections ~~N1101.2 and N1103.5.3~~ N1101.14 through N1104 labeled as “mandatory” be met. The building thermal envelope shall be greater than or equal to levels of efficiency and Solar Heat Gain Coefficient in ~~Table 402.1.2 or 402.1.4 of the 2009 *International Energy Conservation Code*~~ Table 402.1.1 or Table 402.1.3 of the *2012 North Carolina Energy Conservation Code*. Minimum standards associated with compliance shall be the ANSI/RESNET/ICC 301-2014 *Standard for the Calculation and Labeling of the Energy Performance of Low-Rise Residential Buildings using an Energy Rating Index*. A North Carolina *registered design professional* is required to perform the analysis if required by North Carolina licensure laws.

> **Exception:** ~~Supply and return ducts not completely inside the building thermal envelope shall be insulated to a minimum of R-6~~. Supply and return ducts in unconditioned space and outdoors shall be insulated to a minimum R-8. Supply ducts inside semi-conditioned space shall be insulated to a minimum R-4; return ducts inside conditioned and semi-conditioned space are not required to be insulated. Ducts located inside conditioned space are not required to be insulated other than as may be necessary for preventing the formation of condensation on the exterior of cooling ducts.

N1106.4 (R406.4) ERI-based compliance.

Compliance based on an ERI analysis requires that the *rated design* be shown to have an ERI less than or equal to the appropriate value listed in Table N1106.4.1 or Table N1106.4.2, as applicable, when compared to the *ERI reference design*.

~~TABLE N1106.4 (R406.4)~~
~~MAXIMUM ENERGY RATING INDEX~~

~~CLIMATE ZONE~~	~~ENERGY RATING INDEX~~
~~1~~	~~52~~
~~2~~	~~52~~
~~3~~	~~51~~
~~4~~	~~54~~
~~5~~	~~55~~
~~6~~	~~54~~
~~7~~	~~53~~
~~8~~	~~53~~

TABLE N1106.4.1 (R406.4.1)
MAXIMUM ENERGY RATING INDEX
(without calculation of on-site renewable energy)

CLIMATE ZONE	JAN. 1, 2019 – DEC. 31, 2022	JAN. 1, 2023 AND FORWARD
3	65	61
4	67	63
5	67	63

TABLE N1106.4.2 (R406.4.2)
MAXIMUM ENERGY RATING INDEX
(including calculation of on-site renewable energy)

CLIMATE ZONE	JAN. 1, 2019 – DEC. 31, 2022	JAN. 1, 2023 AND FORWARD
3	51	47
4	54	50
5	55	51

N1106.5 (R406.5) Verification ~~by approved agency~~.
Verification of compliance with Section N1106 shall be ~~completed by an *approved* third party~~ performed by the *registered design professional* and the compliance documentation shall be provided to the *code official*. The *code official* shall inspect according to the requirements of Section N1106.6.2.

N1106.6.1 (R406.6.1) Compliance software tools.
~~Documentation verifying that the methods and accuracy of the compliance software tools conform to the provisions of this section shall be provided to the *code official*.~~ Compliance software tools for this section shall be in compliance with ANSI/RESNET/ICC 301-2014.

N1106.6.2 (R406.6.2) Compliance report.
Compliance software tools shall generate a report that documents that the ERI of the *rated design* complies with Sections N1106.3 and N1106.4. The compliance documentation shall include the following information:

1. Address or other identification of the residential building.

2. An inspection checklist documenting the building component characteristics of the *rated design*. The inspection checklist shall show results for both the *ERI reference design* and the *rated design*, and shall document all inputs entered by the user necessary to reproduce the results.

3. Name of individual completing the compliance report.

4. Name and version of the compliance software tool.

~~**Exception:** Multiple orientations. Where an otherwise identical building model is offered in multiple orientations, compliance for any orientation shall be permitted by documenting that the building meets the performance requirements in each of the four (north, east, south and west) cardinal orientations.~~

N1106.6.3 (R406.6.3) Additional documentation. Deleted.
~~The *code official* shall be permitted to require the following documents:~~

~~1. Documentation of the building component characteristics of the *ERI reference design*.~~

~~2. A certification signed by the builder providing the building component characteristics of the *rated design*.~~

~~3. Documentation of the actual values used in the software calculations for the *rated design*.~~

N1106.7.1 R(406.7.1) Minimum capabilities.
Calculation procedures used to comply with this section shall be software tools capable of calculating the ERI as described in Section N1106.3 and shall be in compliance with ANSI/RESNET/ICC 301, and the software shall include the following capabilities:

1. Computer generation of the *ERI reference design* using only the input for the *rated design*.

The calculation procedure shall not allow the user to directly modify the building component characteristics of the *ERI reference design*.

2. Calculation of whole-building, as a single *zone*, sizing for the heating and cooling equipment in the *ERI reference design* residence in accordance with Section N1103.7.

3. 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.

4. Printed *code official* inspection checklist listing each of the *rated design* component characteristics determined by the analysis to provide compliance, along with their respective performance ratings.

N1106.7.2 (406.7.2) Specific approval. Deleted.
~~Performance analysis tools meeting the applicable sections of Section N1106 shall be *approved*. Tools are permitted to be *approved* based on meeting a specified threshold for a jurisdiction. The *code official* shall approve tools for a specified application or limited scope.~~

N1106.7.3 (R406.7.3) Input values. Deleted.
~~When calculations require input values not specified by Sections N1102, N1103, N1104 and N1105, those input values shall be taken from an approved source.~~

SECTION N1107 (R501)

EXISTING BUILDINGS—GENERAL

N1107.1 (R501.1) Scope.
The provisions of Sections N1107 through N1111 shall control the *alteration*, repair, addition and change of occupancy of existing buildings and structures. When a section is identified to apply, the subsections to that section also apply.

N1107.3 (R501.3) Maintenance. Deleted.
~~Buildings and structures, and parts thereof, shall be maintained in a safe and sanitary condition. Devices and systems that are required by this code shall be maintained in conformance with the code edition under which installed. The owner or the owner's authorized agent shall be responsible for the maintenance of buildings and structures. The requirements of this chapter shall not provide the basis for removal or abrogation of energy conservation, fire protection and safety systems and devices in existing structures.~~

N1107.4 (R501.4) Compliance.
Alterations, *repairs*, *additions* and changes of occupancy to, or relocation of, existing buildings and structures shall comply with the provisions for *alterations*, *repairs*, *additions* and changes of occupancy or relocation, respectively, in this code and the *International Building Code*, *International Fire Code*, *International Fuel Gas Code*, *International Mechanical Code*, *International Plumbing Code*, *North Carolina Existing Building Code* ~~*International Property Maintenance Code*, *International Private Sewage Disposal Code*~~ and NFPA 70.

N1107.6 (R501.6) Historic buildings.
No provision of this chapter relating to the construction, *repair, alteration,* restoration and movement of structures, and *change of occupancy* shall be mandatory for *historic buildings* ~~provided a report has been submitted to the code official and signed by the owner, a registered *design professional*, or a representative of the State Historic Preservation Office or the historic preservation authority having jurisdiction, demonstrating that compliance with that provision would threaten, degrade or destroy the historic form, fabric or function of the *building*~~.

SECTION N1108 (R502)

ADDITIONS

N1108.1.1.1 (R502.1.1.1) Building envelope.
New building envelope assemblies that are part of the addition shall comply with Sections N1102.1, N1102.2, N1102.3.1 through N1102.3.5, and N1102.4.

> ~~**Exception:** Where nonconditioned space is changed to conditioned space, the building envelope of the addition shall comply where the UA, as determined in Section N1102.1.4, of the existing building and the addition, and any alterations that are part of the project, is less than or equal to UA generated for the existing building.~~

N1108.1.1.2 (R502.1.1.2) Heating and cooling systems.
New heating, cooling and duct systems that are part of the addition shall comply with Sections N1103.1, N1103.2, N1103.3, ~~N1103.5~~ N1103.4 and N1103.6. New heating and cooling appliances shall be sized in accordance with Section N1103.7. Extensions of ducts from an existing system to a new addition shall require that the existing system be evaluated for the new design.

> **Exception:** ~~Where ducts from an existing heating and cooling system are extended to an addition, duct systems with less than 40 linear feet (12.19 m) in unconditioned spaces shall not be required to be tested in accordance with Section N1103.2.2~~. Installation of an addition to an existing duct system shall not require a duct leakage test.

N1108.1.1.3 (R502.1.1.3) Service hot water systems.
New service hot water systems that are part of the addition shall comply with Section ~~N1103.4~~ N1103.5.

N1108.1.2 (R502.1.2) ~~Existing plus addition compliance (~~Simulated Performance Alternative for additions~~)~~.
~~Where nonconditioned space is changed to conditioned space, the addition shall comply where the annual energy cost or energy use of the addition and the existing building, and any alterations that are part of the project, is less than or equal to the annual energy cost of the existing building when modeled in accordance with Section N1105.~~ The addition ~~and any alterations that are part of the project~~ shall comply with Section N1105 ~~in its entirety~~, as applicable.

SECTION N1109 (R503)

ALTERATIONS

N1109.1 (R503.1) General.
~~*Alterations* to any building or structure shall comply with the requirements of the code for new construction. *Alterations* shall be such that the existing building or structure is no less conforming with the provisions of this chapter than the existing building or structure was prior to the *alteration*.~~

Alterations to an existing building, building system or portion thereof shall conform to the provisions of this chapter as they relate to new construction without requiring the unaltered portions of the existing building or building system to comply with this chapter. Alterations shall not create an unsafe or hazardous condition or overload existing building systems. ~~*Alterations* shall be such that the existing building or structure uses no more energy than the existing building or structure prior to the *alteration*~~. Alterations to existing buildings shall comply with Sections N1109.1.1 through N1109.2.

N1109.1.1 (R503.1.1) Building envelope.
Building envelope assemblies that are part of the alteration shall comply with Section N1102.1.2 or N1102.1.4, Sections N1102.2.1 through ~~N1102.2.12~~ N1102.2.15, N1102.3.1, N1102.3.2, ~~N1102.4.3~~ N1102.4.4 and ~~N1102.4.4~~ N1102.4.6.

Exception: The following alterations to conditioned spaces need not comply with the requirements for new construction ~~provided the energy use of the building is not increased:~~

1. Storm windows installed over existing fenestration.
2. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation. Roof systems requiring air space for ventilation shall retain the ventilation space required.
3. Construction where the existing roof, wall or floor cavity is not exposed.
4. Roof recover and roof replacement such that the existing building or structure is no less conforming to the provisions of this code than the existing building or structure was prior to the *alteration*.
5. ~~Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.~~ Deleted.
6. Surface applied window film installed on existing single pane fenestration assemblies to reduce solar heat gain ~~provided the code does not require the glazing or fenestration assembly to be replaced~~.
7. Converting unconditioned attic space to conditioned attic space for one and two-family dwellings and townhouses. Ceilings shall be insulated to a minimum of R-30, walls shall be insulated to the exterior wall requirements in Table N1102.1.2 or Table N1102.1.4 and follow the backing requirements in Sections N1102.2.14 and N1102.2.15.

N1109.1.1.1 (R503.1.1.1) Replacement fenestration.

~~Where some or all of an existing fenestration unit is replaced with a new fenestration product, including sash and glazing, the replacement fenestration unit shall meet the applicable requirements for *U*-factor and SHGC as provided in Table N1102.1.4.~~ Where an entire existing fenestration unit is replaced with a new fenestration product, including frame, sash and glazing, the replacement fenestration unit shall meet the applicable requirements for *U*-factor and SHGC in Table N1102.1.2.

Exception: *Alterations* that replace less than 50 percent of entire fenestration units may be replaced with like or better fenestration units to match existing fenestration assemblies.

N1109.1.2 (R503.1.2) Heating and cooling systems.

New heating, cooling and duct systems that are part of the alteration shall comply with Sections N1103.1, N1103.2, N1103.3, N1103.4, ~~and~~ N1103.6, and N1103.7.

Exception: ~~Where ducts from an existing heating and cooling system are extended, duct systems with less than 40 linear feet (12.19 m) in unconditioned spaces shall not be required to be tested in accordance with Section N1103.3.3.~~ An *alteration* involving a partial system replacement to an existing duct system shall not require a duct leakage test.

N1109.2 (R503.2) Change in space conditioning.

~~Any nonconditioned or low energy space that is altered to become *conditioned space* shall be required to be brought into full compliance with this chapter.~~ In addition to the requirements of Section N1109.1, projects changing unconditioned space to conditioned space and costing more than $10,000 shall require 10 percent of the project cost to be used toward meeting the requirements of this chapter. Project costs for the purpose of this section is the total project cost listed on all permits related to the work required to convert the unconditioned space to conditioned space and excludes the 10 percent added from this section. Under this section, existing building envelope elements that become a part of the building thermal envelope and are not changed are not required to be upgraded. The additional 10 percent of the project cost shall be appropriated for additional energy conservation features of choice that are addressed in this chapter. In addition to the 10 percent project cost, any existing wall, ceiling, or floor cavities that are exposed during construction shall at a minimum be insulated to comply with this chapter or be insulated to fill the cavity, whichever is less. Roof systems requiring air space for ventilation shall retain the ventilation space required. Projects costing less than $10,000 are not subject to the 10 percent project cost addition provision.

> ~~**Exception:** Where the simulated performance option in Section N1105 is used to comply with this section, the annual energy cost of the proposed design is permitted to be 110 percent of the annual energy cost otherwise allowed by Section N1105.3.~~

SECTION N1110 (R504)

REPAIRS

N1110.1 (R504.1) General.

Repair of the building systems shall not make the building less conforming than it was before the *repair* was undertaken. ~~Buildings, structures and parts thereof shall be repaired in compliance with Section N1107.3 and this section.~~ Work on nondamaged components necessary for the required *repair* of damaged components shall be considered part of the *repair* and shall not be subject to the requirements for *alterations* in this chapter. ~~Routine maintenance required by Section N1107.3, ordinary repairs exempt from *permit*, and abatement of wear due to normal service conditions shall not be subject to the requirements for *repairs* in this section.~~

N1110.2 (R504.2) ~~Application~~ Materials.

~~For the purposes of this code, the following shall be considered repairs:~~

1. ~~Glass-only replacements in an existing sash and frame.~~
2. ~~Roof repairs.~~
3. ~~Repairs where only the bulb and/or ballast within the existing luminaires in a space are replaced provided that the replacement does not increase the installed interior lighting power.~~

Portions of walls that are part of the building thermal envelope shall be insulated in accordance with this code when the repair requires the removal of either the interior or exterior wall membrane such that the wall cavity is exposed during the repair.

> **Exception:** Wall cavities containing existing insulation material.

N1110.3 (R504.3) Glazing.
Repairs requiring the replacement of individual glass panes or sashes shall not require compliance with this code.

SECTION N1111 (R505)

CHANGE OF OCCUPANCY OR USE

N1111.1 (R505.1) General.
~~Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code.~~ *Alterations* performed in spaces undergoing a change in occupancy shall comply with the requirements of this code. Unaltered portions of the existing building or building supply system shall not be required to comply with this code.

N1111.2 (R505.2) General. Deleted.
~~Any space that is converted to a dwelling unit or portion thereof from another use or occupancy shall comply with this code.~~

> ~~**Exception:** Where the simulated performance option in Section N1105 is used to comply with this section, the annual energy cost of the proposed design is permitted to be 110 percent of the annual energy cost otherwise allowed by Section N1105.3.~~

Part V—Mechanical

CHAPTER 12

MECHANICAL ADMINISTRATION

The text of this chapter is extracted from the 2018 edition of the *North Carolina Mechanical Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code for One- and Two-Family Dwellings*. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Mechanical Code.*

SECTION M1201

GENERAL

M1201.1 (101.2) Scope.
The provisions of Chapters 12 through 24 shall regulate the design, installation, maintenance, *alteration* and inspection of mechanical systems that are permanently installed and used to control environmental conditions within buildings. These chapters shall also regulate those mechanical systems, system components, *equipment* and *appliances* specifically addressed in this code.

SECTION M1202

EXISTING MECHANICAL SYSTEMS

M1202.1 (102.4) Additions, alterations or repairs.
Additions, *alterations*, renovations or repairs to a mechanical system shall conform to the requirements for a new mechanical system without requiring the existing mechanical system to comply with all of the requirements of this code. *Additions, alterations* or repairs shall not cause an existing mechanical system to become unsafe, hazardous or overloaded. Minor *additions*, *alterations* or repairs to existing mechanical systems shall meet the provisions for new construction, unless such work is done in the same manner and arrangement as was in the existing system, is not hazardous, and is *approved*.

M1202.2 (102.2) Existing installations.
Except as otherwise provided for in this code, a provision in this code shall not require the removal, *alteration* or abandonment of, nor prevent the continued use and maintenance of, an existing mechanical system lawfully in existence at the time of the adoption of this code.

M1202.3 (102.3) Maintenance. Deleted.
~~Mechanical systems, both existing and new, and parts thereof shall be maintained in proper~~

~~operating condition in accordance with the original design and in a safe and sanitary condition. Devices or safeguards that are required by this code shall be maintained in compliance with the code edition under which installed. The owner or the owner's designated agent shall be responsible for maintenance of the mechanical systems. To determine compliance with this provision, the *building official* shall have the authority to require a mechanical system to be reinspected.~~

M1202.4 (102.6) Historic buildings.

The provisions of this code relating to the construction, *alteration*, repair, enlargement, restoration, relocation or moving of buildings or structures shall not be mandatory for existing buildings or structures identified and classified by the state or local jurisdiction as historic buildings where such buildings or structures are judged by the code official to be safe and in the public interest of health, safety and welfare regarding any proposed construction, *alteration*, repair, enlargement, restoration, relocation or moving of buildings.

CHAPTER 13

GENERAL MECHANICAL SYSTEM REQUIREMENTS

The text of this chapter is extracted from the 2018 edition of the *North Carolina Mechanical Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code for One- and Two-Family Dwellings*. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Mechanical Code.*

SECTION M1301

GENERAL

M1301.2 (301.3) Identification.
Each length of pipe and tubing and each pipe fitting utilized in a mechanical system shall bear the identification of the manufacturer as required by the listing or standard for the piping or tubing.

M1301.4 (301.4) Plastic pipe, fittings and components. Deleted.
~~Plastic pipe, fittings and components shall be third-party certified as conforming to NSF 14.~~

SECTION M1302
APPROVAL

M1302.1 (301.7) Listed and labeled.
Appliances regulated by this code shall be *listed* and *labeled* for the application in which they are installed and used, unless otherwise *approved* in accordance with Section R104.11.

Exceptions:

1. Listing and labeling of *equipment* and appliances used for refrigeration shall be in accordance with Section 1101.2 of the *North Carolina Mechanical Code*.
2. Field erected equipment shall be deemed acceptable, provided it is assembled using listed components and parts, if the design thereof is by a *registered design professional*.

SECTION M1303
LABELING OF APPLIANCES

M1303.1 (301.9) Label information.
A permanent factory-applied nameplate(s) shall be affixed to *appliances* on which shall appear, in legible lettering, the manufacturer's name or trademark, the model number, a serial number and the seal or *mark* of the testing agency. A *label* also shall include the following:

1. Electrical *appliances*. Electrical rating in volts, amperes and motor phase; identification of individual electrical components in volts, amperes or watts and motor phase; and in Btu/h (W) output and required clearances.

2. Absorption units. Hourly rating in Btu/h (W), minimum hourly rating for units having step or automatic modulating controls, type of fuel, type of refrigerant, cooling capacity in Btu/h (W) and required clearances.

3. Fuel-burning units. Hourly rating in Btu/h (W), type of fuel *approved* for use with the *appliance* and required clearances.

4. Electric comfort-heating appliances. The electric rating in volts, amperes and phase; Btu/h (W) output rating; individual marking for each electrical component in amperes or watts, volts and phase; and required clearances from combustibles.

5. Maintenance instructions. Required regular maintenance actions and title or publication number for the operation and maintenance manual for that particular model and type of product.

SECTION M1304
TYPE OF FUEL

M1304.1 (301.12) Fuel types.
Fuel-fired *appliances* shall be designed for use with the type of fuel to which they will be connected and the altitude at which they are installed. *Appliances* that comprise parts of the building mechanical system shall not be converted for the use of a different fuel, except where *approved* and converted in accordance with the manufacturer’s instructions. The fuel input rate shall not be increased or decreased beyond the limit rating for the altitude at which the *appliance* is installed.

SECTION M1305
APPLIANCE ACCESS

M1305.1 (306.1) Appliance access for inspection service, repair and replacement.
Appliances shall be accessible for inspection, service, repair and replacement without removing permanent construction, other *appliances*, or any other piping or ducts not connected to the *appliance* being inspected, serviced, repaired or replaced. A level working space not less than 30 inches deep and 30 inches wide (762 mm by 762 mm) shall be provided in front of the control side to service an *appliance*.

M1305.1.1 (306.1.1) Furnaces and air handlers. Deleted.
~~Furnaces and air handlers within compartments or alcoves shall have a minimum working space clearance of 3 inches (76 mm) along the sides, back and top with a total width of the enclosing space being not less than 12 inches (305 mm) wider than the furnace or air handler. Furnaces having a firebox open to the atmosphere shall have not less than a 6-inch (152 mm) working space along the front combustion chamber side. Combustion air openings at the rear or side of the compartment shall comply with the requirements of Chapter 17.~~

~~**Exception:** This section shall not apply to replacement *appliances* installed in existing compartments and alcoves where the working space clearances are in accordance with the *equipment* or *appliance* manufacturer's installation instructions.~~

M1305.1.2 (306.2) Appliances in rooms.
Appliances installed in a compartment, alcove, *basement* or similar space shall be accessed by an opening or door and an unobstructed passageway measuring not less than 24 inches (610 mm) wide and large enough to allow removal of the largest *appliance* in the space, provided there is a level service space of not less than 30 inches (762 mm) deep and the height of the *appliance*, but not less than 30 inches (762 mm), at the front or service side of the *appliance* with the door open.

M1305.1.3 (306.3) Appliances in attics and above hard ceilings.
Attics containing *appliances* shall be provided with an opening and a clear and unobstructed passageway large enough to allow removal of the largest component of the *appliance*, but not less than 30 inches (762 mm) high and 22 inches (559 mm) wide and not more than 20 feet (6096 mm) long measured along the centerline of the passageway from the opening to the *appliance*. The passageway shall have continuous solid flooring in accordance with Chapter 5 not less than 24 inches (610 mm) wide. A level service space not less than 30 inches (762 mm) deep and 30 inches (762 mm) wide shall be present along all sides of the *appliance* where access is required. The clear access opening dimensions shall be not less than of 20 inches by 30 inches (508 mm by 762 mm), and large enough to allow removal of the largest component of the appliance.

Exceptions:

1. The passageway and level service space are not required where the *appliance* (or disassembled appliance) can be serviced and removed through the required opening.

2. ~~Where the passageway is unobstructed and not less than 6 feet (1829 mm) high and 22 inches (559 mm) wide for its entire length, the passageway shall be not more than 50 feet (15 250 mm) long.~~ Where the passageway is not less than 6 feet (1829 mm) high for its entire length, the passageway shall not be limited in length.

M1305.1.3.1 (306.3.1) ~~Electrical requirements.~~ Lighting outlet and receptacle.
~~A luminaire controlled by a switch located at the required passageway opening and a receptacle outlet shall be installed at or near the *appliance* location in accordance with Chapter 39. Exposed lamps shall be protected from damage by location or lamp guards~~. For reference and coordination purposes only, refer to the *North Carolina Electrical Code,* Article 210.63 for receptacles, and Article 210.70 (3) for lighting outlet and switch locations.

M1305.1.4 (306.4) Appliances under floors and exterior grade installations.
Underfloor spaces containing *appliances* shall be provided with an unobstructed passageway large enough to remove the largest component of the *appliance*, but not less than ~~30 inches (762 mm) high and 22 inches (559 mm) wide~~ 22 inches (559 mm) high and 36 inches (914 mm) wide, nor more than 20 feet (6096 mm) long measured along the centerline of the passageway from the opening to the *appliance*. A level service space not

less than 30 inches (762 mm) deep and 30 inches (762 mm) wide shall be present at the front or service side of the *appliance*. If the depth of the passageway or the service space exceeds 12 inches (305 mm) below the adjoining grade, the walls of the passageway shall be lined with concrete or masonry extending 4 inches (102 mm) above the adjoining grade in accordance with Chapter 4. The rough-framed access opening dimensions shall be not less than 22 inches high by 30 inches wide (559 mm by 762 mm), and large enough to remove the largest component of the *appliance*.

Exceptions:

1. The passageway is not required where the level service space is present when the access is open, and the *appliance* can be serviced and removed through the required opening.
2. ~~Where the passageway is unobstructed and not less than 6 feet high (1929 mm) and 22 inches (559 mm) wide for its entire length, the passageway shall not be limited in length.~~ Where the passageway is not less than 6 feet (1829 mm) high unobstructed and not less than 6 feet (1929 mm) high for its entire length, the passageway shall not be limited in length.

M1305.1.4.1 (304.10.1) Ground clearance.
~~*Equipment* and *appliances* supported from the ground shall be level and firmly supported on a concrete slab or other *approved* material extending not less than 3 inches (76 mm) above the adjoining ground. Such support shall be in accordance with the manufacturer's installation instructions. *Appliances* suspended from the floor shall have a clearance of not less than 6 inches (152 mm) from the ground.~~

M1305.1.4.1.1 (304.10.1) Exterior grade installations.
Equipment and appliances installed above grade level shall be supported on a solid base or approved material a minimum of 2 inches (51 mm) thick.

M1305.1.4.1.2 (304.10.2) Under-floor installation.
Suspended equipment shall be a minimum of 6 inches (152 mm) above the adjoining grade. See Section M1601.4.8 for ductwork support heights.

M1305.1.4.1.3 (304.10.3) Crawl space supports.
A support shall be provided at each corner of the unit not less than 8 inches by 8 inches (203.2 mm by 203.2 mm). The unit shall be supported a minimum of 2 inches (51 mm) above grade. When constructed of brick, the bricks shall be mortared together. All units stacked shall be mortared together. Fabricated units, formed concrete, or other approved materials shall be permitted.

M1305.1.4.1.4 (304.10.4) Drainage.
Below-grade installations shall be provided with a natural drain or an automatic lift or sump pump. For pit requirements, see Section M1305.1.4.2.

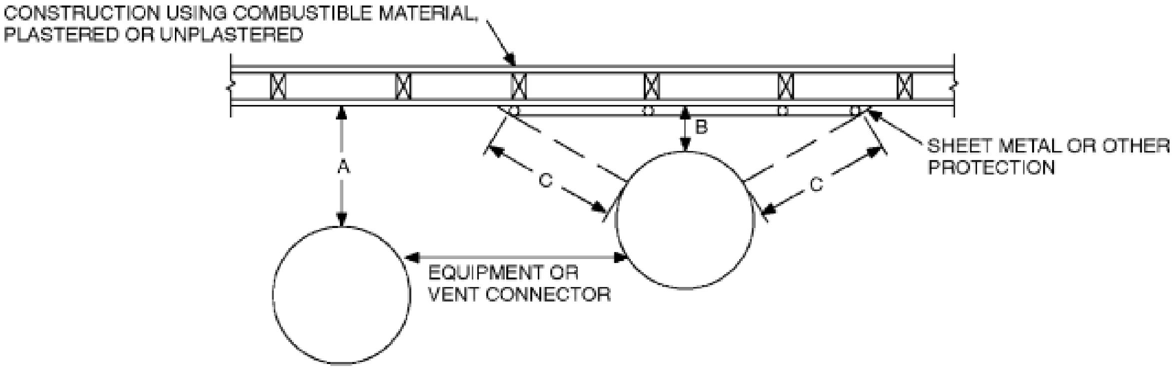
M1305.1.4.2 (303.7) ~~Excavations.~~ Pit locations.
~~Excavations for *appliance* installations shall extend to a depth of 6 inches (152 mm) below the *appliance* and 12 inches (305 mm) on all sides, except that the control side shall have a clearance of 30 inches (762 mm).~~ Appliances installed in pits or excavations

shall not come in direct contact with the surrounding soil. The sides of the pit or excavation shall be held back not less than 12 inches (305 mm) from the *appliance*. Where the depth exceeds 12 inches (305 mm) below adjoining grade, the walls of the pit or excavation shall be lined with concrete or masonry. Such concrete or masonry shall extend not less than 4 inches (102 mm) above adjoining grade and shall have sufficient lateral load-bearing capacity to resist collapse. The *appliance* shall be protected from flooding in an *approved* manner.

M1305.1.4.3 Electrical requirements.
A luminaire controlled by a switch located at the required passageway opening and a receptacle outlet shall be installed at or near the *appliance* location in accordance with ~~Chapter 39~~ the *North Carolina Electrical Code*. Exposed lamps shall be protected from damage by location or lamp guards.

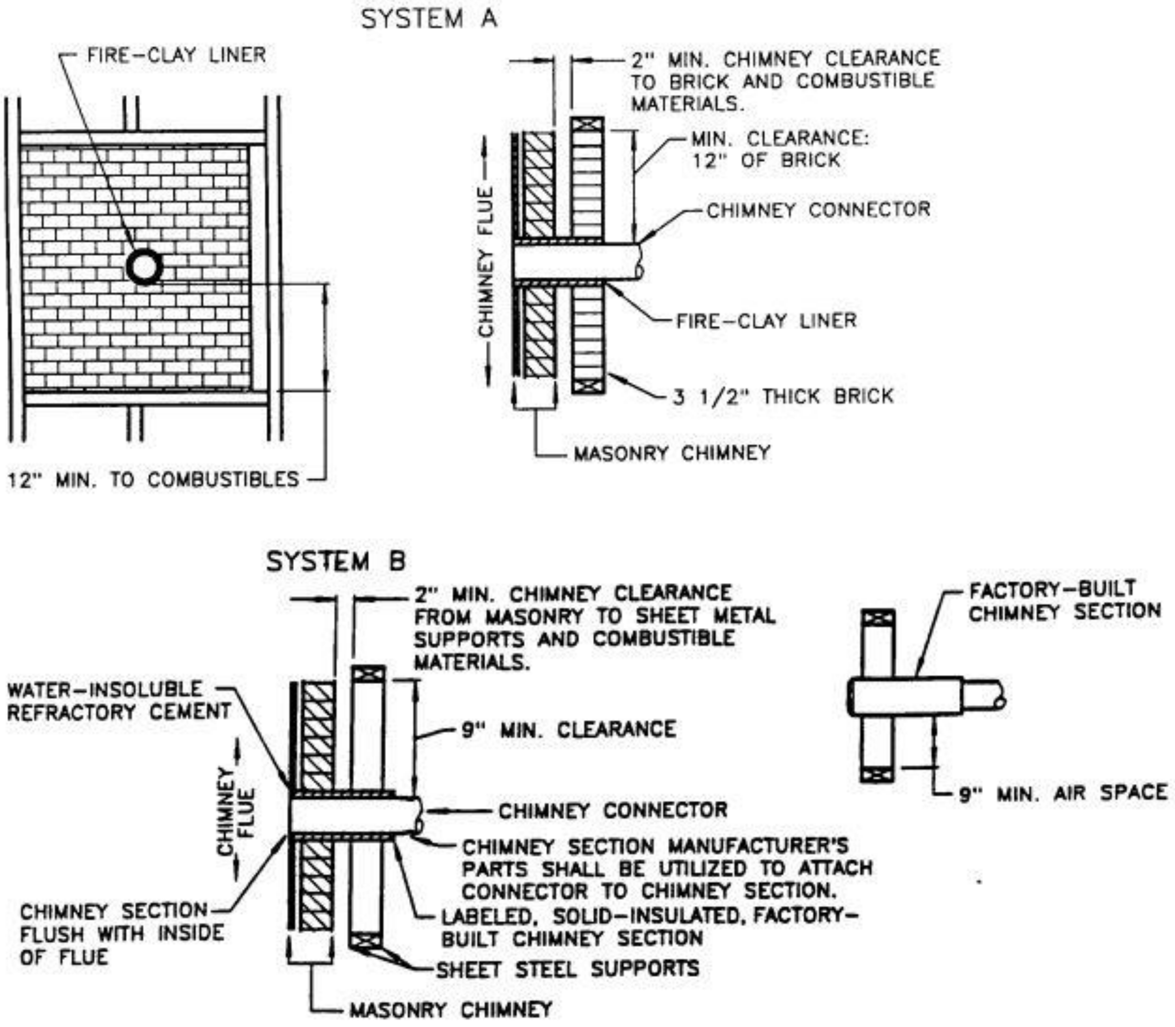
SECTION M1306
CLEARANCES FROM COMBUSTIBLE CONSTRUCTION

M1306.1 (304.9) Appliance clearance.
~~*Appliances* shall be installed with the clearances from unprotected combustible materials as indicated on the *appliance label* and in the manufacturer's installation instructions.~~ Heat-producing *equipment* and *appliances* shall be installed to maintain the required *clearances* to combustible construction as specified in the listing and manufacturer's instructions. Such clearances shall be reduced only in accordance with Section M1306. *Clearances* to combustibles shall include such considerations as door swing, drawer pull, overhead projections or shelving and window swing, shutters, coverings and drapes. Devices such as doorstops or limits, closers, drapery ties or guards shall not be used to provide the required *clearances*.



Note: "A" equals the required clearance with no protection. "B" equals the reduced clearance permitted in accordance with Table M1306.2. The protection applied to the construction using combustible material shall extend far enough in each direction to make "C" equal to "A."

FIGURE M1306.1
REDUCED CLEARANCE DIAGRAM


SYSTEM A
FIRE-CLAY LINER
12" MIN. TO COMBUSTIBLES
2" MIN. CHIMNEY CLEARANCE TO BRICK AND COMBUSTIBLE MATERIALS.
MIN. CLEARANCE: 12" OF BRICK
CHIMNEY CONNECTOR
CHIMNEY FLUE
FIRE-CLAY LINER
3 1/2" THICK BRICK
MASONRY CHIMNEY
SYSTEM B
2" MIN. CHIMNEY CLEARANCE FROM MASONRY TO SHEET METAL SUPPORTS AND COMBUSTIBLE MATERIALS.
WATER-INSOLUBLE REFRACTORY CEMENT
9" MIN. CLEARANCE
CHIMNEY FLUE
CHIMNEY CONNECTOR
CHIMNEY SECTION MANUFACTURER'S PARTS SHALL BE UTILIZED TO ATTACH CONNECTOR TO CHIMNEY SECTION.
CHIMNEY SECTION FLUSH WITH INSIDE OF FLUE
LABELED, SOLID-INSULATED, FACTORY-BUILT CHIMNEY SECTION
SHEET STEEL SUPPORTS
MASONRY CHIMNEY
FACTORY-BUILT CHIMNEY SECTION
9" MIN. AIR SPACE

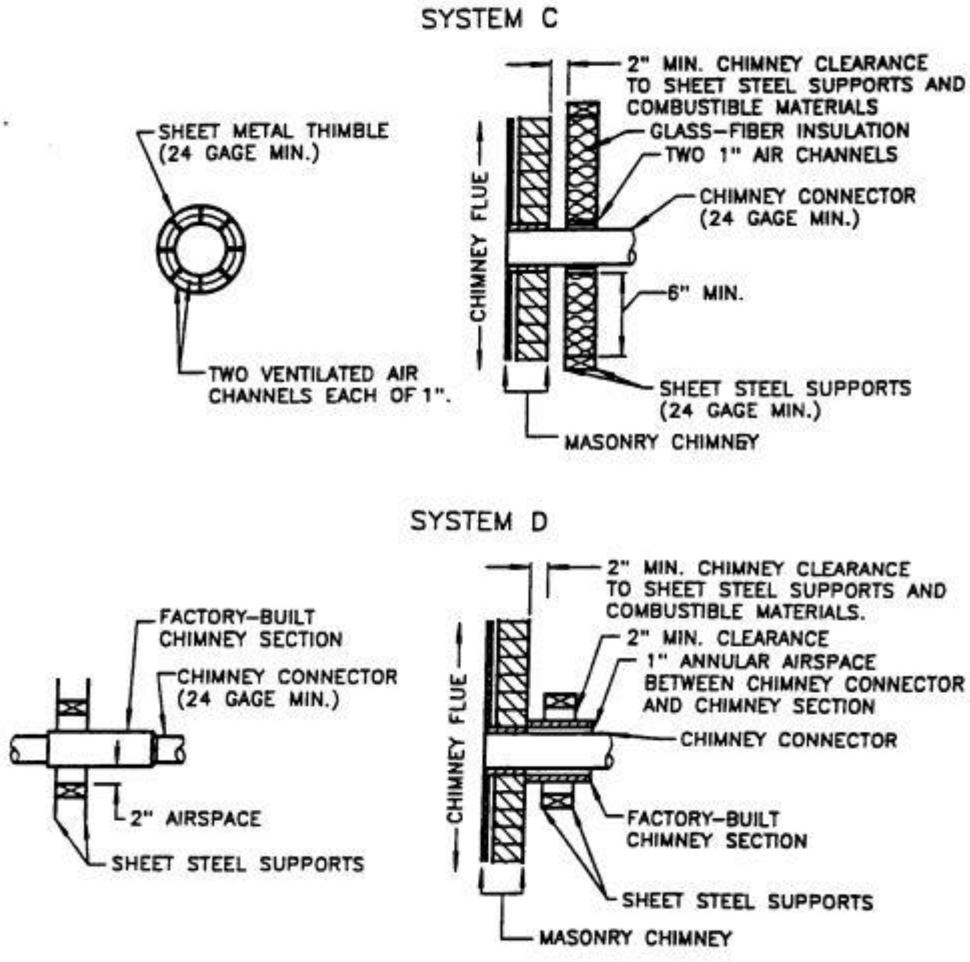


FIGURE M1306.1—continued

CHIMNEY CONNECTOR SYSTEMS

TABLE M1306.2

REDUCTION OF CLEARANCES WITH SPECIFIED FORMS OF PROTECTION[a, c, d, e, f, g, h, i, j, k, l]

~~TYPE OF PROTECTION APPLIED TO AND COVERING ALL~~	~~WHERE THE REQUIRED CLEARANCE WITHOUT PROTECTION FROM APPLIANCE, VENT CONNECTOR, OR SINGLE WALL METAL PIPE IS:~~				
	~~36 inches~~	~~18 inches~~	~~12 inches~~	~~9 inches~~	~~6 inches~~
	~~Allowable clearances with specified protection (Inches)[b]~~				
	~~Use column 1 for clearances above an appliance or horizontal connector.~~ ~~Use column 2 for clearances from an appliance, vertical connector and single-wall metal pipe.~~				

~~SURFACES OF COMBUSTIBLE MATERIAL WITHIN THE DISTANCE SPECIFIED AS THE REQUIRED CLEARANCE WITH NO PROTECTION (See Figures M1306.1 and M1306.2)~~	**~~Above column 1~~**	**~~Sides and rear column 2~~**	**~~Above column 1~~**	**~~Sides and rear column 2~~**	**~~Above column 1~~**	**~~Sides and rear column 2~~**	**~~Above column 1~~**	**~~Sides and rear column 2~~**	**~~Above column 1~~**	**~~Sides and rear column 2~~**
~~3 $^{1}/_{2}$-inch-thick masonry wall without ventilated air space~~	~~—~~	~~24~~	~~—~~	~~12~~	~~—~~	~~9~~	~~—~~	~~6~~	~~—~~	~~5~~
~~$^{1}/_{2}$-inch insulation board over 1-inch glass fiber or mineral wool batts~~	~~24~~	~~18~~	~~12~~	~~9~~	~~9~~	~~6~~	~~6~~	~~5~~	~~4~~	~~3~~
~~Galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) over 1-inch glass fiber or mineral wool batts reinforced with wire or rear face with a ventilated air space~~	~~18~~	~~12~~	~~9~~	~~6~~	~~6~~	~~4~~	~~5~~	~~3~~	~~3~~	~~3~~
~~3 $^{1}/_{2}$-inch-thick masonry wall with ventilated air space~~	~~—~~	~~12~~	~~—~~	~~6~~	~~—~~	~~6~~	~~—~~	~~6~~	~~—~~	~~6~~

~~Galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) with a ventilated air space 1-inch off the combustible assembly~~	~~18~~	~~12~~	~~9~~	~~6~~	~~6~~	~~4~~	~~5~~	~~3~~	~~3~~	~~2~~
~~1/2-inch-thick insulation board with ventilated air space~~	~~18~~	~~12~~	~~9~~	~~6~~	~~6~~	~~4~~	~~5~~	~~3~~	~~3~~	~~3~~
~~Galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) with ventilated air space over 24 gage sheet steel with a ventilated space~~	~~18~~	~~12~~	~~9~~	~~6~~	~~6~~	~~4~~	~~5~~	~~3~~	~~3~~	~~3~~
~~1-inch glass fiber or mineral wool batts sandwiched between two sheets of galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) with a ventilated air space~~	~~18~~	~~12~~	~~9~~	~~6~~	~~6~~	~~4~~	~~5~~	~~3~~	~~3~~	~~3~~

TYPE OF PROTECTIVE ASSEMBLY[a]	**REDUCED CLEARANCE WITH PROTECTION (inches)**[b]	
	Horizontal combustible assemblies located above the heat source	**Horizontal combustible assemblies located beneath the heat source and all vertical combustible assemblies**

	Required clearance to combustibles without protection (inches)[a]				**Required clearance to combustibles without protection (inches)**			
	36	**18**	**9**	**6**	**36**	**18**	**9**	**6**
Galvanized sheet steel, having a minimum thickness of 0.0236 inch (No. 24 gage), mounted on 1-inch glass fiber or mineral wool batt reinforced with wire on the back, 1 inch off the combustible assembly	18	9	5	3	12	6	3	3
Galvanized sheet steel, having a minimum thickness of 0.0236 inch (No. 24 gage), spaced 1 inch off the combustible assembly	18	9	5	3	12	6	3	2
Two layers of galvanized sheet steel, having a minimum thickness of 0.0236 inch (No. 24 gage), having a 1-inch airspace between layers, spaced 1 inch off the combustible assembly	18	9	5	3	12	6	3	3
Two layers of galvanized sheet steel, having a minimum thickness of 0.0236 inch (No. 24 gage), having 1 inch of fiberglass insulation between layers, spaced 1 inch off the combustible assembly	18	9	5	3	12	6	3	3
0.5-inch inorganic insulating board, over 1 inch of fiberglass or mineral wool batt, against the combustible assembly	24	12	6	4	18	9	5	3
3$^{1}/_{2}$-inch brick wall, spaced 1 inch off the combustible wall	-	-	-	-	12	6	6	6
3$^{1}/_{2}$-inch brick wall, against the combustible wall	-	-	-	-	24	12	6	5

For SI: 1 inch = 25.4 mm, 1 pound per cubic foot = 16.019 kg/m^3, °C = [(°F)-32/1.8], 1 Btu/(h × ft^2 × °F/in.) = 0.001442299 (W/cm^2 × °C/cm).

a. Reduction of clearances from combustible materials shall not interfere with combustion air, draft hood clearance and relief, and accessibility of servicing.

b. Clearances shall be measured from the surface of the heat producing appliance or equipment to the outer surface of the combustible material or combustible assembly.

c. Spacers and ties shall be of noncombustible material. Spacers and ties shall not be used directly opposite appliance or connector.

d. Where all clearance reduction systems use a ventilated air space, adequate provision for air circulation shall be provided as described. (See Figures M1306.1 and M1306.2.)

e. There shall be not less than 1 inch between clearance reduction systems and combustible walls and ceilings for reduction systems using ventilated air space.

f. If a wall protector is mounted on a single flat wall away from corners, adequate air circulation shall be permitted to be provided by leaving only the bottom and top edges or only the side and top edges open with not less than a 1-inch air gap.

g. Mineral wool and glass fiber batts (blanket or board) shall have a minimum density of 8 pounds per cubic foot and a minimum melting point of 1,500°F.

h. Insulation material used as part of a clearance reduction system shall have a thermal conductivity of 1.0 Btu inch per square foot per hour °F or less. Insulation board shall be formed of noncombustible material.

i. There shall be not less than 1 inch between the appliance and the protector. The clearance between the appliance and the combustible surface shall not be reduced below that allowed in this table.
j. All clearances and thicknesses are minimum; larger clearances and thicknesses are acceptable.
k. Listed single-wall connectors shall be permitted to be installed in accordance with the terms of their listing and the manufacturer's instructions.
l. For limitations on clearance reduction for solid-fuel-burning appliances see Section M1306.2.3.

M1306.2.1 (308.4.1) Labeled assemblies.
~~The allowable clearance shall be based on an approved reduced clearance protective assembly that is listed and labeled in accordance with UL 1618.~~ The allowable clearance reduction shall be based on an approved reduced clearance protective assembly that has been tested and bears the label of an approved agency.

M1306.2.2 (308.4.2) Reduction table.
Reduction of clearances shall be in accordance with the *appliance* manufacturer's instructions and Table M1306.2. Forms of protection with ventilated air space shall conform to the following requirements:

1. Not less than 1-inch (25 mm) air space shall be provided between the protection and combustible wall surface.
2. Air circulation shall be provided by having edges of the wall protection open not less than 1 inch (25 mm).
3. If the wall protection is mounted on a single flat wall away from corners, air circulation shall be provided by having the bottom and top edges, or the side and top edges not less than 1 inch (25 mm).
4. Wall protection covering two walls in a corner shall be open at the bottom and top edges not less than 1 inch (25 mm).

M1306.2.4 (308.4.2.2) Masonry chimneys.
The *clearance* reduction methods specified in Table M1306.2 shall not be utilized to reduce the *clearances* required for masonry *chimneys* as specified in Chapter 10 and the *International Building Code*.

M1306.2.5 (308.4.2.3) Chimney connector pass-throughs.
The *clearance* reduction methods specified in Table M1306.2 shall not be utilized to reduce the clearances required for *chimney* connector pass-throughs as specified in Table M1803.3.5 and Figure M1306.1.

M1306.2.6 (308.4.2.4) Masonry fireplaces.
The *clearance* reduction methods specified in Table M1306.2 shall not be utilized to reduce the clearances required for masonry fireplaces as specified in Chapter 10 and the *International Building Code*.

SECTION M1307
APPLIANCE INSTALLATION

M1307.1 (304.1) General.

~~Installation of *appliances* shall conform to the conditions of their *listing* and *label* and the manufacturer's instructions. The manufacturer's operating and installation instructions shall remain attached to the *appliance*.~~ Equipment and appliances shall be installed as required by the terms of their approval, in accordance with the conditions of the listing, the manufacturer's installation instructions and this code. Manufacturer's installation instructions shall be available on the job site at the time of inspection.

M1307.2 Anchorage of appliances. Deleted.

~~*Appliances* designed to be fixed in position shall be fastened or anchored in an *approved* manner. In Seismic Design Categories D_0, D_1 and D_2, and in townhouses in Seismic Design Category C, water heaters and thermal storage units shall be anchored or strapped to resist horizontal displacement caused by earthquake motion in accordance with one of the following:~~

1. ~~Anchorage and strapping shall be designed to resist a horizontal force equal to one-third of the operating weight of the water heater storage tank, acting in any horizontal direction. Strapping shall be at points within the upper one-third and lover one-third of the *appliance's* vertical dimensions. At the lower point, the strapping shall maintain a minimum distance of 4 inches (102 mm) above the controls.~~

2. ~~The anchorage strapping shall be in accordance with the appliance manufacturer's recommendations.~~

M1307.3 (304.3) Elevation of ignition source.

Appliances having an *ignition source* shall be elevated such that the source of ignition is not less than 18 inches (457 mm) above the floor in garages. For the purpose of this section, rooms or spaces that are not part of the *living space* of a *dwelling unit* and that communicate with a private garage through openings shall be considered to be part of the garage.

> **Exception:** Elevation of the ignition source is not required for appliances that are listed as flammable-vapor-ignition resistant.

M1307.3.1 Protection from impact.

~~*Appliances* shall not be installed in a location subject to vehicle damage except where protected by *approved* barriers.~~ *Appliances* located in private garages and carports shall be installed with a minimum clearance of 6 feet (1829 mm) above the floor. *Appliances* located out of the normal path of travel are not required to be protected.

> **Exception:** The requirements of this section shall not apply where the appliances are protected from motor vehicle impact and installed in accordance with Section M1307.3.

M1307.4 (304.5) Hydrogen generating and refueling operations.

Ventilation shall be required in accordance with Section M1307.4.1, M1307.4.2 or M1307.4.3 in private garages that contain hydrogen-generating *appliances* or refueling systems. For the purpose of this section, rooms or spaces that are not part of the *living space* of a *dwelling unit* and that communicate directly with a private garage through openings shall be considered to be part of the private garage.

M1307.5 Electrical appliances.

Electrical *appliances* shall be installed in accordance with Chapters 14, 15, 19, and 20 ~~and 34 through 43~~ of this code and the *North Carolina Electrical Code*.

SECTION M1308
MECHANICAL SYSTEMS INSTALLATION

M1308.1 (302.3, 302.5) Drilling and notching.

Wood-framed structural members shall be drilled, notched or altered in accordance with the provisions of Sections R502.8, R602.6, R602.6.1 and R802.7. Holes in load-bearing members of cold-formed steel light-frame construction shall be permitted only in accordance with Sections R505.2.6, R603.2.6 and R804.2.6. In accordance with the provisions of Sections R505.3.5, R603.3.4 and R804.3.3, cutting and notching of flanges and lips of load-bearing members of cold-formed steel light frame construction shall not be permitted. Structural insulated panels (SIPs) shall be drilled and notched or altered in accordance with the provisions of Section R610.7.

M1308.2 (305.5) Protection against physical damage.

Where piping will be concealed within light-frame construction assemblies, the piping shall be protected against penetration by fasteners in accordance with Sections M1308.2.1 through M1308.2.3.

> **Exception:** Cast iron piping and galvanized steel piping shall not be required to be protected.

M1308.2.1 Piping through bored holes or notches.

Where *piping* is installed through holes or notches in framing members and is located less than $1^{1}/_{2}$ inches (38 mm) from the framing member face to which wall, ceiling or floor membranes will be attached, the pipe shall be protected by shield plates that cover the width of the pipe and the framing member and that extend 2 inches (51 mm) to each side of the framing member. Where the framing member that the piping passes through is a bottom plate, bottom track, top plate or top track, the shield plates shall cover the framing member and extend 2 inches (51 mm) above the bottom framing member(s) and 2 inches (51 mm) below the top framing member(s).

M1308.2.2 Piping in other locations.

Where piping is located within a framing member (i.e. steel studs) and is less than $1^{1}/_{2}$ inches (38 mm) from the framing member face to which wall, ceiling or floor membranes will be attached, the piping shall be protected by shield plates that cover the width and length of the piping. Where piping is located outside of a framing member and is located less than $1^{1}/_{2}$ inches (38 mm) from the nearest edge of the face of the framing member to which the membrane will be attached, the piping shall be protected by shield plates that cover the width and length of the piping.

M1308.3 (305.5) Piping Support.

Piping systems shall be supported in accordance with M2101.9.

CHAPTER 14

HEATING AND COOLING EQUIPMENT AND APPLIANCES

The text of this chapter is extracted from the 2018 edition of the *North Carolina Mechanical Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code for One- and Two-Family Dwellings*. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Mechanical Code.*

SECTION M1401
GENERAL

M1401.3 (312.1) Equipment and appliance sizing.

Heating and cooling *equipment* and *appliances* shall be sized in accordance with ACCA Manual S or other approved sizing methodologies based on building loads calculated in accordance with ACCA Manual J or other *approved* heating and cooling calculation methodologies.

> **Exception:** Heating and cooling equipment and appliance sizing shall not be limited to the capacities determined in accordance with Manual S where either of the following conditions applies:
>
> 1. The specified equipment or appliance utilizes multistage technology or variable refrigerant flow technology and the loads calculated in accordance with the approved heating and cooling calculation methodology are within the range of the manufacturer's published capacities for that equipment or appliance.
>
> 2. The specified equipment or appliance manufacturer's published capacities cannot satisfy both the total and sensible heat gains calculated in accordance with the approved heating and cooling calculation methodology and the next larger standard size unit is specified.

For permitting, inspections, certificate of compliance or certificate of occupancy, verification of Calculations for HVAC Systems - ACCA Manual D, ACCA Manual J nor ACCA Manual S calculation submittals and review shall not be required.

M1401.4 (303.5) Exterior installations.

Equipment and *appliances* installed outdoors shall be *listed* and *labeled* for outdoor installation. Supports and foundations shall prevent excessive vibration, settlement or movement of the *equipment*. Supports and foundations shall be in accordance with Section M1305.1.4.1.

SECTION M1402
CENTRAL FURNACES

M1402.1 (918.1) General.

Oil-fired central furnaces shall conform to ANSI/UL 727. Electric furnaces shall conform to UL 1995. Solid fuel furnaces shall be tested in accordance with UL 391.

M1402.4 (918.3) Dampers.
Volume dampers shall not be placed in the air inlet to a furnace in a manner that will reduce the required air to the furnace.

M1402.5 (918.4) Circulating air ducts for forced-air warm-air furnaces.
Circulating air for fuel-burning, forced-air-type, warm-air furnaces shall be conducted into the blower housing from outside the furnace enclosure by continuous air-tight ducts.

M1402.6 (918.5) Outdoor and return air openings.
Outdoor intake openings shall be located in accordance with Section M1602.1. Return air openings shall be located in accordance with Section M1602.2.

M1402.7 (918.6) Outdoor opening protection.
Outdoor air intake openings shall be protected in accordance with Section R303.6.

M1402.8 (918.7) Refrigeration coils in warm-air furnaces.
When a cooling coil is located in the supply plenum of a warm-air furnace, the furnace blower shall be rated at not less than 0.5-inch water column (124 Pa) static pressure unless the furnace is listed and labeled for use with a cooling coil. Cooling coils shall not be located upstream from heat exchangers unless listed and labeled for such use. Conversion of existing furnaces for use with cooling coils shall be permitted provided the furnace will operate within the temperature rise specified for the furnace.

SECTION M1403
HEAT PUMP EQUIPMENT

M1403.1 (918.2) Heat pumps.
Electric heat pumps shall be listed and labeled in accordance with UL 1995 or UL/CSA/ANCE 60335-2-40.

SECTION M1405
BASEBOARD CONVECTORS

M1405.1 (929.1) General.
Electric baseboard convectors shall be installed in accordance with the manufacturer's instructions and Chapters 34 through 43 of this code. Electric baseboard heaters shall be listed and labeled in accordance with UL 1042.

SECTION M1406
RADIANT HEATING SYSTEMS

M1406.1 (927) General.
Electric radiant heating systems shall be installed in accordance with the manufacturer's instructions and ~~Chapters 34 through 43 of this code~~ the *North Carolina Electrical Code* and shall be listed for the application.

M1406.2 Clearances.
Clearances for radiant heating panels or elements to any wiring, outlet boxes and junction boxes used for installing electrical devices or mounting luminaires shall comply with ~~Chapters 34 through 43 of this code~~ the *North Carolina Electrical Code*.

SECTION M1407
DUCT HEATERS

M1407.1 (930.1) General.
Electric duct heaters shall be installed in accordance with the manufacturer's instructions and ~~Chapters 34 through 43 of this code~~ the *North Carolina Electrical Code*. Electric duct heaters shall comply with UL 1996.

M1407.2 (930.2) Installation.
Electric duct heaters shall be installed so that they will not create a fire hazard. Class 1 ducts, duct coverings and linings shall be interrupted at each heater to provide the clearances specified in the manufacturer's installation instructions. Such interruptions are not required for duct heaters *listed* and *labeled* for zero clearance to combustible materials. Insulation installed in the immediate area of each heater shall be classified for the maximum temperature produced on the duct surface.

M1407.3 (930.3) Installation with heat pumps and air conditioners.
Duct heaters located within 4 feet (1219 mm) of a heat pump or air conditioner shall be *listed* and *labeled* for such installations. The heat pump or air conditioner shall additionally be *listed* and *labeled* for such duct heater installations.

M1407.4 (930.4) Access.
Duct heaters shall be accessible for servicing, and clearance shall be maintained to permit adjustment, servicing and replacement of controls and heating elements.

M1407.5 (930.5) Fan interlock.
The fan circuit shall be provided with an interlock to prevent heater operation when the fan is not operating.

SECTION M1408
VENTED FLOOR FURNACES

M1408.1 (910.1) General.
Oil-fired vented floor furnaces shall comply with UL 729 and shall be installed in accordance with their *listing*, the manufacturer's instructions and the requirements of this code.

M1408.2 (910.4) Clearances.
Vented floor furnaces shall be installed in accordance with their listing and the manufacturer's instructions.

M1408.3 (910.2) Location.
Location of floor furnaces shall conform to the following requirements:

1. Floor registers of floor furnaces shall be installed not less than 6 inches (152 mm) from a wall.

2. Wall registers of floor furnaces shall be installed not less than 6 inches (152 mm) from the adjoining wall at inside corners.

3. The furnace register shall be located not less than 12 inches (305 mm) from doors in any position, draperies or similar combustible objects.

4. The furnace register shall be located not less than 5 feet (1524 mm) below any projecting combustible materials.

5. The floor furnace burner assembly shall not project into an occupied under-floor area.

6. The floor furnace shall not be installed in concrete floor construction built on grade.

7. The floor furnace shall not be installed where a door can swing within 12 inches (305 mm) of the grille opening.

M1408.5 (910.4) Installation.
Floor furnace installations shall conform to the following requirements:

1. Thermostats controlling floor furnaces shall be located in the room in which the register of the floor furnace is located.

2. Floor furnaces shall be supported independently of the furnace floor register.

3. Floor furnaces shall be installed not closer than 6 inches (152 mm) to the ground. The minimum clearance shall be 2 inches (51 mm), where the lower 6 inches (152 mm) of the furnace is sealed to prevent water entry.

4. Where excavation is required for a floor furnace installation, the excavation shall extend 30 inches (762 mm) beyond the control side of the floor furnace and 12 inches (305 mm) beyond the remaining sides. Excavations shall slope outward from the perimeter of the base of the excavation to the surrounding *grade* at an angle not exceeding 45 degrees (0.79 rad) from horizontal.

5. Floor furnaces shall not be supported from the ground.

SECTION M1409
VENTED WALL FURNACES

M1409.1 (909.1) General.
Oil-fired vented wall furnaces shall comply with UL 730 and shall be installed in accordance with their *listing*, the manufacturer's instructions and the requirements of this code.

M1409.2 (909.2) Location.
The location of vented wall furnaces shall conform to the following requirements:

1. Vented wall furnaces shall be located where they will not cause a fire hazard to walls, floors, combustible furnishings or doors. Vented wall furnaces installed between bathrooms and adjoining rooms shall not circulate air from bathrooms to other parts of the building.

2. Vented wall furnaces shall not be located where a door can swing within 12 inches (305 mm) of the furnace air inlet or outlet measured at right angles to the opening. Doorstops or door closers shall not be installed to obtain this clearance.

M1409.3 (909.4) Installation.
Vented wall furnace installations shall conform to the following requirements:

1. Required wall thicknesses shall be in accordance with the manufacturer's installation instructions.

2. Ducts shall not be attached to a wall furnace. Casing extensions or boots shall be installed only where listed as part of a *listed* and *labeled appliance*.

3. A manual shut off valve shall be installed ahead of all controls.

M1409.4 (909.6) Access.
Vented wall furnaces shall be provided with access for cleaning of heating surfaces; removal of burners; replacement of sections, motors, controls, filters and other working parts; and for adjustments and lubrication of parts requiring such attention. Panels, grilles and access doors that must be removed for normal servicing operations shall not be attached to the building construction.

SECTION M1410
VENTED ROOM HEATERS

M1410.1 (904.1, 922) General.
Vented room heaters shall be tested in accordance with ASTM E 1509 for pellet-fuel burning, UL 896 for oil-fired or UL 1482 for solid fuel-fired and installed in accordance with their *listing*, the manufacturer's installation instructions and the requirements of this code.

M1410.3 (905.3) Hearth extensions.
Hearth extensions for fireplace stoves shall be installed in accordance with the listing of the fireplace stove. The hearth extension shall be readily distinguishable from the surrounding floor area. Listed and labeled hearth extensions shall comply with UL 1618.

SECTION M1411
HEATING AND COOLING EQUIPMENT

M1411.2 Refrigeration coils in warm-air furnaces.
~~Where a cooling coil is located in the supply plenum of a warm-air furnace, the furnace blower shall be rated at not less than 0.5-inch water column (124 Pa) static pressure unless the furnace is *listed* and *labeled* for use with a cooling coil. Cooling coils shall not be located upstream from heat exchangers unless *listed* and *labeled* for such use. Conversion of existing furnaces for use with cooling coils shall be permitted provided the furnace will operate within the temperature rise specified for the furnace.~~ See Section M1402.8.

M1411.3 (307.2) Condensate disposal.
Condensate from cooling coils, condensing furnaces and evaporators shall be conveyed from the drain pan outlet to an *approved* place of disposal. Such piping shall maintain a minimum

horizontal slope in the direction of discharge of not less than $^{1}/_{8}$ unit vertical in 12 units horizontal (1-percent slope). Where pumps are used, they shall be installed with a factory-equipped auxiliary high-level switch and shall shut off equipment served upon activation of the auxiliary high-level switch. Where damage to any building components will occur as a result of overflow from the pump, the pump shall also be located in the auxiliary drain pan or in a separate drain pan equipped with a separate drain line or water-level detection device. Condensate shall not discharge into a street, alley or other areas where it would cause a nuisance.

M1411.3.1 Auxiliary and secondary drain systems.

In addition to the requirements of Section M1411.3, a secondary drain or auxiliary drain pan shall be required for each cooling or evaporator coil where damage to any building components will occur as a result of overflow from the *equipment* drain pan or stoppage in the condensate drain piping. Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than $^{1}/_{8}$ unit vertical in 12 units horizontal (1-percent slope). Drain piping shall be not less than $^{3}/_{4}$-inch (19 mm) nominal pipe size. One of the following methods shall be used:

1. An auxiliary drain pan with a separate drain shall be installed under the coils on which condensation will occur. The auxiliary pan drain shall discharge to a conspicuous point of disposal to alert occupants in the event of a stoppage of the primary drain. The pan shall have a minimum depth of 1.5 inches (38 mm), shall be not less than 3 inches (76 mm) larger than the unit or the coil dimensions in width and length and shall be constructed of corrosion-resistant material. Galvanized sheet steel pans shall have a minimum thickness of not less than 0.0236-inch (0.6010 mm) (No. 24 Gage). Nonmetallic pans shall have a minimum thickness of not less than 0.0625 inch (1.6 mm).

    a. Appliances with primary condensate pans above appliance components. Cooling coils mounted above the air handler or furnace shall have a secondary drain piped to auxiliary pan under air handler to avoid condensate migrating through appliance components before reaching the auxiliary drain pan.

2. A separate overflow drain line shall be connected to the drain pan installed with the *equipment*. This overflow drain shall discharge to a conspicuous point of disposal to alert occupants in the event of a stoppage of the primary drain. The overflow drain line shall connect to the drain pan at a higher level than the primary drain connection.

3. An auxiliary drain pan without a separate drain line shall be installed under the coils on which condensation will occur. This pan shall be equipped with a water level detection device conforming to UL 508 that will shut off the *equipment* served prior to overflow of the pan. The pan shall be equipped with a fitting to allow for drainage. The auxiliary drain pan shall be constructed in accordance with Item 1 of this section.

4. A water level detection device conforming to UL 508 shall be installed that will shut off the *equipment* served in the event that the primary drain is blocked. The device

shall be installed in the primary drain line, upstream of the primary drain line trap, the overflow drain line or the *equipment*-supplied drain pan, located at a point higher than the primary drain line connection and below the overflow rim of such pan.

Exception: Fuel-fired appliances that automatically shut down operation in the event of a stoppage in the condensate drainage system.

M1411.3.1.1 (307.2.3.1) Water-level monitoring devices.

On down-flow units and other coils that do not have secondary drain or provisions to install a secondary or auxiliary drain pan, a water-level monitoring device shall be installed inside the primary drain pan. This device shall shut off the equipment served in the event that the primary drain becomes restricted. Devices shall not be installed in the drain line.

M1411.3.2 (307.2.2) Drain pipe materials and sizes.

Components of the condensate disposal system shall be ABS, cast iron, copper, cross-linked polyethylene, CPVC, galvanized steel, PE-RT, polyethylene, polypropylene or PVC pipe or tubing. Components shall be selected for the pressure and temperature rating of the installation. Joints and connections shall be made in accordance with the applicable provisions of Chapter 30. Condensate waste and drain line size shall be not less than $^3/_4$-inch (19 mm) nominal diameter from the drain pan connection to the place of condensate disposal. Where the drain pipes from more than one unit are manifolded together for condensate drainage, the pipe or tubing shall be sized in accordance with an *approved* method.

M1411.3.4 (307.2.3.2) Appliances, equipment and insulation in pans.

Where *appliances, equipment* or insulation are subject to water damage when auxiliary drain pans fill, those portions of the *appliances, equipment* and insulation shall be installed above the flood level rim of the pan. Supports located inside of the pan to support the *appliance* or *equipment* shall be water resistant and *approved*.

M1411.3.5 (307.2.4) Traps.

Condensate drains shall be trapped as required by the *equipment* or *appliance* manufacturer.

M1411.3.5.1 (307.2.4.1) Ductless mini-split system traps.

Ductless mini-split equipment that produces condensate shall be provided with an inline check valve located in the drain line, or a trap.

M1411.4 (307.3) Condensate pumps.

Condensate pumps located in uninhabitable spaces, such as attics and crawl spaces, shall be connected to the appliance or equipment served such that when the pump fails, the appliance or equipment will be prevented from operating. Pumps shall be installed in accordance with the manufacturer's instructions.

M1411.6 Insulation of refrigerant piping.

Piping and fittings for refrigerant vapor (suction) lines shall be insulated with insulation having a thermal resistivity of not less than ~~R-4~~ R-3 and having external surface permeance not exceeding 0.05 perm [2.87 ng/(s • m^2 • Pa)] when tested in accordance with ASTM E 96. Insulation shall be protected in accordance with N1103.3.1.

M1411.7 Location and protection of refrigerant piping. Deleted.

~~Refrigerant piping installed within 1$^{1}/_{2}$ inches (38 mm) of the underside of roof decks shall be protected from damage caused by nails and other fasteners.~~

M1411.8 Locking access port caps. Deleted.
~~Refrigerant circuit access ports located outdoors shall be fitted with locking-type tamper-resistant caps or shall be otherwise secured to prevent unauthorized access.~~

SECTION M1412
ABSORPTION COOLING EQUIPMENT
Deleted

~~**M1412.1 Approval of equipment.**~~
~~Absorption systems shall be installed in accordance with the manufacturer's instructions. Absorption equipment shall comply with UL 1995 or UL/CSA/ANCE 60335-2-40.~~

~~**M1412.2 Condensate disposal.**~~
~~Condensate from the cooling coil shall be disposed of as provided in Section M1411.3.~~

~~**M1412.3 Insulation of piping.**~~
~~Refrigerant piping, brine piping and fittings within a building shall be insulated to prevent condensation from forming on piping.~~

~~**M1412.4 Pressure-relief protection.**~~
~~Absorption systems shall be protected by a pressure-relief device. Discharge from the pressure-relief device shall be located where it will not create a hazard to persons or property.~~

SECTION M1413
EVAPORATIVE COOLING EQUIPMENT
Deleted

~~**M1413.1 General.**~~
~~Evaporative cooling equipment and appliances shall comply with UL 1995 or UL/CSA/ANCE 60335-2-40 and shall be installed:~~

1. ~~In accordance with the manufacturer's instructions.~~
2. ~~On level platforms in accordance with Section M1305.1.4.1.~~
3. ~~So that openings in exterior walls are flashed in accordance with Section R703.4.~~
4. ~~So as to protect the potable water supply in accordance with Section P2902.~~
5. ~~So that air intake opening locations are in accordance with Section R303.5.1.~~

SECTION M1414

FIREPLACE STOVES

M1414.1 (905.1) General.

Fireplace stoves shall be *listed*, *labeled* and installed in accordance with the terms of the listing. Fireplace stoves shall be tested in accordance with UL 737. Fireplace inserts intended for installation in fireplaces shall be listed and labeled in accordance with the requirements of UL 1482 and shall be installed in accordance with the manufacturer's instructions.

M1414.2 (905.2) Connection to fireplace.

The connection of solid fuel appliances to *chimney* flues serving fireplaces shall comply with Sections M1803.4 and M1805.3.1.

~~M1414.2~~ M1414.3 (905.3) Hearth extensions.

Hearth extensions for fireplace stoves shall be installed in accordance with the *listing* of the fireplace stove. The supporting structure for a hearth extension for a fireplace stove shall be at the same level as the supporting structure for the fireplace unit. The hearth extension shall be readily distinguishable from the surrounding floor area.

SECTION M1416
FACTORY-BUILT FIREPLACES

M1416.1 (R1004.1) General.

Factory-built fireplaces shall be *listed* and *labeled* and shall be installed in accordance with the conditions of the *listing*. Factory-built fireplaces shall be tested in accordance with UL 127.

M1416.2 (R1004.2) Hearth extensions.

Hearth extensions of *approved* factory-built fireplaces shall be installed in accordance with the *listing* of the fireplace. The hearth extension shall be readily distinguishable from the surrounding floor area. Listed and labeled hearth extensions shall comply with UL 1618.

M1416.3 (R1004.3) Decorative shrouds.

Decorative shrouds shall not be installed at the termination of chimneys for factory-built fireplace system and installed in accordance with the manufacturer's instructions.

M1416.4 (R1004.4) Unvented gas log heaters.

An unvented gas log heater shall not be installed in a factory-built fireplace unless the fireplace system has been specifically tested, *listed* and *labeled* for such use in accordance with UL 127.

M1416.5 (R1004.5) Gasketed fireplace doors.

A gasketed fireplace door shall not be installed on a factory-built fireplace except where the fireplace system has been specifically tested, listed and labeled for such use in accordance with UL 127.

CHAPTER 15

EXHAUST SYSTEMS

The text of this chapter is extracted from the 2018 edition of the *North Carolina Mechanical Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code for One- and Two-Family Dwellings*. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Mechanical Code.*

SECTION M1501
GENERAL

M1501.1 (501.3) Outdoor discharge.

The air removed by every mechanical exhaust system shall be discharged to the outdoors in accordance with Section M1506.2. Air shall not be exhausted into an attic, soffit, ridge vent or crawl space. Exhaust shall not be directed onto walkways, balconies, decks, breezeways, covered walkways and similar horizontal projections.

Exceptions:

1. Whole-house *ventilation*-type *attic* fans that discharge into the *attic* space of *dwelling units* having private *attics* shall be permitted.
2. Where installed in accordance with the manufacturer's instructions and where mechanical or *natural ventilation* is otherwise provided in accordance with Sections M1507 or R303.1, listed and labeled domestic ductless range hoods shall not be required to discharge to the outdoors.

SECTION M1502
CLOTHES DRYER EXHAUST

M1502.3 (504.8.7) Duct termination.

Exhaust ducts shall terminate on the outside of the building. Exhaust duct terminations shall be in accordance with the dryer manufacturer's installation instructions. If the manufacturer's instructions do not specify a termination location, the exhaust duct shall terminate not less than 3 feet (914 mm) in any direction from openings into buildings. Exhaust duct terminations shall be equipped with a backdraft damper. Screens shall not be installed at the duct termination or weather cap outlet. Exhaust duct shall terminate not less than 12 inches (305 mm) above finished grade.

Exception: Where the duct termination is less than 12 inches (305 mm) above finished grade an areaway shall be provided with a cross-sectional area not less than 200 square inches (1290 cm^2). The bottom of the duct termination shall be no less than 12 inches (305 mm) above the areaway bottom.

M1502.4 (504.8) Dryer exhaust ducts.

Dryer exhaust ducts shall conform to the requirements of Sections M1502.4.1 through M1502.4.7.

M1502.4.1 Material and size.

Exhaust ducts shall have a smooth interior finish and be constructed of metal having a minimum thickness of 0.0157 inches (0.3950 mm) ~~(No. 28 gage)~~ (28 ga galv. 26 ga Al). With the exception of the transition duct, flexible ducts are prohibited. The duct shall be 4 inches (102 mm) nominal in diameter.

M1502.4.2 Duct installation.

Exhaust ducts shall be supported at intervals not to exceed 12 feet (3658 mm) and shall be secured in place. The insert end of the duct shall extend into the adjoining duct or fitting in the direction of airflow. Exhaust duct joints shall be sealed in accordance with Section M1601.4.1 and shall be mechanically fastened. ~~Ducts shall not be joined with screws or similar fasteners that protrude more than $^{1}/_{8}$ inch (3.2 mm) into the inside of the duct~~. Ducts shall not be joined with screws or similar fasteners that protrude into the inside of the duct. Ducts shall be sealed in accordance with M1601.4.1.

a. Nonmetallic mechanical fasteners (tie-straps) shall be listed to UL 181B.

b. Metal band duct clamps are not required to be listed.

M1502.4.3 (504.8.3) Transition duct.

Transition ducts used to connect the dryer to the exhaust *duct system* shall be a single length that is *listed* and *labeled* in accordance with UL 2158A. Transition ducts shall be not greater than 8 feet (2438 mm) in length. Transition ducts shall not be concealed within construction and must remain entirely within the room in which the appliance is located.

M1502.4.4 (504.8.4.3) Dryer exhaust duct power ventilators.

Domestic dryer exhaust duct power ventilators shall conform to UL 705 for use in dryer exhaust duct systems. The dryer exhaust duct power ventilator shall be installed in accordance with the manufacturer's instructions.

M1502.4.5 (504.8.4) Duct length.

The maximum allowable exhaust duct length shall be determined by one of the methods specified in Sections M1502.4.5.1 through M1502.4.5.3.

M1502.4.6 Length identification.

Where the exhaust duct equivalent length exceeds 35 feet (10 668 mm), the equivalent length of the exhaust duct shall be identified on a permanent label or tag. The label or tag shall be located within 6 feet (1829 mm) of the exhaust duct connection.

- Label shall be permanently stenciled, laminated, or commercially available plastic or metal tags.
- Labels shall state, at a minimum (fill in the blank):
  - Caution: Equivalent length ______ ft. Any installed dryer must be equipped with exhaust system that meets or exceeds this equivalent length requirement.
- Labels can be attached to wall or vent receptor.

M1502.4.7 (504.8.5) Exhaust duct required.
Where space for a clothes dryer is provided, an exhaust *duct system* shall be installed. ~~Where the clothes dryer is not installed at the time of occupancy the exhaust duct shall be capped or plugged in the space in which it originates and identified and marked “future use.”~~

> **Exception:** Where a *listed* condensing clothes dryer is installed prior to occupancy of the structure.

M1502.5 (504.7) Protection required.
Protective shield plates shall be placed where nails or screws from finish or other work are likely to penetrate the clothes dryer exhaust duct. Shield plates shall be placed on the finished face of framing members where there is less than $1^1/_4$ inches (32 mm) between the duct and the finished face of the framing member. Protective shield plates shall be constructed of steel, shall have a minimum thickness of 0.062-inch (1.6 mm) and shall extend not less than 2 inches (51 mm) above sole plates and below top plates.

SECTION M1503
RANGE HOODS

M1503.1 (505.1) General.
Range hoods shall discharge to the outdoors through a duct. The duct serving the hood shall have a smooth interior surface, shall be air tight, shall be equipped with a back-draft damper and shall be independent of all other exhaust systems. Ducts serving range hoods shall not terminate in an attic or crawl space or areas inside the building.

> **Exception:** Where installed in accordance with the manufacturer’s instructions, and where mechanical or natural *ventilation* is otherwise provided, *listed* and *labeled* ductless range hoods shall not be required to discharge to the outdoors.

M1503.2 (505.1) Duct material.
Ducts serving range hoods shall be constructed of galvanized steel, stainless steel or copper.

> **Exception:** Ducts for domestic kitchen cooking *appliances* equipped with down-draft exhaust systems shall be permitted to be constructed of schedule 40 PVC pipe and fittings provided that the installation complies with all of the following:

1. The duct is installed under a concrete slab poured on grade.
2. The underfloor trench in which the duct is installed is completely backfilled with sand or gravel.
3. The PVC duct extends not more than 1 inch (25 mm) above the indoor concrete floor surface.
4. The PVC duct extends not more than 1 inch (25 mm) above grade *outside of the building.*
5. The PVC ducts are solvent cemented.

M1503.3 Kitchen exhaust rates. Deleted.
~~Where domestic kitchen cooking *appliances* are equipped with ducted range hoods or down-draft exhaust systems, the fans shall be sized in accordance with Section M1507.4.~~

M1503.4 (505.2) Makeup air required.

~~Exhaust hood systems capable of exhausting in excess of 400 cubic feet per minute (0.19 m^3/s) shall be mechanically or naturally provided with makeup air at a rate approximately equal to the exhaust air rate. Such makeup air systems shall be equipped with not less than one damper. Each damper shall be a gravity damper or an electrically operated damper that automatically opens when the exhaust system operates. Dampers shall be accessible for inspection, service, repair and replacement without removing permanent construction or any other ducts not connected to the damper being inspected, serviced, repaired or replaced.~~
Exhaust hood systems capable of exhausting in excess of 400 cubic feet per minute (0.19 m^3/s) shall be provided with makeup air at a rate approximately equal to the exhaust air rate that is in excess of 400 cubic feet per minute (0.19 m^3/s). Such makeup air systems shall be equipped with a means of closure and shall be automatically controlled to start and operate simultaneously with the exhaust system. Dampers shall be accessible for inspection, service, repair and replacement without removing permanent construction or any other ducts not connected to the damper being inspected, serviced, repaired or replaced.

> **Exception:** Where all appliances in the house are direct-vent, power-vent, unvented, or electric, makeup air shall be provided where exhaust fans are capable of exhausting more than 600 cubic feet per minute (0.28 m^3/s). Exhaust hood systems capable of exhausting more than 600 cubic feet per minute (0.28 m^3/s) shall be provided with makeup air at a rate approximately equal to the exhaust air rate that is in excess of 600 cubic feet per minute (0.28 m^3/s).

SECTION M1504
INSTALLATION OF MICROWAVE OVENS

M1504.1 (917.3) Installation of a microwave oven over a cooking appliance.
The installation of a *listed* and *labeled* cooking *appliance* or microwave oven over a *listed* and *labeled* cooking *appliance* shall conform to the terms of the upper *appliance's listing* and *label* and the manufacturer's installation instructions. The microwave oven shall conform to UL 923.

SECTION M1506
EXHAUST DUCTS AND EXHAUST OPENINGS

M1506.2 Duct length.
~~The length of exhaust and supply ducts used with ventilating equipment shall not exceed the lengths determined in accordance with Table M1506.2~~. Exhaust duct length shall comply with the manufacturer's design criteria, standard duct airflow design methods, or where the flow rate of the installed ventilating equipment is verified by the installer or approved third party using a flow hood, flow grid or other airflow measuring device.

> ~~**Exception:** Duct length shall not be limited where the duct system complies with the manufacturer's design criteria or where the flow rate of the installed ventilating equipment is verified by the installer or approved third party using a flow hood, flow grid or other airflow measuring device.~~

~~TABLE M1506.2~~
~~DUCT LENGTH~~

~~DUCT TYPE~~	~~FLEX DUCT~~								~~SMOOTH-WALL DUCT~~							
~~Fan airflow rating (CFM @ 0.25 inch wc[a])~~	~~50~~	~~80~~	~~100~~	~~125~~	~~150~~	~~200~~	~~250~~	~~300~~	~~50~~	~~80~~	~~100~~	~~125~~	~~150~~	~~200~~	~~250~~	~~300~~
~~Diameter[b] (inches)~~	~~Maximum length[c, d, e] (feet)~~															
~~3~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~5~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~4~~	~~56~~	~~4~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~114~~	~~31~~	~~10~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~5~~	~~NL~~	~~81~~	~~42~~	~~16~~	~~2~~	~~X~~	~~X~~	~~X~~	~~NL~~	~~152~~	~~91~~	~~51~~	~~28~~	~~4~~	~~X~~	~~X~~
~~6~~	~~NL~~	~~NL~~	~~158~~	~~91~~	~~55~~	~~18~~	~~1~~	~~X~~	~~NL~~	~~NL~~	~~NL~~	~~168~~	~~112~~	~~53~~	~~25~~	~~9~~
~~7~~	~~NL~~	~~NL~~	~~NL~~	~~NL~~	~~161~~	~~78~~	~~40~~	~~19~~	~~NL~~	~~NL~~	~~NL~~	~~NL~~	~~NL~~	~~148~~	~~88~~	~~54~~
~~8 and above~~	~~NL~~	~~NL~~	~~NL~~	~~NL~~	~~NL~~	~~189~~	~~111~~	~~69~~	~~NL~~	~~NL~~	~~NL~~	~~NL~~	~~NL~~	~~NL~~	~~198~~	~~133~~

~~For SI: 1 foot = 304.8 mm.~~

~~a. Fan airflow rating shall be in acordance with ANSI/AMCA 210-ANSI/ASHRAE 51.~~

~~b. For noncircular ducts, calculate the diameter as four times the cross-sectional area divided by the perimeter.~~

~~c. This table assumes that elbows are not used. Fifteen feet of allowable duct length shall be deducted for each elbow installed in the duct run.~~

~~d. NL = no limit on duct length of this size.~~

~~e. X = not allowed. Any length of duct of this size with assumed turns and fittings will exceed the rated pressure drop.~~

M1506.3 (501.3.1) Exhaust openings.
Air exhaust openings shall terminate not less than 3 feet (914 mm) from property lines; 3 feet (914 mm) from operable and nonoperable openings into the building and 10 feet (3048 mm) from mechanical air intakes except where the opening is located 3 feet (914 mm) above the air intake. Openings shall comply with Sections R303.5.2 and R303.6.

SECTION M1507
MECHANICAL VENTILATION

M1507.1 General.
Where local exhaust or whole-house mechanical ventilation is ~~provided~~ required, the equipment shall be designed in accordance with this section. Refer to Section R303.1 for natural ventilation.

M1507.3.3 (403.3.2) Mechanical ventilation rate.
The whole-house mechanical ventilation system shall provide outdoor air at a continuous rate of not less than that determined in accordance with Table M1507.3.3(1).

Exception: The whole-house mechanical ventilation system is permitted to operate intermittently where the system has controls that enable operation for not less than 25-

percent of each 4-hour segment and the ventilation rate prescribed in Table M1507.3.3(1) is multiplied by the factor determined in accordance with Table M1507.3.3(2).

SECTION M1508 (512)
SUBSLAB SOIL EXHAUST SYSTEMS

M1508.1 (512.1) General.
Where a subslab soil exhaust system is provided, the system shall conform to the requirements of this section.

M1508.2 (512.2) Materials.
Subslab soil exhaust system duct material shall be air duct material *listed* and *labeled* to the requirements of UL 181 for Class 0 air ducts, or any of the following piping materials that comply with the *International Plumbing Code* as building sanitary drainage and vent pipe: cast iron; galvanized steel; brass or copper pipe; copper tube of a weight not less than that of copper drainage tube, Type DWV; and plastic piping.

M15083 (512.3) Grade.
Exhaust system ducts shall not be trapped and shall have a minimum slope of one-eighth unit vertical in 12 units horizontal (1-percent slope).

M1508.4 (512.4) Termination.
Subslab soil exhaust system ducts shall extend through the roof and terminate not less than 6 inches (152 mm) above the roof and not less than 10 feet (3048 mm) from any operable openings or air intake.

M1508.5 (512.5) Identification.
Subslab soil exhaust ducts shall be permanently identified within each floor level by means of a tag, stencil or other *approved* marking.

CHAPTER 16

DUCT SYSTEMS

The text of this chapter is extracted from the 2018 edition of the *North Carolina Mechanical Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code for One- and Two-Family Dwellings*. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Mechanical Code.*

SECTION M1601
DUCT CONSTRUCTION

M1601.1 (601.1) Duct design.
Duct systems serving heating, cooling and *ventilation equipment* shall be installed in accordance with the provisions of this section and ACCA Manual D, the appliance manufacturer's installation instructions or other *approved* methods.

TABLE M1601.1.1
DUCT CONSTRUCTION MINIMUM SHEET METAL THICKNESS FOR SINGLE DWELLING UNITS[a]

~~ROUND DUCT DIAMETER (inches)~~	~~STATIC PRESSURE~~			
	~~1/2 inch water gage~~		~~1 inch water gage~~	
	~~Thickness (inches)~~		~~Thickness (inches)~~	
	~~Galvanized~~	~~Aluminum~~	~~Galvanized~~	~~Aluminum~~
~~≤ 12~~	~~0.013~~	~~0.018~~	~~0.013~~	~~0.018~~
~~12 to 14~~	~~0.013~~	~~0.018~~	~~0.016~~	~~0.023~~
~~15 to 17~~	~~0.016~~	~~0.023~~	~~0.019~~	~~0.027~~
~~18~~	~~0.016~~	~~0.023~~	~~0.024~~	~~0.034~~
~~19 to 20~~	~~0.019~~	~~0.027~~	~~0.024~~	~~0.034~~
~~RECTANGULAR DUCT DIMENSION (inches)~~	~~STATIC PRESSURE~~			
	~~1/2 inch water gage~~		~~1 inch water gage~~	
	~~Thickness (inches)~~		~~Thickness (inches)~~	
	~~Galvanized~~	~~Aluminum~~	~~Galvanized~~	~~Aluminum~~
~~≤ 8~~	~~0.013~~	~~0.018~~	~~0.013~~	~~0.018~~
~~9 to 10~~	~~0.013~~	~~0.018~~	~~0.016~~	~~0.023~~
~~11 to 12~~	~~0.016~~	~~0.023~~	~~0.019~~	~~0.027~~
~~13 to 16~~	~~0.019~~	~~0.027~~	~~0.019~~	~~0.027~~
~~17 to 18~~	~~0.019~~	~~0.027~~	~~0.024~~	~~0.034~~
~~19 to 20~~	~~0.024~~	~~0.034~~	~~0.024~~	~~0.034~~

~~For SI: 1 inch = 25.4 mm, 1 inch water gage = 249 Pa.~~

~~a. Ductwork that exceeds 20 inches by dimension or exceeds a pressure of 1 inch water gage (250 Pa) shall be constructed in accordance with *SMACNA HVAC Duct Construction Standards—Metal and Flexible.*~~

DUCT SIZE	MINIMUM THICKNESS (inches)	EQUIVALENT GAGE (galvanized)	ALUMINUM MINIMUM THICKNESS (inches) [gage]

Round Ducts and Enclosed Rectangular Ducts			
14 inches or less	0.013	30	0.0159 [26]
Over 14 inches	0.016	28	0.0201 [24]
Exposed Rectangular Ducts			
14 inches or less	0.016	28	0.0201 [24]
Over 14 inches	0.019	26	0.0253 [22]

For SI: 1 inch = 25.4 mm

M1601.1.2 (603.8) Underground duct systems.

Underground *duct systems* shall be constructed of *approved* concrete, clay, metal or plastic. The maximum duct temperature for plastic ducts shall not be greater than 150°F (66°C). Metal ducts shall be protected from corrosion in an *approved* manner or shall be completely encased in concrete not less than 2 inches (51 mm) thick. Nonmetallic ducts shall be installed in accordance with the manufacturer's instructions. Plastic pipe and fitting materials shall conform to cell classification 12454-B of ASTM D 1248 or ASTM D 1784 and external loading properties of ASTM D 2412. Ducts shall slope to an accessible point for drainage. Where encased in concrete, ducts shall be sealed and secured prior to any concrete being poured. Metallic ducts having an *approved* protective coating and nonmetallic ducts shall be installed in accordance with the manufacturer's instructions.

M1601.2 ~~Vibration isolators.~~ Flexible connections.

~~Vibration isolators~~ Flexible connectors installed between mechanical *equipment* and metal ducts shall be fabricated from *approved* materials and shall not exceed 10 inches (254 mm) in length.

M1601.3 (604.4) Duct insulation materials.

Duct insulation materials shall conform to the following requirements:

1. Duct coverings and linings, including adhesives where used, shall have a flame spread index not higher than 25, and a smoke-developed index not over 50 when tested in accordance with ASTM E 84 or UL 723, using the specimen preparation and mounting procedures of ASTM E 2231.

   Exception: Spray application of polyurethane foam to the exterior of ducts in *attics* and crawl spaces shall be permitted subject to all of the following:

   1. The flame spread index is not greater than 25 and the smoke-developed index is not greater than 450 at the specified installed thickness.

   2. The foam plastic is protected in accordance with the ignition barrier requirements of Sections R316.5.3 and R316.5.4.

   3. The foam plastic complies with the requirements of Section R316.

2. Duct coverings and linings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C 411 at the temperature to which they are exposed in service. The test temperature shall not fall below 250°F (121°C). Coverings and linings shall be listed and labeled.

3. External reflective duct insulation shall be legibly printed or identified at intervals not greater than 36 inches (914 mm) with the name of the manufacturer, the product *R*-value at the specified installed thickness and the flame spread and smoke-developed indices. The installed thickness of the external duct insulation shall include the enclosed air space(s). The product *R*-value for external reflective duct insulation shall be determined in accordance with ASTM C1668.

4. External duct insulation and factory-insulated flexible ducts shall be legibly printed or identified at intervals not longer than 36 inches (914 mm) with the name of the manufacturer, the thermal resistance *R*-value at the specified installed thickness and the flame spread and smoke-developed indexes of the composite materials. Spray polyurethane foam manufacturers shall provide the same product information and properties, at the nominal installed thickness, to the customer in writing at the time of foam application. Nonreflective duct insulation product *R*-values shall be based on insulation only, excluding air films, vapor retarders or other duct components, and shall be based on tested C-values at 75°F (24°C) mean temperature at the installed thickness, in accordance with recognized industry procedures. The installed thickness of duct insulation used to determine its *R*-value shall be determined as follows:

    4.1. For duct board, duct liner and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.

    4.2. For ductwrap, the installed thickness shall be assumed to be 75 percent (25-percent compression) of nominal thickness.

    4.3. For factory-made flexible air ducts, The installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

    4.4. For spray polyurethane foam, the aged *R*-value per inch measured in accordance with recognized industry standards shall be provided to the customer in writing at the time of foam application. In addition, the total *R*-value for the nominal application thickness shall be provided.

M1601.4.1 Joints, seams and connections.
Longitudinal and transverse joints, seams and connections in metallic and nonmetallic ducts shall be constructed as specified in SMACNA HVAC *Duct Construction Standards—Metal and Flexible* and NAIMA *Fibrous Glass Duct Construction Standards*. Joints, longitudinal and transverse seams, and connections in ductwork shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, liquid sealants or tapes. Tapes and mastics used to seal fibrous glass ductwork shall be *listed* and *labeled* in accordance with UL 181A and shall be marked “181A-P” for pressure-sensitive tape, “181 A-M” for mastic or “181 A-H” for heat-sensitive tape.

Tapes and mastics used to seal metallic and flexible air ducts and flexible air connectors shall comply with UL 181B and shall be marked “181 B-FX” for pressure-sensitive tape or “181 BM” for mastic. Duct connections to flanges of air distribution system equipment shall be sealed and mechanically fastened. Mechanical fasteners for use with flexible nonmetallic air ducts shall comply with UL 181B and shall be marked 181B-C. Crimp joints for round metallic ducts shall have a contact lap of not less than 1 inch (25 mm) and shall be mechanically fastened by means of not less than three sheet-metal screws or rivets equally spaced around the joint. Unlisted duct tape is not permitted as a sealant on any metal ducts.

Closure systems used to seal all ductwork shall be installed in accordance with the manufacturers' instructions.

Exceptions:

1. Spray polyurethane foam shall be permitted to be applied without additional joint seals.
2. Where a duct connection is made that is partially inaccessible, three screws or rivets shall be equally spaced on the exposed portion of the joint so as to prevent a hinge effect.
3. ~~For ducts having a static pressure classification of less than 2 inches of water column (500 Pa), additional closure systems shall not be required for continuously welded joints and seams and locking-type joints and seams of other than the snap-lock and button-lock types.~~ Deleted.

   Exceptions:

   1. Continuously welded joints and seams in ducts.
   2. Ducts exposed within the conditioned space that the ducts serve shall not be required to be sealed.

M1601.4.2 Duct lap.
Crimp joints for round and oval metal ducts shall be lapped not less than 1 inch (25 mm) ~~and the male end of the duct shall extend into the adjoining duct in the direction of airflow~~.

M1601.4.4 Support.
Factory-made ducts listed in accordance with UL 181 shall be supported in accordance with the manufacturer's installation instructions. Field- and shop-fabricated fibrous glass ducts shall be supported in accordance with the SMACNA *Fibrous Glass Duct Construction Standards* or the NAIMA *Fibrous Glass Duct Construction Standards*. Field- and shop-fabricated metal and flexible ducts shall be supported in accordance with the SMACNA HVAC *Duct Construction Standards—Metal and Flexible* or in accordance with M1601.4.4.1.

All equipment shall be supported independently of the duct system except when the duct is used as a support base. When used as a support base, the duct shall be of sufficient strength and designed to support the weight of the unit. Listed bases shall be installed in accordance with the manufacturer's installation instructions.

M1601.4.4.1 (603.10.1) Metal duct minimal support.
Metal ducts shall be securely supported. Where hung or suspended, metal straps a minimum of 1 inch (25 mm) in width and equivalent to or heavier gage than the duct being supported shall be used. Straps, when used, shall be at maximum 64-inch (1626 mm) intervals and shall be securely attached to the building structure. Straps shall be attached to the duct at a minimum of two points with screws or rivets.

M1601.4.6 (604.1) Duct insulation.

Duct insulation shall be installed in accordance with the following requirements:

1. A vapor retarder having a maximum permeance of 0.05 perm [2.87 ng/(s · m^2 · Pa)] in accordance with ASTM E 96, or aluminum foil with a minimum thickness of 2 mils (0.05 mm), shall be installed on the exterior of insulation on cooling supply ducts that pass through unconditioned spaces conducive to condensation except where the insulation is spray polyurethane foam with a maximum water vapor permeance of 3 perm per inch [1722 ng/(s · m^2 · Pa)] at the installed thickness.
2. Exterior *duct systems* shall be protected against the elements.
3. Duct coverings shall not penetrate a fireblocked wall or floor.

Replacement or addition of cooling equipment to existing ductwork located in an attic shall require the ductwork to be insulated. Replacement of heating or the addition of cooling equipment in a crawl space or conditioned basements shall not require the existing ductwork to be insulated. Unconditioned basement ductwork shall require insulation with the addition of cooling.

M1601.4.8 (603.14) Duct separation.

Ducts shall be installed with not less than 4 inches (102 mm) separation from earth except where they meet the requirements of Section M1601.1.2.

SECTION M1602
RETURN AIR

M1602.2 Return air openings.

Return air openings for heating, ventilation and air conditioning systems shall comply with all of the following:

1. Openings shall not be located less than 10 feet (3048 mm) measured in any direction from an open combustion chamber or draft hood of another appliance located in the same room or space.
2. The amount of return air taken from any room or space shall be not greater than the flow rate of supply air delivered to such room or space.
3. Return and transfer openings shall be sized in accordance with the appliance or equipment manufacturers’ installation instructions, Manual D or the design of the registered design professional.
4. Return air shall not be taken from a closet, bathroom, toilet room, kitchen, garage, mechanical room, boiler room, furnace room or unconditioned attic.

   Exceptions:

1. Taking return air from a kitchen is not prohibited where such return air openings serve the kitchen only, and are located not less than 10 feet (3048 mm) from the cooking appliances.

2. Dedicated forced-air systems serving only the garage shall not be prohibited from obtaining return air from the garage.

3. ~~Taking return air from an unconditioned crawl space shall not be accomplished through a direct connection to the return side of a forced-air furnace. Transfer openings in the crawl space enclosure shall not be prohibited.~~ Deleted.

4. Return air from one dwelling unit shall not be discharged into another dwelling unit.

CHAPTER 17

COMBUSTION AIR

The text of this chapter is extracted from the 2018 edition of the *North Carolina Mechanical Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code for One- and Two-Family Dwellings*. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Mechanical Code.*

SECTION M1701
GENERAL

M1701.3 (701.2) Dampered openings.
Where combustion air openings are provided with volume dampers, the dampers shall be interlocked with the firing cycle of the appliances served, so as to prevent operation of any appliance that draws combustion air from the room or space when any of the dampers are closed. Manual dampers shall not be installed in combustion air ducts.

CHAPTER 18

CHIMNEYS AND VENTS

The text of this chapter is extracted from the 2018 edition of the *North Carolina Mechanical Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code for One- and Two-Family Dwellings*. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Mechanical Code.*

SECTION M1801
GENERAL

M1801.1 (801.1) Venting required.
Fuel-burning *appliances* shall be vented to the outdoors in accordance with their *listing* and *label* and manufacturer's installation instructions except *appliances* listed and *labeled* for unvented use. Venting systems shall consist of *approved* chimneys or vents, or venting assemblies that are integral parts of *labeled appliances*. Gas-fired *appliances* shall be vented in accordance with Chapter 24.

M1801.3.3 (801.13) Cleanout.
Masonry chimneys shall be provided with a cleanout opening complying with Section R1003.17.

M1801.3.4 (801.18.4) Clearances.
Chimneys and vents shall have airspace clearance to combustibles in accordance with this code and the chimney or vent manufacturer's installation instructions.

Exception: Masonry chimneys equipped with a chimney lining system tested and *listed* for installation in chimneys in contact with combustibles in accordance with UL 1777, and installed in accordance with the manufacturer's instructions, shall not be required to have a clearance between combustible materials and exterior surfaces of the masonry chimney. Noncombustible firestopping shall be provided in accordance with this code.

M1801.4 (801.17) Space around lining.
The space surrounding a flue lining system or other vent installed within a masonry chimney shall not be used to vent any other *appliance*. This shall not prevent the installation of a separate flue lining in accordance with the manufacturer's installation instructions and this code.

SECTION M1803
CHIMNEY AND VENT CONNECTORS

M1803.2 (803.9) Connectors for oil and solid fuel appliances.
Connectors for oil and solid fuel-burning *appliances* shall be constructed of factory-built chimney material, Type L vent material or single-wall metal pipe having resistance to corrosion and heat and thickness not less than that of galvanized steel as specified in Table M1803.2.

TABLE M1803.2 (803.9(1))

THICKNESS FOR SINGLE-WALL METAL PIPE CONNECTORS

DIAMETER OF CONNECTOR (inches)	GALVANIZED SHEET METAL GAGE NUMBER	MINIMUM THICKNESS (inch)
Less than 6	26	0.019
6 to 10	24	0.024
Over 10 through 16	22	0.029

For SI: 1 inch = 25.4 mm.

M1803.3 (803.10.5) Installation.
Vent and chimney connectors shall be installed in accordance with the manufacturer's instructions and within the space where the *appliance* is located. *Appliances* shall be located as close as practical to the vent or chimney. Connectors shall be as short and straight as possible and installed with a slope of not less than $^{1}/_{4}$ inch (6 mm) rise per foot of run. Connectors shall be securely supported and joints shall be fastened with sheet metal screws or rivets. Devices that obstruct the flow of flue gases shall not be installed in a connector unless *listed* and *labeled* or *approved* for such installations.

M1803.3.1 (803.10.4) Floor, ceiling and wall penetrations.
A chimney connector or vent connector shall not pass through any floor or ceiling. A chimney connector or vent connector shall not pass through a wall or partition unless the connector is *listed* and *labeled* for wall pass-through, or is routed through a device *listed* and *labeled* for wall pass-through and is installed in accordance with the conditions of its *listing* and *label*. Connectors for oil-fired *appliances listed* and *labeled* for Type L vents, passing through walls or partitions shall be in accordance with the following:

1. Type L vent material for oil *appliances* shall be installed with not less than *listed* and *labeled* clearances to combustible material.

2. Single-wall metal pipe shall be *guarded* by a ventilated metal thimble not less than 4 inches (102 mm) larger in diameter than the vent connector. A minimum 6 inches (152 mm) of clearance shall be maintained between the thimble and combustibles.

M1803.3.4 (803.10.6) Clearance.
Connectors shall be installed with clearance to combustibles as set forth in Table M1803.3.4 or Table M1803.3.5. Reduced clearances to combustible materials shall be in accordance with Table M1306.2 and Figure M1306.1.

TABLE M1803.3.5 (803.10.4)
CHIMNEY CONNECTOR SYSTEMS AND CLEARANCES TO COMBUSTIBLE WALL MATERIALS FOR DOMESTIC HEATING APPLIANCES[a, b, c, d]

System A (12-inch clearance)	A 3.5-inch-thick brick wall shall be framed into the combustible wall. An 0.625-inch-thick fire-clay liner (ASTM C 315 or equivalent)[e] shall be firmly cemented in the center of the brick wall maintaining a 12-inch clearance to combustibles. The clay liner shall run from the outer surface of the bricks to the inner surface of the chimney liner.

System B (9-inch clearance)	A labeled solid-insulated factory-built chimney section (1-inch insulation) the same inside diameter as the connector shall be utilized. Sheet steel supports cut to maintain a 9-inch clearance to combustibles shall be fastened to the wall surface and to the chimney section. Fasteners shall not penetrate the chimney flue liner. The chimney length shall be flush with the masonry chimney liner and sealed to the masonry with water-insoluble refractory cement. Chimney manufacturers' parts shall be utilized to securely fasten the chimney connector to the chimney section.
System C (6-inch clearance)	A steel ventilated thimble having a minimum thick- ness of 0.0236 inch (No. 24 gage) having two 1-inch air channels shall be installed with a steel chimney connector. Steel supports shall be cut to maintain a 6- inch clearance between the thimble and combustibles. The chimney connector and steel supports shall have a minimum thickness of 0.0236 inch (No. 24 gage). One side of the support shall be fastened to the wall on all sides. Glass-fiber insulation shall fill the 6-inch space between the thimble and the supports.
System D (2-inch clearance)	A labeled solid-insulated factory-built chimney section (1-inch insulation) with a diameter 2 inches larger than the chimney connector shall be installed with a steel chimney connector having a minimum thickness of 0.0236 inch (24 gage). Sheet steel supports shall be positioned to maintain a 2-inch clearance to combustibles and to hold the chimney connector to ensure that a 1-inch airspace surrounds the chimney connector through the chimney section. The steel support shall be fastened to the wall on all sides and the chimney section shall be fastened to the supports. Fasteners shall not penetrate the liner of the chimney section.

For SI: 1 inch = 25.4 mm, 1.0 Btu x in/ft^2 • h • °F = 0.144 W/m^2 • K.

a. Insulation material that is part of the wall pass-through system shall be noncombustible and shall have a thermal conductivity of 1.0 Btu x in/ft^2 • h • °F or less.

b. All clearances and thicknesses are minimums.

c. Materials utilized to seal penetrations for the connector shall be noncombustible.

d. Connectors for all systems except System B shall extend through the wall pass-through system to the inner face of the flue liner.

e. ASTM C 315.

SECTION M1804
VENTS

M1804.1.1 (801.20) Plastic vent joints.

Plastic pipe and fittings used to vent appliances shall be installed in accordance with the *appliance* manufacturer's installation instructions. Solvent cement joints between ABS pipe and fittings shall be cleaned. Solvent cement joints between CPVC pipe and fittings or PVC pipe and fittings shall be primed. The primer shall be a contrasting color, or an ultraviolet primer may be used.

M1804.2.6 Mechanical draft systems.

Mechanical draft systems shall comply with UL 378 and shall be installed in accordance with their *listing*, the manufacturer's instructions and, except for direct-vent *appliances*, the following requirements:

~~1. The vent terminal shall be located not less than 3 feet (914 mm) above a forced air inlet located within 10 feet (3048 mm).~~

2. ~~The vent terminal shall be located not less than 4 feet (1219 mm) below, 4 feet (1219 mm) horizontally from, or 1 foot (305 mm) above any door, window or gravity air inlet into a *dwelling*.~~

3. ~~The vent termination point shall be located not closer than 3 feet (914 mm) to an interior corner formed by two walls perpendicular to each other.~~

4. ~~The bottom of the vent terminal shall be located not less than 12 inches (305 mm) above finished ground level.~~

5. ~~The vent termination shall not be mounted directly above or within 3 feet (914 mm) horizontally of an oil tank vent or gas meter.~~

6. ~~Power exhauster terminations shall be located not less than 10 feet (3048 mm) from *lot lines* and adjacent buildings.~~

7. ~~The discharge shall be directed away from the building.~~

M1804.2.6.1 (804.3.4) Horizontal terminations.

Vertical terminations shall comply with the following requirements:

1. Where located adjacent to walkways, the termination of mechanical draft systems shall be not less than 7 feet (2134 mm) above the level of the walkway.

2. Vents shall terminate at least 3 feet (914 mm) above any forced air inlet located within 10 feet (3048 mm).

3. The vent system shall terminate at least 4 feet (1219 mm) below, 4 feet (1219 mm) horizontally from or 1 foot (305 mm) above any door, window or gravity air inlet into the building.

4. The vent termination point shall not be located closer than 3 feet (914 mm) to an interior corner formed by two walls perpendicular to each other.

5. The vent termination shall not be mounted directly above or within 3 feet (914 mm) horizontally from an oil tank vent or gas meter.

6. The bottom of the vent termination shall be located at least 12 inches (305 mm) above finished grade.

M1804.2.6.2 (804.3.5) Vertical terminations.

Vertical terminations shall comply with the following requirements:

1. Where located adjacent to walkways, the termination of mechanical draft systems shall be not less than 7 feet (2134 mm) above the level of the walkway.

2. Vents shall terminate not less than 3 feet (914 mm) above any forced air inlet located within 10 feet (3048 mm) horizontally.

3. Where the vent termination is located below an adjacent roof structure, the termination point shall be located not less than 3 feet (914 mm) from such structure.

4. The vent shall terminate not less than 4 feet (1219 mm) below, 4 feet (1219 mm) horizontally from or 1 foot (305 mm) above any door, window or gravity air inlet for the building.

5. A vent cap shall be installed to prevent rain from entering the vent system.

6. The vent termination shall be located not less than 3 feet (914 mm) horizontally from any portion of the roof structure.

M1804.2.6.3 (804.3.8) Mechanical draft systems for manually fired appliances and fireplaces.
A mechanical draft system shall be permitted to be used with manually fired appliances and fireplaces where such system complies with all of the following requirements:

1. The mechanical draft device shall be listed and labeled in accordance with UL 378, and shall be installed in accordance with the manufacturer's instructions.

2. A device shall be installed that produces visible and audible warning upon failure of the mechanical draft device or loss of electrical power, at any time that the mechanical draft device is turned on. This device shall be equipped with a battery backup if it receives power from the building wiring.

3. A smoke detector shall be installed in the room with the *appliance* or fireplace. This device shall be equipped with a battery backup if it receives power from the building wiring.

SECTION M1805
MASONRY AND FACTORY-BUILT CHIMNEYS

M1805.2 (803.10.3) Masonry chimney connection.
A chimney connector shall enter a masonry chimney not less than 6 inches (152 mm) above the bottom of the chimney. Where it is not possible to locate the connector entry at least 6 inches (152 mm) above the bottom of the chimney flue, a cleanout shall be provided by installing a capped tee in the connector next to the chimney. A connector entering a masonry chimney shall extend through, but not beyond, the wall and shall be flush with the inner face of the liner. Connectors, or thimbles where used, shall be firmly cemented into the masonry.

M1805.4 (805.6) Decorative shrouds.
Decorative shrouds shall not be installed at the termination of factory-built *chimneys* except where such shrouds are *listed* and *labeled* for use with the specific factory-built *chimney* system and are installed in accordance with manufacturer's installation instructions.

CHAPTER 19

SPECIAL APPLIANCES, EQUIPMENT AND SYSTEMS

The text of this chapter is extracted from the 2018 edition of the *North Carolina Mechanical Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code for One- and Two-Family Dwellings*. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Mechanical Code.*

SECTION M1901

RANGES AND OVENS

M1901.2 (917.2) Cooking appliances.
Cooking *appliances* shall be *listed* and *labeled* for household use and shall be installed in accordance with the manufacturer's instructions. The installation shall not interfere with *combustion air* or access for operation and servicing. Electric cooking appliances shall comply with UL 1026 or UL 858. Solid-fuel-fired fireplace stoves shall comply with UL 737.

M1901.3 (917.3) Installation of microwave oven over a cooking appliance.
The installation of a listed and labeled cooking appliance or microwave oven over a listed and labeled cooking appliance shall conform to the terms of the upper appliance's listing and label and the manufacturer's installation instructions.

SECTION M1902
SAUNA HEATERS

M1902.1 (914.1) Locations and protection.
Sauna heaters shall be protected from accidental contact by persons with a guard of material having a low thermal conductivity, such as wood. The guard shall not have a substantial effect on the transfer of heat from the heater to the room.

M1902.2 (914.2) Installation.
Sauna heaters shall be installed in accordance with the manufacturer's instructions. Sauna heaters shall comply with UL 875.

M1902.5 (914.5) Sauna room.
A ventilation opening into the sauna room shall be provided as required by the manufacturer.

SECTION M1903
STATIONARY FUEL CELL POWER PLANTS

M1903.1 (924.1) General.
Stationary fuel cell power plants having a power output not exceeding 1,000 kW, shall comply with ANSI/CSA America FC 1 and shall be installed in accordance with the manufacturer's instructions and NFPA 853.

SECTION M1904
GASEOUS HYDROGEN SYSTEMS

M1904.1 (926.1) Installation.
Gaseous hydrogen systems shall be installed in accordance with the applicable requirements of Sections M1307.4 and M1903.1 and the *International Fuel Gas Code*, the *International Fire Code* and the *International Building Code*.

CHAPTER 20

BOILERS AND WATER HEATERS

The text of this chapter is extracted from the 2018 edition of the *North Carolina Mechanical Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code for One- and Two-Family Dwellings*. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Mechanical Code.*

SECTION M2002
OPERATING AND SAFETY CONTROLS

M2002.1 (1006.4) Safety controls.

Electrical and mechanical operating and safety controls for boilers shall be *listed* and *labeled*.

M2002.2 (1010.1) Hot water boiler gauges.

Every hot water boiler shall have a pressure gauge and a temperature gauge, or combination pressure and temperature gauge. The gauges shall indicate the temperature and pressure within the normal range of the system's operation.

M2002.3 (1010.2) Steam boiler gauges.

Every steam boiler shall have a water-gauge glass and a pressure gauge. The pressure gauge shall indicate the pressure within the normal range of the system's operation. The gauge glass shall be installed so that the midpoint is at the normal water level.

M2002.5 (1007.1) Boiler low-water cutoff.

Steam and hot water boilers shall be protected with a low-water cutoff control.

> **Exception:** A low-water cutoff is not required for coil-type and water-tube type boilers that require forced circulation of water through the boiler and that are protected with a flow sensing control.

SECTION M2004
WATER HEATERS USED FOR SPACE HEATING

M2004.1 General.

Water heaters used to supply both potable hot water and hot water for space heating shall be installed in accordance with this chapter, Chapter 24, Chapter 28 and the manufacturer's instructions. Water heaters utilized both to supply potable hot water and provide hot water for space-heating applications shall be *listed* and *labeled* for such applications by the manufacturer and shall be installed in accordance with the manufacturer's instructions and the *International Plumbing Code*.

M2004.1.1 (1002.2.1) Sizing.

Water heaters utilized for both potable water heating and space-heating applications shall be sized to prevent the space-heating load from diminishing the required potable water-heating capacity.

M2004.1.2 (1002.2.2) Temperature limitation.
Where a combination potable water-heating and space-heating system requires water for space heating at temperatures higher than 140°F (60°C), a temperature-actuated mixing valve that conforms to ASSE 1017 shall be provided to temper the water supplied to the potable hot water distribution system to a temperature of 140°F (60°C) or less.

M2004.2 (1002.3) Supplemental water-heating devices.
Potable waterheating devices that utilize refrigerant-to-water heat exchangers shall be *approved* and installed in accordance with the *International Plumbing Code* and the manufacturer's instructions.

SECTION M2005
WATER HEATERS

M2005.1 (1002.1) General.
Water heaters shall be installed in accordance with Chapter 28, the manufacturer's instructions and the requirements of this code. Water heaters installed in an attic shall comply with the requirements of Section M1305.1.3. Gas-fired water heaters shall comply with the requirements in Chapter 24. Domestic electric water heaters shall comply with UL 174. Oiled-fired water heaters shall comply with UL 732. Thermal solar water heaters shall comply with Chapter 23 and UL 174. Solid fuel-fired water heaters shall comply with UL 2523.

M2005.2 Prohibited locations.
Fuel-fired water heaters shall not be installed in a room used as a storage closet. Water heaters located in a room or space accessed only through a bedroom or bathroom shall be installed in ~~a sealed enclosure so that *combustion air* will not be taken from the living space~~ accordance with Section G2406.2. Installation of direct-vent water heaters within an enclosure is not required.

M2005.2.1 Water heater access.
Access to water heaters that are located in an *attic* or underfloor crawl space is permitted to be through a closet located in a sleeping room or bathroom where *ventilation* of those spaces is in accordance with this code and the requirements of Section G2406.2.

M2005.3 Electric water heaters.
Electric water heaters shall also be installed in accordance with the applicable provisions of ~~Chapters 34 through 43~~ the *North Carolina Electrical Code*.

M2005.4 (1002.3) Supplemental water-heating devices.
Potable water heating devices that use refrigerant-to-water heat exchangers shall be *approved* and installed in accordance with the manufacturer's instructions.

SECTION M2006
POOL HEATERS

M2006.1 (916.1) General.
Pool and spa heaters shall be installed in accordance with the manufacturer's installation instructions. Oil-fired pool heaters shall comply with UL 726. Electric pool and spa heaters shall comply with UL 1261.

CHAPTER 21

HYDRONIC PIPING

The text of this chapter is extracted from the 2018 edition of the *North Carolina Mechanical Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code for One- and Two-Family Dwellings*. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Mechanical Code.*

SECTION M2101
HYDRONIC PIPING SYSTEMS INSTALLATION

TABLE M2101.1 (1202.4)
HYDRONIC PIPING MATERIALS

MATERIAL	USE CODE[a]	STANDARD[b]	JOINTS	NOTES
Acrylonitrile butadiene styrene (ABS) plastic pipe	1, 5	ASTM D 1527; ASTM F 2806; ASTM F 2969	Solvent cement joints	
Brass pipe	1	ASTM B 43	Brazed, welded, threaded, mechanical and flanged fittings	
Brass tubing	1	ASTM B 135	Brazed, soldered and mechanical fittings	
Chlorinated poly (vinyl chloride) (CPVC) pipe and tubing	1, 2, 3	ASTM D 2846	Solvent cement joints, compression joints and threaded adapters	
Copper pipe	1	ASTM B 42, B 302	Brazed, soldered and mechanical fittings threaded, welded and flanged	
Copper tubing (type K, L or M)	1, 2	ASTM B 75, B 88, B 251, B 306	Brazed, soldered and flared mechanical fittings	Joints embedded in concrete
Cross-linked polyethylene (PEX)	1, 2, 3	ASTM F 876, F 877	(See PEX fittings)	Install in accordance with manufacturer's instructions
Cross-linked polyethylene/ aluminum/cross-linked polyethylene-(PEX-AL-PEX) pressure pipe	1, 2	ASTM F 1281 or CAN/ CSA B137.10	Mechanical, crimp/insert	Install in accordance with manufacturer's instructions

PEX fittings		ASTM F 877 ASTM F 1807 ASTM F 1960 ASTM F 2098 ASTM F 2159 ASTM F 2735	Copper-crimp/insert fittings, cold expansion fittings, stainless steel clamp, insert fittings	Install in accordance with manufacturer’s instructions
Polybutylene (PB) pipe and tubing	1, 2, 3	ASTM D 3309	Heat-fusion, crimp/insert and compression	Joints in concrete shall be heat-fused
Polyethylene/aluminum/polyethylene (PE-AL-PE) pressure pipe	1, 2, 3	ASTM F 1282 CSA B 137.9	Mechanical, crimp/insert	
Polypropylene (PP)	1, 2, 3	ISO 15874 ASTM F 2389	Heat-fusion joints, mechanical fittings, threaded adapters, compression joints	
Raised temperature polyethylene (PE-RT)	1, 2, 3	ASTM F 2623 ASTM F 2769	Copper crimp/insert fitting stainless steel clamp, insert fittings	
Raised Temperature Polyethylene (PE-RT) fittings	1, 2,3	ASTM F 1807 ASTM F 2159 ASTM F 2735 ASTM F 2769 ASTM F 2098	Copper crimp/insert fitting stainless steel clamp, insert fittings	
Steel pipe	1, 2	ASTM A 53, A 106	Brazed, welded, threaded, flanged and mechanical fittings	Joints in concrete shall be welded. Galvanized pipe shall not be welded or brazed.
Steel tubing	1	ASTM A 254	Mechanical fittings, welded	

For SI: °C = [(°F)-32]/1.8.

a. Use code:
   1. Above ground.
   2. Embedded in radiant systems.
   3. Temperatures below 180°F only.
   4. Low temperature (below 130°F) applications only.
   5. Temperatures below 160°F only.

b. Standards as listed in Chapter 44.

M2101.2 (1206.2) System drain down.

Hydronic piping systems shall be installed to permit draining of the system. Where the system drains to the plumbing drainage system, the installation shall conform to the requirements of Chapters 25 through 32 of this code.

Exception: The buried portions of systems embedded underground or under floors.

M2101.3 (1206.3) Protection of potable water.

The potable water system shall be protected from backflow in accordance with the provisions listed in Section P2902.

M2101.4 (1206.4) Pipe penetrations.

Openings through concrete or masonry building elements shall be sleeved.

M2101.5 (1206.6) Contact with building material.

A hydronic piping system shall not be in direct contact with any building material that causes the piping material to degrade or corrode.

M2101.9 (305.4) Piping support.

Hangers and supports shall be of material of sufficient strength to support the piping, and shall be fabricated from materials compatible with the piping material. Piping shall be supported at intervals not exceeding the spacing specified in Table M2101.9.

M2101.10.1 (1201.4) Test gauges.

Gauges used for testing shall be as follows:

1. Tests requiring a pressure of 10 pounds per square inch (psi) (69 kPa) or less shall utilize a testing gauge having increments of 0.10 psi (0.69 kPa) or less.
2. Tests requiring a pressure of greater than 10 psi (69 kPa) but less than or equal to 100 psi (689 kPa) shall utilize a testing gauge having increments of 1 psi (6.9 kPa) or less.
3. Tests requiring a pressure of greater than 100 psi (689 kPa) shall utilize a testing gauge having increments of 2 psi (14 kPa) or less.

M2101.10.2 (1209.2) Pressurizing during installation.

Piping to be embedded in concrete shall be pressure tested prior to pouring concrete. During pouring, the pipe shall be maintained at the proposed operating pressure.

M2101.11 (1206.11) Condensation.

Provisions shall be made to prevent the formation of condensation on the exterior of hydronic piping.

M2101.12 (1206.4) Pipe penetrations.

Openings for pipe penetrations in walls, floors or ceilings shall be larger than the penetrating pipe. Openings through concrete or masonry building elements shall be sleeved. The annular space surrounding pipe penetrations shall be protected in accordance with the *International Building Code*.

M2101.13 (1206.5) Clearance to combustibles.

A pipe in a hydronic piping system in which the exterior temperature exceeds 250°F (121°C) shall have a minimum *clearance* of 1 inch (25 mm) to combustible materials.

M2101.14 (1206.6) Contact with building material.

A hydronic piping system shall not be in direct contact with building materials that cause the piping material to degrade or corrode, or that interfere with the operation of the system.

M2101.15 (1206.7) Water hammer.
The flow velocity of the hydronic piping system shall be controlled to reduce the possibility of water hammer. Where a quick-closing valve creates water hammer, an *approved* water-hammer arrestor shall be installed. The arrestor shall be located within a range as specified by the manufacturer of the quick-closing valve.

M2101.16 (1206.8) Steam piping pitch.
Steam piping shall be installed to drain to the boiler or the steam trap. Steam systems shall not have drip pockets that reduce the capacity of the steam piping.

M2101.17 (1206.9) Strains and stresses.
Piping shall be installed so as to prevent detrimental strains and stresses in the pipe. Provisions shall be made to protect piping from damage resulting from expansion, contraction and structural settlement. Piping shall be installed so as to avoid structural stresses or strains within building components.

M2101.17.1 (1206.9.1) Flood hazard.
Piping located in a flood hazard area shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the *design flood elevation*.

SECTION M2102
~~BASEBOARD CONVECTORS~~
JOINTS AND CONNECTIONS

~~**M2102.1 General.**~~
~~Baseboard convectors shall be installed in accordance with the manufacturer's instructions. Convectors shall be supported independently of the hydronic piping.~~

M2102.1 (1203.3) Joint preparation and installation.
Joints and connections shall be of an *approved* type. Joints and connections shall be tight for the pressure of the hydronic system. Joints between different piping materials shall be made with *approved* adapter fittings. Pipe shall be cut square, reamed and chamfered, and shall be free of burrs and obstructions. Pipe ends shall have full-bore openings and shall not be undercut.

Where required by Sections M2102.2 through M2102.12, the preparation and installation of brazed, mechanical, soldered, solventcemented, threaded and welded joints shall comply with Sections M2102.1.1 through M2102.1.8.

M2102.1.1 (1203.3.1) Brazed joints.
Joint surfaces shall be cleaned. An *approved* flux shall be applied where required. The joint shall be brazed with a filler metal conforming to AWS A5.8.

M2102.1.2 (1203.3.2) Mechanical joints.
Mechanical joints shall be installed in accordance with the manufacturer's instructions.

M2102.1.3 (1203.3.3) Soldered joints.
Joint surfaces shall be cleaned. A flux conforming to ASTM B 813 shall be applied. The joint shall be soldered with a solder conforming to ASTM B 32.

M2102.1.4 (1203.3.4) Solvent-cemented joints.

Joint surfaces shall be clean and free of moisture. An *approved* primer shall be applied to CPVC and PVC pipe-joint surfaces. Joints shall be made while the cement is wet. Solvent cement conforming to the following standards shall be applied to all joint surfaces:

1. ASTM D 2235 for ABS joints.
2. ASTM F 493 for CPVC joints.
3. ASTM D 2564 for PVC joints.

CPVC joints shall be made in accordance with ASTM D 2846.

Exception: For CPVC pipe joint connections, a primer is not required where all of the following conditions apply:

1. The solvent cement used is third-party certified as conforming to ASTM F 493.
2. The solvent cement is yellow in color.
3. The solvent cement is used only for joining 1/2-inch (12.7 mm) through 2-inch (51 mm) diameter CPVC pipe and fittings.
4. The CPVC pipe and fittings are manufactured in accordance with ASTM D 2846.

M2102.1.5 (1203.3.5) Threaded joints.

Threads shall conform to ASME B1.20.1. Schedule 80 or heavier plastic pipe shall be threaded with dies specifically designed for plastic pipe. Thread lubricant, pipe-joint compound or tape shall be applied on the male threads only and shall be *approved* for application on the piping material.

M2102.1.6 (1203.3.6) Welded joints.

Joint surfaces shall be cleaned by an *approved* procedure. Joints shall be welded with an *approved* filler metal.

M2102.1.7 (1203.3.7) Grooved and shouldered mechanical joints.

Grooved and shouldered mechanical joints shall conform to the requirements of ASTM F 1476 and shall be installed in accordance with the manufacturer's instructions.

M2102.1.8 (1203.3.8) Mechanically formed tee fittings.

Mechanically extracted outlets shall have a height not less than three times the thickness of the branch tube wall.

M2102.1.8.1 (1203.3.8.1) Full flow assurance.

Branch tubes shall not restrict the flow in the run tube. A dimple/depth stop shall be formed in the branch tube to ensure that penetration into the outlet is of the correct depth. For inspection purposes, a second dimple shall be placed 1/4 inch (6.4 mm) above the first dimple. Dimples shall be aligned with the tube run.

M2102.1.8.2 (1203.3.8.2) Brazed joints.

Mechanically formed tee fittings shall be brazed in accordance with Section M2102.1.1.

M2102.2 (1203.4) ABS plastic pipe.

Joints between ABS plastic pipe or fittings shall be solvent-cemented or threaded joints conforming to Section M2102.1.

M2102.3 (1203.5) Brass pipe.

Joints between brass pipe or fittings shall be brazed, mechanical, threaded or welded joints conforming to Section M2102.1.

M2102.4 (1203.6) Brass tubing.

Joints between brass tubing or fittings shall be brazed, mechanical or soldered joints conforming to Section M2102.1.

M2102.5 (1203.7) Copper or copper-alloy pipe.

Joints between copper or copper-alloy pipe or fittings shall be brazed, mechanical, soldered, threaded or welded joints conforming to Section M2102.1.

M2102.6 (1203.8) Copper or copper-alloy tubing.

Joints between copper or copper-alloy tubing or fittings shall be brazed, mechanical or soldered joints conforming to Section M2102.1, flared joints conforming to Section M2102.6.1, push-fit joints conforming to Section M2102.6.2 or press-type joints conforming to Section M2102.6.3.

M2102.6.1 (1203.8.1) Flared joints.

Flared joints shall be made by a tool designed for that operation.

M2102.6.2 (1203.8.2) Push-fit joints.

Push-fit joints shall be installed in accordance with the manufacturer’s instructions.

M2102.6.3 (1203.8.3) Press joints.

Press joints shall be installed in accordance with the manufacturer’s instructions.

M2102.7 (1203.9) CPVC plastic pipe.

Joints between CPVC plastic pipe or fittings shall be solvent-cemented or threaded joints conforming to Section M2102.1.

M2102.8 (1203.10) Polybutylene plastic pipe and tubing.

Joints between polybutylene plastic pipe and tubing or fittings shall be mechanical joints conforming to Section M2102.1 or heatfusion joints conforming to Section M2102.8.1.

M2102.8.1 (1203.10.1) Heat-fusion joints.

Joints shall be of the socket-fusion or butt-fusion type. Joint surfaces shall be clean and free of moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall be undisturbed until cool. Joints shall be made in accordance with ASTM D 3309.

M2102.9 (1203.11) Cross-linked polyethylene (PEX) plastic tubing.

Joints between cross-linked polyethylene plastic tubing and fittings shall conform to Sections M2102.9.1 and M2102.9.2 Mechanical joints shall conform to Section M2102.1.

M2102.9.1 (1203.11.1) Compression-type fittings.

Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

M2102.9.2 (1203.11.2) Plastic-to-metal connections.

Soldering on the metal portion of the system shall be performed not less than 18 inches (457 mm) from a plastic-to-metal adapter in the same water line.

M2102.10 (1203.12) PVC plastic pipe.

Joints between PVC plastic pipe and fittings shall be solvent-cemented or threaded joints conforming to Section M2102.1.

M2102.11 (1203.13) Steel pipe.

Joints between steel pipe or fittings shall be mechanical joints that are made with an *approved* elastomeric seal, or shall be threaded or welded joints conforming to Section M2102.1.

M2102.12 (1203.14) Steel tubing.

Joints between steel tubing or fittings shall be mechanical or welded joints conforming to Section M2102.1.

M2102.13 (1203.15) Polypropylene (PP) plastic.

Joints between PP plastic pipe and fittings shall comply with Sections M2102.13.1 and M2102.13.2.

M2102.13.1 (1203.15.1) Heat-fusion joints.

Heat-fusion joints for polypropylene (PP) pipe and tubing joints shall be installed with socket-type heat-fused polypropylene fittings, electro-fusion polypropylene fittings or by butt fusion. Joint surfaces shall be clean and free from moisture. The joint shall be undisturbed until cool. Joints shall be made in accordance with ASTM F 2389.

M2102.13.2 (1203.15.2) Mechanical and compression sleeve joints.

Mechanical and compression sleeve joints shall be installed in accordance with the manufacturer’s instructions.

M2102.14 (1203.16) Raised temperature polyethylene (PE-RT) plastic tubing.

Joints between raised temperature polyethylene tubing and fittings shall conform to Sections M2102.14.1 and M2102.14.2. Mechanical joints shall conform to Section M2102.1.

M2102.14.1 (1203.16.1) Compression-type fittings.

Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

M2102.14.2 (1203.16.2) PE-RT-to-metal connections.

Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to PE-RT pipe.

M2102.15 (1203.17) Polyethylene/aluminum/polyethylene (PE-ALPE) pressure pipe.

Joints between polyethylene/aluminum/ polyethylene pressure pipe and fittings shall conform to Sections M2102.15.1 and M2102.15.2. Mechanical joints shall comply with Section M2102.1.

M2102.15.1 (1203.17.1) Compression-type fittings.

Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

M2102.15.2 (1203.17.2) PE-AL-PE-to-metal connections.
Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to PE-AL-PE pipe.

M2102.16 (1203.18) Cross-linked polyethylene/aluminum/crosslinked polyethylene (PEX-AL-PEX) pressure pipe.
Joints between cross-linked polyethylene/aluminum/cross-linked polyethylene pressure pipe and fittings shall conform to Sections M2102.16.1 and M2102.16.2. Mechanical joints shall comply with Section M2102.1.

M2102.16.1 (1203.18.1) Compression-type fittings.
Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

M2102.16.2 (1203.18.2) PEX-AL-PEX-to-metal connections.
Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to PEX-AL-PEX pipe.

SECTION M2103
FLOOR HEATING SYSTEMS

M2103.3 Piping joints. Deleted.
~~Copper and copper alloy systems shall be soldered in accordance with ASTM B 828. Fluxes for soldering shall be in accordance with ASTM B 813. Brazing fluxes shall be in accordance with AWS A5.31. Piping joints that are embedded shall be installed in accordance with the following requirements:~~

1. ~~Steel pipe joints shall be welded.~~
2. ~~Copper tubing shall be joined by brazing complying with Section P3003.6.1.~~
3. ~~Polybutylene pipe and tubing joints shall be installed with socket-type heat-fused polybutylene fittings.~~
4. ~~CPVC tubing shall be joined using solvent cement joints.~~
5. ~~Polypropylene pipe and tubing joints shall be installed with socket-type heat-fused polypropylene fittings.~~
6. ~~Cross-linked polyethylene (PEX) tubing shall be joined using cold expansion, insert or compression fittings.~~
7. ~~Raised temperature polyethylene (PE-RT) tubing shall be joined using insert or compression fittings.~~

M2103.4 Testing. Deleted.
~~Piping or tubing to be embedded shall be tested by applying a hydrostatic pressure of not less~~

~~than 100 psi (690 kPa). The pressure shall be maintained for 30 minutes, during which, the joints shall be visually inspected for leaks.~~

SECTION M2105
GROUND-SOURCE HEAT-PUMP SYSTEM LOOP PIPING

M2105.1 (1210.1) Plastic ground-source heat-pump loop piping.
Plastic piping and tubing material used in water-based ground-source heat-pump ground-loop systems shall conform to the standards specified in this section.

M2105.2 (1210.2) Used materials.
Reused pipe, fittings, valves, and other materials shall not be used in ground-source heat-pump loop systems.

M2105.3 (1210.3) Material rating.
Pipe and tubing shall be rated for the operating temperature and pressure of the ground-source heat-pump loop system. Fittings shall be suitable for the pressure applications and recommended by the manufacturer for installation with the pipe and tubing material installed. Where used underground, materials shall be suitable for burial.

M2105.4 (1210.4) Piping and tubing materials standards.
Ground-source heat-pump ground-loop pipe and tubing shall conform to the standards listed in Table M2105.4.

M2105.5 (1210.5) Fittings.
Ground-source heat-pump pipe fittings shall be approved for installation with the piping materials to be installed, shall conform to the standards listed in Table M2105.5 and, where installed underground, shall be suitable for burial.

M2105.6 (1210.6) Joints and connections.
Joints and connections shall be of an approved type. Joints and connections shall be tight for the pressure of the ground-source loop system. Joints used underground shall be approved for such applications.

M2105.6.1 (1210.6.1) Joints between different piping materials.
Joints between different piping materials shall be made with approved transition fittings.

M2105.7 (1210.6.2) Preparation of pipe ends.
Pipe shall be cut square, reamed, and shall be free of burrs and obstructions. CPVC, PE and PVC pipe shall be chamfered. Pipe ends shall have full-bore openings and shall not be undercut.

M2105.8 (1210.6.3) Joint preparation and installation.
Where required by Sections M2105.9 through M2105.11, the preparation and installation of mechanical and thermoplastic-welded joints shall comply with Sections M2105.8.1 and M2015.8.2.

M2105.8.1 (1210.6.3.1) Mechanical joints.
Mechanical joints shall be installed in accordance with the manufacturer’s instructions.

M2105.8.2 (1210.6.3.2) Thermoplastic-welded joints.

Joint surfaces for thermoplastic-welded joints shall be cleaned by an approved procedure. Joints shall be welded in accordance with the manufacturer's instructions.

M2105.9 (1210.6.4) CPVC plastic pipe.

Joints between CPVC plastic pipe or fittings shall be solvent-cemented in accordance with Section P2906.9.1.2. Threaded joints between fittings and CPVC plastic pipe shall be in accordance with Section M2105.9.1.

M2105.10 (1210.6.5) Cross-linked polyethylene (PEX) plastic tubing.

Joints between cross-linked polyethylene plastic tubing and fittings shall comply with Sections M2105.10.1 and M2105.10.2. Mechanical joints shall comply with Section M2105.8.1.

M2105.10.1 (1210.6.5.1) Compression-type fittings.

Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

M2105.10.2 (1210.6.5.2) Plastic-to-metal connections.

Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to plastic pipe or tubing.

M2105.11 (1210.6.6) Polyethylene plastic pipe and tubing.

Joints between polyethylene plastic pipe and tubing or fittings for ground-source heat-pump loop systems shall be heat-fusion joints complying with Section M2105.11.1, electrofusion joints complying with Section M2105.11.2, or stab-type insertion joints complying with Section M2105.11.3.

M2105.11.1 (1210.6.6.1) Heat-fusion joints.

Joints shall be of the socket-fusion, saddle-fusion or butt-fusion type, and joined in accordance with ASTM D 2657. Joint surfaces shall be clean and free of moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall be undisturbed until cool. Fittings shall be manufactured in accordance with ASTM D 2683 or ASTM D 3261.

M2105.11.2 (1210.6.6.1) Electrofusion joints.

Joints shall be of the electrofusion type. Joint surfaces shall be clean and free of moisture, and scoured to expose virgin resin. Joint surfaces shall be heated to melt temperatures for the period of time specified by the manufacturer. The joint shall be undisturbed until cool. Fittings shall be manufactured in accordance with ASTM F 1055.

M2105.11.3 (1210.6.6.3) Stab-type insert fittings.

Joint surfaces shall be clean and free of moisture. Pipe ends shall be chamfered and inserted into the fittings to full depth. Fittings shall be manufactured in accordance with ASTM F 1924.

M2105.12 (1210.6.7) Polypropylene (PP) plastic.

Joints between PP plastic pipe and fittings shall comply with Sections M2105.12.1 and M2105.12.2.

M2105.12.1 (1210.6.7.1) Heat-fusion joints.

Heat-fusion joints for polypropylene (PP) pipe and tubing joints shall be installed with socket-type heat-fused polypropylene fittings, electrofusion polypropylene fittings or by butt fusion. Joint surfaces shall be clean and free from moisture. The joint shall be undisturbed until cool. Joints shall be made in accordance with ASTM F 2389.

M2105.12.2 (1210.6.7.2) Mechanical and compression sleeve joints.
Mechanical and compression sleeve joints shall be installed in accordance with the manufacturer’s instructions.

M2105.13 (1210.6.8) Raised temperature polyethylene (PE-RT) plastic tubing.
Joints between raised temperature polyethylene tubing and fittings shall comply with Sections M2105.13.1 and M2105.13.2. Mechanical joints shall comply with Section M2105.8.1.

M2105.13.1 (1210.6.8.1) Compression-type fittings.
Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

M2105.13.2 (1210.6.8.2) PE-RT-to-metal connections.
Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to PE-RT pipe or tubing.

M2105.14 (1210.6.9) PVC plastic pipe.
Joints between PVC plastic pipe or fittings shall be solvent-cemented in accordance with Section P2906.9.1.4. Threaded joints between fittings and PVC plastic pipe shall be in accordance with Section M2105.9.1.

M2105.15 (1210.7) Shutoff valves.
Shutoff valves shall be installed in ground-source loop piping systems in the locations indicated in Sections M2105.15.1 through M2105.15.6.

M2105.16 (1210.7.7) Reduced pressure.
A pressure relief valve shall be installed on the low-pressure side of a hydronic piping system that has been reduced in pressure. The relief valve shall be set at the maximum pressure of the system design. The valve shall be installed in accordance with Section M2002.

M2105.17 (1210.8) Installation.
Piping, valves, fittings, and connections shall be installed in accordance with the manufacturer’s instructions.

M2105.18 (1210.8.1) Protection of potable water.
Where ground-source heat-pump ground-loop systems have a connection to a potable water supply, the potable water system shall be protected from backflow in accordance with Section P2902.

M2105.19 (1210.8.2) Pipe penetrations.
Openings for pipe penetrations in walls, floors and ceilings shall be larger than the penetrating pipe. Openings through concrete or masonry building elements shall be sleeved. The annular space surrounding pipe penetrations shall be protected in accordance with Section P2606.1.

M2105.20 (1210.8.3) Clearance from combustibles.
A pipe in a ground-source heat pump piping system having an exterior surface temperature

exceeding 250°F (121°C) shall have a clearance of not less than 1 inch (25 mm) from combustible materials.

M2105.21 (1210.8.4) Contact with building material.
A ground-source heat-pump ground-loop piping system shall not be in direct contact with building materials that cause the piping or fitting material to degrade or corrode, or that interfere with the operation of the system.

M2105.22 (1210.8.5) Strains and stresses.
Piping shall be installed so as to prevent detrimental strains and stresses in the pipe. Provisions shall be made to protect piping from damage resulting from expansion, contraction and structural settlement. Piping shall be installed so as to avoid structural stresses or strains within building components.

M2105.23 (1210.8.7) Pipe support.
Pipe shall be supported in accordance with Section M2101.9.

M2105.24 (1210.8.8) Velocities.
Ground-source heat-pump ground-loop systems shall be designed so that the flow velocities do not exceed the maximum flow velocity recommended by the pipe and fittings manufacturer. Flow velocities shall be controlled to reduce the possibility of water hammer.

M2105.25 (1210.8.9) Labeling and marking.
Ground-source heat-pump ground-loop system piping shall be marked with tape, metal tags or other methods where it enters a building. The marking shall state the following words: “GROUND- SOURCE HEAT-PUMP LOOP SYSTEM.” The marking shall indicate if antifreeze is used in the system and shall indicate the chemicals by name and concentration.

M2105.26 (1210.8.10) Chemical compatibility.
Antifreeze and other materials used in the system shall be chemically compatible with the pipe, tubing, fittings and mechanical systems.

M2105.27 (1210.9) Makeup water.
The transfer fluid shall be compatible with the makeup water supplied to the system.

M2105.28 (1210.10) Testing.
Before connection header trenches are backfilled, the assembled loop system shall be pressure tested with water at 100 psi (689 kPa) for 15 minutes without observed leaks. Flow and pressure loss testing shall be performed and the actual flow rates and pressure drops shall be compared to the calculated design values. If actual flow rate or pressure drop values differ from calculated design values by more than 10 percent, the cause shall be identified and corrective action taken.

M2105.29 (1210.11) Embedded piping.
Ground-source heat-pump ground-loop piping to be embedded in concrete shall be pressure tested prior to pouring concrete. During pouring, the pipe shall be maintained at the proposed operating pressure.

SECTION M2106
BASEBOARD CONVECTORS

M2106.1 General.

Baseboard convectors shall be installed in accordance with the manufacturer’s instructions. Convectors shall be supported independently of the hydronic piping.

CHAPTER 22

~~SPECIAL~~ FUEL OIL PIPING AND STORAGE SYSTEMS

The text of this chapter is extracted from the 2018 edition of the *North Carolina Mechanical Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code for One- and Two-Family Dwellings*. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Mechanical Code.*

SECTION M2201
OIL TANKS

M2201.1 Materials.

Supply tanks shall be *listed* and *labeled* and shall conform to UL 58 for underground tanks, UL 142 for above-ground tanks, and UL 80 for indoor tanks.

M2201.2 (1309.2) Above-ground tanks.

The maximum amount of fuel oil stored above ground or inside of a building shall be 660 gallons (2498 L). The supply tank shall be supported on rigid noncombustible supports to prevent settling or shifting.

> **Exception:** The storage of fuel oil, used for space or water heating, above ground or inside buildings in quantities exceeding 660 gallons (2498 L) shall comply with NFPA 31.

M2201.2.1 (1309.2.1) Tanks within buildings.

Supply tanks for use inside of buildings shall be of such size and shape to permit installation and removal from *dwellings* as whole units. Supply tanks larger than 10 gallons (38 L) shall be placed not less than 5 feet (1524 mm) from any fire or flame either within or external to any fuel-burning *appliance*.

M2201.2.2 (1309.2.2) Outside above-ground tanks.

Tanks installed outside above ground shall be a minimum of 5 feet (1524 mm) from an adjoining property line. Such tanks shall be suitably protected from the weather and from physical damage.

M2201.3 (1309.3) Underground tanks.

Excavations for underground tanks shall not undermine the foundations of existing structures. The clearance from the tank to the nearest wall of a *basement*, pit or property line shall be not less than 1 foot (305 mm). Tanks shall be set on and surrounded with noncorrosive inert materials such as clean earth, sand or gravel well tamped in place. Tanks shall be covered with not less than 1 foot (305 mm) of earth. Corrosion protection shall be provided in accordance with Section M2203.7.

M2201.4 (1309.4) Multiple tanks.

Cross connection of two supply tanks shall be permitted in accordance with Section M2203.6.

M2201.5 (1309.5, 1306.3) Oil gauges.

Inside tanks shall be provided with a device to indicate when the oil in the tank has reached a predetermined safe level. Glass gauges or a gauge subject to breakage that could result in the escape of oil from the tank shall not be used. Liquid-level indicating gauges shall comply with UL 180.

M2201.6 (1309.6) Flood-resistant installation.

In flood hazard areas as established by Table R301.2(1), tanks shall be installed at or above the elevation required in Section R322.2.1 or R322.3.2 or shall be anchored to prevent flotation, collapse and lateral movement under conditions of the design flood.

M2201.7 (1301.5) Tanks abandoned or removed.

Exterior above-grade fill piping shall be removed when tanks are abandoned or removed. ~~Tank abandonment and removal shall be in accordance with the *International Fire Code*.~~ Tank abandonment and removal shall be in accordance with Section 5704.2.13 of the *International Fire Code.*

SECTION M2202
OIL PIPING, FITTING AND CONNECTIONS

~~**M2202.1 Materials.**~~

~~Piping shall consist of steel pipe, copper and copper alloy pipe and tubing or steel tubing conforming to ASTM A 539. Aluminum tubing shall not be used between the fuel-oil tank and the burner units.~~

~~**M2202.2 Joints and fittings.**~~

~~Piping shall be connected with standard fittings compatible with the piping material. Cast iron fittings shall not be used for oil piping. Unions requiring gaskets or packings, right or left couplings, and sweat fittings employing solder having a melting point less than 1,000°F (538°C) shall not be used for oil piping. Threaded joints and connections shall be made tight with a lubricant or pipe thread compound.~~

~~**M2202.3 Flexible connectors.**~~

~~Flexible metallic hoses shall be *listed* and *labeled* in accordance with UL 536 and shall be installed in accordance with their *listing* and *labeling* and the manufacturer's installation instructions. Connectors made from combustible materials shall not be used inside of buildings or above ground outside of buildings.~~

M2202.1 (1302.1) General.

Piping materials shall conform to the standards cited in this section.

M2202.2 (1302.2) Rated for system.

All materials shall be rated for the operating temperatures and pressures of the system, and shall be compatible with the type of liquid.

M2202.3 (1302.3) Pipe standards.

Fuel oil pipe shall comply with one of the standards listed in Table M2202.3.

TABLE M2202.3 (1302.3)
FUEL OIL PIPING

MATERIAL	STANDARD

Copper or copper-alloy pipe	ASTM B 42; ASTM B 43; ASTM B 302
Copper or copper-alloy tubing (Type K, L or M)	ASTM B 75; ASTM B 88; ASTM B 280
Labeled pipe	(See Section 1302.4)
Nonmetallic pipe	ASTM D 2996
Steel pipe	ASTM A 53; ASTM A 106
Steel tubing	ASTM A 254; ASTM A 539

M2202.4 (1302.4) Nonmetallic pipe.

Nonmetallic pipe shall be listed and labeled as being acceptable for the intended application for flammable and combustible liquids. Nonmetallic pipe shall be installed only outside, underground**.**

M2202.5 (1302.5) Fittings and valves.

Fittings and valves shall be approved for the piping systems, and shall be compatible with, or shall be of the same material as, the pipe or tubing.

M2202.6 (1302.6) Bending of pipe.

Pipe shall be approved for bending. Pipe bends shall be made with approved equipment. The bend shall not exceed the structural limitations of the pipe.

M2202.7 (1302.7) Pumps.

Pumps that are not part of an appliance shall be of a positive-displacement type. The pump shall automatically shut off the supply when not in operation. Pumps shall be listed and labeled in accordance with UL 343.

M2202.8 (1302.8) Flexible connectors and hoses.

Flexible connectors and hoses shall be listed and labeled in accordance with UL 536.

M2202.9 (1303.1) Approval.

Joints and connections shall be approved and of a type approved for fuel-oil piping systems. Threaded joints and connections shall be made tight with suitable lubricant or pipe compound. Unions requiring gaskets or packings, right or left couplings, and sweat fittings employing solder having a melting point of less than 1,000°F (538°C) shall not be used in oil lines. Cast-iron fittings shall not be used. Joints and connections shall be tight for the pressure required by test.

M2202.9.1 (1303.1.1) Joints between different piping materials.

Joints between different piping materials shall be made with approved adapter fittings. Joints between different metallic piping materials shall be made with approved dielectric fittings or brass converter fittings.

M2202.10 (1303.2) Preparation of pipe ends.

Pipe shall be cut square, reamed and chamfered and be free from all burrs and obstructions. Pipe ends shall have full-bore openings and shall not be undercut.

M2202.11 (1303.3) Joint preparation and installation.

Where required by Sections M2202.12 through M2202.18 the preparation and installation of brazed, mechanical, threaded and welded joints shall comply with Sections M2202.11.1 through M2202.11.4.

M2202.11.1 (1303.3.1) Brazed joints.

All joint surfaces shall be cleaned. An *approved* flux shall be applied where required. The joints shall be brazed with a filler metal conforming to AWS A5.8.

M2202.11.2 (1303.3.2) Mechanical joints.

Mechanical joints shall be installed in accordance with the manufacturer's instructions. Press connect joints shall conform to one of the standards listed in Table 1302.3.

M2202.11.3 (1303.3.3) Threaded joints.

Threads shall conform to ASME B1.20.1. Pipe-joint compound or tape shall be applied on the male threads only.

M2202.11.4 (1303.3.4) Welded joints.

All joint surfaces shall be cleaned by an *approved* procedure. The joint shall be welded with an *approved* filler metal.

M2202.12 (1303.4) Brass pipe.

Joints between brass pipe or fittings shall be brazed, mechanical, threaded or welded joints complying with Section M2202.11.

M2202.13 (1303.5) Brass tubing.

Joints between brass tubing or fittings shall be brazed or mechanical joints complying with Section M2202.11.

M2202.14 (1303.6) Copper or copper-alloy pipe.

Joints between copper or copper-alloy pipe or fittings shall be brazed, mechanical, threaded or welded joints complying with Section M2202.11.

M2202.15 (1303.7) Copper or copper-alloy tubing.

Joints between copper or copper-alloy tubing or fittings shall be brazed or mechanical joints complying with Section M2202.11 or flared joints. Flared joints shall be made by a tool designed for that operation.

M2202.16 (1303.8) Nonmetallic pipe.

Joints between nonmetallic pipe or fittings shall be installed in accordance with the manufacturer's instructions for the *labeled* pipe and fittings.

M2202.17 (1303.9) Steel pipe.

Joints between steel pipe or fittings shall be threaded or welded joints complying with Section M2202.11 or mechanical joints complying with Section M2202.17.1.

M2202.17.1 (1303.9.1) Mechanical joints.

Joints shall be made with an *approved* elastomeric seal. Mechanical joints shall be installed in accordance with the manufacturer's instructions. Mechanical joints shall be installed outside, underground, unless otherwise *approved*.

M2202.18 (1303.10) Steel tubing.

Joints between steel tubing or fittings shall be mechanical or welded joints complying with Section M2202.11.

M2202.19 (1303.11) Piping protection.

Proper allowance shall be made for expansion, contraction, jarring and vibration. Piping other than tubing, connected to underground tanks, except straight fill lines and test wells, shall be provided with flexible connectors, or otherwise arranged to permit the tanks to settle without impairing the tightness of the piping connections.

SECTION M2203
INSTALLATION

M2203.2 Supply piping.

~~Supply piping used in the installation of oil burners and *appliances* shall be not smaller than 3/8-inch (9 mm) pipe or 3/8-inch (9 mm) outside diameter tubing. Copper tubing and fittings shall be a minimum of Type L.~~ The fuel oil system shall be sized for the maximum capacity of fuel oil required. The minimum size of a supply line shall be 3/8-inch (9.5 mm) inside diameter nominal pipe or 3/8-inch (9.5 mm) od tubing. The minimum size of a return line shall be 1/4-inch (6.4 mm) inside diameter nominal pipe or 5/16-inch (7.9 mm) outside diameter tubing. Copper tubing shall have 0.035-inch (0.9 mm) nominal and 0.032-inch (0.8 mm) minimum wall thickness.

M2203.2.1 (1305.3) Supply piping installation.

Supply piping shall connect to the top of the fuel oil tank. Fuel oil shall be supplied by a transfer pump or automatic pump or by other *approved* means.

Exception: This section shall not apply to inside or aboveground fuel oil tanks.

M2203.2.2 (1305.4) Return piping.

Return piping shall connect to the top of the fuel oil tank. Valves shall not be installed on return piping.

M2203.2.3 (1305.5) System pressure.

The system shall be designed for the maximum pressure required by the fuel-oil-burning *appliance*. Air or other gases shall not be used to pressurize tanks.

M2203.2.4 (1308.1) Testing required.

Fuel oil piping shall be tested in accordance with NFPA 31.

M2203.2.4.1 (1201.4) Test gauges.

Gauges used for testing shall be as follows:

1. Tests requiring a pressure of 10 pounds per square inch (psi) (69 kPa) or less shall utilize a testing gauge having increments of 0.10 psi (0.69 kPa) or less.

2. Tests requiring a pressure of greater than 10 psi (69 kPa) but less than or equal to 100 psi (689 kPa) shall utilize a testing gauge having increments of 1 psi (6.9 kPa) or less.

3. Tests requiring a pressure of greater than 100 psi (689 kPa) shall utilize a testing gauge having increments of 2 psi (14 kPa) or less.

M2203.3 (1305.6) Fill piping.

Fill piping shall terminate outside of buildings at a point not less than 2 feet (610 mm) from any building opening at the same or lower level. Fill openings shall be equipped with a tight metal cover.

M2203.4 (1305.7) Vent piping.

Vent piping shall be not smaller than $1^{1}/_{4}$-inch (32 mm) pipe. Vent piping shall be laid to drain toward the tank without sags or traps in which the liquid can collect. Vent pipes shall not be cross connected with fill pipes, lines from burners or overflow lines from auxiliary tanks. The lower end of a vent pipe shall enter the tank through the top and shall extend into the tank not more than 1 inch (25 mm).

M2203.5 (1305.7) Vent termination.

~~Vent piping shall terminate outside of buildings at a point not less than 2 feet (610 mm), measured vertically or horizontally, from any building opening. Outer ends of vent piping shall terminate in a weather-proof cap or fitting having an unobstructed area at least equal to the cross-sectional area of the vent pipe, and shall be located sufficiently above the ground to avoid being obstructed by snow and ice~~. Liquid fuel vent pipes shall terminate outside of buildings at a point not less than 2 feet (610 mm) measured vertically or horizontally from any building opening. Outer ends of vent pipes shall terminate in a weatherproof vent cap or fitting or be provided with a weatherproof hood. Vent caps shall have a minimum free open area equal to the cross-sectional area of the vent pipe and shall not employ screens finer than No. 4 mesh. Vent pipes shall terminate sufficiently above the ground to avoid being obstructed with snow or ice. Vent pipes from tanks containing heaters shall be extended to a location where oil vapors discharging from the vent will be readily diffused. If the static head with a vent pipe filled with oil exceeds 10 pounds per square inch (psi) (69 kPa), the tank shall be designed for the maximum static head that will be imposed.

M2203.6 (1309.7) Cross connection of tanks.

Cross connection of two supply tanks, not exceeding 660 gallons (2498 L) aggregate capacity, with gravity flow from one tank to another, shall be acceptable providing that the two tanks are on the same horizontal plane.

M2203.7 (1309.8) Corrosion protection.

Underground tanks and buried piping shall be protected by corrosion-resistant coatings or special alloys or fiberglass-reinforced plastic.

SECTION M2204
OIL PUMPS AND VALVES

M2204.2 (1307.1) Building shutoff. ~~Shutoff valves~~.

~~A readily accessible manual shutoff valve shall be installed between the oil supply tank and the burner. Where the shutoff valve is installed in the discharge line of an oil pump, a pressure-relief valve shall be incorporated to bypass or return surplus oil. Valves shall comply with UL 842.~~ A shutoff valve shall be installed on the fuel-oil supply line at the entrance to the building. Inside or above-ground tanks are permitted to have valves installed at the tank. The valve shall be capable of stopping the flow of fuel oil to the building or to the *appliance* served where the valve is installed at a tank inside the building.

M2204.3 (1307.2) Appliance shutoff. ~~Maximum pressure.~~

~~Pressure at the oil supply inlet to an *appliance* shall be not greater than 3 pounds per square inch (20.7 kPa).~~ A shutoff valve shall be installed at the connection to each *appliance* where more than one fuel-oil-burning *appliance* is installed.

M2204.4 (1307.3) Pump relief valve. ~~Relief valves~~.

~~Fuel-oil lines incorporating heaters shall be provided with relief valves that will discharge to a return line when excess pressure exists.~~ A relief valve shall be installed on the pump discharge line where a valve is located downstream of the pump and the pump is capable of exceeding the pressure limitations of the fuel oil system.

M2204.5 (1307.4) Fuel-oil heater relief valve.

A relief valve shall be installed on the discharge line of fuel-oil-heating appliances.

M2204.6 (1307.5) Relief valve operation.

The relief valve shall discharge fuel oil when the pressure exceeds the limitations of the system. The discharge line shall connect to the fuel oil tank.

SECTION M2205 (1306)
OIL GAUGING

M2205.1 (1306.1) Level indication.

Tanks in which a constant oil level is not maintained by an automatic pump shall be equipped with a method of determining the oil level.

M2205.2 (1306.2) Test wells.

Test wells shall not be installed inside buildings. For outside service, test wells shall be equipped with a tight metal cover designed to discourage tampering.

M2205.3 (1306.3) Inside tanks.

The gauging of inside tanks by means of measuring sticks shall not be permitted. An inside tank provided with fill and vent pipes shall be provided with a device to indicate either visually or audibly at the fill point when the oil in the tank has reached a predetermined safe level.

M2205.4 (1306.4) Gauging devices.

Gauging devices such as liquid level indicators or signals shall be designed and installed so that oil vapor will not be discharged into a building from the liquid fuel supply system. Liquid-level indicating gauges shall comply with UL 180.

M2205.5 (1306.5) Gauge glass.

A tank used in connection with any oil burner shall not be equipped with a glass gauge or any gauge which, when broken, will permit the escape of oil from the tank.

CHAPTER 23

SOLAR THERMAL ENERGY SYSTEMS

The text of this chapter is extracted from the 2018 edition of the *North Carolina Mechanical Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code for One- and Two-Family Dwellings*. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Mechanical Code.*

SECTION M2301
THERMAL SOLAR ENERGY SYSTEMS

M2301.1 (1401.1) General.

This section provides for the design, construction, installation, *alteration* and repair of *equipment* and systems using thermal solar energy to provide space heating or cooling, hot water heating and swimming pool heating.

M2301.5 (1401.2) Backflow protection.

Connections from the potable water supply to solar systems shall comply with Section P2902.5.5.

Part VI—Fuel Gas

CHAPTER 24

FUEL GAS

The text of this chapter is extracted from the ~~2015~~ 2018 edition of the ~~*International*~~ *North Carolina Fuel Gas Code* and has been modified where necessary to conform to the scope of application of the ~~*International*~~ *North Carolina Residential Code for One- and Two-Family Dwellings*. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the ~~*International*~~ *North Carolina Fuel Gas Code.*

SECTION G2401

(101) GENERAL

G2401.2 (102.6) Historic buildings.

The provisions of this code relating to the construction, *alteration*, repair, enlargement, restoration, relocation or moving of buildings or structures shall not be mandatory for existing buildings or structures identified and classified by the state or local jurisdiction as historic buildings where such buildings or structures are judged by the code official to be safe and in the public interest of health, safety and welfare regarding any proposed construction, *alteration*, repair, enlargement, restoration, relocation or moving of buildings.

SECTION G2403 (202)

GENERAL DEFINITIONS

(Deleted. See Chapter 2.)

~~**ACCESS (TO).** That which enables a device, *appliance* or *equipment* to be reached by ready *access* or by a means that first requires the removal or movement of a panel, door or similar obstruction (see also "Ready *access*").~~

~~**AIR CONDITIONER, GAS-FIRED.** A gas-burning, automatically operated *appliance* for supplying cooled and/or dehumidified air or chilled liquid.~~

~~**AIR CONDITIONING.** The treatment of air so as to control simultaneously the temperature, humidity, cleanness and distribution of the air to meet the requirements of a conditioned space.~~

~~**AIR, EXHAUST.** Air being removed from any space or piece of *equipment* or *appliance* and conveyed directly to the atmosphere by means of openings or ducts.~~

~~**AIR-HANDLING UNIT.** A blower or fan used for the purpose of distributing supply air to a room, space or area.~~

~~**AIR, MAKEUP.** Any combination of outdoor and transfer air intended to replace exhaust air and exfiltration.~~

~~**ALTERATION.** A change in a system that involves an extension, addition or change to the arrangement, type or purpose of the original installation.~~

~~**ANODELESS RISER.** A transition assembly in which plastic *piping* is installed and terminated above ground outside of a building.~~

~~**APPLIANCE.** Any apparatus or device that utilizes a fuel or raw material to produce light, heat, power, refrigeration or air conditioning.~~

~~**APPLIANCE, AUTOMATICALLY CONTROLLED.** Appliances equipped with an automatic *burner* ignition and safety shut-off device and other automatic devices, which accomplish complete turn-on and shut-off of the gas to the *main burner* or *burners*, and graduate the gas supply to the *burner* or *burners*, but do not affect complete shut-off of the gas.~~

~~**APPLIANCE, FAN-ASSISTED COMBUSTION.** An *appliance* equipped with an integral mechanical means to either draw or force products of combustion through the combustion chamber or heat exchanger.~~

~~**APPLIANCE, UNVENTED.** An *appliance* designed or installed in such a manner that the products of combustion are not conveyed by a vent or *chimney* directly to the outside atmosphere.~~

~~**APPLIANCE, VENTED.** An *appliance* designed and installed in such a manner that all of the products of combustion are conveyed directly from the *appliance* to the outside atmosphere through an *approved chimney* or vent system.~~

~~**APPROVED.** Acceptable to the *code official*.~~

~~**APPROVED AGENCY.** An established and recognized agency that is regularly engaged in conducting tests or furnishing inspection services, where such agency has been approved by the *code official*.~~

~~**ATMOSPHERIC PRESSURE.** The pressure of the weight of air and water vapor on the surface of the earth, approximately 14.7 pounds per square inch (psia) (101 kPa absolute) at sea level.~~

~~**AUTOMATIC IGNITION.** Ignition of gas at the *burner(s)* when the gas controlling device is turned on, including reignition if the flames on the *burner(s)* have been extinguished by means other than by the closing of the gas controlling device.~~

~~**BAROMETRIC DRAFT REGULATOR.** A balanced *damper* device attached to a *chimney, vent connector,* breeching or flue gas manifold to protect combustion *appliances* by controlling *chimney draft*. A double-acting *barometric draft regulator* is one whose balancing *damper* is free to move in either direction to protect combustion *appliances* from both excessive *draft* and backdraft.~~

~~**BOILER, LOW-PRESSURE.** A self-contained *appliance* for supplying steam or hot water.~~

~~**Hot water heating boiler.** A boiler in which no steam is generated, from which hot water is circulated for heating purposes and then returned to the boiler, and that operates at water pressures not exceeding 160 pounds per square inch gauge (psig) (1100 kPa gauge) and at water temperatures not exceeding 250ºF (121ºC) at or near the boiler outlet.~~

~~**Hot water supply boiler.** A boiler, completely filled with water, which furnishes hot water to be used externally to itself, and that operates at water pressures not exceeding 160 psig (1100 kPa gauge) and at water temperatures not exceeding 250ºF (121ºC) at or near the boiler outlet.~~

~~**Steam heating boiler.** A boiler in which steam is generated and that operates at a steam pressure not exceeding 15 psig (100 kPa gauge).~~

~~**BONDING JUMPER.** A conductor installed to electrically connect metallic gas *piping* to the grounding electrode system.~~

~~**BRAZING.** A metal-joining process wherein coalescence is produced by the use of a nonferrous filler metal having a melting point above 1,000ºF (538ºC), but lower than that of the base metal being joined. The filler material is distributed between the closely fitted surfaces of the joint by capillary action.~~

~~**BTU.** Abbreviation for British thermal unit, which is the quantity of heat required to raise the temperature of 1 pound (454 g) of water 1ºF (0.56ºC) (1 *Btu* = 1055 J).~~

~~**BURNER.** A device for the final conveyance of the gas, or a mixture of gas and air, to the combustion zone.~~

~~**Induced-draft.** A *burner* that depends on *draft* induced by a fan that is an integral part of the *appliance* and is located downstream from the *burner*.~~

~~**Power.** A *burner* in which gas, air or both are supplied at pressures exceeding, for gas, the line pressure, and for air, atmospheric pressure, with this added pressure being applied at the *burner*.~~

~~**CHIMNEY.** A primarily vertical structure containing one or more flues, for the purpose of carrying gaseous products of *combustion* and air from an *appliance* to the outside atmosphere.~~

~~**Factory-built chimney.** A listed and labeled chimney composed of factory-made components, assembled in the field in accordance with manufacturer's instructions and the conditions of the listing.~~

~~**Masonry chimney.** A field-constructed chimney composed of solid masonry units, bricks, stones or concrete.~~

~~**CLEARANCE.** The minimum distance through air measured between the heat-producing surface of the mechanical *appliance*, device or *equipment* and the surface of the combustible material or assembly.~~

~~**CLOTHES DRYER.** An *appliance* used to dry wet laundry by means of heated air.~~

~~**Type 1.** Factory-built package, multiple production. Primarily used in the family living environment. Usually the smallest unit physically and in function output.~~

~~**CODE.** These regulations, subsequent amendments thereto, or any emergency rule or regulation that the administrative authority having jurisdiction has lawfully adopted.~~

~~**CODE OFFICIAL.** The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative.~~

~~**COMBUSTIBLE ASSEMBLY.**Wall, floor, ceiling or other assembly constructed of one or more component materials that are not defined as noncombustible.~~

~~**COMBUSTIBLE MATERIAL.** Any material not defined as noncombustible.~~

~~**COMBUSTION.** In the context of this code, refers to the rapid oxidation of fuel accompanied by the production of heat or heat and light.~~

~~**COMBUSTION AIR.** Air necessary for complete combustion of a fuel, including theoretical air and excess air.~~

~~**COMBUSTION CHAMBER.** The portion of an *appliance* within which combustion occurs.~~

~~**COMBUSTION PRODUCTS.** Constituents resulting from the combustion of a fuel with the oxygen of the air, including the inert gases, but excluding excess air.~~

~~**CONCEALED LOCATION.** A location that cannot be accessed without damaging permanent parts of the building structure or finish surface. Spaces above, below or behind readily removable panels or doors shall not be considered as concealed.~~

~~**CONCEALED PIPING.** *Piping* that is located in a *concealed location* (see *"Concealed location"*).~~

~~**CONDENSATE.** The liquid that condenses from a gas (including flue gas) caused by a reduction in temperature or increase in pressure.~~

~~**CONNECTOR, APPLIANCE (Fuel).** Rigid metallic *pipe* and fittings, semirigid metallic *tubing* and fittings or a listed and labeled device that connects an *appliance* to the *gas piping system*.~~

~~**CONNECTOR, CHIMNEY OR VENT.** The *pipe* that connects an *appliance* to a chimney or vent.~~

~~**CONTROL.** A manual or automatic device designed to regulate the gas, air, water or electrical supply to, or operation of, a mechanical system.~~

~~**CONVERSION BURNER.** A unit consisting of a *burner* and its *controls* for installation in an *appliance* originally utilizing another fuel.~~

~~**CUBIC FOOT.** The amount of gas that occupies 1 cubic foot (0.02832 m^3) when at a temperature of 60ºF (16ºC), saturated with water vapor and under a pressure equivalent to that of 30 inches of mercury (101 kPa).~~

~~**DAMPER.** A manually or automatically controlled device to regulate *draft* or the rate of flow of air or combustion gases.~~

~~**DECORATIVE APPLIANCE, VENTED.** A *vented appliance* wherein the primary function lies in the aesthetic effect of the flames.~~

~~**DECORATIVE APPLIANCES FOR INSTALLATION IN VENTED FIREPLACES.** A *vented appliance* designed for installation within the fire chamber of a vented *fireplace*, wherein the primary function lies in the aesthetic effect of the flames.~~

~~**DEMAND.** The maximum amount of gas input required per unit of time, usually expressed in cubic feet per hour, or *Btu*/h (1 *Btu*/h = 0.2931 W).~~

~~**DESIGN FLOOD ELEVATION.** The elevation of the “design flood,” including wave height, relative to the datum specified on the community’s legally designated flood hazard map. In areas designated as Zone AO, the *design flood elevation* shall be the elevation of the highest existing grade of the *building’s* perimeter plus the depth number, in feet, specified on the flood hazard map. In areas designated as Zone AO where a depth number is not specified on the map, the depth number shall be taken as being equal to 2 feet (610 mm).~~

~~**DILUTION AIR.** Air that is introduced into a *draft hood* and is mixed with the *flue gases*.~~

~~**DIRECT-VENT APPLIANCES.** *Appliances* that are constructed and installed so that all air for combustion is derived directly from the outside atmosphere and all *flue gases* are discharged directly to the outside atmosphere.~~

~~**DRAFT.** The pressure difference existing between the *appliance* or any component part and the atmosphere, that causes a continuous flow of air and products of combustion through the gas passages of the *appliance* to the atmosphere.~~

> ~~**Mechanical or induced draft.** The pressure difference created by the action of a fan, blower or ejector that is located between the *appliance* and the chimney or vent termination.~~
>
> ~~**Natural draft.** The pressure difference created by a vent or chimney because of its height, and the temperature difference between the *flue gases* and the atmosphere.~~

~~**DRAFT HOOD.** A nonadjustable device built into an *appliance*, or made as part of the vent *connector* from an *appliance*, that is designed to (1) provide for ready escape of the *flue gases* from the *appliance* in the event of no *draft,* backdraft, or stoppage beyond the *draft hood*, (2) prevent a backdraft from entering the *appliance*, and (3) neutralize the effect of stack action of the chimney or gas vent upon operation of the *appliance*.~~

~~**DRAFT REGULATOR.** A device that functions to maintain a desired *draft* in the *appliance* by automatically reducing the *draft* to the desired value.~~

~~**DRIP.** The container placed at a low point in a system of *piping* to collect *condensate* and from which the *condensate* is removable.~~

~~**DUCT FURNACE.** A warm-air *furnace* normally installed in an air-distribution duct to supply warm air for heating. This definition shall apply only to a warm-air heating *appliance* that depends for air circulation on a blower not furnished as part of the *furnace*.~~

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

~~**EQUIPMENT.** Apparatus and devices other than *appliances*.~~

~~**EXCESS FLOW VALVE (EFV).** A valve designed to activate when the fuel gas passing through it exceeds a prescribed flow rate.~~

~~**EXTERIOR MASONRY CHIMNEYS.** Masonry chimneys exposed to the outdoors on one or more sides below the roof line.~~

~~**FIREPLACE.** A fire chamber and hearth constructed of noncombustible material for use with solid fuels and provided with a chimney.~~

> ~~**Factory-built fireplace.** A *fireplace* composed of listed factory-built components assembled in accordance with the terms of listing to form the completed *fireplace.*~~
>
> ~~**Masonry fireplace.** A hearth and fire chamber of solid masonry units such as bricks, stones, listed masonry units or reinforced concrete, provided with a suitable chimney.~~

~~**FLAME SAFEGUARD.** A device that will automatically shut off the fuel supply to a *main burner* or group of *burners* when the means of ignition of such *burners* becomes inoperative, and when flame failure occurs on the *burner* or group of *burners*.~~

~~**FLASHBACK ARRESTOR CHECK VALVE.** A device that will prevent the backflow of one gas into the supply system of another gas and prevent the passage of flame into the gas supply system.~~

~~**FLOOD HAZARD AREA.** The greater of the following two areas:~~

1. ~~The area within a floodplain subject to a 1 percent or greater chance of flooding in any given year.~~

2. ~~This area designated as a *flood hazard area* on a community's flood hazard map, or otherwise legally designated.~~

~~**FLOOR FURNACE.** A completely self-contained *furnace* suspended from the floor of the space being heated, taking air for combustion from outside such space and with means for observing flames and lighting the *appliance* from such space.~~

~~**FLUE, APPLIANCE.** The passage(s) within an *appliance* through which *combustion products* pass from the *combustion chamber* of the *appliance* to the *draft hood* inlet opening on an *appliance* equipped with a *draft hood* or to the outlet of the *appliance* on an *appliance* not equipped with a *draft hood.*~~

~~**FLUE COLLAR.** That portion of an *appliance* designed for the attachment of a *draft hood*, *vent connector* or venting system.~~

~~**FLUE GASES.** Products of combustion plus excess air in *appliance flues* or heat exchangers.~~

~~**FLUE LINER (LINING).** A system or material used to form the inside surface of a flue in a *chimney* or vent, for the purpose of protecting the surrounding structure from the effects of *combustion products* and for conveying *combustion products* without leakage to the atmosphere.~~

~~**FUEL GAS.** A natural gas, manufactured gas, *liquefied petroleum gas* or mixtures of these gases.~~

~~**FURNACE.** A completely self-contained heating unit that is designed to supply heated air to spaces remote from or adjacent to the *appliance* location.~~

~~**FURNACE, CENTRAL.** A self-contained *appliance* for heating air by transfer of heat of *combustion* through metal to the air, and designed to supply heated air through ducts to spaces remote from or adjacent to the *appliance* location.~~

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

~~**GAS CONVENIENCE OUTLET.** A permanently mounted, manually operated device that provides the means for connecting an *appliance* to, and disconnecting an *appliance* from, the supply *piping*. The device includes an integral, manually operated valve with a nondisplaceable valve member and is designed so that disconnection of an *appliance* only occurs when the manually operated valve is in the closed position.~~

~~**GAS PIPING.** An installation of pipe, valves or fittings installed on a premises or in a building and utilized to convey fuel gas.~~

~~**HAZARDOUS LOCATION.** Any location considered to be a fire hazard for flammable vapors, dust, combustible fibers or other highly combustible substances. The location is not necessarily categorized in the *International Building Code* as a high-hazard use group classification.~~

~~**HOUSE PIPING.** See *"Piping system."*~~

~~**IGNITION PILOT.** A *pilot* that operates during the lighting cycle and discontinues during *main burner* operation.~~

~~**IGNITION SOURCE.** A flame spark or hot surface capable of igniting flammable vapors or fumes. Such sources include *appliance burners, burner* ignitors and electrical switching devices.~~

~~**INFRARED RADIANT HEATER.** A heater which directs a substantial amount of its energy output in the form of infrared radiant energy into the area to be heated. Such heaters are of either the vented or unvented type.~~

~~**JOINT, FLARED.** A metal-to-metal compression joint in which a conical spread is made on the end of a tube that is compressed by a flare nut against a mating flare.~~

~~**JOINT, MECHANICAL.** A general form of gas-tight joints obtained by the joining of metal parts through a positive-holding mechanical construction, such as press joint, flanged joint, threaded joint, flared joint or compression joint.~~

~~**JOINT, PLASTIC ADHESIVE.** A joint made in thermoset plastic *piping* by the use of an adhesive substance which forms a continuous bond between the mating surfaces without dissolving either one of them.~~

~~**LABELED.** Equipment, materials or products to which have been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the above-labeled items and whose labeling indicates either that the *equipment*, material or product meets identified standards or has been tested and found suitable for a specified purpose.~~

~~**LEAK CHECK.** An operation performed on a gas *piping system* to verify that the system does not leak.~~

~~**LIQUEFIED PETROLEUM GAS or LPG (LP-GAS).** *Liquefied petroleum gas* composed predominately of propane, propylene, butanes or butylenes, or mixtures thereof that is gaseous under normal atmospheric conditions, but is capable of being liquefied under moderate pressure at normal temperatures.~~

~~**LISTED.** Equipment, materials, products or services included in a list published by an organization acceptable to the code official and concerned with evaluation of products or services that maintains periodic inspection of production of *listed equipment* or materials or periodic evaluation of services and whose listing states either that the *equipment*, material, product or service meets identified standards or has been tested and found suitable for a specified purpose.~~

~~**LIVING SPACE.** Space within a *dwelling unit* utilized for living, sleeping, eating, cooking, bathing, washing and sanitation purposes.~~

~~**LOG LIGHTER.** A manually operated solid-fuel ignition *appliance* for installation in a vented solid-fuel-burning *fireplace*.~~

~~**MAIN BURNER.** A device or group of devices essentially forming an integral unit for the final conveyance of gas or a mixture of gas and air to the combustion zone, and on which combustion takes place to accomplish the function for which the *appliance* is designed.~~

~~**METER.** The instrument installed to measure the volume of gas delivered through it.~~

~~**MODULATING.** Modulating or throttling is the action of a *control* from its maximum to minimum position in either predetermined steps or increments of movement as caused by its actuating medium.~~

~~**NONCOMBUSTIBLE MATERIALS.** Materials that, when tested in accordance with ASTM E 136, have at least three of four specimens tested meeting all of the following criteria:~~

1. ~~The recorded temperature of the surface and interior thermocouples shall not at any time during the test rise more than 54ºF (30ºC) above the furnace temperature at the beginning of the test.~~

2. ~~There shall not be flaming from the specimen after the first 30 seconds.~~

3. ~~If the weight loss of the specimen during testing exceeds 50 percent, the recorded temperature of the surface and interior thermocouples shall not at any time during the test rise above the furnace air temperature at the beginning of the test, and there shall not be flaming of the specimen.~~

~~**OFFSET (VENT).** A combination of *approved* bends that make two changes in direction bringing one section of the vent out of line, but into a line parallel with the other section.~~

~~**OUTLET.** The point at which a gas-fired *appliance* connects to the gas *piping system*.~~

~~**OXYGEN DEPLETION SAFETY SHUTOFF SYSTEM (ODS).** A system designed to act to shut off the gas supply to the main and *pilot burners* if the oxygen in the surrounding atmosphere is reduced below a predetermined level.~~

~~**PILOT.** A small flame that is utilized to ignite the gas at the *main burner* or *burners*.~~

~~**PIPING.** Where used in this code, *"piping"* refers to either *pipe* or *tubing*, or both.~~

~~**Pipe.** A rigid conduit of iron, steel, copper, brass or plastic.~~

~~**Tubing.** Semirigid conduit of copper, aluminum, plastic or steel.~~

~~**PIPING SYSTEM.** All fuel *piping,* valves and fittings from the outlet of the *point of delivery* to the outlets of the *appliance* shutoff valves.~~

~~**PLASTIC, THERMOPLASTIC.** A plastic that is capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature.~~

~~**POINT OF DELIVERY.** For natural gas systems, the *point of delivery* is the outlet of the service meter assembly or the outlet of the service regulator or service shutoff valve where a meter is not provided. Where a valve is provided at the outlet of the service meter assembly, such valve shall be considered to be downstream of the *point of delivery*. For undiluted liquefied petroleum gas systems, the point of delivery shall be considered to be the outlet of the service pressure regulator, exclusive of line gas regulators, in the system.~~

~~**PRESSURE DROP.** The loss in pressure due to friction or obstruction in pipes, valves, fittings, *regulators* and *burners*.~~

~~**PRESSURE TEST.** An operation performed to verify the gas-tight integrity of *gas piping* following its installation or modification.~~

~~**PURGE.** To free a gas conduit of air or gas, or a mixture of gas and air.~~

~~**READY ACCESS (TO).** That which enables a device, *appliance* or *equipment* to be directly reached, without requiring the removal or movement of any panel, door or similar obstruction. (See "Access.")~~

~~**REGULATOR.** A device for controlling and maintaining a uniform gas supply pressure, either pounds-to-inches water column (MP regulator) or inches-to-inches water column (*appliance regulator*).~~

~~**REGULATOR, GAS APPLIANCE.** A *pressure regulator* for controlling pressure to the manifold of the gas *appliance*.~~

~~**REGULATOR, LINE GAS PRESSURE.** A device placed in a gas line between the *service pressure regulator* and the *appliance* for controlling, maintaining or reducing the pressure in that portion of the *piping system* downstream of the device.~~

~~**REGULATOR, MEDIUM-PRESSURE (MP Regulator).** A line *pressure regulator* that reduces gas pressure from the range of greater than 0.5 psig (3.4 kPa) and less than or equal to 5 psig (34.5 kPa) to a lower pressure.~~

~~**REGULATOR, PRESSURE.** A device placed in a gas line for reducing, controlling and maintaining the pressure in that portion of the *piping system* downstream of the device.~~

~~**REGULATOR, SERVICE PRESSURE.** For natural gas systems, a device installed by the serving gas supplier to reduce and limit the service line pressure to delivery pressure. For undiluted liquefied petroleum gas systems, the regulator located upstream from all line gas pressure regulators, where installed, and downstream from any first stage or a high pressure regulator in the system.~~

~~**RELIEF OPENING.** The opening provided in a *draft hood* to permit the ready escape to the atmosphere of the flue products from the *draft hood* in the event of no *draft*, backdraft or stoppage beyond the *draft hood*, and to permit air into the *draft hood* in the event of a strong chimney updraft.~~

~~**RELIEF VALVE (DEVICE).** A safety valve designed to forestall the development of a dangerous condition by relieving either pressure, temperature or vacuum in the hot water supply system.~~

~~**RELIEF VALVE, PRESSURE.**~~
~~An *automatic valve* that opens and closes a relief vent, depending on whether the pressure is above or below a predetermined value.~~

~~**RELIEF VALVE, TEMPERATURE.**~~

> ~~**Manual reset type.** A valve that automatically opens a *relief* vent at a predetermined temperature and that must be manually returned to the closed position.~~
>
> ~~**Reseating or self-closing type.** An *automatic valve* that opens and closes a relief vent, depending on whether the temperature is above or below a predetermined value.~~

~~**RELIEF VALVE, VACUUM.** A valve that automatically opens and closes a vent for relieving a vacuum within the hot water supply system, depending on whether the vacuum is above or below a predetermined value.~~

~~**RISER, GAS.** A vertical *pipe* supplying fuel gas.~~

~~**ROOM HEATER, UNVENTED.** See *“Unvented room heater.”*~~

~~**ROOM HEATER, VENTED.** A free-standing heating unit used for direct heating of the space in and adjacent to that in which the unit is located. (See also "Vented room heater.")~~

~~**SAFETY SHUTOFF DEVICE.** See "Flame safeguard."~~

~~**SHAFT.** An enclosed space extending through one or more stories of a building, connecting vertical openings in successive floors, or floors and the roof.~~

~~**SPECIFIC GRAVITY.** As applied to gas, *specific gravity* is the ratio of the weight of a given volume to that of the same volume of air, both measured under the same condition.~~

~~**THERMOSTAT.**~~

> ~~**Electric switch type.** A device that senses changes in temperature and controls electrically, by means of separate components, the flow of gas to the *burner(s)* to maintain selected temperatures.~~
>
> ~~**Integral gas valve type.** An automatic device, actuated by temperature changes, designed to control the gas supply to the *burner(s)* in order to maintain temperatures between predetermined limits, and in which the thermal actuating element is an integral part of the device.~~
>
> 1. ~~Graduating thermostat. A thermostat in which the motion of the *valve* is approximately in direct proportion to the effective motion of the thermal element induced by temperature change.~~
>
> 2. ~~Snap-acting thermostat. A thermostat in which the thermostatic valve travels instantly from the closed to the open position, and vice versa.~~

~~**THIRD-PARTY CERTIFICATION AGENCY.** An approved agency operating a product or material certification system that incorporates initial product testing, assessment and surveillance of a manufacturer's quality control system.~~

~~**THIRD-PARTY CERTIFIED.** Certification obtained by the manufacturer indicating that the function and performance characteristics of a product or material have been determined by testing and ongoing surveillance by an approved third-party certification agency. Assertion of certification is in the form of identification in accordance with the requirements of the third-party certification agency.~~

~~**THIRD-PARTY TESTED.** Procedure by which an approved testing laboratory provides documentation that a product, material or system conforms to specified requirements.~~

~~**TRANSITION FITTINGS, PLASTIC TO STEEL.** An adapter for joining plastic *pipe* to steel *pipe*. The purpose of this fitting is to provide a permanent, pressure-tight connection between two materials that cannot be joined directly one to another.~~

~~**UNIT HEATER.**~~

~~**High-static pressure type.** A self-contained, automatically controlled, vented *appliance* having integral means for circulation of air against 0.2 inch w.c. (50 Pa) or greater static pressure. Such *appliance* is equipped with provisions for attaching an outlet air duct and, where the *appliance* is for indoor installation remote from the space to be heated, is also equipped with provisions for attaching an inlet air duct.~~

~~**Low-static pressure type.** A self-contained, automatically controlled, vented *appliance*, intended for installation in the space to be heated without the use of ducts, having integral means for circulation of air. Such units are allowed to be equipped with louvers or face extensions made in accordance with the manufacturer's specifications.~~

~~**UNVENTED ROOM HEATER.** An unvented heating *appliance* designed for stationary installation and utilized to provide comfort heating. Such *appliances* provide radiant heat or convection heat by gravity or fan circulation directly from the heater and do not utilize ducts.~~

~~**VALVE.** A device used in *piping* to control the gas supply to any section of a system of *piping* or to an *appliance*.~~

~~**Appliance shutoff.** A *valve* located in the *piping system*, used to isolate individual *appliances* for purposes such as service or replacement.~~

~~**Automatic.** An automatic or semiautomatic device consisting essentially of a *valve* and an operator that control the gas supply to the *burner(s)* during operation of an *appliance*. The operator shall be actuated by application of gas pressure on a flexible diaphragm, by electrical means, by mechanical means or by other *approved* means.~~

~~**Automatic gas shutoff.** A *valve* used in conjunction with an automatic gas shutoff device to shut off the gas supply to a water-heating system. It shall be constructed integrally with the gas shutoff device or shall be a separate assembly.~~

~~**Individual main burner.** A *valve* that controls the gas supply to an individual *main burner*.~~

~~**Main burner control.** A *valve* that controls the gas supply to the *main burner* manifold.~~

~~**Manual main gas-control.** A manually operated *valve* in the gas line for the purpose of completely turning on or shutting off the gas supply to the *appliance*, except to *pilot* or pilots that are provided with independent shutoff.~~

~~**Manual reset.** An automatic shutoff valve installed in the gas supply *piping* and set to shut off when unsafe conditions occur. The device remains closed until manually reopened.~~

~~**Service shutoff.** A valve, installed by the serving gas supplier between the service meter or source of supply and the customer *piping system,* to shut off the entire *piping system.*~~

~~**VENT.** A *pipe* or other conduit composed of factory-made components, containing a passageway for conveying *combustion products* and air to the atmosphere, listed and labeled for use with a specific type or class of *appliance*.~~

~~**Special gas vent.** A vent listed and labeled for use with listed Category II, III and IV gas *appliances.*~~

~~**Type B vent.** A vent listed and labeled for use with *appliances* with *draft hoods* and other Category I *appliances* that are listed for use with Type B vents.~~

~~**Type BW vent.** A vent listed and labeled for use with wall *furnaces*.~~

~~**Type L vent.** A vent listed and labeled for use with *appliances* that are listed for use with Type L or Type B vents.~~

~~**VENT CONNECTOR.** See "Connector."~~

~~**VENT PIPING.**~~

~~**Breather.** *Piping* run from a pressure-regulating device to the outdoors, designed to provide a reference to *atmospheric pressure*. If the device incorporates an integral pressure *relief* mechanism, a breather vent can also serve as a *relief* vent.~~

~~**Relief.** *Piping* run from a pressure-regulating or pressure-limiting device to the outdoors, designed to provide for the safe venting of gas in the event of excessive pressure in the *gas piping system*.~~

~~**VENTED APPLIANCE CATEGORIES.** *Appliances* that are categorized for the purpose of vent selection are classified into the following four categories:~~

~~**Category I.** An *appliance* that operates with a nonpositive vent static pressure and with a vent gas temperature that avoids excessive *condensate* production in the vent.~~

~~**Category II.** An *appliance* that operates with a nonpositive *vent* static pressure and with a vent gas temperature that is capable of causing excessive *condensate* production in the vent.~~

~~**Category III.** An *appliance* that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive *condensate* production in the vent.~~

~~**Category IV.** An *appliance* that operates with a positive vent static pressure and with a vent gas temperature that is capable of causing excessive *condensate* production in the vent.~~

~~**VENTED ROOM HEATER.** A vented self-contained, free-standing, nonrecessed *appliance* for furnishing warm air to the space in which it is installed, directly from the heater without duct connections.~~

~~**VENTED WALL FURNACE.** A self-contained vented *appliance* complete with grilles or equivalent, designed for incorporation in or permanent attachment to the structure of a building, mobile home or travel trailer, and furnishing heated air circulated by gravity or by a fan directly into the space to be heated through openings in the casing. This definition shall exclude *floor furnaces, unit heaters* and *central furnaces* as herein defined.~~

~~**VENTING SYSTEM.** A continuous open passageway from the *flue collar* or *draft hood* of an *appliance* to the outdoor atmosphere for the purpose of removing flue or vent gases. A venting~~

~~system is usually composed of a vent or a chimney and *vent connector*, if used, assembled to form the open passageway.~~

~~**WALL HEATER, UNVENTED TYPE.** A room heater of the type designed for insertion in or attachment to a wall or partition. Such heater does not incorporate concealed venting arrangements in its construction and discharges all products of *combustion* through the front into the room being heated.~~

~~**WATER HEATER.** Any heating *appliance* or *equipment* that heats potable water and supplies such water to the potable hot water distribution system.~~

SECTION G2404 (301)

GENERAL

> **G2404.9.1 (301.14.1) Foundation and exterior wall sealing.**
> Annular spaces around pipes, electric cables, conduits or other openings in the walls shall be protected against the passage of rodents by closing such opening with cement mortar, concrete masonry, silicone caulking or noncorrosive metal.

G2404.10 (307.1) Evaporators and cooling coils.
Condensate drainage systems shall be provided for *equipment* and appliances containing evaporators and cooling coils in accordance with the *International Mechanical Code.*

G2404.11 (307.2) Fuel-burning appliances.
Liquid combustion byproducts of condensing appliances shall be collected and discharged to an *approved* plumbing fixture or disposal area in accordance with the manufacturer's instructions. Condensate *piping* shall be of *approved* corrosion-resistant material and shall be not smaller than the drain connection on the *appliance*. Such *piping* shall maintain a minimum slope in the direction of discharge of not less than one-eighth unit vertical in 12 units horizontal (1-percent slope).

~~**G2404.10**~~ **G2404.12 (307.5) Auxiliary drain pan.**
Category IV condensing *appliances* shall be provided with an auxiliary drain pan where damage to any building component will occur as a result of stoppage in the *condensate* drainage system. Such pan shall be installed in accordance with the applicable provisions of Section M1411.

> **Exception:** An auxiliary drain pan shall not be required for *appliances* that automatically shut down operation in the event of a stoppage in the *condensate* drainage system.

~~**G2404.11**~~ **G2404.13 (307.6) Condensate pumps.**
Condensate pumps located in uninhabitable spaces, such as attics and crawl spaces, shall be connected to the *appliance* or *equipment* served such that when the pump fails, the *appliance* or *equipment* will be prevented from operating. Pumps shall be installed in accordance with the manufacturer's instructions.

SECTION G2405 (302)

STRUCTURAL SAFETY

G2405.1.1 (302.3) Cutting, notching and boring in wood members.

The cutting, notching and boring of wood members shall comply with Sections G2405.1.1.1 through G2405.1.1.3.

G2405.1.1.1 (302.3.2) Joist notching and boring.

Notching at the ends of joists shall not exceed one-fourth the joist depth. Holes bored in joists shall not be within 2 inches (51 mm) of the top and bottom of the joist and their diameters shall not exceed one-third the depth of the member. Notches in the top or bottom of the joist shall not exceed one-sixth the depth and shall not be located in the middle one-third of the span.

G2405.1.1.2 (302.3.3) Stud cutting and notching.

In exterior walls and bearing partitions, any wood stud is permitted to be cut or notched to a depth not exceeding 25 percent of its width. Cutting or notching of studs to a depth not greater than 40 percent of the width of the stud is permitted in nonload-bearing partitions supporting no loads other than the weight of the partition.

G2405.1.1.3 (302.3.4) Bored holes.

The diameter of bored holes in wood studs shall not exceed 40 percent of the stud depth. The diameter of bored holes in wood studs shall not exceed 60 percent of the stud depth in nonbearing partitions. The diameter of bored holes in wood studs shall not exceed 60 percent of the stud depth in any wall where each stud is doubled, provided that not more than two such successive doubled studs are so bored. The edge of the bored hole shall be not closer than 5/8 inch (15.9 mm) to the edge of the stud. Bored holes shall not be located at the same section of stud as a cut or notch.

G2405.3 (302.3.1) Engineered wood products.

Cuts, notches and holes bored in trusses, structural composite lumber, structural glued-laminated members and I-joists are prohibited except where permitted by the manufacturer’s recommendations or where the effects of such *alterations* are specifically considered in the design of the member by a registered design professional.

G2405.4 (302.5) Cutting, notching and boring holes in structural steel framing.

The cutting, notching and boring of holes in structural steel framing members shall be as prescribed by the registered design professional.

G2405.5 (302.6) Cutting, notching and boring holes in cold-formed steel framing.

Flanges and lips of load-bearing, cold-formed steel framing members shall not be cut or notched. Holes in webs of load-bearing, cold-formed steel framing members shall be permitted along the centerline of the web of the framing member and shall not exceed the dimensional limitations, penetration spacing or minimum hole edge distance as prescribed by the registered design professional. Cutting, notching and boring holes of steel floor/ roof decking shall be as prescribed by the registered design professional.

G2405.6 (302.7) Cutting, notching and boring holes in nonstructural cold-formed steel wall framing.

Flanges and lips of nonstructural cold-formed steel wall studs shall be permitted along the centerline of the web of the framing member, shall not exceed 1 1/2 inches (38 mm) in width or 4 inches (102 mm) in length, and the holes shall not be spaced less than 24 inches (610 mm) center to center from another hole or less than 10 inches (254 mm) from the bearing end.

SECTION G2406 (303)

APPLIANCE LOCATION

G2406.1 (303.1) General.
Appliances shall be located as required by this section, specific requirements elsewhere in this code and the conditions of the *equipment* and *appliance* listing. See Section M1305 for appliance access requirements.

G2406.2 (303.3) Prohibited locations.
Appliances shall not be located in sleeping rooms, bathrooms, toilet rooms, closets used for storage ~~storage closets~~ or surgical rooms, or in a space that opens only into such rooms or spaces, except where the installation complies with one of the following:

1. The *appliance* is a direct-vent *appliance* installed in accordance with the conditions of the listing and the manufacturer's instructions.

2. *Vented room heaters*, wall *furnaces*, vented decorative *appliances*, vented gas *fireplaces*, vented gas *fireplace* heaters and decorative *appliances* for installation in vented solid fuel-burning *fireplaces* are installed in rooms that meet the required volume criteria of Section G2407.5.

3. A single wall-mounted *unvented room heater* is installed in a bathroom and such *unvented room heater* is equipped as specified in Section G2445.6 and has an input rating not greater than 6,000 *Btu*/h (1.76 kW). The bathroom shall meet the required volume criteria of Section G2407.5.

4. A single wall-mounted *unvented room heater* is installed in a bedroom and such *unvented room heater* is equipped as specified in Section G2445.6 and has an input rating not greater than 10,000 *Btu*/h (2.93 kW). The bedroom shall meet the required volume criteria of Section G2407.5.

5. The *appliance* is installed in a room or space that opens only into a bedroom or bathroom, and such room or space is used for no other purpose and is provided with a solid weather-stripped door equipped with an *approved* self-closing device. All *combustion air* shall be taken directly from the outdoors in accordance with Section G2407.6.

G2406.4 (303.7) Pit locations.
Appliances installed in pits or excavations shall not come in direct contact with the surrounding soil. The sides of the pit or excavation shall be held back a minimum of 12 inches (305 mm) from the *appliance*. Where the depth exceeds 12 inches (305 mm) below adjoining grade, the walls of the pit or excavation shall be lined with concrete or masonry, such concrete or masonry shall extend a minimum of 4 inches (102 mm) above adjoining grade and shall have sufficient lateral load-bearing capacity to resist collapse.

G2406.5 (303.8) Drainage.

Below-grade installations shall be provided with a natural drain or an automatic lift or sump pump.

G2406.6 (303.4) Protection from vehicle impact damage.
Appliances shall not be installed in a location subject to vehicle impact damage except where protected by an *approved* means. Protection is not required for appliances located out of the vehicle's normal travel path.

G2406.7 (303.5) Indoor locations.
Furnaces and boilers installed in closets and alcoves shall be *listed* for such installation.

SECTION G2408

(305) INSTALLATION

G2408.3 (305.5) Private garages.
Appliances located in private garages shall be installed with a minimum *clearance* of 6 feet (1829 mm) above the floor.

> **Exception:** The requirements of this section shall not apply where the *appliances* are protected from motor vehicle impact and installed in accordance with Section G2408.2 and G2406.4.

G2408.4 (305.7) ~~Clearances from grade.~~ Under-floor and exterior grade installations.
~~*Equipment* and *appliances* installed at grade level shall be supported on a level concrete slab or other *approved* material extending not less than 3 inches (76 mm) above adjoining grade or shall be suspended not less than 6 inches (152 mm) above adjoining grade. Such supports shall be installed in accordance with the manufacturer's instructions.~~

G2408.4.1 (305.7.1) Exterior grade installations.
Equipment and appliances installed above grade level shall be supported on a solid base or on approved material that is a minimum of 2 inches (51 mm) thick.

G2408.4.2 (305.7.2) Under-floor installation.
Suspended equipment shall be a minimum of 6 inches (152 m) above the adjoining grade.

G2408.4.3 (305.7.3) Crawl space supports.
A support shall be provided at each corner of the unit not less than 8 inches by 8 inches (204 mm by 204 mm). The unit shall be supported a minimum of 2 inches (51 mm) above grade. When constructed of brick, the bricks shall be mortared together. All units stacked shall be mortared together. Fabricated units, formed concrete, or other approved materials shall be permitted.

G2408.4.4 (303.7) Pit Locations.
Appliances installed in pits shall be installed in accordance with Section G2406.4.

G2408.4.5 (305.7.4) Drainage.
Below-grade installations shall be provided with a natural drain or an automatic lift or sump pump. For pit requirements, see Section G2406.4.

SECTION G2410 (309)

ELECTRICAL

G2410.2 (309.2) Connections.
Electrical connections between *appliances* and the building wiring, including the grounding of the *appliances,* shall conform to ~~Chapters 34 through 43~~ the *North Carolina Electrical Code*.

SECTION G2411 (310)

ELECTRICAL BONDING

G2411.1.1 (310.1.1) CSST.
~~Corrugated stainless steel tubing (CSST) gas *piping* systems and piping systems containing one or more segments of CSST shall be bonded to the electrical service grounding electrode system or, where provided, the lightning protection electrode system.~~
Corrugated stainless steel tubing (CSST) gas *piping* systems and piping systems containing one or more segments of CSST shall be bonded to the electrical service grounding electrode system.

> **Exception:** CSST with an arc-resistant jacket tested in accordance with ANSI LC 1, and listed by an *approved* agency for installation without the direct bonding, as prescribed in this section, shall be installed in accordance with Section G2411.1 and the manufacturer's installation instructions.

SECTION G2412 (401)

GENERAL

G2412.2 (401.2) Liquefied petroleum gas storage.
~~The storage system for *liquefied petroleum gas* shall be designed and installed in accordance with the *International Fire Code* and NFPA 58.~~
The enforcement of the location of undiluted liquefied petroleum gas containers shall be the responsibility of the North Carolina Department of Agriculture and Consumer Services in accordance with Article 5 of Chapter 119 of the North Carolina General Statutes.

G2412.5 (401.5) Identification.
~~For other than steel *pipe*, exposed *piping* shall be identified by a yellow label marked "Gas" in black letters. The marking shall be spaced at intervals not exceeding 5 feet (1524 mm). The marking shall not be required on *pipe* located in the same room as the *appliance* served.~~
Exposed *piping* shall be identified by a yellow label marked "Gas" in black letters. The marking shall be spaced at intervals not exceeding 5 feet (1524 mm). All piping and tubing systems, greater than 0.5-pounds per square inch (3.45 kPa) service pressure, shall be identified by a yellow label with black letters indicating the piping system pressure. The system shall be marked at the beginning, all ends and at intervals not exceeding 5 feet (1524 mm) along its exposed length.

Exceptions:

1. Gas lines extending from the undiluted liquefied petroleum gas storage tanks to the building are not required to be labeled.

2. Black steel piping, 0.5-pounds per square inch (3.45 kPa) or less, located at dwelling units shall not be required to be labeled.

G2412.7 (401.7) Piping meter identification.
Piping from multiple *meter* installations shall be marked with ~~an *approved*~~ a permanent identification by the installer so that the *piping system* supplied by each *meter* is readily identifiable.

G2412.9 (401.9) ~~Identification.~~ Meter location.
~~Each length of pipe and tubing and each pipe fitting, utilized in a fuel gas system, shall bear the identification of the manufacturer.~~
When required, a meter shall be provided for the building or residence to be served. The location shall be such that the meter can be read, serviced or changed. The location, space requirements, dimensions and proper clearances shall be acceptable to the local gas company.

G2412.10 (401.10) Third-party testing and certification. Deleted.
~~Piping, tubing and fittings shall comply with the applicable referenced standards, specifications and performance criteria of this code and shall be identified in accordance with Section G2412.9. Piping, tubing and fittings shall either be tested by an approved third-party testing agency or certified by an approved *third-party certification agency*.~~

SECTION G2413 (402)

PIPE SIZING

G2413.2 (402.2) Maximum gas demand.
~~The volumetric flow rate of gas to be provided shall be the sum of the maximum input of the *appliances* served.~~

~~The total connected hourly load shall be used as the basis for pipe sizing, assuming that all appliances could be operating at full capacity simultaneously. Where a diversity of load can be established, pipe sizing shall be permitted to be based on such loads.~~

~~The volumetric flow rate of gas to be provided shall be adjusted for altitude where the installation is above 2,000 feet (610 m) in elevation.~~
The volume of gas to be provided, in cubic feet per hour, (MBtu for undiluted propane) shall be determined directly from the manufacturer’s input ratings of the appliances served. Where an input rating is not indicated, the gas supplier, *appliance* manufacturer or a qualified agency shall be contacted. The total connected hourly load shall be used as the basis for pipe sizing, assuming that all appliances could be operating at full capacity simultaneously. Where a diversity of load can be established, pipe sizing shall be permitted to be based on such loads.

G2413.4 (402.4) Sizing tables and equations.
Where Tables G2413.4(1) through ~~G2413.4(21)~~ G2413.4(23) are used to size *piping* or *tubing*, the *pipe* length shall be determined in accordance with Section G2413.4.1, G2413.4.2 or G2413.4.3.

Where Equations 24-3 and 24-4 are used to size *piping* or *tubing*, the *pipe* or *tubing* shall have smooth inside walls and the pipe length shall be determined in accordance with Section G2413.4.1, G2413.4.2 or G2413.4.3.

1. Low-pressure gas equation [Less than $1^{1}/_{2}$ pounds per square inch (psi) (10.3 kPa)]:

$$D = \frac{Q^{0.381}}{19.17\left(\frac{\Delta H}{C_r \times L}\right)^{0.206}}$$

(Equation 24-3)

2. High-pressure gas equation [1.5 psi (10.3 kPa) and above]:

$$D = \frac{Q^{0.381}}{18.93\left[\frac{(P_1^2 - P_2^2) \times Y}{C_r \times L}\right]^{0.206}}$$

(Equation 24-4)

where:

D = Inside diameter of *pipe*, inches (mm).
Q = Input rate *appliance(s)*, cubic feet per hour at 60ºF (16ºC) and 30-inch mercury column.
P_1 = Upstream pressure, psia (P_1 + 14.7).
P_2 = Downstream pressure, psia (P_2 + 14.7).
L = Equivalent length of *pipe*, feet.
D*H* = *Pressure drop*, inch water column (27.7 inch water column = 1 psi).

TABLE G2413.4(22) [402.4(38)]
POLYETHYLENE PLASTIC TUBING

Gas	Undiluted Propane
Inlet Pressure	10 psi
Pressure Drop	1.0 psi
Specific Gravity	1.50

INTENDED USE	**PE pipe sizing between first stage and second stage regulator.**					
PLASTIC TUBING SIZE (inches)						
Nominal OD	**$^{1}/_{2}$**	**$^{3}/_{4}$**	**1**	**$1^{1}/_{4}$**	**$1^{1}/_{2}$**	**2**
Designation	**SDR 9.33**	**SDR 11**	**SDR 11**	**SDR 10**	**SDR 11**	**SDR 11**
Actual ID	**0.660**	**0.860**	**1.077**	**1.328**	**1.554**	**1.943**
Length (ft)	**Capacity in Thousands of Btu per Hour**					
10	3,836	7,680	13,857	24,007	36,254	65,140
20	2,636	4,239	7,648	16,500	24,917	44,770
30	2,143	4,292	7,744	13,416	20,260	36,402

40	1,835	3,673	6,628	11,482	17,340	31,155
50	1,626	3,256	5,874	10,176	15,368	27,612
60	1,473	2,950	5,322	9,220	13,924	25,019
70	1,355	2,714	4,896	8,483	12,810	23,017
80	1,261	2,525	4,555	7,891	11,918	21,413
90	1,183	2,369	4,274	7,404	11,182	20,091
100	1,117	2,238	4,037	6,994	10,562	18,978
125	990	1,983	3,578	6,199	9,361	16,820
150	897	1,797	3,242	5,616	8,482	15,240
175	826	1,653	2,983	5,467	7,803	14,020
200	678	1,539	2,775	4,807	7,259	13,043
225	721	1,443	2,603	4,510	6,811	12,238
250	681	1,363	2,459	4,260	6,434	11,560
275	646	1,294	2,336	4,046	6,111	10,979
300	617	1,235	2,228	3,860	5,830	10,474
350	567	1,136	2,050	3,551	5,363	9,636
400	528	1,057	1,907	3,304	4,989	8,965
450	495	992	1,789	3,100	4,681	8,411
500	468	937	1,690	2,928	4,422	7,945
600	424	849	1,531	2,653	4,007	7,199
700	390	781	1,409	2,441	3,686	6,623
800	363	726	1,311	2,271	3,429	6,161
900	340	682	1,230	2,131	3,217	5,781
1,000	322	644	1,162	2,012	3,039	5,461
1,500	258	517	933	1,616	2,441	4,385
2,000	221	443	798	1,383	2,089	3,753

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.2931 W.

TABLE G2413.4(23) [402.4(39)]
POLYETHYLENE PLASTIC TUBING

Gas	Undiluted Propane
Inlet Pressure	10.0 psi
Pressure Drop	1.0 psi
Specific Gravity	1.50

INTENDED USE: PE pipe sizing between first stage and second stage regulator.		
Plastic Tubing Size (CTS) (inch)		
Nominal OD	**1/2**	**1**
Designation	**SDR 7**	**SDR 11.5**
Actual ID	**0.445**	**0.927**
Length (ft)	**Capacity in thousands of Btu per Hour**	
10	1,364	9,350
20	938	6,427
30	762	5,225
40	653	4,472
50	578	3,964
60	524	3,591
70	482	3,304
80	448	3,074

90	421	2,884
100	397	2,724
125	352	2,414
150	319	2,188
175	294	2,013
200	273	1,872
225	256	1,757
250	242	1,659
275	230	1,576
300	219	1,503
350	202	1,383
400	188	1,287
450	176	1,207
500	166	1,140
600	151	1,033
700	139	951
800	129	884
900	121	830
1,000	114	784
1,500	92	629
2,000	79	539

For SI:1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.2931 W.

SECTION G2414 (403)

PIPING MATERIALS

G2414.8 (403.8) Protective coating.

Where in contact with material or atmosphere exerting a corrosive action, metallic *piping* and fittings coated with a corrosion-resistant material shall be used. External or internal coatings or linings used on *piping* or components shall not be considered as adding strength. See Section G2415.6 for corrosion protection through an exterior wall, and Section G2415.11 for specific underground installations.

G2414.10.1 (403.10.1) Pipe joints.

~~*Pipe* joints shall be threaded, flanged, brazed or welded. Where nonferrous *pipe* is brazed, the *brazing* materials shall have a melting point in excess of 1,000ºF (538ºC). *Brazing* alloys shall not contain more than 0.05-percent phosphorus.~~

Pipe joints shall be threaded, flanged, brazed, or welded, or made with press-connect fittings complying with ANSI LC-4. Where nonferrous pipe is brazed, the brazing materials shall have a melting point in excess of 1,000°F (538°C). Brazing alloys shall not contain more than 0.05-percent phosphorous.

SECTION G2415 (404)

PIPING SYSTEM INSTALLATION

G2415.6 (404.6) ~~Underground penetrations prohibited.~~ Piping through foundation wall.

~~Gas *piping* shall not penetrate building foundation walls at any point below grade. Gas *piping*~~

~~shall enter and exit a building at a point above grade and the annular space between the *pipe* and the wall shall be sealed.~~
Underground piping, where installed below grade through the outer foundation or basement wall of a building, shall be encased in a protective pipe sleeve, or shall be protected by an approved device or method. The annular space between the gas piping and the sleeve and between the sleeve and the wall shall be sealed.

G2415.7.1 (404.7.1) Piping through bored holes or notches.

Where *piping* is installed through holes or notches in framing members and the *piping* is located less than $1^{1}/_{2}$ inches (38 mm) from the framing member face to which wall, ceiling or floor membranes will be attached, the pipe shall be protected by shield plates that cover the width of the pipe and the framing member and that extend not less than 4 inches (51 mm) to each side of the framing member(s). Where the framing member that the *piping* passes through is a bottom plate, bottom track, top plate or top track, the shield plates shall cover the framing member and extend not less than 4 inches (51 mm) above the bottom framing member(s) and not less than 4 inches (51 mm) below the top framing member(s).

G2415.7.2 (404.7.2) Piping installed in other locations.

Where the *piping* is located within a framing member (i.e. steel studs) and is less than $1^{1}/_{2}$ inches (38 mm) from the framing member face to which wall, ceiling or floor membranes will be attached, the *piping* shall be protected by shield plates that cover the width and length of the *piping*. Where the *piping* is located outside of a framing member and is located less than $1^{1}/_{2}$ inches (38 mm) from the nearest edge of the face of the framing member to which the membrane will be attached, the *piping* shall be protected by shield plates that cover the width and length of the *piping*.

G2415.9 (404.9) Above-ground piping outdoors.

P*iping* installed outdoors shall be elevated not less than $3^{1}/_{2}$ inches (152 mm) above ground and where installed across roof surfaces, shall be elevated not less than $3^{1}/_{2}$ inches (152 mm) above the roof surface. *Piping* installed above ground, outdoors, and installed across the surface of roofs shall be securely supported and located where it will be protected from physical damage. Where passing through an outside wall, the *piping* shall also be protected against corrosion by coating or wrapping with an inert material. Where *piping* is encased in a protective pipe sleeve, the annular space between the *piping* and the sleeve shall be sealed.

Ferrous metal exposed in exterior locations shall be protected from corrosion with one coat of exterior paint. Zinc coatings (galvanized) shall be deemed adequate protection for gas piping above ground.

G2415.10 (404.10) Isolation.

Metallic *piping* and metallic *tubing* that conveys *fuel gas* from an LP-gas storage container shall be provided with an *approved* dielectric fitting to electrically isolate the underground portion of the pipe or tube from the above ground portion that enters a building. Such dielectric fitting or dielectric regulator shall be installed above ground outdoors.

G2415.11 (404.11) Protection against corrosion underground.

Metallic pipe or *tubing* exposed to corrosive action, such as soil condition or moisture, shall be protected in an *approved* manner. Zinc coatings (galvanizing) shall not be deemed adequate protection for *gas piping* underground. Where dissimilar metals are joined underground, an insulating coupling or fitting shall be used. *Piping* shall not be laid in contact with cinders.

G2415.11.2 (404.11.2) Protective coatings and wrapping.

Pipe protective coatings and wrappings shall be *approved* for the application and shall be factory applied.

Exception: Where installed in accordance with the manufacturer's instructions, field application of coatings and wrappings shall be permitted. ~~for pipe nipples, fittings and locations where the factory coating or wrapping has been damaged or necessarily removed at joints~~.

G2415.12 (404.12) Minimum burial depth.

Underground *piping systems* shall be installed a minimum depth of 12 inches (305 mm) below grade, except as provided for in Section G2415.12.1 and G2415.12.2.

G2415.12.2 (404.12.2) Alternate to burial depth.

Metal piping shall be provided with a protective conduit of wrought iron, plastic pipe, or steel pipe, and topped with a 3 inch (76 mm) thick by 6 inch (152 mm) wide concrete barrier. See Section G2415.17 for plastic gas pipe requirements and limitations.

SECTION G2417 (406)

INSPECTION, TESTING AND PURGING

G2417.1 (406.1) General.

Prior to acceptance and initial operation, all *piping* installations shall be visually inspected and pressure tested to determine that the materials, design, fabrication and installation practices comply with the requirements of this code.
(See NC GS 143-139.3 for alternate inspection of liquefied propane gas piping systems for residential structures.)

G2417.4.1 (406.4.1) Test pressure.

The test pressure to be used shall be not less than $1^{1}/_{2}$ times the proposed maximum working pressure, but not less than ~~3 psig (20 kPa gauge)~~ 10 psig (69 kPa gauge), irrespective of design pressure. Where the test pressure exceeds 125 psig (862 kPa gauge), the test pressure shall not exceed a value that produces a hoop stress in the *piping* greater than 50 percent of the specified minimum yield strength of the pipe.

Exception: Fuel piping system that are being tested with manifolds, regulator or other pressure regulating appliance in place at the time of the test shall be tested no less than 11/2 times the proposed maximum working pressure, but not less than 3 psig (20 kPa gauge), irrespective of design pressure.

G2417.4.2.1 (406.4.3) Test gauges.

Gauges used for testing shall be as follows:

1. Tests requiring a pressure of 10 pounds per square inch (psi) (69 kPa) or less shall utilize a testing gauge having increments of 0.10 psi (0.69 kPa) or less.
2. Tests requiring a pressure of greater than 10 psi (69 kPa) but less than or equal to 100 psi (689 kPa) shall utilize a testing gauge having increments of 1 psi (6.9 kPa) or less.
3. Tests requiring a pressure of greater than 100 psi (689 kPa) shall utilize a testing gauge having increments of 2 psi (14 kPa) or less.

G2417.5.1 (406.5.1) Detection methods.

The leakage shall be located by means of an *approved* gas detector, a noncorrosive leak detection fluid or other *approved* leak detection methods.

Matches, candles, open flames or other methods that could provide a source of ignition shall not be used.

G2417.7.1.1 (406.7.1.1) Removal from service.

Where existing gas piping is opened, the section that is opened shall be isolated from the gas supply and the line pressure vented to the outdoors in accordance with Section G2417.7.1.3. Where gas *piping* meeting the criteria of Table G2417.7.1.1 is removed from service, the residual fuel gas in the *piping* shall be displaced with an inert gas.

G2417.7.1.1.1 (406.7.1.1.1) Piping added to facilitate purging.

Any piping added to facilitate purging to the outdoors shall be limited to the piping materials allowed and installed per Section G2414, or, if constantly attended, the temporary use of flexible hose complying with ANSI/UL 21 standard shall be used in accordance with NFPA 58.

Exception: If the line pressure cannot be vented to the outdoors; the building and all effected spaces shall be evacuated of personnel not involved with purging the gas lines, quantities of flammable gas shall not exceed 25 percent of the lower explosive limit (1.0-percent fuel/air mixture for natural gas or 0.6-percent fuel/air mixture for LP-gas) as measured by a combustible gas detector, all ignition sources shall be eliminated, and adequate ventilation to prevent accumulation of flammable gases shall be provided.

G2417.7.2.1 (406.7.2.1) Purging procedure.

The *piping system* shall be purged in accordance with one or more of the following:

1. The *piping* shall be purged with fuel gas and shall discharge to the outdoors.
2. The *piping* shall be purged with fuel gas and shall discharge to the indoors or outdoors through an *appliance* burner not located in a combustion chamber. Such burner shall be provided with a continuous source of ignition.

3. The *piping* shall be purged with fuel gas and shall discharge to the indoors or outdoors through a burner that has a continuous source of ignition and that is designed for such purpose.

4. The *piping* shall be purged with fuel gas that is discharged to the indoors or outdoors, and the point of discharge shall be monitored with a listed combustible gas detector in accordance with Section G2417.7.2.2. Purging shall be stopped when fuel gas is detected.

5. ~~The *piping* shall be purged by the gas supplier in accordance with written procedures~~. Deleted.

G2417.7.4 (406.7.4) Personnel training.
Personnel performing purging operation shall be trained according to the hazards associated with purging and shall not rely on odor when monitoring the concentration of combustible gas.

SECTION G2419 (408)

DRIPS AND SLOPED PIPING

G2419.1 (408.1) Slopes. Deleted.

~~*Piping* for other than dry gas conditions shall be sloped not less than 1/4 inch in 15 feet (6.4 mm in 4572 mm) to prevent traps~~.

G2419.2 (408.2) Drips. Deleted.
~~Where wet gas exists, a *drip* shall be provided at any point in the line of pipe where *condensate* could collect. A *drip* shall also be provided at the outlet of the *meter* and shall be installed so as to constitute a trap wherein an accumulation of *condensate* will shut off the flow of gas before the *condensate* will run back into the *meter*.~~

G2419.3 (408.3) Location of drips. Deleted.
~~*Drips* shall be provided with *ready access* to permit cleaning or emptying. A *drip* shall not be located where the *condensate* is subject to freezing.~~

G2419.4 (408.4) Sediment trap.
Where a sediment trap is not incorporated as part of the appliance, a sediment trap shall be installed downstream of the appliance shutoff valve as close to the inlet of the appliance as practical. The sediment trap shall be either a tee fitting having a capped nipple of any length installed vertically in the bottommost opening of the tee as illustrated in Figure G2419.4 or other device approved as an effective sediment trap. Illuminating appliances, ranges, clothes dryers, log lighters, gas logs, decorative vented appliances for installation in vented fireplaces, gas fireplaces and outdoor grills need not be so equipped. The sediment trap required by a MP regulator can act as the Section G2419.4 required sediment trap, (See Section G2421.2 Item 5), if it is located within 6 feet (nom.) of appliance.

SECTION G2420 (409)

SHUTOFF VALVES

G2420.2 (409.2) Meter valve. Deleted.
~~Every *meter* shall be equipped with a shutoff valve located on the supply side of the *meter*.~~

G2420.5.1 (409.5.1) Located within same room.
The shutoff valve shall be located in the same room as the *appliance*. The shutoff valve shall be within 6 feet (1829 mm) of the *appliance*, and shall be installed upstream of the union, connector or quick disconnect device it serves. Such shutoff *valves* shall be provided with access. *Appliance shutoff valves* located in the firebox of a *fireplace* shall be installed in accordance with the *appliance* manufacturer's instructions.

This section shall not prohibit the use or the installation of gas shutoff valves in the firebox of fireplaces serving listed gas appliances.

G2420.5.3 (409.5.3) Located at manifold. Deleted.
~~Where the *appliance* shutoff valve is installed at a manifold, such shutoff valve shall be located within 50 feet (15 240 mm) of the *appliance* served and shall be readily accessible and permanently identified. The *piping* from the manifold to within 6 feet (1829 mm) of the *appliance* shall be designed, sized and installed in accordance with Sections G2412 through G2419~~.

SECTION G2421 (410)

FLOW CONTROLS

G2421.2 (410.2) MP regulators.
MP *pressure regulators* shall comply with the following:

1. The MP *regulator* shall be *approved* and shall be suitable for the inlet and outlet gas pressures for the application.
2. The MP *regulator* shall maintain a reduced outlet pressure under lock-up (no-flow) conditions.
3. The capacity of the MP *regulator*, determined by published ratings of its manufacturer, shall be adequate to supply the *appliances* served.
4. The MP *pressure regulator* shall be provided with access. Where located indoors, the *regulator* shall be vented to the outdoors or shall be equipped with a leak-limiting device, in either case complying with Section G2421.3.
5. A tee fitting with one opening capped or plugged shall be installed between the MP *regulator* and its upstream shutoff valve. Such tee fitting shall be positioned to allow connection of a pressure-measuring instrument and to serve as a sediment trap.
6. ~~A tee fitting with one opening capped or plugged shall be installed not less than 10 pipe diameters downstream of the MP *regulator* outlet. Such tee fitting shall be positioned to allow connection of a pressure-measuring instrument.~~ A means to test pressure shall be

installed not less than 10 pipe diameters downstream of the MP regulator outlet. Such fitting shall be positioned to allow connection of a pressure-measuring instrument.

7. Where connected to rigid piping, a union shall be installed within 1 foot (304 mm) of either side of the MP regulator.

   Exception: Where other than rigid piping is connected to the MP regulator, the union is not required.

G2421.3 (410.3) Venting of regulators.

Pressure regulators that require a vent shall be vented directly to the outdoors. The vent shall be designed to prevent the entry of insects, water and foreign objects.

a. Regulator vent outlets serving propane piping shall be located 3 feet (914 mm) horizontally from openings and operable openings that are below the vent, and 5 feet (1524 mm) in any direction from direct vent appliance intakes and mechanical ventilation intakes or 1 foot (305 mm) below openings and operable openings, and 3 feet (914 mm) below direct vent and mechanical vent intakes.

b. Regulator vent outlets serving natural gas piping shall be located 3 feet (914 mm) horizontally from operable openings above the vent, and 5 feet (1524 mm) horizontally from direct vent appliance intakes and mechanical ventilation air intakes located above the vent, or 1 foot (305 mm) above openings and operable openings, and 3 feet (914 mm) above direct vent and mechanical vent intakes.

Exception: A vent to the outdoors is not required for *regulators* equipped with and labeled for utilization with an *approved* vent-limiting device installed in accordance with the manufacturer's instructions.

G2421.6 (416) Overpressure protection devices.

G2421.6.1 (416.1) Where required.

Where the serving gas supplier delivers gas at a pressure greater than 2 psi for piping systems serving appliances designed to operate at a gas pressure of 14 inches w.c. or less, overpressure protection devices shall be installed. Piping systems serving equipment designed to operate at inlet pressures greater than 14 inches w.c. shall be equipped with overpressure protection devices as required by the appliance manufacturer's installation instructions.

G2421.6.2 (416.2) Pressure limitation requirements.

The requirements for pressure limitation shall be in accordance with Sections G2421.6.2.1 through G2421.6.2.5.

G2421.6.2.1 (416.2.1) Pressure under 14 inches w.c.

Where piping systems serving appliances designed to operate with a gas supply pressure of 14 inches w.c. or less are required to be equipped with overpressure protection by Section 416.1, each overpressure protection device shall be adjusted to limit the gas pressure to each connected appliance to 2 psi or less upon a failure of the line pressure regulator.

G2421.6.2.2 (416.2.2) Pressure over 14 inches w.c.

Where piping systems serving appliances designed to operate with a gas supply pressure greater than 14 inches w.c. are required to be equipped with overpressure protection by Section G2421.6.1, each overpressure protection device shall be adjusted to limit the gas pressure to each connected appliance as required by the appliance manufacturer’s installation instructions.

G2421.6.2.3 (416.2.3) Device capability.

Each overpressure protection device installed to meet the requirements of this section shall be capable of limiting the pressure to its connected appliance(s) as required by this Section G2421.6.2.1, independently of any other pressure control equipment in the piping system.

G2421.6.2.4 (416.2.4) Failure detection.

Each gas piping system for which an overpressure protection device is required by Section G2421.6 shall be designed and installed so that a failure of the primary pressure control device(s) is detectable.

G2421.6.2.5 (416.2.5) Relief valve.

Where a pressure relief valve is used to meet the requirements of Section G2421.6, it shall have a flow capacity such that the pressure in the protected system is maintained at or below the limits specified in Section G2421.6.2.1 under all of the following conditions:

1. The line pressure regulator for which the relief valve is providing overpressure protection has failed wide open.
2. The gas pressure at the inlet of the line pressure regulator for which the relief valve is providing overpressure protection is not less than the regulator’s normal operating inlet pressure.

G2421.6.3 (416.3) Devices.

Pressure-relieving or pressure-limiting devices shall be one of the following:

1. Pressure relief valve.
2. Monitoring regulator.
3. Series regulator installed upstream from the line regulator and set to continuously limit the pressure on the inlet of the line regulator to the maximum values specified by Section G2421.6.2.1.
4. Automatic shutoff device installed in series with the line pressure regulator and set to shut off when the pressure on the downstream *piping* system reaches the maximum values specified by Section G2421.6.2.1. This device shall be designed so that it will remain closed until manually reset.

The devices specified in this section shall be installed either as an integral part of the service or line pressure regulator or as separate units. Where separate pressure-relieving or pressure-limiting devices are installed, they shall comply with Sections G2421.6.3.1 through G2421.6.3.6.

G2421.6.3.1 (416.3.1) Construction and installation.

Pressure-relieving and pressure-limiting devices shall be constructed of materials so that the operation of the devices will not be impaired by corrosion of external parts by the atmosphere or of internal parts by the gas. Pressure-relieving and pressure-limiting devices shall be designed and installed so that they can be operated to determine whether the valve is free. The devices shall be designed and installed so that they can be tested to determine the pressure at which they will operate and examined for leakage when in the closed position.

G2421.6.3.2 (416.3.2) External control piping.

External control *piping* shall be designed and installed so that damage to the control *piping* of one device will not render both the regulator and the overpressure protection device inoperative.

G2421.6.3.3 (416.3.3) Setting.

Each pressure-relieving or pressure-limiting device shall be set so that the gas pressure supplied to the connected appliances does not exceed the limits specified in Section G2421.6.2.1.

G2421.6.3.4 (416.3.4) Unauthorized operation.

Where unauthorized operation of any shutoff valve could render a pressure relieving valve or pressure-limiting device inoperative, one of the following shall be accomplished:

1. The valve shall be locked in the open position. Authorized personnel shall be instructed in the importance of leaving the shutoff valve open and of being present while the shutoff valve is closed so that it can be locked in the open position before leaving the premises.

2. Duplicate relief valves shall be installed, each having adequate capacity to protect the system, and the isolating valves and three-way valves shall be arranged so that only one relief valve can be rendered inoperative at a time.

G2421.6.3.5 (416.3.5) Vents.

The discharge stacks, vents and outlet parts of all pressure-relieving and pressure-limiting devices shall be located so that gas is safely discharged to the outdoors. Discharge stacks and vents shall be designed to prevent the entry of water, insects and other foreign material that could cause blockage. The discharge stack or vent line shall be not less than the same size as the outlet of the pressure-relieving device.

G2421.6.3.6 (416.3.6) Size of fittings, pipe and openings.

The fittings, pipe and openings located between the system to be protected and the pressure-relieving device shall be sized to prevent hammering of the valve and to prevent impairment of relief capacity.

SECTION G2422 (411)

APPLIANCE CONNECTIONS

G2422.1.2.3 (411.1.3.3) Prohibited locations and penetrations.
Connectors shall not be concealed within, or extended through, walls, floors, partitions, ceilings or *appliance* housings.

Exceptions:

1. Connectors constructed of materials allowed for *piping systems* in accordance with Section G2414 shall be permitted to pass through walls, floors, partitions and ceilings where installed in accordance with Section G2420.5.2 ~~or G2420.5.3~~.

2. Rigid steel pipe connectors shall be permitted to extend through openings in *appliance* housings.

3. *Fireplace* inserts that are factory equipped with grommets, sleeves or other means of protection in accordance with the listing of the *appliance*.

4. Semirigid *tubing* and listed connectors shall be permitted to extend through an opening in an *appliance* housing, cabinet or casing where the tubing or connector is protected against damage.

SECTION G2424 (415)

PIPING SUPPORT INTERVALS

G2424.1 (415.1) Interval of support.
Piping shall be supported at intervals not exceeding the spacing specified in Table G2424.1. Spacing of supports for CSST shall be in accordance with the CSST manufacturer's instructions.

> **Exception:** Fuel gas piping from grade-mounted propane tanks, < 2000 Gallon WC, extending from the tank into the ground, or into the building with less than 4 feet of pipe shall not require additional support.

SECTION G2425 (501)

GENERAL

G2425.4 (501.4) Minimum size of chimney or vent.
Chimneys and vents shall be sized in accordance with Sections G2427 and G2428. Examples of methodologies are shown in Appendix B.

SECTION G2426 (502)

VENTS

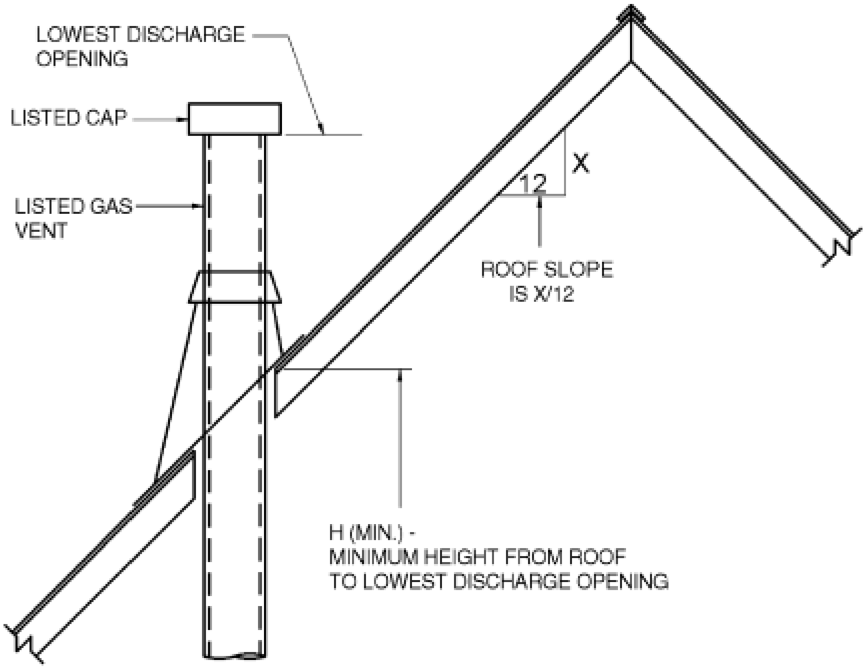
G2426.4 (502.4) Insulation shield.
Where type B, BW and L vents pass through insulated assemblies, an insulation shield

constructed of steel having a minimum thickness of 0.0187 inch (0.4712 mm) (No. 26 gage) shall be installed to provide *clearance* between the vent and the insulation material. The *clearance* shall not be less than the *clearance* to combustibles specified by the vent manufacturer's installation instructions. Where vents pass through attic space, the shield shall terminate not less than 2 inches (51 mm) above the insulation materials and shall be secured in place to prevent displacement. Insulation shields provided as part of a listed vent system shall be installed in accordance with the manufacturer's instructions.

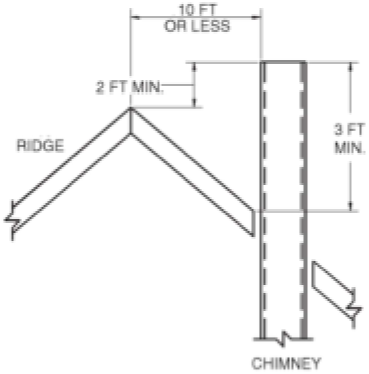
SECTION G2427 (503)

VENTING OF APPLIANCES

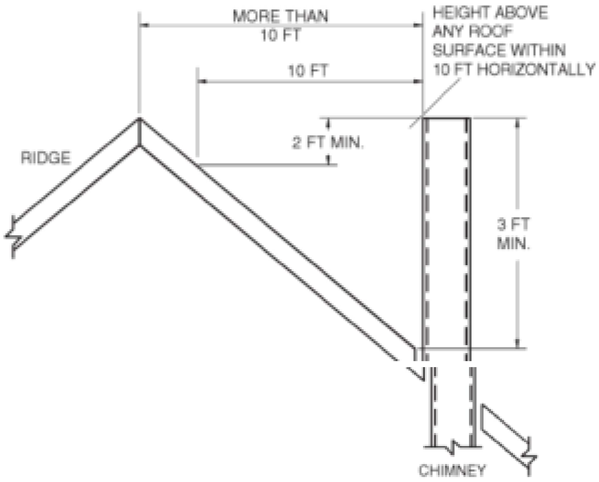
G2427.4.1.1 (503.4.1.1) (IFGS) Plastic vent joints.
Plastic *pipe* and fittings used to vent *appliances* shall be installed in accordance with the *appliance* manufacturer's instructions. Where a primer is required, it shall be of a contrasting color <u>or an ultraviolet primer in accordance with Section P2906.9.1.4.</u>



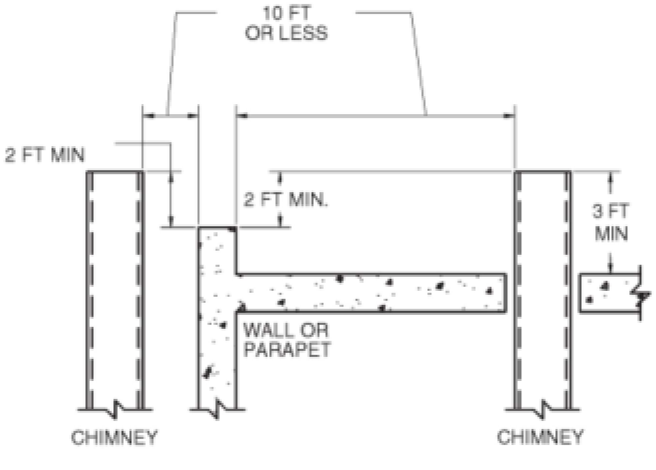
For SI: 1 foot = 304.8 mm.



A. TERMINATION 10 FT OR LESS FROM RIDGE, WALL, OR PARAPET



B. TERMINATION MORE THAN 10 FT FROM RIDGE, WALL, OR PARAPET



ROOF SLOPE	H (minimum) ft
Flat to $^{6}/_{12}$	1.0
Over $^{6}/_{12}$ to $^{7}/_{12}$	1.25
Over $^{7}/_{12}$ to $^{8}/_{12}$	1.5
Over $^{8}/_{12}$ to $^{9}/_{12}$	2.0
Over $^{9}/_{12}$ to $^{10}/_{12}$	2.5
Over $^{10}/_{12}$ to $^{11}/_{12}$	3.25
Over $^{11}/_{12}$ to $^{12}/_{12}$	4.0
Over $^{12}/_{12}$ to $^{14}/_{12}$	5.0
Over $^{14}/_{12}$ to $^{16}/_{12}$	6.0
Over $^{16}/_{12}$ to $^{18}/_{12}$	7.0
Over $^{18}/_{12}$ to $^{20}/_{12}$	7.5
Over $^{20}/_{12}$ to $^{21}/_{12}$	8.0

For SI: 1 foot = 304.8 mm

FIGURE G2427.6.3 (503.6.4)
TERMINATION LOCATIONS FOR GAS VENTS WITH LISTED CAPS 12 INCHES OR LESS IN SIZE AT LEAST 8 FEET FROM A VERTICAL WALL

G2427.6.8.3 (503.6.9.3) Category II, III and IV appliances.

The sizing of gas vents for Category II, III and IV appliances shall be in accordance with the appliance manufacturer's instructions. The sizing of plastic pipe that is specified by the appliance manufacturer as a venting material for Category II, III and IV appliances, shall be in accordance with the appliance manufacturer's instructions.

G2427.8 (503.8) Venting system termination location.

The location of venting system terminations shall comply with the following (see Appendix C):

1. A mechanical *draft* venting system shall terminate not less than 3 feet (914 mm) above any forced-air inlet located within 10 feet (3048 mm).

Exceptions:

    1. This provision shall not apply to the *combustion air* intake of a direct-vent *appliance*.

    2. This provision shall not apply to the separation of the integral outdoor air inlet and flue gas discharge of listed outdoor *appliances*.

2. A mechanical *draft* venting system, excluding *direct*-vent *appliances*, shall terminate not less than 4 feet (1219 mm) below, 4 feet (1219 mm) horizontally from, or 1 foot (305 mm) above any door, operable window or gravity air inlet into any building. The bottom of the vent terminal shall be located not less than 12 inches (305 mm) above finished ground level.

3. The vent terminal of a *direct*-vent *appliance* with an input of 10,000 *Btu* per hour (3 kW) or less shall be located not less than 6 inches (152 mm) from any air opening into a building. Such an *appliance* with an input over 10,000 *Btu* per hour (3 kW) but not over 50,000 *Btu* per hour (14.7 kW) shall be installed with a 9-inch (230 mm) vent termination *clearance*, and an *appliance* with an input over 50,000 Btu per hour (14.7 kW) shall have not less than a 12-inch (305 mm) vent termination *clearance*. The bottom of the vent terminal and the air intake shall be located not less than 12 inches (305 mm) above grade finished ground level.

4. Through-the-wall vents for Category II and IV *appliances* and noncategorized condensing *appliances* shall not terminate over public walkways or over an area where *condensate* or vapor could create a nuisance or hazard or could be detrimental to the operation of *regulators, relief valves* or other *equipment*. Where local experience indicates that *condensate* is a problem with Category I and III *appliances*, this provision shall also apply. Drains for *condensate* shall be installed in accordance with the appliance and vent manufacturer's installation instructions.

5. Vent systems for Category IV appliances that terminate through an outside wall of a building and discharge flue gases perpendicular to the adjacent wall shall be located not less than 10 feet (3048 mm) horizontally from an operable opening in an adjacent building. This requirement shall not apply to vent terminals that are 2 feet (607 mm) or more above or 25 feet (7620 mm) or more below operable openings.

    Exception: If manufacturer's installation instructions allow closer clearances, those instructions can be followed.

6. Externally mounted appliances. Vent systems for externally wall-mounted appliances shall be located as required by the manufacturer's installation instructions.

SECTION G2439 (614)

CLOTHES DRYER EXHAUST

G2439.7.1 (614.8.1) Material and size.

Exhaust ducts shall have a smooth interior finish and shall be constructed of metal a minimum ~~0.016~~ 0.0157-inch (0.4 mm) thick (28ga galv., 26 ga AL). The exhaust duct size shall be 4 inches (102 mm) nominal in diameter. With the exception of the transition duct, flexible ducts are prohibited.

G2439.7.2 (614.8.2) Duct installation.
Exhaust ducts shall be supported at 4-foot (1219 mm) intervals and secured in place. The insert end of the duct shall extend into the adjoining duct or fitting in the direction of airflow. ~~Ducts shall not be joined with screws or similar fasteners that protrude more than $^1/_8$ inch (3.2 mm) into the inside of the duct.~~ Ducts shall not be joined with screws or similar fasteners that protrude into the inside of the duct. Ducts shall be sealed in accordance with M1601.4.1.

a. Nonmetallic mechanical fasteners (tie-straps) shall be listed to UL 181B.

b. Metal band duct clamps are not required to be listed.

G2439.7.3 (614.8.3) Transition ducts.
Transition ducts used to connect the dryer to the exhaust duct system shall be a single length that is listed and labeled in accordance with UL 2158A. Transition ducts shall be not more than 8 feet (2438 mm) in length and shall not be concealed within construction, and must remain entirely within the room in which the appliance is located.

G2439.7.5 (614.8.5) Length identification.
Where the exhaust duct equivalent length exceeds 35 feet (10 668 mm), the equivalent length of the exhaust duct shall be identified on a permanent label or tag. The label or tag shall be located within 6 feet (1829 mm) of the exhaust duct connection

- Label shall be permanently stenciled, laminated, or commercially available plastic or metal tags.
- Labels shall state, at a minimum (fill in the blank):
  - Caution: Equivalent length ______ ft. Any installed dryer must be equipped with exhaust system that meets or exceeds this equivalent length requirement.
- Labels can be attached to wall or vent receptor.

G2439.7.6 (614.8.6) Exhaust duct required.
Where space for a *clothes dryer* is provided, an exhaust duct system shall be installed.

~~Where the *clothes dryer* is not installed at the time of occupancy, the exhaust duct shall be capped at location of the future dryer.~~

Exception: Where a listed condensing *clothes dryer* is installed prior to occupancy of the structure.

G2439.7.7 (614.8.7) Exhaust duct termination.
Exhaust duct shall terminate not less than 12 inches (305 mm) above finished grade.

Exception: Where the duct termination is less than 12 inches (305 mm) above finished grade an areaway shall be provided with a cross-sectional area not less than 200 square inches (1290 cm^2). The bottom of the duct termination shall be no less than 12 inches (305 mm) above the areaway bottom.

SECTION G2440 (615)

SAUNA HEATERS

G2440.7 (615.7) Sauna room.
~~A ventilation opening into the sauna room shall be provided. The opening shall be not less than 4 inches by 8 inches (102 mm by 203 mm) located near the top of the door into the sauna room.~~
A ventilation opening into the sauna room shall be provided as required by the manufacturer.

SECTION G2442 (618)

FORCED-AIR WARM-AIR FURNACES

G2442.2 (618.2) Forced-air furnaces.
The minimum unobstructed total area of the outside and return air ducts or openings to a forced-air warm-air *furnace* shall be not less than 2 square inches for each 1,000 *Btu*/h (4402 mm^2/W) output rating capacity of the *furnace* and not less than that specified in the *furnace* manufacturer's installation instructions. The minimum unobstructed total area of supply ducts from a forced-air warm-air *furnace* shall be not less than 2 square inches for each 1,000 *Btu*/h (4402 mm^2/W) output rating capacity of the *furnace* and not less than that specified in the *furnace* manufacturer's installation instructions.

With the addition of a cooling coil, the sizing criteria shall be based on 6 square inches (3870 mm^2) for each 1,000 Btu/h (13 206 mm^2/W) output.

> **Exception:** The total area of the supply air ducts and outside and return air ducts shall not be required to be larger than the minimum size required by the *furnace* manufacturer's installation instructions.

G2442.4 (618.4) Prohibited sources.
Outdoor or return air for forced-air heating and cooling systems shall not be taken from the following locations:

1. Closer than 10 feet (3048 mm) from an *appliance* vent outlet, a vent opening from a plumbing drainage system or the discharge outlet of an exhaust fan, unless the outlet is 3 feet (914 mm) above the outside air inlet.

2. Where there is the presence of objectionable odors, fumes or flammable vapors; or where located less than 10 feet (3048 mm) above the surface of any abutting public way or driveway; or where located at grade level by a sidewalk, street, alley or driveway.

3. A hazardous or insanitary location or a refrigeration machinery room as defined in the *International Mechanical Code*.

4. A room or space, the volume of which is less than 25 percent of the entire volume served by such system. Where connected by a permanent opening having an area sized in accordance with Section G2442.2, adjoining rooms or spaces shall be considered as

a single room or space for the purpose of determining the volume of such rooms or spaces.

Exception: The minimum volume requirement shall not apply where the amount of return air taken from a room or space is less than or equal to the amount of supply air delivered to such room or space.

5. A room or space containing an *appliance* where such a room or space serves as the sole source of return air.

   Exception: This shall not apply where:

   1. The *appliance* is a direct-vent *appliance* or an *appliance* not requiring a vent in accordance with Section G2425.8.

   2. The room or space complies with the following requirements:

      2.1. The return air shall be taken from a room or space having a volume exceeding 1 cubic foot for each 10 Btu/h (9.6L/W) of combined input rating of all fuel-burning appliances therein.

      2.2. The volume of supply air discharged back into the same space shall be approximately equal to the volume of return air taken from the space.

      2.3. Return-air inlets shall not be located within 10 feet (3048 mm) of a draft hood in the same room or space or the combustion chamber of any atmospheric burner *appliance* in the same room or space.

   3. Rooms or spaces containing solid fuel-burning appliances, provided that return-air inlets are located not less than 10 feet (3048 mm) from the firebox of such appliances.

6. A closet, bathroom, toilet room, kitchen, garage, boiler room, furnace room or unconditioned attic.

   Exceptions:

   1. Where return air intakes are located not less than 10 feet (3048 mm) from cooking appliances ~~and serve only the kitchen area~~, taking return air from a kitchen area shall not be prohibited.

   2. Dedicated forced air systems serving only a garage shall not be prohibited from obtaining return air from the garage.

7. ~~A crawl space by means of direct connection to the return side of a forced-air system. Transfer openings in the crawl space enclosure shall not be prohibited~~. Deleted.

G2442.7.1 (618.9) Refrigeration coils in warm-air furnaces.

When a cooling coil is located in the supply plenum of a warm-air furnace, the furnace blower shall be rated at not less than 0.5-inch water column (124 Pa) static pressure unless the furnace is listed and labeled for use with a cooling coil. Cooling coils shall not be located upstream from heat exchangers unless listed and labeled for such use. Conversion of existing furnaces for use with cooling coils shall be permitted, provided the furnace will operate within the temperature rise specified for the furnace.

G2442.7.2 (618.10) Return-air intake (nonengineered systems).
If only one central return-air grille is installed, it shall be of a size sufficient to return a volume of air compatible with the cubic foot per minute requirements and the temperature rise limitations specified by the equipment manufacturer. The face velocity of return air grilles shall not exceed 450 feet per minute (fpm) (2.3 m/s). At least one separate return shall be installed on each level of a multilevel structure. For split-level and split-foyer structures, one return may serve more than one level if located within the split area and the total area of the levels does not exceed 1,600 square feet (148.6 m^2). Return-air grilles shall not be located in bathrooms. The return air from one residential living unit shall not be mixed with the return air from other living units. In dwellings with 1,600 square feet (148.6 m^2) or less of conditioned area, a central return is permitted. When the dwelling contains more than 1,600 square feet (148.6 m^2) of conditioned area, additional returns shall be provided. Each return shall serve not more than 1,600 square feet (148.6 m^2) of area and shall be located in the area it serves. Return air may travel through the living space to the return-air intake if there are no restrictions, such as solid doors, to the air movement. Undercut doors are allowed. When panned joists are used for return air, the structural integrity shall be maintained. Air capacity for joists 16 inches (406 mm) on center shall be a maximum of 375 cubic foot per minute (0.177 m^3/s) for 8-inch (203 mm) joists and 525 cubic foot per minute (0.248 m^3/s) for 10-inch (254 mm) joists. Wiring located in spaces used for return-air ducts shall comply with the *North Carolina Electrical Code*.

SECTION G2445 (621)

UNVENTED ROOM HEATERS

G2445.7 (621.7) Unvented decorative (log) room heaters.
An unvented decorative room heater shall not be installed in a *factory-built fireplace* unless the *fireplace* system has been specifically tested, listed and labeled for such use in accordance with UL 127.

G2445.7.1 (621.7.1) Ventless firebox enclosures.
Ventless firebox enclosures used with unvented decorative (log) room heaters shall be listed as complying with ANSI Z21.91.

SECTION G2453 (634)

CHIMNEY DAMPER OPENING AREA

Deleted.

~~**G2453.1 (634.1) Free opening area of chimney dampers.**~~
~~Where an unlisted decorative *appliance* for installation in a vented *fireplace* is installed, the *fireplace damper* shall have a permanent free opening equal to or greater than specified in Table G2453.1.~~

~~TABLE G2453.1 (634.1)~~
~~FREE OPENING AREA OF CHIMNEY DAMPER FOR VENTING FLUE GASES FROM UNLISTED DECORATIVE APPLIANCES FOR INSTALLATION IN VENTED FIREPLACES~~

~~CHIMNEY HEIGHT (feet)~~	~~MINIMUM PERMANENT FREE OPENING (square inches)~~[a]						
	~~8~~	~~13~~	~~20~~	~~29~~	~~39~~	~~51~~	~~64~~
	~~Appliance input rating (Btu per hour)~~						
~~6~~	~~7,800~~	~~14,000~~	~~23,200~~	~~34,000~~	~~46,400~~	~~62,400~~	~~80,000~~
~~8~~	~~8,400~~	~~15,200~~	~~25,200~~	~~37,000~~	~~50,400~~	~~68,000~~	~~86,000~~
~~10~~	~~9,000~~	~~16,800~~	~~27,600~~	~~40,400~~	~~55,800~~	~~74,400~~	~~96,400~~
~~15~~	~~9,800~~	~~18,200~~	~~30,200~~	~~44,600~~	~~62,400~~	~~84,000~~	~~108,800~~
~~20~~	~~10,600~~	~~20,200~~	~~32,600~~	~~50,400~~	~~68,400~~	~~94,000~~	~~122,200~~
~~30~~	~~11,200~~	~~21,600~~	~~36,600~~	~~55,200~~	~~76,800~~	~~105,800~~	~~138,600~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square inch = 645.16 mm~~^{2}~~, 1,000 Btu per hour = 0.293 kW.~~

~~a. The first six minimum permanent free openings (8 to 51 square inches) correspond approximately to the cross-sectional areas of chimneys having diameters of 3 through 8 inches, respectively. The 64-square-inch opening corresponds to the cross-sectional area of standard 8-inch by 8-inch chimney tile.~~

SECTION G2455 (616)
ENGINE AND GAS TURBINE-POWERED EQUIPMENT

G2455.1 (616.1) Powered equipment.
Permanently installed *equipment* powered by internal combustion engines and turbines shall be installed in accordance with the manufacturer’s instructions and NFPA 37. Stationary engine generator assemblies shall meet the requirements of UL 2200.

G2455.2 (616.2) Gas supply connection.
Equipment powered by internal combustion engines and turbines shall not be rigidly connected to the gas supply *piping*.

Part VII—Plumbing

CHAPTER 25

PLUMBING ADMINISTRATION

~~*User note: Code change proposals to this chapter will be considered by the IRC – Plumbing and Mechanical Code Development Committee during the 2015 (Group A) Code Development Cycle. See explanation on page xvii.*~~

The text of this chapter is extracted from the 2018 edition of the *North Carolina Plumbing Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code* for One- and Two-Family Dwellings. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Plumbing Code*.

SECTION P2501
GENERAL

P2501.1 (101.1) Scope.
~~The provisions of this chapter shall establish the general administrative requirements applicable to plumbing systems and inspection requirements of this code.~~ The provisions of Chapters 25 through 33 of this code shall apply to the erection, installation, alteration, repairs, relocation, replacement, addition to, use or maintenance of plumbing systems within this jurisdiction. The installation of fuel gas distribution piping and equipment, fuel-gas-fired water heaters and water heater venting systems shall be regulated by the *International Fuel Gas Code*. Provisions in the appendices shall not apply unless specifically adopted.

P2501.2 (102.1) Application.
In addition to the general administration requirements of Chapter 1, the administrative provisions of this chapter shall also apply to the plumbing requirements of Chapters 25 through 32.

P2501.3 Intent.
The purpose of this code is to establish minimum standards to provide a reasonable level of safety, health, property protection and public welfare by regulating and controlling the design, construction, installation, quality of materials, location, operation and maintenance or use of plumbing equipment and systems.

P2501.4 Severability.
If any section, subsection, sentence, clause or phrase of this code is for any reason held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this code.

P2501.5 Appendices.
Provisions in the appendices shall not apply unless specifically adopted or referenced in this

code.

P2501.6 Requirements of other State agencies, occupational licensing board or commissions.

The North Carolina State Building Codes do not include all additional requirements for buildings and structures that may be imposed by other State agencies, occupational licensing boards and commissions. It shall be the responsibility of a permit holder, design professional, contractor or occupational license holder to determine whether any additional requirements exist.

SECTION P2502
EXISTING PLUMBING SYSTEMS

P2502.1 Existing building sewers and building drains.

~~Where the entire sanitary drainage system of an existing building is replaced, existing *building drains* under concrete slabs and existing *building sewers* that will serve the new system shall be internally examined to verify that the piping is sloping in the correct direction, is not broken, is not obstructed and is sized for the drainage load of the new plumbing drainage system to be installed.~~ Plumbing systems lawfully in existence at the time of the adoption of this code shall be permitted to have their use and maintenance continued if the use, maintenance or repair is in accordance with the original design and hazard to life, health or property is not created by such plumbing system.

P2502.3 Change in occupancy.

It shall be unlawful to make any change in the *occupancy* of any structure that will subject the structure to any special provision of this code applicable to the new *occupancy* without approval of the code official. The code official shall certify that such structure meets the intent of the provisions of law governing building construction for the proposed new *occupancy* and that such change of *occupancy* does not result in any hazard to the public health, safety or welfare.

P2502.4 Historic buildings.

The provisions of this code relating to the construction, alteration, repair, enlargement, restoration, relocation or moving of buildings or structures shall not be mandatory for existing buildings or structures identified and classified by the state or local jurisdiction as historic buildings where such buildings or structures are judged by the code official to be safe and in the public interest of health, safety and welfare regarding any proposed construction, alteration, repair, enlargement, restoration, relocation or moving of buildings.

P2502.5 Moved buildings.

Except as determined by Section P2502.1, plumbing systems that are a part of buildings or structures moved into or within the jurisdiction shall comply with the provisions of this code for new installations.

P2502.6 Referenced codes and standards.

The codes and standards referenced in this code shall be those that are listed in Chapter 44 and such codes and standards shall be considered as part of the requirements of this code to the prescribed extent of each such reference and as further regulated in Sections P2502.6.1 and P2502.6.2.

P2502.6.1 Conflicts.

Where conflicts occur between provisions of this code and the referenced standards, the provisions of this code shall apply.

P2502.6.2 Provisions in referenced codes and standards.
Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code the provisions of this code shall be the minimum requirements.

P2502.7 Requirements not covered by code.
Any requirements necessary for the strength, stability or proper operation of an existing or proposed plumbing system, or for the public safety, health and general welfare, not specifically covered by this code shall be determined by the code official.

P2502.8 Other laws.
The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law.

P2502.9 Application of references.
Reference to chapter section numbers, or to provisions not specifically identified by number, shall be construed to refer to such chapter, section or provision of this code.

SECTION P2503
INSPECTION AND TESTS

P2503.3 (312.1) Responsibility of permittee.
~~Test equipment, materials and labor shall be furnished by the permittee.~~ The permit holder shall make the applicable tests prescribed in Sections P2503.4 through P2503.8 to determine compliance with the provisions of this code. The permit holder shall give reasonable advance notice to the code official when the plumbing work is ready for tests. The equipment, material, power and labor necessary for the inspection and test shall be furnished by the permit holder and the permit holder shall be responsible for determining that the work will withstand the test pressure prescribed in the following tests. All plumbing system piping shall be tested with either water or by air. After the plumbing fixtures have been set and their traps filled with water, the entire drainage system shall be submitted to final tests. The code official shall require the removal of any cleanouts if necessary to ascertain whether the pressure has reached all parts of the system.

P2503.4 Building sewer testing. Deleted.
~~The *building sewer* shall be tested by insertion of a test plug at the point of connection with the public sewer, filling the *building sewer* with water and pressurizing the sewer to not less than 10-foot (3048 mm) head of water. The test pressure shall not decrease during a period of not less than 15 minutes. The *building sewer* shall be watertight at all points.~~

~~A forced sewer test shall consist of pressurizing the piping to a pressure of not less than 5 psi (34.5 kPa) greater than the pump rating and maintaining such pressure for not less than 15 minutes. The forced sewer shall be water tight at all points.~~

P2503.5.1 Rough plumbing.
~~DWV systems shall be tested on completion of the rough piping installation by water or, for piping systems other than plastic, by air, without evidence of leakage. Either test shall be~~

~~applied to the drainage system in its entirety or in sections after rough-in piping has been installed, as follows:~~

1. Water test. ~~Each section shall be filled with water to a point not less than 5 feet (1524 mm) above the highest fitting connection in that section, or to the highest point in the completed system. Water shall be held in the section under test for a period of 15 minutes. The system shall prove leak free by visual inspection~~. A water test shall be applied to the drainage system within the building either in its entirety or in sections. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening, and the system shall be filled with water to the point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest openings of the section under test, and each section shall be filled with water, but no section shall be tested with less than a 10-foot (3048 mm) head of water. In testing successive sections, at least the upper 10 feet (3048 mm) of the next preceding section shall be tested so that no joint or pipe in the building, except the uppermost 10 feet (3048 mm) of the system, shall have been submitted to a test of less than a 10-foot (3048 mm) head of water. This pressure shall be held for not less than 15 minutes. The system shall then be tight at all points.

    Exception: Rough plumbing testing for one- and two-family dwellings shall be as specified above except the water level shall be a minimum of 3 feet (914 mm) above the highest drainage fitting. Under slab piping systems shall be tested with a minimum of 10 feet (3048 mm) of head.

2. ~~Air test. The portion under test shall be maintained at a gauge pressure of 5 pounds per square inch (psi) (34 kPa) or 10 inches of mercury column (34 kPa). This pressure shall be held without introduction of additional air for a period of 15 minutes.~~ Drainage and vent air test. An air test shall be made by forcing air into the system until there is a uniform gauge pressure of 5 psi (34.5 kPa) or sufficient to balance a 10-inch (254 mm) column of mercury. This pressure shall be held for a test period of not less than 15 minutes. Any adjustments to the test pressure required because of changes in ambient temperatures or the seating of gaskets shall be made prior to the beginning of the test period.

P2503.6 Shower liner or pan test.

Where shower floors and receptors are made water tight by the application of materials required by Section P2709.2, the completed liner installation shall be tested. The pipe from the shower drain shall be plugged water tight for the test. The floor and receptor area shall be filled with ~~potable~~ water to a depth of not less than 2 inches (51 mm) measured at the threshold. Where a threshold of not less than 2 inches (51 mm) in height does not exist, a temporary threshold shall be constructed to retain the test water in the lined floor or receptor area to a level not less than 2 inches (51 mm) in depth measured at the threshold. The water shall be retained for a test period of not less than 15 minutes and there shall not be evidence of leakage.

P2503.7 Water-supply system testing.

~~Upon completion of the water-supply system or a section of it, the system or portion completed shall be tested and proved tight under a water pressure of not less than the working pressure of the system or, for piping systems other than plastic, by an air test of not less than 50 psi (345 kPa). This pressure shall be held for not less than 15 minutes. The water used for tests shall be obtained from a potable water source.~~ Upon completion of a section of or the entire water distribution system, the system, or portion completed, shall be tested and proved tight under a water or air test of not less than 100 psi (688 kPa). Repaired sections of existing water systems shall be tested at existing operating pressure. This pressure shall be held for not less than 15 minutes. The water utilized for tests shall be obtained from a potable source of supply. The required tests shall be performed in accordance with this section.

P2503.8 Inspection and testing of backflow prevention devices. Deleted.
~~Inspection and testing of backflow prevention devices shall comply with Sections P2503.8.1 and P2503.8.2.~~

> ~~**P2503.8.1 Inspections.**~~
> ~~Inspections shall be made of backflow prevention assemblies to determine whether they are operable.~~
>
> ~~**P2503.8.2 Testing.**~~
> ~~Reduced pressure principle, double check, double check detector and pressure vacuum breaker backflow preventer assemblies shall be tested at the time of installation, immediately after repairs or relocation and every year thereafter.~~

P2503.9 (312.1.1) Test gauges.
Gauges used for testing shall be as follows:

1. Tests requiring a pressure of 10 psi or less shall utilize a testing gauge having increments of 0.10 psi (0.69 kPa) or less.
2. Tests requiring a pressure ~~higher~~ greater than 10 psi (0.69 kPa) but less than or equal to 100 psi (690 kPa) shall use a testing gauge having increments of 1 psi (6.9 kPa) or less.
3. Tests requiring a pressure ~~higher~~ greater than 100 psi (690 kPa) shall use a testing gauge having increments of 2 psi (14 kPa) or less.

SECTION P2504
APPROVAL

P2504.1 Modifications.
Where there are practical difficulties involved in carrying out the provisions of this code, the code official shall have the authority to grant modifications for individual cases, upon application of the owner or owner's authorized agent, provided the code official shall first find that special individual reason makes the strict letter of this code impractical and the modification conforms to the intent and purpose of this code and that such modification does not lessen health, life and fire safety requirements. The details of action granting modifications shall be recorded and entered in the files of the plumbing inspection department.

P2504.2 Alternative materials, methods and equipment.
The provisions of this code are not intended to prevent the installation of any material or to prohibit any method of construction not specifically prescribed by this code, provided that any such alternative has been *approved.* An alternative material or method of construction shall be *approved* where the code official finds that the proposed alternative material, method or equipment complies with the intent of the provisions of this code and is not less than the equivalent of that prescribed in this code. Where the alternative material, design or method of construction is not *approved*, the code official shall respond in writing, stating the reasons why

the alternative was not *approved*.

P2504.2.1 Research reports.

Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved* sources.

P2504.3 Required testing.

Where there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternate materials or methods, the code official shall have the authority to require tests as evidence of compliance to be made at no expense to the jurisdiction.

P2504.3.1 Test methods.

Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the code official shall approve the testing procedures.

P2504.3.2 Testing agency.

Tests shall be performed by an *approved agency*.

P2504.3.3 Test reports.

Reports of tests shall be retained by the code official for the period required for retention of public records.

P2504.4 Alternative engineered design.

The design, documentation, inspection, testing and approval of an *alternative engineered design* plumbing system shall comply with Sections P2504.4.1 through P2504.4.6.

P2504.4.1 Design criteria.

An *alternative engineered design* shall conform to the intent of the provisions of this code and shall provide an equivalent level of quality, strength, effectiveness, fire resistance, durability and safety. Material, equipment or components shall be designed and installed in accordance with the manufacturer’s installation instructions.

P2504.4.2 Submittal.

The registered design professional shall indicate on the permit application that the plumbing system is an *alternative engineered design*. The permit and permanent permit records shall indicate that an *alternative engineered design* was part of the *approved* installation.

P2504.4.3 Technical data.

The registered design professional shall submit sufficient technical data to substantiate the proposed *alternative engineered design* and to prove that the performance meets the intent of this code.

P2504.4.4 Construction documents.

The registered design professional shall submit to the code official two complete sets of signed and sealed construction documents for the *alternative engineered design*. The construction documents shall include floor plans and a riser diagram of the work. Where appropriate, the construction documents shall indicate the direction of flow, all pipe sizes, grade of horizontal piping, loading, and location of fixtures and appliances.

P2504.4.5 Design approval.

Where the code official determines that the *alternative engineered design* conforms to the intent of this code, the plumbing system shall be *approved*. If the *alternative engineered design* is not *approved*, the code official shall notify the registered design professional in writing, stating the reasons thereof.

P2504.4.6 Inspection and testing.

The *alternative engineered design* shall be tested and inspected in accordance with the requirements of Section P2503.

P2504.5 Approved materials and equipment.

Materials, equipment and devices *approved* by the code official shall be constructed and installed in accordance with such approval.

P2504.5.1 Material and equipment reuse.

Materials, equipment and devices shall not be reused unless such elements have been reconditioned, tested, placed in good and proper working condition and *approved*.

SECTION P2505
TEMPORARY EQUIPMENT, SYSTEMS AND USES

P2505.1 General.

The code official is authorized to issue a permit for temporary equipment, systems and uses. Such permits shall be limited as to time of service, but shall not be permitted for more than 180 days. The code official is authorized to grant extensions for demonstrated cause.

P2505.2 Conformance.

Temporary equipment, systems and uses shall conform to the structural strength, fire safety, means of egress, accessibility, light, ventilation and sanitary requirements of this code as necessary to ensure the public health, safety and general welfare.

P2505.3 Temporary utilities.

The code official is authorized to give permission to temporarily supply utilities before an installation has been fully completed and the final certificate of completion has been issued. The part covered by the temporary certificate shall comply with the requirements specified for temporary lighting, heat or power in the code.

P2505.4 Termination of approval.

The code official is authorized to terminate such permit for temporary equipment, systems or uses and to order the temporary equipment, systems or uses to be discontinued.

P2505.5 (311.1)Toilet Facilities

Toilet facilities shall be provided for construction workers in accordance with the table below and such facilities shall be maintained in a sanitary condition. Construction worker toilet facilities of the non-sewer type shall conform to ANSI Z4.3.

Number of Employees	**Minimum Number of Facilities**
Less than 20	1 toilet
20 to 200	1 toilet & 1 urinal per 40 workers
More than 200	1 toilet & urinal per 50 workers

There shall be at least one facility for every two contiguous construction sites. Such facilities may be portable, enclosed, chemically treated, tank-tight units. Portable toilets shall be enclosed, screened and weatherproofed with internal latches. Temporary toilet facilities need not be provided on site for crews on a job site for no more than one working day and having transportation readily available to toilet facilities.

CHAPTER 26

GENERAL PLUMBING REQUIREMENTS

~~*User note: Code change proposals to this chapter will be considered by the IRC – Plumbing and Mechanical Code Development Committee during the 2015 (Group A) Code Development Cycle. See explanation on page xvii.*~~

The text of this chapter is extracted from the 2018 edition of the *North Carolina Plumbing Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code* for One- and Two-Family Dwellings. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Plumbing Code*.

SECTION P2601
GENERAL

P2601.1 (301.1) Scope.
The provisions of this chapter shall govern the installation of plumbing not specifically covered in other chapters applicable to plumbing systems. The installation of plumbing, *appliances, equipment* and systems not addressed by this code shall comply with the applicable provisions of the *International Plumbing Code*.

P2601.2 (301.3) Connections to drainage system.
Plumbing fixtures, drains, appurtenances and *appliances* used to receive or discharge liquid wastes or sewage shall be directly connected to the sanitary drainage system of the building or premises, in accordance with the requirements of this code. This section shall not be construed to prevent indirect waste connections where required by the code.

> **Exception:** ~~Bathtubs, showers, lavatories, clothes washers and laundry trays shall not be required to discharge to the sanitary drainage system where such fixtures discharge to systems complying with Sections P2910 and P2911~~. All drain, waste and vent piping associated with gray water or rain water recycling systems shall be installed in compliance with this code.

SECTION P2602
INDIVIDUAL WATER SUPPLY AND SEWAGE DISPOSAL

P2602.1 General.
The water-distribution and drainage system of any building or premises where plumbing fixtures are installed shall be connected to a public water supply or sewer system, respectively, if available. Where either a public water-supply or sewer system, or both, are not available, or connection to them is not feasible, an individual water supply or individual (private) sewage-disposal system, or both, shall be provided.

Exception: All drain, waste and vent piping associated with gray water or rain water recycling systems shall be installed in compliance with this code.

P2602.2 (309.2) Flood-resistant installation.
In flood hazard areas as established by Table R301.2(1):

1. Water supply systems shall be designed and constructed to prevent infiltration of floodwaters.

2. Pipes for sewage disposal systems shall be designed and constructed to prevent infiltration of floodwaters into the systems and discharges from the systems into floodwaters.

SECTION P2603
STRUCTURAL AND PIPING PROTECTION

P2603.3 (305.1) Protection against corrosion.
~~Metallic piping, except for cast iron, ductile iron and galvanized steel, shall not be placed in direct contact with steel framing members, concrete or masonry. Metallic piping shall not be placed in direct contact with corrosive soil. Where sheathing is used to prevent direct contact, the sheathing material thickness shall be not less than 0.008 inch (8 mil) (0.203 mm) and shall be made of plastic. Where sheathing protects piping that penetrates concrete or masonry walls or floors, the sheathing shall be installed in a manner that allows movement of the piping within the sheathing.~~ Pipes passing through concrete or cinder walls and floors or other corrosive material shall be protected against external corrosion by a protective sheathing or wrapping or other means that will withstand any reaction from the lime and acid of concrete, cinder or other corrosive material. Sheathing or wrapping shall allow for movement including expansion and contraction of piping. The wall thickness of the material shall be not less than 0.025 inch (0.64 mm).

P2603.4 (305.3) ~~Pipes through foundation walls.~~ Pipes through or under footings or foundation walls
~~A pipe that passes through a foundation wall shall be provided with a relieving arch, or a pipe sleeve shall be built into the foundation wall. The sleeve shall be two pipe sizes greater than the pipe passing through the wall.~~ Any pipe that passes within 12 inches (305 mm) of the bottom of the footing or through a foundation wall shall be provided with a relieving arch or a pipe sleeve. Pipe sleeves for foundation walls shall be built into the foundation wall. The sleeve shall be two pipe sizes greater than the pipe passing through the wall. Piping shall not be run under pier footings (refer to Section P2604). Annular spaces between sleeves and pipes shall be filled or tightly sealed in an *approved* manner. Annular spaces between sleeves and pipes in fire-resistance-rated assemblies shall be filled or tightly sealed in accordance with the *North Carolina Building Code*. Only sleeves through foundation or exterior building walls shall be sealed on both sides.

P2603.5 Freezing.
~~In localities having a winter design temperature of 32°F (0°C) or lower as shown in Table R301.2(1) of this code, a water, soil or waste pipe shall not be installed outside of a building, in exterior walls, in *attics* or crawl spaces, or in any other place subjected to freezing temperature unless adequate provision is made to protect it from freezing by insulation or heat or both. Water service pipe shall be installed not less than 12 inches (305 mm) deep and not less than 6~~

~~inches (152 mm) below the frost line.~~ Water pipes installed in a wall exposed to the exterior shall be located on the heated side of the wall insulation. In other cases water, soil and waste pipes shall not be installed outside of a building, in unconditioned attics, unconditioned utility rooms or in any other place subjected to freezing temperatures unless adequate provision is made to protect such pipes from freezing by a minimum of R-6.5 insulation determined at 75°F (24°C) in accordance with ASTM C-177 or heat or both.

Exterior water supply system piping shall be installed not less than 6 inches (152 mm) below the frost line and not less than 12 inches (305 mm) below grade.

Note: These provisions are minimum requirements, which have been found suitable for normal weather conditions. Abnormally low temperatures for extended periods may require additional provisions to prevent freezing.

P2603.5.1 Sewer depth.

Building sewers that connect to private sewage disposal systems shall be installed not less than ~~[NUMBER]~~ 3 inches (76.2 mm) below finished grade at the point of septic tank connection. *Building sewers* shall be not less than ~~[NUMBER]~~ 3 inches (76.2 mm) below grade.

SECTION P2604
TRENCHING AND BACKFILLING

P2604.1 (306.2) Trenching and bedding.

~~Where trenches are excavated such that the bottom of the trench forms the bed for the pipe, solid and continuous load-bearing support shall be provided between joints. Where over-excavated, the trench shall be backfilled to the proper grade with compacted earth, sand, fine gravel or similar granular material. Piping shall not be supported on rocks or blocks at any point. Rocky or unstable soil shall be over-excavated by two or more pipe diameters and brought to the proper grade with suitable compacted granular material.~~ Where trenches are excavated such that the bottom of the trench forms the bed for the pipe, solid and continuous load-bearing support shall be provided between joints. Bell holes, hub holes and coupling holes shall be provided at points where the pipe is joined. Such pipe shall not be supported on blocks to grade. In instances where the materials manufacturer's installation instructions are more restrictive than those prescribed by the code, the material shall be installed in accordance with the more restrictive requirement.

P2604.1.1 Over-excavation.

Where trenches are excavated below the installation level of the pipe such that the bottom of the trench does not form the bed for the pipe, the trench shall be backfilled to the installation level of the bottom of the pipe with sand or fine gravel placed in layers not greater than 6 inches (152 mm) in depth and such backfill shall be compacted after each placement.

P2604.1.2 Rock removal.

Where rock is encountered in trenching, the rock shall be removed to not less than 3 inches (76 mm) below the installation level of the bottom of the pipe, and the trench shall be backfilled to the installation level of the bottom of the pipe with sand tamped in place so as to provide uniform load-bearing support for the pipe between joints. The pipe, including the joints, shall not rest on rock at any point.

P2604.1.3 Soft load-bearing materials.

If soft materials of poor load-bearing quality are found at the bottom of the trench, stabilization shall be achieved by over excavating not less than two pipe diameters and backfilling to the installation level of the bottom of the pipe with fine gravel, crushed stone or a concrete foundation. The concrete foundation shall be bedded with sand tamped into place so as to provide uniform load-bearing support for the pipe between joints.

SECTION P2606
PENETRATIONS

P2606.1 (315.1) Sealing of annular spaces.

The annular space between the outside of a pipe and the inside of a pipe sleeve or between the outside of a pipe and an opening in a building envelope wall, floor, or ceiling assembly penetrated by a pipe shall be sealed with caulking material or foam sealant or closed with a gasketing system. The caulking material, foam sealant or gasketing system shall be designed for the conditions at the penetration location and shall be compatible with the pipe, sleeve and building materials in contact with the sealing materials. Annular spaces created by pipes penetrating fire-resistance-rated assemblies or membranes of such assemblies shall be sealed or closed in accordance with the building portion of this code.

SECTION P2607
WATERPROOFING OF OPENINGS

P2607.1 (305.5) Pipes penetrating roofs.

Where a pipe penetrates a roof, a flashing of lead, copper, galvanized steel or an approved elastomeric material shall be installed in manner that prevents water entry into the building. Counterflashing into the opening of pipe serving as a vent terminal shall not reduce the required internal cross-sectional area of the vent pipe to less than the internal cross-sectional area of one pipe size smaller. Joints at the roof and around vent pipes shall be made watertight by the use of lead, copper, galvanized steel, aluminum, plastic or other *approved* flashings or flashing material.

P2607.2 (305.5) Pipes penetrating exterior walls.

Where a pipe penetrates an exterior wall, a waterproof seal shall be made on the exterior of the wall by one of the following methods:

1. A waterproof sealant applied at the joint between the wall and the pipe.
2. A flashing of an approved elastomeric material.

SECTION P2609
MATERIALS EVALUATION AND LISTING

P2609.2.1 (402.2) Materials for specialty fixtures.

Materials for specialty fixtures not otherwise covered in this code shall be of stainless steel, soapstone, chemical stoneware or plastic, or shall be lined with lead, copper-base alloy, nickel-copper alloy, corrosion-resistant steel or other material especially suited to the application for which the fixture is intended.

P2609.2.2 (402.3) Sheet copper.

Sheet copper for general applications shall conform to ASTM B 152 and shall not weigh less than 12 ounces per square foot (3.7 kg/m^2).

P2609.2.3 (402.4) Sheet lead.

Sheet lead for pans shall not weigh less than 4 pounds per square foot (19.5 kg/m^2) and shall be coated with an asphalt paint or other *approved* coating.

CHAPTER 27

PLUMBING FIXTURES

~~*User note: Code change proposals to this chapter will be considered by the IRC – Plumbing and Mechanical Code Development Committee during the 2015 (Group A) Code Development Cycle. See explanation on page xvii.*~~

The text of this chapter is extracted from the 2018 edition of the *North Carolina Plumbing Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code* for One- and Two-Family Dwellings. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Plumbing Code*.

SECTION P2701
FIXTURES, FAUCETS AND FIXTURE FITTINGS

P2701.1 (402.1) Quality of fixtures.
Plumbing fixtures, faucets and fixture fittings shall have smooth impervious surfaces, shall be free from defects, shall not have concealed fouling surfaces, and shall conform to the standards indicated in Table P2701.1 and elsewhere in this code. All porcelain enameled surfaces on plumbing fixtures shall be acid resistant.

SECTION P2702
FIXTURE ACCESSORIES

P2702.1 (802.3.3) Plumbing fixtures.
Plumbing fixtures, other than water closets, shall be provided with *approved* strainers.

> ~~**Exception:** Hub drains receiving only clear water waste and standpipes shall not require strainers.~~

P2702.2 Waste fittings.
Waste fittings shall conform to ASME A112.18.2/CSA B125.2, ASTM F 409 or shall be made from pipe and pipe fittings complying with any of the standards indicated in Tables P3002.1(1) and P3002.3.

P2702.3 Plastic tubular fittings.
Plastic tubular fittings shall conform to ASTM F 409 as indicated in Table P2701.1.

P2702.4 (405.4.3) Carriers for wall-hung water closets.
Wall hung water closet bowls shall be supported by a concealed metal carrier that is attached to the building structural members so that strain is not transmitted to the closet connector or any other part of the plumbing system. Carriers for wall-hung water closets shall conform to ASME A112.6.1 or ASME A112.6.2.

SECTION P2704
ACCESS TO CONNECTIONS

P2704.1 (405.8) General.
Slip joints shall be made with an *approved* elastomeric gasket and shall be installed only on the trap outlet, trap inlet and within the trap seal. Fixtures with concealed slip-joint connections shall be provided with an access panel or utility space not less than 12 inches (305 mm) in its smallest dimension or other *approved* arrangement so as to provide access to the slip connections for inspection and repair. Where such access cannot be provided, access doors shall not be required, provided that all joints are soldered, solvent cemented or screwed to form a solid connection.

SECTION P2705
INSTALLATION

P2705.1 General.
The installation of fixtures shall conform to the following:

1. Floor-outlet or floor-mounted fixtures shall be secured to the drainage connection and to the floor, where so designed, by screws, bolts, washers, nuts and similar fasteners of copper, copper alloy or other corrosion-resistant material.
2. Wall-hung fixtures shall be rigidly supported so that strain is not transmitted to the plumbing system.
3. Where fixtures come in contact with walls and floors, the contact area shall be sealed water tight.
4. Plumbing fixtures shall be usable.
5. ~~Water closets, lavatories and bidets. A water closet, lavatory or bidet shall not be set closer than 15 inches (381 mm) from its center to any side wall, partition or vanity or closer than 30 inches (762 mm) center-to-center between adjacent fixtures. There shall be a clearance of not less than 21 inches (533 mm) in front of a water closet, lavatory or bidet to any wall, fixture or door.~~ See Figure R307.1 for minimum fixture clearances.
6. The location of piping, fixtures or equipment shall not interfere with the operation of windows or doors.
7. In flood hazard areas as established by Table R301.2(1), plumbing fixtures shall be located or installed in accordance with Section R322.1.7.
8. Integral fixture-fitting mounting surfaces on manufactured plumbing fixtures or plumbing fixtures constructed on site, shall meet the design requirements of ASME A112.19.2/CSA B45.1 or ASME A112.19.3/CSA B45.4.
9. Floor flanges for water closets or similar fixtures shall be not less than 0.125 inch (3.2 mm) thick for brass, 0.25 inch (6.4 mm) thick for plastic and 0.25 inch (6.4 mm) thick and not less than a 2-inch (51 mm) caulking depth for cast iron or galvanized malleable iron. Floor flanges of hard lead shall weigh not less than 1 pound, 9 ounces (0.7 kg) and shall

be composed of lead alloy with not less than 7.75-percent antimony by weight. Flanges shall be secured to the building structure with corrosion-resistant screws or bolts.

10. Where any fixture is provided with an overflow, the waste shall be designed and installed so that standing water in the fixture will not rise in the overflow when the stopper is closed, and no water will remain in the overflow when the fixture is empty. The overflow from any fixture shall discharge into the drainage system on the inlet or fixture side of the trap.

    Exception: The overflow from a flush tank serving a water closet or urinal shall discharge into the fixture served.

11. Fixtures shall be set level and in proper alignment with reference to adjacent walls.

SECTION P2706
WASTE RECEPTORS

P2706.1 General.

~~For other than hub drains that receive only clear-water waste and standpipes, a removable strainer or basket shall cover the waste outlet of waste receptors. Waste receptors shall not be installed in concealed spaces.~~ Every waste receptor shall be of an *approved* type. A removable strainer or basket shall cover the waste outlet of waste receptors. Waste receptors shall be installed in ventilated spaces. Waste receptors shall not be installed in plenums, attics, crawl spaces or interstitial spaces above ceilings and below floors. Waste receptors shall be readily accessible.

Exception: Hub drains.

P2706.1.1 Hub drains.

Hub drains shall be in the form of a hub or a pipe that extends not less than 1 inch (25 mm) above a water-impervious floor and shall not be required to have a strainer.

P2706.1.2 Standpipes.

~~Standpipes shall extend not less than 18 inches (457 mm) and not greater than 42 inches (1067 mm) above the trap weir.~~ Standpipes shall be individually trapped. Access shall be provided to standpipes and drains for rodding. Standpipes shall be 2 inches (51 mm) in diameter and not less than 18 inches (762 mm) or more than 48 inches (1219 mm) in height as measured from the crown weir. The standpipe shall extend 34 inches (864 mm) minimum above the base of the clothes washer unless recommended otherwise by the manufacturer. The connection of a laundry tray waste line may be made into a standpipe for the automatic clothes-washer drain. The standpipe shall extend above the flood level rim of the laundry tray. The outlet of the laundry tray shall be a maximum horizontal distance of 30 inches (762 mm) from the standpipe trap.

P2706.1.2.1 Laundry tray connection to standpipe. Deleted.
~~Where a laundry tray waste line connects into a standpipe for an automatic clothes washer drain, the standpipe shall extend not less than 30 inches (762 mm) above the standpipe trap weir and shall extend above the flood level rim of the laundry tray. The~~

~~outlet of the laundry tray shall not be greater than 30 inches (762 mm) horizontally from the standpipe trap.~~

SECTION P2707
DIRECTIONAL FITTINGS
Deleted

~~**P2707.1 Directional fitting required.**~~
~~*Approved* directional-type branch fittings shall be installed in fixture tailpieces receiving the discharge from food-waste disposer units or dishwashers.~~

SECTION P2708
SHOWERS

P2708.1 General.

Shower compartments shall have not less than 900 square inches (0.6 m^2) of interior cross-sectional area. Shower compartments shall be not less than 30 inches (762 mm) in minimum dimension measured from the finished interior dimension of the shower compartment, exclusive of fixture valves, shower heads, soap dishes, and safety grab bars or rails. The minimum required area and dimension shall be measured from the finished interior dimension at a height equal to the top of the threshold and at a point tangent to its centerline and shall be continued to a height of not less than 70 inches (1778 mm) above the shower drain outlet. Hinged shower doors shall open outward. The wall area above built-in tubs having installed shower heads and in shower compartments shall be constructed in accordance with Section R702.4. Such walls shall form a water-tight joint with each other and with either the tub, receptor or shower floor.

Exceptions:

1. Fold-down seats shall be permitted in the shower, provided the required 900-square-inch (0.6 m^2) dimension is maintained when the seat is in the folded-up position.

2. Shower compartments having not less than 25 inches (635 mm) in minimum dimension measured from the finished interior dimension of the compartment provided that the shower compartment has a cross-sectional area of not less than 1,300 square inches (0.838 m^2).

3. Shower compartments with prefabricated receptors conforming to the standards listed in Table P2708.1 (417.4).
4. Where load-bearing, bonded, waterproof membranes meeting ANSI A118.10 are used, integrated bonding flange drains shall be approved. Clamping devices and weep holes are not required where shower drains include an integrated bonding flange. Manufacturer's installation instructions shall be followed to achieve a watertight seal between the bonded waterproof membrane and the integrated bonding flange drain. Integrated bonding flange drains shall conform to ASME A112.6.3, ASME A112.18.2/CSA B125.2, or CSA B79.

TABLE P2708.1 (417.4)
PREFABRICATED SHOWER

RECEPTOR STANDARDS MATERIALS STANDARDS

Plastic shower receptors and shower stalls	ANSI Z124
Shower pans, nonmetallic	ASTM D 4551

P2708.2 (417.3) Shower drain.

Shower drains shall have an outlet size of not less than ~~1 1/2~~ 2 inches [~~38~~ 51 mm] in diameter, and for other than waste outlets in bathtubs, shall have removable strainers not less than 3 inches (76 mm) in diameter with strainer openings not less than 1/4 inch (6.4 mm) in least dimension. Where each shower space is not provided with an individual waste outlet, the waste outlet shall be located and the floor pitched so that waste from one shower does not flow over the floor area serving another shower. Waste outlets shall be fastened to the waste pipe in an *approved* manner.

> **Exception:** Retaining pre-existing 1-1/2 inch (38 mm) in diameter waste outlets shall be permitted when removing an existing bathtub and installing a shower in its place.

P2708.3 (417.2) Water supply riser.

Water supply risers from the shower valve to the shower head outlet, whether exposed or concealed, shall be attached to the structure using support devices designed for use with the specific piping material or fittings anchored ~~with screws~~ with corrosion resistant screws of a minimum nominal length of ¾ inch (19 mm).

P2708.4 (424.3) Shower control valves.

Individual shower and tub/shower combination valves shall be equipped with control valves of the pressure-balance, thermostatic-mixing or combination pressure-balance/thermostatic-mixing valve types with a high limit stop in accordance with ASSE 1016/ASME A112.1016/CSA B125.16. The high limit stop shall be set to limit the water temperature to not greater than 120°F (49°C), which shall be field adjusted in accordance with the manufacturer’s instructions. In-line thermostatic valves shall not be used for compliance with this section. Scald preventative valves are not required in dwelling units with individual water heaters set at 120°F (49°C).

SECTION P2709
SHOWER RECEPTORS

P2709.2 (417.5.2) Lining required.

The adjoining walls and floor framing enclosing on-site built-up shower receptors shall be lined with one of the following materials:

1. Sheet lead. Sheet lead shall weigh not less than 4 pounds per square foot (19.5 kg/m^2) and shall be coated with an asphalt paint or other *approved* coating. The lead sheet shall be insulated from conducting substances other than the connecting drain by 15-pound (6.80 kg) asphalt felt or an equivalent. Sheet lead shall be joined by burning.

2. Sheet copper. Sheet copper shall conform to ASTM B 152 and shall weigh not less than 12 ounces per square foot (3.7 kg/m^2). The copper sheet shall be insulated from conducting substances other than the connecting drain by 15-pound (6.80 kg) asphalt felt or an equivalent. Sheet copper shall be joined by brazing or soldering.

3. Plastic liner material ~~that complies~~ shall be a minimum of 0.040 inch (1.02mm) thick and shall comply with ASTM D 4068 or ASTM D 4551.

4. Hot mopping in accordance with Section P2709.2.3

5. Sheet-applied load-bearing, bonded waterproof membranes that comply with ANSI A118.10.

The lining material shall extend not less than 2 inches (51 mm) beyond or around the rough jambs and not less than 2 inches (51 mm) above finished thresholds. Sheet-applied load bearing, bonded waterproof membranes shall be applied in accordance with the manufacturer's instructions.

P2709.2.1 (417.5.2.1) PVC sheets.
Plasticized polyvinyl chloride (PVC) sheet shall be a minimum of 0.040 inch (1.02 mm) thick and shall meet the requirements of ASTM D 4551. Sheets shall be joined by solvent welding in accordance with the manufacturer's instructions.

P2709.2.2 (417.5.2.2) Chlorinated polyethylene (CPE) sheets.
Nonplasticized chlorinated polyethylene sheet shall be a minimum of 0.040 inch (1.02 mm) thick and shall meet the requirements of ASTM D 4068. The liner shall be joined in accordance with the manufacturer's instructions.

P2709.3 Installation.
Lining materials shall be sloped a minimum of one-fourth unit vertical in 12 units horizontal (2-percent slope) to weep holes in the subdrain by means of a smooth, solidly formed subbase, shall be properly recessed and fastened to *approved* backing so as not to occupy the space required for the wall covering, and shall not be nailed or perforated at any point less than 1 inch (25.4 mm) above the finished threshold.

P2709.3.1 Materials.
Lead and copper linings shall be insulated from conducting substances other than the connecting drain by 15-pound (6.80 kg) asphalt felt or its equivalent. Sheet lead liners shall weigh not less than 4 pounds per square foot (19.5 kg/m^2) and shall be coated with an asphalt paint or other *approved* coating. Sheet copper liners shall weigh not less than 12 ounces per square foot (3.7 kg/m^2). Joints in lead and copper pans or liners shall be burned or silver brazed, respectively. Joints in plastic liner materials shall be joined in accordance with the manufacturer's instructions.

SECTION P2712
WATER CLOSETS

P2712.10 (420.4) Water closet connections.
A 4-inch by 3-inch (102 mm by 76 mm) closet bend shall be acceptable. Where a 3-inch (76 mm) bend is utilized on water closets, a 4-inch by 3-inch (102 mm by 76 mm) flange shall be installed to receive the fixture horn.

SECTION P2713
BATHTUBS

P2713.4 (407.1) Approval.

Bathtubs shall conform to ASME A112.19.1/ CSA B45.2, ASME A112.19.2/CSA B45.1, ASME A112.19.3/ CSA B45.4 or CSA B45.5/IAPMO Z124.

SECTION P2717
DISHWASHING MACHINES

P2717.2 Sink and dishwasher.

The combined discharge from a dishwasher and a one- or two-compartment sink, with or without a food-waste disposer, shall be served by a trap of not less than 1$^{1}/_{2}$ inches (38 mm) in outside diameter. The dishwasher discharge pipe or tubing shall rise to the underside of the counter ~~and be fastened or otherwise held in that position~~ and shall be securely fastened to the underside of the sink rim or counter before connecting to the head of the food-waste disposer or to a wye fitting in the sink tailpiece.

SECTION P2718
CLOTHES WASHING MACHINE

P2718.1 (406.2) Waste connection.

~~The discharge from a clothes washing machine shall be through an *air break*.~~ The waste from an automatic clothes washer shall connect to a vertical drain of not less than 2 inches (51 mm) in diameter, or a horizontal drain of not less than 3 inches (76 mm) in diameter. The 2-inch (51 mm) trap in the waste connection may be used as a cleanout for both the 2-inch (51 mm) and the 3-inch (76 mm). In retrofit or remodel work automatic domestic clothes washers shall be permitted to drain to a laundry sink. Automatic clothes washers that discharge by gravity shall be permitted to drain to a waste receptor or an approved trench drain.

P2718.2 (406.1) Water connection.

The water supply to an automatic clothes washer shall be protected against backflow by an *air gap* that is integral with the machine or a backflow preventer shall be installed in accordance with Section 608. *Air gaps* shall comply with ASME A112.1.2 or A112.1.3.

SECTION P2719
FLOOR DRAINS

P2719.2 (412.5) Location.

Floor drains shall be located to drain the entire floor area.

SECTION P2720
WHIRLPOOL BATHTUBS

P2720.1 Access to pump.

Access shall be provided to circulation pumps in accordance with the fixture or pump manufacturer's installation instructions. Where the manufacturer’s instructions do not specify the location and minimum size of field-fabricated access openings, an opening of not less than 12-inches by 12-inches (305 mm by 305 mm) shall be installed for access to the circulation pump. Where pumps are located more than 2 feet (610 mm) from the access opening, an opening of not less than 18 inches by 18 inches (457 mm by 457 mm) shall be installed. A door or panel shall be permitted to close the opening. The access opening shall be unobstructed and be of the size necessary to permit the removal and replacement of the circulation pump. A minimum clearance of 21 inches (533 mm) is required in front of the access door. Removal of a toilet cannot be used to obtain the required clearance.

P2720.2 Piping drainage.

The circulation pump shall be accessibly located above the crown weir of the trap. ~~The pump drain line shall be properly graded to ensure minimum water retention in the volute after fixture use. The circulation piping shall be installed to be self-draining.~~ The pump drain and circulation piping shall be sloped to drain the water in the volute and the circulation piping when the whirlpool bathtub is empty.

P2720.5 (421.4) Suction fittings.

Suction fittings for whirlpool bathtubs shall comply with ASME A112.19.7/CSA B45.10.

SECTION P2721
BIDET INSTALLATIONS

P2721.3 (408.1) Approval.

Bidets shall conform to ASME A112.19.2/ CSA B45.1.

SECTION P2722
FIXTURE FITTING

P2722.1 (424.1) General.

Fixture supply valves and faucets shall comply with ASME A112.18.1/CSA B125.1 as indicated in Table P2701.1. Faucets and fixture fittings that supply drinking water for human ingestion shall conform to the requirements of NSF 61, Section 9. Flexible water connectors shall conform to the requirements of Section P2905.7.

P2722.2 (607.5) Hot water.

Fixture fittings supplied with both hot and cold water shall be installed and adjusted so that the left-hand side of the water temperature control represents the flow of hot water when facing the outlet.

> **Exception:** Shower and tub/shower mixing valves conforming to ASSE 1016/ASME A112.1016/CSA B125.16, where the water temperature control corresponds to the markings on the device.

P2722.3 (424.6) Hose-connected outlets.

Faucets and fixture fittings with hose-connected outlets shall conform to ASME A112.18.3 or ASME A112.18.1/CSA B125.1.

P2722.4 (604.11) Individual pressure-balancing in-line valves for individual fixture fittings.

Individual pressure-balancing in-line valves for individual fixture fittings shall comply with ASSE 1066. Such valves shall be installed in an accessible location and shall not be used as a substitute for the balanced pressure, thermostatic or combination shower valves required in Section P2708.3.

P2722.5 (424.9) Water closet personal hygiene devices.

Personal hygiene devices integral to water closets or water closet seats shall conform to ASME A112.4.2.

SECTION P2723

MACERATING TOILET SYSTEMS

P2723.1 General.

Macerating toilet systems shall comply with ASME A112.3.4/CSA B45.9 and shall be installed in accordance with manufacturer’s instructions.

CHAPTER 28

WATER HEATERS

~~*User note: Code change proposals to this chapter will be considered by the IRC – Plumbing and Mechanical Code Development Committee during the 2015 (Group A) Code Development Cycle. See explanation on page xvii.*~~

The text of this chapter is extracted from the 2018 edition of the *North Carolina Plumbing Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code* for One- and Two-Family Dwellings. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Plumbing Code*.

SECTION P2801
GENERAL

P2801.2 Drain valves.

Drain valves for emptying shall be installed at the bottom of each tank-type water heater and *hot water* storage tank. ~~The drain valve inlet shall be not less than $^{3}/_{4}$-inch (19.1 mm) nominal iron pipe size and the outlet shall be provided with a male hose thread.~~ Drain valves shall conform to ASSE 1005.

P2801.6 Required pan.

~~Where a storage tank-type water heater or a hot water storage tank is installed in a location where water leakage from the tank will cause damage, the tank shall be installed in a pan constructed of one of the following:~~

1. ~~Galvanized steel or aluminum of not less than 0.0236 inch (0.6010 mm) in thickness.~~
2. ~~Plastic not less than 0.036 inch (0.9 mm) in thickness.~~
3. ~~Other approved materials.~~

~~A plastic pan shall not be installed beneath a gas-fired water heater.~~

Where a storage tank-type water heater or a hot water storage tank is installed in: (a) remote locations such as a suspended ceiling, (b) attics, (c) above occupied spaces, or (d) unventilated crawl spaces, a location where water leakage from the tank will cause damage to primary structural members, the tank or water heater shall be installed in a galvanized steel or aluminum pan having a material thickness of not less than 0.0236 inch (0.6010 mm) (No. 24 gage for steel or No. 26 gage for aluminum), or other pans *approved* for such use.

Exceptions:

1. Electric water heaters may rest in a high-impact plastic pan of at least 1/16 inch (1.6 mm) thickness.
2. Water heater mounted on concrete floor with a floor drain.

P2801.6.1 Pan size and drain.

The pan shall be not less than 1$^{1}/_{2}$ inches (38 mm) deep and shall be of sufficient size and shape to receive dripping or condensate from the tank or water heater. The pan shall be drained by an indirect waste pipe of not less than ~~$^{3}/_{4}$~~ 1 inch (~~19~~ 25.4 mm) diameter. Piping for safety pan drains shall be of those materials indicated in Table P2905.5. Where a pan drain was not previously installed, a pan drain shall not be required for a replacement water heater installation.

P2801.7 (502.5) Water heaters installed in garages.

Water heaters having an *ignition source* shall be elevated such that the source of ignition is not less than 18 inches (457 mm) above the garage floor. Appliances shall be located or protected so that they are not subject to physical damage by a moving vehicle. The ignition source would apply to both electric and gas water heaters. The ignition source (not the bottom of the water heater) shall be elevated to minimum of 18 inches (457 mm) above the garage floor.

Exception: Elevation of the *ignition source* is not required for appliances that are listed as flammable vapor ignition- resistant.

P2801.9 (502.2) Rooms used as a plenum.

Water heaters using solid, liquid or gas fuel shall not be installed in a room containing air-handling machinery where such room is used as a plenum.

P2801.10 (502.3) Water heaters installed in attics.

Attics containing a water heater shall be provided with an opening and unobstructed passageway large enough to allow removal of the water heater. The passageway shall be not less than 30 inches (762 mm) in height and 22 inches (559 mm) in width and not more than 20 feet (6096 mm) in length when measured along the centerline of the passageway from the opening to the water heater. If 6 feet (1829 mm) of headroom is provided along the centerline of the passageway from the opening to the water heater, the length of the passageway is permitted to exceed 20 feet (6096 mm) in length. The passageway shall have continuous solid flooring not less than 24 inches (610 mm) in width. A level service space not less than 30 inches (762 mm) in length and 30 inches (762 mm) in width shall be present at the front or service side of the water heater. The clear access opening dimensions shall be not less than 20 inches by 30 inches (508 mm by 762 mm) where such dimensions are large enough to allow removal of the water heater.

P2801.11 (502.6) Installation in crawl spaces.

Under-floor spaces containing appliances requiring access shall be provided with an access opening and unobstructed passageway large enough to remove the largest component of the appliance. The passageway shall not be less than 22 inches (559 mm) high and 36 inches (914 mm) wide, nor more than 20 feet (6096 mm) in length when measured along the centerline of the passageway from the opening to the equipment. A level service space not less than 30 inches (762 mm) deep and 30 inches (762 mm) wide shall be present at the front or service side of the appliance. If the depth of the passageway or the service space exceeds 12 inches (305mm) below the adjoining grade, the walls of the passageway shall be lined with concrete or masonry extending 4 inches (102 mm) above the adjoining grade and having sufficient lateral-bearing capacity to resist collapse. The clear access opening dimensions shall be a minimum of

22 inches by 30 inches (559 mm by 762 mm), where such dimensions are large enough to allow removal of the largest component of the appliance.

Exceptions:

1. The passageway is not required where the level service space is present when the access is open and the appliance is capable of being serviced and removed through the required opening.

2. Where the passageway is not less than 6 feet high (1829 mm) for its entire length, the passageway shall not be limited in length.

P2801.12 (502.7) Under-floor and exterior-grade installation.

P2801.12.1 (502.7.1) Exterior-grade installations.

Equipment and appliances installed above grade level shall be supported on a solid base or approved material a minimum of 2 inches (51 mm) thick.

P2801.12.2 (502.7.2) Under-floor installation.

Suspended equipment shall be a minimum of 6 inches (152 mm) above the adjoining grade.

P2801.12.3 (502.7.3) Crawl space supports.

The support shall be a minimum of a 2-inch (51 mm) thick solid base, 2-inch (51 mm) thick formed concrete, or stacked masonry units held in place by mortar or other approved method. The water heater shall be supported not less than 2 inches (51 mm) above grade.

P2801.12.4 (502.7.4) Drainage.

Below-grade installations shall be provided with a natural drain or an automatic lift or sump pump. Existing installation that can be terminated outdoors must terminate outdoors. Where the installation is such that outdoor termination is impossible, indoor termination is allowable.

P2801.13 (502.8) Prohibited installations.

Water heaters, (using solid, liquid or gas fuel) with the exception of those having direct vent systems, shall not be installed in bathrooms and bedrooms or in a closet with access only through a bedroom or bathroom. However, water heaters of the automatic storage type may be installed as replacement in a bathroom, when approved by the plumbing official, provided they are vented and supplied with adequate combustion air.

Exception: When a closet, having a weather-stripped solid door with an approved closing device, has been designed exclusively for the water heater and where all air for combustion and ventilation is supplied from outdoors.

SECTION P2804
RELIEF VALVES

P2804.6.1 Requirements for discharge pipe.

The discharge piping serving a pressure-relief valve, temperature-relief valve or combination valve shall:

1. Not be directly connected to the drainage system.

2. Discharge ~~through an air gap located~~ in the same room as the water heater either on the floor, into an indirect waste receptor or into a water heater pan.

    a. Discharge through an *air gap* or air gap fitting to a remote termination point that is observable by the building occupants.

3. Not be smaller than the diameter of the outlet of the valve served and shall discharge full size to the air gap.

4. Serve a single relief device and shall not connect to piping serving any other relief device or equipment.

5. Discharge to the floor, to the pan serving the water heater or storage tank, to a waste receptor or to the outdoors.

6. Discharge in a manner that does not cause personal injury or structural damage.

7. ~~Discharge to a termination point that is readily observable by the building occupants~~.Deleted.

8. Not be trapped.

9. Be installed to flow by gravity.

10. Terminate not more than 6 inches (152 mm) and not less than two times the discharge pipe diameter above the floor or waste receptor flood level rim.

11. Not have a threaded connection at the end of the piping.

12. Not have valves or tee fittings.

13. Be constructed of those materials indicated in Section P2906.5 or materials tested, rated and *approved* for such use in accordance with ASME A112.4.1.

14. ~~Be one nominal size larger than the size of the relief-valve outlet, where the relief-valve discharge piping is constructed of PEX or PE-RT tubing. The outlet end of such tubing shall be fastened in place.~~ The discharge pipe shall be clamped or otherwise supported with not less than one clamp or support within 12-inches (305 mm) of the point of discharge.

P2804.8 (501.9) Relief valve installation by manufacturer.

The following is a reprint of GS 66-27.1, “Safety Features of Hot Water Heaters.”

a. No individual, firm, corporation or business shall install, sell or offer for sale any automatic hot water tank or heater of 120-gallon (454 L) capacity or less, except for a tankless water heater, which does not have installed thereon by the manufacturer of the tank or heater an American Society of Mechanical Engineers and National Board of Boiler and Pressure Vessel Inspectors approved type pressure-temperature relief valve set at or below the safe working pressure of the tank as indicated, and so labeled by the manufacturer's Identification stamped or cast upon the tank or heater or upon a plate secured to it.

b. No individual, firm, corporation or business shall install, sell or offer for sale any relief valve, whether it be pressure type, temperature type or pressure-temperature type, which does not carry the stamp of approval of the American Society of Mechanical Engineers and the National Board of Boiler and Pressure Vessel Inspectors.

The following is a reprint of GS 66-27.1A, "Water heater thermostat settings."

a. The thermostat of any new residential water heater offered for sale or lease for use in a single-family or multifamily dwelling in the State shall be preset by the manufacturer or installer no higher than approximately 120°F (49°C). A water heater reservoir temperature may be set higher if it is supplying space heaters that require higher temperatures. For purposes of this section, a water heater shall mean the primary source of hot water for any single-family or multifamily residential dwelling including, but not limited to any solar or other hot water heating systems.

b. Nothing in this section shall prohibit the occupant of a single-family or multiunit residential dwelling with an individual water heater from resetting or having reset the thermostat on the water heater. Any such resetting shall relieve the manufacturer or installer of the water heater and, in the case of a residential dwelling that is leased or rented, also the unit's owner, from liability for damages attributed to the resetting.

c. A warning tag or sticker shall be placed on or near the operating thermostat control of any residential water heater. This tag or sticker shall state that the thermostat settings above the preset temperature may cause severe burns. This tag or sticker may carry such other appropriate warnings as may be agreed upon by manufacturers, installers and other interested parties.

P2804.9 (501.10) Fossil fuel equipment installation.

The installation of the following equipment and systems shall comply with the *North Carolina Fuel Gas Code*:

a. Fuel piping for any fossil fuel-burning equipment.

b. Venting systems for fossil fuel-burning equipment which is part of the plumbing system.

SECTION P2805 (503)
CONNECTIONS

P2805.1 (503.1) Cold water line valve.

The cold water *branch* line from the main water supply line to each hot water storage tank or water heater shall be provided with a valve, located within 3 feet (914 mm) of the equipment and serving only the hot water storage tank or water heater. The valve shall not interfere or cause a disruption of the cold water supply to the remainder of the cold water system. The valve shall be provided with *access* on the same floor level as the water heater served.

P2805.2 (503.2) Water circulation.
The method of connecting a circulating water heater to the tank shall provide circulation of water through the water heater. The pipe or tubes required for the installation of appliances that will draw from the water heater or storage tank shall comply with the provisions of this code for material and installation. Installation shall comply with the manufacturer's instructions and the requirements of the *North Carolina Energy Conservation Code*.

SECTION P2806 (504)
SAFETY DEVICES

P2806.1 (504.1) Antisiphon devices.
An *approved* means, such as a cold water "dip" tube with a hole at the top or a vacuum relief valve installed in the cold water supply line above the top of the heater or tank, shall be provided to prevent siphoning of any storage water heater or tank.

P2806.2 (504.3) Shutdown.
A means for disconnecting an electric hot water supply system from its energy supply shall be provided in accordance with NFPA 70. A separate valve shall be provided to shut off the energy fuel supply to all other types of hot water supply systems.

SECTION P2807 (505)
INSULATION

P2807.1 (505.1) Unfired vessel insulation.
Unfired hot water storage tanks shall be insulated to R-12.5 ($h \cdot ft^2 \cdot °F$)/Btu (R-2.2 $m^2 \cdot K/W$).

CHAPTER 29

WATER SUPPLY AND DISTRIBUTION

~~*User note: Code change proposals to this chapter will be considered by the IRC – Plumbing and Mechanical Code Development Committee during the 2015 (Group A) Code Development Cycle. See explanation on page xvii.*~~

The text of this chapter is extracted from the 2018 edition of the *North Carolina Plumbing Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code* for One- and Two-Family Dwellings. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Plumbing Code*.

SECTION P2901
GENERAL

P2901.3 (608.10) Reuse of piping.

Piping that has been utilized for any purpose other than conveying potable water shall not be utilized for conveying potable water.

SECTION P2902
PROTECTION OF POTABLE WATER SUPPLY

TABLE P2902.3
APPLICATION FOR BACKFLOW PREVENTERS

DEVICE	DEGREE OF HAZARD[a]	APPLICATION[b]	APPLICABLE STANDARDS
Backflow Prevention Assemblies			
Double check backflow prevention assembly and double check fire protection backflow prevention assembly	Low hazard	Backpressure or backsiphonage Sizes $^{3}/_{8}$″ – 16″	ASSE 1015, AWWA C510, CSA B64.5, CSA B64.5.1
Double check detector fire protection backflow prevention assemblies	Low hazard	Backpressure or backsiphonage Sizes 2″ – 16″	ASSE 1048
Pressure vacuum breaker assembly	High or low hazard	Backsiphonage only Sizes $^{1}/_{2}$″ – 2″	ASSE 1020, CSA B64.1.2
Reduced pressure principle backflow prevention assembly and reduced pressure principle fire protection backflow prevention assembly	High or low hazard	Backpressure or backsiphonage Sizes $^{3}/_{8}$″ – 16″	ASSE 1013, AWWA C511, CSA B64.4, CSA B64.4.1
Reduced pressure detector fire protection backflow prevention assemblies	High or low hazard	Backsiphonage or backpressure (Fire sprinkler systems)	ASSE 1047

Spill-resistant vacuum breaker	High or low hazard	Backsiphonage only Sizes 1/4″ – 2″	ASSE 1056, CSA B64.1.3
Backflow Preventer Plumbing Devices			
Antisiphon-type fill valves for gravity water closet flush tanks	High hazard	Backsiphonage only	ASSE 1002, CSA B125.3
Backflow preventer with intermediate atmospheric vents	Low hazard	Backpressure or backsiphonage Sizes 1/4″ – 3/8″	ASSE 1012, CSA B64.3
Dual-check-valve-type backflow preventers	Low hazard	Backpressure or backsiphonage Sizes 1/4″ – 1″	ASSE 1024, CSA B64.6
Hose-connection backflow preventer	High or low hazard	Low head backpressure, rated working pressure backpressure or backsiphonage Sizes 1/2″ – 1″	ASSE 1052, CSA B64.2.1.1
Hose-connection vacuum breaker	High or low hazard	Low head backpressure or backsiphonage Sizes 1/2″, 3/4″, 1″	ASSE 1011, CSA B64.2, B64.2.1
~~Laboratory faucet backflow preventer~~	~~High or low hazard~~	~~Low head backpressure and backsiphonage~~	~~ASSE 1035, CSA B64.7~~
Pipe-applied atmospheric-type vacuum breaker	High or low hazard	Backsiphonage only Sizes 1/4″ – 4″	ASSE 1001, CSA B64.1.1
Vacuum breaker wall hydrants, frost-resistant, automatic-draining type	High or low hazard	Low head backpressure or backsiphonage Sizes 3/4″ – 1″	ASSE 1019, CSA B64.2.2
Other Means Or Methods			
Air gap	High or low hazard	Backsiphonage only	ASME A112.1.2
Air gap fittings for use with plumbing fixtures, appliances and appurtenances	High or low hazard	Backsiphonage or backpressure	ASME A112.1.3

For SI: 1 inch = 25.4 mm.

a. Low hazard—See Pollution (Section R202). High hazard—See Contamination (Section R202).

b. See Backpressure (Section R202). See Backpressure, Low Head (Section R202). See Backsiphonage (Section R202).

P2902.5.5 Solar thermal systems.

Where a solar thermal system heats potable water to supply a potable *hot water* distribution or any other type of heating system, the solar thermal system shall be in accordance with Section P2902.5.5.1, P2902.5.5.2 or P2902.5.5.3 as applicable. Solar energy systems used for heating potable water or using an independent medium for heating potable water shall comply with the applicable requirements of this code. The use of solar energy shall not compromise the requirements for cross connection or protection of the potable water supply system required by this code.

SECTION P2903
WATER SUPPLY SYSTEM

P2903.3.1 Maximum pressure.

The static water pressure shall be not greater than 80 psi (551 kPa). Where the main pressure exceeds 80 psi (551 kPa), an *approved* pressure-reducing valve conforming to ASSE 1003 or CSA B356 shall be installed on the domestic water branch main or riser at the connection to the water service pipe.

Exception: Service lines to sill cocks and outside hydrants when equipped with a shutoff valve.

P2903.5 Water hammer.

The flow velocity of the water distribution system shall be controlled to reduce the possibility of water hammer. A water-hammer arrestor shall be installed where *quick-closing valves* (example: clothes washers, dishwashers, ice makers) and metallic piping are used. The water-hammer arrestor shall not be required on any valves where plastic pipe is used for water distribution piping. Water-hammer arrestors shall be installed in accordance with the manufacturer's instructions. Water-hammer arrestors shall conform to ASSE 1010.

P2903.8 Gridded and parallel water distribution systems.

~~Hot water and c~~Cold water manifolds installed with parallel-connected individual distribution lines and cold water manifolds installed with gridded distribution lines to each fixture or fixture fitting shall be designed in accordance with Sections P2903.8.1 through P2903.8.5. Gridded systems for hot water distribution systems shall be prohibited.

P2903.9.1 Service valve.

Each *dwelling unit* shall be provided with an accessible main shutoff valve near the entrance of the water service. The valve shall be of a full-open type having nominal restriction to flow, with provision for drainage such as a bleed orifice or installation of a separate drain valve. ~~Additionally, the water service shall be valved at the curb or lot line in accordance with local requirements.~~

P2903.9.2 Water heater valve.

A *readily accessible* full-open valve shall be installed in the cold-water supply pipe to each water heater ~~at or near~~ within 3 feet (914 mm) of the water heater.

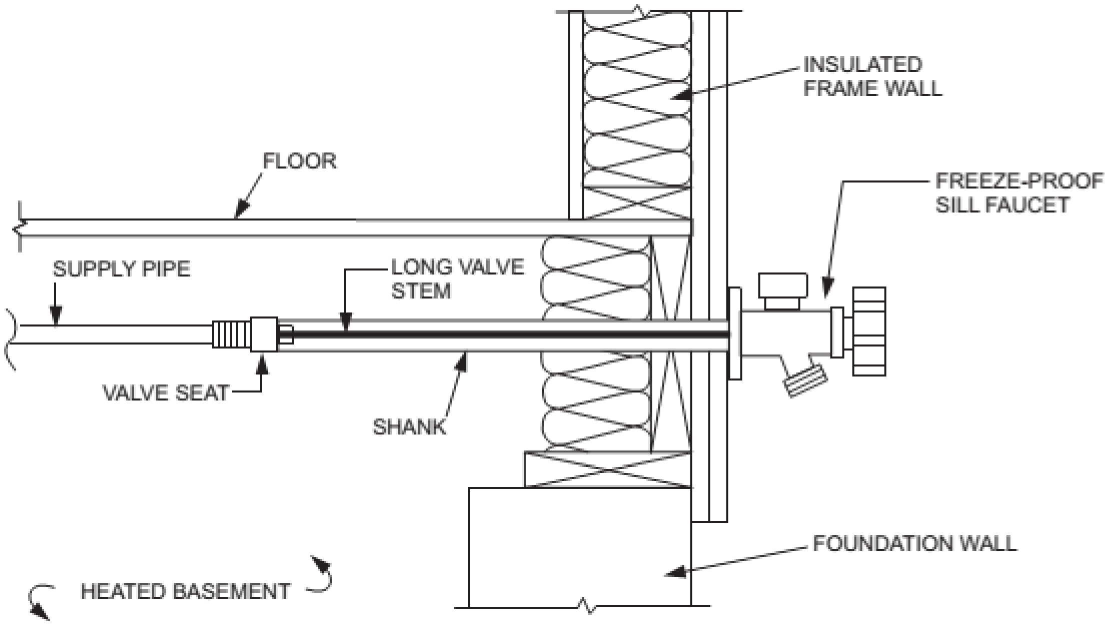


FIGURE P2903.10
TYPICAL FROSTPROOF HOSE BIBB INSTALLATION NOT REQUIRING SEPARATE VALVE

SECTION P2906
MATERIALS, JOINTS AND CONNECTIONS

P2906.2 Lead content.

The lead content in pipe and fittings used in the water supply system shall be ~~not greater than 8 percent~~ in accordance with Section P2906.2.1.

P2906.4 Water service pipe.

Water service pipe shall conform to NSF 61 and shall conform to one of the standards indicated in Table P2906.4. Water service pipe or tubing, installed underground and outside of the structure, shall have a working pressure rating of not less than 160 pounds per square inch at 73.4°F (1103 kPa at 23°C). Where the water pressure exceeds 160 pounds per square inch (1103 kPa), piping material shall have a rated working pressure equal to or greater than the highest available pressure. ~~Water service piping materials not third-party certified for water distribution shall terminate at or before the full open valve located at the entrance to the structure~~ 5 feet (1524 mm) outside of the building. Ductile iron water service piping shall be cement mortar lined in accordance with AWWA C104/A21.4.

TABLE P2906.4
WATER SERVICE PIPE

MATERIAL	STANDARD
Acrylonitrile butadiene styrene (ABS) plastic pipe	ASTM D 1527; ASTM D 2282
Chlorinated polyvinyl chloride (CPVC) plastic pipe	ASTM D 2846; ASTM F 441; ASTM F 442; CSA B137.6

Chlorinated polyvinyl chloride/aluminum/chlorinated polyvinyl chloride (CPVC/AL/CPVC) plastic pipe	ASTM F 2855
Copper or copper-alloy pipe	ASTM B 42; ASTM B 43; ASTM B 302
Copper or copper-alloy tubing (Type K, WK, L, WL, M or WM)[a]	ASTM B 75; ASTM B 88; ASTM B 251; ASTM B 447
Cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pipe	ASTM F 1281; ASTM F 2262; CSA B137.10
Cross-linked polyethylene/aluminum/high-density polyethylene (PEX-AL-HDPE) pipe	ASTM F 1986
Cross-linked polyethylene (PEX) plastic tubing	ASTM F 876; ASTM F 877; CSA B137.5
Ductile iron water pipe	AWWA C115/A21.15; AWWA C151/A21.51
Galvanized steel pipe	ASTM A 53
Polyethylene/aluminum/polyethylene (PE-AL-PE) pipe	ASTM F 1282; CSA B137.9
Polyethylene (PE) plastic pipe	ASTM D 2104; ASTM D 2239; AWWA C901; CSA B137.1
Polyethylene (PE) plastic tubing	ASTM D 2737; AWWA C901; CSA B137.1
Polyethylene of raised temperature (PE-RT) plastic tubing	ASTM F 2769
Polypropylene (PP) plastic tubing	ASTM F 2389; CSA B137.11
Polyvinyl chloride (PVC) plastic pipe	ASTM D 1785; ASTM D 2241; ASTM D 2672; CSA B137.3
Stainless steel (Type 304/304L) pipe	ASTM A 312; ASTM A 778
Stainless steel (Type 316/316L) pipe	ASTM A 312; ASTM A 778

a. Below grade Type K, WK, L, WL

P2906.5 Water-distribution pipe.

Water-distribution piping within *dwelling units* shall conform to NSF 61 and shall conform to one of the standards indicated in Table P2906.5. Hot-water-distribution pipe and tubing shall have a pressure rating of not less than 100 psi at 180°F (689 kPa at 82°C). Cold water distribution pipe and tubing shall have a minimum pressure rating of 160 psi (1100 kPa) at 73.4°F (23°C)

TABLE P2906.5
WATER DISTRIBUTION PIPE

MATERIAL	STANDARD
Chlorinated polyvinyl chloride (CPVC) plastic pipe and tubing	ASTM D 2846; ASTM F 441; ASTM F 442; CSA B137.6
Chlorinated polyvinyl chloride/aluminum/chlorinated polyvinyl chloride (CPVC/AL/CPVC) plastic pipe	ASTM F 2855
Copper or copper-alloy pipe	ASTM B 42; ASTM B 43; ASTM B 302
Copper or copper-alloy tubing (Type K, WK, L, WL, M or WM)[a]	ASTM B 75; ASTM B 88; ASTM B 251; ASTM B 447
Cross-linked polyethylene (PEX) plastic tubing	ASTM F 876; ASTM F 877; CSA B137.5
Cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pipe	ASTM F 1281; ASTM F 2262; CSA B137.10
Cross-linked polyethylene/aluminum/high-density polyethylene (PEX-AL-HDPE) pipe	ASTM F 1986
Galvanized steel pipe	ASTM A 53
Polyethylene/aluminum/polyethylene (PE-AL-PE) composite pipe	ASTM F 1282
Polyethylene of raised temperature (PE-RT) plastic tubing	ASTM F 2769
Polypropylene (PP) plastic pipe or tubing	ASTM F 2389; CSA B137.11
Stainless steel (Type 304/304L) pipe	ASTM A 312; ASTM A 778

a. Below grade Type K, WK, L, WL

TABLE P2906.6
PIPE FITTINGS

MATERIAL	STANDARD
Acrylonitrile butadiene styrene (ABS) plastic	ASTM D 2468
Cast-iron	ASME B16.4
Chlorinated polyvinyl chloride (CPVC) plastic	ASSE 1061; ASTM D 2846; ASTM F 437; ASTM F 438; ASTM F 439; CSA B137.6
Copper or copper alloy	ASSE 1061; ASME B16.15; ASME B16.18; ASME B16.22; ASME B16.26; ASME B16.51
Cross-linked polyethylene/aluminum/high-density polyethylene (PEX-AL-HDPE)	ASTM F 1986
Fittings for cross-linked polyethylene (PEX) plastic tubing	ASSE 1061; ASTM F 877; ASTM F 1807; ASTM F 1960; ASTM F 2080; ASTM F 2098; ASTM F 2159; ASTM F 2434; ASTM F 2735; CSA B137.5
Gray iron and ductile iron	AWWA C110/A21.10; AWWA C153/A21.53
Malleable iron	ASME B16.3
Polybutylene (PB) plastic	ASSE 1061; CSA B137.8
Insert fittings for Polyethylene/aluminum/polyethylene (PE-AL-PE) and cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX)	ASTM F 1974; ASTM F 1281; ASTM F 1282; CSA B137.9; CSA B137.10
Polyethylene (PE) plastic	ASTM D 2609; CSA B137.1
Fittings for polyethylene of raised temperature (PE-RT) plastic tubing	ASTM F 1807; ASTM F2098; ASTM F 2159; ASTM F 2735; ASTM F 2769
Polypropylene (PP) plastic pipe or tubing	ASTM F 2389; CSA B137.11
Polyvinyl chloride (PVC) plastic	ASTM D 2464; ASTM D 2466; ASTM D 2467; CSA B137.2; CSA B137.3
Stainless steel (Type 304/304L) pipe	ASTM A 312; ASTM A 77
Stainless steel (Type 316/316L) pipe	ASTM A 312; ASTM A 778
Steel	ASME B16.9; ASME B16.11; ASME B16.28

P2906.9.1.1 ABS plastic pipe.

~~Solvent cement for ABS plastic pipe conforming to ASTM D 2235 shall be applied to all joint surfaces.~~ Joint surfaces shall be clean and free from moisture. Solvent cement that conforms to ASTM D 2235 shall be applied to all joint surfaces. The joint shall be made while the cement is wet. Joints shall be made in accordance with ASTM D 2235. Solvent-cement joints shall be permitted above or below ground.

P2906.9.1.3 CPVC/AL/CPVC pipe.

Joint surfaces shall be clean and free from moisture, and an approved primer shall be applied. Solvent cement, orange in color and conforming to ASTM F 493, shall be applied to all joint surfaces. The joint shall be made while the cement is wet, and in accordance with ASTM D 2846 or ASTM F 493. Solvent-cement joints shall be installed above or below ground.

Exception: A primer shall not be required where all of the following conditions apply:

1. The solvent cement used is third-party certified as conforming to ASTM F 493.
2. The solvent cement used is yellow in color.
3. The solvent cement is used only for joining $^{1}/_{2}$-inch (12.7 mm) through 1-inch (25 mm) diameter CPVC/AL/CPVC pipe and CPVC fittings.
4. The CPVC ~~fittings~~ systems are ~~manufactured~~ installed in accordance with ASTM D 2846.

P2906.9.1.4 PVC plastic pipe.

A purple primer or an ultraviolet purple primer that conforms to ASTM F 656 shall be applied to PVC solvent-cemented joints. When an ultraviolet primer is used, the installer shall provide an ultraviolet light to the inspector to be used during the inspection. Solvent cement for PVC plastic pipe conforming to ASTM D 2564 shall be applied to all joint surfaces.

P2906.17.2 Plastic pipe or tubing to other piping material.

Joints between different types of plastic pipe or between plastic pipe and other piping material shall be made with an *approved* adapter fitting or transition fittings.

P2906.17.3 Stainless steel.

Joints between stainless steel and different piping materials shall be made with a mechanical joint of the compression or mechanical-sealing type or a dielectric fitting or a dielectric union conforming to ASSE 1079.

P2906.19 Polyethylene of raised temperature plastic. (PE-RT)

Joints between polyethylene of raised temperature plastic tubing and fittings shall be in accordance with Section P2906.19.1.

P2906.19.1 Mechanical joints.

Mechanical joints shall be installed in accordance with the manufacturer's instructions. Fittings for polyethylene of raised temperature plastic tubing shall comply with the applicable standards listed in Table P2906.6 and shall be installed in accordance with the manufacturer's instructions. Polyethylene of raised temperature plastic tubing shall be factory marked with the applicable standards for the fittings that the manufacturer of the tubing specifies for use with the tubing.

P2906.20 (605.26) Polybutylene plastic.

Joints between polybutylene plastic pipe and tubing or fittings shall comply with Sections P2906.20.1 through P2906.20.3.

P2906.20.1 (605.26.1) Flared joints.

Flared pipe ends shall be made by a tool designed for that operation.

P2906.20.1 (605.26.2) Heat-fusion joints.

Joints shall be of the socket-fusion or butt-fusion type. Joint surfaces shall be clean and free from moisture. All joint surfaces shall be heated to the melting temperature and joined. The joint shall be undisturbed until cool. Joints shall be made in accordance with ASTM D 2657, ASTM D 3309 or CAN3-B137.8M.

P2906.20.3 (605.26.3) Mechanical joints.

Mechanical joints shall be installed in accordance with the manufacturer’s installation instructions.

SECTION P2909
DRINKING WATER TREATMENT UNITS

P2909.1 Design.

Drinking water treatment units shall meet the requirements of NSF42, NSF 44, NSF 53, NSF 60, NSF 62 or CSA B483.1.

SECTION P2910
NONPOTABLE WATER SYSTEMS

P2910.2.2 Filtration required.

Nonpotable water utilized for water closet and urinal flushing applications shall be filtered by a 100 micron or finer filter. Non-potable water for use within a building shall be colored blue or green.

Exception: Reclaimed water sources shall not be required to comply with the requirements of this section.

P2910.2.3 (1301.2.3) Applications.

Untreated *rainwater* shall be utilized in accordance with Section P2910.2.3.1. Treated *rainwater* shall be utilized in accordance with Section P2910.2.3.2.

P2910.2.3.1 (1301.2.3.1) Examples of acceptable uses without treatment.

1. Outdoor Irrigation

2. Decorative Fountains

3. Yard Hydrants

4. Industrial Processes (eg. Dust Control, Indoor Hose Bibs Spray)

5. Vehicle Washing

6. Outdoor Hose Bibs (not routed through building wall)

P2910.2.3.2 (1301.2.3.2) Examples of acceptable uses with disinfection and filtration.

1. Toilet Flushing

2. Urinal Flushing

3. Evaporative Cooling Tower Make-up
4. Trap Primers
5. Fire Suppression Systems
6. Clothes Washers
7. Outdoor Pools and Spas
8. Hose Bibs – Residential

P2910.3 Signage required.

Nonpotable water outlets such as hose connections, sillcocks, hose bibs, wall hydrants, yard hydrants, other outdoor outlets, open-ended pipes and faucets shall be identified at the point of use for each outlet with signage that reads as follows: “Nonpotable water is utilized for [application name]. CAUTION: NONPOTABLE WATER. DO NOT DRINK.” The words shall be legibly and indelibly printed on a tag or sign constructed of corrosion-resistant, waterproof material or shall be indelibly printed on the fixture. The letters of the words shall be not less than 0.5 inches (12.7 mm) in height and in colors contrasting the background on which they are applied. In addition to the required wordage, the pictograph shown in Figure P2910.3 shall appear on the signage required by this section.

P2910.6.1 (1301.6.1) Identification of non-potable water systems.

Where non-potable plumbing systems (drainage or supply within gray water, rain water or reclaimed water systems) are installed, the piping conveying the non-potable water shall be identified either by color marking, metal tags or tape in accordance with Section P2910.6.2.

P2910.6.2 (1301.6.2) Non-potable pipe labeling and marking.

Non-potable distribution piping shall be purple in color or shall be embossed, or integrally stamped or marked, with the words: “CAUTION: NON-POTABLE WATER – DO NOT DRINK” or the piping shall be installed with a purple identification tape or wrap. Pipe identification shall include the contents of the piping system and an arrow indicating the direction of flow. Hazardous piping systems shall also contain information addressing the nature of the hazard. Pipe identification shall be repeated at intervals not exceeding 25 feet (7620 mm) and at each point where the piping passes through a wall, floor or roof. Lettering shall be readily observable within the room or space where the piping is located.

P2910.6.2.1 (1301.6.2.1) Color.

The color of the pipe identification shall be discernable and consistent throughout the building. The color purple shall be used to identify reclaimed, rain and gray water distribution systems.

P2910.6.2.2 (1301.6.2.2) Lettering size.

The size of the background color field and lettering shall comply with Table P2910.6.2.2.

TABLE P2910.6.2.2 (1301.6.2.2)
SIZE OF PIPE IDENTIFICATION

PIPE DIAMETER (inches)	**LENGTH BACKGROUND COLOR FIELD (inches)**	**SIZE OF LETTERS (inches)**
3/8 to 1-1/4	8	0.5
1-1/2 to 2	8	0.75
2-1/2 to 6	12	1.25
8 to 10	24	2.5
over 10	32	3.5

For SI 1 inch = 25.4 mm.

P2910.6.2.3 (1301.6.2.3) Identification tape.

Where used, identification tape shall be at least 3 inches (76 mm) wide and have white or black lettering on a purple field stating "CAUTION: NON-POTABLE WATER – DO NOT DRINK." Identification tape shall be installed on top of non-potable rainwater distribution pipes, fastened at least every 10 feet (3048 mm) to each pipe length and run continuously the entire length of the pipe.

P2910.7 Insect and vermin control.

The system shall be protected to prevent the entrance of insects and vermin into storage tanks and piping systems. Screens installed on vent pipes, inlets, and overflow pipes shall have an aperture of not greater than 1/16 inch (1.59 mm) and shall be close-fitting or other *approved* methods. Screen materials shall be compatible with contacting system components and shall not accelerate the corrosion of system components.

TABLE P2910.9.6
SIZE OF DRAIN PIPES FOR WATER TANKS

TANK CAPACITY (gallons)	**DRAIN PIPE (inches)**
Up to 750	1
751 to 1500	1 1/2
1501 to 3000	2
3001 to 5000	2 1/2
5001 to 7500	3
Over 7500	4

For SI: 1 gallon = 3.875 liters, 1 inch = 25.4 mm.

P2910.11 Storage tank tests.

Storage tanks shall be tested in accordance with the following:

1. Storage tanks shall be filled with water to the overflow line prior to and during inspection. Seams and joints shall be left exposed and the tank shall remain water tight without leakage for a period of 24 hours.

   Exception: If air testing, system shall be pressurized with air equivalent to the water pressure for the full depth of the tank in accordance with Section P2503.7.

2. After 24 hours, supplemental water shall be introduced for a period of 15 minutes to verify proper drainage of the overflow system and leaks do not exist.

3. Following a successful test of the overflow, the water level in the tank shall be reduced to a level that is 2 inches (51 mm) below the makeup water trigger point by using the tank drain. The tank drain shall be observed for proper operation. The makeup water system shall be observed for proper operation, and successful automatic shutoff of the system at the refill threshold shall be verified. Water shall not be drained from the overflow at any time during the refill test.

P2910.14 Outdoor outlet access. Deleted.
~~Sillcocks, hose bibs, wall hydrants, yard hydrants and other outdoor outlets supplied by nonpotable water shall be located in a locked vault or shall be operable only by means of a removable key.~~

SECTION P2911
ON-SITE NONPOTABLE WATER REUSE SYSTEMS

P2911.1 (1302.1) General.
The provisions of this section shall govern the construction, installation, alteration and repair of on-site nonpotable water reuse systems for the collection, storage, treatment and distribution of on-site sources of nonpotable water as permitted by the jurisdiction.

P2911.2 (1302.2) Sources.
On-site nonpotable water reuse systems shall collect waste discharge only from the following sources: bathtubs, showers, lavatories, clothes washers and laundry trays. Water from other approved nonpotable sources including swimming pool backwash operations, air conditioner condensate, rainwater, foundation drain water, fluid cooler discharge water and fire pump test water shall be permitted to be collected for reuse by on-site nonpotable water reuse systems, as approved by the building official and as appropriate for the intended application.

P2911.2.1 (1302.2.1) Prohibited sources.
Reverse osmosis system reject water, water softener backwash water, kitchen sink wastewater, dishwasher wastewater and wastewater containing urine or fecal matter shall not be collected for reuse within an on- site nonpotable water reuse system.

P2911.3 (1302.3) Traps.
Traps serving fixtures and devices discharging waste water to on-site nonpotable water reuse systems shall comply with the Section P3201.2.

P2911.4 (1302.4) Collection pipe.
On-site nonpotable water reuse systems shall utilize drainage piping approved for use within plumbing drainage systems to collect and convey untreated water for reuse. Vent piping approved for use within plumbing venting systems shall be utilized for vents within the gray-water system. Collection and vent piping materials shall comply with Section P3002.

P2911.4.1 (1302.4.1) Installation.
Collection piping conveying untreated water for reuse shall be installed in accordance with Section P3005.

P2911.4.2 (1302.4.2) Joints.
Collection piping conveying untreated water for reuse shall utilize joints approved for use with the distribution piping and appropriate for the intended applications as specified in Section P3002.

P2911.4.3 (1302.4.3) Size.
Collection piping conveying untreated water for reuse shall be sized in accordance with drainage sizing requirements specified in Section P3005.4.

P2911.4.4 (1302.4.4) Labeling and Marking.
Additional marking of collection piping conveying untreated water for reuse shall not be required beyond that required for sanitary drainage, waste and vent piping by the Chapter 30.

P2911.5 (1302.5) Filtration.
Untreated water collected for reuse shall be filtered as required for the intended end use. Filters shall be accessible for inspection and maintenance. Filters shall utilize a pressure gauge or other approved method to provide indication when a filter requires servicing or replacement. Filters shall be installed with shutoff valves immediately upstream and downstream to allow for isolation during maintenance. Non-potable water for use within a building shall be colored blue or green.

P2911.6 (1302.6) Disinfection.
Nonpotable water collected on site for reuse shall be disinfected, treated or both as determined by a *registered design professional* to provide the quality of water needed for the intended end-use application. Where the intended end-use application does not have requirements for the quality of water, disinfection and treatment of water collected on site for reuse shall not be required. Nonpotable water collected on site containing untreated gray water shall be retained in collection reservoirs for not more than 24 hours.

P2911.6.1 (1302.6.1) Gray water used for fixture flushing.
Gray water used for flushing water closets and urinals shall be disinfected and treated by an on-site water reuse treatment system complying with NSF 350.

P2911.7 (1302.7) Storage tanks.
Storage tanks utilized in on-site nonpotable water reuse systems shall comply with Section P2910.9 and Sections P2911.7.1 through P2911.7.3.

P2911.7.1 (1302.7.1) Location.
Storage tanks shall be located with a minimum horizontal distance between various elements as indicated in Table P2911.7.1.

P2911.7.3 (1302.7.3) Outlets.
Outlets shall be located not less than 4 inches (102 mm) above the bottom of the storage tank, and shall not skim water from the surface.

P2911.8 (1302.8) Valves.
Valves shall be supplied on on-site nonpotable water reuse systems in accordance with Sections P2911.8.1 and P2911.8.2.

P2911.8.1 (1302.8.1) Bypass valve.
One three-way diverter valve certified to NSF 50 or other approved device shall be installed on collection piping upstream of each storage tank, or drainfield, as applicable, to divert untreated on-site reuse sources to the sanitary sewer to allow servicing and inspection of the system. Bypass valves shall be installed downstream of fixture traps and vent connections. Bypass valves shall be labeled to indicate the direction of flow, connection and storage tank or drainfield connection. Bypass valves shall be installed in accessible locations. Two shutoff valves shall not be installed to serve as a bypass valve.

P2911.8.2 (1302.8.2) Backwater valve.
Backwater valves shall be installed on each overflow and tank drain pipe. Backwater valves shall be in accordance with Section P3008.

P2911.9 (1302.9) Pumping and control system.
Mechanical equipment including pumps, valves and filters shall be accessible and removable in order to perform repair, maintenance and cleaning. The minimum flow rate and flow pressure delivered by the pumping system shall be appropriate for the application and in accordance with Section P2903.

P2911.10 (1302.10) Water-pressure-reducing valve or regulator.
Where the water pressure supplied by the pumping system exceeds 80 psi (552 kPa) static, a pressure-reducing valve shall be installed to reduce the pressure in the nonpotable water distribution system piping to 80 psi (552 kPa) static or less. Pressure-reducing valves shall be specified and installed in accordance with Section P2903.3.1.

Exception: Service lines to sill cocks and outside hydrants, and main supply risers where pressure from the mains is reduced to 80 psi (552 kPa) or less at individual fixtures.

P2911.11 (1302.11) Distribution pipe.
Distribution piping utilized in on-site nonpotable water reuse systems shall comply with Sections P2911.11.1 through P2911.11.3.

Exception: Irrigation piping located outside of the building and downstream of a backflow preventer.

P2910.11.1 (1302.11.1) Materials, joints and connections.
Distribution piping shall conform to the standards and requirements specified in Section P2906 for nonpotable water.

P2911.11.2 (1302.11.2) Design.
On-site nonpotable water reuse distribution piping systems shall be designed and sized in accordance with Section P2903 for the intended application.

P2911.11.3 (1302.11.3) Marking.
On-site nonpotable water distribution piping labeling and marking shall comply with Section P2901.2

P2911.12 (1302.12) Tests and inspections.
Tests and inspections shall be performed in accordance with Sections P2911.12.1 through P2911.12.6.

P2911.12.1 (1302.12.1) Collection pipe and vent test.
Drain, waste and vent piping used for on-site water reuse systems shall be tested in accordance with Section P2503.

P2911.12.2 (1302.12.2) Storage tank test.
Storage tanks shall be tested with either air or water in accordance with Section P2910.11.

P2911.12.3 (1302.12.3) Water supply system test.
The testing of makeup water supply piping and distribution piping shall be conducted in accordance with Section P2503.7.

P2911.12.4 (1302.12.4) Inspection and testing of backflow prevention assemblies.
Deleted.
~~The testing of backflow preventers and backwater valves shall be conducted in accordance with Section P2503.8.~~

P2911.12.5 (1302.12.5) Inspection of vermin and insect protection.
Inlets and vents to the system shall be inspected to verify that each is protected to prevent the entrance of insects and vermin into the storage tank and piping systems in accordance with Section P2910.7.

P2911.12.6 (1302.12.6) Water quality test.
The quality of the water for the intended application shall be verified at the point of use in accordance with the requirements of the jurisdiction.

P2911.13 (1302.13) Operation and maintenance manuals.
Operation and maintenance materials shall be supplied with nonpotable on-site water reuse systems in accordance with Sections P2910.13.1 through P2910.13.4.

P2911.13.1 (1302.13.1) Manual.
A detailed operations and maintenance manual shall be supplied in hard-copy form for each system.

P2911.13.2 (1302.13.2) Schematics.
The manual shall include a detailed system schematic, the location of system components and a list of system components that includes the manufacturers and model numbers of the components.

P2911.13.3 (1302.13.3) Maintenance procedures.
The manual shall provide a schedule and procedures for system components requiring periodic maintenance. Consumable parts including filters shall be noted along with part numbers.

P2911.13.4 (1302.13.4) Operations procedures.
The manual shall include system startup and shutdown procedures. The manual shall include detailed operating procedures for the system.

SECTION P2912
NONPOTABLE RAINWATER COLLECTION AND DISTRIBUTION SYSTEMS

P2912.1 (1303.1) General.

The provisions of this section shall govern the construction, installation, alteration, and repair of rainwater collection and conveyance systems for the collection, storage, treatment and distribution of rainwater for nonpotable applications, as permitted by the jurisdiction.

P2912.2 (1303.2) Collection surface.

Rainwater shall be collected only from above-ground impervious roofing surfaces constructed from approved materials for acceptable uses without treatment listed in Section P2910.2.3 or where additional appropriate treatment is designed by a *registered design professional*. Collection of water from vehicular parking or pedestrian walkway surfaces shall be prohibited except where the water is used exclusively for landscape irrigation. Overflow and bleed-off pipes from roof-mounted appliances including, but not limited to, evaporative coolers, water heaters and solar water heaters shall not discharge onto rainwater collection surfaces.

P2912.3 (1303.3) Debris excluders.

Downspouts and leaders shall be connected to a roof washer and shall be equipped with a debris excluder or equivalent device to prevent the contamination of collected rainwater with leaves, sticks, pine needles and ~~similar~~ undesirable material. Debris excluders and equivalent devices shall be self-cleaning.

P2912.4 (1303.4) Roof washer.

An amount of rainwater shall be diverted at the beginning of each rain event, and not allowed to enter the storage tank, to wash accumulated debris from the collection surface. The amount of rainfall to be diverted shall be field adjustable as necessary to minimize storage tank water contamination. The roof washer shall not rely on manually operated valves or devices, and shall operate automatically. Diverted rainwater shall not be drained to the roof surface, and shall be discharged in a manner consistent with the storm water runoff requirements of the jurisdiction. Roof washers shall be accessible for maintenance and service.

P2912.5 (1303.5) Roof gutters and downspouts.

Gutters and downspouts shall be constructed of materials that are compatible with the collection surface and the rainwater quality for the desired end use. Joints shall be watertight.

P2912.5.1 (1303.5.1) Slope.

Roof gutters, leaders and rainwater collection piping shall slope continuously toward collection inlets and shall be free of leaks. Gutters and downspouts shall have a slope of not less than $^{1}/_{8}$ inch per foot (10.4 mm/m) along their entire length. Gutters and downspouts shall be installed so that water does not pool at any point.

> **Exception:** Siphonic drainage systems installed in accordance with the manufacturer’s instructions shall not be required to have a slope.

P2912.5.2 (1303.5.3) Cleanouts.

Cleanouts shall be provided in the water conveyance system to allow access to filters, flushes, pipes and downspouts.

P2912.6 (1303.6) Drainage.

Water drained from the roof washer (first flush diverter) or debris excluder shall not be drained to the sanitary sewer. Such water shall be diverted from the storage tank and shall discharge to a location that will not cause erosion or damage to property. Roof washers and debris excluders shall be provided with an automatic means of self-draining between rain events and shall not drain onto roof surfaces.

P2912.7 (1303.7) Collection pipe.
Rainwater collection and conveyance systems shall utilize drainage piping approved for use within plumbing drainage systems to collect and convey captured rainwater. Vent piping approved for use within plumbing venting systems shall be utilized for vents within the rainwater system. Collection and vent piping materials shall comply with Section P3002.

P2912.7.1 (1303.7.1) Installation.
Collection piping conveying captured rainwater shall be installed in accordance with Section P3005.3.

P2912.7.2 (1303.7.2) Joints.
Collection piping conveying captured rainwater shall utilize joints approved for use with the distribution piping and appropriate for the intended applications as specified in Section P3003.

P2912.7.3 (1303.7.3) Size.
Collection piping conveying captured rainwater shall be sized in accordance with drainage-sizing requirements specified in Section P3005.4.

P2912.7.4 (1303.7.4) Marking.
Additional marking of collection piping conveying captured rainwater for reuse shall not be required beyond that required for sanitary drainage, waste, and vent piping by Chapter 30.

P2912.8 (1303.8) Filtration.
Collected rainwater shall be filtered as required for the intended end use. Filters shall be accessible for inspection and maintenance. Filters shall utilize a pressure gauge or other approved method to provide indication when a filter requires servicing or replacement. Filters shall be installed with shutoff valves installed immediately upstream and downstream to allow for isolation during maintenance. Non-potable water for use within a building shall be colored blue or green.

P2912.9 (1303.9) Disinfection.
Where the intended application for rainwater requires disinfection or other treatment or both, it shall be disinfected as ~~needed~~ determined by a *registered design professional* to ensure that the required water quality is delivered at the point of use.

P2912.10 (1303.10) Storage tanks.
Storage tanks utilized in nonpotable rainwater collection and conveyance systems shall comply with Section P2910.9 and Sections P2912.10.1 through P2912.10.3.

P2912.10.1 (1303.10.1) Location.
Storage tanks shall be located with a minimum horizontal distance between various elements as indicated in Table P2912.10.1.

P2912.10.2 (1303.10.2) Inlets.
Storage tank inlets shall be designed to introduce collected rainwater into the tank with minimum turbulence, and shall be located and designed to avoid agitating the contents of the storage tank.

P2912.10.3 (1303.10.3) Outlets.

Outlets shall be located not less than 4 inches (102 mm) above the bottom of the storage tank and shall not skim water from the surface.

P2912.11 (1303.11) Valves.

Valves shall be supplied on rainwater collection and conveyance systems in accordance with Sections P2912.11.1 and P2912.11.2.

P2912.11.2 (1303.11.1) Backwater valve.

Backwater valves shall be installed on each overflow and tank drain pipe. Backwater valves shall be in accordance with Section P3008.

P2912.12 (1303.12) Pumping and control system.

Mechanical equipment including pumps, valves and filters shall be easily accessible and removable in order to perform repair, maintenance and cleaning. The minimum flow rate and flow pressure delivered by the pumping system shall appropriate for the application and in accordance with Section P2903.

P2912.13 (1303.13) Water-pressure-reducing valve or regulator.

Where the water pressure supplied by the pumping system exceeds 80 psi (552 kPa) static, a pressure-reducing valve shall be installed to reduce the pressure in the rainwater distribution system piping to 80 psi (552 kPa) static or less. Pressure-reducing valves shall be specified and installed in accordance with Section P2903.3.1.

Exception: Service lines to sill cocks and outside hydrants, and main supply risers where pressure from the mains is reduced to 80 psi (552 kPa) or less at individual fixtures.

P2912.14 (1303.14) Distribution pipe.

Distribution piping utilized in rainwater collection and conveyance systems shall comply with Sections P2912.14.1 through P2912.14.3.

Exception: Irrigation piping located outside of the building and downstream of a backflow preventer.

P2912.14.1 (1303.14.1) Materials, joints and connections.

Distribution piping shall conform to the standards and requirements specified in Section P2906 for nonpotable water.

P2912.14.2 (1303.14.2) Design.

Distribution piping systems shall be designed and sized in accordance with the Section P2903 for the intended application.

P2912.14.3 (1303.14.3) Labeling and marking.

Nonpotable rainwater distribution piping labeling and marking shall comply with Section P2901.2.

P2912.15 (1303.15) Tests and inspections.

Tests and inspections shall be performed in accordance with Sections P2912.15.1 through P2912.15.8.

P2912.15.1 (1303.15.1) Roof gutter inspection and test. Deleted.
~~Roof gutters shall be inspected to verify that the installation and slope is in accordance with Section P2912.5.1. Gutters shall be tested by pouring not less than one gallon of water (3.8 L) into the end of the gutter opposite the collection point. The gutter being tested shall not leak and shall not retain standing water.~~

P2912.15.2 (1303.15.2) Roofwasher test. Deleted.
~~Roofwashers shall be tested by introducing water into the gutters. Proper diversion of the first quantity of water in accordance with the requirements of Section P2912.4 shall be verified.~~

P2912.15.3 (1303.15.3) Collection pipe and vent test.
Drain, waste and vent piping used for rainwater collection and conveyance systems shall be tested in accordance with Section P2503.

P2912.15.4 (1303.15.4) Storage tank test.
Storage tanks shall be tested with either air or water in accordance with the Section P2910.11.

P2912.15.5 (1303.15.5) Water supply system test.
The testing of makeup water supply piping and distribution piping shall be conducted in accordance with Section P2503.7.

P2912.15.6 (1303.15.6) Inspection and testing of backflow prevention assemblies.
The testing of backflow preventers and backwater valves shall be conducted in accordance with Section P2503.8.

P2912.15.7 (1303.15.7) Inspection of vermin and insect protection.
Inlets and vents to the system shall be inspected to verify that each is protected to prevent the entrance of insects and vermin into the storage tank and piping systems in accordance with Section P2910.7.

P2912.15.8 (1303.15.8) Water quality test.
The quality of the water for the intended application shall be verified at the point of use in accordance with the requirements of the jurisdiction.

P2912.16 (1303.16) Operation and maintenance manuals.
Operation and maintenance manuals shall be supplied with rainwater collection and conveyance systems in accordance with Sections P2912.16.1 through P2912.16.4.

P2912.16.1 (1303.16.1) Manual.
A detailed operations and maintenance manual shall be supplied ~~in hard-copy form~~ for each system.

P2912.16.2 (1303.16.2) Schematics.
The manual shall include a detailed system schematic, the location of system components and a list of system components that includes the manufacturers and model numbers of the components.

P2912.16.3 (1303.16.3) Maintenance procedures.
The manual shall provide a maintenance schedule and procedures for system components

requiring periodic maintenance. Consumable parts, including filters, shall be noted along with part numbers.

P2912.16.4 (1303.16.4) Operations procedures.

The manual shall include system startup and shutdown procedures, and detailed operating procedures.

SECTION P2913

RECLAIMED WATER SYSTEMS

P2913.1 (1304.1) General.

The provisions of this section shall govern the construction, installation, alteration and repair of systems supplying nonpotable reclaimed water.

P2913.2 (1304.2) Water-pressure-reducing valve or regulator.

Where the reclaimed water pressure supplied to the building exceeds 80 psi (552 kPa) static, a pressure-reducing valve shall be installed to reduce the pressure in the reclaimed water distribution system piping to 80 psi (552 kPa) static or less. Pressure-reducing valves shall be specified and installed in accordance with Section P2903.3.1

Exception: Service lines to sill cocks and outside hydrants, and main supply risers where pressure from the mains is reduced to 80 psi (552 kPa) or less at individual fixtures.

P2913.3 (1304.3) Reclaimed water systems.

The design of the reclaimed water systems shall conform to accepted engineering practice.

P2913.3.1 (1304.3.1) Distribution pipe.

Distribution piping shall comply with Sections P2913.3.1.1 through P2913.3.1.3.

Exception: Irrigation piping located outside of the building and downstream of a backflow preventer.

P2913.3.1.1 (1304.3.1.1) Materials, joints and connections.

Distribution piping conveying reclaimed water shall conform to standards and requirements specified in Section P2905 for nonpotable water.

P2913.3.1.2 (1304.3.1.2) Design.

Distribution piping systems shall be designed and sized in accordance with Section P2903 for the intended application.

P2913.3.1.3 (1304.3.1.3) Labeling and marking.

Nonpotable rainwater distribution piping labeling and marking shall comply with Section P2901.2.

P2913.4 (1304.4) Tests and inspections.

Tests and inspections shall be performed in accordance with Sections P2913.4.1 and P2913.4.2.

P2913.4.1 (1304.4.1) Water supply system test.
The testing of makeup water supply piping and reclaimed water distribution piping shall be conducted in accordance with Section P2503.7.

P2913.4.2 (1304.4.2) Inspection and testing of backflow prevention assemblies.
Deleted.
~~The testing of backflow preventers shall be conducted in accordance with Section P2503.8~~.

CHAPTER 30

SANITARY DRAINAGE

~~*User note: Code change proposals to this chapter will be considered by the IRC – Plumbing and Mechanical Code Development Committee during the 2015 (Group A) Code Development Cycle. See explanation on page xvii.*~~

The text of this chapter is extracted from the 2018 edition of the *North Carolina Plumbing Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code* for One- and Two-Family Dwellings. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Plumbing Code*.

SECTION P3001
GENERAL

P3001.1 (701.1) Scope.
The provisions of this chapter shall govern the materials, design, construction and installation of sanitary drainage systems. Plumbing materials shall conform to the requirements of this chapter. The drainage, waste and vent (DWV) system shall consist of piping for conveying wastes from plumbing fixtures, appliances and appurtenances, including fixture traps; above-grade drainage piping; below-grade drains within the building (*building drain*); below- and above-grade venting systems; and piping to the public sewer or private septic system.

P3001.2 (305.4) Protection from freezing.
~~No portion of the above- grade DWV system, other than vent terminals, shall be located outside of a building, in *attics* or crawl spaces, concealed in outside walls, or in any other place subjected to freezing temperatures unless adequate provision is made to protect them from freezing by insulation or heat or both, except in localities having a winter design temperature greater than 32°F (0°C) (ASHRAE 97.5 percent column, winter, see Chapter 3).~~
No traps of soil or waste pipe shall be installed or permitted outside of a building, or concealed in outside walls or in any place where they may be subjected to freezing temperatures, unless adequate provision is made to protect them from freezing.

Building sewers that connect to private sewage disposal systems shall be installed not less than 3 inches (76.2 mm) below finished grade at the point of septic tank connection. *Building sewers* shall be installed not less than 3 inches (76.2 mm) below grade.

Note: These provisions are minimum requirements, which have been found suitable for normal weather conditions. Abnormally low temperatures for extended periods may require additional provisions to prevent freezing.

P3001.3 (309.1) Flood-resistant installation.
In flood hazard areas as established by Table R301.2(1), drainage, waste and vent systems shall be located and installed to prevent infiltration of floodwaters into the systems and discharges from the systems into floodwaters.

SECTION P3002
MATERIALS

P3002.1 (702.1) Piping within buildings.
Drain, waste and vent (DWV) piping in buildings shall be as indicated in Tables P3002.1(1) and P3002.1(2) except that galvanized wrought-iron or galvanized steel pipe shall not be used underground and shall be maintained not less than 6 inches (152 mm) above ground. Allowance shall be made for the thermal expansion and contraction of plastic piping.

TABLE P3002.2
BUILDING SEWER PIPE

MATERIAL	STANDARD
Acrylonitrile butadiene styrene (ABS) plastic pipe in IPS diameters, including schedule 40, DR 22 (PS 200) and DR 24 (PS 140); with a solid, cellular core or composite wall	ASTM D 2661; ASTM F 628; ASTM F 1488
Cast-iron pipe	ASTM A 74; ASTM A 888; CISPI 301
Acrylonitrile butadiene styrene (ABS) plastic pipe in sewer and drain diameters, including SDR 42 (PS 20), PS35, SDR 35 (PS 45), PS50, PS100, PS140, SDR 23.5 (PS 150) and PS200; with a solid, cellular core or composite wall	ASTM F 1488; ASTM D 2751
Polyvinyl chloride (PVC) plastic pipe in sewer and drain diameters, including PS 25, SDR 41 (PS 28), PS 35, SDR 35 (PS 46), PS 50, PS 100, SDR 26 (PS 115), PS140 and PS 200; with a solid, cellular core or composite wall	ASTM F 891; ASTM F 1488; ASTM D 3034; CSA B182.2; CSA B182.4 ANSI/AWWA C900
Concrete pipe	ASTM C 14; ASTM C 76; CSA A257.1M; CSA A257.2M
Copper or copper-alloy tubing (Type K or L)	ASTM B 75; ASTM B 88; ASTM B 251
Ductile iron pipe	ANSI/AWWA C150/A21.50
Polyethylene (PE) plastic pipe (SDR-PR)	ASTM F 714
Polyolefin pipe	ASTM F 1412; CSA B181.3
Polyvinyl chloride (PVC) plastic pipe in IPS diameters, including schedule 40, DR 22 (PS 200) and DR 24 (PS 140); with solid, cellular core or composite wall	ASTM D 2665; ASTM D 2949; ASTM D 3034; ASTM F 1412; CSA B182.2; CSA B182.4
Polyvinyl chloride (PVC) plastic pipe with a 3.25 inch O.D. and a solid, cellular core or composite wall	ASTM D 2949, ASTM F 1488
Stainless steel drainage systems, Types 304 and 316L	ASME A 112.3.1
Vitrified clay pipe	ASTM C 425; ASTM C 700

For SI: 1 inch = 25.4 mm.

P3002.2.1 (703.1) Building sewer pipe near the water service.

The proximity of a *building sewer* to a water service shall comply with Section P2905.4.2.

P3002.3 Fittings.

Pipe fittings shall be *approved* for installation with the piping material installed and shall comply with the applicable standards indicated in Table P3002.3. Pipe fittings shall not be solvent cemented inside of plastic pipe.

TABLE P3002.3
PIPE FITTINGS

PIPE MATERIAL	FITTING STANDARD
Acrylonitrile butadiene styrene (ABS) plastic pipe in IPS diameters	ASTM D 2661; ASTM D 3311; ASTM F 628; CSA B181.1
Cast-iron	ASME B 16.4; ASME B 16.12; ASTM A 74; ASTM A 888; CISPI 301
Acrylonotrile butadiene styrene (ABS) plastic pipe in sewer and drain diameters	ASTM D 2751
Polyvinyl chloride (PVC) plastic pipe in sewer and drain diameters	ASTM D 3034, ASTM D3139
Copper or copper alloy	ASME B 16.15; ASME B 16.18; ASME B 16.22; ASME B 16.23; ASME B 16.26; ASME B 16.29
Gray iron and ductile iron	AWWA C 110/A21.10
Polyolefin	ASTM F 1412; CSA B181.3
Polyvinyl chloride (PVC) plastic in IPS diameters	ASTM D 2665; ASTM D 3311; ASTM F 1866
Polyvinyl chloride (PVC) plastic pipe with a 3.25 inch O.D.	ASTM D 2949
PVC fabricated fittings	ASTM F 1866
Stainless steel drainage systems, Types 304 and 316L	ASME A 112.3.1
Vitrified clay	ASTM C 700

For SI: 1 inch = 25.4 mm.

P3002.3.1 (706.2) Drainage fittings.

Drainage fittings shall have a smooth interior waterway of the same diameter as the piping served. Fittings shall conform to the type of pipe used. Drainage fittings shall not have ledges, shoulders or reductions that can retard or obstruct drainage flow in the piping. Threaded drainage pipe fittings shall be of the recessed drainage type, black or galvanized. Drainage fittings shall be designed to maintain one-fourth unit vertical in 12 units horizontal (2-percent slope) grade. This section shall not be applicable to tubular waste fittings ~~used to convey vertical flow upstream of the trap seal liquid level of a fixture trap~~.

P3002.4.1 (902.3) Sheet lead.

Sheet lead shall weigh not less than indicated for the following applications:

1. Flashing of vent terminals, 3 psf (15 kg/m^2).
2. Prefabricated flashing for vent pipes, $2^{1}/_{2}$ psf (12 kg/m^2).

P3002.4.3 (902.2) Sheet copper.
Sheet copper shall weigh not less than indicated for the following applications:

1. General use, 12 ounces per square feet (4 kg/m^2).

2. Flashing for vent pipes, 8 ounces per square feet (2.5 kg/m^2).

SECTION P3003
JOINTS AND CONNECTIONS

P3003.2 (707.1) Prohibited joints.
Running threads and bands shall not be used in the drainage system. Drainage and vent piping shall not be drilled, tapped, burned or welded.

The following types of joints and connections shall be prohibited:

1. Cement or concrete.

2. Mastic or hot-pour bituminous joints.

3. Joints made with fittings not *approved* for the specific installation.

4. Joints between different diameter pipes made with elastomeric rolling O-rings.

5. Solvent-cement joints between different types of plastic pipe.

6. Saddle-type fittings.

P3003.3 (705.2) ABS plastic.
Joints between ABS plastic pipe or fittings shall comply with Sections P3003.3.1 through P3003.3.3.

P3003.3.1 (705.2.1) Mechanical joints.
Mechanical joints on drainage pipes shall be made with an elastomeric seal conforming to ASTM C 1173, ASTM D 3212 or CSA B602. Mechanical joints shall be installed only in underground systems unless otherwise *approved*. Joints shall be installed in accordance with the manufacturer’s instructions.

P3003.3.2 (705.2.2) Solvent cementing.
Joint surfaces shall be clean and free from moisture. Solvent cement that conforms to ASTM D 2235 or CSA B181.1 shall be applied to joint surfaces. The joint shall be made while the cement is wet. Joints shall be made in accordance with ASTM D 2235, ASTM D 2661, ASTM F 628 or CSA B181.1. Solvent-cement joints shall be permitted above or below ground.

P3003.3.3 (705.2.3) Threaded joints.
Threads shall conform to ASME B1.20.1. Schedule 80 or heavier pipe shall be permitted to

be threaded with dies specifically designed for plastic pipe. *Approved* thread lubricant or tape shall be applied on the male threads only.

P3003.4 (705.4) Cast iron.

Joints between cast-iron pipe or fittings shall comply with Sections P3003.4.1 through P3003.4.3.

P3003.4.1 (705.4.1) Caulked joints.

Joints for hub and spigot pipe shall be firmly packed with oakum or hemp. Molten lead shall be poured in one operation to a depth of not less than 1 inch (25 mm). The lead shall not recede more than 1/8 inch (3 mm) below the rim of the hub and shall be caulked tight. Paint, varnish or other coatings shall not be permitted on the jointing material until after the joint has been tested and *approved*. Lead shall be run in one pouring and shall be caulked tight.

P3003.4.2 (705.4.2) Compression gasket joints.

Compression gaskets for hub and spigot pipe and fittings shall conform to ASTM C 564. Gaskets shall be compressed when the pipe is fully inserted.

P3003.4.3 (705.4.3) Mechanical joint coupling.

Mechanical joint couplings for hubless pipe and fittings shall consist of an elastomeric sealing sleeve and a metallic shield that comply with CISPI 310, ASTM C 1277 or ASTM C 1540. The elastomeric sealing sleeve shall conform to ASTM C 564 or CSA B602 and shall have a center stop. Mechanical joint couplings shall be installed in accordance with the manufacturer’s instructions.

P3003.5 (705.5) Concrete joints.

Joints between concrete pipe and fittings shall be made with an elastomeric seal conforming to ASTM C 443, ASTM C 1173, CSA A257.3M or CSA B602.

P3003.6 (705.6) Copper and copper-alloy pipe and tubing.

Joints between copper or copper-alloy pipe tubing or fittings shall comply with Sections P3003.6.1 through P3003.6.4.

P3003.6.1 (705.6.1) (705.5) Brazed joints.

All joint surfaces shall be cleaned. An *approved* flux shall be applied where required. Brazing materials shall have a melting point in excess of 1,000ºF (538ºC). Brazing alloys filler metal shall be in accordance with AWS A5.8.

P3003.6.2 (705.6.2) Mechanical joints.

Mechanical joints shall be installed in accordance with the manufacturer’s instructions.

P3003.6.3 (705.6.3) Soldered joints.

Copper and copper-alloy joints shall be soldered in accordance with ASTM B 828. Cut tube ends shall be reamed to the full inside diameter of the tube end. All joint surfaces shall be cleaned. Fluxes for soldering shall be in accordance with ASTM B 813 and shall become noncorrosive and nontoxic after soldering. The joint shall be soldered with a solder conforming to ASTM B 32.

P3003.6.4 (705.6.4) Threaded joints.

Threads shall conform to ASME B1.20.1. Pipe-joint compound or tape shall be applied on the male threads only.

P3003.7 (705.9) Steel.
Joints between galvanized steel pipe or fittings shall comply with Sections P3003.7.1 and P3003.7.2.

P3003.7.1 (705.9.1) Threaded joints.
Threads shall conform to ASME B1.20.1. Pipe-joint compound or tape shall be applied on the male threads only.

P3003.7.2 (705.9.2) Mechanical joints.
Joints shall be made with an *approved* elastomeric seal. Mechanical joints shall be installed in accordance with the manufacturer's instructions.

P3003.8 (705.10) Lead.
Joints between lead pipe or fittings shall comply with Sections P3003.8.1 and P3003.8.2.

P3003.8.1 (705.10.1) Burned.
Burned joints shall be uniformly fused together into one continuous piece. The thickness of the joint shall be not less than the thickness of the lead being joined. The filler metal shall be of the same material as the pipe.

P3003.8.2 (705.10.2) Wiped.
Joints shall be fully wiped, with an exposed surface on each side of the joint not less than 3/4 inch (19 mm). The joint shall be not less than 3/8 inch (9.5 mm) thick at the thickest point.

P3003.9 (705.11) PVC plastic.
Joints between PVC plastic pipe or fittings shall comply with Sections P3003.9.1 through P3003.9.3.

P3003.9.1 (705.11.1) Mechanical joints.
Mechanical joints on drainage pipe shall be made with an elastomeric seal conforming to ASTM C 1173, ASTM D 3212 or CSA B602. Mechanical joints shall not be installed in above-ground systems, unless otherwise *approved*. Joints shall be installed in accordance with the manufacturer's instructions.

P3003.9.2 (705.11.2) Solvent cementing.
Joint surfaces shall be clean and free from moisture. A purple primer or an ultraviolet purple primer that conforms to ASTM F 656 shall be applied. When an ultraviolet primer is used, the installer shall provide an ultraviolet light to the inspector to be used during the inspection. Solvent cement not purple in color and conforming to ASTM D 2564, CSA B137.3 or CSA B181.2 shall be applied to all joint surfaces. The joint shall be made while the cement is wet, and shall be in accordance with ASTM D 2855. Solvent-cement joints shall be installed above or below ground. Clear primer conforming to ASTM F 656 may be applied to all joint surfaces where the piping is exposed under sinks and in buildings.

~~**Exception:** A primer shall not be required where all of the following conditions apply:~~

1. ~~The solvent cement used is third-party certified as conforming to ASTM D 2564.~~

2. ~~The solvent cement is used only for joining PVC drain, waste and vent pipe and fittings in non-pressure applications in sizes up to and including 4 inches (102 mm) in diameter~~

P3003.9.3 (705.11.3) Threaded joints.
Threads shall conform to ASME B1.20.1. Schedule 80 or heavier pipe shall be permitted to be threaded with dies specifically designed for plastic pipe. *Approved* thread lubricant or tape shall be applied on the male threads only.

P3003.10 (705.12) Vitrified clay.
Joints between vitrified clay pipe or fittings shall be made with an elastomeric seal conforming to ASTM C 425, ASTM C 1173 or CSA B602.

P3003.11 (705.14) Polyolefin plastic.
Joints between polyolefin plastic pipe and fittings shall comply with Sections P3003.11.1 and P3003.11.2.

P3003.11.1 (705.14.1) Heat-fusion joints.
Heat-fusion joints for polyolefin pipe and tubing joints shall be installed with socket-type heat-fused polyolefin fittings or electrofusion polyolefin fittings. Joint surfaces shall be clean and free from moisture. The joint shall be undisturbed until cool. Joints shall be made in accordance with ASTM F 1412 or CSA B181.3.

P3003.11.2 (705.14.2) Mechanical and compression sleeve joints.
Mechanical and compression sleeve joints shall be installed in accordance with the manufacturer's instructions.

P3003.12 (705.13) Polyethylene plastic pipe.
Joints between polyethylene plastic pipe and fittings shall be underground and shall comply with Section P3003.12.1 or P3003.12.2.

P3003.12.1 (705.13.1) Heat fusion joints.
Joint surfaces shall be clean and free from moisture. Joint surfaces shall be cut, heated to melting temperature and joined using tools specifically designed for the operation. Joints shall be undisturbed until cool. Joints shall be made in accordance with ASTM D 2657 and the manufacturer's instructions.

P3003.12.2 (705.13.2) Mechanical joints.
Mechanical joints in drainage piping shall be made with an elastomeric seal conforming to ASTM C 1173, ASTM D 3212 or CSA B602. Mechanical joints shall be installed in accordance with the manufacturer's instructions.

P3003.13 (705.16) Joints between different materials.
Joints between different piping materials shall be made with a mechanical joint of the compression or mechanical-sealing type conforming to ASTM C 1173, ASTM C 1460 or ASTM C 1461. Connectors and adapters shall be *approved* for the application and such joints shall have an elastomeric seal conforming to ASTM C 425, ASTM C 443, ASTM C 564, ASTM C 1440, ASTM D 1869, ASTM F 477, CSA A257.3M or CSA B602, or as required in Sections P3003.13.1 through P3003.13.6. Joints between glass pipe and other types of materials shall be made with adapters having a TFE seal. Joints shall be installed in accordance with the manufacturer's instructions.

P3003.13.1 (705.16.1) Copper or copper-alloy tubing to cast-iron hub pipe.
Joints between copper or copper-alloy tubing and cast-iron hub pipe shall be made with a copper-alloy ferrule or compression joint. The copper or copper-alloy tubing shall be soldered to the ferrule in an *approved* manner, and the ferrule shall be joined to the cast-iron hub by a caulked joint or a mechanical compression joint.

P3003.13.2 (705.16.2) Copper or copper-alloy tubing to galvanized steel pipe.
Joints between copper or copper-alloy tubing and galvanized steel pipe shall be made with a copper-alloy fitting or dielectric fitting. The copper tubing shall be soldered to the fitting in an *approved* manner, and the fitting shall be screwed to the threaded pipe.

P3003.13.3 (705.16.3) Cast-iron pipe to galvanized steel or brass pipe.
Joints between cast-iron and galvanized steel or copper-alloy pipe shall be made by either caulked or threaded joints or with an *approved* adapter fitting.

P3003.13.4 (705.16.4) Plastic pipe or tubing to other piping material.
Joints between different types of plastic pipe or between plastic pipe and other piping material shall be made with an *approved* adapter fitting. Joints between plastic pipe and cast-iron hub pipe shall be made by a caulked joint or a mechanical compression joint.

P3003.13.5 (705.16.5) Lead pipe to other piping material.
Joints between lead pipe and other piping material shall be made by a wiped joint to a caulking ferrule, soldering nipple, or bushing or shall be made with an *approved* adapter fitting.

P3003.13.6 (705.16.7) Stainless steel drainage systems to other materials.
Joints between stainless steel drainage systems and other piping materials shall be made with *approved* mechanical couplings.

P3003.14 (405.4) Joints between drainage piping and water closets.
Joints between drainage piping and water closets or similar fixtures shall be made by means of a closet flange or a waste connector and sealing gasket compatible with the drainage system material, securely fastened to a structurally firm base. Floor outlet fixtures shall be secured to the floor or floor flanges by screws or bolts of corrosion-resistant material. The joint shall be bolted, with an *approved* gasket flange to fixture connection complying with ASME A112.4.3 or setting compound between the fixture and the closet flange or waste connector and sealing gasket. The waste connector and sealing gasket joint shall comply with the joint-tightness test of ASME A112.4.3 and shall be installed in accordance with the manufacturer’s instructions.

P3003.14.1 (405.4.1) Floor flanges.
Floor flanges for water closets or similar fixtures shall be not less than 0.125 inch (3.2 mm) thick for brass, 0.25 inch (6.4 mm) thick for plastic and 0.25 inch (6.4 mm) thick and not less than a 2-inch (51 mm) caulking depth for cast iron or galvanized malleable iron.

Floor flanges of hard lead shall weigh not less than 1 pound, 9 ounces (0.7 kg) and shall be composed of lead alloy with not less than 7.75-percent antimony by weight.

P3003.14.2 (405.4.3) Securing wall-hung water closet bowls.
Wall hung water closet bowls shall be supported by a concealed metal carrier that is attached to the building structural members so that strain is not transmitted to the closet

connector or any other part of the plumbing system. The carrier shall conform to ASME A112.6.1M or ASME A112.6.2.

SECTION P3004
DETERMINING DRAINAGE FIXTURE UNITS

P3004.1 (709.1) DWV system load.
The load on DWV-system piping shall be computed in terms of drainage fixture unit (d.f.u.) values in accordance with Table P3004.1.

TABLE P3004.1 (709.1)
DRAINAGE FIXTURE UNIT (d.f.u.) VALUES FOR VARIOUS PLUMBING FIXTURES

TYPE OF FIXTURE OR GROUP OF FIXTURES	DRAINAGE FIXTURE UNIT VALUE (d.f.u.)[a]
Bar sink	1
Bathtub (with or without a shower head or whirlpool attachments)	2
Bidet	1
Clothes washer standpipe	2
Dishwasher	2
Floor drain[b] (including waste receptors or hub drains for condensate waste)	0
Kitchen sink	2
Lavatory	1
Laundry tub	2
Shower stall	2
Water closet (1.6 gallons per flush)	3
Water closet (greater than 1.6 gallons per flush)	4
Full-bath group with bathtub (with 1.6 gallon per flush water closet, and with or without shower head and/or whirlpool attachment on the bathtub or shower stall)	5
Full-bath group with bathtub (water closet greater than 1.6 gallon per flush, and with or without shower head and/or whirlpool attachment on the bathtub or shower stall)	6
Half-bath group (1.6 gallon per flush water closet plus lavatory)	4
Half-bath group (water closet greater than 1.6 gallon per flush plus lavatory)	5
Kitchen group (dishwasher and sink with or without food-waste disposer)	2
Laundry group (clothes washer standpipe and laundry tub)	3
Multiple-bath groups[c]:	
1.5 baths	7
2 baths	8
2.5 baths	9
3 baths	10
3.5 baths	11

For SI: 1 gallon = 3.785 L.

a. For a continuous or semicontinuous flow into a drainage system, such as from a pump or similar device, ~~1.5~~ 2 fixture units shall be allowed per gpm of flow. For a fixture not listed, use the highest d.f.u. value for a similar listed fixture.

b. A floor drain itself does not add hydraulic load. Where used as a receptor, the fixture unit value of the fixture discharging into the receptor shall be applicable.

c. Add 2 d.f.u. for each additional full bath.

SECTION P3005
DRAINAGE SYSTEM

P3005.1 Drainage fittings and connections.

Fittings shall be installed to guide sewage and waste in the direction of flow. Changes in direction in drainage piping shall be made by the appropriate use of sanitary tees, wyes, sweeps, bends or by a combination of these drainage fittings in accordance with Table P3005.1. Change in direction by combination fittings, heel or side inlets or increasers shall be installed in accordance with Table P3005.1 and Sections P3005.1.1 through P3005.1.4. based on the pattern of flow created by the fitting. Double sanitary tee patterns shall not receive the discharge of appliances with pumping action discharge.

TABLE P3005.1
FITTINGS FOR CHANGE IN DIRECTION

TYPE OF FITTING PATTERN	CHANGE IN DIRECTION		
	Horizontal to vertical[c]	**Vertical to horizontal**	**Horizontal to horizontal**
Sixteenth bend	X	X	X
Eighth bend	X	X	X
Sixth bend	X	X	X
Quarter bend	X	X[~~a~~d,f]	X[~~a~~e]
Short sweep	X	X[a,b]	X[a]
Long sweep	X	X	X
Sanitary tee	X[c]	—	—
Wye	X	X	X
Combination wye and eighth bend	X	X	X

For SI: 1 inch = 25.4 mm.

a. ~~The fittings shall only be permitted for a 2-inch or smaller fixture drain.~~ The fittings shall only be permitted for a 2-inch or smaller sink or lavatory fixture drain.

b. ~~Three~~ Two inches and larger.

c. For a limitation on ~~multiple connection fittings~~ double sanitary tees, see Section P3005.1.1.

d. May be used only within 12 inches below water closet flange measured to centerline of the quarter bend.

e. This fitting shall only be permitted to be used as the first fitting directly behind the fixture for drains 2 inches and smaller, except clothes washers.

f. The heel inlet connection of a quarter bend may be used as a wet or dry vent if the heel inlet connection of the quarter bend is located in the vertical position. The heel or side inlet connection may be used as a wet vent if the quarter bend is located directly below a water closet or other fixture with one integral trap.

P3005.1.1 (706.3) Horizontal to vertical (multiple connection fittings).

Double fittings such as double sanitary tees and tee-wyes or *approved* multiple connection fittings and back-to-back fixture arrangements that connect two or more branches at the same level shall be permitted as long as directly opposing connections are the same size and the discharge into directly opposing connections is from similar fixture types or fixture groups. Double sanitary tee patterns shall not receive the discharge of ~~back-to-back water closets and fixtures or~~ appliances with pumping action discharge.

~~**Exception:** Back-to-back water closet connections to double sanitary tee patterns shall be permitted where the horizontal *developed length* between the outlet of the water closet and the connection to the double sanitary tee is 18 inches (457 mm) or greater.~~

P3005.1.2 (706.4) Heel- or side-inlet quarter bends, drainage. Deleted**.**
~~Heel-inlet quarter bends shall be an acceptable means of connection, except where the quarter bends serves a water closet. A low-heel inlet shall not be used as a wet-vented connection. Side-inlet quarter bends shall be an acceptable means of connection for both drainage, wet venting and stack venting arrangements.~~

P3005.1.4 (420.4) Water closet connection between flange and pipe.
One-quarter bends 3 inches (76 mm) in diameter shall be acceptable for water closet or similar connections, provided that a 4-inch by 3-inch (102 mm by 76 mm) flange is installed to receive the closet fixture horn. Alternately, a 4-inch by 3-inch (102 mm by 76 mm) elbow shall be acceptable with a 4-inch (102 mm) flange.

P3005.1.5 (704.4) Provisions for future fixtures.
Where drainage has been roughed-in for future fixtures, the drainage unit values of the future fixtures shall be considered in determining the required drain sizes. Such future installations shall be terminated with an accessible permanent plug or cap fitting.

P3005.1.6 (704.2) Change in size.
The size of the drainage piping shall not be reduced in size in the direction of the flow. A 4-inch by 3-inch (102 mm by 76 mm) water closet connection shall not be considered as a reduction in size.

P3005.2 (708.1) Cleanouts required.
Cleanouts shall be provided for drainage piping in accordance with Sections P3005.2.1 through P3005.2.11.

P3005.2.1 (708.1.1) Gravity horizontal drains and building drains.
Horizontal drainage pipes in buildings shall have cleanouts located at intervals of not more than 100 feet (30 480 mm). *Building drains* shall have cleanouts located at intervals of not more than 100 feet (30 480 mm) except where manholes are used instead of cleanouts, the manholes shall be located at intervals of not more than 400 feet (122 m). The interval length shall be measured from the cleanout or manhole opening, along the *developed length* of the piping to the next drainage fitting providing access for cleaning, the end of the horizontal drain or the end of the *building drain*.

Exception: Horizontal fixture drain piping serving a nonremovable trap shall not be required to have a cleanout for the section of piping between the trap and the vent connection for such trap.

P3005.2.2 (708.1.2) Gravity building sewers.
Building sewers smaller than 8 inches (203 mm) shall have cleanouts located at intervals of not more than 100 feet (30 480 mm). *Building sewers* 8 inches (203 mm) and larger shall have a manhole located not more than 200 feet (60 960 mm) from the junction of the *building drain* and *building sewer* and at intervals of not more than 400 feet (122 m). The interval length shall be measured from the cleanout or manhole opening, along the *developed length* of the piping to the next drainage fitting providing access for cleaning, a manhole or the end of the *building sewer*.

P3005.2.3 (708.1.3) Building drain and building sewer junction.

~~The junction of the *building drain* and the *building sewer* shall be served by a cleanout that is located at the junction or within 10 feet (3048 mm) *developed length* of piping upstream of the junction. For the requirements of this section, removal of a water closet shall not be required to provide cleanout access.~~ There shall be a cleanout at the junction of the building drain and the building sewer. The cleanout shall be outside the building wall and shall be brought up to the finished ground level. An approved two-way cleanout is allowed to be used at this location to serve as a required cleanout for both the building drain and building sewer. The cleanout at the junction of the building drain and building sewer shall not be required if the cleanout on a 3 inch (76 mm) or larger diameter soil stack is located within a developed length of not more than 15 feet (4572 mm) from the building drain and building sewer connection and is extended to the outside of the building. The minimum size of the cleanout at the junction of the building drain and building sewer shall comply with Section P3005.2.5.

P3005.2.4 (708.1.4) Changes of direction.

~~Where a horizontal drainage pipe, a *building drain* or a *building sewer* has a change of horizontal direction greater than 45 degrees (0.79 rad), a cleanout shall be installed at the change of direction. Where more than one change of horizontal direction greater than 45 degrees (0.79 rad) occurs within 40 feet (12 192 mm) of *developed length* of piping, the cleanout installed for the first change of direction shall serve as the cleanout for all changes in direction within that 40 feet (12 192 mm) of developed length of piping.~~ One cleanout shall be required for every four horizontal 45 degree (0.79 rad) changes located in series. (A long sweep is equivalent to two 45 degree (0.79 rad) bends.)

P3005.2.5 (708.1.5) Cleanout size.

Cleanouts shall be the same size as the piping served by the cleanout, except cleanouts for piping larger than 4 inches (102 mm) need not be larger than 4 inches (102 mm).

Exceptions:

1. ~~Cleanouts located on stacks can be one size smaller than the stack size. 1.~~"P" traps connected to the drainage piping with slip joints or ground joint connections.

2. ~~The size of cleanouts for cast-iron piping can be in accordance with the referenced standards for cast iron fittings as indicated in Table P3002.3. 2.~~"P" traps into which floor drains, shower drains or tub drains with removable strainers discharge.

3. "P" traps into which the straight-through type waste and overflow discharge with the overflow connecting to the top of the tee.

4. "P" traps into which residential washing machines discharge.

5. Test tees or cleanouts in a vertical pipe.

6. Cleanout near the junction of the building drain and the building sewer which may be rodded both ways.

7. Water closets for the water closet fixture drain only.

8. Cast-iron cleanout sizing shall be in accordance with referenced standards in Table P3002.3, ASTM A 74 for hub and spigot fittings or ASTM A 888 or CISPI 301 for hubless fittings.

9. Cleanouts located on *stacks* can be one size smaller than the *stack* size.

P3005.2.6 (708.1.6) Cleanout plugs.

Cleanout plugs shall be copper alloy, plastic or other *approved* materials. Cleanout plugs for borosilicate glass piping systems shall be of borosilicate glass. Brass cleanout plugs shall conform to ASTM A74 and shall be limited for use only on metallic piping systems. Plastic cleanout plugs shall conform to the referenced standards for plastic pipe fittings as indicated in Table P3002.3. Cleanout plugs shall have a raised square head, a countersunk square head or a countersunk slot head. Where a cleanout plug will have a trim cover screw installed into the plug, the plug shall be manufactured with a blind end threaded hole for such purpose.

P3005.2.7 (708.1.7) Manholes.

Manholes and manhole covers shall be of an approved type. Manholes located inside of a building shall have gas-tight covers that require tools for removal.

P3005.2.8 (708.1.8) Installation arrangement.

The installation arrangement of a cleanout shall enable cleaning of drainage piping only in the direction of drainage flow.

Exceptions:

1. Test tees serving as cleanouts.

2. A two-way cleanout installation that is *approved* for meeting the requirements of Section P3005.2.3.

P3005.2.9 (708.1.9) Required clearance.

Cleanouts for 6-inch (153 mm) and smaller piping shall be provided with a clearance of not less than 18 inches (457 mm) from, and perpendicular to, the face of the opening to any obstruction. Cleanouts for 8-inch (203 mm) and larger piping shall be provided with a clearance of not less than 36 inches (914 mm) from, and perpendicular to, the face of the opening to any obstruction.

P3005.2.10 (708.1.10) Cleanout access.

Required cleanouts shall not be installed in concealed locations. For the purposes of this section, concealed locations include, but are not limited to, the inside of plenums, within walls, within floor/ceiling assemblies, below grade and in crawl spaces where the height from the crawl space floor to the nearest obstruction along the path from the crawl space opening to the cleanout location is less than 24 inches (610 mm). Cleanouts with openings at a finished wall shall have the face of the opening located within $1^{1}/_{2}$ inches (38 mm) of the finished wall surface. Cleanouts located below grade shall be extended to grade level so that the top of the cleanout plug is at or above grade. A cleanout installed in a floor or walkway that will not have a trim cover installed shall have a counter-sunk plug installed so the top surface of the plug is flush with the finished surface of the floor or walkway.

P3005.2.10.1 <u>(708.1.10.1)</u> Cleanout plug trim covers.
Trim covers and access doors for cleanout plugs shall be designed for such purposes. Trim cover fasteners that thread into cleanout plugs shall be corrosion resistant. Cleanout plugs shall not be covered with mortar, plaster or any other permanent material.

P3005.2.10.2 <u>(708.1.10.2)</u> Floor cleanout assemblies.
Where it is necessary to protect a cleanout plug from the loads of vehicular traffic, cleanout assemblies in accordance with ASME A112.36.2M shall be installed.

P3005.2.11 <u>(708.1.11)</u> Prohibited use.
The use of a threaded cleanout opening to add a fixture or extend piping shall be prohibited except where another cleanout of equal size is installed with the required access and clearance.

P3005.3 <u>(704.1)</u> Horizontal drainage piping slope.
Horizontal drainage piping shall be installed in uniform alignment at uniform slopes not less than $^1/_4$ unit vertical in 12 units horizontal (2-percent slope) for $2^1/_2$ inch (64 mm) diameter and less, and not less than $^1/_8$ unit vertical in 12 units horizontal (1-percent slope) for diameters of 3 inches (76 mm) or more.

P3005.4 <u>(710.1)</u> Drain pipe sizing.
Drain pipes shall be sized according to drainage fixture unit (d.f.u.) loads. The size of the drainage piping shall not be reduced in size in the direction of flow. The following general procedure is permitted to be used:

1. Draw an isometric layout or riser diagram denoting fixtures on the layout.

2. Assign d.f.u. values to each fixture group plus individual fixtures using Table P3004.1.

3. Starting with the top floor or most remote fixtures, work downstream toward the *building drain* accumulating d.f.u. values for fixture groups plus individual fixtures for each branch. Where multiple bath groups are being added, use the reduced d.f.u. values in Table P3004.1, which take into account probability factors of simultaneous use.

4. Size branches and stacks by equating the assigned d.f.u. values to pipe sizes shown in Table P3005.4.1.

5. Determine the pipe diameter and slope of the *building drain* and *building sewer* based on the accumulated d.f.u. values, using Table P3005.4.2.

P3005.4.1 Branch and stack sizing.
Branches and stacks shall be sized in accordance with Table P3005.4.1. Below grade drain

pipes shall be not less than ~~1 1/2~~ 2 inches (~~38~~ 51 mm) in diameter. Drain stacks shall be not smaller than the largest horizontal branch connected.

Exceptions:

1. A 4-inch by 3-inch (102 mm by 76 mm) closet bend or flange.
2. A 4-inch (102 mm) closet bend connected to a 3-inch (76 mm) stack tee shall not be prohibited.

TABLE P3005.4.1
MAXIMUM FIXTURE UNITS ALLOWED TO BE CONNECTED TO BRANCHES AND STACKS[e]

NOMINAL PIPE SIZE (inches)	ANY HORIZONTAL FIXTURE BRANCH[d]	ANY ONE VERTICAL STACK OR DRAIN
1 1/4[a]	—	—
1 1/2[b]	3	4
2[b]	6	10
2 1/2[b]	12	20
3[f]	20[c]	48
4	160	240

For SI: 1 inch = 25.4 mm.

a. 1 1/4-inch pipe size limited to a single-fixture drain or trap arm. See Table P3201.7.

b. No water closets.

c. No more than three water closets.

d. 50 percent less for circuit-vented fixture branches.

e. Minimum of 2-inch diameter underground.

f. The minimum size of any branches serving a water closet shall be 3 inches.

TABLE P3005.4.2
MAXIMUM NUMBER OF FIXTURE UNITS ALLOWED TO BE CONNECTED TO THE BUILDING DRAIN, BUILDING DRAIN BRANCHES OR THE BUILDING SEWER[c, e]

DIAMETER OF PIPE (inches)	SLOPE PER FOOT		
	1/8 inch	**1/4 inch**	**1/2 inch**
1 1/2[a,b]	—	Note a	Note a
2[b]	—	21	27

$2\frac{1}{2}$[b]	—	24	31
3[d]	36	42	50
4	180	216	250

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

a. $1\frac{1}{2}$-inch pipe size limited to a building drain branch serving not more than two waste fixtures, or not more than one waste fixture if serving a pumped discharge fixture or food waste disposer discharge.
b. No water closets.
c. No building sewer shall be less than 4 inches in size.
d. No more than three water closets.
e. Minimum of 2-inch diameter underground.

SECTION P3007
SUMPS AND EJECTORS

P3007.1 (712.1) Building subdrains.
Building subdrains that cannot be discharged to the sewer by gravity flow shall be discharged into a tightly covered and vented sump from which the liquid shall be lifted and discharged into the building gravity drainage system by automatic pumping equipment or other *approved* method. In other than existing structures, the sump shall not receive drainage from any piping within the building capable of being discharged by gravity to the *building sewer*.

P3007.2 (712.2) Valves required.
A check valve, ~~and~~ a full open valve and a means for cleanout located on the discharge side of the check valve shall be installed in the pump or ejector discharge piping between the pump or ejector and the gravity drainage system. Access shall be provided to such valves. Such valves shall be located above the sump cover required by Section P3007.3.2 or, where the discharge pipe from the ejector is below grade, the valves shall be accessibly located outside the sump below grade in an access pit with a removable access cover.

P3007.3 (712.3) Sump design.
The sump pump, pit and discharge piping shall conform to the requirements of Sections P3007.3.1 through P3007.3.5.

P3007.3.1 (712.3.1) Sump pump.
The sump pump capacity and head shall be appropriate to anticipated use requirements.

P3007.3.2 (712.3.2) Sump pit.
The sump pit shall be not less than 18 inches (457 mm) in diameter and 24 inches (610 mm) deep, unless otherwise *approved*. The pit shall be accessible and located so that drainage flows into the pit by gravity. The sump pit shall be constructed of tile, concrete, steel, plastic or other *approved* materials. The pit bottom shall be solid and provide permanent support for the pump. The sump pit shall be fitted with a gas-tight removable cover that is installed above grade level or floor level, or not more than 2 inches (51 mm) below grade or floor level. The cover shall be adequate to support anticipated loads in the area of use. The sump pit shall be vented in accordance with Chapter 31.

P3007.3.3 (712.3.3) Discharge pipe and fittings.
Discharge pipe and fittings serving sump pumps and ejectors shall be constructed of

materials pressure-rated for not less than the maximum discharge pressure of the pump in accordance with Sections P3007.3.3.1 and P3007.3.3.2 and shall be *approved*.

P3007.3.3.1 (712.3.3.1) Materials.

~~Pipe and fitting materials shall be constructed of copper alloy, copper, CPVC, ductile iron, PE, or PVC~~ Forced main sewer piping shall conform to one of the standards for ABS plastic pipe, copper or copper-alloy tubing, PVC plastic pipe or pressure-rated pipe indicated in Table P3002.2., excluding cell-core products.

P3007.3.3.2 (712.3.3.2) Ratings.

Pipe and fittings shall be rated for the maximum system operating pressure and temperature. Pipe fitting materials shall be compatible with the pipe material. Where pipe and fittings are buried in the earth, they shall be suitable for burial.

P3007.3.4 (712.3.4) Maximum effluent level.

The effluent level control shall be adjusted and maintained to at all times prevent the effluent in the sump from rising to within 2 inches (51 mm) of the invert of the gravity drain inlet into the sump.

P3007.3.4.1 (712.3.4.1) Sump alarms.

Sumps that discharge by means of automatic pumping equipment shall be provided with an approved, electrically operated high-water indicating alarm. A remote sensor shall activate the alarm when the fluid level exceeds a preset level that is less than the maximum capacity of the sump. The alarm shall function to provide an audiovisual signal to occupants within the building. Electrical power for the alarm shall be supplied through a branch circuit separate from that supplying the pump motor.

> **Exception:** Sump alarms are not required for single point-of-use sump pumps and macerating toilet systems.

P3007.3.5 (712.3.5) Ejector connection to the drainage system.

Pumps connected to the drainage system shall connect to a *building sewer, building drain*, soil stack, waste stack or horizontal branch drain. Where the discharge line connects into horizontal drainage piping, the connection shall be made through a wye fitting into the top of the drainage piping and such wye fitting shall be located not less than 10 pipe diameters from the base of any soil stack, waste stack or fixture drain.

P3007.4 (712.4) Sewage pumps and sewage ejectors.

A sewage pump or sewage ejector shall automatically discharge the contents of the sump to the building drainage system. The ejector pump discharge pipe shall not discharge directly into a septic tank. The pumped line shall discharge laterally into a 4-inch (102 mm) gravity line not less than 10 feet (3048 mm) from the connection to the tank through a lateral wye branch.

P3007.5 (712.4.1) Macerating toilet systems and pumped waste systems.

Macerating toilet systems and pumped waste systems shall comply with ASME A112.3.4/CSA B45.9 and shall be installed in accordance with the manufacturer's instructions.

P3007.6 (712.4.2) Capacity.

Sewage pumps and sewage ejectors shall have the capacity and head for the application requirements. Pumps and ejectors that receive the discharge of water closets shall be capable of handling spherical solids with a diameter of up to and including 2 inches (51 mm). Other pumps or ejectors shall be capable of handling spherical solids with a diameter of up to and including 1 inch (25.4 mm). The minimum capacity of a pump or ejector based on the diameter of the discharge pipe shall be in accordance with Table 3007.6.

Exceptions:

1. Grinder pumps or grinder ejectors that receive the discharge of water closets shall have a discharge opening of not less than $1^{1}/_{4}$ inches (32 mm).
2. Macerating toilet assemblies that serve single water closets shall have a discharge opening of not less than $^{3}/_{4}$ inch (19 mm).

TABLE 3007.6 (712.4.2)
MINIMUM CAPACITY OF SEWAGE PUMP OR SEWAGE EJECTOR

DIAMETER OF THE DISCHARGE PIPE (inches)	CAPACITY OF PUMP OR EJECTOR (gpm)
2	21
$2^{1}/_{2}$	30
3	46

For SI: 1 inch = 25.4 mm, 1 gallon per minute = 3.785 L/m.

SECTION P3008
BACKWATER VALVES

P3008.1 (715.1) Sewage backflow.
Where the ~~flood level rims of plumbing fixtures are below~~ plumbing fixtures are installed on a floor with a finished floor elevation below the elevation of the manhole cover of the next upstream manhole in the public sewer, the fixtures shall be protected by a backwater valve installed in the *building drain*, branch of the *building drain* or horizontal branch serving such fixtures. Plumbing fixtures ~~having flood level rims~~ installed on a floor with a finished floor elevation above the elevation of the manhole cover of the next upstream manhole in the public sewer shall not discharge through a backwater valve.

Exceptions:

1. In existing buildings, fixtures above the elevation of the manhole cover of the next upstream manhole in the *public sewer* shall not be prohibited from discharging through a backwater valve.
2. Where the sewer service line ties directly to a manhole, that manhole is considered to be the next upstream manhole.
3. Where hub drains are located in the crawl space for condensate waste, a backwater valve or check valve be installed.

P3008.2 (715.2) Material.
Bearing parts of backwater valves shall be of corrosion-resistant material. Backwater valves shall comply with ASME A112.14.1, CSA B181.1 or CSA B181.2.

P3008.3 (715.3) Seal.
Backwater valves shall be constructed to provide a mechanical seal against backflow.

P3008.4 (715.4) Diameter.
Backwater valves, when fully opened, shall have a capacity not less than that of the pipes in which they are installed.

P3008.5 (715.5) Location.
Backwater valves shall be installed so that the working parts are accessible for service and repair.

P3008.6 (715.6) Crawl spaces.
All hub drains or floor drains installed in crawl spaces shall be protected from backflow into the building by a check valve or back-water valve installed in the lateral serving the said hub drain or floor drain.

SECTION P3009
SUBSURFACE LANDSCAPE IRRIGATION SYSTEMS

Deleted.

~~**P3009.1 Scope.**~~
~~The provisions of this section shall govern the materials, design, construction and installation of subsurface landscape irrigation systems connected to nonpotable water from on-site water reuse systems.~~

~~**P3009.2 Materials.**~~
~~Above-ground drain, waste and vent piping for subsurface landscape irrigation systems shall conform to one of the standards indicated in Table P3002.2(1). Subsurface landscape irrigation, underground building drainage and vent pipe shall conform to one of the standards indicated in Table P3002.1(2).~~

~~**P3009.3 Tests.**~~
~~Drain, waste and vent piping for subsurface landscape irrigation systems shall be tested in accordance with Section P2503.~~

~~**P3009.4 Inspections.**~~
~~Subsurface landscape irrigation systems shall be inspected in accordance with Section R109.~~

~~**P3009.5 Disinfection.**~~
~~Disinfection shall not be required for on-site nonpotable reuse water for subsurface landscape irrigation systems.~~

~~**P3009.6 Coloring.**~~
~~On-site nonpotable reuse water used for subsurface landscape irrigation systems shall not be required to be dyed.~~

~~P3009.7 Sizing.~~

~~The system shall be sized in accordance with the sum of the output of all water sources connected to the subsurface irrigation system. Where gray-water collection piping is connected to subsurface landscape irrigation systems, gray-water output shall be calculated according to the gallons-per-day-per-occupant (liters per day per occupant) number based on the type of fixtures connected. The gray-water discharge shall be calculated by the following equation:~~

~~$C = A \times B$~~ **~~(Equation 30-1)~~**

~~where:~~

~~A = Number of occupants:~~
~~Number of occupants shall be determined by the actual number of occupants, but not less than two occupants for one bedroom and one occupant for each additional bedroom.~~
~~B = Estimated flow demands for each occupant:~~
~~25 gallons (94.6 L) per day per occupant for showers, bathtubs and lavatories and 15 gallons (56.7 L) per day per occupant for clothes washers or laundry trays.~~
~~C = Estimated gray-water discharge based on the total number of occupants.~~

~~P3009.8 Percolation tests.~~

~~The permeability of the soil in the proposed absorption system shall be determined by percolation tests or permeability evaluation.~~

~~P3009.8.1 Percolation tests and procedures.~~

~~Not less than three percolation tests in each system area shall be conducted. The holes shall be spaced uniformly in relation to the bottom depth of the proposed absorption system. More percolation tests shall be made where necessary, de-pending on system design.~~

~~P3009.8.1.1 Percolation test hole.~~

~~The test hole shall be dug or bored. The test hole shall have vertical sides and a horizontal dimension of 4 inches to 8 inches (102 mm to 203 mm). The bottom and sides of the hole shall be scratched with a sharp-pointed instrument to expose the natural soil. Loose material shall be removed from the hole and the bottom shall be covered with 2 inches (51 mm) of gravel or coarse sand.~~

~~P3009.8.1.2 Test procedure, sandy soils.~~

~~The hole shall be filled with clear water to not less than 12 inches (305 mm) above the bottom of the hole for tests in sandy soils. The time for this amount of water to seep away shall be determined, and this procedure shall be repeated if the water from the second filling of the hole seeps away in 10 minutes or less. The test shall proceed as follows: Water shall be added to a point not more than 6 inches (152 mm) above the gravel or coarse sand. Thereupon, from a fixed reference point, water levels shall be measured at 10-minute intervals for a period of 1 hour. Where 6 inches (152 mm) of water seeps away in less than 10 minutes, a shorter interval between measurements shall be used. The water depth shall not exceed 6 inches (152 mm). Where 6 inches (152 mm) of water seeps away in less than 2 minutes, the test shall be stopped and a rate of less than 3 minutes per inch (7.2 s/mm) shall be reported. The final water level drop shall be used to calculate the percolation rate. Soils not meeting these requirements shall be tested in accordance with Section P3009.8.1.3.~~

~~P3009.8.1.3 Test procedure, other soils.~~

~~The hole shall be filled with clear water, and a minimum water depth of 12 inches (305 mm) shall be maintained above the bottom of the hole for a 4-hour period by refilling whenever necessary or by use of an automatic siphon. Water remaining in the hole after 4 hours shall not be removed. Thereafter, the soil shall be allowed to swell not less than 16 hours or more than 30 hours. Immediately after the soil swelling period, the measurements for determining the percolation rate shall be made as follows: any soil sloughed into the hole shall be removed and the water level shall be adjusted to 6 inches (152 mm) above the gravel or coarse sand. Thereupon, from a fixed reference point, the water level shall be measured at 30-minute intervals for a period of 4 hours, unless two successive water level drops do not vary by more than $^{1}/_{16}$ inch (1.59 mm). Not less than three water level drops shall be observed and recorded. The hole shall be filled with clear water to a point not more than 6 inches (152 mm) above the gravel or coarse sand whenever it becomes nearly empty. Adjustments of the water level shall not be made during the three measurement periods except to the limits of the last measured water level drop. When the first 6 inches (152 mm) of water seeps away in less than 30 minutes, the time interval between measurements shall be 10 minutes and the test run for 1 hour. The water depth shall not exceed 5 inches (127 mm) at any time during the measurement period. The drop that occurs during the final measurement period shall be used in calculating the percolation rate.~~

~~P3009.8.1.4 Mechanical test equipment.~~

~~Mechanical percolation test equipment shall be of an approved type.~~

~~P3009.8.2 Permeability evaluation.~~

~~Soil shall be evaluated for estimated percolation based on structure and texture in accordance with accepted soil evaluation practices. Borings shall be made in accordance with Section P3009.8.1.1 for evaluating the soil.~~

~~P3009.9 Subsurface landscape irrigation site location.~~

~~The surface grade of soil absorption systems shall be located at a point lower than the surface grade of any water well or reservoir on the same or adjoining lot. Where this is not possible, the site shall be located so surface water drainage from the site is not directed toward a well or reservoir. The soil absorption system shall be located with a minimum horizontal distance between various elements as indicated in Table P3009.9. Private sewage disposal systems in compacted areas, such as parking lots and driveways, are prohibited. Surface water shall be diverted away from any soil absorption site on the same or neighboring lots.~~

~~TABLE P3009.9~~
~~LOCATION OF SUBSURFACE IRRIGATION SYSTEM~~

~~ELEMENT~~	~~MINIMUM HORIZONTAL DISTANCE~~	
	~~STORAGE TANK (feet)~~	~~IRRIGATION DISPOSAL FIELD (feet)~~
~~Buildings~~	~~5~~	~~2~~
~~Lot line adjoining private property~~	~~5~~	~~5~~
~~Water wells~~	~~50~~	~~100~~

~~Streams and lakes~~	~~50~~	~~50~~
~~Seepage pits~~	~~5~~	~~5~~
~~Septic tanks~~	~~0~~	~~5~~
~~Water service~~	~~5~~	~~5~~
~~Public water main~~	~~10~~	~~10~~

~~For SI: 1 foot = 304.8 mm.~~

~~P3009.10 Installation.~~
~~Absorption systems shall be installed in accordance with Sections P3009.10.1 through P30091.10.5 to provide landscape irrigation without surfacing of water.~~

~~P3009.10.1 Absorption area.~~
~~The total absorption area required shall be computed from the estimated daily gray-water discharge and the design-loading rate based on the percolation rate for the site. The required absorption area equals the estimated gray-water discharge divided by the design loading rate from Table P3009.10.1.~~

~~TABLE P3009.10.1~~
~~DESIGN LOADING RATE~~

~~PERCOLATION RATE (minutes per inch)~~	**~~DESIGN LOADING FACTOR (gallons per square foot per day)~~**
~~0 to less than 10~~	~~1.2~~
~~10 to less than 30~~	~~0.8~~
~~30 to less than 45~~	~~0.72~~
~~45 to 60~~	~~0.4~~

~~For SI: 1 minute per inch = min/25.4 mm,1 gallon per square foot = 40.7 L/m~~^{2}~~.~~

~~P3009.10.2 Seepage trench excavations.~~
~~Seepage trench excavations shall be not less than 1 foot (304 mm) in width and not greater than 5 feet (1524 mm) in width. Trench excavations shall be spaced not less than 2 feet (610 mm) apart. The soil absorption area of a seepage trench shall be computed by using the bottom of the trench area (width) multiplied by the length of pipe. Individual seepage trenches shall be not greater than 100 feet (30 480 mm) in developed length.~~

~~P3009.10.3 Seepage bed excavations.~~
~~Seepage bed excavations shall be not less than 5 feet (1524 mm) in width and have more than one distribution pipe. The absorption area of a seepage bed shall be computed by using the bottom of the trench area. Distribution piping in a seepage bed shall be uniformly spaced not greater than 5 feet (1524 mm) and not less than 3 feet (914 mm) apart, and greater than 3 feet (914 mm) and not less than 1 foot (305 mm) from the sidewall or headwall.~~

~~P3009.10.4 Excavation and construction.~~
~~The bottom of a trench or bed excavation shall be level. Seepage trenches or beds shall not be excavated where the soil is so wet that such material rolled between the hands forms a soil wire. Smeared or compacted soil surfaces in the sidewalls or bottom of seepage trench or bed excavations shall be scarified to the depth of smearing or compaction and the loose material removed. Where rain falls on an open excavation, the soil shall be left until~~

~~sufficiently dry so a soil wire will not form when soil from the excavation bottom is rolled between the hands. The bottom area shall then be scarified and loose material removed.~~

~~P3009.10.5 Aggregate and backfill.~~

~~Not less than 6 inches (150 mm) in depth of aggregate ranging in size from $^{1}/_{2}$ to 2$^{1}/_{2}$ inches (12.7 mm to 64 mm) shall be laid into the trench below the distribution piping elevation. The aggregate shall be evenly distributed not less than 2 inches (51 mm) in depth over the top of the distribution pipe. The aggregate shall be covered with *approved* synthetic materials or 9 inches (229 mm) of uncompacted marsh hay or straw. Building paper shall not be used to cover the aggregate. Not less than 9 inches (229 mm) of soil backfill shall be provided above the covering.~~

~~P3009.11 Distribution piping.~~

~~Distribution piping shall be not less than 3 inches (76 mm) in diameter. Materials shall comply with Table P3009.11. The top of the distribution pipe shall be not less than 8 inches (203 mm) below the original surface. The slope of the distribution pipes shall be not less than 2 inches (51 mm) and not greater than 4 inches (102 mm) per 100 feet (30 480 mm).~~

~~TABLE P3009.11~~
~~DISTRIBUTION PIPE~~

~~MATERIAL~~	~~STANDARD~~
~~Polyethylene (PE) plastic pipe~~	~~ASTM F 405~~
~~Polyvinyl chloride (PVC) plastic pipe~~	~~ASTM D 2729~~
~~Polyvinyl chloride (PVC) plastic pipe with a 3.5-inch O.D. and solid cellular core or composite wall~~	~~ASTM F 1488~~

~~For SI: 1 inch = 25.4 mm.~~

~~P3009.11.1 Joints.~~

~~Joints in distribution pipe shall be made in accordance with Section P3003 of this code.~~

SECTION P3010
REPLACEMENT OF UNDERGROUND SEWERS BY PIPE BURSTING METHODS

P3010.1 (717.1) General.

This section shall govern the replacement of existing *building sewer* piping by pipe-bursting methods.

P3010.2 (717.2) Applicability.

The replacement of building sewer piping by pipe bursting methods shall be limited to gravity drainage piping of sizes 6 inches (150 mm) and smaller. The replacement piping shall be of the same nominal size as the existing piping.

P3010.3 (717.3) Preinstallation inspection.

The existing piping sections to be replaced shall be inspected internally by a recorded video camera survey. The survey shall include notations of the position of cleanouts and the depth of connections to the existing piping.

P3010.4 (717.4) Pipe.

The replacement pipe shall be made of a high-density polyethylene (HDPE) that conforms to cell classification number PE3608, PE4608 or PE4710 as indicated in ASTM F 714. The pipe fittings shall be manufactured with an SDR of 17 and in compliance with ASTM F 714.

P3010.5 (717.5) Pipe fittings.

Pipe fittings to be connected to the replacement piping shall be made of high-density polyethylene (HDPE) that conforms to cell classification number PE3608, PE4608 or PE4710 as indicated in ASTM F 714. The pipe fittings shall be manufactured with an SDR of 17 and in compliance with ASTM D 2683.

P3010.6 (717.6) Cleanouts.

Where the existing building sewer did not have cleanouts meeting the requirements of this code, cleanout fittings shall be installed as required by this code.

P3010.7 (717.7) Post-installation inspection.

The completed replacement piping section shall be inspected internally by a recorded video camera survey. The video survey shall be reviewed and *approved* by the building official prior to pressure testing of the replacement piping system.

P3010.8 (717.8) Pressure testing.

The replacement piping system ~~and the connections to the replacement piping~~ shall be tested in accordance with Section P2503.4.

CHAPTER 31

VENTS

~~*User note: Code change proposals to this chapter will be considered by the IRC – Plumbing and Mechanical Code Development Committee during the 2015 (Group A) Code Development Cycle. See explanation on page xvii.*~~

The text of this chapter is extracted from the 2018 edition of the *North Carolina Plumbing Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code* for One- and Two-Family Dwellings. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Plumbing Code*.

SECTION P3101
VENT SYSTEMS

P3101.1 (901.1) General.
This chapter shall govern the selection and installation of piping, tubing and fittings for vent systems. This chapter shall control the minimum diameter of vent pipes, circuit vents, branch vents and individual vents, and the size and length of vents and various aspects of vent stacks and stack vents. Additionally, this chapter regulates vent grades and connections, height above fixtures and relief vents for stacks and fixture traps, and the venting of sumps and sewers.

P3101.2 (901.2) Trap seal protection.
The plumbing system shall be provided with a system of vent piping that will allow the admission or emission of air so that the liquid seal of any fixture trap shall not be subjected to a pressure differential of more than 1 inch of water column (249 Pa).

P3101.2.1 (901.2.1) Venting required.
Every *trap* and trapped fixture shall be vented in accordance with one of the venting methods specified in this chapter. All fixtures discharging downstream from a water closet shall be individually vented except as provided in Section P3107.

P3101.3 (901.4) Use limitations.
The plumbing vent system shall not be used for purposes other than the venting of the plumbing system.

P3101.4 (903.2) Extension outside a structure. Deleted.
~~In climates where the 97.5-percent value for outside design temperature is 0°F (-18°C) or less (ASHRAE 97.5-percent column, winter, see Chapter 3), vent pipes installed on the exterior of the structure shall be protected against freezing by insulation, heat or both. Vent terminals shall be protected from frost closure in accordance with Section P3103.2.~~

P3101.5 (309.2) Flood resistance.
In flood hazard areas as established by Table R301.2(1), vents shall be located at or above the elevation required in Section R322.1 (flood hazard areas including A Zones) or R322.2 (coastal

high-hazard areas including V Zones). The plumbing systems, pipes and fixtures shall not be mounted on or penetrate through walls intended to break away under flood loads.

P3101.6 (901.5) Tests.

The vent system shall be tested in accordance with Section P2503.5.

P3101.7 (902.1) Materials

The materials and methods utilized for the construction and installation of venting systems shall comply with the applicable provisions of Section P2906.

P3101.7.1 (902.2) Sheet copper.

Sheet copper for vent pipe flashings shall conform to ASTM B 152 and shall weigh not less than 8 ounces per square foot (2.5 kg/m^2).

P3101.7.2 (902.3) Sheet lead.

Sheet lead for vent pipe flashings shall weigh not less than 3 pounds per square foot (15 kg/m^2) for field-constructed flashings and not less than 2-1/2 pounds per square foot (12 kg/m^2) for prefabricated flashings.

SECTION P3102
VENT STACKS AND STACK VENTS

P3102.1 (904.1) ~~Required vent extension~~ Stack required.

~~The vent system serving each *building drain* shall have not less than one vent pipe that extends to the outdoors~~. Every building in which plumbing is installed shall have at least one stack the size of which is not less than one-half of the required diameter of the building drain, and not less than 2 inches (51 mm) in diameter. Such stack shall run undiminished in size and as directly as possible from the building drain through to the open air or to a vent header that extends to the open air.

P3102.1.1 (904.1.1) Connection to drainage system.

A vent stack shall connect to the building drain or to the base of a drainage stack in accordance with Section P3005.5. A stack vent shall be an extension of the drainage stack. For townhouses and one- and two-family dwellings, the main vent shall connect to the building drain, building stack or branch thereof not less than 3 inches (76 mm) in size.

P3102.4 (904.3) Stack vent termination.

Stack vents shall terminate outdoors to the open air or to a stack-type air admittance valve in accordance with Section P3114.

P3102.5 (904.5) Stack vent headers.

Stack vents connected into a common vent header at the top of the *stacks* and extending to the open air at one point shall be sized in accordance with the requirements of Section P3113.1. The number of fixture units shall be the sum of all fixture units on all *stacks* connected thereto, and the *developed length* shall be the longest vent length from the intersection at the base of the most distant *stack* to the vent terminal in the open air, as a direct extension of one *stack.*

SECTION P3103
VENT TERMINALS

P3103.1 (903.1) Roof extension.
Open vent pipes that extend through a roof shall be terminated not less than 6 inches (152 mm) above the roof or 6 inches (152 mm) above the anticipated snow accumulation, whichever is greater. Where a roof is to be used for assembly, as a promenade, observation deck or sunbathing deck or for similar purposes, open vent pipes shall terminate not less than 7 feet (2134 mm) above the roof.

P3103.2 (903.2) Frost closure. Deleted.
~~Where the 97.5-percent value for outside design temperature is 0°F (-18°C) or less, vent extensions through a roof or wall shall be not less than 3 inches (76 mm) in diameter. Any increase in the size of the vent shall be made not less than 1 foot (304.8 mm) inside the thermal envelope of the building.~~

P3103.3 (903.3) Flashings and sealing.
The juncture of each vent pipe with the roof line shall be made water tight by an *approved* flashing. Vent extensions in walls and soffits shall be made weather tight by caulking.

P3103.4 (903.4) Prohibited use.
~~A vent terminal shall not be used for any purpose other than a vent terminal.~~ Vent terminals shall not be used as a flag pole or to support flag poles, television aerials or similar items, except when the piping has been anchored in an approved manner.

P3103.5 (903.5) Location of vent terminal.
~~An open vent terminal from a drainage system shall not be located less than 4 feet (1219 mm) directly beneath any door, openable window, or other air intake opening of the building or of an adjacent building, nor shall any such vent terminal be within 10 feet (3048 mm) horizontally of such an opening unless it is not less than 3 feet (914 mm) above the top of such opening.~~ An open vent terminal from a drainage system shall not be located directly beneath any door, openable window, or other air intake opening of the building or of an adjacent building or property line, and any such vent terminal shall not be within 10 feet (3048 mm) horizontally of such an opening unless it is 2 feet (610 mm) or more above the top of such opening.

P3103.6 (903.6) Extension through the wall.
Vent terminals extending through the wall shall terminate not less than 10 feet (3048 mm) from the *lot line* and 10 feet (3048 mm) above the highest adjacent *grade* within 10 feet (3048 mm) horizontally of the vent terminal. Vent terminals shall not terminate under the overhang of a structure with soffit vents. Side wall vent terminals shall be protected to prevent birds or rodents from entering or blocking the vent opening.

SECTION P3104 (905)
VENT CONNECTIONS AND GRADES

P3104.1 (905.1) Connection.
Individual branch and circuit vents shall connect to a vent stack, stack vent or extend to the open air.

Exception: Individual, branch and circuit vents shall be permitted to terminate at an *air admittance valve* in accordance with Section P3114.

P3104.2 (905.2) Grade.

Vent and branch vent pipes shall be graded, connected and supported to allow moisture and condensate to drain back to the soil or waste pipe by gravity.

P3104.3 (905.3) Vent connection to drainage system.

A dry vent connecting to a horizontal drain shall connect above the centerline of the horizontal drain pipe.

P3104.4 (905.4) Vertical rise of vent.

A dry vent shall rise vertically to not less than 6 inches (152 mm) above the flood level rim of the highest trap or trapped fixture being vented.

Exceptions:

1. Vents for interceptors located outdoors.
2. When vents for interceptors are not located near an adjacent wall, the vent must rise 6 inches (152 mm) vertically before turning horizontally and continuing to the nearest wall. For cleaning purposes, a cleanout of the same size as the vent shall be installed.

P3104.5 (905.5) Height above fixtures.

A connection between a vent pipe and a vent stack or stack vent shall be made not less than 6 inches (152 mm) above the flood level rim of the highest fixture served by the vent. Horizontal vent pipes forming branch vents shall be not less than 6 inches (152 mm) above the flood level rim of the highest fixture served.

P3104.6 (905.6) Vent for future fixtures.

Where the drainage piping has been roughed-in for future fixtures, a rough-in connection for a vent, not less than one-half the diameter of the drain, shall be installed. The vent rough-in shall connect to the vent system or shall be vented by other means as provided in this chapter. The connection shall be identified to indicate that the connection is a vent.

SECTION P3105
FIXTURE VENTS

P3105.1 (909.1) Distance of trap from vent.

Each fixture trap shall have a protecting vent located so that the slope and the *developed length* in the *fixture drain* from the trap weir to the vent fitting are within the requirements set forth in Table P3105.1.

Exception: The *developed length* of the *fixture drain* from the trap weir to the vent fitting for self-siphoning fixtures, such as water closets, shall not be limited.

P3105.2 (909.2) Fixture drains.

The total fall in a *fixture drain* resulting from pipe slope shall not exceed one pipe diameter, nor shall the vent pipe connection to a *fixture drain*, except for water closets, be below the weir of the trap.

P3105.3 (909.3) Crown vent prohibited.
A vent shall not be installed within two pipe diameters of the trap weir.

SECTION P3106 (910)
INDIVIDUAL VENT

P3106.1 (910.1) Individual vent permitted.
Each trap and trapped fixture shall be permitted to be provided with an individual vent. The individual vent shall connect to the *fixture drain* of the trap or trapped fixture being vented.

SECTION P3107
COMMON VENT

P3107.1 (911.1) Individual vent as common vent.
An individual vent shall be permitted to vent two traps or trapped fixtures as a common vent. The traps or trapped fixtures being common vented shall be located on the same floor level.

P3107.2 (911.2) Connection at the same level.
Where the *fixture drains* being common vented connect at the same level, the vent connection shall be at the interconnection of the *fixture drains* ~~or downstream of the interconnection~~.

P3107.3 (911.3) Connection at different levels.
Where the *fixture drains* connect at different levels, the vent shall connect as a vertical extension of the vertical drain. The vertical drain pipe connecting the two *fixture drains* shall be considered the vent for the lower *fixture drain*, and shall be sized in accordance with Table P3107.3. The upper fixture shall not be a water closet or clothes washer.

TABLE P3107.3
COMMON VENT SIZES

PIPE SIZE (inches)	MAXIMUM DISCHARGE FROM UPPER FIXTURE DRAIN (d.f.u.)
$1\frac{1}{2}$	1
2	4
$2\frac{1}{2}$ to 3	6

For SI: 1 inch = 25.4 mm.

SECTION P3108
WET VENTING

P3108.1 (912.1) Horizontal wet vent permitted.
Any combination of fixtures ~~within two *bathroom groups*~~ located on the same floor level shall be permitted to be vented by a ~~horizontal~~ wet vent. The wet vent shall be considered the vent for the fixtures and shall extend from the connection of the dry vent along the direction of the flow in

the drain pipe to the most downstream *fixture drain* connection. Each *fixture drain* shall connect horizontally to the horizontal branch being wet vented or shall have a dry vent. Each wet-vented *fixture drain* shall connect independently to the horizontal wet vent. ~~Only the fixtures within the *bathroom groups* shall connect to the wet-vented horizontal branch drain. Any additional fixtures shall discharge downstream of the horizontal wet vent.~~ A residential clothes washer drain line shall not be used as a wet vent.

P3108.2 (912.2) Dry vent connection.

The required dry-vent connection for wet-vented systems shall comply with Sections P3108.2.1 and P3108.2.2.

P3108.2.1 (912.2.1) Horizontal wet vent.

The dry-vent connection for a horizontal wet-vent system shall be an individual vent or a common vent for any ~~*bathroom group*~~ fixture, except an emergency floor drain. Where the dry vent connects to a water closet *fixture drain*, the drain shall connect horizontally to the horizontal wet vent system. ~~Not more than one wet-vented *fixture drain* shall discharge upstream of the dry-vented *fixture drain* connection.~~

P3108.2.2 (912.2.2) Vertical wet vent.

The dry-vent connection for a vertical wet-vent system shall be an individual vent or common vent for the most upstream *fixture drain*.

P3108.3 (912.3) Size.

Horizontal and vertical wet vents shall be not less than the size as specified in Table P3108.3, based on the fixture unit discharge to the wet vent. The dry vent serving the wet vent shall be sized based on the largest required diameter of pipe within the wet-vent system served by the dry vent.

P3108.4 (912.1.1) Vertical wet vent permitted.

A combination of fixtures located on the same floor level shall be permitted to be vented by a vertical wet vent. The vertical wet vent shall be considered the vent for the fixtures and shall extend from the connection of the dry vent down to the lowest *fixture drain* connection. Each wet-vented fixture shall connect independently to the vertical wet vent. All water closet drains shall connect at the same elevation. Other *fixture drains* shall connect above or at the same elevation as the water closet *fixture drains*. The dry vent connection to the vertical wet vent shall be an individual or common vent serving one or two fixtures.

SECTION P3109 (913)
WASTE STACK VENT

P3109.1 (913.1) Waste stack vent permitted.

A waste stack shall be considered a vent for all of the fixtures discharging to the stack where installed in accordance with the requirements of this section.

P3109.2 (913.2) Stack installation.

The waste stack shall be vertical, and both horizontal and vertical offsets shall be prohibited between the lowest *fixture drain* connection and the highest *fixture drain* connection to the stack. Every *fixture drain* shall connect separately to the waste stack. The stack shall not receive the discharge of water closets or urinals.

P3109.3 (913.3) Stack vent.

A stack vent shall be installed for the waste stack. The size of the stack vent shall be not less than the size of the waste stack. Offsets shall be permitted in the stack vent and shall be located not less than 6 inches (152 mm) above the flood level of the highest fixture, and shall be in accordance with Section P3104.5. The stack vent shall be permitted to connect with other stack vents and vent stacks in accordance with Section P3113.3.

P3109.4 (913.4) Waste stack size.

The waste stack shall be sized based on the total discharge to the stack and the discharge within a *branch interval* in accordance with Table P3109.4. The waste stack shall be the same size throughout the length of the waste stack.

SECTION P3110 (914)
CIRCUIT VENTING

P3110.1 (914.1) Circuit vent permitted.

Not greater than eight fixtures connected to a horizontal branch drain shall be permitted to be circuit vented. Each *fixture drain* shall connect horizontally to the horizontal branch being circuit vented. The horizontal branch drain shall be classified as a vent from the most downstream *fixture drain* connection to the most upstream *fixture drain* connection to the horizontal branch.

P3110.1.1 (914.1.1) Multiple circuit-vented branches.

Circuit-vented horizontal *branch* drains are permitted to be connected together. Each group of a maximum of eight fixtures shall be considered a separate circuit vent and shall conform to the requirements of this section.

P3110.2 (914.2) Vent connection.

The circuit vent connection shall be located between the two most upstream *fixture drains*. The vent shall connect to the horizontal branch and shall be installed in accordance with Section P3104. The circuit vent pipe shall not receive the discharge of any soil or waste.

P3110.3 (914.3) Slope and size of horizontal branch.

The slope of the vent section of the horizontal branch drain shall be not greater than one unit vertical in 12 units horizontal (8-percent slope). The entire length of the vent section of the horizontal branch drain shall be sized for the total drainage discharge to the branch in accordance with Table P3005.4.1. Drainage discharge dfu values for horizontal fixture branches shall be reduced 50% in Table P3005.4.1 for circuit vented fixture branches.

P3110.4 (914.5) Additional fixtures.

Fixtures, other than the circuit vented fixtures shall be permitted to discharge, to the horizontal branch drain. Such fixtures shall be located on the same floor as the circuit vented fixtures and shall be either individually or common vented.

SECTION P3111
COMBINATION WASTE AND VENT SYSTEM

Deleted.

~~**P3111.1 Type of fixtures.**~~

~~A combination waste and vent system shall not serve fixtures other than floor drains, sinks and lavatories. A combination waste and vent system shall not receive the discharge of a food waste disposer.~~

~~P3111.2 Installation.~~
~~The only vertical pipe of a combination waste and vent system shall be the connection between the fixture drain and the horizontal combination waste and vent pipe. The vertical distance shall be not greater than 8 feet (2438 mm).~~

~~P3111.2.1 Slope.~~

~~The horizontal combination waste and vent pipe shall have a slope of not greater than $^{1}/_{2}$ unit vertical in 12 units horizontal (4-percent slope). The minimum slope shall be in accordance with Section P3005.3.~~

~~P3111.2.2 Connection.~~
~~The combination waste and vent system shall be provided with a dry vent connected at any point within the system or the system shall connect to a horizontal drain that serves vented fixtures located on the same floor. Combination waste and vent systems connecting to *building drains* receiving only the discharge from one or more stacks shall be provided with a dry vent. The vent connection to the combination waste and vent pipe shall extend vertically to a point not less than 6 inches (152 mm) above the flood level rim of the highest fixture being vented before offsetting horizontally.~~

~~P3111.2.3 Vent size.~~
~~The vent shall be sized for the total fixture unit load in accordance with Section P3113.1.~~

~~P3111.2.4 Fixture branch or drain.~~
~~The fixture branch or *fixture drain* shall connect to the combination waste and vent within a distance specified in Table P3105.1. The combination waste and vent pipe shall be considered the vent for the fixture.~~

~~P3111.3 Size.~~
~~The size of a combination drain and vent pipe shall be not less than that specified in Table 3111.3. The horizontal length of a combination drain and vent system shall be unlimited.~~

~~TABLE P3111.3~~
~~SIZE OF COMBINATION WASTE AND VENT PIPE~~

~~DIAMETER PIPE (inches)~~	**~~MAXIMUM NUMBER OF FIXTURE UNITS (d.f.u.)~~**	
	~~Connecting to a horizontal branch or stack~~	**~~Connecting to a building drain or building subdrain~~**
~~2~~	~~3~~	~~4~~
~~$2^{1}/_{2}$~~	~~6~~	~~26~~
~~3~~	~~12~~	~~31~~
~~4~~	~~20~~	~~50~~

~~For SI: 1 inch = 25.4 mm.~~

SECTION P3112 (916)
ISLAND FIXTURE VENTING

P3112.1 (916.1) Limitation.
Island fixture venting shall not be permitted for fixtures other than sinks and lavatories. Kitchen sinks with a dishwasher waste connection, a food waste disposer, or both, in combination with the kitchen sink waste, shall be permitted to be vented in accordance with this section.

P3112.2 (916.2) Vent connection.
The island fixture vent shall connect to the *fixture drain* as required for an individual or common vent. The vent shall rise vertically to above the drainage outlet of the fixture being vented before offsetting horizontally or vertically downward. The vent or branch vent for multiple island fixture vents shall extend not less than 6 inches (152 mm) above the highest island fixture being vented before connecting to the outside vent terminal.

P3112.3 (916.3) Vent installation below the fixture flood level rim.
The vent located below the flood level rim of the fixture being vented shall be installed as required for drainage piping in accordance with Chapter 30, except for sizing. The vent shall be sized in accordance with Section P3113.1. The lowest point of the island fixture vent shall connect full size to the drainage system. The connection shall be to a vertical drain pipe or to the top half of a horizontal drain pipe. Cleanouts shall be provided in the island fixture vent to permit rodding of all vent piping located below the flood level rim of the fixtures. Rodding in both directions shall be permitted through a cleanout.

SECTION P3113
VENT PIPE SIZING

P3113.1 (906.1) Size of vents.
The required diameter of individual vents, branch vents, circuit vents, vent stacks and stack vents shall be not less than one-half the required diameter of the drain served. The required size of the drain shall be determined in accordance with Chapter 30. Vent pipes shall be not less than $1^{1}/_{4}$ inches (32 mm) in diameter. Vents exceeding 40 feet (12 192 mm) in *developed length* shall be increased by one nominal pipe size for the entire *developed length* of the vent pipe.

P3113.2 (906.3) Developed length.
The *developed length* of individual, branch, and circuit vents shall be measured from the farthest point of vent connection to the drainage system, to the point of connection to the vent stack, stack vent or termination outside of the building.

P3113.3 (906.4) Branch vents.
Where branch vents are connected to a common branch vent, the common branch vent shall be sized in accordance with this section, based on the size of the common horizontal drainage branch that is or would be required to serve the total drainage fixture unit (d.f.u.) load being vented.

P3113.4 (906.5) Sump vents.
Sump vent sizes shall be determined in accordance with Sections P3113.4.1 and P3113.4.2.

P3113.4.1 (906.5.1) Sewage pumps and sewage ejectors other than pneumatic.
Drainage piping below sewer level shall be vented in the same manner as that of a gravity system. Building sump vent sizes for sumps with sewage pumps or sewage ejectors, other

than pneumatic, shall be determined in accordance with Table P3113.4.1. An open vent terminal from a drainage system shall not be located directly beneath any door, openable window, or other air intake opening of the building or of an adjacent building or property line, and any such vent terminal shall not be within 10 feet (3048 mm) horizontally of such an opening unless it is at least 2 feet (610 mm) above the top of such opening.

P3113.4.2 (906.5.2) Pneumatic sewage ejectors.

The air pressure relief pipe from a pneumatic sewage ejector shall be connected to an independent vent stack terminating as required for vent extensions through the roof. The relief pipe shall be sized to relieve air pressure inside the ejector to atmospheric pressure, but shall be not less than $1^{1}/_{4}$ inches (32 mm) in size.

SECTION P3114 (918)

AIR ADMITTANCE VALVES

P3114.1 (918.1) General.

Vent systems using *air admittance valves* shall comply with this section. Individual and branch-type air admittance valves shall conform to ASSE 1051. Stack-type air admittance valves shall conform to ASSE 1050.

P3114.2 (918.2) Installation.

The valves shall be installed in accordance with the requirements of this section and the manufacturer’s instructions. *Air admittance valves* shall be installed after the DWV testing required by Section P2503.5.1 or P2503.5.2 has been performed.

P3114.3 (918.3) Where permitted.

Individual vents, branch vents, circuit vents and stack vents shall be permitted to terminate with a connection to an *air admittance valve*. Individual and branch type air admittance valves shall vent only fixtures that are on the same floor level and connect to a horizontal branch drain.

P3114.4 (918.4) Location.

Individual and branch *air admittance valves* shall be located not less than 4 inches (102 mm) above the horizontal branch drain or *fixture drain* being vented. Stack-type air admittance valves shall be located not less than 6 inches (152 mm) above the flood level rim of the highest fixture being vented. The *air admittance valve* shall be located within the maximum *developed length* permitted for the vent. The *air admittance valve* shall be installed not less than 6 inches (152 mm) above insulation materials where installed in *attics*.

P3114.5 (918.5) Access and ventilation.

Access shall be provided to *air admittance valves*. Such valves shall be installed in a location that allows air to enter the valve.

P3114.6 (918.6) Size.

The *air admittance valve* shall be rated for the size of the vent to which the valve is connected.

P3114.7 (918.7) Vent required.

Within each plumbing system, not less than one stack vent or a vent stack shall extend outdoors to the open air.

P3114.8 (918.8) Prohibited installations.

Air admittance valves shall not be used to vent sumps or tanks except where the vent system for the sump or tank has been designed by an engineer. Air admittance valves shall not be located in spaces utilized as supply or return air plenums.

CHAPTER 32

TRAPS

~~*User note: Code change proposals to this chapter will be considered by the IRC – Plumbing and Mechanical Code Development Committee during the 2015 (Group A) Code Development Cycle. See explanation on page xvii.*~~

<u>The text of this chapter is extracted from the 2018 edition of the *North Carolina Plumbing Code* and has been modified where necessary to conform to the scope of application of the *North Carolina Residential Code* for One- and Two-Family Dwellings. The section numbers appearing in parentheses after each section number are the section numbers of the corresponding text in the *North Carolina Plumbing Code*.</u>

SECTION P3201 <u>(1002)</u>
FIXTURE TRAPS

P3201.1 <u>(1002.2)</u> Design of traps.

Traps shall be of standard design, shall have smooth uniform internal waterways, shall be self-cleaning and shall not have interior partitions except where integral with the fixture. Traps shall be constructed of lead, cast iron, copper or copper alloy or *approved* plastic. Copper or copper alloy traps shall be not less than No. 20 gage (0.8 mm) thickness. Solid connections, slip joints and couplings shall be permitted to be used on the trap inlet, trap outlet, or within the trap seal. Slip joints shall be accessible.

P3201.2 <u>(1002.4)</u> Trap seals.

Each fixture trap shall have a liquid seal of not less than 2 inches (51 mm) and not more than 4 inches (102 mm).

> <u>**Exception:** Trap seal protection for waste receptors or hub drains used for condensate waste shall be by the use of a deep seal trap.</u>

P3201.2.1 <u>(1002.4)</u> Trap seal protection.

Traps seals of emergency floor drain traps and traps subject to evaporation shall be protected by one of the methods in Sections P3201.2.1.1 through P3201.2.1.4.

P3201.2.1.1 <u>(1002.4.1)</u> Potable water-supplied trap seal primer valve.

A potable water-supplied trap seal primer valve shall supply water to the trap. Water-supplied trap seal primer valves shall conform to ASSE 1018. The discharge pipe from the trap seal primer valve shall connect to the trap above the trap seal on the inlet side of the trap.

P3201.2.1.2 <u>(1002.4.2)</u> Reclaimed or gray-water-supplied trap seal primer valve.

A reclaimed or gray-water-supplied trap seal primer valve shall supply water to the trap. Water-supplied trap seal primer valves shall conform to ASSE 1018. The quality of reclaimed or gray water supplied to trap seal primer valves shall be in accordance with the requirements of the manufacturer of the trap seal primer valve. The discharge pipe from the trap seal primer valve shall connect to the trap above the trap seal on the inlet side of the trap.

P3201.2.1.3 (1002.4.3) Waste-water-supplied trap primer device.
A waste-water-supplied trap primer device shall supply water to the trap. Waste-water-supplied trap primer devices shall conform to ASSE 1044. The discharge pipe from the trap seal primer device shall connect to the trap above the trap seal on the inlet side of the trap.

P3201.2.1.4 (1002.4.4) Barrier-type trap seal protection device. Deleted.
~~A barrier-type trap seal protection device shall protect the floor drain trap seal from evaporation. Barrier-type floor drain trap seal protection devices shall conform to ASSE 1072. The devices shall be installed in accordance with the manufacturer's instructions.~~

P3201.3 (1002.7) Trap setting and protection.
Traps shall be set level with respect to their water seals and shall be protected from freezing. Trap seals shall be protected from siphonage, aspiration or back pressure by an *approved* system of venting (see Section P3101).

P3201.4 (1002.6) Building traps.
Building traps shall be prohibited.

P3201.5 (1002.3) Prohibited trap designs.
The following types of traps are prohibited:

1. Bell traps.

2. Separate fixture traps with interior partitions, except those lavatory traps made of plastic, stainless steel or other corrosion-resistant material.

3. "S" traps.

4. Drum traps.

5. Trap designs with moving parts.

P3201.6 (1002.1) Number of fixtures per trap.
Each plumbing fixture shall be separately trapped by a water seal trap. The vertical distance from the fixture outlet to the trap weir shall not exceed 24 inches (610 mm) and the horizontal distance shall not exceed 30 inches (762 mm) measured from the center line of the fixture outlet to the centerline of the inlet of the trap. The height of a clothes washer standpipe above a trap shall conform to Section P2706.1.2. Fixtures shall not be double trapped.

Exceptions:

1. Fixtures that have integral traps.

2. A single trap shall be permitted to serve two or three like fixtures limited to kitchen sinks, laundry tubs and lavatories. Such fixtures shall be adjacent to each other and located in the same room with a continuous waste arrangement. The trap shall be

installed at the center fixture where three fixtures are installed. Common trapped fixture outlets shall be not more than 30 inches (762 mm) apart.

3. Connection of a laundry tray waste line into a standpipe for the automatic clothes-washer drain shall be permitted in accordance with Section P2706.1.2.1.

CHAPTER 33

STORM DRAINAGE

Deleted

~~User note: Code change proposals to this chapter will be considered by the IRC – Plumbing and Mechanical Code Development Committee during the 2015 (Group A) Code Development Cycle. See explanation on page xvii.~~

~~SECTION P3301~~
~~GENERAL~~

~~P3301.1 Scope.~~
~~The provisions of this chapter shall govern the materials, design, construction and installation of storm drainage.~~

~~SECTION P3302~~
~~SUBSOIL DRAINS~~

~~P3302.1 Subsoil drains.~~
~~Subsoil drains shall be open-jointed, horizontally split or perforated pipe conforming to one of the standards listed in Table P3302.1. Such drains shall be not less than 4 inches (102 mm) in diameter. Where the building is subject to backwater, the subsoil drain shall be protected by an accessibly located backwater valve. Subsoil drains shall discharge to a trapped area drain, sump, dry well or~~ *~~approved~~* ~~location above ground. The subsoil sump shall not be required to have either a gas-tight cover or a vent. The sump and pumping system shall comply with Section P3303.~~

~~TABLE P3302.1~~
~~SUBSOIL DRAIN PIPE~~

~~**MATERIAL**~~	~~**STANDARD**~~
~~Cast-iron pipe~~	~~ASTM A 74; ASTM A 888; CISPI 301~~
~~Polyethylene (PE) plastic pipe~~	~~ASTM F 405; CSA B182.1; CSA B182.6; CSA B182.8~~
~~Polyvinyl chloride (PVC) Plastic pipe (type sewer pipe, SDR 35, PS25, PS50 or PS100)~~	~~ASTM D 2729; ASTM D3034; ASTM F 891; CSA B182.2; CSA B182.4~~
~~Stainless steel drainage systems, Type 316L~~	~~ASME A112.3.1~~
~~Vitrified clay pipe~~	~~ASTM C 4; ASTM C 700~~

~~SECTION P3303~~
~~SUMPS AND PUMPING SYSTEMS~~

~~P3303.1 Pumping system.~~
~~The sump pump, pit and discharge piping shall conform to Sections P3303.1.1 through P3303.1.4.~~

~~P3303.1.1 Pump capacity and head.~~
~~The sump pump shall be of a capacity and head appropriate to anticipated use requirements.~~

~~P3303.1.2 Sump pit.~~
~~The sump pit shall be not less than 18 inches (457 mm) in diameter and 24 inches (610 mm) deep, unless otherwise *approved*. The pit shall be accessible and located so that all drainage flows into the pit by gravity. The sump pit shall be constructed of tile, steel, plastic, cast-iron, concrete or other *approved* material, with a removable cover adequate to support anticipated loads in the area of use. The pit floor shall be solid and provide permanent support for the pump.~~

~~P3303.1.3 Electrical.~~
~~Electrical outlets shall meet the requirements of Chapters 34 through 43.~~

~~P3303.1.4 Piping.~~
~~Discharge piping shall meet the requirements of Sections P3002.1, P3002.2, P3002.3 and P3003. Discharge piping shall include an accessible full flow check valve. Pipe and fittings shall be the same size as, or larger than, the pump discharge tapping.~~

Part VIII—Electrical

CHAPTER 34

GENERAL REQUIREMENTS

Deleted. See the *North Carolina Electrical Code.*

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~~SECTION E3401~~
~~GENERAL~~

~~E3401.1 Applicability.~~
~~The provisions of Chapters 34 through 43 shall establish the general scope of the electrical system and equipment requirements of this code. Chapters 34 through 43 cover those wiring methods and materials most commonly encountered in the construction of one- and two-family dwellings and structures regulated by this code. Other wiring methods, materials and subject matter covered in NFPA 70 are also allowed by this code.~~

~~E3401.2 Scope.~~
~~Chapters 34 through 43 shall cover the installation of electrical systems, equipment and components indoors and outdoors that are within the scope of this code, including services, power distribution systems, fixtures, appliances, devices and appurtenances. Services within the scope of this code shall be limited to 120/240-volt, 0- to 400-ampere, single-phase systems. These chapters specifically cover the equipment, fixtures, appliances, wiring methods and materials that are most commonly used in the construction or alteration of one- and two-family dwellings and accessory structures regulated by this code. The omission from these chapters of any material or method of construction provided for in the referenced standard NFPA 70 shall not be construed as prohibiting the use of such material or method of construction. Electrical systems, equipment or components not specifically covered in these chapters shall comply with the applicable provisions of NFPA 70.~~

~~E3401.3 Not covered.~~
~~Chapters 34 through 43 do not cover the following:~~

1. ~~Installations, including associated lighting, under the exclusive control of communications utilities and electric utilities.~~

2. ~~Services over 400 amperes.~~

~~E3401.4 Additions and alterations.~~
~~Any addition or alteration to an existing electrical system shall be made in conformity to the provisions of Chapters 34 through 43. Where additions subject portions of existing systems to loads exceeding those permitted herein, such portions shall be made to comply with Chapters 34 through 43.~~

~~SECTION E3402~~
~~BUILDING STRUCTURE PROTECTION~~

~~E3402.1 Drilling and notching.~~
~~Wood-framed structural members shall not be drilled, notched or altered in any manner except as provided for in this code.~~

~~E3402.2 Penetrations of fire-resistance-rated assemblies.~~
~~Electrical installations in hollow spaces, vertical shafts and ventilation or air-handling ducts shall be made so that the possible spread of fire or products of combustion will not be substantially increased. Electrical penetrations into or through fire-resistance-rated walls, partitions, floors or ceilings shall be protected by approved methods to maintain the fire-resistance rating of the element penetrated. Penetrations of fire-resistance-rated walls shall be limited as specified in Section R317.3. (300.21)~~

~~E3402.3 Penetrations of firestops and draftstops.~~
~~Penetrations through fire blocking and draftstopping shall be protected in an approved manner to maintain the integrity of the element penetrated.~~

~~SECTION E3403~~

~~INSPECTION AND APPROVAL~~

~~E3403.1 Approval.~~
~~Electrical materials, components and equipment shall be approved. (110.2)~~

~~E3403.2 Inspection required.~~
~~New electrical work and parts of existing systems affected by new work or alterations shall be inspected by the building official to ensure compliance with the requirements of Chapters 34 through 43.~~

~~E3403.3 Listing and labeling.~~
~~Electrical materials, components, devices, fixtures and equipment shall be listed for the application, shall bear the label of an approved agency and shall be installed, and used, or both, in accordance with the manufacturer's installation instructions. [110.3(B)]~~

~~SECTION E3404~~

~~GENERAL EQUIPMENT REQUIREMENTS~~

~~E3404.1 Voltages.~~
~~Throughout Chapters 34 through 43, the voltage considered shall be that at which the circuit operates. (110.4)~~

~~E3404.2 Interrupting rating.~~
~~Equipment intended to interrupt current at fault levels shall have a minimum interrupting rating of 10,000 amperes. Equipment intended to interrupt current at levels other than fault levels shall have an interrupting rating at nominal circuit voltage of not less than the current that must be interrupted. (110.9)~~

~~E3404.3 Circuit characteristics.~~
~~The overcurrent protective devices, total impedance, equipment short-circuit current ratings and other characteristics of the circuit to be protected shall be so selected and coordinated as to permit the circuit protective devices that are used to clear a fault to do so without extensive damage to the electrical equipment of the circuit. This fault shall be assumed to be either between two or more of the circuit conductors or between any circuit conductor and the equipment grounding conductors permitted in Section E3908.8. Listed equipment applied in accordance with its listing shall be considered to meet the requirements of this section. (110.10)~~

~~E3404.4 Enclosure types.~~

~~Enclosures, other than surrounding fences or walls, of panelboards, meter sockets, enclosed switches, transfer switches, circuit breakers, pullout switches and motor controllers, rated not over 600 volts nominal and intended for such locations, shall be marked with an enclosure-type number as shown in Table E3404.4.~~

~~Table E3404.4 shall be used for selecting these enclosures for use in specific locations other than hazardous (classified) locations. The enclosures are not intended to protect against conditions such as condensation, icing, corrosion, or contamination that might occur within the enclosure or enter through the conduit or unsealed openings. (110.28)~~

~~TABLE E3404.4 (Table 110.28)~~
~~ENCLOSURE SELECTION~~

~~PROVIDES A DEGREE OF PROTECTION AGAINST THE FOLLOWING ENVIRONMENTAL CONDITIONS~~	~~FOR OUTDOOR USE~~									
	~~Enclosure-type Number~~									
	~~3~~	~~3R~~	~~3S~~	~~3X~~	~~3RX~~	~~3SX~~	~~4~~	~~4X~~	~~6~~	~~6P~~
~~Incidental contact with the enclosed equipment~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~Rain, snow and sleet~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~Sleet~~[a]	—	—	~~X~~	—	—	~~X~~	—	—	—	—
~~Windblown dust~~	~~X~~	—	~~X~~	~~X~~	—	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~Hosedown~~	—	—	—	—	—	—	~~X~~	~~X~~	~~X~~	~~X~~
~~Corrosive agents~~	—	—	—	~~X~~	~~X~~	~~X~~	—	~~X~~	—	~~X~~
~~Temporary submersion~~	—	—	—	—	—	—	—	—	~~X~~	~~X~~
~~Prolonged submersion~~	—	—	—	—	—	—	—	—	—	~~X~~
~~PROVIDES A DEGREE OF PROTECTION AGAINST THE FOLLOWING ENVIRONMENTAL CONDITIONS~~	~~FOR INDOOR USE~~									
	~~Enclosure-type Number~~									
	~~1~~	~~2~~	~~4~~	~~4X~~	~~5~~	~~6~~	~~6P~~	~~12~~	~~12K~~	~~13~~
~~Incidental contact with the enclosed equipment~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~Falling dirt~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~Falling liquids and light splashing~~	—	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~Circulating dust, lint, fibers and flyings~~	—	—	~~X~~	~~X~~	—	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~Settling airborne dust, lint, fibers and flings~~	—	—	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
~~Hosedown and splashing water~~	—	—	~~X~~	~~X~~	—	~~X~~	~~X~~	—	—	—
~~Oil and coolant seepage~~	—	—	—	—	—	—	—	~~X~~	~~X~~	~~X~~
~~Oil or coolant spraying and splashing~~	—	—	—	—	—	—	—	—	—	~~X~~
~~Corrosive agents~~	—	—	—	~~X~~	—	—	~~X~~	—	—	—
~~Temporary submersion~~	—	—	—	—	—	~~X~~	~~X~~	—	—	—
~~Prolonged submersion~~	—	—	—	—	—	—	~~X~~	—	—	—

~~a. Mechanism shall be operable when ice covered.~~

~~Note 1: The term raintight is typically used in conjunction with Enclosure Types 3, 3S, 3SX, 3X, 4, 4X, 6 and 6P. The term rainproof is typically used in conjunction with Enclosure Types 3R and 3RX. The term watertight is typically used in conjunction with Enclosure Types 4, 4X, 6 and 6P. The term driptight is typically used in~~

~~conjunction with Enclosure Types 2, 5, 12, 12K and 13. The term dusttight is typically used in conjunction with Enclosure Types 3, 3S, 3SX, 3X, 5, 12, 12K and 13.~~

~~Note 2: Ingress protection (IP) ratings are found in ANSI/NEMA 60529, *Degrees of Protection Provided by Enclosures*. IP ratings are not a substitute for enclosure-type ratings.~~

~~E3404.5 Protection of equipment.~~

~~Equipment not identified for outdoor use and equipment identified only for indoor use, such as “dry locations,” “indoor use only” “damp locations,” or enclosure Type 1, 2, 5, 12, 12K and/or 13, shall be protected against damage from the weather during construction. (110.11)~~

~~E3404.6 Unused openings.~~

~~Unused openings, other than those intended for the operation of equipment, those intended for mounting purposes, and those permitted as part of the design for listed equipment, shall be closed to afford protection substantially equivalent to the wall of the equipment. Where metallic plugs or plates are used with nonmetallic enclosures they shall be recessed at least 1/4 inch (6.4 mm) from the outer surface of the enclosure. [110.12(A)]~~

~~E3404.7 Integrity of electrical equipment.~~

~~Internal parts of electrical equipment, including busbars, wiring terminals, insulators and other surfaces, shall not be damaged or contaminated by foreign materials such as paint, plaster, cleaners or abrasives, and corrosive residues. There shall not be any damaged parts that might adversely affect safe operation or mechanical strength of the equipment such as parts that are broken; bent; cut; deteriorated by corrosion, chemical action, or overheating. Foreign debris shall be removed from equipment. [110.12(B)]~~

~~E3404.8 Mounting.~~

~~Electrical equipment shall be firmly secured to the surface on which it is mounted. Wooden plugs driven into masonry, concrete, plaster, or similar materials shall not be used. [110.13(A)]~~

~~E3404.9 Energized parts guarded against accidental contact.~~

~~Approved enclosures shall guard energized parts that are operating at 50 volts or more against accidental contact. [110.27(A)]~~

~~E3404.10 Prevent physical damage.~~

~~In locations where electrical equipment is likely to be exposed to physical damage, enclosures or guards shall be so arranged and of such strength as to prevent such damage. [110.27(B)]~~

~~E3404.11 Equipment identification.~~

~~The manufacturer’s name, trademark or other descriptive marking by which the organization responsible for the product can be identified shall be placed on all electric equipment. Other markings shall be provided that indicate voltage, current, wattage or other ratings as specified elsewhere in Chapters 34 through 43. The marking shall have the durability to withstand the environment involved. [110.21(A)]~~

~~E3404.12 Field-applied hazard markings.~~

~~Where caution, warning, or danger signs or labels are required by this code, the labels shall meet the following requirements:~~

1. ~~The marking shall adequately warn of the hazard using effective words, colors, or symbols or combinations of such.~~

2. ~~Labels shall be permanently affixed to the equipment or wiring method.~~

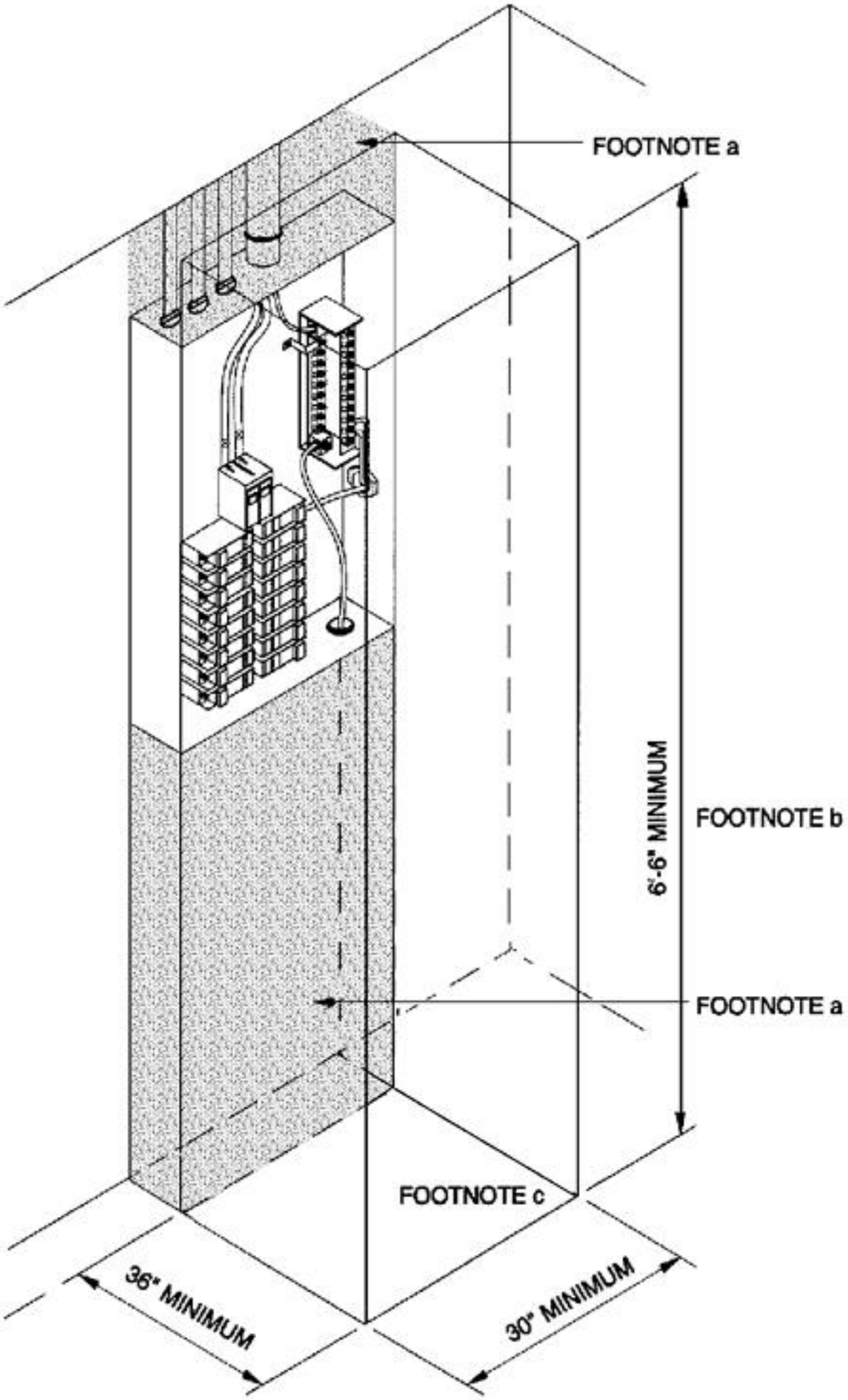
3. ~~Labels shall not be hand written except for portions of labels or markings that are variable, or that could be subject to changes. Labels shall be legible.~~

4. ~~Labels shall be of sufficient durability to withstand the environment involved. [110.21(B)]~~

~~E3404.13 Identification of disconnecting means.~~
~~Each disconnecting means shall be legibly marked to indicate its purpose, except where located and arranged so that the purpose is evident. The marking shall have the durability to withstand the environment involved. [110.22(A)]~~

~~SECTION E3405~~
~~EQUIPMENT LOCATION AND CLEARANCES~~

~~E3405.1 Working space and clearances.~~
~~Access and working space shall be provided and maintained around all electrical equipment to permit ready and safe operation and maintenance of such equipment in accordance with this section and Figure E3405.1. (110.26)~~



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

~~a. Equipment, piping and ducts foreign to the electrical installation shall not be placed in the shaded areas extending from thefloor to a height of 6 feet above the panelboard enclosure, or to the structural ceiling, whichever is lower.~~

~~b. The working space shall be clear and unobstructed from the floor to a height of 6.5 feet or the height of the equipment, whichever is greater.~~
~~c. The working space shall not be designated for storage.~~
~~d. Panelboards, service equipment and similar enclosures shall not be located in bathrooms, toilet rooms, clothes closets or over the steps of a stairway.~~
~~e. Such work spaces shall be provided with artificial lighting where located indoors and shall not be controlled by automatic means only.~~

~~FIGURE E3405.1~~ ~~[a, b, c, d, e]~~
~~WORKING SPACE AND CLEARANCES~~

~~E3405.2 Working clearances for energized equipment and panelboards.~~

~~Except as otherwise specified in Chapters 34 through 43, the dimension of the working space in the direction of access to panelboards and live parts of other equipment likely to require examination, adjustment, servicing or maintenance while energized shall be not less than 36 inches (914 mm) in depth. Distances shall be measured from the energized parts where such parts are exposed or from the enclosure front or opening where such parts are enclosed. In addition to the 36-inch dimension (914 mm), the work space shall not be less than 30 inches (762 mm) wide in front of the electrical equipment and not less than the width of such equipment. The work space shall be clear and shall extend from the floor or platform to a height of 6.5 feet (1981 mm) or the height of the equipment, whichever is greater. In all cases, the work space shall allow at least a 90-degree (1.57 rad) opening of equipment doors or hinged panels. Equipment associated with the electrical installation located above or below the electrical equipment shall be permitted to extend not more than 6 inches (152 mm) beyond the front of the electrical equipment. [110.26(A) (1), (2), (3)]~~

~~Exceptions:~~

1. ~~In existing dwelling units, service equipment and panelboards that are not rated in excess of 200 amperes shall be permitted in spaces where the height of the working space is less than 6.5 feet (1981 mm). [110.26(A)(3) Exception No. 1]~~

2. ~~Meters that are installed in meter sockets shall be permitted to extend beyond the other equipment. Meter sockets shall not be exempt from the requirements of this section. [110.26(A)(3) Exception No. 2]~~

~~E3405.3 Indoor dedicated panelboard space.~~

~~The indoor space equal to the width and depth of the panelboard and extending from the floor to a height of 6 feet (1829 mm) above the panelboard, or to the structural ceiling, whichever is lower, shall be dedicated to the electrical installation. Piping, ducts, leak protection apparatus and other equipment foreign to the electrical installation shall not be installed in such dedicated space. The area above the dedicated space shall be permitted to contain foreign systems, provided that protection is installed to avoid damage to the electrical equipment from condensation, leaks and breaks in such foreign systems (see Figure E3405.1).~~

~~Exception:~~ ~~Suspended ceilings with removable panels shall be permitted within the 6-foot (1829 mm) dedicated space.~~

~~E3405.4 Outdoor dedicated panelboard space.~~

~~The outdoor space equal to the width and depth of the panelboard, and extending from grade to~~

~~a height of 6 feet (1.8 m) above the panelboard, shall be dedicated to the electrical installation. Piping and other equipment foreign to the electrical installation shall not be located in this zone.~~

~~E3405.5 Location of working spaces and equipment.~~
~~Required working space shall not be designated for storage. Panelboards and overcurrent protection devices shall not be located in clothes closets, in bathrooms, or over the steps of a stairway. [110.26(B), 240.24(D), (E), (F)]~~

~~E3405.6 Access and entrance to working space.~~
~~Access shall be provided to the required working space. [110.26(C)(1)]~~

~~E3405.7 Illumination.~~
~~Artificial illumination shall be provided for all working spaces for service equipment and panelboards installed indoors and shall not be controlled by automatic means only. Additional lighting outlets shall not be required where the work space is illuminated by an adjacent light source or as permitted by Exception 1 of Section E3903.2 for switched receptacles. [110.26(D)]~~

~~SECTION E3406~~
~~ELECTRICAL CONDUCTORS AND CONNECTIONS~~

~~E3406.1 General.~~
~~This section provides general requirements for conductors, connections and splices. These requirements do not apply to conductors that form an integral part of equipment, such as motors, appliances and similar equipment, or to conductors specifically provided for elsewhere in Chapters 34 through 43. (310.1)~~

~~E3406.2 Conductor material.~~
~~Conductors used to conduct current shall be of copper except as otherwise provided in Chapters 34 through 43. Where the conductor material is not specified, the material and the sizes given in these chapters shall apply to copper conductors. Where other materials are used, the conductor sizes shall be changed accordingly. (110.5)~~

~~E3406.3 Minimum size of conductors.~~
~~The minimum size of conductors for feeders and branch circuits shall be 14 AWG copper and 12 AWG aluminum. The minimum size of service conductors shall be as specified in Chapter 36. The minimum size of Class 2 remote control, signaling and power-limited circuits conductors shall be as specified in Chapter 43. [310.106(A)]~~

~~E3406.4 Stranded conductors.~~
~~Where installed in raceways, conductors 8 AWG and larger shall be stranded. A solid 8 AWG conductor shall be permitted to be installed in a raceway only to meet the requirements of Sections E3610.2 and E4204. [310.106(C)]~~

~~E3406.5 Individual conductor insulation.~~
~~Except where otherwise permitted in Sections E3605.1 and E3908.9, and E4303, current-carrying conductors shall be insulated. Insulated conductors shall have insulation types identified as RHH, RHW, RHW-2, THHN, THHW, THW, THW-2, THWN, THWN-2, TW, UF, USE, USE-2, XHHW or XHHW-2. Insulation types shall be approved for the application. [310.106(C), 310.104]~~

~~E3406.6 Conductors in parallel.~~

~~Circuit conductors that are connected in parallel shall be limited to sizes 1/0 AWG and larger. Conductors in parallel shall: be of the same length; consist of the same conductor material; be the same circular mil area and have the same insulation type. Conductors in parallel shall be terminated in the same manner. Where run in separate raceways or cables, the raceway or cables shall have the same physical characteristics. Where conductors are in separate raceways or cables, the same number of conductors shall be used in each raceway or cable. [310.10(H)]~~

~~E3406.7 Conductors of the same circuit.~~

~~All conductors of the same circuit and, where used, the grounded conductor and all equipment grounding conductors and bonding conductors shall be contained within the same raceway, cable or cord. [300.3(B)]~~

~~E3406.8 Aluminum and copper connections.~~

~~Terminals and splicing connectors shall be identified for the material of the conductors joined. Conductors of dissimilar metals shall not be joined in a terminal or splicing connector where physical contact occurs between dissimilar conductors such as copper and aluminum, copper and copper-clad aluminum, or aluminum and copper-clad aluminum, except where the device is listed for the purpose and conditions of application. Materials such as inhibitors and compounds shall be suitable for the application and shall be of a type that will not adversely affect the conductors, installation or equipment. (110.14)~~

~~E3406.9 Fine stranded conductors.~~

~~Connectors and terminals for conductors that are more finely stranded than Class B and Class C stranding as shown in Table E3406.9, shall be identified for the specific conductor class or classes. (110.14)~~

~~TABLE E3406.9 (Chapter 9, Table 10)~~

~~CONDUCTOR STRANDING~~[~~c~~]

~~CONDUCTOR SIZE~~		~~NUMBER OF STRANDS~~		
		~~Copper~~		~~Aluminum~~
~~AWG or kcmil~~	~~mm~~^{2}	~~Class B~~	~~Class C~~	~~Class B~~
~~24-30~~	~~0.20-0.05~~	~~a~~	~~—~~	~~—~~
~~22~~	~~0.32~~	~~7~~	~~—~~	~~—~~
~~20~~	~~0.52~~	~~10~~	~~—~~	~~—~~
~~18~~	~~0.82~~	~~16~~	~~—~~	~~—~~
~~16~~	~~1.3~~	~~26~~	~~—~~	~~—~~
~~14-2~~	~~2.1-33.6~~	~~7~~	~~19~~	~~7~~[~~b~~]
~~1-4/0~~	~~42.4-107~~	~~19~~	~~37~~	~~19~~
~~250-500~~	~~127-253~~	~~37~~	~~61~~	~~37~~
~~600-1000~~	~~304-508~~	~~61~~	~~91~~	~~61~~
~~1250-1500~~	~~635-759~~	~~91~~	~~127~~	~~91~~
~~1750-2000~~	~~886-1016~~	~~127~~	~~271~~	~~127~~

~~a. Number of strands vary.~~

~~b. Aluminum 14 AWG (2.1 mm~~^{2}~~) is not available.~~

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~~E3406.10 Terminals.~~

~~Connection of conductors to terminal parts shall be made without damaging the conductors and shall be made by means of pressure connectors, including set-screw type, by means of splices to flexible leads, or for conductor sizes of 10 AWG and smaller, by means of wire binding screws or studs and nuts having upturned lugs or the equivalent. Terminals for more than one conductor and terminals for connecting aluminum conductors shall be identified for the application. [110.14(A)]~~

~~E3406.11 Splices.~~

~~Conductors shall be spliced or joined with splicing devices listed for the purpose. Splices and joints and the free ends of conductors shall be covered with an insulation equivalent to that of the conductors or with an insulating device listed for the purpose. Wire connectors or splicing means installed on conductors for direct burial shall be listed for such use. [110.14(B)]~~

~~E3406.11.1 Continuity.~~

~~Conductors in raceways shall be continuous between outlets, boxes, and devices and shall be without splices or taps in the raceway.~~

> ~~**Exception:** Splices shall be permitted within surface-mounted raceways that have a removable cover. [300.13(A)]~~

~~E3406.11.2 Device connections.~~

~~The continuity of a grounded conductor in multiwire branch circuits shall not be dependent on connection to devices such as receptacles and lampholders. The arrangement of grounding connections shall be such that the disconnection or the removal of a receptacle, luminaire or other device fed from the box does not interfere with or interrupt the grounding continuity. [300.13(B)]~~

~~E3406.11.3 Length of conductor for splice or termination.~~

~~Where conductors are to be spliced, terminated or connected to fixtures or devices, a minimum length of 6 inches (152 mm) of free conductor shall be provided at each outlet, junction or switch point. The required length shall be measured from the point in the box where the conductor emerges from its raceway or cable sheath. Where the opening to an outlet, junction or switch point is less than 8 inches (200 mm) in any dimension, each conductor shall be long enough to extend at least 3 inches (75 mm) outside of such opening. (300.14)~~

~~E3406.12 Grounded conductor continuity.~~

~~The continuity of a grounded conductor shall not depend on connection to a metallic enclosure, raceway or cable armor. [200.2(B)]~~

~~E3406.13 Connection of grounding and bonding equipment.~~

~~The connection of equipment grounding conductors, grounding electrode conductors and bonding jumpers shall be in accordance with Sections E3406.13.1 and E3406.13.2.~~

~~E3406.13.1 Permitted methods.~~

~~Equipment grounding conductors, grounding electrode conductors, and bonding jumpers shall be connected by one or more of the following means:~~

1. ~~Listed pressure connectors.~~
2. ~~Terminal bars.~~
3. ~~Pressure connectors listed as grounding and bonding equipment.~~
4. ~~Exothermic welding process.~~
5. ~~Machine screw-type fasteners that engage not less than two threads or are secured with a nut.~~
6. ~~Thread-forming machine screws that engage not less than two threads in the enclosure.~~
7. ~~Connections that are part of a listed assembly.~~
8. ~~Other listed means. [250.8 (A)]~~

~~**E3406.13.2 Methods not permitted.**~~
~~Connection devices or fittings that depend solely on solder shall not be used. [250.8 (B)]~~

~~SECTION E3407~~
~~CONDUCTOR AND TERMINAL IDENTIFICATION~~

~~**E3407.1 Grounded conductors.**~~
~~Insulated grounded conductors of sizes 6 AWG or smaller shall be identified by a continuous white or gray outer finish or by three continuous white or gray stripes on other than green insulation along the entire length of the conductors. Conductors of sizes 4 AWG or larger shall be identified either by a continuous white or gray outer finish or by three continuous white or gray stripes on other than green insulation along its entire length or at the time of installation by a distinctive white or gray marking at its terminations. This marking shall encircle the conductor or insulation. [200.6(A) & (B)]~~

~~**E3407.2 Equipment grounding conductors.**~~
~~Equipment grounding conductors of sizes 6 AWG and smaller shall be identified by a continuous green color or a continuous green color with one or more yellow stripes on the insulation or covering, except where bare. Conductors with insulation or individual covering that is green, green with one or more yellow stripes, or otherwise identified as permitted by this section shall not be used for ungrounded or grounded circuit conductors. (250.119)~~

~~Equipment grounding conductors 4 AWG and larger AWG that are not identified as required for conductors of sizes 6 AWG and smaller shall, at the time of installation, be permanently identified as an equipment grounding conductor at each end and at every point where the conductor is accessible, except where such conductors are bare.~~

~~The required identification for conductors 4 AWG and larger shall encircle the conductor and shall be accomplished by one of the following:~~

1. ~~Stripping the insulation or covering from the entire exposed length.~~

2. ~~Coloring the exposed insulation or covering green at the termination.~~

3. ~~Marking the exposed insulation or covering with green tape or green adhesive labels at the termination. [250.119(A)]~~

~~Exceptions:~~

1. ~~Conductors 4 AWG and larger shall not be required to be identified in conduit bodies that do not contain splices or unused hubs. [250.119(A)(1) Exception]~~

2. ~~Power-limited, Class 2 or Class 3 circuit cables containing only circuits operating at less than 50 volts shall be permitted to use a conductor with green insulation for other than equipment grounding purposes. [250.119 Exception No. 1]~~

~~E3407.3 Ungrounded conductors.~~

~~Insulation on the ungrounded conductors shall be a continuous color other than white, gray and green. [310.110(C)]~~

> **~~Exception:~~** ~~An insulated conductor that is part of a cable or flexible cord assembly and that has a white or gray finish or a finish marking with three continuous white or gray stripes shall be permitted to be used as an ungrounded conductor where it is permanently reidentified to indicate its use as an ungrounded conductor by marking tape, painting, or other effective means at all terminations and at each location where the conductor is visible and accessible. Identification shall encircle the insulation and shall be a color other than white, gray, and green. [200.7(C)(1)]~~
>
> ~~Where used for single-pole, 3-way or 4-way switch loops, the reidentified conductor with white or gray insulation or three continuous white or gray stripes shall be used only for the supply to the switch, not as a return conductor from the switch to the outlet. [200.7(C)(2)]~~

~~E3407.4 Identification of terminals.~~

~~Terminals for attachment to conductors shall be identified in accordance with Sections E3407.4.1 and E3407.4.2.~~

~~E3407.4.1 Device terminals.~~

~~All devices excluding panelboards, provided with terminals for the attachment of conductors and intended for connection to more than one side of the circuit shall have terminals properly marked for identification, except where the terminal intended to be connected to the grounded conductor is clearly evident. [200.10(A)]~~

> **~~Exception:~~** ~~Terminal identification shall not be required for devices that have a normal current rating of over 30 amperes, other than polarized attachment caps and polarized receptacles for attachment caps as required in Section E3407.4.2. [200.10(A) Exception]~~

~~E3407.4.2 Receptacles, plugs and connectors.~~

~~Receptacles, polarized attachment plugs and cord connectors for plugs and polarized plugs shall have the terminal intended for connection to the grounded (white) conductor identified. Identification shall be by a metal or metal coating substantially white in color or by the word~~

~~“white” or the letter “W” located adjacent to the identified terminal. Where the terminal is not visible, the conductor entrance hole for the connection shall be colored white or marked with the word “white” or the letter “W.” [200.10(B)]~~

CHAPTER 35

ELECTRICAL DEFINITIONS

Deleted. See the *North Carolina Electrical Code.*

~~SECTION E3501~~
~~GENERAL~~

~~**E3501.1 Scope.**~~
~~This chapter contains definitions that shall apply only to the electrical requirements of Chapters 34 through 43. Unless otherwise expressly stated, the following terms shall, for the purpose of this code, have the meanings indicated in this chapter. Words used in the present tense include the future; the singular number includes the plural and the plural the singular. Where terms are not defined in this section and are defined in Section R202 of this code, such terms shall have the meanings ascribed to them in that section. Where terms are not defined in these sections, they shall have their ordinarily accepted meanings or such as the context implies.~~

~~**ACCESSIBLE.** (As applied to equipment.) Admitting close approach; not guarded by locked doors, elevation or other effective means.~~

~~**ACCESSIBLE.** (As applied to wiring methods.) Capable of being removed or exposed without damaging the building structure or finish, or not permanently closed in by the structure or finish of the building.~~

~~**ACCESSIBLE, READILY.** Capable of being reached quickly for operation, renewal or inspections, without requiring those to whom ready access is requisite to take actions such as to use tools, to climb over or remove obstacles or to resort to portable ladders, etc.~~

~~**AMPACITY.** The maximum current in amperes that a conductor can carry continuously under the conditions of use without exceeding its temperature rating.~~

~~**APPLIANCE.** Utilization equipment, normally built in standardized sizes or types, that is installed or connected as a unit to perform one or more functions such as clothes washing, air conditioning, food mixing, deep frying, etc.~~

~~**APPROVED.** Acceptable to the authority having jurisdiction.~~

~~**ARC-FAULT CIRCUIT INTERRUPTER.** A device intended to provide protection from the effects of arc-faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc-fault is detected.~~

~~**ATTACHMENT PLUG (PLUG CAP) (PLUG).** A device that, by insertion into a receptacle, establishes connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle.~~

~~**AUTOMATIC.** Performing a function without the necessity of human intervention.~~

~~**BATHROOM.** An area, including a basin, with one or more of the following: a toilet, a urinal, a tub, a shower, a bidet, or similar plumbing fixture.~~

~~**BONDED (BONDING).** Connected to establish electrical continuity and conductivity.~~

~~**BONDING CONDUCTOR OR JUMPER.** A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected.~~

~~**BONDING JUMPER (EQUIPMENT).** The connection between two or more portions of the equipment grounding conductor.~~

~~**BONDING JUMPER, MAIN.** The connection between the grounded circuit conductor and the equipment grounding conductor at the service.~~

~~**BONDING JUMPER, SUPPLY-SIDE.** A conductor installed on the supply side of a service or within a service equipment enclosure(s) that ensures the required electrical conductivity between metal parts required to be electrically connected.~~

~~**BRANCH CIRCUIT.** The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s).~~

~~**BRANCH CIRCUIT, APPLIANCE.** A branch circuit that supplies energy to one or more outlets to which appliances are to be connected, and that has no permanently connected luminaires that are not a part of an appliance.~~

~~**BRANCH CIRCUIT, GENERAL PURPOSE.** A branch circuit that supplies two or more receptacle outlets or outlets for lighting and appliances.~~

~~**BRANCH CIRCUIT, INDIVIDUAL.** A branch circuit that supplies only one utilization equipment.~~

~~**BRANCH CIRCUIT, MULTIWIRE.** A branch circuit consisting of two or more ungrounded conductors having voltage difference between them, and a grounded conductor having equal voltage difference between it and each ungrounded conductor of the circuit, and that is connected to the neutral or grounded conductor of the system.~~

~~**CABINET.** An enclosure designed either for surface or flush mounting and provided with a frame, mat or trim in which a swinging door or doors are or may be hung.~~

~~**CIRCUIT BREAKER.** A device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating.~~

~~**CLOTHES CLOSET.** A nonhabitable room or space intended primarily for storage of garments and apparel.~~

~~**CONCEALED.** Rendered inaccessible by the structure or finish of the building.~~

~~**CONDUCTOR.**~~

~~**Bare.** A conductor having no covering or electrical insulation whatsoever.~~

~~**Covered.** A conductor encased within material of composition or thickness that is not recognized by this code as electrical insulation.~~

~~**Insulated.** A conductor encased within material of composition and thickness that is recognized by this code as electrical insulation.~~

~~**CONDUIT BODY.** A separate portion of a conduit or tubing system that provides access through a removable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system. Boxes such as FS and FD or larger cast or sheet metal boxes are not classified as conduit bodies.~~

~~**CONNECTOR, PRESSURE (SOLDERLESS).** A device that establishes a connection between two or more conductors or between one or more conductors and a terminal by means of mechanical pressure and without the use of solder.~~

~~**CONTINUOUS LOAD.** A load where the maximum current is expected to continue for 3 hours or more.~~

~~**COOKING UNIT, COUNTER-MOUNTED.** A cooking appliance designed for mounting in or on a counter and consisting of one or more heating elements, internal wiring and built-in or separately mountable controls.~~

~~**COPPER-CLAD ALUMINUM CONDUCTORS.** Conductors drawn from a copper-clad aluminum rod with the copper metallurgically bonded to an aluminum core. The copper forms a minimum of 10 percent of the cross-sectional area of a solid conductor or each strand of a stranded conductor.~~

~~**CUTOUT BOX.** An enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with the walls of the box proper (see "Cabinet").~~

~~**DEAD FRONT.** Without live parts exposed to a person on the operating side of the equipment.~~

~~**DEMAND FACTOR.** The ratio of the maximum demand of a system, or part of a system, to the total connected load of a system or the part of the system under consideration.~~

~~**DEVICE.** A unit of an electrical system that carries or controls electrical energy as it principal function.~~

~~**DISCONNECTING MEANS.** A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply.~~

~~**DWELLING.**~~

~~**Dwelling unit.** A single unit, providing complete and independent living facilities for one or more persons, including permanent provisions for living, sleeping, cooking and sanitation.~~

~~**One-family dwelling.** A building consisting solely of one dwelling unit.~~

~~**Two-family dwelling.** A building consisting solely of two dwelling units.~~

~~**EFFECTIVE GROUND-FAULT CURRENT PATH.** An intentionally constructed, low-impedance electrically conductive path designed and intended to carry current under ground-fault conditions from the point of a ground fault on a wiring system to the electrical supply source and that facilitates the operation of the overcurrent protective device or ground-fault detectors.~~

~~**ENCLOSED.** Surrounded by a case, housing, fence or walls that will prevent persons from accidentally contacting energized parts.~~

~~**ENCLOSURE.** The case or housing of apparatus, or the fence or walls surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage.~~

~~**ENERGIZED.** Electrically connected to, or is, a source of voltage.~~

~~**EQUIPMENT.** A general term including material, fittings, devices, appliances, luminaires, apparatus, machinery and the like used as a part of, or in connection with, an electrical installation.~~

~~**EXPOSED.** (As applied to live parts.) Capable of being inadvertently touched or approached nearer than a safe distance by a person.~~

~~**EXPOSED.** (As applied to wiring methods.) On or attached to the surface or behind panels designed to allow access.~~

~~**EXTERNALLY OPERABLE.** Capable of being operated without exposing the operator to contact with live parts.~~

~~**FEEDER.** All circuit conductors between the service equipment, or the source of a separately derived system, or other power supply source and the final branch-circuit overcurrent device.~~

~~**FITTING.** An accessory such as a locknut, bushing or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function.~~

~~**GROUND.** The earth.~~

~~**GROUNDED (GROUNDING).** Connected (connecting) to ground or to a conductive body that extends the ground connection.~~

~~**GROUNDED, EFFECTIVELY.** Intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to prevent the buildup of voltages that may result in undue hazards to connected equipment or to persons.~~

~~**GROUNDED CONDUCTOR.** A system or circuit conductor that is intentionally grounded.~~

~~**GROUNDING CONDUCTOR, EQUIPMENT (EGC).** The conductive path(s) that provides a ground-fault current path and connects normally noncurrent-carrying metal parts of equipment together and, to the system grounded conductor, the grounding electrode conductor or both.~~

~~**GROUNDING ELECTRODE.** A conducting object through which a direct connection to earth is established.~~

~~**GROUNDING ELECTRODE CONDUCTOR.** A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system.~~

~~**GROUND-FAULT CIRCUIT-INTERRUPTER.** A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds the value for a Class A device.~~

~~**GROUND-FAULT CURRENT PATH.** An electrically conductive path from the point of a ground fault on a wiring system through normally non-current-carrying conductors, equipment, or the earth to the electrical supply source.~~

~~Examples of ground-fault current paths are any combination of equipment grounding conductors, metallic raceways, metallic cable sheaths, electrical equipment, and any other electrically conductive material such as metal, water, and gas piping; steel framing members; stucco mesh; metal ducting; reinforcing steel; shields of communications cables; and the earth itself.~~

~~**GUARDED.** Covered, shielded, fenced, enclosed or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger.~~

~~**IDENTIFIED.** (As applied to equipment.) Recognizable as suitable for the specific purpose, function, use, environment, application, etc., where described in a particular code requirement.~~

~~**INTERRUPTING RATING.** The highest current at rated voltage that a device is identified to interrupt under standard test conditions.~~

~~**INTERSYSTEM BONDING TERMINATION.** A device that provides a means for connecting intersystem bonding conductors for communications systems to the grounding electrode system.~~

~~**ISOLATED.** (As applied to location.) Not readily accessible to persons unless special means for access are used.~~

~~**KITCHEN.** An area with a sink and permanent provisions for food preparation and cooking.~~

~~**LABELED.** Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.~~

~~**LIGHTING OUTLET.** An outlet intended for the direct connection of a lampholder or luminaire.~~

~~**LIGHTING TRACK (Track Lighting).** A manufactured assembly designed to support and energize luminaires that are capable of being readily repositioned on the track. Its length can be altered by the addition or subtraction of sections of track.~~

~~**LISTED.** Equipment, materials or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states either that the equipment, material or services meets identified standards or has been tested and found suitable for a specified purpose.~~

~~**LIVE PARTS.** Energized conductive components.~~

~~**LOCATION, DAMP.** Location protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture.~~

~~**LOCATION, DRY.** A location not normally subject to dampness or wetness. A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction.~~

~~**LOCATION, WET.** Installations underground or in concrete slabs or masonry in direct contact with the earth and locations subject to saturation with water or other liquids, such as vehicle-washing areas, and locations exposed to weather.~~

~~**LUMINAIRE.** A complete lighting unit consisting of a light source such as a lamp or lamps together with the parts designed to position the light source and connect it to the power supply. A luminaire can include parts to protect the light source or the ballast or to distribute the light. A lampholder itself is not a luminaire.~~

~~**MULTIOUTLET ASSEMBLY.** A type of surface, or flush, or freestanding raceway; designed to hold conductors and receptacles, assembled in the field or at the factory.~~

~~**NEUTRAL CONDUCTOR.** The conductor connected to the neutral point of a system that is intended to carry current under normal conditions.~~

~~**NEUTRAL POINT.** The common point on a wye-connection in a polyphase system or midpoint on a single-phase, 3-wire system, or midpoint of a single-phase portion of a 3-phase delta system, or a midpoint of a 3-wire, direct-current system.~~

~~**OUTLET.** A point on the wiring system at which current is taken to supply utilization equipment.~~

~~**OVERCURRENT.** Any current in excess of the rated current of equipment or the ampacity of a conductor. Such current might result from overload, short circuit or ground fault.~~

~~**OVERLOAD.** Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload.~~

~~**PANELBOARD.** A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat or power circuits, designed to be placed in a cabinet or cutout box placed in or against a wall, partition or other support and accessible only from the front.~~

~~**PLENUM.** A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.~~

~~**POWER OUTLET.** An enclosed assembly that may include receptacles, circuit breakers, fuseholders, fused switches, buses and watt-hour meter mounting means, intended to supply and control power to mobile homes, recreational vehicles or boats, or to serve as a means for distributing power required to operate mobile or temporarily installed equipment.~~

~~**PREMISES WIRING (SYSTEM).** Interior and exterior wiring, including power, lighting, control and signal circuit wiring together with all of their associated hardware, fittings and wiring devices, both permanently and temporarily installed. This includes wiring from the service point or power source to the outlets and wiring from and including the power source to the outlets where there is no service point. Such wiring does not include wiring internal to appliances, luminaires, motors, controllers, and similar equipment.~~

~~**QUALIFIED PERSON.** One who has the skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.~~

~~**RACEWAY.** An enclosed channel of metallic or nonmetallic materials designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this code.~~

~~**RAINPROOF.** Constructed, protected or treated so as to prevent rain from interfering with the successful operation of the apparatus under specified test conditions.~~

~~**RAIN TIGHT.** Constructed or protected so that exposure to a beating rain will not result in the entrance of water under specified test conditions.~~

~~**RECEPTACLE.** A receptacle is a contact device installed at the outlet for the connection of an attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke.~~

~~**RECEPTACLE OUTLET.** An outlet where one or more receptacles are installed.~~

~~**SERVICE.** The conductors and equipment for delivering energy from the serving utility to the wiring system of the premises served.~~

~~**SERVICE CABLE.** Service conductors made up in the form of a cable.~~

~~**SERVICE CONDUCTORS.** The conductors from the service point to the service disconnecting means.~~

~~**SERVICE CONDUCTORS, OVERHEAD.** The overhead conductors between the service point and the first point of connection to the service-entrance conductors at the building or other structure.~~

~~**SERVICE CONDUCTORS, UNDERGROUND.** The underground conductors between the service point and the first point of connection to the service-entrance conductors in a terminal box, meter, or other enclosure, inside or outside of the building wall.~~

~~**SERVICE DROP.** The overhead service conductors between the utility electric supply system and the service point.~~

~~**SERVICE-ENTRANCE CONDUCTORS, OVERHEAD SYSTEM.** The service conductors between the terminals of the service equipment and a point usually outside of the building, clear of building walls, where joined by tap or splice to the service drop or overhead service conductors.~~

~~**SERVICE-ENTRANCE CONDUCTORS, UNDERGROUND SYSTEM.** The service conductors between the terminals of the service equipment and the point of connection to the service lateral or underground service conductors.~~

~~**SERVICE EQUIPMENT.** The necessary equipment, usually consisting of a circuit breaker(s) or switch(es) and fuse(s), and their accessories, connected to the load end of the service conductors to a building or other structure, or an otherwise designated area, and intended to constitute the main control and cutoff of the supply.~~

~~**SERVICE LATERAL.** The underground service conductors between the electric utility supply system and the service point.~~

~~**SERVICE POINT.** The point of connection between the facilities of the serving utility and the premises wiring.~~

~~**STRUCTURE.** That which is built or constructed.~~

~~**SWITCHES.**~~

~~**General-use switch.** A switch intended for use in general distribution and branch circuits. It is rated in amperes and is capable of interrupting its rated current at its rated voltage.~~

~~**General-use snap switch.** A form of general-use switch constructed so that it can be installed in device boxes or on box covers or otherwise used in conjunction with wiring systems recognized by this code.~~

~~**Isolating switch.** A switch intended for isolating an electric circuit from the source of power. It has no interrupting rating and is intended to be operated only after the circuit has been opened by some other means.~~

~~**Motor-circuit switch.** A switch, rated in horsepower that is capable of interrupting the maximum operating overload current of a motor of the same horsepower rating as the switch at the rated voltage.~~

~~**UNGROUNDED.** Not connected to ground or to a conductive body that extends the ground connection.~~

~~**UTILIZATION EQUIPMENT.** Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting or similar purposes.~~

~~**VENTILATED.** Provided with a means to permit circulation of air sufficient to remove an excess of heat, fumes or vapors.~~

~~**VOLTAGE (OF A CIRCUIT).** The greatest root-mean-square (rms) (effective) difference of potential between any two conductors of the circuit concerned.~~

~~**VOLTAGE, NOMINAL.** A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (e.g., 120/240). The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.~~

~~**VOLTAGE TO GROUND.** For grounded circuits, the voltage between the given conductor and that point or conductor of the circuit that is grounded. For ungrounded circuits, the greatest voltage between the given conductor and any other conductor of the circuit.~~

~~**WATERTIGHT.** Constructed so that moisture will not enter the enclosure under specified test conditions.~~

~~**WEATHERPROOF.** Constructed or protected so that exposure to the weather will not interfere with successful operation.~~

CHAPTER 36

SERVICES

Deleted. See the *North Carolina Electrical Code.*

~~SECTION E3601~~
~~GENERAL SERVICES~~

~~**E3601.1 Scope.**~~
~~This chapter covers service conductors and equipment for the control and protection of services and their installation requirements. (230.1)~~

~~**E3601.2 Number of services.**~~
~~One- and two-family dwellings shall be supplied by only one service. (230.2)~~

~~**E3601.3 One building or other structure not to be supplied through another.**~~
~~Service conductors supplying a building or other structure shall not pass through the interior of another building or other structure. (230.3)~~

~~**E3601.4 Other conductors in raceway or cable.**~~
~~Conductors other than service conductors shall not be installed in the same service raceway or service cable. (230.7)~~

~~**Exceptions:**~~

1. ~~Grounding electrode conductors and equipment bonding jumpers or conductors.~~
2. ~~Load management control conductors having overcurrent protection.~~

~~**E3601.5 Raceway seal.**~~
~~Where a service raceway enters from an underground distribution system, it shall be sealed in accordance with Section E3803.6. (230.8)~~

~~**E3601.6 Service disconnect required.**~~
~~Means shall be provided to disconnect all conductors in a building or other structure from the service entrance conductors. (230.70)~~

~~**E3601.6.1 Marking of service equipment and disconnects.**~~
~~Service disconnects shall be permanently marked as a service disconnect. [230.70(B)]~~

~~**E3601.6.2 Service disconnect location.**~~
~~The service disconnecting means shall be installed at a readily accessible location either outside of a building or inside nearest the point of entrance of the service conductors. Service disconnecting means shall not be installed in bathrooms. Each occupant shall have access to the disconnect serving the dwelling unit in which they reside. [230.70(A)(1), 230.72(C)]~~

~~E3601.7 Maximum number of disconnects.~~
~~The service disconnecting means shall consist of not more than six switches or six circuit breakers mounted in a single enclosure or in a group of separate enclosures. [230.71(A)]~~

~~SECTION E3602~~
~~SERVICE SIZE AND RATING~~

~~E3602.1 Ampacity of ungrounded conductors.~~
~~Ungrounded service conductors shall have an ampacity of not less than the load served. For one-family dwellings, the ampacity of the ungrounded conductors shall be not less than 100 amperes, 3 wire. For all other installations, the ampacity of the ungrounded conductors shall be not less than 60 amperes. [230.42(B), 230.79(C) & (D)]~~

~~E3602.2 Service load.~~
~~The minimum load for ungrounded service conductors and service devices that serve 100 percent of the dwelling unit load shall be computed in accordance with Table E3602.2. Ungrounded service conductors and service devices that serve less than 100 percent of the dwelling unit load shall be computed as required for feeders in accordance with Chapter 37. [220.82(A)]~~

~~TABLE E3602.2~~
~~MINIMUM SERVICE LOAD CALCULATION [220.82(B) & (C)]~~

~~LOADS AND PROCEDURE~~
~~3 volt-amperes per square foot of floor area for general lighting and general use receptacle outlets.~~
~~Plus~~
~~1,500 volt-amperes multiplied by total number of 20-ampere-rated small appliance and laundry circuits.~~
~~Plus~~
~~The nameplate volt-ampere rating of all fastened-in-place, permanently connected or dedicated circuit-supplied appliances such as ranges, ovens, cooking units, clothes dryers not connected to the laundry branch circuit and water heaters.~~
~~Apply the following demand factors to the above subtotal:~~
~~The minimum subtotal for the loads above shall be 100 percent of the first 10,000 volt-amperes of the sum of the above loads plus 40 percent of any portion of the sum that is in excess of 10,000 volt-amperes.~~
~~Plus the largest of the following:~~
~~One-hundred percent of the nameplate rating(s) of the air-conditioning and cooling equipment.~~
~~One hundred percent of the nameplate rating(s) of the heat pump where a heat pump is used without any supplemental electric heating.~~
~~One-hundred percent of the nameplate rating of the electric thermal storage and other heating systems where the usual load is expected to be continuous at the full nameplate value. Systems qualifying under this selection shall not be figured under any other category in this table.~~
~~One-hundred percent of nameplate rating of the heat pump compressor and sixty-five percent of the supplemental electric heating load for central electric space-heating systems. If the heat pump compressor is prevented from operating at the same time as the supplementary heat, the compressor load does not need to be added to the supplementary heat load for the total central electric space-heating load.~~
~~Sixty-five percent of nameplate rating(s) of electric space-heating units if less than four separately controlled units.~~
~~Forty percent of nameplate rating(s) of electric space-heating units of four or more separately controlled units.~~

~~The minimum total load in amperes shall be the volt-ampere sum calculated above divided by 240 volts.~~

~~E3602.2.1 Services under 100 amperes.~~
~~Services that are not required to be 100 amperes shall be sized in accordance with Chapter 37. [230.42(A), (B), and (C)].~~

~~E3602.3 Rating of service disconnect.~~
~~The combined rating of all individual service disconnects serving a single dwelling unit shall be not less than the load determined from Table E3602.2 and shall be not less than as specified in Section E3602.1. (230.79 & 230.80)~~

~~E3602.4 Voltage rating.~~
~~Systems shall be three-wire, 120/240-volt, single-phase with a grounded neutral. [220.82(A)]~~

~~SECTION E3603~~
~~SERVICE, FEEDER AND GROUNDING ELECTRODE CONDUCTOR SIZING~~

~~E3603.1 Grounded and ungrounded service conductor size.~~
~~Service and feeder conductors supplied by a single-phase, 120/240-volt system shall be sized in accordance with Sections E3603.1.1 through E3603.1.4 and Table 3705.1.~~

~~E3603.1.1~~
~~For a service rated at 100 through 400 amperes, the service conductors supplying the entire load associated with a one-family dwelling, or the service conductors supplying the entire load associated with an individual dwelling unit in a two-family dwelling, shall have an ampacity of not less than 83 percent of the service rating.~~

~~E3603.1.2~~
~~For a feeder rated at 100 through 400 amperes, the feeder conductors supplying the entire load associated with a one-family dwelling, or the feeder conductors supplying the entire load associated with an individual dwelling unit in a two-family dwelling, shall have an ampacity of not less than 83 percent of the feeder rating.~~

~~E3603.1.3~~
~~A feeder for an individual dwelling unit shall not be required to have an ampacity greater than that specified in Sections E3603.1.1 and E3603.1.2.~~

~~E3603.1.4~~
~~The grounded conductor ampacity shall be not less than the maximum unbalance of the load and the size of the grounded conductor shall be not smaller than the required minimum grounding electrode conductor size specified in Table E3603.4. [310.15(B)(7)]~~

~~E3603.2 Ungrounded service conductors for accessory buildings and structures.~~
~~Ungrounded conductors for other than dwelling units shall have an ampacity of not less than 60 amperes and shall be sized as required for feeders in Chapter 37. [230.79(D)]~~

~~Exceptions:~~

1. ~~For limited loads of a single branch circuit, the service conductors shall have an ampacity of not less than 15 amperes. [230.79(A)]~~

2. ~~For loads consisting of not more than two two-wire branch circuits, the service conductors shall have an ampacity of not less than 30 amperes. [230.79(C)]~~

~~E3603.3 Overload protection.~~

~~Each ungrounded service conductor shall have overload protection. (230.90)~~

~~E3603.3.1 Ungrounded conductor.~~

~~Overload protection shall be provided by an overcurrent device installed in series with each ungrounded service conductor. The overcurrent device shall have a rating or setting not higher than the allowable service or feeder rating specified in Section E3603.1. A set of fuses shall be considered to be all of the fuses required to protect all of the ungrounded conductors of a circuit. Single pole circuit breakers, grouped in accordance with Section E3601.7, shall be considered as one protective device. [230.90(A)]~~

> ~~**Exception:** Two to six circuit breakers or sets of fuses shall be permitted as the overcurrent device to provide the overload protection. The sum of the ratings of the circuit breakers or fuses shall be permitted to exceed the ampacity of the service conductors, provided that the calculated load does not exceed the ampacity of the service conductors. [230.90(A) Exception No. 3]~~

~~E3603.3.2 Not in grounded conductor.~~

~~Overcurrent devices shall not be connected in series with a grounded service conductor except where a circuit breaker is used that simultaneously opens all conductors of the circuit. [230.90(B)]~~

~~E3603.3.3 Location.~~

~~The service overcurrent device shall be an integral part of the service disconnecting means or shall be located immediately adjacent thereto. (230.91)~~

~~E3603.4 Grounding electrode conductor size.~~

~~The grounding electrode conductors shall be sized based on the size of the service entrance conductors as required in Table E3603.4. (250.66)~~

~~TABLE E3603.4~~

~~GROUNDING ELECTRODE CONDUCTOR SIZE~~~~[a, b, c, d, e, f]~~

~~SIZE OF LARGEST UNGROUNDED SERVICE-ENTRANCE CONDUCTOR OR EQUIVALENT AREA FOR PARALLEL CONDUCTORS (AWG/kcmil)~~		~~SIZE OF GROUNDING ELECTRODE CONDUCTOR (AWG/kcmil)~~	
~~Copper~~	**~~Aluminum or copper-clad aluminum~~**	**~~Copper~~**	**~~Aluminum or copper-clad aluminum~~**
~~2 or smaller~~	~~1/0 or smaller~~	~~8~~	~~6~~
~~1 or 1/0~~	~~2/0 or 3/0~~	~~6~~	~~4~~
~~2/0 or 3/0~~	~~4/0 or 250~~	~~4~~	~~2~~
~~Over 3/0 through 350~~	~~Over 250 through 500~~	~~2~~	~~1/0~~

~~Over 350 through 600~~	~~Over 500 through 900~~	~~1/0~~	~~3/0~~

~~a. If multiple sets of service-entrance conductors connect directly to a service drop, set of overhead service conductors, set of underground service conductors, or service lateral, the equivalent size of the largest service-entrance conductor shall be determined by the largest sum of the areas of the corresponding conductors of each set.~~
~~b. Where there are no service-entrance conductors, the grounding electrode conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.~~
~~c. Where protected by a ferrous metal raceway, grounding electrode conductors shall be electrically bonded to the ferrous metal raceway at both ends. [250.64(E)(1)]~~
~~d. An 8 AWG grounding electrode conductor shall be protected with rigid metal conduit, intermediate metal conduit, rigid polyvinyl chloride (Type PVC) nonmetallic conduit, rigid thermosetting resin (Type RTRC) nonmetallic conduit, electrical metallic tubing or cable armor. [250.64(B)]~~
~~e. Where not protected, 6 AWG grounding electrode conductor shall closely follow a structural surface for physical protection. The supports shall be spaced not more than 24 inches on center and shall be within 12 inches of any enclosure or termination. [250.64(B)]~~
~~f. Where the sole grounding electrode system is a ground rod or pipe as covered in Section E3608.3, the grounding electrode conductor shall not be required to be larger than 6 AWG copper or 4 AWG aluminum. Where the sole grounding electrode system is the footing steel as covered in Section E3608.1.2, the grounding electrode conductor shall not be required to be larger than 4 AWG copper conductor. [250.66(A) and (B)]~~

~~**E3603.5 Temperature limitations.**~~

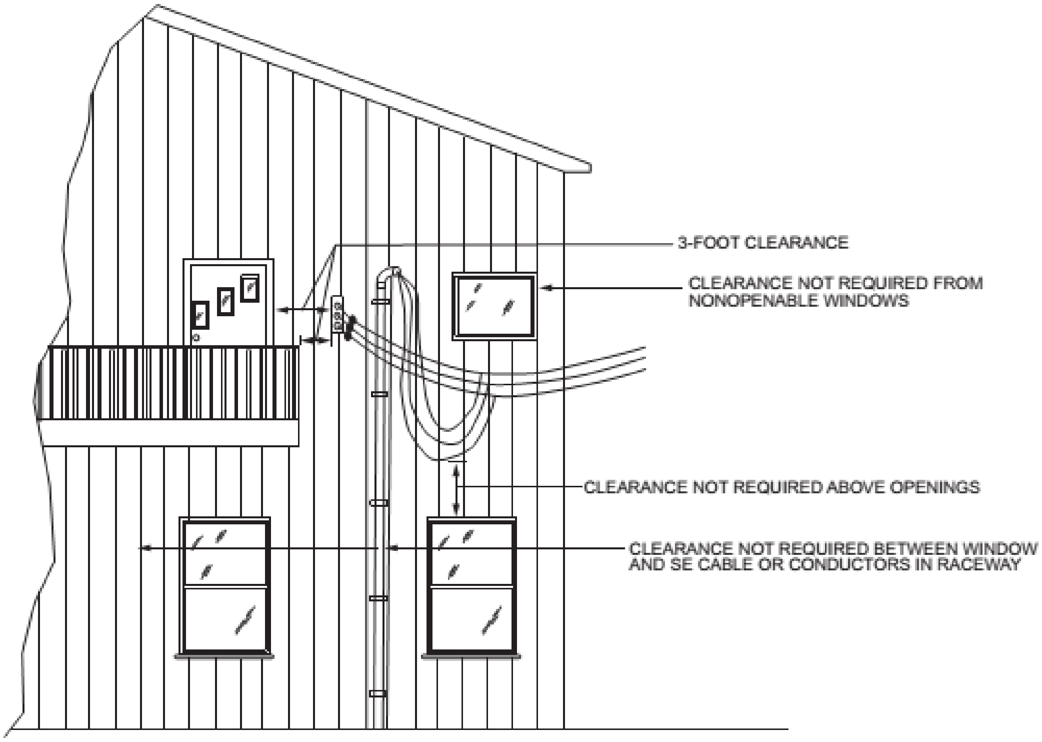
~~Except where the equipment is marked otherwise, conductor ampacities used in determining equipment termination provisions shall be based on Table E3705.1. [110.14(C)(1)]~~

~~SECTION E3604~~

~~OVERHEAD SERVICE AND SERVICE-ENTRANCE CONDUCTOR INSTALLATION~~

~~**E3604.1 Clearances on buildings.**~~

~~Open conductors and multiconductor cables without an overall outer jacket shall have a clearance of not less than 3 feet (914 mm) from the sides of doors, porches, decks, stairs, ladders, fire escapes and balconies, and from the sides and bottom of windows that open. See Figure E3604.1. [230.9(A)]~~



For SI: 1 foot = 304.8 mm.

~~For SI: 1 foot = 304.8 mm.~~

~~FIGURE E3604.1~~
~~CLEARANCES FROM BUILDING OPENINGS~~

~~E3604.2 Vertical clearances.~~
~~Overhead service conductors shall not have ready access and shall comply with Sections E3604.2.1 and E3604.2.2. (230.24)~~

~~E3604.2.1 Above roofs.~~
~~Conductors shall have a vertical clearance of not less than 8 feet (2438 mm) above the roof surface. The vertical clearance above the roof level shall be maintained for a distance of not less than 3 feet (914 mm) in all directions from the edge of the roof. See Figure E3604.2.1. [230.24(A)]~~

~~Exceptions:~~

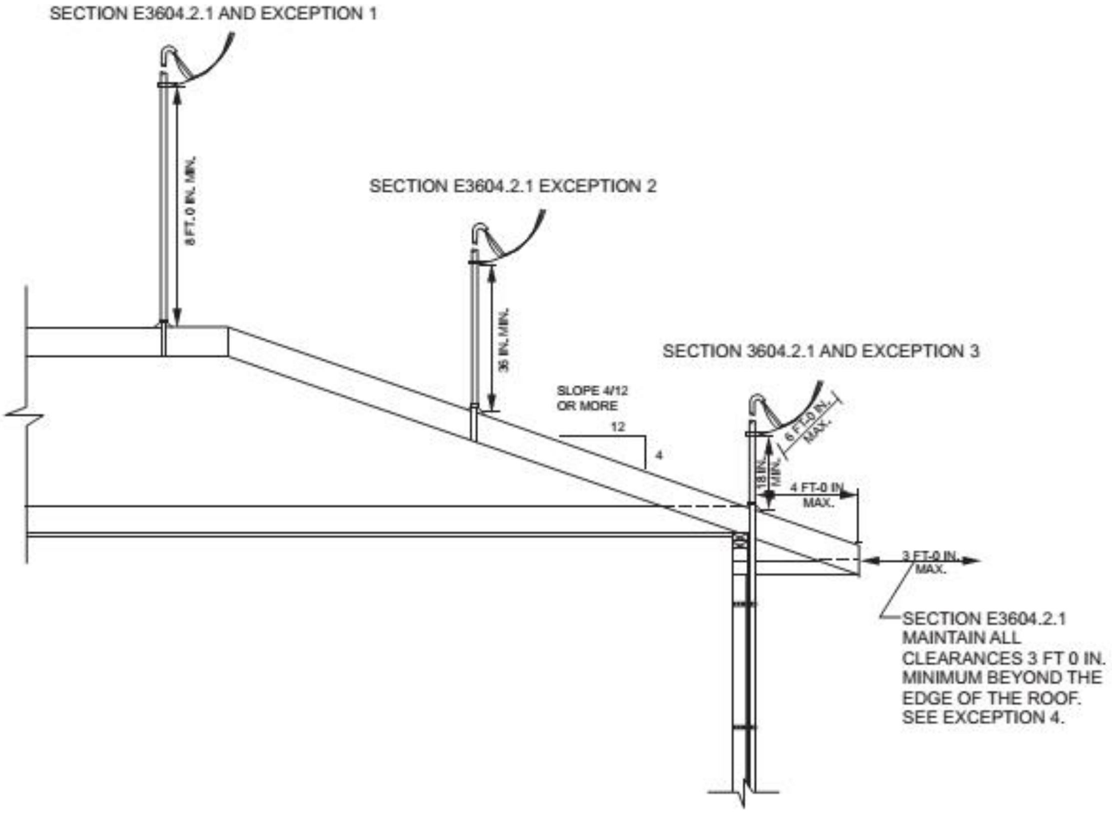
1. ~~Conductors above a roof surface subject to pedestrian traffic shall have a vertical clearance from the roof surface in accordance with Section E3604.2.2. [230.24(A) Exception No. 1]~~

2. ~~Where the roof has a slope of 4 inches (102 mm) in 12 inches (305 mm), or greater, the minimum clearance shall be 3 feet (914 mm). [230.24(A) Exception No. 2]~~

3. ~~The minimum clearance above only the overhanging portion of the roof shall not be less than 18 inches (457 mm) where not more than 6 feet (1829 mm) of overhead service conductor length passes over 4 feet (1219 mm) or less of roof surface measured horizontally and such conductors are terminated at a through-the-roof raceway or approved support. [230.24(A) Exception No. 3]~~

4. ~~The requirement for maintaining the vertical clearance for a distance of 3 feet (914 mm) from the edge of the roof shall not apply to the final conductor span where the service drop is attached to the side of a building. [230.24(A) Exception No. 4]~~

5. ~~Where the voltage between conductors does not exceed 300 and the roof area is guarded or isolated, a reduction in clearance to 3 feet (914 mm) shall be permitted. [230.24(A) Exception No. 5]~~



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

~~FIGURE E3604.2.1~~
~~CLEARANCES FROM ROOFS~~

~~E3604.2.2 Vertical clearance from grade.~~
~~Overhead service conductors shall have the following minimum clearances from final grade:~~

1. ~~For conductors supported on and cabled together with a grounded bare messenger wire, the minimum vertical clearance shall be 10 feet (3048 mm) at the electric service entrance to buildings, at the lowest point of the drip loop of the building electric entrance, and above areas or sidewalks accessed by pedestrians only. Such clearance shall be measured from final grade or other accessible surfaces.~~

2. ~~Twelve feet (3658 mm)—over residential property and driveways.~~

3. ~~Eighteen feet (5486 mm)—over public streets, alleys, roads or parking areas subject to truck traffic. [(230.24(B)(1), (2), and (4)]~~

~~E3604.3 Point of attachment.~~
~~The point of attachment of the overhead service conductors to a building or other structure shall provide the minimum clearances as specified in Sections E3604.1 through E3604.2.2. The point of attachment shall be not less than 10 feet (3048 mm) above finished grade. (230.26)~~

~~E3604.4 Means of attachment.~~
~~Multiconductor cables used for overhead service conductors shall be attached to buildings or other structures by fittings approved for the purpose. (230.27)~~

~~E3604.5 Service masts as supports.~~
~~A service mast used for the support of service-drop or overhead service conductors shall comply with Sections E3604.5.1 and E3604.5.2. Only power service drop or overhead service conductors shall be attached to a service mast.~~

~~E3504.5.1 Strength.~~
~~The service mast shall be of adequate strength or shall be supported by braces or guys to safely withstand the strain imposed by the service-drop or overhead service conductors. Hubs intended for use with a conduit that serves as a service mast shall be identified for use with service-entrance equipment.~~

~~E3604.5.2 Attachment.~~
~~Service-drop or overhead service conductors shall not be attached to a service mast at a point between a coupling and a weatherhead or the end of the conduit, where the coupling is located above the last point of securement of the building or other structure or is located above the building or other structure. [230.28(A) & (B)]~~

~~E3604.6 Supports over buildings.~~
~~Service conductors passing over a roof shall be securely supported. Where practicable, such supports shall be independent of the building. (230.29)~~

~~SECTION E3605~~
~~SERVICE-ENTRANCE CONDUCTORS~~

~~E3605.1 Insulation of service-entrance conductors.~~
~~Service-entrance conductors entering or on the exterior of buildings or other structures shall be insulated in accordance with Section E3406.5. (230.41)~~

~~Exceptions:~~

1. ~~A copper grounded conductor shall not be required to be insulated where it is:~~
    1.1. ~~In a raceway or part of a service cable assembly,~~
    1.2. ~~Directly buried in soil of suitable condition, or~~
    1.3. ~~Part of a cable assembly listed for direct burial without regard to soil conditions.~~
2. ~~An aluminum or copper-clad aluminum grounded conductor shall not be required to be insulated where part of a cable or where identified for direct burial or utilization in underground raceways. (230.41 Exception)~~

~~E3605.2 Wiring methods for services.~~
~~Service-entrance wiring methods shall be installed in accordance with the applicable requirements in Chapter 38. (230.43)~~

~~E3605.3 Spliced conductors.~~
~~Service-entrance conductors shall be permitted to be spliced or tapped. Splices shall be made in enclosures or, if directly buried, with listed underground splice kits. Conductor splices shall be made in accordance with Chapters 34, 37, 38 and 39. (230.33, 230.46)~~

~~E3605.4 Protection of underground service entrance conductors.~~
~~Underground service-entrance conductors shall be protected against physical damage in accordance with Chapter 38. (230.32)~~

~~E3605.5 Protection of all other service cables.~~
~~Above-ground service-entrance cables, where subject to physical damage, shall be protected by one or more of the following: rigid metal conduit, intermediate metal conduit, Schedule 80 PVC conduit, electrical metallic tubing or other approved means. [230.50(1)]~~

~~E3605.6 Locations exposed to direct sunlight.~~
~~Insulated conductors and cables used where exposed to direct rays of the sun shall comply with one of the following:~~

1. ~~The conductors and cables shall be listed, or listed and marked, as being sunlight resistant.~~
2. ~~The conductors and cables are covered with insulating material, such as tape or sleeving, that is listed, or listed and marked, as being sunlight resistant. [310.10(D)]~~

~~E3605.7 Mounting supports.~~
~~Service-entrance cables shall be supported by straps or other approved means within 12 inches (305 mm) of every service head, gooseneck or connection to a raceway or enclosure and at intervals not exceeding 30 inches (762 mm). [230.51(A)]~~

~~E3605.8 Raceways to drain.~~
~~Where exposed to the weather, raceways enclosing service-entrance conductors shall be suitable for use in wet locations and arranged to drain. Where embedded in masonry, raceways shall be arranged to drain. (230.53)~~

~~E3605.9 Overhead service locations.~~
~~Connections at service heads shall be in accordance with Sections E3605.9.1 through E3605.9.7. (230.54)~~

~~E3605.9.1 Rain-tight service head.~~
~~Service raceways shall be equipped with a service head at the point of connection to service-drop or overhead conductors. The service head shall be listed for use in wet locations. [230.54(A)]~~

~~E3605.9.2 Service cable, service head or gooseneck.~~
~~Service-entrance cable shall be equipped with a service head or shall be formed into a gooseneck in an approved manner. The service head shall be listed for use in wet locations. [230.54(B)]~~

~~E3605.9.3 Service-head location.~~
~~Service heads, and goosenecks in service-entrance cables, shall be located above the point of attachment of the service-drop or overhead service conductors to the building or other structure. [230.54(C)]~~

> **~~Exception:~~** ~~Where it is impracticable to locate the service head or gooseneck above the point of attachment, the service head or gooseneck location shall be not more than 24 inches (610 mm) from the point of attachment. [230.54(C) Exception]~~

~~E3605.9.4 Separately bushed openings.~~
~~Service heads shall have conductors of different potential brought out through separately bushed openings. [230.54(E)]~~

~~E3605.9.5 Drip loops.~~
~~Drip loops shall be formed on individual conductors. To prevent the entrance of moisture, service-entrance conductors shall be connected to the service-drop or overhead conductors either below the level of the service head or below the level of the termination of the service-entrance cable sheath. [230.54(F)]~~

~~E3605.9.6 Conductor arrangement.~~
~~Service-entrance and overhead service conductors shall be arranged so that water will not enter service raceways or equipment. [230.54(G)]~~

~~E3605.9.7 Secured.~~
~~Service-entrance cables shall be held securely in place. [230.54(D)]~~

~~SECTION E3606~~

~~SERVICE EQUIPMENT—GENERAL~~

~~E3606.1 Service equipment enclosures.~~
~~Energized parts of service equipment shall be enclosed. (230.62)~~

~~E3606.2 Working space.~~

~~The working space in the vicinity of service equipment shall be not less than that specified in Chapter 34. (110.26)~~

~~E3606.3 Available short-circuit current.~~

~~Service equipment shall be suitable for the maximum fault current available at its supply terminals, but not less than 10,000 amperes. (110.9)~~

~~E3606.4 Marking.~~

~~Service equipment shall be marked to identify it as being suitable for use as service equipment. Service equipment shall be listed. Individual meter socket enclosures shall not be considered as service equipment. (230.66)~~

~~SECTION E3607~~

~~SYSTEM GROUNDING~~

~~E3607.1 System service ground.~~

~~The premises wiring system shall be grounded at the service with a grounding electrode conductor connected to a grounding electrode system as required by this code. Grounding electrode conductors shall be sized in accordance with Table E3603.4. [250.20(B)(1) and 250.24(A)]~~

~~E3607.2 Location of grounding electrode conductor connection.~~

~~The grounding electrode conductor shall be connected to the grounded service conductor at any accessible point from the load end of the overhead service conductors, service drop, underground service conductors, or service lateral to and including the terminal or bus to which the grounded service conductor is connected at the service disconnecting means. A grounding connection shall not be made to any grounded circuit conductor on the load side of the service disconnecting means, except as provided in Section E3607.3.2. [250.24(A)(1) and (A)(5)]~~

~~E3607.3 Buildings or structures supplied by feeder(s) or branch circuit(s).~~

~~Buildings or structures supplied by feeder(s) or branch circuit(s) shall have a grounding electrode or grounding electrode system installed in accordance with Section E3608. The grounding electrode conductor(s) shall be connected in a manner specified in Section E3607.3.1 or, for existing premises wiring systems only, Section E3607.3.2. Where there is no existing grounding electrode, the grounding electrode(s) required in Section E3608 shall be installed. [250.32(A)]~~

> **~~Exception:~~** ~~A grounding electrode shall not be required where only one branch circuit, including a multiwire branch circuit, supplies the building or structure and the branch circuit includes an equipment grounding conductor for grounding the noncurrent-carrying parts of all equipment. For the purposes of this section, a multiwire branch circuit shall be considered as a single branch circuit. [250.32(A) Exception]~~

~~E3607.3.1 Equipment grounding conductor.~~

~~An equipment grounding conductor as described in Section E3908 shall be run with the supply conductors and connected to the building or structure disconnecting means and to the grounding electrode(s). The equipment grounding conductor shall be used for grounding or bonding of equipment, structures or frames required to be grounded or bonded. The~~

~~equipment grounding conductor shall be sized in accordance with Section E3908.12. Any installed grounded conductor shall not be connected to the equipment grounding conductor or to the grounding electrode(s). [250.32(B) and Table 250.122]~~

~~E3607.3.2 Grounded conductor, existing premises.~~

~~For installations made in compliance with previous editions of this code that permitted such connection and where an equipment grounding conductor is not run with the supply conductors to the building or structure, there are no continuous metallic paths bonded to the grounding system in both buildings or structures involved, and ground-fault protection of equipment has not been installed on the supply side of the feeder(s), the grounded conductor run with the supply to the buildings or structure shall be connected to the building or structure disconnecting means and to the grounding electrode(s) and shall be used for grounding or bonding of equipment, structures, or frames required to be grounded or bonded. Where used for grounding in accordance with this provision, the grounded conductor shall be not smaller than the larger of:~~

1. ~~That required by Section E3704.3.~~
2. ~~That required by Section E3908.12. [250.32(B)(1) Exception]~~

~~E3607.4 Grounding electrode conductor.~~

~~A grounding electrode conductor shall be used to connect the equipment grounding conductors, the service equipment enclosures, and the grounded service conductor to the grounding electrode(s). This conductor shall be sized in accordance with Table E3603.4. [250.24(D)]~~

~~E3607.5 Main bonding jumper.~~

~~An unspliced main bonding jumper shall be used to connect the equipment grounding conductor(s) and the service-disconnect enclosure to the grounded conductor of the system within the enclosure for each service disconnect. [250.24(B)]~~

~~E3607.6 Common grounding electrode.~~

~~Where an ac system is connected to a grounding electrode in or at a building or structure, the same electrode shall be used to ground conductor enclosures and equipment in or on that building or structure. Where separate services, feeders or branch circuits supply a building and are required to be connected to a grounding electrode(s), the same grounding electrode(s) shall be used. Two or more grounding electrodes that are effectively bonded together shall be considered as a single grounding electrode system. (250.58)~~

~~SECTION E3608~~

~~GROUNDING ELECTRODE SYSTEM~~

~~E3608.1 Grounding electrode system.~~

~~All electrodes specified in Sections E3608.1.1, E3608.1.2, E3608.1.3, E3608.1.4 E3608.1.5 and E3608.1.6 that are present at each building or structure served shall be bonded together to form the grounding electrode system. Where none of these electrodes are present, one or more of the electrodes specified in Sections E3608.1.3, E3608.1.4, E3608.1.5 and E3608.1.6 shall be installed and used. (250.50)~~

~~**Exception:** Concrete-encased electrodes of existing buildings or structures shall not be required to be part of the grounding electrode system where the steel reinforcing bars or rods are not accessible for use without disturbing the concrete. (250.50 Exception)~~

~~E3608.1.1 Metal underground water pipe.~~

~~A metal underground water pipe that is in direct contact with the earth for 10 feet (3048 mm) or more, including any well casing effectively bonded to the pipe and that is electrically continuous, or made electrically continuous by bonding around insulating joints or insulating pipe to the points of connection of the grounding electrode conductor and the bonding conductors, shall be considered as a grounding electrode (see Section E3608.1). [250.52(A)(1)]~~

~~E3608.1.1.1 Interior metal water piping.~~

~~Interior metal water piping located more than 5 feet (1524 mm) from the entrance to the building shall not be used as a conductor to interconnect electrodes that are part of the grounding electrode system. [250.68(C)(1)]~~

~~E3608.1.1.2 Installation.~~

~~Continuity of the grounding path or the bonding connection to interior piping shall not rely on water meters, filtering devices and similar equipment. A metal underground water pipe shall be supplemented by an additional electrode of a type specified in Sections E3608.1.2 through E3608.1.6. The supplemental electrode shall be bonded to the grounding electrode conductor, the grounded service-entrance conductor, a nonflexible grounded service raceway, any grounded service enclosure or to the equipment grounding conductor provided in accordance with Section E3607.3.1. Where the supplemental electrode is a rod, pipe or plate electrode in accordance with Section E3608.1.4 or E3608.1.5, it shall comply with Section E3608.4.~~

~~Where the supplemental electrode is a rod, pipe or plate electrode in accordance with Section E3608.1.4 or E3608.1.5, that portion of the bonding jumper that is the sole connection to the supplemental grounding electrode shall not be required to be larger than 6 AWG copper or 4 AWG aluminum wire. [250.53(D) and (E)]~~

~~E3608.1.2 Concrete-encased electrode.~~

~~A concrete-encased electrode consisting of at least 20 feet (6096 mm) of either of the following shall be considered as a grounding electrode:~~

1. ~~One or more bare or zinc galvanized or other electrically conductive coated steel reinforcing bars or rods not less than $^{1}/_{2}$ inch (13 mm) in diameter, installed in one continuous 20-foot (6096 mm) length, or if in multiple pieces connected together by the usual steel tie wires, exothermic welding, welding, or other effective means to create a 20-foot (6096 mm) or greater length.~~

2. ~~A bare copper conductor not smaller than 4 AWG.~~

~~Metallic components shall be encased by at least 2 inches (51 mm) of concrete and shall be located horizontally within that portion of a concrete foundation or footing that is in direct contact with the earth or within vertical foundations or structural components or members that are in direct contact with the earth.~~

~~Where multiple concrete-encased electrodes are present at a building or structure, only one shall be required to be bonded into the grounding electrode system. [250.52(A)(3)]~~

~~E3608.1.3 Ground rings.~~

~~A ground ring encircling the building or structure, in direct contact with the earth at a depth below the earth's surface of not less than 30 inches (762 mm), consisting of at least 20 feet (6096 mm) of bare copper conductor not smaller than 2 AWG shall be considered as a grounding electrode. [250.52(A)(4)]~~

~~E3608.1.4 Rod and pipe electrodes.~~

~~Rod and pipe electrodes not less than 8 feet (2438 mm) in length and consisting of the following materials shall be considered as a grounding electrode:~~

1. ~~Grounding electrodes of pipe or conduit shall not be smaller than trade size ${}^{3}/_{4}$ (metric designator 21) and, where of iron or steel, shall have the outer surface galvanized or otherwise metal-coated for corrosion protection.~~
2. ~~Rod-type grounding electrodes of stainless steel and copper or zinc-coated steel shall be at least ${}^{5}/_{8}$ inch (15.9 mm) in diameter unless listed. [250.52(A)(5)]~~

~~E3608.1.4.1 Installation.~~

~~The rod and pipe electrodes shall be installed such that at least 8 feet (2438 mm) of length is in contact with the soil. They shall be driven to a depth of not less than 8 feet (2438 mm) except that, where rock bottom is encountered, electrodes shall be driven at an oblique angle not to exceed 45 degrees (0.79 rad) from the vertical or shall be buried in a trench that is at least 30 inches (762 mm) deep. The upper end of the electrodes shall be flush with or below ground level except where the aboveground end and the grounding electrode conductor attachment are protected against physical damage. (250.53(G)]~~

~~E3608.1.5 Plate electrodes.~~

~~A plate electrode that exposes not less than 2 square feet (0.186 m^2) of surface to exterior soil shall be considered as a grounding electrode. Electrodes of bare or conductively coated iron or steel plates shall be at least ${}^{1}/_{4}$ inch (6.4 mm) in thickness. Solid, uncoated electrodes of nonferrous metal shall be at least 0.06 inch (1.5 mm) in thickness. Plate electrodes shall be installed not less than 30 inches (762 mm) below the surface of the earth. [250.52(A)(7)]~~

~~E3608.1.6 Other electrodes.~~

~~In addition to the grounding electrodes specified in Sections E3608.1.1 through E3608.1.5, other listed grounding electrodes shall be permitted. [250.52(A)(6)]~~

~~E3608.2 Bonding jumper.~~

~~The bonding jumper(s) used to connect the grounding electrodes together to form the grounding electrode system shall be installed in accordance with Sections E3610.2, and E3610.3, shall be sized in accordance with Section E3603.4, and shall be connected in the manner specified in Section E3611.1. [250.53(C)]~~

~~E3608.3 Rod, pipe and plate electrode requirements.~~
~~Where practicable, rod, pipe and plate electrodes shall be embedded below permanent moisture level. Such electrodes shall be free from nonconductive coatings such as paint or enamel. Where more than one such electrode is used, each electrode of one grounding system shall be not less than 6 feet (1829 mm) from any other electrode of another grounding system. Two or more grounding electrodes that are effectively bonded together shall be considered as a single grounding electrode system. That portion of a bonding jumper that is the sole connection to a rod, pipe or plate electrode shall not be required to be larger than 6 AWG copper or 4 AWG aluminum wire. [250.53(A)(1), 250.53(B), 250.53(C)]~~

~~E3608.4 Supplemental electrode required.~~
~~A single rod, pipe, or plate electrode shall be supplemented by an additional electrode of a type specified in Sections E3608.1.2 through E3608.1.6. The supplemental electrode shall be bonded to one of the following:~~

1. ~~A rod, pipe, or plate electrode.~~
2. ~~A grounding electrode conductor.~~
3. ~~A grounded service-entrance conductor.~~
4. ~~A nonflexible grounded service raceway.~~
5. ~~A grounded service enclosure.~~

~~Where multiple rod, pipe, or plate electrodes are installed to meet the requirements of this section, they shall not be less than 6 feet (1829 mm) apart. [250.53(A)(2) and (A)(3)]~~

> **~~Exception:~~** ~~Where a single rod, pipe, or plate grounding electrode has a resistance to earth of 25 ohms or less, the supplemental electrode shall not be required. [250.53(A)(2) Exception]~~

~~E3608.5 Aluminum electrodes.~~
~~Aluminum electrodes shall not be permitted. [250.52(B)(2)]~~

~~E3608.6 Metal underground gas piping system.~~
~~A metal underground gas piping system shall not be used as a grounding electrode. [250.52(B)(1)]~~

~~SECTION E3609~~

~~BONDING~~

~~E3609.1 General.~~
~~Bonding shall be provided where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed. (250.90)~~

~~E3609.2 Bonding of equipment for services.~~

~~The noncurrent-carrying metal parts of the following equipment shall be effectively bonded together:~~

1. ~~Raceways or service cable armor or sheath that enclose, contain, or support service conductors.~~
2. ~~Service enclosures containing service conductors, including meter fittings, and boxes, interposed in the service raceway or armor. [250.92(A)]~~

~~E3609.3 Bonding for other systems.~~

~~An intersystem bonding termination for connecting intersystem bonding conductors required for other systems shall be provided external to enclosures at the service equipment or metering equipment enclosure and at the disconnecting means for any additional buildings or structures. The intersystem bonding termination shall comply with all of the following:~~

1. ~~It shall be accessible for connection and inspection.~~
2. ~~It shall consist of a set of terminals with the capacity for connection of not less than three intersystem bonding conductors.~~
3. ~~It shall not interfere with opening of the enclosure for a service, building or structure disconnecting means, or metering equipment.~~
4. ~~Where located at the service equipment, it shall be securely mounted and electrically connected to an enclosure for the service equipment, to the meter enclosure, or to an exposed nonflexible metallic service raceway, or shall be mounted at one of these enclosures and connected to the enclosure or to the grounding electrode conductor with a 6 AWG or larger copper conductor.~~
5. ~~Where located at the disconnecting means for a building or structure, it shall be securely mounted and electrically connected to the metallic enclosure for the building or structure disconnecting means, or shall be mounted at the disconnecting means and connected to the metallic enclosure or to the grounding electrode conductor with a 6 AWG or larger copper conductor.~~
6. ~~It shall be listed as grounding and bonding equipment. (250.94)~~

~~E3609.4 Method of bonding at the service.~~

~~Bonding jumpers meeting the requirements of this chapter shall be used around impaired connections, such as reducing washers or oversized, concentric, or eccentric knockouts. Standard locknuts or bushings shall not be the only means for the bonding required by this section but shall be permitted to be installed to make mechanical connections of raceways. Electrical continuity at service equipment, service raceways and service conductor enclosures shall be ensured by one or more of the methods specified in Sections E3609.4.1 through E3609.4.4.~~

~~E3609.4.1 Grounded service conductor.~~

~~Equipment shall be bonded to the grounded service conductor in a manner provided in this code.~~

~~E3609.4.2 Threaded connections.~~
~~Equipment shall be bonded by connections using threaded couplings or threaded hubs on enclosures. Such connections shall be made wrench tight.~~

~~E3609.4.3 Threadless couplings and connectors.~~
~~Equipment shall be bonded by threadless couplings and connectors for metal raceways and metal-clad cables. Such couplings and connectors shall be made wrench tight. Standard locknuts or bushings shall not be used for the bonding required by this section.~~

~~E3609.4.4 Other devices.~~
~~Equipment shall be bonded by other listed devices, such as bonding-type locknuts, bushings and bushings with bonding jumpers. [250.92(B)]~~

~~E3609.5 Sizing supply-side bonding jumper and main bonding jumper.~~
~~The bonding jumper shall not be smaller than the sizes shown in Table E3603.4 for grounding electrode conductors. Where the service-entrance conductors are paralleled in two or more raceways or cables, and an individual supply-side bonding jumper is used for bonding these raceways or cables, the supply-side bonding jumper for each raceway or cable shall be selected from Table E3603.4 based on the size of the ungrounded supply conductors in each raceway or cable. A single supply-side bonding jumper installed for bonding two or more raceways or cables shall be sized in accordance with Table E3603.4 based on the largest set of parallel ungrounded supply conductors. [250.102(C)]~~

~~E3609.6 Metal water piping bonding.~~
~~The metal water piping system shall be bonded to the service equipment enclosure, the grounded conductor at the service, the grounding electrode conductor where of sufficient size, or to the one or more grounding electrodes used. The bonding jumper shall be sized in accordance with Table E3603.4. The points of attachment of the bonding jumper(s) shall be accessible. [250.104(A) and 250.104(A)(1)]~~

~~E3609.7 Bonding other metal piping.~~
~~Where installed in or attached to a building or structure, metal piping systems, including gas piping, capable of becoming energized shall be bonded to the service equipment enclosure, the grounded conductor at the service, the grounding electrode conductor where of sufficient size, or to the one or more grounding electrodes used. The bonding conductor(s) or jumper(s) shall be sized in accordance with Table E3908.12 using the rating of the circuit capable of energizing the piping. The equipment grounding conductor for the circuit that is capable of energizing the piping shall be permitted to serve as the bonding means. The points of attachment of the bonding jumper(s) shall be accessible. [250.104(B)]~~

~~SECTION E3610~~

~~GROUNDING ELECTRODE CONDUCTORS~~

~~E3610.1 Continuous.~~
~~The grounding electrode conductor shall be installed in one continuous length without splices or joints and shall run to any convenient grounding electrode available in the grounding electrode system where the other electrode(s), if any, are connected by bonding jumpers in accordance with Section E3608.2, or to one or more grounding electrode(s) individually. The grounding~~

~~electrode conductor shall be sized for the largest grounding electrode conductor required among all of the electrodes connected to it. [250.64(C)]~~

> ~~**Exception:** Splicing of the grounding electrode conductor by irreversible compression-type connectors listed as grounding and bonding equipment or by the exothermic welding process shall not be prohibited. [250.64(C)(1)]~~

~~E3610.2 Securing and protection against physical damage.~~

~~Where exposed, a grounding electrode conductor or its enclosure shall be securely fastened to the surface on which it is carried. Grounding electrode conductors shall be permitted to be installed on or through framing members. A 4 AWG or larger conductor shall be protected where exposed to physical damage. A 6 AWG grounding conductor that is free from exposure to physical damage shall be permitted to be run along the surface of the building construction without metal covering or protection where it is and securely fastened to the construction; otherwise, it shall be in rigid metal conduit, intermediate metal conduit, rigid polyvinyl chloride (PVC), nonmetallic conduit, reinforced thermosetting resin (RTRC) nonmetallic conduit, electrical metallic tubing or cable armor. Grounding electrode conductors smaller than 6 AWG shall be in rigid metal conduit, intermediate metal conduit, rigid polyvinyl chloride (PVC) nonmetallic conduit, reinforced thermoseting resin (RTRC) nonmetallic conduit, electrical metallic tubing or cable armor. Grounding electrode conductors and grounding electrode bonding jumpers shall not be required to comply with Section E3803. [250.64(B)]~~

~~Bare aluminum or copper-clad aluminum grounding electrode conductors shall not be used where in direct contact with masonry or the earth or where subject to corrosive conditions. Where used outside, aluminum or copper-clad aluminum grounding electrode conductors shall not be installed within 18 inches (457 mm) of the earth. [250.64(A)]~~

~~E3610.3 Raceways and enclosures for grounding electrode conductors.~~

~~Ferrous metal raceways and enclosures for grounding electrode conductors shall be electrically continuous from the point of attachment to cabinets or equipment to the grounding electrode, and shall be securely fastened to the ground clamp or fitting. Nonferrous metal raceways and enclosures shall not be required to be electrically continuous. Ferrous metal raceways and enclosures shall be bonded at each end of the raceway or enclosure to the grounding electrode or to the grounding electrode conductor. Bonding methods in compliance with Section E3609.4 for installations at service equipment locations and with E3609.4.2 through E3609.4.4 for other than service equipment locations shall apply at each end and to all intervening ferrous raceways, boxes, and enclosures between the cabinets or equipment and the grounding electrode. The bonding jumper for a grounding electrode conductor raceway shall be the same size or larger than the required enclosed grounding electrode conductor.~~

~~Where a raceway is used as protection for a grounding conductor, the installation shall comply with the requirements of Chapter 38. [250.64(E)(4)]~~

~~E3610.4 Prohibited use.~~

~~An equipment grounding conductor shall not be used as a grounding electrode conductor. (250.121)~~

> ~~**Exception:** A wire-type equipment grounding conductor shall be permitted to serve as both an equipment grounding conductor and a grounding electrode conductor where installed in accordance with the applicable requirements for both the equipment grounding conductor~~

~~and the grounding electrode conductor in Chapters 36 and 39. Where used as a grounding electrode conductor, the wire-type equipment grounding conductor shall be installed and arranged in a manner that will prevent objectionable current. [250.121 Exception, 250.6(A)]~~

~~SECTION E3611~~

~~GROUNDING ELECTRODE CONDUCTOR~~

~~CONNECTION TO THE GROUNDING ELECTRODES~~

~~E3611.1 Methods of grounding conductor connection to electrodes.~~
~~The grounding or bonding conductor shall be connected to the grounding electrode by exothermic welding, listed lugs, listed pressure connectors, listed clamps or other listed means. Connections depending on solder shall not be used. Ground clamps shall be listed for the materials of the grounding electrode and the grounding electrode conductor and, where used on pipe, rod or other buried electrodes, shall also be listed for direct soil burial or concrete encasement. Not more than one conductor shall be connected to the grounding electrode by a single clamp or fitting unless the clamp or fitting is listed for multiple conductors. One of the methods indicated in the following items shall be used:~~

1. ~~A pipe fitting, pipe plug or other approved device screwed into a pipe or pipe fitting.~~

2. ~~A listed bolted clamp of cast bronze or brass, or plain or malleable iron.~~

3. ~~For indoor communications purposes only, a listed sheet metal strap-type ground clamp having a rigid metal base that seats on the electrode and having a strap of such material and dimensions that it is not likely to stretch during or after installation.~~

4. ~~Other equally substantial approved means. (250.70)~~

~~E3611.2 Accessibility.~~
~~All mechanical elements used to terminate a grounding electrode conductor or bonding jumper to the grounding electrodes that are not buried or concrete encased shall be accessible. [250.68(A) and 250.68(A) Exception]~~

~~E3611.3 Effective grounding path.~~
~~The connection of the grounding electrode conductor or bonding jumper shall be made in a manner that will ensure a permanent and effective grounding path. Where necessary to ensure effective grounding for a metal piping system used as a grounding electrode, effective bonding shall be provided around insulated joints and sections and around any equipment that is likely to be disconnected for repairs or replacement. Bonding jumpers shall be of sufficient length to permit removal of such equipment while retaining the integrity of the grounding path. [250.68(B)]~~

~~E3611.4 Interior metal water piping.~~
~~Where grounding electrode conductors and bonding jumpers are connected to interior metal water piping as a means to extend the grounding electrode conductor connection to an electrode(s), such piping shall be located not more than 5 feet (1524 mm) from the point of entry into the building.~~

~~Where interior metal water piping is used as a conductor to interconnect electrodes that are part of the grounding electrode system, such piping shall be located not more than 5 feet (1524 mm) from the point of entry into the building. [250.68(C)(1)]~~

~~E3611.5 Protection of ground clamps and fittings.~~

~~Ground clamps or other fittings shall be approved for applications without protection or shall be protected from physical damage by installing them where they are not likely to be damaged or by enclosing them in metal, wood or equivalent protective coverings. (250.10)~~

~~E3611.6 Clean surfaces.~~

~~Nonconductive coatings (such as paint, enamel and lacquer) on equipment to be grounded shall be removed from threads and other contact surfaces to ensure good electrical continuity or shall be connected by fittings that make such removal unnecessary. (250.12)~~

CHAPTER 37

BRANCH CIRCUIT AND FEEDER REQUIREMENTS

Deleted. See the *North Carolina Electrical Code.*

~~SECTION E3701~~
~~GENERAL~~

~~E3701.1 Scope.~~
~~This chapter covers branch circuits and feeders and specifies the minimum required branch circuits, the allowable loads and the required overcurrent protection for branch circuits and feeders that serve less than 100 percent of the total dwelling unit load. Feeder circuits that serve 100 percent of the dwelling unit load shall be sized in accordance with the procedures in Chapter 36. [310.15(B)(7)(2)]~~

~~E3701.2 Branch-circuit and feeder ampacity.~~
~~Branch-circuit and feeder conductors shall have ampacities not less than the maximum load to be served. Where a branch circuit or a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, the minimum branch-circuit or feeder conductor size, before the application of any adjustment or correction factors, shall have an allowable ampacity equal to or greater than the noncontinuous load plus 125 percent of the continuous load. [210.19(A)(1)(a) and 215.2(A)(1)(a)]~~

> **~~Exception:~~** ~~The grounded conductors of feeders that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the continuous and noncontinuous load. [215.1(A)(1) Exception No. 2]~~

~~E3701.3 Selection of ampacity.~~
~~Where more than one calculated or tabulated ampacity could apply for a given circuit length, the lowest value shall be used. [310.15(A)(2)]~~

> **~~Exception:~~** ~~Where two different ampacities apply to adjacent portions of a circuit, the higher ampacity shall be permitted to be used beyond the point of transition, a distance equal to 10 feet (3048 mm) or 10 percent of the circuit length figured at the higher ampacity, whichever is less. [310.15(A)(2) Exception]~~

~~E3701.4 Branch circuits with more than one receptacle.~~
~~Conductors of branch circuits supplying more than one receptacle for cord-and-plug-connected portable loads shall have ampacities of not less than the rating of the branch circuit. [210.19(A)(2)]~~

~~E3701.5 Multiwire branch circuits.~~
~~All conductors for multiwire branch circuits shall originate from the same panelboard or similar distribution equipment. Except where all ungrounded conductors are opened simultaneously by the branch-circuit overcurrent device, multiwire branch circuits shall supply only line-to-neutral loads or only one appliance. [210.4(A) and 210.4(C)]~~

~~**E3701.5.1 Disconnecting means.**~~
~~Each multiwire branch circuit shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point where the branch circuit originates. [210.4(B)]~~

~~**E3701.5.2 Grouping.**~~
~~The ungrounded and grounded circuit conductors of each multiwire branch circuit shall be grouped by cable ties or similar means in at least one location within the panelboard or other point of origination. [210.4(D)]~~

> ~~**Exception:** Grouping shall not be required where the circuit conductors enter from a cable or raceway unique to the circuit, thereby making the grouping obvious, or where the conductors are identified at their terminations with numbered wire markers corresponding to their appropriate circuit number. [210.4(D) Exception].~~

~~SECTION E3702~~
~~BRANCH CIRCUIT RATINGS~~

~~**E3702.1 Branch-circuit voltage limitations.**~~
~~The voltage ratings of branch circuits that supply luminaires or receptacles for cord-and-plug-connected loads of up to 1,400 volt-amperes or of less than $^{1}/_{4}$ horsepower (0.186 kW) shall be limited to a maximum rating of 120 volts, nominal, between conductors.~~

~~Branch circuits that supply cord-and-plug-connected or permanently connected utilization equipment and appliances rated at over 1,440 volt-amperes or $^{1}/_{4}$ horsepower (0.186 kW) and greater shall be rated at 120 volts or 240 volts, nominal. [210.6(A), (B), and (C)]~~

~~**E3702.2 Branch-circuit ampere rating.**~~
~~Branch circuits shall be rated in accordance with the maximum allowable ampere rating or setting of the overcurrent protection device. The rating for other than individual branch circuits shall be 15, 20, 30, 40 and 50 amperes. Where conductors of higher ampacity are used, the ampere rating or setting of the specified over-current device shall determine the circuit rating. (210.3)~~

~~**E3702.3 Fifteen- and 20-ampere branch circuits.**~~
~~A 15- or 20-ampere branch circuit shall be permitted to supply lighting units, or other utilization equipment, or a combination of both. The rating of any one cord-and-plug-connected utilization equipment not fastened in place shall not exceed 80 percent of the branch-circuit ampere rating. The total rating of utilization equipment fastened in place, other than luminaires, shall not exceed 50 percent of the branch-circuit ampere rating where lighting units, cord-and-plug-connected utilization equipment not fastened in place, or both, are also supplied. [210.23(A)(1) and (2)]~~

~~**E3702.4 Thirty-ampere branch circuits.**~~
~~A 30-ampere branch circuit shall be permitted to supply fixed utilization equipment. A rating of any one cord-and-plug-connected utilization equipment shall not exceed 80 percent of the branch-circuit ampere rating. [210.23(B)]~~

~~E3702.5 Branch circuits serving multiple loads or outlets.~~

~~General-purpose branch circuits shall supply lighting outlets, appliances, equipment or receptacle outlets, and combinations of such. Multioutlet branch circuits serving lighting or receptacles shall be limited to a maximum branch-circuit rating of 20 amperes. [210.23(A), (B), and (C)]~~

~~E3702.6 Branch circuits serving a single motor.~~

~~Branch-circuit conductors supplying a single motor shall have an ampacity not less than 125 percent of the motor full-load current rating. [430.22(A)]~~

~~E3702.7 Branch circuits serving motor-operated and combination loads.~~

~~For circuits supplying loads consisting of motor-operated utilization equipment that is fastened in place and that has a motor larger than $^{1}/_{8}$ horsepower (0.093 kW) in combination with other loads, the total calculated load shall be based on 125 percent of the largest motor load plus the sum of the other loads. [220.18(A)]~~

~~E3702.8 Branch-circuit inductive and LED lighting loads.~~

~~For circuits supplying luminaires having ballasts or LED drivers, the calculated load shall be based on the total ampere ratings of such units and not on the total watts of the lamps. [220.18(B)]~~

~~E3702.9 Branch-circuit load for ranges and cooking appliances.~~

~~It shall be permissible to calculate the branch-circuit load for one range in accordance with Table E3704.2(2). The branch-circuit load for one wall-mounted oven or one counter-mounted cooking unit shall be the nameplate rating of the appliance. The branch-circuit load for a counter-mounted cooking unit and not more than two wall-mounted ovens all supplied from a single branch circuit and located in the same room shall be calculated by adding the nameplate ratings of the individual appliances and treating the total as equivalent to one range. (220.55 Note 4)~~

~~E3702.9.1 Minimum branch circuit for ranges.~~

~~Ranges with a rating of 8.75 kVA or more shall be supplied by a branch circuit having a minimum rating of 40 amperes. [210.19(A)(3)]~~

~~E3702.10 Branch circuits serving heating loads.~~

~~Electric space-heating and water-heating appliances shall be considered to be continuous loads. Branch circuits supplying two or more outlets for fixed electric space-heating equipment shall be rated 15, 20, 25 or 30 amperes. [424.3(A)]~~

~~E3702.11 Branch circuits for air-conditioning and heat pump equipment.~~

~~The ampacity of the conductors supplying multimotor and combination load equipment shall be not less than the minimum circuit ampacity marked on the equipment. The branch-circuit overcurrent device rating shall be the size and type marked on the appliance. [440.4(B), 440.35, 440.62(A)]~~

~~E3702.12 Branch circuits serving room air conditioners.~~

~~A room air conditioner shall be considered as a single motor unit in determining its branch-circuit requirements where all the following conditions are met:~~

1. ~~It is cord- and attachment plug-connected.~~

2. ~~The rating is not more than 40 amperes and 250 volts; single phase.~~

3. ~~Total rated-load current is shown on the room air-conditioner nameplate rather than individual motor currents.~~

4. ~~The rating of the branch-circuit short-circuit and ground-fault protective device does not exceed the ampacity of the branch-circuit conductors, or the rating of the branch-circuit conductors, or the rating of the receptacle, whichever is less. [440.62(A)]~~

~~E3702.12.1 Where no other loads are supplied.~~
~~The total marked rating of a cord- and attachment plug-connected room air conditioner shall not exceed 80 percent of the rating of a branch circuit where no other appliances are also supplied. [440.62(B)]~~

~~E3702.12.2 Where lighting units or other appliances are also supplied.~~
~~The total marked rating of a cord- and attachment plug-connected room air conditioner shall not exceed 50 percent of the rating of a branch circuit where lighting or other appliances are also supplied. Where the circuitry is interlocked to prevent simultaneous operation of the room air conditioner and energization of other outlets on the same branch circuit, a cord- and attachment-plug-connected room air conditioner shall not exceed 80 percent of the branch-circuit rating. [440.62(C)]~~

~~E3702.13 Electric vehicle branch circuit.~~
~~Outlets installed for the purpose of charging electric vehicles shall be supplied by a separate branch circuit. Such circuit shall not supply other outlets. (210.17)~~

~~E3702.14 Branch-circuit requirement—summary.~~
~~The requirements for circuits having two or more outlets, or receptacles, other than the receptacle circuits of Sections E3703.2, E3703.3 and E3703.4, are summarized in Table E3702.14. Branch circuits in dwelling units shall supply only loads within that dwelling unit or loads associated only with that dwelling unit. Branch circuits installed for the purpose of lighting, central alarm, signal, communications or other purposes for public or common areas of a two-family dwelling shall not be supplied from equipment that supplies an individual dwelling unit. (210.24 and 210.25)~~

~~TABLE E3702.14 (Table 210.24)~~

~~BRANCH-CIRCUIT REQUIREMENTS-SUMMARY~~~~[a, b]~~

	~~CIRCUIT RATING~~		
	~~15 amp~~	**~~20 amp~~**	**~~30 amp~~**
~~Conductors:~~ ~~Minimum size (AWG) circuit conductors~~	~~14~~	~~12~~	~~10~~
~~Maximum overcurrent-protection device rating Ampere rating~~	~~15~~	~~20~~	~~30~~
~~Outlet devices:~~ ~~Lampholders permitted~~ ~~Receptacle rating (amperes)~~	~~Any type 15 maximum~~	~~Any type~~ ~~15 or 20~~	~~N/A~~ ~~30~~

~~Maximum load (amperes)~~	~~15~~	~~20~~	~~30~~

~~a. These gages are for copper conductors.~~
~~b. N/A means not allowed.~~

~~SECTION E3703~~
~~REQUIRED BRANCH CIRCUITS~~

~~E3703.1 Branch circuits for heating.~~
~~Central heating equipment other than fixed electric space heating shall be supplied by an individual branch circuit. Permanently connected air-conditioning equipment, and auxiliary equipment directly associated with the central heating equipment such as pumps, motorized valves, humidifiers and electrostatic air cleaners, shall not be prohibited from connecting to the same branch circuit as the central heating equipment. (422.12 and 422.12 Exceptions No. 1 and No. 2)~~

~~E3703.2 Kitchen and dining area receptacles.~~
~~A minimum of two 20-ampere-rated branch circuits shall be provided to serve all wall and floor receptacle outlets located in the kitchen, pantry, breakfast area, dining area or similar area of a dwelling. The kitchen countertop receptacles shall be served by a minimum of two 20-ampere-rated branch circuits, either or both of which shall also be permitted to supply other receptacle outlets in the same kitchen, pantry, breakfast and dining area including receptacle outlets for refrigeration appliances. [210.11(C)(1) and 210.52(B)(1) and (B)(2)]~~

> **~~Exception:~~** ~~The receptacle outlet for refrigeration appliances shall be permitted to be supplied from an individual branch circuit rated 15 amperes or greater. [210.52(B)(1) Exception No. 2]~~

~~E3703.3 Laundry circuit.~~
~~A minimum of one 20-ampere-rated branch circuit shall be provided for receptacles located in the laundry area and shall serve only receptacle outlets located in the laundry area. [210.11(C)(2)]~~

~~E3703.4 Bathroom branch circuits.~~
~~A minimum of one 20-ampere branch circuit shall be provided to supply bathroom receptacle outlet(s). Such circuits shall have no other outlets. [210.11(C)(3)]~~

> **~~Exception:~~** ~~Where the 20-ampere circuit supplies a single bathroom, outlets for other equipment within the same bathroom shall be permitted to be supplied in accordance with Section E3702. [210.11(C)(3) Exception)~~

~~E3703.5 Number of branch circuits.~~
~~The minimum number of branch circuits shall be determined from the total calculated load and the size or rating of the circuits used. The number of circuits shall be sufficient to supply the load served. In no case shall the load on any circuit exceed the maximum specified by Section E3702. [210.11(A)]~~

~~E3703.6 Branch-circuit load proportioning.~~

~~Where the branch-circuit load is calculated on a volt-amperes-per-square-foot (m^2) basis, the wiring system, up to and including the branch-circuit panelboard(s), shall have the capacity to~~

~~serve not less than the calculated load. This load shall be evenly proportioned among multioutlet branch circuits within the panelboard(s). Branch-circuit overcurrent devices and circuits shall only be required to be installed to serve the connected load. [210.11(B)]~~

~~SECTION E3704~~
~~FEEDER REQUIREMENTS~~

~~E3704.1 Conductor size.~~

~~Feeder conductors that do not serve 100 percent of the dwelling unit load and branch-circuit conductors shall be of a size sufficient to carry the load as determined by this chapter. Feeder conductors shall not be required to be larger than the service-entrance conductors that supply the dwelling unit. The load for feeder conductors that serve as the main power feeder to a dwelling unit shall be determined as specified in Chapter 36 for services. [310.15(B)(7)(2) and (3)]~~

~~E3704.2 Feeder loads.~~

~~The minimum load in volt-amperes shall be calculated in accordance with the load calculation procedure prescribed in Table E3704.2(1). The associated table demand factors shall be applied to the actual load to determine the minimum load for feeders. (220.40)~~

~~TABLE E3704.2(1)~~
~~(Table 220.12, 220.14, Table 220.42, 220.50, 220.51, 220.52, 220.53, 220.54, 220.55, and 220.60)~~
~~FEEDER LOAD CALCULATION~~

~~LOAD CALCULATION PROCEDURE~~	**~~APPLIED DEMAND FACTOR~~**
~~Lighting and receptacles: A unit load of not less than 3 VA per square foot of total floor area shall constitute the lighting and 120-volt, 15- and 20-ampere general use receptacle load. 1,500 VA shall be added for each 20-ampere branch circuit serving receptacles in the kitchen, dining room, pantry, breakfast area and laundry area.~~	~~100 percent of first 3,000 VA or less and 35 percent of that in excess of 3,000 VA.~~
~~Plus~~	
~~Appliances and motors: The nameplate rating load of all fastened-in-place appliances other than dryers, ranges, air-conditioning and space-heating equipment.~~	~~100 percent of load for three or less appliances.~~ ~~75 percent of load for four or more appliances.~~
~~Plus~~	
~~Fixed motors: Full-load current of motors plus 25 percent of the full load current of the largest motor.~~	
~~Plus~~	
~~Electric clothes dryer: The dryer load shall be 5,000 VA for each dryer circuit or the nameplate rating load of each dryer, whichever is greater.~~	
~~Plus~~	
~~Cooking appliances: The nameplate rating of ranges, wall-mounted ovens, counter-mounted cooking units and other cooking appliances rated in excess of 1.75 kVA shall be summed.~~	~~Demand factors shall be as allowed by Table E3704.2(2).~~
~~Plus the largest of either the heating or cooling load~~	
~~Largest of the following two selections:~~ ~~1. 100 percent of the nameplate rating(s) of the air conditioning and cooling, including heat pump~~	

~~compressors.~~ ~~2. 100 percent of the fixed electric space heating.~~

~~For SI: 1 square foot = 0.0929 m^2.~~

~~TABLE E3704.2(2) (220.55 and Table 220.55)~~
~~DEMAND LOADS FOR ELECTRIC RANGES, WALL-MOUNTED OVENS, COUNTER-MOUNTED COOKING UNITS AND OTHER COOKING APPLIANCES OVER $1\frac{3}{4}$ kVA RATING~~[a, b]

~~NUMBER OF APPLIANCES~~	~~MAXIMUM DEMAND~~[b, c]	~~DEMAND FACTORS (percent)~~[d]	
	~~Column A maximum 12 kVA rating~~	~~Column B less than $3\frac{1}{2}$ kVA rating~~	~~Column C $3\frac{1}{2}$ to $8\frac{3}{4}$ kVA rating~~
~~1~~	~~8 kVA~~	~~80~~	~~80~~
~~2~~	~~11 kVA~~	~~75~~	~~65~~

~~a. Column A shall be used in all cases except as provided for in Footnote d.~~

~~b. For ranges all having the same rating and individually rated more than 12 kVA but not more than 27 kVA, the maximum demand in Column A shall be increased 5 percent for each additional kVA of rating or major fraction thereof by which the rating of individual ranges exceeds 12 kVA.~~

~~c. For ranges of unequal ratings and individually rated more than 8.75 kVA, but none exceeding 27 kVA, an average value of rating shall be computed by adding together the ratings of all ranges to obtain the total connected load (using 12 kVA for any ranges rated less than 12 kVA) and dividing by the total number of ranges; and then the maximum demand in Column A shall be increased 5 percent for each kVA or major fraction thereof by which this average value exceeds 12 kVA.~~

~~d. Over 1.75 kVA through 8.75 kVA. As an alternative to the method provided in Column A, the nameplate ratings of all ranges rated more than 1.75 kVA but not more than 8.75 kVA shall be added and the sum shall be multiplied by the demand factor specified in Column B or C for the given number of appliances.~~

~~E3704.3 Feeder neutral load.~~

~~The feeder neutral load shall be the maximum unbalance of the load determined in accordance with this chapter. The maximum unbalanced load shall be the maximum net calculated load between the neutral and any one ungrounded conductor. For a feeder or service supplying electric ranges, wall-mounted ovens, counter-mounted cooking units and electric dryers, the maximum unbalanced load shall be considered as 70 percent of the load on the ungrounded conductors. [220.61(A) and (B)]~~

~~E3704.4 Lighting and general use receptacle load.~~

~~A unit load of not less than 3 volt-amperes shall constitute the minimum lighting and general use receptacle load for each square foot of floor area (33 VA for each square meter of floor area). The floor area for each floor shall be calculated from the outside dimensions of the building. The calculated floor area shall not include open porches, garages, or unused or unfinished spaces not adaptable for future use. [220.12, Table 220.12, and 220.14(J)]~~

~~E3704.5 Ampacity and calculated loads.~~

~~The calculated load of a feeder shall be not less than the sum of the loads on the branch circuits supplied, as determined by Section E3704, after any applicable demand factors permitted by Section E3704 have been applied. (220.40)~~

~~E3704.6 Equipment grounding conductor.~~

~~Where a feeder supplies branch circuits in which equipment grounding conductors are required, the feeder shall include or provide an equipment grounding conductor that is one or more or a combination of the types specified in Section E3908.8, to which the equipment grounding conductors of the branch circuits shall be connected. Where the feeder supplies a separate building or structure, the requirements of Section E3607.3.1 shall apply. (215.6)~~

~~SECTION E3705~~
~~CONDUCTOR SIZING~~
~~AND OVERCURRENT PROTECTION~~

~~E3705.1 General.~~

~~Ampacities for conductors shall be determined based in accordance with Table E3705.1 and Sections E3705.2 and E3705.3. [310.15(A)]~~

~~TABLE E3705.1~~
~~ALLOWABLE AMPACITIES~~

~~CONDUCTOR SIZE~~	**~~CONDUCTOR TEMPERATURE RATING~~**						**~~CONDUCTOR SIZE~~**
	~~60°C~~	**~~75°C~~**	**~~90°C~~**	**~~60°C~~**	**~~75°C~~**	**~~90°C~~**	
~~AWG kcmil~~	~~Types TW, UF~~	~~Types RHW, THHW, THW, THWN, USE, XHHW~~	~~Types RHW-2, THHN, THHW, THW-2, THWN-2, XHHW, XHHW-2, USE-2~~	~~Types TW, UF~~	~~Types RHW, THHW, THW, THWN, USE, XHHW~~	~~Types RHW-2, THHN, THHW, THW-2, THWN-2, XHHW, XHHW-2, USE-2~~	~~AWG kcmil~~
	~~Copper~~			~~Aluminum or copper-clad aluminum~~			
~~14[a]~~	~~15~~	~~20~~	~~25~~	~~—~~	~~—~~	~~—~~	~~—~~
~~12[a]~~	~~20~~	~~25~~	~~30~~	~~15~~	~~20~~	~~25~~	~~12[a]~~
~~10[a]~~	~~30~~	~~35~~	~~40~~	~~25~~	~~30~~	~~35~~	~~10[a]~~
~~8~~	~~40~~	~~50~~	~~55~~	~~35~~	~~40~~	~~45~~	~~8~~
~~6~~	~~55~~	~~65~~	~~75~~	~~40~~	~~50~~	~~55~~	~~6~~
~~4~~	~~70~~	~~85~~	~~95~~	~~55~~	~~65~~	~~75~~	~~4~~
~~3~~	~~85~~	~~100~~	~~115~~	~~65~~	~~75~~	~~85~~	~~3~~
~~2~~	~~95~~	~~115~~	~~130~~	~~75~~	~~90~~	~~100~~	~~2~~
~~1~~	~~110~~	~~130~~	~~145~~	~~85~~	~~100~~	~~115~~	~~1~~
~~1/0~~	~~125~~	~~150~~	~~170~~	~~100~~	~~120~~	~~135~~	~~1/0~~
~~2/0~~	~~145~~	~~175~~	~~195~~	~~115~~	~~135~~	~~150~~	~~2/0~~
~~3/0~~	~~165~~	~~200~~	~~225~~	~~130~~	~~155~~	~~175~~	~~3/0~~
~~4/0~~	~~195~~	~~230~~	~~260~~	~~150~~	~~180~~	~~205~~	~~4/0~~
~~250~~	~~215~~	~~255~~	~~290~~	~~170~~	~~205~~	~~230~~	~~250~~
~~300~~	~~240~~	~~285~~	~~320~~	~~195~~	~~230~~	~~260~~	~~300~~
~~350~~	~~260~~	~~310~~	~~350~~	~~210~~	~~250~~	~~280~~	~~350~~
~~400~~	~~280~~	~~335~~	~~380~~	~~225~~	~~270~~	~~305~~	~~400~~
~~500~~	~~320~~	~~380~~	~~430~~	~~260~~	~~310~~	~~350~~	~~500~~

~~600~~	~~350~~	~~420~~	~~475~~	~~285~~	~~340~~	~~385~~	~~600~~
~~700~~	~~385~~	~~460~~	~~520~~	~~315~~	~~375~~	~~425~~	~~700~~
~~750~~	~~400~~	~~475~~	~~535~~	~~320~~	~~385~~	~~435~~	~~750~~
~~800~~	~~410~~	~~490~~	~~555~~	~~330~~	~~395~~	~~445~~	~~800~~
~~900~~	~~435~~	~~520~~	~~585~~	~~355~~	~~425~~	~~480~~	~~900~~

~~For SI: °C = [(°F) - 32]/1.8.~~
~~a. See Table E3705.5.3 for conductor overcurrent protection limitations.~~

~~E3705.2 Correction factor for ambient temperatures.~~

~~For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities specified in Table E3705.1 by the appropriate correction factor shown in Table E3705.2. [310.15(B)(2)]~~

~~TABLE E3705.2 [Table 310.15(B)(2)(a)]~~
~~AMBIENT TEMPERATURE CORRECTION FACTORS~~

~~For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate correction factor shown below.~~				
~~Ambient Temperature (°C)~~	**~~Temperature Rating of Conductor~~**			**~~Ambient Temperature (°F)~~**
	~~60°C~~	**~~75°C~~**	**~~90°C~~**	
~~10 or less~~	~~1.29~~	~~1.20~~	~~1.15~~	~~50 or less~~
~~11-15~~	~~1.22~~	~~1.15~~	~~1.12~~	~~51-59~~
~~16-20~~	~~1.15~~	~~1.11~~	~~1.08~~	~~60-68~~
~~21-25~~	~~1.08~~	~~1.05~~	~~1.04~~	~~69-77~~
~~26-30~~	~~1.00~~	~~1.00~~	~~1.00~~	~~78-86~~
~~31-35~~	~~0.91~~	~~0.94~~	~~0.96~~	~~87-95~~
~~36-40~~	~~0.82~~	~~0.88~~	~~0.91~~	~~96-104~~
~~41-45~~	~~0.71~~	~~0.82~~	~~0.87~~	~~105-113~~
~~46-50~~	~~0.58~~	~~0.75~~	~~0.82~~	~~114-122~~
~~51-55~~	~~0.41~~	~~0.67~~	~~0.76~~	~~123-131~~
~~56-60~~	~~—~~	~~0.58~~	~~0.71~~	~~132-140~~
~~61-65~~	~~—~~	~~0.47~~	~~0.65~~	~~141-149~~
~~66-70~~	~~—~~	~~0.33~~	~~0.58~~	~~150-158~~
~~71-75~~	~~—~~	~~—~~	~~0.50~~	~~159-167~~
~~76-80~~	~~—~~	~~—~~	~~0.41~~	~~168-176~~
~~81-85~~	~~—~~	~~—~~	~~0.29~~	~~177-185~~

~~For SI: 1 °C = [(°F) - 32]/1.8.~~

~~E3705.3 Adjustment factor for conductor proximity.~~

~~Where the number of current-carrying conductors in a raceway or cable exceeds three, or where single conductors or multiconductor cables are stacked or bundled for distances greater than 24 inches (610 mm) without maintaining spacing and are not installed in raceways, the allowable ampacity of each conductor shall be reduced as shown in Table E3705.3. [310.15(B)(3)]~~

~~Exceptions:~~

1. ~~Adjustment factors shall not apply to conductors in nipples having a length not exceeding 24 inches (610 mm). [310.15(B)(3)(2)]~~

2. ~~Adjustment factors shall not apply to underground conductors entering or leaving an outdoor trench if those conductors have physical protection in the form of rigid metal conduit, intermediate metal conduit, or rigid nonmetallic conduit having a length not exceeding 10 feet (3048 mm) and the number of conductors does not exceed four. [310.15(B)(3)(3)]~~

3. ~~Adjustment factors shall not apply to type AC cable or to type MC cable without an overall outer jacket meeting all of the following conditions:~~

    3.1. ~~Each cable has not more than three current-carrying conductors.~~

    3.2. ~~The conductors are 12 AWG copper.~~

    3.3. ~~Not more than 20 current-carrying conductors are bundled, stacked or supported on bridle rings. [310.15(B)(3)(4)]~~

4. ~~An adjustment factor of 60 percent shall be applied to Type AC cable and Type MC cable where all of the following conditions apply:~~

    4.1. ~~The cables do not have an overall outer jacket.~~

    4.2. ~~The number of current-carrying conductors exceeds 20.~~

    4.3. ~~The cables are stacked or bundled longer than 24 inches (607 mm) without spacing being maintained. [310.15(B)(3)(5)]~~

~~TABLE E3705.3 [Table 310.15(B)(3)(a)]~~
~~CONDUCTOR PROXIMITY ADJUSTMENT FACTORS~~

~~NUMBER OF CURRENT-CARRYING CONDUCTORS IN CABLE OR RACEWAY~~	~~PERCENT OF VALUES IN TABLE E3705.1~~
~~4-6~~	~~80~~
~~7-9~~	~~70~~
~~10-20~~	~~50~~
~~21-30~~	~~45~~
~~31-40~~	~~40~~
~~41 and above~~	~~35~~

~~E3705.4 Temperature limitations.~~
~~The temperature rating associated with the ampacity of a conductor shall be so selected and coordinated to not exceed the lowest temperature rating of any connected termination, conductor or device. Conductors with temperature ratings higher than specified for terminations shall be permitted to be used for ampacity adjustment, correction, or both. Except where the equipment is marked otherwise, conductor ampacities used in determining equipment termination provisions shall be based on Table E3705.1. [110.14(C)]~~

~~E3705.4.1 Conductors rated 60°C.~~
~~Except where the equipment is marked otherwise, termination provisions of equipment for circuits rated 100 amperes or less, or marked for 14 AWG through 1 AWG conductors, shall be used only for one of the following:~~

1. ~~Conductors rated 60°C (140°F);~~

2. ~~Conductors with higher temperature ratings, provided that the ampacity of such conductors is determined based on the 60°C (140°F) ampacity of the conductor size used;~~

3. ~~Conductors with higher temperature ratings where the equipment is listed and identified for use with such conductors; or~~

4. ~~For motors marked with design letters B, C, or D conductors having an insulation rating of 75°C (167°F) or higher shall be permitted to be used provided that the ampacity of such conductors does not exceed the 75°C (167°F) ampacity. [110.14(C)(1)(a)]~~

~~E3705.4.2 Conductors rated 75°C.~~
~~Termination provisions of equipment for circuits rated over 100 amperes, or marked for conductors larger than 1 AWG, shall be used only for:~~

1. ~~Conductors rated 75°C (167°F).~~

2. ~~Conductors with higher temperature ratings provided that the ampacity of such conductors does not exceed the 75°C (167°F) ampacity of the conductor size used, or provided that the equipment is listed and identified for use with such conductors. [110.14(C)(1)(b)]~~

~~E3705.4.3 Separately installed pressure connectors.~~
~~Separately installed pressure connectors shall be used with conductors at the ampacities not exceeding the ampacity at the listed and identified temperature rating of the connector. [110.14(C)(2)]~~

~~E3705.4.4 Conductors of Type NM cable.~~
~~Conductors in NM cable assemblies shall be rated at 90°C (194°F). Types NM, NMC, and NMS cable identified by the markings NM-B, NMC-B, and NMS-B meet this requirement. The allowable ampacity of Types NM, NMC, and NMS cable shall not exceed that of 60°C (140°F) rated conductors and shall comply with Section E3705.1 and Table E3705.5.3. The 90°C (194°F) rating shall be permitted to be used for ampacity adjustment and calculations provided that the final corrected or adjusted ampacity does not exceed that for a 60°C (140°F) rated conductor. Where more than two NM cables containing two or more current-carrying conductors are installed, without maintaining spacing between the cables, through the same opening in wood framing that is to be sealed with thermal insulation, caulk or sealing foam, the allowable ampacity of each conductor shall be adjusted in accordance with Table E3705.3. Where more than two NM cables containing two or more current-carrying conductors are installed in contact with thermal insulation without maintaining spacing between cables, the allowable ampacity of each conductor shall be adjusted in accordance with Table E3705.3. (334.80 and 334.112)~~

~~E3705.4.5 Conductors of Type SE cable.~~
~~Where used as a branch circuit or feeder wiring method within the interior of a building and installed in thermal insulation, the ampacity of the conductors in Type SE cable assemblies~~

~~shall be in accordance with the 60°C (140°F) conductor temperature rating. The maximum conductor temperature rating shall be permitted to be used for ampacity adjustment and correction purposes, provided that the final derated ampacity does not exceed that for a 60°C (140°F) rated conductor. [338.10(B)(4)(a)]~~

~~E3705.5 Overcurrent protection required.~~

~~All ungrounded branch-circuit and feeder conductors shall be protected against overcurrent by an overcurrent device installed at the point where the conductors receive their supply. Overcurrent devices shall not be connected in series with a grounded conductor. Overcurrent protection and allowable loads for branch circuits and for feeders that do not serve as the main power feeder to the dwelling unit load shall be in accordance with this chapter.~~

~~Branch-circuit conductors and equipment shall be protected by overcurrent protective devices having a rating or setting not exceeding the allowable ampacity specified in Table E3705.1 and Sections E3705.2, E3705.3 and E3705.4 except where otherwise permitted or required in Sections E3705.5.1 through E3705.5.3. [240.4, 240.21, and 310.15(B)(7)(2)]~~

~~E3705.5.1 Cords.~~

~~Cords shall be protected in accordance with Section E3909.2. [240.5(B)]~~

~~E3705.5.2 Overcurrent devices of the next higher rating.~~

~~The next higher standard overcurrent device rating, above the ampacity of the conductors being protected, shall be permitted to be used, provided that all of the following conditions are met:~~

1. ~~The conductors being protected are not part of a branch circuit supplying more than one receptacle for cord- and plug-connected portable loads.~~
2. ~~The ampacity of conductors does not correspond with the standard ampere rating of a fuse or a circuit breaker without overload trip adjustments above its rating (but that shall be permitted to have other trip or rating adjustments).~~
3. ~~The next higher standard device rating does not exceed 400 amperes. [240.4(B)]~~

~~E3705.5.3 Small conductors.~~

~~Except as specifically permitted by Section E3705.5.4, the rating of overcurrent protection devices shall not exceed the ratings shown in Table E3705.5.3 for the conductors specified therein. [240.4(D)]~~

~~TABLE E3705.5.3 [240.4(D)]~~
~~OVERCURRENT-PROTECTION RATING~~

~~COPPER~~		~~ALUMINUM OR COPPER-CLAD ALUMINUM~~	
~~Size (AWG)~~	~~Maximum overcurrent-protection-device rating~~~~[a]~~ ~~(amps)~~	~~Size (AWG)~~	~~Maximum overcurrent-protection-device rating~~~~[a]~~ ~~(amps)~~
~~14~~	~~15~~	~~12~~	~~15~~
~~12~~	~~20~~	~~10~~	~~25~~
~~10~~	~~30~~	~~8~~	~~30~~

~~a. The maximum overcurrent-protection-device rating shall not exceed the conductor allowable ampacity determined by the application of the correction and adjustment factors in accordance with Sections E3705.2 and E3705.3.~~

~~E3705.5.4 Air-conditioning and heat pump equipment.~~

~~Air-conditioning and heat pump equipment circuit conductors shall be permitted to be protected against overcurrent in accordance with Section E3702.11. [240.4(G)]~~

~~E3705.6 Fuses and fixed trip circuit breakers.~~

~~The standard ampere ratings for fuses and inverse time circuit breakers shall be considered 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125, 150, 175, 200, 225, 250, 300, 350 and 400 amperes. (240.6)~~

~~E3705.7 Location of overcurrent devices in or on premises.~~

~~Overcurrent devices shall:~~

1. ~~Be readily accessible. [240.24(A)]~~
2. ~~Not be located where they will be exposed to physical damage. [240.24(C)]~~
3. ~~Not be located where they will be in the vicinity of easily ignitible material such as in clothes closets. [240.24(D)]~~
4. ~~Not be located in bathrooms. [240.24(E)]~~
5. ~~Not be located over steps of a stairway.~~
6. ~~Be installed so that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, is not more than 6 feet 7 inches (2007 mm) above the floor or working platform. [240.24(A)]~~

~~Exceptions:~~

1. ~~This section shall not apply to supplementary overcurrent protection that is integral to utilization equipment. [240.24(A)(2)]~~
2. ~~Overcurrent devices installed adjacent to the utilization equipment that they supply shall be permitted to be accessible by portable means. [240.24(A)(4)]~~

~~E3705.8 Ready access for occupants.~~

~~Each occupant shall have ready access to all overcurrent devices protecting the conductors supplying that occupancy. [240.24(B)]~~

~~E3705.9 Enclosures for overcurrent devices.~~

~~Overcurrent devices shall be enclosed in cabinets, cutout boxes, or equipment assemblies. The operating handle of a circuit breaker shall be permitted to be accessible without opening a door or cover. [240.30(A) and (B)]~~

~~SECTION E3706~~
~~PANELBOARDS~~

~~E3706.1 Panelboard rating.~~

~~All panelboards shall have a rating not less than that of the minimum service or feeder capacity required for the calculated load. (408.30)~~

~~E3706.2 Panelboard circuit identification.~~

~~All circuits and circuit modifications shall be legibly identified as to their clear, evident, and specific purpose or use. The identification shall include an approved degree of detail that allows each circuit to be distinguished from all others. Spare positions that contain unused overcurrent devices or switches shall be described accordingly. The identification shall be included in a circuit directory located on the face of the panelboard enclosure or inside the panel door. Circuits shall not be described in a manner that depends on transient conditions of occupancy. [408.4(A)]~~

~~E3706.3 Panelboard overcurrent protection.~~

~~In addition to the requirement of Section E3706.1, a panelboard shall be protected by an overcurrent protective device having a rating not greater than that of the panelboard. Such overcurrent protective device shall be located within or at any point on the supply side of the panelboard. (408.36)~~

~~E3706.4 Grounded conductor terminations.~~

~~Each grounded conductor shall terminate within the panelboard on an individual terminal that is not also used for another conductor, except that grounded conductors of circuits with parallel conductors shall be permitted to terminate on a single terminal where the terminal is identified for connection of more than one conductor. (408.41 and 408.41 Exception)~~

~~E3706.5 Back-fed devices.~~

~~Plug-in-type overcurrent protection devices or plug-in-type main lug assemblies that are back-fed and used to terminate field-installed ungrounded supply conductors shall be secured in place by an additional fastener that requires other than a pull to release the device from the mounting means on the panel. [408.36(D)]~~

CHAPTER 38

WIRING METHODS

Deleted. See the *North Carolina Electrical Code.*

~~SECTION E3801~~
~~GENERAL REQUIREMENTS~~

~~E3801.1 Scope.~~
~~This chapter covers the wiring methods for services, feeders and branch circuits for electrical power and distribution. (300.1)~~

~~E3801.2 Allowable wiring methods.~~
~~The allowable wiring methods for electrical installations shall be those listed in Table E3801.2. Single conductors shall be used only where part of one of the recognized wiring methods listed in Table E3801.2. As used in this code, abbreviations of the wiring-method types shall be as indicated in Table E3801.2. [110.8, 300.3(A)]~~

~~TABLE E3801.2~~
~~ALLOWABLE WIRING METHODS~~

~~ALLOWABLE WIRING METHOD~~	**~~DESIGNATED ABBREVIATION~~**
~~Armored cable~~	~~AC~~
~~Electrical metallic tubing~~	~~EMT~~
~~Electrical nonmetallic tubing~~	~~ENT~~
~~Flexible metal conduit~~	~~FMC~~
~~Intermediate metal conduit~~	~~IMC~~
~~Liquidtight flexible conduit~~	~~LFC~~
~~Metal-clad cable~~	~~MC~~
~~Nonmetallic sheathed cable~~	~~NM~~
~~Rigid polyvinyl chloride conduit (Type PVC)~~	~~RNC~~
~~Rigid metallic conduit~~	~~RMC~~
~~Service entrance cable~~	~~SE~~
~~Surface raceways~~	~~SR~~
~~Underground feeder cable~~	~~UF~~
~~Underground service cable~~	~~USE~~

~~E3801.3 Circuit conductors.~~
~~All conductors of a circuit, including equipment grounding conductors and bonding conductors, shall be contained in the same raceway, trench, cable or cord. [300.3(B)]~~

~~E3801.4 Wiring method applications.~~
~~Wiring methods shall be applied in accordance with Table E3801.4. (Chapter 3 and 300.2)~~

~~TABLE E3801.4 (Chapter 3 and 300.2)~~
~~ALLOWABLE APPLICATIONS FOR WIRING METHODS~~~~$^{a, b, c, d, e, f, g, h, i, j, k}$~~

~~ALLOWABLE APPLICATIONS (application allowed where marked with an "A")~~	~~AC~~	~~EMT~~	~~ENT~~	~~FMC~~	~~IMC RMC RNC~~	~~LFC[a, g]~~	~~MC~~	~~NM~~	~~SR~~	~~SE~~	~~UF~~	~~USE~~
~~Services~~	—	~~A~~	~~A[h]~~	~~A[i]~~	~~A~~	~~A[i]~~	~~A~~	—	—	~~A~~	—	~~A~~
~~Feeders~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	—	~~A[b]~~	~~A~~	~~A[b]~~
~~Branch circuits~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A[c]~~	~~A~~	—
~~Inside a building~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	—
~~Wet locations exposed to sunlight~~	—	~~A~~	~~A[h]~~	—	~~A~~	~~A~~	~~A~~	—	—	~~A~~	~~A[e]~~	~~A[e]~~
~~Damp locations~~	—	~~A~~	~~A~~	~~A[d]~~	~~A~~	~~A~~	~~A~~	—	—	~~A~~	~~A~~	~~A~~
~~Embedded in noncinder concrete in dry location~~	—	~~A~~	~~A~~	—	~~A~~	~~A[j]~~	—	—	—	—	—	—
~~In noncinder concrete in contact with grade~~	—	~~A[f]~~	~~A~~	—	~~A[f]~~	~~A[j]~~	—	—	—	—	—	—
~~Embedded in plaster not exposed to dampness~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	—	—	~~A~~	~~A~~	—
~~Embedded in masonry~~	—	~~A~~	~~A~~	—	~~A[f]~~	~~A~~	~~A~~	—	—	—	—	—
~~In masonry voids and cells exposed to dampness or below grade line~~	—	~~A[f]~~	~~A~~	~~A[d]~~	~~A[f]~~	~~A~~	~~A~~	—	—	~~A~~	~~A~~	—
~~Fished in masonry voids~~	~~A~~	—	—	~~A~~	—	~~A~~	~~A~~	~~A~~	—	~~A~~	~~A~~	—
~~In masonry voids and cells not exposed to dampness~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	—	~~A~~	~~A~~	—
~~Run exposed~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	—
~~Run exposed and subject to physical damage~~	—	—	—	—	~~A[g]~~	—	—	—	—	—	—	—
~~For direct burial~~	—	~~A[f]~~	—	—	~~A[f]~~	~~A~~	~~A[f]~~	—	—	—	~~A~~	~~A~~

~~For SI: 1 foot = 304.8 mm.~~

~~a. Liquid-tight flexible nonmetallic conduit without integral reinforcement within the conduit wall shall not exceed 6 feet in length.~~

~~b. Type USE cable shall not be used inside buildings.~~

~~c. The grounded conductor shall be insulated.~~

~~d. Conductors shall be a type approved for wet locations and the installation shall prevent water from entering other raceways.~~

~~e. Shall be listed as "Sunlight Resistant."~~

~~f. Metal raceways shall be protected from corrosion and approved for the application. Aluminum RMC requires approved supplementary corrosion protection.~~

~~g. RNC shall be Schedule 80.~~

~~h. Shall be listed as "Sunlight Resistant" where exposed to the direct rays of the sun.~~

~~i. Conduit shall not exceed 6 feet in length.~~

~~j. Liquid-tight flexible nonmetallic conduit is permitted to be encased in concrete where listed for direct burial and only straight connectors listed for use with LFNC are used.~~

~~k. In wet locations under any of the following conditions:~~

~~1. The metallic covering is impervious to moisture.~~

~~2. A lead sheath or moisture-impervious jacket is provided under the metal covering.~~

~~3. The insulated conductors under the metallic covering are listed for use in wet locations and a corrosion-resistant jacket is provided over the metallic sheath.~~

~~SECTION E3802~~
~~ABOVE-GROUND INSTALLATION REQUIREMENTS~~

~~E3802.1 Installation and support requirements.~~
~~Wiring methods shall be installed and supported in accordance with Table E3802.1. (Chapter 3 and 300.11)~~

~~TABLE E3802.1 (Chapter 3)~~
~~GENERAL INSTALLATION AND SUPPORT REQUIREMENTS FOR WIRING METHODS~~ [~~a, b, c, d, e, f, g, h, i, j, k~~]

~~INSTALLATION REQUIREMENTS (Requirement applicable only to wiring methods marked "A")~~	**~~AC~~ ~~MC~~**	**~~EMT~~ ~~IMC~~ ~~RMC~~**	**~~ENT~~**	**~~FMC~~ ~~LFC~~**	**~~NM~~ ~~UF~~**	**~~RNC~~**	**~~SE~~**	**~~SR~~ [~~a~~]**	**~~USE~~**
~~Where run parallel with the framing member or furring strip, the wiring shall be not less than $1\frac{1}{4}$ inches from the edge of a furring strip or a framing member such as a joist, rafter or stud or shall be physically protected.~~	~~A~~	—	~~A~~	~~A~~	~~A~~	—	~~A~~	—	—
~~Bored holes in framing members for wiring shall be located not less than $1\frac{1}{4}$ inches from the edge of the framing member or shall be protected with a minimum 0.0625-inch steel plate or sleeve, a listed steel plate or other physical protection.~~	~~A^{k}~~	—	~~A^{k}~~	~~A^{k}~~	~~A^{k}~~	—	~~A^{k}~~	—	—
~~Where installed in grooves, to be covered by wallboard, siding, paneling, carpeting, or similar finish, wiring methods shall be protected by 0.0625-inch-thick steel plate, sleeve, or equivalent, a listed steel plate or by not less than $1\frac{1}{4}$-inch free space for the full length of the groove in which the cable or raceway is installed.~~	~~A~~	—	~~A~~	~~A~~	~~A~~	—	~~A~~	~~A~~	~~A~~
~~Securely fastened bushings or grommets shall be provided to protect wiring run through openings in metal framing members.~~	—	—	~~A^{j}~~	—	~~A^{j}~~	—	~~A^{j}~~	—	—
~~The maximum number of 90-degree bends shall not exceed four between junction boxes.~~	—	~~A~~	~~A~~	~~A~~	—	~~A~~	—	—	—
~~Bushings shall be provided where entering a box, fitting or enclosure unless the box or fitting is designed to afford equivalent protection.~~	~~A~~	~~A~~	~~A~~	~~A~~	—	~~A~~	—	~~A~~	—
~~Ends of raceways shall be reamed to remove rough edges.~~	—	~~A~~	~~A~~	~~A~~	—	~~A~~	—	~~A~~	—

~~Maximum allowable on center support spacing for the wiring method in feet.~~	~~4.5[b, c]~~	~~10[l]~~	~~3[b]~~	~~4.5[b]~~	~~4.5[i]~~	~~3[d, l]~~	~~2.5[e]~~	—	~~2.5~~
~~Maximum support distance in inches from box or other terminations.~~	~~12[b, f]~~	~~36~~	~~36~~	~~12[b, g]~~	~~12[h, i]~~	~~36~~	~~12~~	—	—

~~For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad.~~

~~a. Installed in accordance with listing requirements.~~

~~b. Supports not required in accessible ceiling spaces between light fixtures where lengths do not exceed 6 feet.~~

~~c. Six feet for MC cable.~~

~~d. Five feet for trade sizes greater than 1 inch.~~

~~e. Two and one-half feet where used for service or outdoor feeder and 4.5 feet where used for branch circuit or indoor feeder.~~

~~f. Twenty-four inches for Type AC cable and thirty-six inches for interlocking Type MC cable where flexibility is necessary.~~

~~g. Where flexibility after installation is necessary, lengths of flexible metal conduit and liquidtight flexible metal conduit measured from the last point where the raceway is securely fastened shall not exceed: 36 inches for trade sizes $\frac{1}{2}$ through 1$\frac{1}{4}$, 48 inches for trade sizes 1$\frac{1}{2}$ through 2 and 5 feet for trade sizes 2$\frac{1}{2}$ and larger.~~

~~h. Within 8 inches of boxes without cable clamps.~~

~~i. Flat cables shall not be stapled on edge.~~

~~j. Bushings and grommets shall remain in place and shall be listed for the purpose of cable protection.~~

~~k. See Sections R502.8 and R802.7 for additional limitations on the location of bored holes in horizontal framing members.~~

~~E3802.2 Cables in accessible attics.~~

~~Cables in attics or roof spaces provided with access shall be installed as specified in Sections E3802.2.1 and E3802.2.2. (320.3 and 334.23)~~

~~E3802.2.1 Across structural members.~~

~~Where run across the top of floor joists, or run within 7 feet (2134 mm) of floor or floor joists across the face of rafters or studding, in attics and roof spaces that are provided with access, the cable shall be protected by substantial guard strips that are at least as high as the cable. Where such spaces are not provided with access by permanent stairs or ladders, protection shall only be required within 6 feet (1829 mm) of the nearest edge of the attic entrance. [330.23(A) and 334.23]~~

~~E3802.2.2 Cable installed through or parallel to framing members.~~

~~Where cables are installed through or parallel to the sides of rafters, studs or floor joists, guard strips and running boards shall not be required, and the installation shall comply with Table E3802.1. [330.23(B) and 334.23]~~

~~E3802.3 Exposed cable.~~

~~In exposed work, except as provided for in Sections E3802.2 and E3802.4, cable assemblies shall be installed as specified in Sections E3802.3.1 and E3802.3.2. (330.15 and 334.15)~~

~~E3802.3.1 Surface installation.~~

~~Cables shall closely follow the surface of the building finish or running boards. [334.15(A)]~~

~~E3802.3.2 Protection from physical damage.~~

~~Where subject to physical damage, cables shall be protected by rigid metal conduit, intermediate metal conduit, electrical metallic tubing, Schedule 80 PVC rigid nonmetallic conduit, or other approved means. Where passing through a floor, the cable shall be enclosed in rigid metal conduit, intermediate metal conduit, electrical metallic tubing, Schedule 80 PVC rigid nonmetallic conduit or other approved means extending not less than 6 inches (152 mm) above the floor. [334.15(B)]~~

~~E3802.3.3 Locations exposed to direct sunlight.~~

~~Insulated conductors and cables used where exposed to direct rays of the sun shall be listed or listed and marked, as being “sunlight resistant,” or shall be covered with insulating material, such as tape or sleeving, that is listed or listed and marked as being “sunlight resistant.” [310.10(D)]~~

~~E3802.4 In unfinished basements and crawl spaces.~~

~~Where type NM or SE cable is run at angles with joists in unfinished basements and crawl spaces, cable assemblies containing two or more conductors of sizes 6 AWG and larger and assemblies containing three or more conductors of sizes 8 AWG and larger shall not require additional protection where attached directly to the bottom of the joists. Smaller cables shall be run either through bored holes in joists or on running boards. Type NM or SE cable installed on the wall of an unfinished basement shall be permitted to be installed in a listed conduit or tubing or shall be protected in accordance with Table E3802.1. Conduit or tubing shall be provided with a suitable insulating bushing or adapter at the point where the cable enters the raceway. The sheath of the Type NM or SE cable shall extend through the conduit or tubing and into the outlet or device box not less than $^{1}/_{4}$ inch (6.4 mm). The cable shall be secured within 12 inches (305 mm) of the point where the cable enters the conduit or tubing. Metal conduit, tubing, and metal outlet boxes shall be connected to an equipment grounding conductor complying with Section E3908.13. [334.15(C)]~~

~~E3802.5 Bends.~~

~~Bends shall be made so as not to damage the wiring method or reduce the internal diameter of raceways.~~

~~For types NM and SE cable, bends shall be so made, and other handling shall be such that the cable will not be damaged and the radius of the curve of the inner edge of any bend shall be not less than five times the diameter of the cable. (334.24 and 338.24)~~

~~E3802.6 Raceways exposed to different temperatures.~~

~~Where portions of a raceway or sleeve are known to be subjected to different temperatures and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway or sleeve shall be filled with an approved material to prevent the circulation of warm air to a colder section of the raceway or sleeve. [300.7(A)]~~

~~E3802.7 Raceways in wet locations above grade.~~

~~Where raceways are installed in wet locations above grade, the interior of such raceways shall be considered to be a wet location. Insulated conductors and cables installed in raceways in wet locations above grade shall be listed for use in wet locations. (300.9)~~

~~SECTION E3803~~
~~UNDERGROUND INSTALLATION REQUIREMENTS~~

~~E3803.1 Minimum cover requirements.~~
~~Direct buried cable or raceways shall be installed in accordance with the minimum cover requirements of Table E3803.1. [300.5(A)]~~

~~TABLE E3803.1 (Table 300.5)~~
~~MINIMUM COVER REQUIREMENTS, BURIAL IN INCHES~~[a, b, c, d, e]

~~LOCATION OF WIRING METHOD OR CIRCUIT~~	**~~TYPE OF WIRING METHOD OR CIRCUIT~~**				
	~~1 Direct burial cables or conductors~~	**~~2 Rigid metal conduit or intermediate metal conduit~~**	**~~3 Nonmetallic raceways listed for direct burial without concrete encasement or other approved raceways~~**	**~~4 Residential branch circuits rated 120 volts or less with GFCI protection and maximum overcurrent protection of 20 amperes~~**	**~~5 Circuits for control of irrigation and landscape lighting limited to not more than 30 volts and installed with type UF or in other identified cable or raceway~~**
~~All locations not specified below~~	~~24~~	~~6~~	~~18~~	~~12~~	~~6~~
~~In trench below 2-inch-thick concrete or equivalent~~	~~18~~	~~6~~	~~12~~	~~6~~	~~6~~
~~Under a building~~	~~0 (In raceway only or Type MC identified for direct burial)~~	~~0~~	~~0~~	~~0 (In raceway only or Type MC identified for direct burial)~~	~~0 (In raceway only or Type MC identified for direct burial)~~
~~Under minimum of 4-inch-thick concrete exterior slab with no vehicular traffic and the slab extending not less than 6 inches beyond the underground installation~~	~~18~~	~~4~~	~~4~~	~~6 (Direct burial)~~ ~~4 (In raceway)~~	~~6 (Direct burial)~~ ~~4 (In raceway)~~

~~Under streets, highways, roads, alleys, driveways and parking lots~~	~~24~~	~~24~~	~~24~~	~~24~~	~~24~~
~~One- and two-family dwelling driveways and outdoor parking areas, and used only for dwelling-related purposes~~	~~18~~	~~18~~	~~18~~	~~12~~	~~18~~
~~In solid rock where covered by minimum of 2 inches concrete extending down to rock~~	~~2 (In raceway only)~~	~~2~~	~~2~~	~~2 (In raceway only)~~	~~2 (In raceway only)~~

~~For SI: 1 inch = 25.4 mm.~~

~~a. Raceways approved for burial only where encased concrete shall require concrete envelope not less than 2 inches thick.~~

~~b. Lesser depths shall be permitted where cables and conductors rise for terminations or splices or where access is otherwise required.~~

~~c. Where one of the wiring method types listed in columns 1 to 3 is combined with one of the circuit types in columns 4 and 5, the shallower depth of burial shall be permitted.~~

~~d. Where solid rock prevents compliance with the cover depths specified in this table, the wiring shall be installed in metal or nonmetallic raceway permitted for direct burial. The raceways shall be covered by a minimum of 2 inches of concrete extending down to the rock.~~

~~e. Cover is defined as the shortest distance in inches (millimeters) measured between a point on the top surface of any direct-buried conductor, cable, conduit or other raceway and the top surface of finished grade, concrete, or similar cover.~~

~~E3803.2 Warning ribbon.~~

~~Underground service conductors that are not encased in concrete and that are buried 18 inches (457 mm) or more below grade shall have their location identified by a warning ribbon that is placed in the trench not less than 12 inches (305 mm) above the underground installation. [300.5(D)(3)]~~

~~E3803.3 Protection from damage.~~

~~Direct buried conductors and cables emerging from the ground shall be protected by enclosures or raceways extending from the minimum cover distance below grade required by Section E3803.1 to a point at least 8 feet (2438 mm) above finished grade. In no case shall the protection be required to exceed 18 inches (457 mm) below finished grade. Conductors entering a building shall be protected to the point of entrance. Where the enclosure or raceway is subject to physical damage, the conductors shall be installed in rigid metal conduit, intermediate metal conduit, Schedule 80 rigid nonmetallic conduit or the equivalent. [300.5(D)(1)]~~

~~E3803.4 Splices and taps.~~

~~Direct buried conductors or cables shall be permitted to be spliced or tapped without the use of splice boxes. The splices or taps shall be made by approved methods with materials listed for the application. [300.5(E)]~~

~~E3803.5 Backfill.~~

~~Backfill containing large rock, paving materials, cinders, large or sharply angular substances, or corrosive material shall not be placed in an excavation where such materials cause damage to raceways, cables or other substructures or prevent adequate compaction of fill or contribute to corrosion of raceways, cables or other substructures. Where necessary to prevent physical damage to the raceway or cable, protection shall be provided in the form of granular or selected material, suitable boards, suitable sleeves or other approved means. [300.5(F)]~~

~~E3803.6 Raceway seals.~~

~~Conduits or raceways shall be sealed or plugged at either or both ends where moisture will enter and contact live parts. [300.5(G)]~~

~~E3803.7 Bushing.~~

~~A bushing, or terminal fitting, with an integral bushed opening shall be installed on the end of a conduit or other raceway that terminates underground where the conductors or cables emerge as a direct burial wiring method. A seal incorporating the physical protection characteristics of a bushing shall be considered equivalent to a bushing. [300.5(H)]~~

~~E3803.8 Single conductors.~~

~~All conductors of the same circuit and, where present, the grounded conductor and all equipment grounding conductors shall be installed in the same raceway or shall be installed in close proximity in the same trench. [300.5(I)]~~

> ~~**Exception:** Conductors shall be permitted to be installed in parallel in raceways, multiconductor cables, and direct-buried single conductor cables. Each raceway or multiconductor cable shall contain all conductors of the same circuit, including equipment grounding conductors. Each direct-buried single conductor cable shall be located in close proximity in the trench to the other single conductor cables in the same parallel set of conductors in the circuit, including equipment grounding conductors. [300.5(I) Exception No.1]~~

~~E3803.9 Earth movement.~~

~~Where direct buried conductors, raceways or cables are subject to movement by settlement or frost, direct buried conductors, raceways or cables shall be arranged to prevent damage to the enclosed conductors or to equipment connected to the raceways. [300.5(J)]~~

~~E3803.10 Wet locations.~~

~~The interior of enclosures or raceways installed underground shall be considered to be a wet location. Insulated conductors and cables installed in such enclosures or raceways in underground installations shall be listed for use in wet locations. Connections or splices in an underground installation shall be approved for wet locations. [300.5(B)]~~

~~E3803.11 Under buildings.~~

~~Underground cable and conductors installed under a building shall be in a raceway. [300.5(C)]~~

> ~~**Exception:** Type MC Cable shall be permitted under a building without installation in a raceway where the cable is listed and identified for direct burial or concrete encasement and one or more of the following applies:~~
>
> 1. ~~The metallic covering is impervious to moisture.~~

2. ~~A moisture-impervious jacket is provided under the metal covering.~~

3. ~~The insulated conductors under the metallic covering are listed for use in wet locations, and a corrosion-resistant jacket is provided over the metallic sheath. [300.5(C) Exception No.2]~~

CHAPTER 39

POWER AND LIGHTING DISTRIBUTION

Deleted. See the *North Carolina Electrical Code.*

~~SECTION E3901~~
~~RECEPTACLE OUTLETS~~

~~E3901.1 General.~~
~~Outlets for receptacles rated at 125 volts, 15-and 20-amperes shall be provided in accordance with Sections E3901.2 through E3901.11. Receptacle outlets required by this section shall be in addition to any receptacle that is:~~

1. ~~Part of a luminaire or appliance;~~

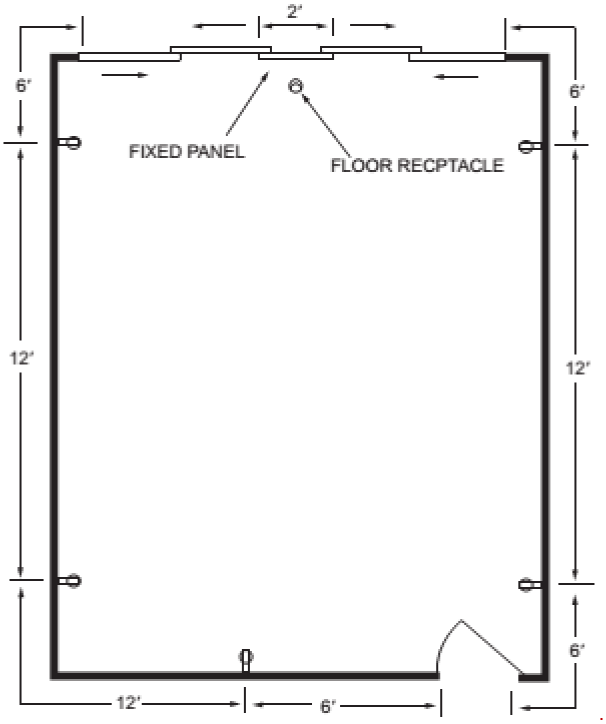
2. ~~Located within cabinets or cupboards;~~

3. ~~Controlled by a wall switch in accordance with Section E3903.2, Exception 1; or~~

4. ~~Located over 5.5 feet (1676 mm) above the floor.~~

~~Permanently installed electric baseboard heaters equipped with factory-installed receptacle outlets, or outlets provided as a separate assembly by the baseboard manufacturer shall be permitted as the required outlet or outlets for the wall space utilized by such permanently installed heaters. Such receptacle outlets shall not be connected to the heater circuits. (210.52)~~

~~E3901.2 General purpose receptacle distribution.~~
~~In every kitchen, family room, dining room, living room, parlor, library, den, sun room, bedroom, recreation room, or similar room or area of dwelling units, receptacle outlets shall be installed in accordance with the general provisions specified in Sections E3901.2.1 through E3901.2.3 (see Figure E3901.2).~~



~~For SI:1 foot = 304.8 mm.~~

~~FIGURE E3901.2~~
~~GENERAL USE RECEPTACLE DISTRIBUTION~~

~~E3901.2.1 Spacing.~~

~~Receptacles shall be installed so that no point measured horizontally along the floor line of any wall space is more than 6 feet (1829 mm), from a receptacle outlet. [210.52(A)(1)]~~

~~E3901.2.2 Wall space.~~

~~As used in this section, a wall space shall include the following: [210.52(A)(2)]~~

1. ~~Any space that is 2 feet (610 mm) or more in width, including space measured around corners, and that is unbroken along the floor line by doorways and similar openings, fireplaces, and fixed cabinets.~~
2. ~~The space occupied by fixed panels in exterior walls, excluding sliding panels.~~
3. ~~The space created by fixed room dividers such as railings and freestanding bar-type counters.~~

~~E3901.2.3 Floor receptacles.~~

~~Receptacle outlets in floors shall not be counted as part of the required number of receptacle outlets except where located within 18 inches (457 mm) of the wall. [210.52(A)(3)]~~

~~E3901.2.4 Countertop receptacles.~~

~~Receptacles installed for countertop surfaces as specified in Section E3901.4 shall not be considered as the receptacles required by Section E3901.2. [210.52(A)(4)]~~

~~E3901.3 Small appliance receptacles.~~

~~In the kitchen, pantry, breakfast room, dining room, or similar area of a dwelling unit, the two or more 20-ampere small-appliance branch circuits required by Section E3703.2, shall serve all wall and floor receptacle outlets covered by Sections E3901.2 and E3901.4 and those receptacle outlets provided for refrigeration appliances. [210.52(B)(1)]~~

~~Exceptions:~~

1. ~~In addition to the required receptacles specified by Sections E3901.1 and E3901.2, switched receptacles supplied from a general-purpose branch circuit as defined in Section E3903.2, Exception 1 shall be permitted. [210.52(B)(1) Exception No. 1]~~

2. ~~The receptacle outlet for refrigeration appliances shall be permitted to be supplied from an individual branch circuit rated at 15 amperes or greater. [210.52(B)(1) Exception No. 2]~~

~~E3901.3.1 Other outlets prohibited.~~

~~The two or more small-appliance branch circuits specified in Section E3901.3 shall serve no other outlets. [210.52(B)(2)]~~

~~Exceptions:~~

1. ~~A receptacle installed solely for the electrical supply to and support of an electric clock in any of the rooms specified in Section E3901.3. [210.52(B)(2) Exception No.1]~~

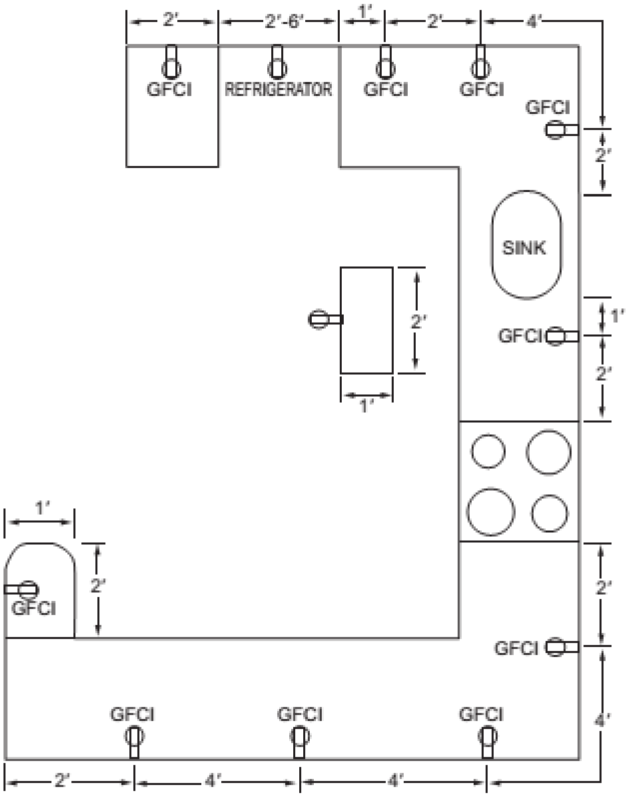
2. ~~Receptacles installed to provide power for supplemental equipment and lighting on gas-fired ranges, ovens, and counter-mounted cooking units. [210.52(B)(2) Exception No.2]~~

~~E3901.3.2 Limitations.~~

~~Receptacles installed in a kitchen to serve countertop surfaces shall be supplied by not less than two small-appliance branch circuits, either or both of which shall also be permitted to supply receptacle outlets in the same kitchen and in other rooms specified in Section E3901.3. Additional small-appliance branch circuits shall be permitted to supply receptacle outlets in the kitchen and other rooms specified in Section E3901.3. A small-appliance branch circuit shall not serve more than one kitchen. [210.52(B)(3)]~~

~~E3901.4 Countertop receptacles.~~

~~In kitchens pantries, breakfast rooms, dining rooms and similar areas of dwelling units, receptacle outlets for countertop spaces shall be installed in accordance with Sections E3901.4.1 through E3901.4.5 (see Figure E3901.4). [210.52(C)]~~

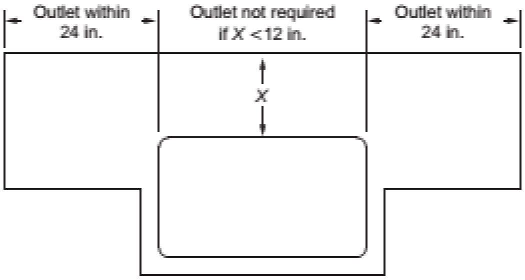


~~For SI:1 foot = 304.8 mm.~~

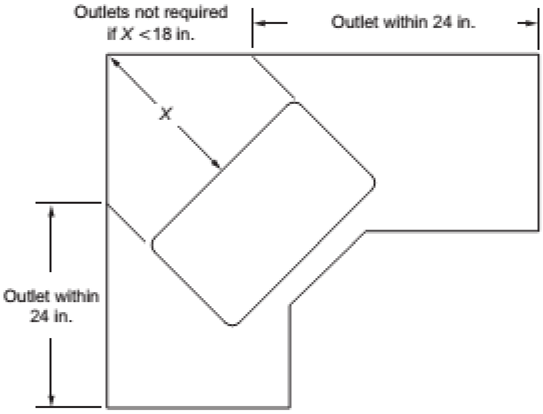
~~**FIGURE E3901.4**~~
~~**COUNTERTOP RECEPTACLES**~~

~~**E3901.4.1 Wall countertop space.**~~
~~A receptacle outlet shall be installed at each wall countertop space 12 inches (305 mm) or wider. Receptacle outlets shall be installed so that no point along the wall line is more than 24 inches (610 mm), measured horizontally from a receptacle outlet in that space. [210.52(C)(1)]~~

~~**Exception:** Receptacle outlets shall not be required on a wall directly behind a range, counter-mounted cooking unit or sink in the installation described in Figure E3901.4.1. [210.52(C)(1) Exception]~~



Sink, range or counter-mounted cooking unit extending from face of counter



Sink, range or counter-mounted cooking unit mounted in corner

~~For SI:1 inch = 25.4 mm.~~

~~FIGURE E3901.4.1~~
~~DETERMINATION OF AREA BEHIND SINK OR RANGE~~

~~E3901.4.2 Island countertop spaces.~~

~~At least one receptacle outlet shall be installed at each island countertop space with a long dimension of 24 inches (610 mm) or greater and a short dimension of 12 inches (305 mm) or greater. [210.52(C)(2)]~~

~~E3901.4.3 Peninsular countertop space.~~

~~At least one receptacle outlet shall be installed at each peninsular countertop space with a long dimension of 24 inches (610 mm) or greater and a short dimension of 12 inches (305 mm) or greater. A peninsular countertop is measured from the connecting edge. [210.52(C)(3)]~~

~~E3901.4.4 Separate spaces.~~

~~Countertop spaces separated by range tops, refrigerators, or sinks shall be considered as separate countertop spaces in applying the requirements of Sections E3901.4.1, E3901.4.2 and E3901.4.3. Where a range, counter-mounted cooking unit, or sink is installed in an island or peninsular countertop and the depth of the countertop behind the range, counter-mounted cooking unit, or sink is less than 12 inches (305 mm), the range, counter-mounted cooking unit, or sink has divided the countertop space into two separate countertop spaces as defined in Section E3901.4.4. Each separate countertop space shall comply with the applicable requirements of this section. [210.52(C)(4)]~~

~~E3901.4.5 Receptacle outlet location.~~
~~Receptacle outlets shall be located not more than 20 inches (508 mm) above the countertop. Receptacle outlet assemblies installed in countertops shall be listed for the application. Receptacle outlets shall not be installed in a face-up position in the work surfaces or countertops. Receptacle outlets rendered not readily accessible by appliances fastened in place, appliance garages, sinks or rangetops as addressed in the exception to Section E3901.4.1, or appliances occupying dedicated space shall not be considered as these required outlets. [210.52(C)(5)]~~

> **~~Exception:~~** ~~Receptacle outlets shall be permitted to be mounted not more than 12 inches (305 mm) below the countertop in construction designed for the physically impaired and for island and peninsular countertops where the countertop is flat across its entire surface and there are no means to mount a receptacle within 20 inches (508 mm) above the countertop, such as in an overhead cabinet. Receptacles mounted below the countertop in accordance with this exception shall not be located where the countertop extends more than 6 inches (152 mm) beyond its support base. [210.52(C)(5) Exception]~~

~~E3901.5 Appliance receptacle outlets.~~
~~Appliance receptacle outlets installed for specific appliances, such as laundry equipment, shall be installed within 6 feet (1829 mm) of the intended location of the appliance. (210.50(C)]~~

~~E3901.6 Bathroom.~~
~~At least one wall receptacle outlet shall be installed in bathrooms and such outlet shall be located within 36 inches (914 mm) of the outside edge of each lavatory basin. The receptacle outlet shall be located on a wall or partition that is adjacent to the lavatory basin location, located on the countertop, or installed on the side or face of the basin cabinet. The receptacle shall be located not more than 12 inches (305 mm) below the top of the basin.~~

~~Receptacle outlets shall not be installed in a face-up position in the work surfaces or countertops in a bathroom basin location. Receptacle outlet assemblies installed in countertops shall be listed for the application. [210.52(D)]~~

~~E3901.7 Outdoor outlets.~~
~~Not less than one receptacle outlet that is readily accessible from grade level and located not more than 6 feet, 6 inches (1981 mm) above grade, shall be installed outdoors at the front and back of each dwelling unit having direct access to grade level. Balconies, decks, and porches that are accessible from inside of the dwelling unit shall have at least one receptacle outlet installed within the perimeter of the balcony, deck, or porch. The receptacle shall be located not more than 6 feet, 6 inches (1981 mm) above the balcony, deck, or porch surface. [210.52(E)]~~

~~E3901.8 Laundry areas.~~
~~Not less than one receptacle outlet shall be installed in areas designated for the installation of laundry equipment.~~

~~E3901.9 Basements, garages and accessory buildings.~~
~~Not less than one receptacle outlet, in addition to any provided for specific equipment, shall be installed in each separate unfinished portion of a basement, in each attached garage, and in each detached garage or accessory building that is provided with electrical power. The branch circuit supplying the receptacle(s) in a garage shall not supply outlets outside of the garage and~~

~~not less than one receptacle outlet shall be installed for each motor vehicle space. [210.52(G)(1),(2), and (3)]~~

~~E3901.10 Hallways.~~

~~Hallways of 10 feet (3048 mm) or more in length shall have at least one receptacle outlet. The hall length shall be considered the length measured along the centerline of the hall without passing through a doorway. [210.52(H)]~~

~~E3901.11 Foyers.~~

~~Foyers that are not part of a hallway in accordance with Section E3901.10 and that have an area that is greater than 60 ft^2 (5.57 m^2) shall have a receptacle(s) located in each wall space that is 3 feet (914 mm) or more in width. Doorways, door-side windows that extend to the floor, and similar openings shall not be considered as wall space. [210.52(H)]~~

~~E3901.12 HVAC outlet.~~

~~A 125-volt, single-phase, 15-or 20-ampere-rated receptacle outlet shall be installed at an accessible location for the servicing of heating, air-conditioning and refrigeration equipment. The receptacle shall be located on the same level and within 25 feet (7620 mm) of the heating, air-conditioning and refrigeration equipment. The receptacle outlet shall not be connected to the load side of the HVAC equipment disconnecting means. (210.63)~~

> **~~Exception:~~** ~~A receptacle outlet shall not be required for the servicing of evaporative coolers. (210.63 Exception)~~

~~SECTION E3902~~

~~GROUND-FAULT AND ARC-FAULT CIRCUIT-INTERRUPTER PROTECTION~~

~~E3902.1 Bathroom receptacles.~~

~~125-volt, single-phase, 15-and 20-ampere receptacles installed in bathrooms shall have ground-fault circuit-interrupter protection for personnel. [210.8(A)(1)]~~

~~E3902.2 Garage and accessory building receptacles.~~

~~125-volt, single-phase, 15- or 20-ampere receptacles installed in garages and grade-level portions of unfinished accessory buildings used for storage or work areas shall have ground-fault circuit-interrupter protection for personnel. [210.8(A)(2)]~~

~~E3902.3 Outdoor receptacles.~~

~~125-volt, single-phase, 15-and 20-ampere receptacles installed outdoors shall have ground-fault circuit-interrupter protection for personnel. [210.8(A)(3)]~~

> **~~Exception:~~** ~~Receptacles as covered in Section E4101.7. [210.8(A)(3) Exception]~~

~~E3902.4 Crawl space receptacles.~~

~~Where a crawl space is at or below grade level, 125-volt, single-phase, 15- and 20-ampere receptacles installed in such spaces shall have ground-fault circuit-interrupter protection for personnel. [210.8(A)(4)]~~

~~E3902.5 Unfinished basement receptacles.~~

~~125-volt, single-phase, 15- and 20-ampere receptacles installed in unfinished basements shall~~

~~have ground-fault circuit-interrupter protection for personnel. For purposes of this section, unfinished basements are defined as portions or areas of the basement not intended as habitable rooms and limited to storage areas, work areas, and similar areas. [210.8(A)(5)]~~

> ~~**Exception:** A receptacle supplying only a permanently installed fire alarm or burglar alarm system. Receptacles installed in accordance with this exception shall not be considered as meeting the requirement of Section E3901.9. [210.8(A)(5) Exception]~~

~~E3902.6 Kitchen receptacles.~~

~~125-volt, single-phase, 15- and 20-ampere receptacles that serve countertop surfaces shall have ground-fault circuit-interrupter protection for personnel. [210.8(A)(6)]~~

~~E3902.7 Sink receptacles.~~

~~125-volt, single-phase, 15- and 20-ampere receptacles that are located within 6 feet (1829 mm) of the outside edge of a sink shall have ground-fault circuit-interrupter protection for personnel. Receptacle outlets shall not be installed in a face-up position in the work surfaces or countertops. [210.8(A)(7)]~~

~~E3902.8 Bathtub or shower stall receptacles.~~

~~125-volt, single phase, 15- and 20-ampere receptacles that are located within 6 feet (1829 mm) of the outside edge of a bathtub or shower stall shall have ground-fault circuit interrupter protection for personnel. [210.8(A)(8)]~~

~~E3902.9 Laundry areas.~~

~~125-volt, single-phase, 15- and 20-ampere receptacles installed in laundry areas shall have ground fault circuit interrupter protection for personnel. [210.8(A)(9)]~~

~~E3902.10 Kitchen dishwasher branch circuit.~~

~~Ground-fault circuit-interrupter protection shall be provided for outlets that supply dishwashers in dwelling unit locations. [210.8(D)]~~

~~E3902.11 Boathouse receptacles.~~

~~125-volt, single-phase, 15- or 20-ampere receptacles installed in boathouses shall have ground-fault circuit-interrupter protection for personnel. [210.8(A)(8)]~~

~~E3902.12 Boat hoists.~~

~~Ground-fault circuit-interrupter protection for personnel shall be provided for 240-volt and less outlets that supply boat hoists. [210.8(C)]~~

~~E3902.13 Electrically heated floors.~~

~~Ground-fault circuit-interrupter protection for personnel shall be provided for electrically heated floors in bathrooms, kitchens and in hydromassage bathtub, spa and hot tub locations. [424.44(G)]~~

~~E3902.14 Location of ground-fault circuit interrupters.~~

~~Ground-fault circuit interrupters shall be installed in a readily accessible location. [210.8(A)]~~

~~E3902.15 Location of arc-fault circuit interrupters.~~

~~Arc-fault circuit interrupters shall be installed in readily accessible locations.~~

~~E3902.16 Arc-fault circuit-interrupter protection.~~

~~Branch circuits that supply 120-volt, single-phase, 15- and 20-ampere outlets installed in kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreations rooms, closets, hallways, laundry areas and similar rooms or areas shall be protected by any of the following: [210.12(A)]~~

1. ~~A listed combination-type arc-fault circuit interrupter, installed to provide protection of the entire branch circuit. [210.12(A)(1)]~~

2. ~~A listed branch/feeder-type AFCI installed at the origin of the branch-circuit in combination with a listed outlet branch-circuit type arc-fault circuit interrupter installed at the first outlet box on the branch circuit. The first outlet box in the branch circuit shall be marked to indicate that it is the first outlet of the circuit. [210.12(A)(2)]~~

3. ~~A listed supplemental arc protection circuit breaker installed at the origin of the branch circuit in combination with a listed outlet branch-circuit type arc-fault circuit interrupter installed at the first outlet box on the branch circuit where all of the following conditions are met:~~

    ~~3.1. The branch-circuit wiring shall be continuous from the branch-circuit overcurrent device to the outlet branch-circuit arc-fault circuit interrupter.~~

    ~~3.2. The maximum length of the branch-circuit wiring from the branch-circuit overcurrent device to the first outlet shall not exceed 50 feet (15.2 m) for 14 AWG conductors and 70 feet (21.3 m) for 12 AWG conductors.~~

    ~~3.3. The first outlet box on the branch circuit shall be marked to indicate that it is the first outlet on the circuit. [210.12(A)(3)]~~

4. ~~A listed outlet branch-circuit type arc-fault circuit interrupter installed at the first outlet on the branch circuit in combination with a listed branch-circuit overcurrent protective device where all of the following conditions are met:~~

    ~~4.1. The branch-circuit wiring shall be continuous from the branch-circuit overcurrent device to the outlet branch-circuit arc-fault circuit interrupter.~~

    ~~4.2. The maximum length of the branch-circuit wiring from the branch-circuit overcurrent device to the first outlet shall not exceed 50 feet (15.2 m) for 14 AWG conductors and 70 feet (21.3 m) for 12 AWG conductors.~~

    ~~4.3. The first outlet box on the branch circuit shall be marked to indicate that it is the first outlet on the circuit.~~

    ~~4.4. The combination of the branch-circuit overcurrent device and outlet branch-circuit AFCI shall be identified as meeting the requirements for a system combination-type AFCI and shall be listed as such. [210.12(A)(4)]~~

5. ~~Where metal outlet boxes and junction boxes and RMC, IMC, EMT, Type MC or steel-armored Type AC cables meeting the requirements of Section E3908.8, metal wireways or metal auxiliary gutters are installed for the portion of the branch circuit between the~~

~~branch-circuit overcurrent device and the first outlet, a listed outlet branch-circuit type AFCI installed at the first outlet shall be considered as providing protection for the remaining portion of the branch circuit. [210.12(A)(5)]~~

6. ~~Where a listed metal or nonmetallic conduit or tubing or Type MC cable is encased in not less than 2 inches (50.8 mm) of concrete for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet, a listed outlet branch-circuit type AFCI installed at the first outlet shall be considered as providing protection for the remaining portion of the branch circuit. [210.12(A)(6)]~~

    ~~**Exception:** AFCI protection is not required for an individual branch circuit supplying only a fire alarm system where the branch circuit is wired with metal outlet and junction boxes and RMC, IMC, EMT or steel-sheathed armored cable Type AC or Type MC meeting the requirements of Section E3908.8.~~

~~**E3902.17 Arc-fault circuit interrupter protection for branch circuit extensions or modifications.**~~

~~Where branch-circuit wiring is modified, replaced, or extended in any of the areas specified in Section E3902.16, the branch circuit shall be protected by one of the following:~~

1. ~~A combination-type AFCI located at the origin of the branch circuit~~
2. ~~An outlet branch-circuit type AFCI located at the first receptacle outlet of the existing branch circuit. [210.12(B)]~~

~~**Exception:** AFCI protection shall not be required where the extension of the existing conductors is not more than 6 feet (1.8 m) in length and does not include any additional outlets or devices. [210.12(B) Exception]~~

~~SECTION E3903~~
~~LIGHTING OUTLETS~~

~~**E3903.1 General.**~~

~~Lighting outlets shall be provided in accordance with Sections E3903.2 through E3903.4. [210.70(A)]~~

~~**E3903.2 Habitable rooms.**~~

~~At least one wall switch-controlled lighting outlet shall be installed in every habitable room and bathroom. [210.70(A)(1)]~~

~~**Exceptions:**~~

1. ~~In other than kitchens and bathrooms, one or more receptacles controlled by a wall switch shall be considered equivalent to the required lighting outlet. [210.70(A)(1) Exception No. 1]~~
2. ~~Lighting outlets shall be permitted to be controlled by occupancy sensors that are in addition to wall switches, or that are located at a customary wall switch location and equipped with a manual override that will allow the sensor to function as a wall switch. [210.70(A)(1) Exception No. 2]~~

~~E3903.3 Additional locations.~~
~~At least one wall-switch-controlled lighting outlet shall be installed in hallways, stairways, attached garages, and detached garages with electric power. At least one wall-switch-controlled lighting outlet shall be installed to provide illumination on the exterior side of each outdoor egress door having grade level access, including outdoor egress doors for attached garages and detached garages with electric power. A vehicle door in a garage shall not be considered as an outdoor egress door. Where one or more lighting outlets are installed for interior stairways, there shall be a wall switch at each floor level and landing level that includes an entryway to control the lighting outlets where the stairway between floor levels has six or more risers. [210.70(A)(2)]~~

> **~~Exception:~~** ~~In hallways, stairways, and at outdoor egress doors, remote, central, or automatic control of lighting shall be permitted. [210.70(A)(2) Exception]~~

~~E3903.4 Storage or equipment spaces.~~
~~In attics, under-floor spaces, utility rooms and basements, at least one lighting outlet shall be installed where these spaces are used for storage or contain equipment requiring servicing. Such lighting outlet shall be controlled by a wall switch or shall have an integral switch. At least one point of control shall be at the usual point of entry to these spaces. The lighting outlet shall be provided at or near the equipment requiring servicing. [210.70(A)(3)]~~

~~SECTION E3904~~
~~GENERAL INSTALLATION REQUIREMENTS~~

~~E3904.1 Electrical continuity of metal raceways and enclosures.~~
~~Metal raceways, cable armor and other metal enclosures for conductors shall be mechanically joined together into a continuous electric conductor and shall be connected to all boxes, fittings and cabinets so as to provide effective electrical continuity. Raceways and cable assemblies shall be mechanically secured to boxes, fittings cabinets and other enclosures. (300.10)~~

> **~~Exception:~~** ~~Short sections of raceway used to provide cable assemblies with support or protection against physical damage. (300.10 Exception No.1)~~

~~E3904.2 Mechanical continuity—raceways and cables.~~
~~Metal or nonmetallic raceways, cable armors and cable sheaths shall be continuous between cabinets, boxes, fittings or other enclosures or outlets.~~

> **~~Exception:~~** ~~Short sections of raceway used to provide cable assemblies with support or protection against physical damage. (300.12 Exception No. 1)~~

~~E3904.3 Securing and supporting.~~
~~Raceways, cable assemblies, boxes, cabinets and fittings shall be securely fastened in place. (300.11)~~

> **~~E3904.3.1 Prohibited means of support.~~**
> ~~Cable wiring methods shall not be used as a means of support for other cables, raceways and nonelectrical equipment. [300.11(C)]~~

~~E3904.4 Raceways as means of support.~~

~~Raceways shall be used as a means of support for other raceways, cables or nonelectric equipment only under the following conditions:~~

1. ~~Where the raceway or means of support is identified as a means of support; or~~
2. ~~Where the raceway contains power supply conductors for electrically controlled equipment and is used to support Class 2 circuit conductors or cables that are solely for the purpose of connection to the control circuits of the equipment served by such raceway; or~~
3. ~~Where the raceway is used to support boxes or conduit bodies in accordance with Sections E3906.8.4 and E3906.8.5. [300.11(B)]~~

~~E3904.5 Raceway installations.~~

~~Raceways shall be installed complete between outlet, junction or splicing points prior to the installation of conductors. (300.18)~~

> ~~**Exception:** Short sections of raceways used to contain conductors or cable assemblies for protection from physical damage shall not be required to be installed complete between outlet, junction, or splicing points. (300.18 Exception)~~

~~E3904.6 Conduit and tubing fill.~~

~~The maximum number of conductors installed in conduit or tubing shall be in accordance with Tables E3904.6(1) through E3904.6(10). (300.17, Chapter 9, Table 1 and Annex C)~~

~~TABLE E3904.6(1)(Annex C, Table C.1)~~

~~MAXIMUM NUMBER OF CONDUCTORS IN ELECTRICAL METALLIC TUBING (EMT)~~[a]

~~TYPE LETTERS~~	~~CONDUCTOR SIZE AWG/kcmil~~	~~TRADE SIZES (inches)~~					
		~~1/2~~	~~3/4~~	~~1~~	~~1 1/4~~	~~1 1/2~~	~~2~~
~~RHH, RHW, RHW-2~~	~~14~~	~~4~~	~~7~~	~~11~~	~~20~~	~~27~~	~~46~~
	~~12~~	~~3~~	~~6~~	~~9~~	~~17~~	~~23~~	~~38~~
	~~10~~	~~2~~	~~5~~	~~8~~	~~13~~	~~18~~	~~30~~
	~~8~~	~~1~~	~~2~~	~~4~~	~~7~~	~~9~~	~~16~~
	~~6~~	~~1~~	~~1~~	~~3~~	~~5~~	~~8~~	~~13~~
	~~4~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~10~~
	~~3~~	~~1~~	~~1~~	~~1~~	~~4~~	~~5~~	~~9~~
	~~2~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~1~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~1/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~3/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
~~TW, THHW, THW, THW-2~~	~~14~~	~~8~~	~~15~~	~~25~~	~~43~~	~~58~~	~~96~~
	~~12~~	~~6~~	~~11~~	~~19~~	~~33~~	~~45~~	~~74~~
	~~10~~	~~5~~	~~8~~	~~14~~	~~24~~	~~33~~	~~55~~
	~~8~~	~~2~~	~~5~~	~~8~~	~~13~~	~~18~~	~~30~~

~~RHH[a], RHW[a], RHW-2[a]~~	~~14~~	~~6~~	~~10~~	~~16~~	~~28~~	~~39~~	~~64~~
	~~12~~	~~4~~	~~8~~	~~13~~	~~23~~	~~31~~	~~51~~
	~~10~~	~~3~~	~~6~~	~~10~~	~~18~~	~~24~~	~~40~~
	~~8~~	~~1~~	~~4~~	~~6~~	~~10~~	~~14~~	~~24~~
~~RHH[a], RHW[a], RHW-2[a], TW, THW, THHW, THW-2~~	~~6~~	~~1~~	~~3~~	~~4~~	~~8~~	~~11~~	~~18~~
	~~4~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~13~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~12~~
	~~2~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~10~~
	~~1~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~1/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
~~THHN, THWN, THWN-2~~	~~14~~	~~12~~	~~22~~	~~35~~	~~61~~	~~84~~	~~138~~
	~~12~~	~~9~~	~~16~~	~~26~~	~~45~~	~~61~~	~~101~~
	~~10~~	~~5~~	~~10~~	~~16~~	~~28~~	~~38~~	~~63~~
	~~8~~	~~3~~	~~6~~	~~9~~	~~16~~	~~22~~	~~36~~
	~~6~~	~~2~~	~~4~~	~~7~~	~~12~~	~~16~~	~~26~~
	~~4~~	~~1~~	~~2~~	~~4~~	~~7~~	~~10~~	~~16~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~13~~
	~~2~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~11~~
	~~1~~	~~1~~	~~1~~	~~1~~	~~4~~	~~5~~	~~8~~
	~~1/0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~4/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
~~XHH, XHHW, XHHW-2~~	~~14~~	~~8~~	~~15~~	~~25~~	~~43~~	~~58~~	~~96~~
	~~12~~	~~6~~	~~11~~	~~19~~	~~33~~	~~45~~	~~74~~
	~~10~~	~~5~~	~~8~~	~~14~~	~~24~~	~~33~~	~~55~~
	~~8~~	~~2~~	~~5~~	~~8~~	~~13~~	~~18~~	~~30~~
	~~6~~	~~1~~	~~3~~	~~6~~	~~10~~	~~14~~	~~22~~
	~~4~~	~~1~~	~~2~~	~~4~~	~~7~~	~~10~~	~~16~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~14~~
	~~2~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~11~~
	~~1~~	~~1~~	~~1~~	~~1~~	~~4~~	~~5~~	~~8~~
	~~1/0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~4/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~

~~For SI:1 inch = 25.4 mm.~~

~~a. Types RHW, and RHW-2 without outer covering.~~

~~TABLE E3904.6(2)(Annex C, Table C.2)~~

~~MAXIMUM NUMBER OF CONDUCTORS IN ELECTRICAL NONMETALLIC TUBING (ENT)[a]~~

~~TYPE LETTERS~~	~~CONDUCTOR SIZE AWG/kcmil~~	~~TRADE SIZES (inches)~~					
		~~1/2~~	~~3/4~~	~~1~~	~~1 1/4~~	~~1 1/2~~	~~2~~

~~RHH, RHW, RHW-2~~	~~14~~	~~3~~	~~6~~	~~10~~	~~19~~	~~26~~	~~43~~
	~~12~~	~~2~~	~~5~~	~~9~~	~~16~~	~~22~~	~~36~~
	~~10~~	~~1~~	~~4~~	~~7~~	~~13~~	~~17~~	~~29~~
	~~8~~	~~1~~	~~1~~	~~3~~	~~6~~	~~9~~	~~15~~
	~~6~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~12~~
	~~4~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~9~~
	~~3~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~	~~8~~
	~~2~~	~~0~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~1~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~1/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~2/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
~~RHH, RHW, RHW-2~~	~~3/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~
~~TW, THHW, THW, THW-2~~	~~14~~	~~7~~	~~13~~	~~22~~	~~40~~	~~55~~	~~92~~
	~~12~~	~~5~~	~~10~~	~~17~~	~~31~~	~~42~~	~~71~~
	~~10~~	~~4~~	~~7~~	~~13~~	~~23~~	~~32~~	~~52~~
	~~8~~	~~1~~	~~4~~	~~7~~	~~13~~	~~17~~	~~29~~
~~RHH[a], RHW[a], RHW-2[a]~~	~~14~~	~~4~~	~~8~~	~~15~~	~~27~~	~~37~~	~~61~~
	~~12~~	~~3~~	~~7~~	~~12~~	~~21~~	~~29~~	~~49~~
	~~10~~	~~3~~	~~5~~	~~9~~	~~17~~	~~23~~	~~38~~
	~~8~~	~~1~~	~~3~~	~~5~~	~~10~~	~~14~~	~~23~~
~~RHH[a], RHW[a], RHW-2[a], TW, THW, THHW, THW-2~~	~~6~~	~~1~~	~~2~~	~~4~~	~~7~~	~~10~~	~~17~~
	~~4~~	~~1~~	~~1~~	~~3~~	~~5~~	~~8~~	~~13~~
	~~3~~	~~1~~	~~1~~	~~2~~	~~5~~	~~7~~	~~11~~
	~~2~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~9~~
	~~1~~	~~0~~	~~1~~	~~1~~	~~3~~	~~4~~	~~6~~
	~~1/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~5~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~3/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
~~THHN, THWN, THWN-2~~	~~14~~	~~10~~	~~18~~	~~32~~	~~58~~	~~80~~	~~132~~
	~~12~~	~~7~~	~~13~~	~~23~~	~~42~~	~~58~~	~~96~~
	~~10~~	~~4~~	~~8~~	~~15~~	~~26~~	~~36~~	~~60~~
	~~8~~	~~2~~	~~5~~	~~8~~	~~15~~	~~21~~	~~35~~
	~~6~~	~~1~~	~~3~~	~~6~~	~~11~~	~~15~~	~~25~~
	~~4~~	~~1~~	~~1~~	~~4~~	~~7~~	~~9~~	~~15~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~5~~	~~8~~	~~13~~
	~~2~~	~~1~~	~~1~~	~~2~~	~~5~~	~~6~~	~~11~~
~~THHN, THWN, THWN-2~~	~~1~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~	~~8~~
	~~1/0~~	~~0~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~5~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~4~~

~~XHH, XHHW, XHHW-2~~	~~14~~	~~7~~	~~13~~	~~22~~	~~40~~	~~55~~	~~92~~
	~~12~~	~~5~~	~~10~~	~~17~~	~~31~~	~~42~~	~~71~~
	~~10~~	~~4~~	~~7~~	~~13~~	~~23~~	~~32~~	~~52~~
	~~8~~	~~1~~	~~4~~	~~7~~	~~13~~	~~17~~	~~29~~
	~~6~~	~~1~~	~~3~~	~~5~~	~~9~~	~~13~~	~~21~~
	~~4~~	~~1~~	~~1~~	~~4~~	~~7~~	~~9~~	~~15~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~13~~
	~~2~~	~~1~~	~~1~~	~~2~~	~~5~~	~~6~~	~~11~~
	~~1~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~	~~8~~
	~~1/0~~	~~0~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~4~~

~~For SI:1 inch = 25.4 mm.~~

~~a. Types RHW, and RHW-2 without outer covering.~~

~~TABLE E3904.6(3)(Annex C, Table C.3)~~

~~MAXIMUM NUMBER OF CONDUCTORS IN FLEXIBLE METALLIC CONDUIT (FMC)~~[a]

~~TYPE LETTERS~~	~~CONDUCTOR SIZE AWG/kcmil~~	~~TRADE SIZES (inches)~~					
		~~1/2~~	~~3/4~~	~~1~~	~~1 1/4~~	~~1 1/2~~	~~2~~
~~RHH, RHW, RHW-2~~	~~14~~	~~4~~	~~7~~	~~11~~	~~17~~	~~25~~	~~44~~
	~~12~~	~~3~~	~~6~~	~~9~~	~~14~~	~~21~~	~~37~~
	~~10~~	~~3~~	~~5~~	~~7~~	~~11~~	~~17~~	~~30~~
	~~8~~	~~1~~	~~2~~	~~4~~	~~6~~	~~9~~	~~15~~
	~~6~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~12~~
	~~4~~	~~1~~	~~1~~	~~2~~	~~4~~	~~5~~	~~10~~
	~~3~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~
~~RHH, RHW, RHW-2~~	~~2~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~1~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~5~~
	~~1/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~1~~	~~3~~
	~~3/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
~~TW, THHW, THW, THW-2~~	~~14~~	~~9~~	~~15~~	~~23~~	~~36~~	~~53~~	~~94~~
	~~12~~	~~7~~	~~11~~	~~18~~	~~28~~	~~41~~	~~72~~
	~~10~~	~~5~~	~~8~~	~~13~~	~~21~~	~~30~~	~~54~~
	~~8~~	~~3~~	~~5~~	~~7~~	~~11~~	~~17~~	~~30~~
~~RHH~~[a]~~, RHW~~[a]~~, RHW-2~~[a]	~~14~~	~~6~~	~~10~~	~~15~~	~~24~~	~~35~~	~~62~~
	~~12~~	~~5~~	~~8~~	~~12~~	~~19~~	~~28~~	~~50~~
	~~10~~	~~4~~	~~6~~	~~10~~	~~15~~	~~22~~	~~39~~
	~~8~~	~~1~~	~~4~~	~~6~~	~~9~~	~~13~~	~~23~~
~~RHH~~[a]~~, RHW~~[a]~~, RHW-2~~[a]~~, TW, THW, THHW, THW-2~~	~~6~~	~~1~~	~~3~~	~~4~~	~~7~~	~~10~~	~~18~~
	~~4~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~13~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~4~~	~~6~~	~~11~~
	~~2~~	~~1~~	~~1~~	~~2~~	~~4~~	~~5~~	~~10~~
	~~1~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~	~~7~~
	~~1/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~6~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~

~~THHN, THWN, THWN-2~~	~~14~~	~~13~~	~~22~~	~~33~~	~~52~~	~~76~~	~~134~~
	~~12~~	~~9~~	~~16~~	~~24~~	~~38~~	~~56~~	~~98~~
	~~10~~	~~6~~	~~10~~	~~15~~	~~24~~	~~35~~	~~62~~
	~~8~~	~~3~~	~~6~~	~~9~~	~~14~~	~~20~~	~~35~~
~~THHN, THWN, THWN-2~~	~~6~~	~~2~~	~~4~~	~~6~~	~~10~~	~~14~~	~~25~~
	~~4~~	~~1~~	~~2~~	~~4~~	~~6~~	~~9~~	~~16~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~13~~
	~~2~~	~~1~~	~~1~~	~~3~~	~~4~~	~~6~~	~~11~~
	~~1~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~8~~
	~~1/0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~	~~7~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~6~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~5~~
	~~4/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~1~~	~~4~~
~~XHH, XHHW, XHHW-2~~	~~14~~	~~9~~	~~15~~	~~23~~	~~36~~	~~53~~	~~94~~
	~~12~~	~~7~~	~~11~~	~~18~~	~~28~~	~~41~~	~~72~~
	~~10~~	~~5~~	~~8~~	~~13~~	~~21~~	~~30~~	~~54~~
	~~8~~	~~3~~	~~5~~	~~7~~	~~11~~	~~17~~	~~30~~
	~~6~~	~~1~~	~~3~~	~~5~~	~~8~~	~~12~~	~~22~~
	~~4~~	~~1~~	~~2~~	~~4~~	~~6~~	~~9~~	~~16~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~13~~
	~~2~~	~~1~~	~~1~~	~~3~~	~~4~~	~~6~~	~~11~~
	~~1~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~	~~8~~
	~~1/0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~	~~7~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~4/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~

~~For SI:1 inch = 25.4 mm.~~

~~a. Types RHW, and RHW-2 without outer covering.~~

~~TABLE E3904.6(4)(Annex C, Table C.4)~~

~~MAXIMUM NUMBER OF CONDUCTORS IN INTERMEDIATE METALLIC CONDUIT (IMC)~~[a]

~~TYPE LETTERS~~	~~CONDUCTOR SIZE AWG/kcmil~~	~~TRADE SIZES (inches)~~					
		~~1/2~~	~~3/4~~	~~1~~	~~1 1/4~~	~~1 1/2~~	~~2~~
~~RHH, RHW, RHW-2~~	~~14~~	~~4~~	~~8~~	~~13~~	~~22~~	~~30~~	~~49~~
	~~12~~	~~4~~	~~6~~	~~11~~	~~18~~	~~25~~	~~41~~
	~~10~~	~~3~~	~~5~~	~~8~~	~~15~~	~~20~~	~~33~~
	~~8~~	~~1~~	~~3~~	~~4~~	~~8~~	~~10~~	~~17~~
	~~6~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~14~~
	~~4~~	~~1~~	~~1~~	~~3~~	~~5~~	~~6~~	~~11~~
	~~3~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~9~~
	~~2~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~	~~8~~
	~~1~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~5~~
	~~1/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~3/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
~~TW, THHW, THW, THW-2~~	~~14~~	~~10~~	~~17~~	~~27~~	~~47~~	~~64~~	~~104~~
	~~12~~	~~7~~	~~13~~	~~21~~	~~36~~	~~49~~	~~80~~
	~~10~~	~~5~~	~~9~~	~~15~~	~~27~~	~~36~~	~~59~~
	~~8~~	~~3~~	~~5~~	~~8~~	~~15~~	~~20~~	~~33~~

~~RHH[a], RHW[a], RHW-2[a]~~	~~14~~	~~6~~	~~11~~	~~18~~	~~31~~	~~42~~	~~69~~
	~~12~~	~~5~~	~~9~~	~~14~~	~~25~~	~~34~~	~~56~~
	~~10~~	~~4~~	~~7~~	~~11~~	~~19~~	~~26~~	~~43~~
	~~8~~	~~2~~	~~4~~	~~7~~	~~12~~	~~16~~	~~26~~
~~RHH[a], RHW[a], RHW-2[a], TW, THW, THHW, THW-2~~	~~6~~	~~1~~	~~3~~	~~5~~	~~9~~	~~12~~	~~20~~
	~~4~~	~~1~~	~~2~~	~~4~~	~~6~~	~~9~~	~~15~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~13~~
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~~THHN, THWN, THWN-2~~	~~14~~	~~14~~	~~24~~	~~39~~	~~68~~	~~91~~	~~149~~
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	~~2/0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~6~~
~~THHN, THWN, THWN-2~~	~~3/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~5~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
~~XHH, XHHW, XHHW-2~~	~~14~~	~~10~~	~~17~~	~~27~~	~~47~~	~~64~~	~~104~~
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	~~2/0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~6~~
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~~For SI:1 inch = 25.4 mm.~~

~~a. Types RHW, and RHW-2 without outer covering.~~

~~TABLE E3904.6(5)(Annex C, Table C.5)~~
~~MAXIMUM NUMBER OF CONDUCTORS IN LIQUID-TIGHT FLEXIBLE NONMETALLIC CONDUIT (FNMC-B)~~[a]

~~TYPE LETTERS~~	~~CONDUCTOR SIZE AWG/kcmil~~	~~TRADE SIZES (inches)~~						
		~~3/8~~	~~1/2~~	~~3/4~~	~~1~~	~~1 1/4~~	~~1 1/2~~	~~2~~

~~RHH, RHW, RHW-2~~	~~14~~	~~2~~	~~4~~	~~7~~	~~12~~	~~21~~	~~27~~	~~44~~
	~~12~~	~~1~~	~~3~~	~~6~~	~~10~~	~~17~~	~~22~~	~~36~~
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	~~6~~	~~1~~	~~1~~	~~1~~	~~3~~	~~6~~	~~7~~	~~12~~
	~~4~~	~~0~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~9~~
~~RHH, RHW, RHW-2~~	~~3~~	~~0~~	~~1~~	~~1~~	~~1~~	~~4~~	~~5~~	~~8~~
	~~2~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~1~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
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	~~2/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~1~~	~~3~~
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~~TW, THHW, THW, THW-2~~	~~14~~	~~5~~	~~9~~	~~15~~	~~25~~	~~44~~	~~57~~	~~93~~
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~~RHH[a], RHW[a], RGW-2[a]~~	~~14~~	~~3~~	~~6~~	~~10~~	~~16~~	~~29~~	~~38~~	~~62~~
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	~~10~~	~~1~~	~~3~~	~~6~~	~~10~~	~~18~~	~~23~~	~~39~~
	~~8~~	~~1~~	~~1~~	~~4~~	~~6~~	~~11~~	~~14~~	~~23~~
~~RHH[a], RHW[a], RHW-2[a], TW, THW, THHW, THW-2~~	~~6~~	~~1~~	~~1~~	~~3~~	~~5~~	~~8~~	~~11~~	~~18~~
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	~~3~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~11~~
	~~2~~	~~0~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~9~~
	~~1~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~1/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
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	~~3/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
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~~THHN, THWN, THWN-2~~	~~14~~	~~8~~	~~13~~	~~22~~	~~36~~	~~63~~	~~81~~	~~133~~
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~~THHN, THWN, THWN-2~~	~~6~~	~~1~~	~~2~~	~~4~~	~~7~~	~~12~~	~~15~~	~~25~~
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	~~3~~	~~1~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~13~~
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	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~

~~XHH, XHHW, XHHW-2~~	~~14~~	~~5~~	~~9~~	~~15~~	~~25~~	~~44~~	~~57~~	~~93~~
	~~12~~	~~4~~	~~7~~	~~12~~	~~19~~	~~33~~	~~43~~	~~71~~
	~~10~~	~~3~~	~~5~~	~~9~~	~~14~~	~~25~~	~~32~~	~~53~~
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	~~6~~	~~1~~	~~1~~	~~3~~	~~6~~	~~10~~	~~13~~	~~22~~
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	~~3~~	~~1~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~13~~
	~~2~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~11~~
	~~1~~	~~0~~	~~1~~	~~1~~	~~1~~	~~4~~	~~5~~	~~8~~
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	~~2/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~3/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~

~~For SI:1 inch = 25.4 mm.~~

~~a. Types RHW, and RHW-2 without outer covering.~~

~~TABLE E3904.6(6)(Annex C, Table C.6)~~
~~MAXIMUM NUMBER OF CONDUCTORS IN LIQUID-TIGHT FLEXIBLE NONMETALLIC CONDUIT (FNMC-A)~~[a]

~~TYPE LETTERS~~	~~CONDUCTOR SIZE AWG/kcmil~~	~~TRADE SIZES (inches)~~						
		~~3/8~~	~~1/2~~	~~3/4~~	~~1~~	~~1 1/4~~	~~1 1/2~~	~~2~~
~~RHH, RHW, RHW-2~~	~~14~~	~~2~~	~~4~~	~~7~~	~~11~~	~~20~~	~~27~~	~~45~~
	~~12~~	~~1~~	~~3~~	~~6~~	~~9~~	~~17~~	~~23~~	~~38~~
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	~~6~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~13~~
	~~4~~	~~0~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~10~~
	~~3~~	~~0~~	~~1~~	~~1~~	~~1~~	~~4~~	~~5~~	~~8~~
	~~2~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~1~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
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	~~4/0~~	~~0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
~~TW, THHW, THW, THW-2~~	~~14~~	~~5~~	~~9~~	~~15~~	~~24~~	~~43~~	~~58~~	~~96~~
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	~~8~~	~~1~~	~~3~~	~~5~~	~~8~~	~~13~~	~~18~~	~~30~~
~~RHH[a], RHW[a], RHW-2[a]~~	~~14~~	~~3~~	~~6~~	~~10~~	~~16~~	~~28~~	~~38~~	~~64~~
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	~~8~~	~~1~~	~~1~~	~~4~~	~~6~~	~~10~~	~~14~~	~~24~~
~~RHH[a], RHW[a], RHW-2[a], TW, THW, THHW, THW-2~~	~~6~~	~~1~~	~~1~~	~~3~~	~~4~~	~~8~~	~~11~~	~~18~~
	~~4~~	~~1~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~13~~
	~~3~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~11~~
	~~2~~	~~0~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~10~~
	~~1~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~

~~RHH[a], RHW[a], RHW-2[a], TW, THW, THHW, THW-2~~	~~1/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~2/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
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~~THHN, THWN, THWN-2~~	~~14~~	~~8~~	~~13~~	~~22~~	~~35~~	~~62~~	~~83~~	~~137~~
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	~~1/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
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~~XHH, XHHW, XHHW-2~~	~~14~~	~~5~~	~~9~~	~~15~~	~~24~~	~~43~~	~~58~~	~~96~~
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	~~3~~	~~1~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~14~~
	~~2~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~11~~
	~~1~~	~~0~~	~~1~~	~~1~~	~~1~~	~~4~~	~~5~~	~~8~~
~~XHH, XHHW, XHHW-2~~	~~1/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~2/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~3/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~

~~For SI:1 inch = 25.4 mm.~~

~~a. Types RHW, and RHW-2 without outer covering.~~

~~TABLE E3904.6(7)(Annex C, Table C.7)~~

~~MAXIMUM NUMBER OF CONDUCTORS IN LIQUID-TIGHT FLEXIBLE METAL CONDUIT (LFMC)[a]~~

~~TYPE LETTERS~~	~~CONDUCTOR SIZE AWG/kcmil~~	~~TRADE SIZES (inches)~~					
		~~1/2~~	~~3/4~~	~~1~~	~~1 1/4~~	~~1 1/2~~	~~2~~

~~RHH, RHW, RHW-2~~	~~14~~	~~4~~	~~7~~	~~12~~	~~21~~	~~27~~	~~44~~
	~~12~~	~~3~~	~~6~~	~~10~~	~~17~~	~~22~~	~~36~~
	~~10~~	~~3~~	~~5~~	~~8~~	~~14~~	~~18~~	~~29~~
	~~8~~	~~1~~	~~2~~	~~4~~	~~7~~	~~9~~	~~15~~
	~~6~~	~~1~~	~~1~~	~~3~~	~~6~~	~~7~~	~~12~~
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	~~2/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~1~~	~~3~~
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~~TW, THHW, THW, THW-2~~	~~14~~	~~9~~	~~15~~	~~25~~	~~44~~	~~57~~	~~93~~
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~~RHH[a], RHW[a], RHW-2[a], THHW, THW, THW-2~~	~~14~~	~~6~~	~~10~~	~~16~~	~~29~~	~~38~~	~~62~~
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~~RHH[a], RHW[a], RHW-2[a], TW, THW, THHW, THW-2~~	~~6~~	~~1~~	~~3~~	~~5~~	~~8~~	~~11~~	~~18~~
	~~4~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~13~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~11~~
	~~2~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~9~~
	~~1~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
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~~THHN, THWN, THWN-2~~	~~14~~	~~13~~	~~22~~	~~36~~	~~63~~	~~81~~	~~133~~
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	~~2/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
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	~~10~~	~~5~~	~~9~~	~~14~~	~~25~~	~~32~~	~~53~~
	~~8~~	~~3~~	~~5~~	~~8~~	~~14~~	~~18~~	~~29~~

~~XHH, XHHW, XHHW-2~~	~~6~~	~~1~~	~~3~~	~~6~~	~~10~~	~~13~~	~~22~~
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	~~3~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~13~~
	~~2~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~11~~
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	~~1/0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~4/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~

~~For SI:1 inch = 25.4 mm.~~
~~a. Types RHW, and RHW-2 without outer covering.~~

~~TABLE E3904.6(8)(Annex C, Table C.8)~~

~~MAXIMUM NUMBER OF CONDUCTORS IN RIGID METAL CONDUIT (RMC)~~[a]

~~TYPE LETTERS~~	~~CONDUCTOR SIZE AWG/kcmil~~	~~TRADE SIZES (inches)~~					
		~~1/2~~	~~3/4~~	~~1~~	~~1 1/4~~	~~1 1/2~~	~~2~~
~~RHH, RHW, RHW-2~~	~~14~~	~~4~~	~~7~~	~~12~~	~~21~~	~~28~~	~~46~~
	~~12~~	~~3~~	~~6~~	~~10~~	~~17~~	~~23~~	~~38~~
	~~10~~	~~3~~	~~5~~	~~8~~	~~14~~	~~19~~	~~31~~
	~~8~~	~~1~~	~~2~~	~~4~~	~~7~~	~~10~~	~~16~~
	~~6~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~13~~
	~~4~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~10~~
	~~3~~	~~1~~	~~1~~	~~2~~	~~4~~	~~5~~	~~9~~
	~~2~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~1~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~1/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~3/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
~~TW, THHW, THW, THW-2~~	~~14~~	~~9~~	~~15~~	~~25~~	~~44~~	~~59~~	~~98~~
	~~12~~	~~7~~	~~12~~	~~19~~	~~33~~	~~45~~	~~75~~
	~~10~~	~~5~~	~~9~~	~~14~~	~~25~~	~~34~~	~~56~~
	~~8~~	~~3~~	~~5~~	~~8~~	~~14~~	~~19~~	~~31~~
~~RHH[a], RHW[a], RHW-2[a]~~	~~14~~	~~6~~	~~10~~	~~17~~	~~29~~	~~39~~	~~65~~
	~~12~~	~~5~~	~~8~~	~~13~~	~~23~~	~~32~~	~~52~~
	~~10~~	~~3~~	~~6~~	~~10~~	~~18~~	~~25~~	~~41~~
	~~8~~	~~1~~	~~4~~	~~6~~	~~11~~	~~15~~	~~24~~
~~RHH[a], RHW[a], RHW-2[a], TW, THW, THHW, THW-2~~	~~6~~	~~1~~	~~3~~	~~5~~	~~8~~	~~11~~	~~18~~
	~~4~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~14~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~12~~
	~~2~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~10~~
	~~1~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~1/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~5~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~

~~THHN, THWN, THWN-2~~	~~14~~	~~13~~	~~22~~	~~36~~	~~63~~	~~85~~	~~140~~
	~~12~~	~~9~~	~~16~~	~~26~~	~~46~~	~~62~~	~~102~~
	~~10~~	~~6~~	~~10~~	~~17~~	~~29~~	~~39~~	~~64~~
	~~8~~	~~3~~	~~6~~	~~9~~	~~16~~	~~22~~	~~37~~
	~~6~~	~~2~~	~~4~~	~~7~~	~~12~~	~~16~~	~~27~~
	~~4~~	~~1~~	~~2~~	~~4~~	~~7~~	~~10~~	~~16~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~14~~
	~~2~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~11~~
	~~1~~	~~1~~	~~1~~	~~1~~	~~4~~	~~5~~	~~8~~
~~THHN, THWN, THWN-2~~	~~1/0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~4/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
~~XHH, XHHW, XHHW-2~~	~~14~~	~~9~~	~~15~~	~~25~~	~~44~~	~~59~~	~~98~~
	~~12~~	~~7~~	~~12~~	~~19~~	~~33~~	~~45~~	~~75~~
	~~10~~	~~5~~	~~9~~	~~14~~	~~25~~	~~34~~	~~56~~
	~~8~~	~~3~~	~~5~~	~~8~~	~~14~~	~~19~~	~~31~~
	~~6~~	~~1~~	~~3~~	~~6~~	~~10~~	~~14~~	~~23~~
	~~4~~	~~1~~	~~2~~	~~4~~	~~7~~	~~10~~	~~16~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~14~~
	~~2~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~12~~
	~~1~~	~~1~~	~~1~~	~~1~~	~~4~~	~~5~~	~~9~~
	~~1/0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~4/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~

~~For SI:1 inch = 25.4 mm.~~

~~a. Types RHW, and RHW-2 without outer covering.~~

~~TABLE E3904.6(9)(Annex C, Table C.9)~~

~~MAXIMUM NUMBER OF CONDUCTORS IN RIGID PVC CONDUIT, SCHEDULE 80 (PVC-80)~~[a]

~~TYPE LETTERS~~	~~CONDUCTOR SIZE AWG/kcmil~~	~~TRADE SIZES (inches)~~					
		~~1/2~~	~~3/4~~	~~1~~	~~1 1/4~~	~~1 1/2~~	~~2~~
~~RHH, RHW, RHW-2~~	~~14~~	~~3~~	~~5~~	~~9~~	~~17~~	~~23~~	~~39~~
	~~12~~	~~2~~	~~4~~	~~7~~	~~14~~	~~19~~	~~32~~
	~~10~~	~~1~~	~~3~~	~~6~~	~~11~~	~~15~~	~~26~~
	~~8~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~13~~
	~~6~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~11~~
	~~4~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~	~~8~~
~~RHH, RHW, RHW-2~~	~~3~~	~~0~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~2~~	~~0~~	~~1~~	~~1~~	~~3~~	~~4~~	~~6~~
	~~1~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~1/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
	~~2/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
	~~3/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
	~~4/0~~	~~0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~2~~
~~TW, THHW, THW, THW-2~~	~~14~~	~~6~~	~~11~~	~~20~~	~~35~~	~~49~~	~~82~~
	~~12~~	~~5~~	~~9~~	~~15~~	~~27~~	~~38~~	~~63~~
	~~10~~	~~3~~	~~6~~	~~11~~	~~20~~	~~28~~	~~47~~
	~~8~~	~~1~~	~~3~~	~~6~~	~~11~~	~~15~~	~~26~~

~~RHH[a], RHW[a], RHW-2[a]~~	~~14~~ ~~12~~ ~~10~~ ~~8~~	~~4~~ ~~3~~ ~~2~~ ~~1~~	~~8~~ ~~6~~ ~~5~~ ~~3~~	~~13~~ ~~10~~ ~~8~~ ~~5~~	~~23~~ ~~19~~ ~~15~~ ~~9~~	~~32~~ ~~26~~ ~~20~~ ~~12~~	~~55~~ ~~44~~ ~~34~~ ~~20~~
~~RHH[a], RHW[a], RHW-2[a], TW, THW, THHW, THW-2~~	~~6~~ ~~4~~ ~~3~~ ~~2~~ ~~1~~ ~~1/0~~	~~1~~ ~~1~~ ~~1~~ ~~1~~ ~~0~~ ~~0~~	~~1~~ ~~1~~ ~~1~~ ~~1~~ ~~1~~ ~~1~~	~~3~~ ~~3~~ ~~2~~ ~~1~~ ~~1~~ ~~1~~	~~7~~ ~~5~~ ~~4~~ ~~3~~ ~~2~~ ~~1~~	~~9~~ ~~7~~ ~~6~~ ~~5~~ ~~3~~ ~~3~~	~~16~~ ~~12~~ ~~10~~ ~~8~~ ~~6~~ ~~5~~
~~RHH[a], RHW[a], RHW-2[a], TW, THW, THHW, THW-2~~	~~2/0~~ ~~3/0~~ ~~4/0~~	~~0~~ ~~0~~ ~~0~~	~~1~~ ~~0~~ ~~0~~	~~1~~ ~~1~~ ~~1~~	~~1~~ ~~1~~ ~~1~~	~~2~~ ~~1~~ ~~1~~	~~4~~ ~~3~~ ~~3~~
~~THHN, THWN, THWN-2~~	~~14~~ ~~12~~ ~~10~~ ~~8~~ ~~6~~ ~~4~~ ~~3~~ ~~2~~ ~~1~~ ~~1/0~~ ~~2/0~~ ~~3/0~~ ~~4/0~~	~~9~~ ~~6~~ ~~4~~ ~~2~~ ~~1~~ ~~1~~ ~~1~~ ~~1~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~17~~ ~~12~~ ~~7~~ ~~4~~ ~~3~~ ~~1~~ ~~1~~ ~~1~~ ~~1~~ ~~1~~ ~~1~~ ~~1~~ ~~0~~	~~28~~ ~~20~~ ~~13~~ ~~7~~ ~~5~~ ~~3~~ ~~3~~ ~~2~~ ~~1~~ ~~1~~ ~~1~~ ~~1~~ ~~1~~	~~51~~ ~~37~~ ~~23~~ ~~13~~ ~~9~~ ~~6~~ ~~5~~ ~~4~~ ~~3~~ ~~2~~ ~~1~~ ~~1~~ ~~1~~	~~70~~ ~~51~~ ~~32~~ ~~18~~ ~~13~~ ~~8~~ ~~7~~ ~~6~~ ~~4~~ ~~3~~ ~~3~~ ~~2~~ ~~1~~	~~118~~ ~~86~~ ~~54~~ ~~31~~ ~~22~~ ~~14~~ ~~12~~ ~~10~~ ~~7~~ ~~6~~ ~~5~~ ~~4~~ ~~3~~
~~XHH, XHHW, XHHW-2~~	~~14~~ ~~12~~ ~~10~~ ~~8~~ ~~6~~	~~6~~ ~~5~~ ~~3~~ ~~1~~ ~~1~~	~~11~~ ~~9~~ ~~6~~ ~~3~~ ~~2~~	~~20~~ ~~15~~ ~~11~~ ~~6~~ ~~4~~	~~35~~ ~~27~~ ~~20~~ ~~118~~	~~49~~ ~~38~~ ~~28~~ ~~15~~ ~~11~~	~~82~~ ~~63~~ ~~47~~ ~~26~~ ~~19~~

~~(continued)~~

~~TABLE E3904.6(9)(Annex C, Table C.9)—continued~~

~~MAXIMUM NUMBER OF CONDUCTORS IN RIGID PVC CONDUIT, SCHEDULE 80 (PVC-80)~~[a]

~~TYPE LETTERS~~	~~CONDUCTOR SIZE AWG/kcmil~~	~~TRADE SIZES (inches)~~					
		~~$^{1}/_{2}$~~	~~$^{3}/_{4}$~~	~~1~~	~~1 $^{1}/_{4}$~~	~~1 $^{1}/_{2}$~~	~~2~~

~~XHH, XHHW, XHHW-2~~	~~14~~	~~6~~	~~11~~	~~20~~	~~35~~	~~49~~	~~82~~
	~~12~~	~~5~~	~~9~~	~~15~~	~~27~~	~~38~~	~~63~~
	~~10~~	~~3~~	~~6~~	~~11~~	~~20~~	~~28~~	~~47~~
	~~8~~	~~1~~	~~3~~	~~6~~	~~11~~	~~15~~	~~26~~
	~~6~~	~~1~~	~~2~~	~~4~~	~~8~~	~~11~~	~~19~~
	~~4~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~14~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~12~~
	~~2~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~10~~
	~~1~~	~~0~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~1/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~

~~For SI:1 inch = 25.4 mm.~~

~~a. Types RHW, and RHW-2 without outer covering.~~

~~TABLE E3904.6(10)(Annex C, Table C.10)~~

~~MAXIMUM NUMBER OF CONDUCTORS IN RIGID PVC CONDUIT SCHEDULE 40 (PVC-40)~~[a]

~~TYPE LETTERS~~	~~CONDUCTOR SIZE AWG/kcmil~~	~~TRADE SIZES (inches)~~					
		~~1/2~~	~~3/4~~	~~1~~	~~1 1/4~~	~~1 1/2~~	~~2~~
~~RHH, RHW, RHW-2~~	~~14~~	~~4~~	~~7~~	~~11~~	~~20~~	~~27~~	~~45~~
	~~12~~	~~3~~	~~5~~	~~9~~	~~16~~	~~22~~	~~37~~
	~~10~~	~~2~~	~~4~~	~~7~~	~~13~~	~~18~~	~~30~~
	~~8~~	~~1~~	~~2~~	~~4~~	~~7~~	~~9~~	~~15~~
	~~6~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~12~~
	~~4~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~10~~
	~~3~~	~~1~~	~~1~~	~~1~~	~~4~~	~~5~~	~~8~~
	~~2~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
~~RHH, RHW, RHW-2~~	~~1~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~1/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~2/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
	~~3/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~
~~TW, THHW, THW, THW-2~~	~~14~~	~~8~~	~~14~~	~~24~~	~~42~~	~~57~~	~~94~~
	~~12~~	~~6~~	~~11~~	~~18~~	~~32~~	~~44~~	~~72~~
	~~10~~	~~4~~	~~8~~	~~13~~	~~24~~	~~32~~	~~54~~
	~~8~~	~~2~~	~~4~~	~~7~~	~~13~~	~~18~~	~~30~~
~~RHH[a], RHW[a], RHW-2[a]~~	~~14~~	~~5~~	~~9~~	~~16~~	~~28~~	~~38~~	~~63~~
	~~12~~	~~4~~	~~8~~	~~13~~	~~22~~	~~30~~	~~50~~
	~~10~~	~~3~~	~~6~~	~~10~~	~~17~~	~~24~~	~~39~~
	~~8~~	~~1~~	~~3~~	~~6~~	~~10~~	~~14~~	~~23~~
~~RHH[a], RHW[a], RHW-2[a], TW, THW, THHW, THW-2~~	~~6~~	~~1~~	~~2~~	~~4~~	~~8~~	~~11~~	~~18~~
	~~4~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~13~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~11~~
	~~2~~	~~1~~	~~1~~	~~2~~	~~4~~	~~6~~	~~10~~
	~~1~~	~~0~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~1/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
	~~4/0~~	~~0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~

~~THHN, THWN, THWN-2~~	~~14~~	~~11~~	~~21~~	~~34~~	~~60~~	~~82~~	~~135~~
	~~12~~	~~8~~	~~15~~	~~25~~	~~43~~	~~59~~	~~99~~
	~~10~~	~~5~~	~~9~~	~~15~~	~~27~~	~~37~~	~~62~~
	~~8~~	~~3~~	~~5~~	~~9~~	~~16~~	~~21~~	~~36~~
~~THHN, THWN, THWN-2~~	~~6~~	~~1~~	~~4~~	~~6~~	~~11~~	~~15~~	~~26~~
	~~4~~	~~1~~	~~2~~	~~4~~	~~7~~	~~9~~	~~16~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~13~~
	~~2~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~11~~
	~~1~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~	~~8~~
	~~1/0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~4/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~
~~XHH, XHHW, XHHW-2~~	~~14~~	~~8~~	~~14~~	~~24~~	~~42~~	~~57~~	~~94~~
	~~12~~	~~6~~	~~11~~	~~18~~	~~32~~	~~44~~	~~72~~
	~~10~~	~~4~~	~~8~~	~~13~~	~~24~~	~~32~~	~~54~~
	~~8~~	~~2~~	~~4~~	~~7~~	~~13~~	~~18~~	~~30~~
	~~6~~	~~1~~	~~3~~	~~5~~	~~10~~	~~13~~	~~22~~
	~~4~~	~~1~~	~~2~~	~~4~~	~~7~~	~~9~~	~~16~~
	~~3~~	~~1~~	~~1~~	~~3~~	~~6~~	~~8~~	~~13~~
	~~2~~	~~1~~	~~1~~	~~3~~	~~5~~	~~7~~	~~11~~
	~~1~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~	~~8~~
	~~1/0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~4~~	~~7~~
	~~2/0~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~6~~
	~~3/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~3~~	~~5~~
	~~4/0~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~4~~

~~For SI:1 inch = 25.4 mm.~~
~~a. Types RHW, and RHW-2 without outer covering.~~

~~E3904.7 Air handling-stud cavity and joist spaces.~~

~~Where wiring methods having a nonmetallic covering pass through stud cavities and joist spaces used for air handling, such wiring shall pass through such spaces perpendicular to the long dimension of the spaces. [300.22(C) Exception]~~

~~SECTION E3905~~
~~BOXES, CONDUIT BODIES AND FITTINGS~~

~~E3905.1 Box, conduit body or fitting—where required.~~

~~A box or conduit body shall be installed at each conductor splice point, outlet, switch point, junction point and pull point except as otherwise permitted in Sections E3905.1.1 through E3905.1.6.~~

~~Fittings and connectors shall be used only with the specific wiring methods for which they are designed and listed. (300.15)~~

~~E3905.1.1 Equipment.~~

~~An integral junction box or wiring compartment that is part of listed equipment shall be permitted to serve as a box or conduit body. [300.15(B)]~~

~~E3905.1.2 Protection.~~

~~A box or conduit body shall not be required where cables enter or exit from conduit or tubing that is used to provide cable support or protection against physical damage. A fitting shall be~~

~~provided on the end(s) of the conduit or tubing to protect the cable from abrasion. [300.15(C)]~~

~~E3905.1.3 Integral enclosure.~~

~~A wiring device with integral enclosure identified for the use, having brackets that securely fasten the device to walls or ceilings of conventional on-site frame construction, for use with nonmetallic-sheathed cable, shall be permitted in lieu of a box or conduit body. [300.15(E)]~~

~~E3905.1.4 Fitting.~~

~~A fitting identified for the use shall be permitted in lieu of a box or conduit body where such fitting is accessible after installation and does not contain spliced or terminated conductors. [300.15(F)]~~

~~E3905.1.5 Buried conductors.~~

~~Splices and taps in buried conductors and cables shall not be required to be enclosed in a box or conduit body where installed in accordance with Section E3803.4.~~

~~E3905.1.6 Luminaires.~~

~~Where a luminaire is listed to be used as a raceway, a box or conduit body shall not be required for wiring installed therein. [300.15(J)]~~

~~E3905.2 Metal boxes.~~

~~Metal boxes shall be grounded. (314.4)~~

~~E3905.3 Nonmetallic boxes.~~

~~Nonmetallic boxes shall be used only with cabled wiring methods with entirely nonmetallic sheaths, flexible cords and nonmetallic raceways. (314.3)~~

~~Exceptions:~~

1. ~~Where internal bonding means are provided between all entries, nonmetallic boxes shall be permitted to be used with metal raceways and metal-armored cables. (314.3 Exception No. 1)~~

2. ~~Where integral bonding means with a provision for attaching an equipment grounding jumper inside the box are provided between all threaded entries in nonmetallic boxes listed for the purpose, nonmetallic boxes shall be permitted to be used with metal raceways and metal-armored cables. (314.3 Exception No. 2)~~

~~E3905.3.1 Nonmetallic-sheathed cable and nonmetallic boxes.~~

~~Where nonmetallic-sheathed cable is used, the cable assembly, including the sheath, shall extend into the box not less than $^{1}/_{4}$ inch (6.4 mm) through a nonmetallic-sheathed cable knockout opening. (314.7(C)]~~

~~E3905.3.2 Securing to box.~~

~~Wiring methods shall be secured to the boxes. [314.17(C)]~~

~~**Exception:** Where nonmetallic-sheathed cable is used with boxes not larger than a nominal size of 2 1/4 inches by 4 inches (57 mm by 102 mm) mounted in walls or ceilings, and where the cable is fastened within 8 inches (203 mm) of the box measured along the sheath, and where the sheath extends through a cable knockout not less than 1/4 inch (6.4 mm), securing the cable to the box shall not be required. [314.17(C) Exception]~~

~~**E3905.3.3 Conductor rating.**~~
~~Nonmetallic boxes shall be suitable for the lowest temperature-rated conductor entering the box. [314.17(C)]~~

~~**E3905.4 Minimum depth of boxes for outlets, devices, and utilization equipment.**~~
~~Outlet and device boxes shall have an approved depth to allow equipment installed within them to be mounted properly and without the likelihood of damage to conductors within the box. (314.24)~~

~~**E3905.4.1 Outlet boxes without enclosed devices or utilization equipment.**~~
~~Outlet boxes that do not enclose devices or utilization equipment shall have an internal depth of not less than 1/2 inch (12.7 mm). [314.24(A)]~~

~~**E3905.4.2 Utilization equipment.**~~
~~Outlet and device boxes that enclose devices or utilization equipment shall have a minimum internal depth that accommodates the rearward projection of the equipment and the size of the conductors that supply the equipment. The internal depth shall include that of any extension boxes, plaster rings, or raised covers. The internal depth shall comply with all of the applicable provisions that follow. [314.24(B)]~~

~~**Exception:** Utilization equipment that is listed to be installed with specified boxes.~~

1. ~~Large equipment. Boxes that enclose devices or utilization equipment that projects more than 1 7/8 inches (48 mm) rearward from the mounting plane of the box shall have a depth that is not less than the depth of the equipment plus 1/4 inch (6.4 mm). [314.24(B)(1)]~~

2. ~~Conductors larger than 4 AWG. Boxes that enclose devices or utilization equipment supplied by conductors larger than 4 AWG shall be identified for their specific function. [314.24(B)(2)]~~

3. ~~Conductors 8, 6, or 4 AWG. Boxes that enclose devices or utilization equipment supplied by 8, 6, or 4 AWG conductors shall have an internal depth that is not less than 2 1/16 inches (52.4 mm). [314.24(B)(3)]~~

4. ~~Conductors 12 or 10 AWG. Boxes that enclose devices or utilization equipment supplied by 12 or 10 AWG conductors shall have an internal depth that is not~~

~~less than $1^{3}/_{16}$ inches (30.2 mm). Where the equipment projects rearward from the mounting plane of the box by more than 1 inch (25.4 mm), the box shall have a depth that is not less than that of the equipment plus $^{1}/_{4}$ inch (6.4 mm). [314.24(B)(4)]~~

5. ~~Conductors 14 AWG and smaller. Boxes that enclose devices or utilization equipment supplied by 14 AWG or smaller conductors shall have a depth that is not less than $^{15}/_{16}$ inch (23.8 mm). [314.24(B)(5)]~~

~~E3905.5 Boxes enclosing flush-mounted devices.~~

~~Boxes enclosing flush-mounted devices shall be of such design that the devices are completely enclosed at the back and all sides and shall provide support for the devices. Screws for supporting the box shall not be used for attachment of the device contained therein. (314.19)~~

~~E3905.6 Boxes at luminaire outlets.~~

~~Outlet boxes used at luminaire or lampholder outlets shall be designed for the support of luminaires and lampholders and shall be installed as required by Section E3904.3. [314.27(A)]~~

~~E3905.6.1 Vertical surface outlets.~~

~~Boxes used at luminaire or lampholder outlets in or on a vertical surface shall be identified and marked on the interior of the box to indicate the maximum weight of the luminaire or lamp holder that is permitted to be supported by the box if other than 50 pounds (22.7 kg). [314.27(A)(1)]~~

> ~~**Exception:** A vertically-mounted luminaire or lampholder weighing not more than 6 pounds (2.7 kg) shall be permitted to be supported on other boxes or plaster rings that are secured to other boxes, provided that the luminaire or its supporting yoke is secured to the box with not fewer than two No. 6 or larger screws. [314.27(A)(1) Exception]~~

~~E3905.6.2 Ceiling outlets.~~

~~For outlets used exclusively for lighting, the box shall be designed or installed so that a luminaire or lampholder can be attached. Such boxes shall be capable of supporting a luminaire weighing up to 50 pounds (22.7 kg). A luminaire that weighs more than 50 pounds (22.7 kg) shall be supported independently of the outlet box, unless the outlet box is listed and marked on the interior of the box to indicate the maximum weight that the box is permitted to support. [314.27(A)(2)]~~

~~E3905.7 Floor boxes.~~

~~Where outlet boxes for receptacles are installed in the floor, such boxes shall be listed specifically for that application. [314.27(B)]~~

~~E3905.8 Boxes at fan outlets.~~

~~Outlet boxes and outlet box systems used as the sole support of ceiling-suspended fans (paddle) shall be marked by their manufacturer as suitable for this purpose and shall not support ceiling-suspended fans (paddle) that weigh more than 70 pounds (31.8 kg). For outlet boxes and outlet box systems designed to support ceiling-suspended fans (paddle) that weigh more than 35 pounds (15.9 kg), the required marking shall include the maximum weight to be supported.~~

~~Where spare, separately switched, ungrounded conductors are provided to a ceiling-mounted outlet box and such box is in a location acceptable for a ceiling-suspended (paddle) fan, the outlet box or outlet box system shall be listed for sole support of a ceiling-suspended (paddle) fan. [314.27(C)]~~

~~E3905.9 Utilization equipment.~~

~~Boxes used for the support of utilization equipment other than ceiling-suspended (paddle) fans shall meet the requirements of Sections E3905.6.1 and E3905.6.2 for the support of a luminaire that is the same size and weight. [314.27(D)]~~

> ~~**Exception:** Utilization equipment weighing not more than 6 pounds (2.7 kg) shall be permitted to be supported on other boxes or plaster rings that are secured to other boxes, provided that the equipment or its supporting yoke is secured to the box with not fewer than two No. 6 or larger screws. [314.27(D) Exception]~~

~~E3905.10 Conduit bodies and junction, pull and outlet boxes to be accessible.~~

~~Conduit bodies and junction, pull and outlet boxes shall be installed so that the wiring therein can be accessed without removing any part of the building or structure or, in underground circuits, without excavating sidewalks, paving, earth or other substance used to establish the finished grade. (314.29)~~

> ~~**Exception:** Boxes covered by gravel, light aggregate or noncohesive granulated soil shall be listed for the application, and the box locations shall be effectively identified and access shall be provided for excavation. (314.29 Exception)~~

~~E3905.11 Damp or wet locations.~~

~~In damp or wet locations, boxes, conduit bodies and fittings shall be placed or equipped so as to prevent moisture from entering or accumulating within the box, conduit body or fitting. Boxes, conduit bodies and fittings installed in wet locations shall be listed for use in wet locations. Where drainage openings are installed in the field in boxes or conduit bodies listed for use in damp or wet locations, such openings shall be approved and not larger than $^{1}/_{4}$ inch (6.4 mm). For listed drain fittings, larger openings are permitted where installed in the field in accordance with the manufacturer's instructions. (314.15)~~

~~E3905.12 Number of conductors in outlet, device, and junction boxes, and conduit bodies.~~

~~Boxes and conduit bodies shall be of an approved size to provide free space for all enclosed conductors. In no case shall the volume of the box, as calculated in Section E3905.12.1, be less than the box fill calculation as calculated in Section E3905.12.2. The minimum volume for conduit bodies shall be as calculated in Section E3905.12.3. The provisions of this section shall not apply to terminal housings supplied with motors or generators. (314.16)~~

~~E3905.12.1 Box volume calculations.~~

~~The volume of a wiring enclosure (box) shall be the total volume of the assembled sections, and, where used, the space provided by plaster rings, domed covers, extension rings, etc., that are marked with their volume in cubic inches or are made from boxes the dimensions of which are listed in Table E3905.12.1. [314.16(A)]~~

~~TABLE E3905.12.1 [Table 314.16(A)]~~

~~MAXIMUM NUMBER OF CONDUCTORS IN METAL BOXES~~[a]

~~BOX DIMENSIONS (inches trade size and type)~~	~~MAXIMUM CAPACITY (cubic inches)~~	~~MAXIMUM NUMBER OF CONDUCTORS~~[a]						
		~~18 Awg~~	~~16 Awg~~	~~14 Awg~~	~~12 Awg~~	~~10 Awg~~	~~8 Awg~~	~~6 Awg~~
~~4 × 1 1/4 round or octagonal~~	~~12.5~~	~~8~~	~~7~~	~~6~~	~~5~~	~~5~~	~~4~~	~~2~~
~~4 × 1 1/2 round or octagonal~~	~~15.5~~	~~10~~	~~8~~	~~7~~	~~6~~	~~6~~	~~5~~	~~3~~
~~4 × 2 1/8 round or octagonal~~	~~21.5~~	~~14~~	~~12~~	~~10~~	~~9~~	~~8~~	~~7~~	~~4~~
~~4 × 1 1/4 square~~	~~18.0~~	~~12~~	~~10~~	~~9~~	~~8~~	~~7~~	~~6~~	~~3~~
~~4 × 1 1/2 square~~	~~21.0~~	~~14~~	~~12~~	~~10~~	~~9~~	~~8~~	~~7~~	~~4~~
~~4 × 2 1/8 square~~	~~30.3~~	~~20~~	~~17~~	~~15~~	~~13~~	~~12~~	~~10~~	~~6~~
~~4 11/16 × 1 1/4 square~~	~~25.5~~	~~17~~	~~14~~	~~12~~	~~11~~	~~10~~	~~8~~	~~5~~
~~4 11/16 × 1 1/2 square~~	~~29.5~~	~~19~~	~~16~~	~~14~~	~~13~~	~~11~~	~~9~~	~~5~~
~~4 11/16 × 2 1/8 square~~	~~42.0~~	~~28~~	~~24~~	~~21~~	~~18~~	~~16~~	~~14~~	~~8~~
~~3 × 2 × 1 1/2 device~~	~~7.5~~	~~5~~	~~4~~	~~3~~	~~3~~	~~3~~	~~2~~	~~1~~
~~3 × 2 × 2 device~~	~~10.0~~	~~6~~	~~5~~	~~5~~	~~4~~	~~4~~	~~3~~	~~2~~
~~3 × 2 × 2 1/4 device~~	~~10.5~~	~~7~~	~~6~~	~~5~~	~~4~~	~~4~~	~~3~~	~~2~~
~~3 × 2 × 2 1/2 device~~	~~12.5~~	~~8~~	~~7~~	~~6~~	~~5~~	~~5~~	~~4~~	~~2~~
~~3 × 2 × 2 3/4 device~~	~~14.0~~	~~9~~	~~8~~	~~7~~	~~6~~	~~5~~	~~4~~	~~2~~
~~3 × 2 × 3 1/2 device~~	~~18.0~~	~~12~~	~~10~~	~~9~~	~~8~~	~~7~~	~~6~~	~~3~~
~~4 × 2 1/8 × 1 1/2 device~~	~~10.3~~	~~6~~	~~5~~	~~5~~	~~4~~	~~4~~	~~3~~	~~2~~
~~4 × 2 1/8 × 1 7/8 device~~	~~13.0~~	~~8~~	~~7~~	~~6~~	~~5~~	~~5~~	~~4~~	~~2~~
~~4 × 2 1/8 × 2 1/8 device~~	~~14.5~~	~~9~~	~~8~~	~~7~~	~~6~~	~~5~~	~~4~~	~~2~~

~~$3\frac{3}{4} \times 2 \times 2\frac{1}{2}$ masonry box/gang~~	~~14.0~~	~~9~~	~~8~~	~~7~~	~~6~~	~~5~~	~~4~~	~~2~~
~~$3\frac{3}{4} \times 2 \times 3\frac{1}{2}$ masonry box/gang~~	~~21.0~~	~~14~~	~~12~~	~~10~~	~~9~~	~~8~~	~~7~~	~~4~~

~~For SI:1 inch = 25.4 mm, 1 cubic inch = 16.4 cm^3.~~

~~a. Where volume allowances are not required by Sections E3905.12.2.2 through E3905.12.2.5.~~

~~E3905.12.1.1 Standard boxes.~~

~~The volumes of standard boxes that are not marked with a cubic-inch capacity shall be as given in Table E3905.12.1. [314.16(A)(1)]~~

~~E3905.12.1.2 Other boxes.~~

~~Boxes 100 cubic inches (1640 cm^3) or less, other than those described in Table E3905.12.1, and nonmetallic boxes shall be durably and legibly marked by the manufacturer with their cubic-inch capacity. Boxes described in Table E3905.12.1 that have a larger cubic inch capacity than is designated in the table shall be permitted to have their cubic-inch capacity marked as required by this section. [314.16(A)(2)]~~

~~E3905.12.2 Box fill calculations.~~

~~The volumes in Section E3905.12.2.1 through Section E3905.12.2.5, as applicable, shall be added together. No allowance shall be required for small fittings such as locknuts and bushings. [314.16(B)]~~

~~E3905.12.2.1 Conductor fill.~~

~~Each conductor that originates outside the box and terminates or is spliced within the box shall be counted once, and each conductor that passes through the box without splice or termination shall be counted once. Each loop or coil of unbroken conductor having a length equal to or greater than twice that required for free conductors by Section E3406.11.3, shall be counted twice. The conductor fill, in cubic inches, shall be computed using Table E3905.12.2.1. A conductor, no part of which leaves the box, shall not be counted. [314.16(B)(1)]~~

> ~~**Exception:** An equipment grounding conductor or not more than four fixture wires smaller than No. 14, or both, shall be permitted to be omitted from the calculations where such conductors enter a box from a domed fixture or similar canopy and terminate within that box. [314.16(B)(1) Exception]~~

~~TABLE E3905.12.2.1 [Table 314.16(B)]~~
~~VOLUME ALLOWANCE REQUIRED PER CONDUCTOR~~

~~SIZE OF CONDUCTOR~~	~~FREE SPACE WITHIN BOX FOR EACH CONDUCTOR (cubic inches)~~
~~18 AWG~~	~~1.50~~
~~16 AWG~~	~~1.75~~
~~14 AWG~~	~~2.00~~
~~12 AWG~~	~~2.25~~
~~10 AWG~~	~~2.50~~

~~8 AWG~~	~~3.00~~
~~6 AWG~~	~~5.00~~

~~For SI:1 cubic inch = 16.4 cm~~^{3}~~.~~

~~E3905.12.2.2 Clamp fill.~~

~~Where one or more internal cable clamps, whether factory or field supplied, are present in the box, a single volume allowance in accordance with Table E3905.12.2.1 shall be made based on the largest conductor present in the box. An allowance shall not be required for a cable connector having its clamping mechanism outside of the box. A clamp assembly that incorporates a cable termination for the cable conductors shall be listed and marked for use with specific nonmetallic boxes. Conductors that originate within the clamp assembly shall be included in conductor fill calculations provided in Section E3905.12.2.1 as though they entered from outside of the box. The clamp assembly shall not require a fill allowance, but, the volume of the portion of the assembly that remains within the box after installation shall be excluded from the box volume as marked in accordance with Section E3905.12.1.2. [314.16(B)(2)]~~

~~E3905.12.2.3 Support fittings fill.~~

~~Where one or more fixture studs or hickeys are present in the box, a single volume allowance in accordance with Table E3905.12.2.1 shall be made for each type of fitting based on the largest conductor present in the box. [314.16(B)(3)]~~

~~E3905.12.2.4 Device or equipment fill.~~

~~For each yoke or strap containing one or more devices or equipment, a double volume allowance in accordance with Table E3905.12.2.1 shall be made for each yoke or strap based on the largest conductor connected to a device(s) or equipment supported by that yoke or strap. For a device or utilization equipment that is wider than a single 2-inch (51 mm) device box as described in Table E3905.12.1, a double volume allowance shall be made for each ganged portion required for mounting of the device or equipment. [314.16(B)(4)]~~

~~E3905.12.2.5 Equipment grounding conductor fill.~~

~~Where one or more equipment grounding conductors or equipment bonding jumpers enters a box, a single volume allowance in accordance with Table E3905.12.2.1 shall be made based on the largest equipment grounding conductor or equipment bonding jumper present in the box. [314.16(B)(5)]~~

~~E3905.12.3 Conduit bodies.~~

~~Conduit bodies enclosing 6 AWG conductors or smaller, other than short-radius conduit bodies, shall have a cross-sectional area not less than twice the cross-sectional area of the largest conduit or tubing to which they can be attached. The maximum number of conductors permitted shall be the maximum number permitted by Section E3904.6 for the conduit to which it is attached. [314.16(C)(1)]~~

~~E3905.12.3.1 Splices, taps or devices.~~

~~Only those conduit bodies that are durably and legibly marked by the manufacturer with their cubic inch capacity shall be permitted to contain splices, taps or devices. The maximum number of conductors shall be calculated using the same procedure for similar conductors in other than standard boxes. [314.16(C)(2)]~~

~~E3905.12.3.2 Short-radius conduit bodies.~~
~~Conduit bodies such as capped elbows and service-entrance elbows that enclose conductors 6 AWG or smaller and that are only intended to enable the installation of the raceway and the contained conductors, shall not contain splices, taps, or devices and shall be of sufficient size to provide free space for all conductors enclosed in the conduit body. [314.16(C)(3)]~~

~~SECTION E3906~~
~~INSTALLATION OF BOXES, CONDUIT BODIES AND FITTINGS~~

~~E3906.1 Conductors entering boxes, conduit bodies or fittings.~~
~~Conductors entering boxes, conduit bodies or fittings shall be protected from abrasion. (314.17)~~

~~E3906.1.1 Insulated fittings.~~
~~Where raceways contain 4 AWG or larger insulated circuit conductors and these conductors enter a cabinet, box enclosure, or raceway, the conductors shall be protected by an identified fitting providing a smoothly rounded insulating surface, unless the conductors are separated from the fitting or raceway by identified insulating material securely fastened in place. [300.4(G)]~~

~~Exception:~~ ~~Where threaded hubs or bosses that are an integral part of a cabinet, box enclosure, or raceway provide a smoothly rounded or flared entry for conductors. [300.4(G) Exception]~~

~~Conduit bushings constructed wholly of insulating material shall not be used to secure a fitting or raceway. The insulating fitting or insulating material shall have a temperature rating not less than the insulation temperature rating of the installed conductors. [330.4(G)]~~

~~E3906.2 Openings.~~
~~Openings through which conductors enter shall be closed in an approved manner. [314.17(A)]~~

~~E3906.3 Metal boxes and conduit bodies.~~
~~Where raceway or cable is installed with metal boxes, or conduit bodies, the raceway or cable shall be secured to such boxes and conduit bodies. [314.17(B)]~~

~~E3906.4 Unused openings.~~
~~Unused openings other than those intended for the operation of equipment, those intended for mounting purposes, or those permitted as part of the design for listed equipment, shall be closed to afford protection substantially equivalent to that of the wall of the equipment. Metal plugs or plates used with nonmetallic boxes or conduit bodies shall be recessed at least $^{1}/_{4}$ inch (6.4 mm) from the outer surface of the box or conduit body. [110.12(A)]~~

~~E3906.5 In wall or ceiling.~~
~~In walls or ceilings of concrete, tile or other noncombustible material, boxes employing a flush-type cover or faceplate shall be installed so that the front edge of the box, plaster ring, extension ring, or listed extender will not be set back from the finished surface more than $^{1}/_{4}$ inch (6.4~~

~~mm). In walls and ceilings constructed of wood or other combustible material, boxes, plaster rings, extension rings and listed extenders shall be flush with the finished surface or project therefrom. (314.20)~~

~~E3906.6 Noncombustible surfaces.~~

~~Openings in noncombustible surfaces that accommodate boxes employing a flush-type cover or faceplate shall be made so that there are no gaps or open spaces greater than $^1/_8$ inch (3.2 mm) around the edge of the box. (314.21)~~

~~E3906.7 Surface extensions.~~

~~Surface extensions shall be made by mounting and mechanically securing an extension ring over the box. (314.22)~~

> ~~**Exception:** A surface extension shall be permitted to be made from the cover of a flush-mounted box where the cover is designed so it is unlikely to fall off, or be removed if its securing means becomes loose. The wiring method shall be flexible for an approved length that permits removal of the cover and provides access to the box interior and shall be arranged so that any bonding or grounding continuity is independent of the connection between the box and cover. (314.22 Exception)~~

~~E3906.8 Supports.~~

~~Boxes and enclosures shall be supported in accordance with one or more of the provisions in Sections E3906.8.1 through E3906.8.6. (314.23)~~

~~E3906.8.1 Surface mounting.~~

~~An enclosure mounted on a building or other surface shall be rigidly and securely fastened in place. If the surface does not provide rigid and secure support, additional support in accordance with other provisions of Section E3906.8 shall be provided. [314.23(A)]~~

~~E3906.8.2 Structural mounting.~~

~~An enclosure supported from a structural member or from grade shall be rigidly supported either directly, or by using a metal, polymeric or wood brace. [314.23(B)]~~

~~E3906.8.2.1 Nails and screws.~~

~~Nails and screws, where used as a fastening means, shall be attached by using brackets on the outside of the enclosure, or they shall pass through the interior within $^1/_4$ inch (6.4 mm) of the back or ends of the enclosure. Screws shall not be permitted to pass through the box except where exposed threads in the box are protected by an approved means to avoid abrasion of conductor insulation. [314.23(B)(1)]~~

~~E3906.8.2.2 Braces.~~

~~Metal braces shall be protected against corrosion and formed from metal that is not less than 0.020 inch (0.508 mm) thick uncoated. Wood braces shall have a cross section not less than nominal 1 inch by 2 inches (25.4 mm by 51 mm). Wood braces in wet locations shall be treated for the conditions. Polymeric braces shall be identified as being suitable for the use. [314.23(B)(2)]~~

~~E3906.8.3 Mounting in finished surfaces.~~
~~An enclosure mounted in a finished surface shall be rigidly secured there to by clamps, anchors, or fittings identified for the application. [314.23(C)]~~

~~E3906.8.4 Raceway supported enclosures without devices or fixtures.~~
~~An enclosure that does not contain a device(s), other than splicing devices, or support a luminaire, lampholder or other equipment, and that is supported by entering raceways shall not exceed 100 cubic inches (1640 cm~~^{3}~~) in size. The enclosure shall have threaded entries or identified hubs. The enclosure shall be supported by two or more conduits threaded wrenchtight into the enclosure or hubs. Each conduit shall be secured within 3 feet (914 mm) of the enclosure, or within 18 inches (457 mm) of the enclosure if all entries are on the same side of the enclosure. [314.23(E)]~~

> **~~Exception:~~** ~~Rigid metal, intermediate metal, or rigid polyvinyl chloride nonmetallic conduit or electrical metallic tubing shall be permitted to support a conduit body of any size, provided that the conduit body is not larger in trade size than the largest trade size of the supporting conduit or electrical metallic tubing. [314.23(E) Exception]~~

~~E3906.8.5 Raceway supported enclosures, with devices or luminaire.~~
~~An enclosure that contains a device(s), other than splicing devices, or supports a luminaire, lampholder or other equipment and is supported by entering raceways shall not exceed 100 cubic inches (1640 cm~~^{3}~~) in size. The enclosure shall have threaded entries or identified hubs. The enclosure shall be supported by two or more conduits threaded wrench-tight into the enclosure or hubs. Each conduit shall be secured within 18 inches (457 mm) of the enclosure. [314.23(F)]~~

> **~~Exceptions:~~**
>
> 1. ~~Rigid metal or intermediate metal conduit shall be permitted to support a conduit body of any size, provided that the conduit bodies are not larger in trade size than the largest trade size of the supporting conduit. [314.23(F) Exception No. 1]~~
>
> 2. ~~An unbroken length(s) of rigid or intermediate metal conduit shall be permitted to support a box used for luminaire or lampholder support, or to support a wiring enclosure that is an integral part of a luminaire and used in lieu of a box in accordance with Section E3905.1.1, where all of the following conditions are met:~~
>
>   ~~2.1. The conduit is securely fastened at a point so that the length of conduit beyond the last point of conduit support does not exceed 3 feet (914 mm).~~
>
>   ~~2.2. The unbroken conduit length before the last point of conduit support is 12 inches (305 mm) or greater, and that portion of the conduit is securely fastened at some point not less than 12 inches (305 mm) from its last point of support.~~
>
>   ~~2.3. Where accessible to unqualified persons, the luminaire or lampholder, measured to its lowest point, is not less than 8 feet (2438 mm) above grade or standing area and at least 3 feet (914 mm) measured~~

~~horizontally to the 8-foot (2438 mm) elevation from windows, doors, porches, fire escapes, or similar locations.~~

~~2.4. A luminaire supported by a single conduit does not exceed 12 inches (305 mm) in any direction from the point of conduit entry.~~

~~2.5. The weight supported by any single conduit does not exceed 20 pounds (9.1 kg).~~

~~2.6. At the luminaire or lampholder end, the conduit(s) is threaded wrenchtight into the box, conduit body, or integral wiring enclosure, or into hubs identified for the purpose. Where a box or conduit body is used for support, the luminaire shall be secured directly to the box or conduit body, or through a threaded conduit nipple not over 3 inches (76 mm) long. [314.23(F) Exception No. 2]~~

~~E3906.8.6 Enclosures in concrete or masonry.~~
~~An enclosure supported by embedment shall be identified as being suitably protected from corrosion and shall be securely embedded in concrete or masonry. [314.23(G)]~~

~~E3906.9 Covers and canopies.~~
~~Outlet boxes shall be effectively closed with a cover, faceplate or fixture canopy. Screws used for the purpose of attaching covers, or other equipment to the box shall be either machine screws matching the thread gauge or size that is integral to the box or shall be in accordance with the manufacturer's instructions. (314.25)~~

~~E3906.10 Covers and plates.~~
~~Covers and plates shall be nonmetallic or metal. Metal covers and plates shall be grounded. [314.25(A)]~~

~~E3906.11 Exposed combustible finish.~~
~~Combustible wall or ceiling finish exposed between the edge of a fixture canopy or pan and the outlet box shall be covered with noncombustible material. [314.25(B)]~~

~~SECTION E3907~~
~~CABINETS AND PANELBOARDS~~

~~E3907.1 Switch and overcurrent device enclosures with splices, taps, and feed-through conductors.~~
~~Where the wiring space of enclosures for switches or overcurrent devices contains conductors that are feeding through, spliced, or tapping off to other enclosures, switches, or overcurrent devices, all of the following conditions shall apply:~~

1. ~~The total area of all conductors installed at any cross section of the wiring space shall not exceed 40 percent of the cross-sectional area of that space.~~

2. ~~The total area of all conductors, splices, and taps installed at any cross section of the wiring space shall not exceed 75 percent of the cross-sectional area of that space.~~

3. ~~A warning label shall be applied to the enclosure that identifies the closest disconnecting means for any feed-through conductors. (312.8)~~

~~E3907.2 Damp and wet locations.~~

~~In damp or wet locations, cabinets and panelboards of the surface type shall be placed or equipped so as to prevent moisture or water from entering and accumulating within the cabinet, and shall be mounted to provide an air-space not less than $^1/_4$ inch (6.4 mm) between the enclosure and the wall or other supporting surface. Cabinets installed in wet locations shall be weatherproof. For enclosures in wet locations, raceways and cables entering above the level of uninsulated live parts shall be installed with fittings listed for wet locations. (312.2)~~

> ~~**Exception:** Nonmetallic enclosures installed on concrete, masonry, tile, or similar surfaces shall not be required to be installed with an air space between the enclosure and the wall or supporting surface. (312.2 Exception)~~

~~E3907.3 Position in wall.~~

~~In walls of concrete, tile or other noncombustible material, cabinets and panelboards shall be installed so that the front edge of the cabinet will not set back of the finished surface more than $^1/_4$ inch (6.4 mm). In walls constructed of wood or other combustible material, cabinets shall be flush with the finished surface or shall project therefrom. (312.3)~~

~~E3907.4 Repairing noncombustible surfaces.~~

~~Noncombustible surfaces that are broken or incomplete shall be repaired so that there will not be gaps or open spaces greater than $^1/_8$ inch (3.2 mm) at the edge of the cabinet or cutout box employing a flush-type cover. (312.4)~~

~~E3907.5 Unused openings.~~

~~Unused openings, other than those intended for the operation of equipment, those intended for mounting purposes, and those permitted as part of the design for listed equipment, shall be closed to afford protection substantially equivalent to that of the wall of the equipment. Metal plugs and plates used with nonmetallic cabinets shall be recessed at least $^1/_4$ inch (6.4 mm) from the outer surface. Unused openings for circuit breakers and switches shall be closed using identified closures, or other approved means that provide protection substantially equivalent to the wall of the enclosure. (110.12(A)]~~

~~E3907.6 Conductors entering cabinets.~~

~~Conductors entering cabinets and panelboards shall be protected from abrasion and shall comply with Section E3906.1.1. (312.5)~~

~~E3907.7 Openings to be closed.~~

~~Openings through which conductors enter cabinets, panelboards and meter sockets shall be closed in an approved manner. [312.5(A)]~~

~~E3907.8 Cables.~~

~~Where cables are used, each cable shall be secured to the cabinet, panelboard, cutout box, or meter socket enclosure. [312.5(C)]~~

~~**Exception:** Cables with entirely nonmetallic sheaths shall be permitted to enter the top of a surface-mounted enclosure through one or more sections of rigid raceway not less than 18 inches (457 mm) nor more than 10 feet (3048 mm) in length, provided all the following conditions are met:~~

1. ~~Each cable is fastened within 12 inches (305 mm), measured along the sheath, of the outer end of the raceway.~~
2. ~~The raceway extends directly above the enclosure and does not penetrate a structural ceiling.~~
3. ~~A fitting is provided on each end of the raceway to protect the cable(s) from abrasion and the fittings remain accessible after installation.~~
4. ~~The raceway is sealed or plugged at the outer end using approved means so as to prevent access to the enclosure through the raceway.~~
5. ~~The cable sheath is continuous through the raceway and extends into the enclosure beyond the fitting not less than $^1/_4$ inch (6.4 mm).~~
6. ~~The raceway is fastened at its outer end and at other points in accordance with Section E3802.1.~~
7. ~~The allowable cable fill shall not exceed that permitted by Table E3907.8. A multiconductor cable having two or more conductors shall be treated as a single conductor for calculating the percentage of conduit fill area. For cables that have elliptical cross sections, the cross-sectional area calculation shall be based on the major diameter of the ellipse as a circle diameter. [312.5(C) Exception]~~

~~TABLE E3907.8 (Chapter 9, Table 1)~~
~~PERCENT OF CROSS SECTION OF CONDUIT AND TUBING FOR CONDUCTORS~~

~~NUMBER OF CONDUCTORS~~	~~MAXIMUM PERCENT OF CONDUIT AND TUBING AREA FILLED BY CONDUCTORS~~
~~1~~	~~53~~
~~2~~	~~31~~
~~Over 2~~	~~40~~

~~E3907.9 Wire-bending space within an enclosure containing a panelboard.~~
~~Wire-bending space within an enclosure containing a panelboard shall comply with the requirements of Sections E3907.9.1 through E3907.9.3.~~

~~E3907.9.1 Top and bottom wire-bending space.~~
~~The top and bottom wire-bending space for a panelboard enclosure shall be sized in accordance with Table E3907.9.1(1) based on the largest conductor entering or leaving the enclosure. [408.55 (A)]~~

~~Exceptions:~~

1. ~~For a panelboard rated at 225 amperes or less and designed to contain not more than 42 overcurrent devices, either the top or bottom wire-bending space shall be permitted to be sized in accordance with Table E3907.9.1(2). For the purposes of this exception, a 2-pole or a 3-pole circuit breaker shall be considered as two or three overcurrent devices, respectively. [408.55(A) Exception No. 1]~~

2. ~~For any panelboard, either the top or bottom wire-bending space shall be permitted to be sized in accordance with Table E3907.9.1(2) where the wire-bending space on at least one side is sized in accordance with Table E3907.9.1(1) based on the largest conductor to be terminated in any side wire-bending space. [408.55(A) Exception No. 2]~~

3. ~~Where the panelboard is designed and constructed for wiring using only a single 90-degree bend for each conductor, including the grounded circuit conductor, and the wiring diagram indicates and specifies the method of wiring that must be used, the top and bottom wire-bending space shall be permitted to be sized in accordance with Table E3907.9.1(2). [408.55(A) Exception No. 3]~~

4. ~~Where there are no conductors terminated in that space, either the top or the bottom wire-bending space, shall be permitted to be sized in accordance with Table E3907.9.1(2). [408.55(A) Exception No. 4]~~

~~TABLE E3907.9.1(1)[Table 312.6(B)]~~
~~MINIMUM WIRE-BENDING SPACE AT TERMINALS (see note 1)~~

~~**WIRE SIZE (AWG or kcmil)**~~		~~**WIRES PER TERMINAL**~~			
~~**All other conductors**~~	~~Compact stranded AA-8000 aluminum alloy conductors (see Note 3)~~	~~One (see note 2)~~		~~Two~~	
		~~**inches**~~	~~mm~~	~~inches~~	~~mm~~
~~14-10~~	~~12-8~~	~~Not specified~~	~~Not specified~~	~~—~~	~~—~~
~~8~~	~~6~~	~~1 1/2~~	~~38.1~~	~~—~~	~~—~~
~~6~~	~~4~~	~~2~~	~~50.8~~	~~—~~	~~—~~
~~4~~	~~2~~	~~3~~	~~76.2~~	~~—~~	~~—~~
~~3~~	~~1~~	~~3~~	~~76.2~~	~~—~~	~~—~~
~~2~~	~~1/0~~	~~3 1/2~~	~~88.9~~	~~—~~	~~—~~
~~1~~	~~2/0~~	~~4 1/2~~	~~114~~	~~—~~	~~—~~
~~1/0~~	~~3/0~~	~~5 1/2~~	~~140~~	~~5 1/2~~	~~140~~
~~2/0~~	~~4/0~~	~~6~~	~~152~~	~~6~~	~~152~~
~~3/0~~	~~250~~	~~6 1/2[a]~~	~~165[a]~~	~~6 1/2[a]~~	~~165[a]~~

~~4/0~~	~~300~~	~~7~~[b]	~~178~~[b]	~~7 1/2~~[c]	~~190~~[c]
~~250~~	~~350~~	~~8 1/2~~[d]	~~216~~[d]	~~8 1/2~~[d]	~~229~~[d]
~~300~~	~~400~~	~~10~~[c]	~~254~~[c]	~~10~~[d]	~~254~~[d]
~~350~~	~~500~~	~~12~~[c]	~~305~~[c]	~~12~~[c]	~~305~~[c]
~~400~~	~~600~~	~~13~~[c]	~~330~~[c]	~~13~~[c]	~~330~~[c]
~~500~~	~~700-750~~	~~14~~[c]	~~356~~[c]	~~14~~[c]	~~356~~[c]
~~600~~	~~800-900~~	~~15~~[c]	~~381~~[c]	~~16~~[c]	~~406~~[c]
~~700~~	~~1000~~	~~16~~[c]	~~406~~[c]	~~18~~[c]	~~457~~[c]

1. ~~Bending space at terminals shall be measured in a straight line from the end of the lug or wire connector in a direction perpendicular to the enclosure wall.~~
2. ~~For removable and lay-in wire terminals intended for only one wire, bending space shall be permitted to be reduced by the following number of millimeters (inches):~~
   - ~~a. 1/2 inches (12.7 mm)~~
   - ~~b. 1 inches (25.4 mm)~~
   - ~~c. 1 1/2 inches (38.1 mm)~~
   - ~~d. 2 inches (50.8 mm)~~
3. ~~This column shall be permitted to determine the required wire-bending space for compact stranded aluminum conductors in sizes up to 1000 kcmil and manufactured using AA-8000 series electrical grade aluminum alloy conductor material.~~

~~TABLE E3907.9.1(2)[Table 312.6(A)]~~
~~MINIMUM WIRE-BENDING SPACE AT TERMINALS AND MINIMUM WIDTH OF WIRING GUTTERS (see note 1)~~

~~WIRE SIZE (AWG or kcmil)~~	**~~WIRES PER TERMINAL~~**			
	~~One~~		**~~Two~~**	
	~~inches~~	**~~mm~~**	**~~inches~~**	**~~mm~~**
~~14-10~~	~~Not specified~~	~~Not specified~~	~~—~~	~~—~~
~~8-6~~	~~1 1/2~~	~~38.1~~	~~—~~	~~—~~
~~4-3~~	~~2~~	~~50.8~~	~~—~~	~~—~~
~~2~~	~~2 1/2~~	~~63.5~~	~~—~~	~~—~~
~~1~~	~~2~~	~~76.2~~	~~—~~	~~—~~
~~1/0-2/0~~	~~3 1/2~~	~~88.9~~	~~5~~	~~127~~
~~3/0-4/0~~	~~4~~	~~102~~	~~6~~	~~152~~
~~250~~	~~4 1/2~~	~~114~~	~~6~~	~~152~~

~~300-350~~	~~5~~	~~127~~	~~8~~	~~203~~
~~400-500~~	~~6~~	~~152~~	~~8~~	~~203~~
~~600-700~~	~~8~~	~~203~~	~~10~~	~~254~~

1. ~~Bending space at terminals shall be measured in a straight line from the end of the lug or wire connector in the direction that the wire leaves the terminal to the wall, barrier, or obstruction.~~

~~E3907.9.2 Side wire-bending space.~~
~~Side wire-bending space shall be in accordance with Table E3907.9.1(2) based on the largest conductor to be terminated in that space. [408.55(B)]~~

~~E3907.9.3 Back wire-bending space.~~
~~The distance between the center of the rear entry and the nearest termination for the entering conductors shall be not less than the distance given in Table E3907.9.1(1). Where a raceway or cable entry is in the wall of the enclosure, opposite a removable cover, the distance from that wall to the cover shall be permitted to comply with the distance required in Table E3907.9.1(2). [408.55 (C)]~~

~~SECTION E3908~~
~~GROUNDING~~

~~E3908.1 Metal enclosures.~~
~~Metal enclosures of conductors, devices and equipment shall be connected to the equipment grounding conductor. (250.86)~~

~~Exceptions:~~

1. ~~Short sections of metal enclosures or raceways used to provide cable assemblies with support or protection against physical damage. (250.86 Exception No. 2)~~

2. ~~A metal elbow that is installed in an underground installation of rigid nonmetallic conduit and is isolated from possible contact by a minimum cover of 18 inches (457 mm) to any part of the elbow or that is encased in not less than 2 inches (51 mm) of concrete. (250.86 Exception No. 3)~~

~~E3908.2 Equipment fastened in place or connected by permanent wiring methods (fixed).~~
~~Exposed, normally noncurrent-carrying metal parts of fixed equipment supplied by or enclosing conductors or components that are likely to become energized shall be connected to the equipment grounding conductor where any of the following conditions apply:~~

1. ~~Where within 8 feet (2438 mm) vertically or 5 feet (1524 mm) horizontally of earth or grounded metal objects and subject to contact by persons;~~

2. ~~Where located in a wet or damp location and not isolated; or~~

3. ~~Where in electrical contact with metal. (250.110)~~

~~E3908.3 Specific equipment fastened in place (fixed) or connected by permanent wiring methods.~~

~~Exposed, normally noncurrent-carrying metal parts of the following equipment and enclosures shall be connected to an equipment grounding conductor:~~

1. ~~Luminaires as provided in Chapter 40. [250.112(J)]~~

2. ~~Motor-operated water pumps, including submersible types.Where a submersible pump is used in a metal well casing, the well casing shall be connected to the pump circuit equipment grounding conductor. [250.112(L)]~~

~~E3908.4 Effective ground-fault current path.~~

~~Electrical equipment and wiring and other electrically conductive material likely to become energized shall be installed in a manner that creates a low-impedance circuit facilitating the operation of the overcurrent device or ground detector for high-impedance grounded systems. Such circuit shall be capable of safely carrying the maximum ground-fault current likely to be imposed on it from any point on the wiring system where a ground fault might occur to the electrical supply source. [250. (A)(5)]~~

~~E3908.5 Earth as a ground-fault current path.~~

~~The earth shall not be considered as an effective ground-fault current path. [250.4(A)(5)]~~

~~E3908.6 Load-side grounded conductor neutral.~~

~~A grounded conductor shall not be connected to normally noncurrent-carrying metal parts of equipment, to equipment grounding conductor(s), or be reconnected to ground on the load side of the service disconnecting means. [250.24(A)(5)]~~

~~E3908.7 Load-side equipment.~~

~~A grounded circuit conductor shall not be used for grounding noncurrent-carrying metal parts of equipment on the load side of the service disconnecting means. [250.142(B)]~~

~~E3908.8 Types of equipment grounding conductors.~~

~~The equipment grounding conductor run with or enclosing the circuit conductors shall be one or more or a combination of the following:~~

1. ~~A copper, aluminum or copper-clad conductor.This conductor shall be solid or stranded; insulated, covered or bare; and in the form of a wire or a busbar of any shape. [250.118(1)]~~

2. ~~Rigid metal conduit. [250.118(2)]~~

3. ~~Intermediate metal conduit. [250.118(3)]~~

4. ~~Electrical metallic tubing. [250.118(4)]~~

5. ~~Armor of Type AC cable in accordance with Section E3908.4. [250.118(8)]~~

6. ~~Type MC cable that provides an effective ground-fault current path in accordance with one or more of the following:~~

    - ~~6.1. It contains an insulated or uninsulated equipment grounding conductor in compliance with Item 1 of this section.~~

    - ~~6.2. The combined metallic sheath and uninsulated equipment grounding/bonding conductor of interlocked metal tape-type MC cable that is listed and identified as an equipment grounding conductor.~~

    - ~~6.3. The metallic sheath or the combined metallic sheath and equipment grounding conductors of the smooth or corrugated tube-type MC cable that is listed and identified as an equipment grounding conductor. [250.118(10)]~~

~~7. Other electrically continuous metal raceways and auxiliary gutters. [250.118(13)]~~

~~8. Surface metal raceways listed for grounding. [250.118(14)]~~

~~E3908.8.1 Flexible metal conduit.~~
~~Flexible metal conduit shall be permitted as an equipment grounding conductor where all of the following conditions are met:~~

1. ~~The conduit is terminated in listed fittings.~~

2. ~~The circuit conductors contained in the conduit are protected by overcurrent devices rated at 20 amperes or less.~~

3. ~~The combined length of flexible metal conduit and flexible metallic tubing and liquid-tight flexible metal conduit in the same ground return path does not exceed 6 feet (1829 mm).~~

~~If used to connect equipment where flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation, an equipment grounding conductor shall be installed. [250.118(5)]~~

~~E3908.8.2 Liquid-tight flexible metal conduit.~~
~~Liquid-tight flexible metal conduit shall be permitted as an equipment grounding conductor where all of the following conditions are met:~~

1. ~~The conduit is terminated in listed fittings.~~

2. ~~For trade sizes $^{3}/_{8}$ through $^{1}/_{2}$ (metric designator 12 through 16), the circuit conductors contained in the conduit are protected by overcurrent devices rated at 20 amperes or less.~~

3. ~~For trade sizes $^{3}/_{4}$ through 1$^{1}/_{4}$ (metric designator 21 through 35), the circuit conductors contained in the conduit are protected by overcurrent devices rated at not more than 60 amperes and there is no flexible metal conduit, flexible metallic tubing, or liquid-tight flexible metal conduit in trade sizes $^{3}/_{8}$ inch or $^{1}/_{2}$ inch (9.5 mm through 12.7 mm) in the ground fault current path.~~

4. ~~The combined length of flexible metal conduit and flexible metallic tubing and liquid-tight flexible metal conduit in the same ground return path does not exceed 6 feet (1829 mm).~~

~~If used to connect equipment where flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation, an equipment grounding conductor shall be installed. [250.118(6)]~~

~~E3908.8.3 Nonmetallic sheathed cable (Type NM).~~
~~In addition to the insulated conductors, the cable shall have an insulated, covered, or bare equipment grounding conductor. Equipment grounding conductors shall be sized in accordance with Table E3908.12. (334.108)~~

~~E3908.9 Equipment fastened in place or connected by permanent wiring methods.~~
~~Noncurrent-carrying metal parts of equipment, raceways and other enclosures, where required to be grounded, shall be grounded by one of the following methods: (250.134)~~

1. ~~By any of the equipment grounding conductors permitted by Sections E3908.8 through E3908.8.3. [250.134(A)]~~

2. ~~By an equipment grounding conductor contained within the same raceway, cable or cord, or otherwise run with the circuit conductors. Equipment grounding conductors shall be identified in accordance with Section E3407.2. [250.134(B)]~~

~~E3908.10 Methods of equipment grounding.~~
~~Fixtures and equipment shall be considered grounded where mechanically connected to an equipment grounding conductor as specified in Sections E3908.8 through E3908.8.3. Wire type equipment grounding conductors shall be sized in accordance with Section E3908.12. (250 Part VII)~~

~~E3908.11 Equipment grounding conductor installation.~~
~~Where an equipment grounding conductor consists of a raceway, cable armor or cable sheath or where such conductor is a wire within a raceway or cable, it shall be installed in accordance with the provisions of this chapter and Chapters 34 and 38 using fittings for joints and terminations approved for installation with the type of raceway or cable used. All connections, joints and fittings shall be made tight using suitable tools. (250.120)~~

~~E3908.12 Equipment grounding conductor size.~~
~~Copper, aluminum and copper-clad aluminum equipment grounding conductors of the wire type shall be not smaller than shown in Table E3908.12, but they shall not be required to be larger than the circuit conductors supplying the equipment. Where a raceway or a cable armor or sheath is used as the equipment grounding conductor, as provided in Section E3908.8, it shall comply with Section E3908.4. Where ungrounded conductors are increased in size from the minimum size that has sufficient ampacity for the intended installation, wire type equipment grounding conductors shall be increased proportionally according to the circular mil area of the ungrounded conductors. [250.122(A) and (B)]~~

~~TABLE E3908.12 (Table 250.122)~~

~~EQUIPMENT GROUNDING CONDUCTOR SIZING~~

~~RATING OR SETTING OF AUTOMATIC OVERCURRENT DEVICE IN CIRCUIT AHEAD OF EQUIPMENT, CONDUIT, ETC., NOT EXCEEDING THE FOLLOWING RATINGS (amperes)~~	~~MINIMUM SIZE~~	
	~~Copper wire No. (AWG)~~	~~Aluminum or copper-clad aluminum wire No. (AWG)~~
~~15~~	~~14~~	~~12~~
~~20~~	~~12~~	~~10~~
~~60~~	~~10~~	~~8~~
~~100~~	~~8~~	~~6~~
~~200~~	~~6~~	~~4~~
~~300~~	~~4~~	~~2~~
~~400~~	~~3~~	~~1~~

~~E3908.12.1 Multiple circuits.~~

~~Where a single equipment grounding conductor is run with multiple circuits in the same raceway or cable, it shall be sized for the largest overcurrent device protecting conductors in the raceway or cable. [250.122(C)]~~

~~E3908.13 Continuity and attachment of equipment grounding conductors to boxes.~~

~~Where circuit conductors are spliced within a box or terminated on equipment within or supported by a box, any equipment grounding conductors associated with the circuit conductors shall be connected within the box or to the box with devices suitable for the use. Connections depending solely on solder shall not be used. Splices shall be made in accordance with Section E3406.10 except that insulation shall not be required. The arrangement of grounding connections shall be such that the disconnection or removal of a receptacle, luminaire or other device fed from the box will not interfere with or interrupt the grounding continuity. [250.146(A) and (C)]~~

~~E3908.14 Connecting receptacle grounding terminal to box.~~

~~An equipment bonding jumper, sized in accordance with Table E3908.12 based on the rating of the overcurrent device protecting the circuit conductors, shall be used to connect the grounding terminal of a grounding-type receptacle to a grounded box except where grounded in accordance with one of the following: (250.146)~~

1. ~~Surface mounted box.Where the box is mounted on the surface, direct metal-to-metal contact between the device yoke and the box shall be permitted to ground the receptacle to the box. At least one of the insulating washers shall be removed from receptacles that do not have a contact yoke or device designed and listed to be used in conjunction with the supporting screws to establish the grounding circuit between the device yoke and flush-type boxes. This provision shall not apply to cover-mounted receptacles except where the box and cover combination are listed as providing satisfactory ground continuity between the box and the receptacle. A listed exposed work cover shall be considered to be the grounding and bonding means where the device is attached to the cover with at least two fasteners that are permanent, such as a rivet or have a thread locking or screw locking means and where the cover mounting holes are located on a flat non-raised portion of the cover. [250.146(A)]~~

2. ~~Contact devices or yokes. Contact devices or yokes designed and listed for the purpose shall be permitted in conjunction with the supporting screws to establish equipment bonding between the device yoke and flush-type boxes. [250.146(B)]~~

3. ~~Floor boxes.The receptacle is installed in a floor box designed for and listed as providing satisfactory ground continuity between the box and the device. [250.146(C)]~~

~~E3908.15 Metal boxes.~~
~~A connection shall be made between the one or more equipment grounding conductors and a metal box by means of a grounding screw that shall be used for no other purpose, equipment listed for grounding or by means of a listed grounding device. Where screws are used to connect grounding conductors or connection devices to boxes, such screws shall be one or more of the following: [250.148(C)]~~

1. ~~Machine screw-type fasteners that engage not less than two threads.~~

2. ~~Machine screw-type fasteners that are secured with a nut.~~

3. ~~Thread-forming machine screws that engage not less than two threads in the enclosure. [250.8(5) and (6)]~~

~~E3908.16 Nonmetallic boxes.~~
~~One or more equipment grounding conductors brought into a nonmetallic outlet box shall be arranged to allow connection to fittings or devices installed in that box. [250.148(D)]~~

~~E3908.17 Clean surfaces.~~
~~Nonconductive coatings such as paint, lacquer and enamel on equipment to be grounded shall be removed from threads and other contact surfaces to ensure electrical continuity or the equipment shall be connected by means of fittings designed so as to make such removal unnecessary. (250.12)~~

~~E3908.18 Bonding other enclosures.~~
~~Metal raceways, cable armor, cable sheath, enclosures, frames, fittings and other metal noncurrent-carrying parts that serve as equipment grounding conductors, with or without the use of supplementary equipment grounding conductors, shall be effectively bonded where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed on them. Any nonconductive paint, enamel and similar coating shall be removed at threads, contact points and contact surfaces, or connections shall be made by means of fittings designed so as to make such removal unnecessary. [250.96(A)]~~

~~E3908.19 Size of equipment bonding jumper on load side of an overcurrent device.~~
~~The equipment bonding jumper on the load side of an overcurrent devices shall be sized, as a minimum, in accordance with Table E3908.12, but shall not be required to be larger than the circuit conductors supplying the equipment. An equipment bonding conductor shall be not smaller than No. 14 AWG.~~

~~A single common continuous equipment bonding jumper shall be permitted to connect two or more raceways or cables where the bonding jumper is sized in accordance with Table E3908.12 for the largest overcurrent device supplying circuits therein. [250.102(D) and 250.122]~~

~~E3908.20 Installation equipment bonding jumper.~~
~~Bonding jumpers or conductors and equipment bonding jumpers shall be installed either inside or outside of a raceway or an enclosure in accordance with Sections E3908.20.1 and E3908.20.2. [250.102(E)]~~

~~E3908.20.1 Inside raceway or enclosure.~~
~~Where installed inside a raceway or enclosure, equipment bonding jumpers and bonding jumpers or conductors shall comply with the requirements of Sections E3407.2 and E3908.13. [250.102(E)(1)]~~

~~E3908.20.2 Outside raceway or enclosure.~~
~~Where installed outside of a raceway or enclosure, the length of the bonding jumper or conductor or equipment bonding jumper shall not exceed 6 feet (1829 mm) and shall be routed with the raceway or enclosure. [250.102(E)(2)]~~

~~Equipment bonding jumpers and supply-side bonding jumpers installed for bonding grounding electrodes and installed at outdoor pole locations for the purpose of bonding or grounding isolated sections of metal raceways or elbows installed in exposed risers of metal conduit or other metal raceway, shall not be limited in length and shall not be required to be routed with a raceway or enclosure. [250.102(E)(2) Exception]~~

~~E3908.20.3 Protection.~~
~~Bonding jumpers or conductors and equipment bonding jumpers shall be installed in accordance with Section E3610.2. [250.102(E)(3)]~~

~~SECTION E3909~~
~~FLEXIBLE CORDS~~

~~E3909.1 Where permitted.~~
~~Flexible cords shall be used only for the connection of appliances where the fastening means and mechanical connections of such appliances are designed to permit ready removal for maintenance, repair or frequent interchange and the appliance is listed for flexible cord connection. Flexible cords shall not be installed as a substitute for the fixed wiring of a structure; shall not be run through holes in walls, structural ceilings, suspended ceilings, dropped ceilings or floors; shall not be concealed behind walls, floors, ceilings or located above suspended or dropped ceilings. (400.7 and 400.8)~~

~~E3909.2 Loading and protection.~~
~~The ampere load of flexible cords serving fixed appliances shall be in accordance with Table E3909.2. This table shall be used in conjunction with applicable end use product standards to ensure selection of the proper size and type. Where flexible cord is approved for and used with a specific listed appliance, it shall be considered to be protected where applied within the appliance listing requirements. [240.4, 240.5(A), 240.5(B)(1), 400.5, and 400.13]~~

~~TABLE E3909.2 [Table 400.5(A)(1)]~~
~~MAXIMUM AMPERE LOAD FOR FLEXIBLE CORDS~~

~~CORD SIZE (AWG)~~	~~CORD TYPES S, SE, SEO, SJ, SJE, SJEO, SJO, SJOO, SJT, SJTO, SJTOO, SO, SOO, SRD, SRDE, SRDT, ST, STD, SV, SVO, SVOO, SVTO, SVTOO~~

	~~**Maximum ampere load**~~	
	~~**Three current-carrying conductors**~~	~~**Two current-carrying conductors**~~
~~18~~	~~7~~	~~10~~
~~16~~	~~10~~	~~13~~
~~14~~	~~15~~	~~18~~
~~12~~	~~20~~	~~25~~

~~E3909.3 Splices.~~

~~Flexible cord shall be used only in continuous lengths without splices or taps. (400.9)~~

~~E3909.4 Attachment plugs.~~

~~Where used in accordance with Section E3909.1, each flexible cord shall be equipped with an attachment plug and shall be energized from a receptacle outlet. [400.7(B)]~~

CHAPTER 40

DEVICES AND LUMINAIRES

Deleted. See the *North Carolina Electrical Code.*

~~SECTION E4001~~
~~SWITCHES~~

~~E4001.1 Rating and application of snap switches.~~
~~General-use snap switches shall be used within their ratings and shall control only the following loads:~~

1. ~~Resistive and inductive loads not exceeding the ampere rating of the switch at the voltage involved.~~
2. ~~Tungsten-filament lamp loads not exceeding the ampere rating of the switch at 120 volts.~~
3. ~~Motor loads not exceeding 80 percent of the ampere rating of the switch at its rated voltage. [404.14(A)]~~

~~E4001.2 CO/ALR snap switches.~~
~~Snap switches rated 20 amperes or less directly connected to aluminum conductors shall be marked CO/ALR. [404.14(C)]~~

~~E4001.3 Indicating.~~
~~General-use and motor-circuit switches and circuit breakers shall clearly indicate whether they are in the open OFF or closed ON position. Where single-throw switches or circuit breaker handles are operated vertically rather than rotationally or horizontally, the up position of the handle shall be the closed (on) position.~~

~~E4001.4 Time switches and similar devices.~~
~~Time switches and similar devices shall be of the enclosed type or shall be mounted in cabinets or boxes or equipment enclosures. A barrier shall be used around energized parts to prevent operator exposure when making manual adjustments or switching. (404.5]~~

~~E4001.5 Grounding of enclosures.~~
~~Metal enclosures for switches or circuit breakers shall be connected to an equipment grounding conductor. Metal enclosures for switches or circuit breakers used as service equipment shall comply with the provisions of Section E3609.4. Where nonmetallic enclosures are used with metal raceways or metal-armored cables, provisions shall be made for connecting the equipment grounding conductor.~~

~~Nonmetallic boxes for switches shall be installed with a wiring method that provides or includes an equipment grounding conductor. (404.12)~~

~~E4001.6 Access.~~
~~Switches and circuit breakers used as switches shall be located to allow operation from a readily accessible location. Such devices shall be installed so that the center of the grip of the~~

~~operating handle of the switch or circuit breaker, when in its highest position, will not be more than 6 feet 7 inches (2007 mm) above the floor or working platform. [404.8(A)]~~

> ~~**Exception:** This section shall not apply to switches and circuit breakers that are accessible by portable means and are installed adjacent to the motors, appliances and other equipment that they supply. [404.8(A) Exception]~~

~~E4001.7 Damp or wet locations.~~

~~A surface mounted switch or circuit breaker located in a damp or wet location or outside of a building shall be enclosed in a weatherproof enclosure or cabinet. A flush-mounted switch or circuit breaker in a damp or wet location shall be equipped with a weatherproof cover. Switches shall not be installed within wet locations in tub or shower spaces unless installed as part of a listed tub or shower assembly. [404.8(A),(B), and (C)]~~

~~E4001.8 Grounded conductors.~~

~~Switches or circuit breakers shall not disconnect the grounded conductor of a circuit except where the switch or circuit breaker simultaneously disconnects all conductors of the circuit. [404.2(B)]~~

~~E4001.9 Switch connections.~~

~~Three- and four-way switches shall be wired so that all switching occurs only in the ungrounded circuit conductor. Color coding of switch connection conductors shall comply with Section E3407.3. Where in metal raceways or metal-jacketed cables, wiring between switches and outlets shall be in accordance with Section E3406.7. [404.2(A)]~~

> ~~**Exception:** Switch loops do not require a grounded conductor. [404.2(A) Exception]~~

~~E4001.10 Box mounted.~~

~~Flush-type snap switches mounted in boxes that are recessed from the finished wall surfaces as covered in Section E3906.5 shall be installed so that the extension plaster ears are seated against the surface of the wall. Flush-type snap switches mounted in boxes that are flush with the finished wall surface or project therefrom shall be installed so that the mounting yoke or strap of the switch is seated against the box. Screws used for the purpose of attaching a snap switch to a box shall be of the type provided with a listed snap switch, or shall be machine screws having 32 threads per inch or part of listed assemblies or systems, in accordance with the manufacturer’s instructions. [404.10(B)]~~

~~E4001.11 Snap switch faceplates.~~

~~Faceplates provided for snap switches mounted in boxes and other enclosures shall be installed so as to completely cover the opening and, where the switch is flush mounted, seat against the finished surface. [404.9(A)]~~

~~E4001.11.1 Faceplate grounding.~~

~~Snap switches, including dimmer and similar control switches, shall be connected to an equipment grounding conductor and shall provide a means to connect metal faceplates to the equipment grounding conductor, whether or not a metal faceplate is installed. Snap switches shall be considered to be part of an effective ground-fault current path if either of the following conditions is met:~~

1. ~~The switch is mounted with metal screws to a metal box or metal cover that is connected to an equipment grounding conductor or to a nonmetallic box with integral means for connecting to an equipment grounding conductor.~~

2. ~~An equipment grounding conductor or equipment bonding jumper is connected to an equipment grounding termination of the snap switch. [404.9(B)]~~

~~Exceptions:~~

1. ~~Where a means to connect to an equipment grounding conductor does not exist within the snap-switch enclosure or where the wiring method does not include or provide an equipment grounding conductor, a snap switch without a grounding connection to an equipment grounding conductor shall be permitted for replacement purposes only. A snap switch wired under the provisions of this exception and located within 8 feet (2438 mm) vertically or 5 feet (1524 mm) horizontally of ground or exposed grounded metal objects, shall be provided with a faceplate of nonconducting noncombustible material with nonmetallic attachment screws, except where the switch-mounting strap or yoke is nonmetallic or the circuit is protected by a ground-fault circuit interrupter. [404.9(B) Exception No.1]~~

2. ~~Listed kits or listed assemblies shall not be required to be connected to an equipment grounding conductor if all of the following conditions apply:~~

    2.1. ~~The device is provided with a nonmetallic faceplate that cannot be installed on any other type of device.~~

    2.2. ~~The device does not have mounting means to accept other configurations of faceplates.~~

    2.3. ~~The device is equipped with a nonmetallic yoke.~~

    2.4. ~~All parts of the device that are accessible after installation of the faceplate are manufactured of nonmetallic materials. [404.9(B) Exception No. 2]~~

3. ~~Connection to an equipment grounding conductor shall not be required for snap switches that have an integral nonmetallic enclosure complying with Section E3905.1.3. [404.9(B) Exception No. 3]~~

~~E4001.12 Dimmer switches.~~
~~General-use dimmer switches shall be used only to control permanently installed incandescent luminaires (lighting fixtures) except where listed for the control of other loads and installed accordingly. [404.14(E)]~~

~~E4001.13 Multipole snap switches.~~
~~A multipole, general-use snap switch shall not be fed from more than a single circuit unless it is listed and marked as a two-circuit or three-circuit switch. [404.8(C)]~~

~~E4001.14 Cord-and-plug-connected loads.~~
~~Where snap switches are used to control cord-and-plug-connected equipment on a general-~~

~~purpose branch circuit, each snap switch controlling receptacle outlets or cord connectors that are supplied by permanently connected cord pendants shall be rated at not less than the rating of the maximum permitted ampere rating or setting of the overcurrent device protecting the receptacles or cord connectors, as provided in Sections E4002.1.1 and E4002.1.2. [404.14(F)]~~

~~E4001.15 Switches controlling lighting loads.~~
~~The grounded circuit conductor for the controlled lighting circuit shall be provided at the location where switches control lighting loads that are supplied by a grounded general-purpose branch circuit for other than the following:~~

1. ~~Where conductors enter the box enclosing the switch through a raceway, provided that the raceway is large enough for all contained conductors, including a grounded conductor.~~
2. ~~Where the box enclosing the switch is accessible for the installation of an additional or replacement cable without removing finish materials.~~
3. ~~Where snap switches with integral enclosures comply with E3905.1.3.~~
4. ~~Where the switch does not serve a habitable room or bathroom.~~
5. ~~Where multiple switch locations control the same lighting load such that the entire floor area of the room or space is visible from the single or combined switch locations.~~
6. ~~Where lighting in the area is controlled by automatic means.~~
7. ~~Where the switch controls a receptacle load. [404.2(C)]~~

~~SECTION E4002~~
~~RECEPTACLES~~

~~E4002.1 Rating and type.~~
~~Receptacles and cord connectors shall be rated at not less than 15 amperes, 125 volts, or 15 amperes, 250 volts, and shall not be a lampholder type. Receptacles shall be rated in accordance with this section. [406.3(B)]~~

~~E4002.1.1 Single receptacle.~~
~~A single receptacle installed on an individual branch circuit shall have an ampere rating not less than that of the branch circuit. [210.21(B)]~~

~~E4002.1.2 Two or more receptacles.~~
~~Where connected to a branch circuit supplying two or more receptacles or outlets, receptacles shall conform to the values listed in Table E4002.1.2. [210.21(B)(3)]~~

~~TABLE E4002.1.2 [Table 210.21(B)(3)]~~
~~RECEPTACLE RATINGS FOR~~
~~VARIOUS SIZE MULTI-OUTLET CIRCUITS~~

~~CIRCUIT RATING (amperes)~~	~~RECEPTACLE RATING (amperes)~~
~~15~~	~~15~~

~~20~~	~~15 or 20~~
~~30~~	~~30~~
~~40~~	~~40 or 50~~
~~50~~	~~50~~

~~E4002.2 Grounding type.~~
~~Receptacles installed on 15- and 20-ampere-rated branch circuits shall be of the grounding type. [406.4(A)]~~

~~E4002.3 CO/ALR receptacles.~~
~~Receptacles rated at 20 amperes or less and directly connected to aluminum conductors shall be marked CO/ALR. [406.3(C)]~~

~~E4002.4 Faceplates.~~
~~Metal face plates shall be grounded. [406.6(B)]~~

~~E4002.5 Position of receptacle faces.~~
~~After installation, receptacle faces shall be flush with or project from face plates of insulating material and shall project a minimum of 0.015 inch (0.381 mm) from metal face plates. Faceplates shall be installed so as to completely cover the opening and seat against the mounting surface. Receptacle faceplates mounted inside of a box having a recess-mounted receptacle shall effectively close the opening and seat against the mounting surface. [406.5(D), 406.6]~~

> **~~Exception:~~** ~~Listed kits or assemblies encompassing receptacles and nonmetallic faceplates that cover the receptacle face, where the plate cannot be installed on any other receptacle, shall be permitted. [406.5(D) Exception]~~

~~E4002.6 Receptacle mounted in boxes.~~
~~Receptacles mounted in boxes that are set back from the finished wall surface as permitted by Section E3906.5 shall be installed so that the mounting yoke or strap of the receptacle is held rigidly at the finished surface of the wall. Screws used for the purpose of attaching receptacles to a box shall be of the type provided with a listed receptacle, or shall be machine screws having 32 threads per inch or part of listed assemblies or systems, in accordance with the manufacturer’s instructions. Receptacles mounted in boxes that are flush with the wall surface or project therefrom shall be so installed that the mounting yoke or strap is seated against the box or raised cover. [406.5(A) and (B)]~~

~~E4002.7 Receptacles mounted on covers.~~
~~Receptacles mounted to and supported by a cover shall be held rigidly against the cover by more than one screw or shall be a device assembly or box cover listed and identified for securing by a single screw. [406.5(C)]~~

~~E4002.8 Damp locations.~~
~~A receptacle installed outdoors in a location protected from the weather or in other damp locations shall have an enclosure for the receptacle that is weatherproof when the receptacle cover(s) is closed and an attachment plug cap is not inserted. An installation suitable for wet locations shall also be considered suitable for damp locations. A receptacle shall be considered to be in a location protected from the weather where located under roofed open porches, canopies and similar structures and not subject to rain or water runoff. Fifteen- and 20-ampere,~~

~~125- and 250-volt nonlocking receptacles installed in damp locations shall be listed a weather-resistant type. [406.9(A)]~~

~~E4002.9 Fifteen- and 20-ampere receptacles in wet locations.~~

~~Where installed in a wet location, 15- and 20-ampere, 125- and 250-volt receptacles shall have an enclosure that is weatherproof whether or not the attachment plug cap is inserted. An outlet box hood installed for this purpose shall be listed and identified as "extra-duty." Fifteen- and 20-ampere, 125- and 250-volt nonlocking receptacles installed in wet locations shall be a listed weather-resistant type. [406.9(B)(1)]~~

~~E4002.10 Other receptacles in wet locations.~~

~~Where a receptacle other than a 15- or 20-amp, 125- or 250-volt receptacle is installed in a wet location and where the product intended to be plugged into it is not attended while in use, the receptacle shall have an enclosure that is weatherproof both when the attachment plug cap is inserted and when it is removed. Where such receptacle is installed in a wet location and where the product intended to be plugged into it will be attended while in use, the receptacle shall have an enclosure that is weatherproof when the attachment plug cap is removed. [406.9(B)(2)]~~

~~E4002.11 Bathtub and shower space.~~

~~A receptacle shall not be installed within or directly over a bathtub or shower stall. [406.9(C)]~~

~~E4002.12 Flush mounting with faceplate.~~

~~In damp or wet locations, the enclosure for a receptacle installed in an outlet box flush-mounted in a finished surface shall be made weatherproof by means of a weatherproof faceplate assembly that provides a water-tight connection between the plate and the finished surface. [406.9(E)]~~

~~E4002.13 Exposed terminals.~~

~~Receptacles shall be enclosed so that live wiring terminals are not exposed to contact. [406.5(G)]~~

~~E4002.14 Tamper-resistant receptacles.~~

~~In areas specified in Section E3901.1, 125-volt, 15- and 20-ampere receptacles shall be listed tamper-resistant receptacles. [406.12(A)]~~

> ~~**Exception:** Receptacles in the following locations shall not be required to be tamper resistant:~~
>
> 1. ~~Receptacles located more than 5.5 feet (1676 mm) above the floor.~~
> 2. ~~Receptacles that are part of a luminaire or appliance.~~
> 3. ~~A single receptacle for a single appliance or a duplex receptacle for two appliances where such receptacles are located in spaces dedicated for the appliances served and, under conditions of normal use, the appliances are not easily moved from one place to another. The appliances shall be cord-and-plug-connected to such receptacles in accordance with Section E3909.4. [406.12(A) Exception]~~

~~E4002.15 Dimmer-controlled receptacles.~~

~~A receptacle supplying lighting loads shall not be connected to a dimmer except where the plug~~

~~and receptacle combination is a nonstandard configuration type that is specifically listed and identified for each such unique combination.~~

~~SECTION E4003~~
~~LUMINAIRES~~

~~E4003.1 Energized parts.~~
~~Luminaires, lampholders, and lamps shall not have energized parts normally exposed to contact. (410.5)~~

~~E4003.2 Luminaires near combustible material.~~
~~Luminaires shall be installed or equipped with shades or guards so that combustible material will not be subjected to temperatures in excess of 90°C (194°F). (410.11)~~

~~E4003.3 Exposed conductive parts.~~
~~The exposed metal parts of luminaires shall be connected to an equipment grounding conductor or shall be insulated from the equipment grounding conductor and other conducting surfaces. Lamp tie wires, mounting screws, clips and decorative bands on glass spaced at least $1^{1}/_{2}$ inches (38 mm) from lamp terminals shall not be required to be grounded. (410.42)~~

~~E4003.4 Screw-shell type.~~
~~Lampholders of the screw-shell type shall be installed for use as lampholders only. (410.90)~~

~~E4003.5 Recessed incandescent luminaires.~~
~~Recessed incandescent luminaires shall have thermal protection and shall be listed as thermally protected. [410.115(C)]~~

~~Exceptions:~~

1. ~~Thermal protection shall not be required in recessed luminaires listed for the purpose and installed in poured concrete. [410.115(C) Exception No.1]~~

2. ~~Thermal protection shall not be required in recessed luminaires having design, construction, and thermal performance characteristics equivalent to that of thermally protected luminaires, and such luminaires are identified as inherently protected. [410.115(C) Exception No. 2]~~

~~E4003.6 Thermal protection.~~
~~The ballast of a fluorescent luminaire installed indoors shall have integral thermal protection. Replacement ballasts shall also have thermal protection integral with the ballast. A simple reactance ballast in a fluorescent luminaire with straight tubular lamps shall not be required to be thermally protected. [410.130(E)(1)]~~

~~E4003.7 High-intensity discharge luminaires.~~
~~Recessed high-intensity luminaires designed to be installed in wall or ceiling cavities shall have thermal protection and be identified as thermally protected. Thermal protection shall not be required in recessed high-intensity luminaires having design, construction and thermal performance characteristics equivalent to that of thermally protected luminaires, and such luminaires are identified as inherently protected. Thermal protection shall not be required in~~

~~recessed high-intensity discharge luminaires installed in and identified for use in poured concrete. A recessed remote ballast for a high-intensity discharge luminaire shall have thermal protection that is integral with the ballast and shall be identified as thermally protected. [110.130(F)(1),(2),(3), and (4)]~~

~~E4003.8 Metal halide lamp containment.~~

~~Luminaires that use a metal halide lamp other than a thick-glass parabolic reflector lamp (PAR) shall be provided with a containment barrier that encloses the lamp, or shall be provided with a physical means that allows the use of only a lamp that is Type O. [(110.130(F)(5)]~~

~~E4003.9 Wet or damp locations.~~

~~Luminaires installed in wet or damp locations shall be installed so that water cannot enter or accumulate in wiring compartments, lampholders or other electrical parts. All luminaires installed in wet locations shall be marked SUITABLE FOR WET LOCATIONS. All luminaires installed in damp locations shall be marked SUITABLE FOR WET LOCATIONS or SUITABLE FOR DAMP LOCATIONS. (410.10)~~

~~E4003.10 Lampholders in wet or damp locations.~~

~~Lampholders installed in wet locations shall be listed for use in wet locations. Lampholders installed in damp locations shall be listed for damp locations or shall be listed for wet locations. (410.96)~~

~~E4003.11 Bathtub and shower areas.~~

~~Cord-connected luminaires, chain-, cable-, or cord-suspended-luminaires, lighting track, pendants, and ceiling-suspended (paddle) fans shall not have any parts located within a zone measured 3 feet (914 mm) horizontally and 8 feet (2438 mm) vertically from the top of a bathtub rim or shower stall threshold. This zone is all encompassing and includes the space directly over the tub or shower. Luminaires within the actual outside dimension of the bathtub or shower to a height of 8 feet (2438 mm) vertically from the top of the bathtub rim or shower threshold shall be marked for damp locations and where subject to shower spray, shall be marked for wet locations. [410.4(D)]~~

~~E4003.12 Luminaires in clothes closets.~~

~~For the purposes of this section, storage space shall be defined as a volume bounded by the sides and back closet walls and planes extending from the closet floor vertically to a height of 6 feet (1829 mm) or the highest clothes-hanging rod and parallel to the walls at a horizontal distance of 24 inches (610 mm) from the sides and back of the closet walls respectively, and continuing vertically to the closet ceiling parallel to the walls at a horizontal distance of 12 inches (305 mm) or the width of the shelf, whichever is greater. For a closet that permits access to both sides of a hanging rod, the storage space shall include the volume below the highest rod extending 12 inches (305 mm) on either side of the rod on a plane horizontal to the floor extending the entire length of the rod (see Figure E4003.12). (410.2)~~

~~The types of luminaires installed in clothes closets shall be limited to surface-mounted or recessed incandescent or LED luminaires with completely enclosed light sources, surface-mounted or recessed fluorescent luminaires, and surface-mounted fluorescent or LED luminaires identified as suitable for installation within the closet storage area. Incandescent luminaires with open or partially enclosed lamps and pendant luminaires or lamp-holders shall be prohibited. The minimum clearance between luminaires installed in clothes closets and the nearest point of a closet storage area shall be as follows: [410.16(A) and (B)]~~

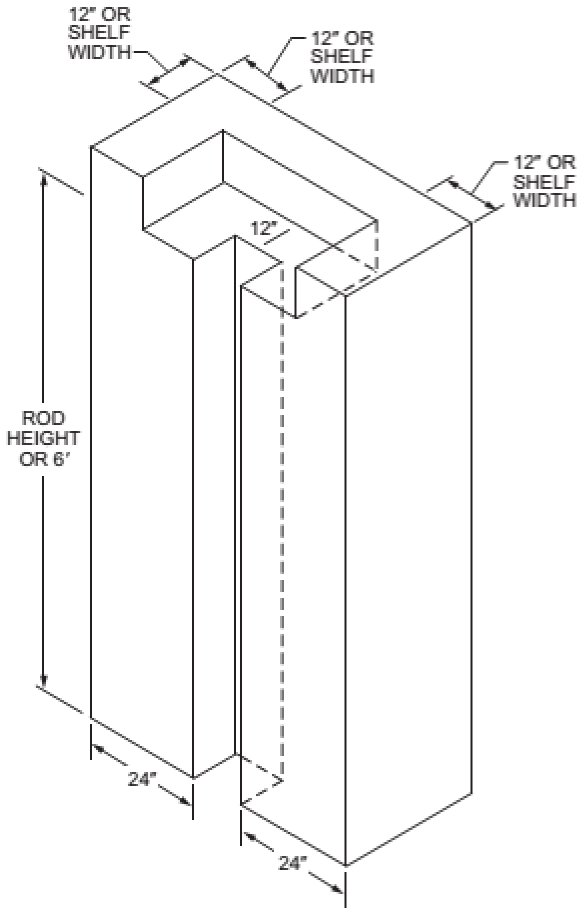
1. ~~Surface-mounted incandescent or LED luminaires with a completely enclosed light source shall be installed on the wall above the door or on the ceiling, provided that there is a minimum clearance of 12 inches (305 mm) between the fixture and the nearest point of a storage space.~~

2. ~~Surface-mounted fluorescent luminaires shall be installed on the wall above the door or on the ceiling, provided that there is a minimum clearance of 6 inches (152 mm).~~

3. ~~Recessed incandescent luminaires or LED luminaires with a completely enclosed light source shall be installed in the wall or the ceiling provided that there is a minimum clearance of 6 inches (152 mm).~~

4. ~~Recessed fluorescent luminaires shall be installed in the wall or on the ceiling provided that there is a minimum clearance of 6 inches (152 mm) between the fixture and the nearest point of a storage space.~~

5. ~~Surface-mounted fluorescent or LED luminaires shall be permitted to be installed within the closet storage space where identified for this use. [410.16(C)]~~



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

~~FIGURE E4003.12~~
~~CLOSET STORAGE SPACE~~

~~E4003.13 Luminaire wiring—general.~~
~~Wiring on or within luminaires shall be neatly arranged and shall not be exposed to physical damage. Excess wiring shall be avoided. Conductors shall be arranged so that they are not subjected to temperatures above those for which the conductors are rated. (410.48)~~

~~E4003.13.1 Polarization of luminaires.~~
~~Luminaires shall be wired so that the screw shells of lampholders will be connected to the same luminaire or circuit conductor or terminal. The grounded conductor shall be connected to the screw shell.~~

~~E4003.13.2 Luminaires as raceways.~~
~~Luminaires shall not be used as raceways for circuit conductors except where such luminaires are listed and marked for use as a raceway or are identified for through-wiring. Luminaires designed for end-to-end connection to form a continuous assembly, and luminaires connected together by recognized wiring methods, shall not be required to be listed as a raceway where they contain the conductors of one 2-wire branch circuit or one multiwire branch circuit and such conductors supply the connected luminaires. One additional 2-wire branch circuit that separately supplies one or more of the connected luminaires shall also be permitted. [410.64(A),(B), and (C)]~~

~~SECTION E4004~~
~~LUMINAIRE INSTALLATION~~

~~E4004.1 Outlet box covers.~~
~~In a completed installation, each outlet box shall be provided with a cover except where covered by means of a luminaire canopy, lampholder or device with a faceplate. (410.22)~~

~~E4004.2 Combustible material at outlet boxes.~~
~~Combustible wall or ceiling finish exposed between the inside edge of a luminaire canopy or pan and the outlet box and having a surface area of 180 in.^{2} (116 129 mm^2) or more shall be covered with a noncombustible material.~~

~~E4004.3 Access.~~
~~Luminaires shall be installed so that the connections between the luminaire conductors and the circuit conductors can be accessed without requiring the disconnection of any part of the wiring. Luminaires that are connected by attachment plugs and receptacles meet the requirement of this section. (410.8)~~

~~E4004.4 Supports.~~
~~Luminaires and lampholders shall be securely supported. A luminaire that weighs more than 6 pounds (2.72 kg) or exceeds 16 inches (406 mm) in any dimension shall not be supported by the screw shell of a lampholder. [410.30(A)]~~

~~E4004.5 Means of support.~~
~~Outlet boxes or fittings installed as required by Sections E3905 and E3906 shall be permitted to support luminaires. [410.36(A)]~~

~~E4004.6 Exposed components.~~

~~Luminaires having exposed ballasts, transformers, LED drivers or power supplies shall be installed so that such ballasts, transformers, LED drivers or power supplies are not in contact with combustible material unless listed for such condition. [410.136(A)]~~

~~E4004.7 Combustible low-density cellulose fiberboard.~~

~~Where a surface-mounted luminaire containing a ballast, transformer, LED driver or power supply is installed on combustible low-density cellulose fiberboard, the luminaire shall be marked for this purpose or it shall be spaced not less than 1$^{1}/_{2}$ inches (38 mm) from the surface of the fiberboard. Where such luminaires are partially or wholly recessed, the provisions of Sections E4004.8 and E4004.9 shall apply. [410.136(B)]~~

~~E4004.8 Recessed luminaire clearance.~~

~~A recessed luminaire that is not identified for contact with insulation shall have all recessed parts spaced at least $^{1}/_{2}$ inch (12.7 mm) from combustible materials. The points of support and the finish trim parts at the opening in the ceiling, wall or other finished surface shall be permitted to be in contact with combustible materials. A recessed luminaire that is identified for contact with insulation, Type IC, shall be permitted to be in contact with combustible materials at recessed parts, points of support, and portions passing through the building structure and at finish trim parts at the opening in the ceiling or wall. [410.116(A)(1) and (A)(2)]~~

~~E4004.9 Recessed luminaire installation.~~

~~Thermal insulation shall not be installed above a recessed luminaire or within 3 inches (76 mm) of the recessed luminaire’s enclosure, wiring compartment, ballast, transformer, LED driver or power supply except where such luminaire is identified for contact with insulation, Type IC. [410.116(B)]~~

~~SECTION E4005~~

~~TRACK LIGHTING~~

~~E4005.1 Installation.~~

~~Lighting track shall be permanently installed and permanently connected to a branch circuit having a rating not more than that of the track. [410.151(A) and (B)]~~

~~E4005.2 Fittings.~~

~~Fittings identified for use on lighting track shall be designed specifically for the track on which they are to be installed. Fittings shall be securely fastened to the track, shall maintain polarization and connection to the equipment grounding conductor, and shall be designed to be suspended directly from the track. Only lighting track fittings shall be installed on lighting track. Lighting track fittings shall not be equipped with general-purpose receptacles. [410.151(A) and (B)]~~

~~E4005.3 Connected load.~~

~~The connected load on lighting track shall not exceed the rating of the track. [410.151(B)]~~

~~E4005.4 Prohibited locations.~~

~~Lighting track shall not be installed in the following locations:~~

1. ~~Where likely to be subjected to physical damage.~~
2. ~~In wet or damp locations.~~
3. ~~Where subject to corrosive vapors.~~
4. ~~In storage battery rooms.~~
5. ~~In hazardous (classified) locations.~~
6. ~~Where concealed.~~
7. ~~Where extended through walls or partitions.~~
8. ~~Less than 5 feet (1524 mm) above the finished floor except where protected from physical damage or the track operates at less than 30 volts rms open-circuit voltage.~~
9. ~~Where prohibited by Section E4003.11. [410.151(C)]~~

~~E4005.5 Fastening.~~
~~Lighting track shall be securely mounted so that each fastening will be suitable for supporting the maximum weight of luminaires that can be installed. Except where identified for supports at greater intervals, a single section 4 feet (1219 mm) or shorter in length shall have two supports and, where installed in a continuous row, each individual section of not more than 4 feet (1219 mm) in length shall have one additional support. (410.154)~~

~~E4005.6 Grounding.~~
~~Lighting track shall be grounded in accordance with Chapter 39, and the track sections shall be securely coupled to maintain continuity of the circuitry, polarization and grounding throughout. [410.155(B)]~~

CHAPTER 41

APPLIANCE INSTALLATION

Deleted. See the *North Carolina Electrical Code.*

~~SECTION E4101~~
~~GENERAL~~

~~E4101.1 Scope.~~

~~This section covers installation requirements for appliances and fixed heating equipment. (422.1 and 424.1)~~

~~E4101.2 Installation.~~

~~Appliances and equipment shall be installed in accordance with the manufacturer's installation instructions. Electrically heated appliances and equipment shall be installed with the required clearances to combustible materials. [110.3(B) and 422.17]~~

~~E4101.3 Flexible cords.~~

~~Cord-and-plug-connected appliances shall use cords suitable for the environment and physical conditions likely to be encountered. Flexible cords shall be used only where the appliance is listed to be connected with a flexible cord. The cord shall be identified as suitable in the installation instructions of the appliance manufacturer. Receptacles for cord-and-plug-connected appliances shall be accessible and shall be located to avoid physical damage to the flexible cord. Except for a listed appliance marked to indicate that it is protected by a system of double-insulation, the flexible cord supplying an appliance shall terminate in a grounding-type attachment plug. A receptacle for a cord-and-plug-connected range hood shall be supplied by an individual branch circuit. Specific appliances have additional requirements as specified in Table E4101.3 (see Section E3909). [422.16(B)(1), (B)(2)]~~

~~TABLE E4101.3~~
~~FLEXIBLE CORD LENGTH~~

~~APPLIANCE~~	~~MINIMUM CORD LENGTH (inches)~~	~~MAXIMUM CORD LENGTH (inches)~~
~~Electrically operated in-sink waste disposal~~	~~18~~	~~36~~
~~Built-in dishwasher~~	~~36~~	~~48~~
~~Trash compactor~~	~~36~~	~~48~~
~~Range hoods~~	~~18~~	~~36~~

~~For SI: 1 inch = 25.4 mm.~~

~~E4101.4 Overcurrent protection.~~

~~Each appliance shall be protected against overcurrent in accordance with the rating of the appliance and its listing. [110.3(B), 422.11(A)]~~

~~E4101.4.1 Single nonmotor-operated appliance.~~

~~The overcurrent protection for a branch circuit that supplies a single nonmotor-operated appliance shall not exceed that marked on the appliance. Where the overcurrent protection~~

~~rating is not marked and the appliance is rated at over 13.3 amperes, the overcurrent protection shall not exceed 150 percent of the appliance rated current. Where 150 percent of the appliance rating does not correspond to a standard overcurrent device ampere rating, the next higher standard rating shall be permitted. Where the overcurrent protection rating is not marked and the appliance is rated at 13.3 amperes or less, the overcurrent protection shall not exceed 20 amperes. [422.11(E)]~~

~~**E4101.5 Disconnecting means.**~~

~~Each appliance shall be provided with a means to disconnect all ungrounded supply conductors. For fixed electric space-heating equipment, means shall be provided to disconnect the heater and any motor controller(s) and supplementary overcurrent-protective devices. Switches and circuit breakers used as a disconnecting means shall be of the indicating type. Disconnecting means shall be as set forth in Table E4101.5. (422.30, 422.35, and 424.19)~~

~~**TABLE E4101.5**~~
~~**DISCONNECTING MEANS [422.31(A), (B), and (C); 422.34; 422.35; 424.19; 424.20; and 440.14]**~~

~~**DESCRIPTION**~~	~~**ALLOWED DISCONNECTING MEANS**~~
~~Permanently connected appliance rated at not over 300 volt-amperes or $^1/_8$ horsepower.~~	~~anch-circuit overcurrent device.~~
~~rmanently connected appliances rated in excess of 300 volt-amperes.~~	~~anch circuit breaker or switch located within sight of appliance or such devices in any location that are capable of being locked in the open position. The provision for locking or adding a lock to the disconnecting means shall be installed on or at the switch or circuit breaker used as the disconnecting means and shall remain in place with or without the lock installed.~~
~~tor-operated appliances rated over $^1/_8$ horsepower.~~	~~r permanently connected motor-operated appliances with motors rated over $^1/_8$ horsepower, the branch circuit switch or circuit breaker shall be permitted to serve as the disconnecting means where the switch or circuit breaker is within sight from the appliance. Where the branch circuit switch is not located within sight from the appliance, the disconnecting means shall be one of the following types: a listed motor-circuit switch rated in horsepower, a listed molded case circuit breaker, a listed molded case switch, a listed manual motor controller ladditionally marked "Suitable as Motor Disconnect" where installed~~

	~~between the final motor branch-circuit short-circuit protective device and the motor. For stationary motors rated at 2 hp or less and 300 volts or less, the disconnecting means shall be permitted to be one of the following devices:~~ ~~1. A general-use switch having an ampere rating not less than twice the full-load current rating of the motor.~~ ~~2. On AC circuits, a general-use snap switch suitable only for use on AC, not general-use AC–DC snap switches, where the motor full-load current rating is not more than 80 percent of the ampere rating of the switch.~~ ~~3. A listed manual motor controller having a horsepower rating not less than the rating of the motor and marked "Suitable as Motor Disconnect".~~ ~~The disconnecting means for motor circuits rated 600 volts, nominal, or less shall have an ampere rating not less than 115 percent of the full-load current rating of the motor except that a listed unfused motor-circuit switch having a horsepower rating not less than the motor horsepower shall be permitted to have an ampere rating less than 115 percent of the full-load current rating of the motor. The disconnecting means shall be installed within sight of the appliance.~~ ~~**Exception:** A unit switch with a marked-off position that is a part of an appliance and disconnects all ungrounded conductors shall be permitted as the disconnecting means and the switch or circuit breaker serving as the other disconnecting means shall be permitted to be out of sight from the appliance.~~
~~pliances listed for cord-and-plug connection.~~	~~eparable connector or attachment plug and receptacle provided with access.~~

~~*(continued)*~~

~~TABLE E4101.5—continued~~
~~DISCONNECTING MEANS~~

~~DESCRIPTION~~	~~ALLOWED DISCONNECTING MEANS~~
~~Permanently installed heating equipment with motors rated at not over 1/8 horsepower with supplementary overcurrent protection.~~	~~Disconnect, on the supply side of fuses, in sight from the supplementary overcurrent device, and in sight of the heating equipment or, in any location, if capable of being locked in the open position.~~

~~Heating equipment containing motors rated over $^1/_8$ horsepower with supplementary overcurrent protection.~~	~~Disconnect permitted to serve as required disconnect for both the heating equipment and the controller where, on the supply side of fuses, and in sight from the supplementary overcurrent devices, if the disconnecting means is also in sight from the controller, or is capable of being locked off and simultaneously disconnects the heater, motor controller(s) and supplementary overcurrent protective devices from all ungrounded conductors. The provision for locking or adding a lock to the disconnecting means shall be installed on or at the switch or circuit breaker used as the disconnecting means and shall remain in place with or without the lock installed. The disconnecting means shall have an ampere rating not less than 125 percent of the total load of the motors and the heaters.~~
~~Heating equipment containing no motor rated over $^1/_8$ horsepower without supplementary overcurrent protection.~~	~~Branch-circuit switch or circuit breaker where within sight from the heating equipment or capable of being locked off and simultaneously disconnects the heater, motor controller(s) and supplementary overcurrent protective devices from all ungrounded conductors. The provision for locking or adding a lock to the disconnecting means shall be installed on or at the switch or circuit breaker used as the disconnecting means and shall remain in place with or without the lock installed. The disconnecting means shall have an ampere rating not less than 125 percent of the total load of the motors and the heaters.~~
~~Heating equipment containing motors rated over $^1/_8$ horsepower without supplementary overcurrent protection.~~	~~Disconnecting means in sight from motor controller or as provided for heating equipment with motor rated over $^1/_8$ horsepower with supplementary overcurrent protection and simultaneously disconnects the heater, motor controller(s) and supplementary overcurrent protective devices from all ungrounded conductors. The provision for locking or adding a lock to the disconnecting means shall be installed on or at the switch or circuit breaker used as the disconnecting means and shall~~

	~~remain in place with or without the lock installed. The disconnecting means shall have an ampere rating not less than 125 percent of the total load of the motors and the heaters.~~
~~Air-conditioning condensing units and heat pump units.~~	~~A readily accessible disconnect within sight from unit as the only allowable means.~~[a]
~~Appliances and fixed heating equipment with unit switches having a marked OFF position.~~	~~Unit switch where an additional individual switch or circuit breaker serves as a redundant disconnecting means.~~
~~Thermostatically controlled fixed heating equipment.~~	~~Thermostats with a marked OFF position that directly open all ungrounded conductors, which when manually placed in the OFF position are designed so that the circuit cannot be energized automatically and that are located within sight of the equipment controlled.~~

~~For SI: 1 horsepower = 0.746 kW.~~

[a] ~~The disconnecting means shall be permitted to be installed on or within the unit. It shall not be located on panels designed to allow access to the unit or located so as to obscure the air-conditioning equipment nameplate(s).~~

~~E4101.6 Support of ceiling-suspended paddle fans.~~

~~Ceiling-suspended fans (paddle) shall be supported independently of an outlet box or by a listed outlet box or outlet box system identified for the use and installed in accordance with Section E3905.9. (422.18)~~

~~E4101.7 Snow-melting and deicing equipment protection.~~

~~Outdoor receptacles that are not readily accessible and are supplied from a dedicated branch circuit for electric snow-melting or deicing equipment shall be permitted to be installed without ground-fault circuit-interrupter protection for personnel. However, ground-fault protection of equipment shall be provided for fixed outdoor electric deicing and snow-melting equipment. [210.8(A)(3) Exception, 426.28]~~

CHAPTER 42

SWIMMING POOLS

Deleted. See the *North Carolina Electrical Code.*

~~SECTION E4201~~
~~GENERAL~~

~~E4201.1 Scope.~~
~~The provisions of this chapter shall apply to the construction and installation of electric wiring and equipment associated with all swimming pools, wading pools, decorative pools, fountains, hot tubs and spas, and hydromassage bathtubs, whether permanently installed or storable, and shall apply to metallic auxiliary equipment, such as pumps, filters and similar equipment. Sections E4202 through E4206 provide general rules for permanent pools, spas and hot tubs. Section E4207 provides specific rules for storable pools and storable/portable spas and hot tubs. Section E4208 provides specific rules for spas and hot tubs. Section E4209 provides specific rules for hydromassage bathtubs. (680.1)~~

~~E4201.2 Definitions.~~
~~(680.2)~~

~~CORD-AND-PLUG-CONNECTED LIGHTING ASSEMBLY.~~ ~~A lighting assembly consisting of a cord-and-plug-connected transformer and a luminaire intended for installation in the wall of a spa, hot tub, or storable pool.~~

~~DRY-NICHE LUMINAIRE.~~ ~~A luminaire intended for installation in the floor or wall of a pool, spa or fountain in a niche that is sealed against the entry of water.~~

~~FORMING SHELL.~~ ~~A structure designed to support a wet-niche luminaire assembly and intended for mounting in a pool or fountain structure.~~

~~FOUNTAIN.~~ ~~Fountains, ornamental pools, display pools, and reflection pools. The definition does not include drinking fountains.~~

~~HYDROMASSAGE BATHTUB.~~ ~~A permanently installed bathtub equipped with a recirculating piping system, pump, and associated equipment. It is designed so it can accept, circulate and discharge water upon each use.~~

~~LOW VOLTAGE CONTACT LIMIT.~~ ~~A voltage not exceeding the following values:~~

1. ~~15 volts (RMS) for sinusoidal AC~~
2. ~~21.2 volts peak for nonsinusoidal AC~~
3. ~~30 volts for continuous DC~~
4. ~~12.4 volts peak for DC that is interrupted at a rate of 10 to 200 Hz~~

~~**MAXIMUM WATER LEVEL.** The highest level that water can reach before it spills out.~~

~~**NO-NICHE LUMINAIRE.** A luminaire intended for installation above or below the water without a niche.~~

~~**PACKAGED SPA OR HOT TUB EQUIPMENT ASSEMBLY.** A factory-fabricated unit consisting of water-circulating, heating and control equipment mounted on a common base, intended to operate a spa or hot tub. Equipment may include pumps, air blowers, heaters, luminaires, controls and sanitizer generators.~~

~~**PERMANENTLY INSTALLED SWIMMING, WADING, IMMERSION AND THERAPEUTIC POOLS.** Those that are constructed in the ground or partially in the ground, and all others capable of holding water with a depth greater than 42 inches (1067 mm), and all pools installed inside of a building, regardless of water depth, whether or not served by electrical circuits of any nature.~~

~~**POOL.** Manufactured or field-constructed equipment designed to contain water on a permanent or semipermanent basis and used for swimming, wading, immersion, or therapeutic purposes.~~

~~**POOL COVER, ELECTRICALLY OPERATED.** Motor-driven equipment designed to cover and uncover the water surface of a pool by means of a flexible sheet or rigid frame.~~

~~**SELF-CONTAINED SPA OR HOT TUB.** A factory-fabricated unit consisting of a spa or hot tub vessel with all water-circulating, heating and control equipment integral to the unit. Equipment may include pumps, air blowers, heaters, luminaires, controls and sanitizer generators.~~

~~**SPA OR HOT TUB.** A hydromassage pool, or tub for recreational or therapeutic use, not located in health care facilities, designed for immersion of users, and usually having a filter, heater, and motor-driven blower. They are installed indoors or outdoors, on the ground or supporting structure, or in the ground or supporting structure. Generally, a spa or hot tub is not designed or intended to have its contents drained or discharged after each use.~~

~~**STORABLE SWIMMING, WADING OR IMMERSION POOLS; OR STORABLE/PORTABLE SPAS AND HOT TUBS.** Those that are constructed on or above the ground and are capable of holding water with a maximum depth of 42 inches (1067 mm), or a pool with nonmetallic, molded polymeric walls or inflatable fabric walls regardless of dimension.~~

~~**THROUGH-WALL LIGHTING ASSEMBLY.** A lighting assembly intended for installation above grade, on or through the wall of a pool, consisting of two interconnected groups of components separated by the pool wall.~~

~~**WET-NICHE LUMINAIRE.** A luminaire intended for installation in a forming shell mounted in a pool or fountain structure where the luminaire will be completely surrounded by water.~~

~~SECTION E4202~~

~~WIRING METHODS FOR POOLS, SPAS, HOT TUBS AND HYDROMASSAGE BATHTUBS~~

~~E4202.1 General.~~

~~Wiring methods used in conjunction with permanently installed swimming pools, spas, hot tubs~~

~~or hydromassage bathtubs shall be installed in accordance with Table E4202.1 and Chapter 38 except as otherwise stated in this section. Storable swimming pools shall comply with Section E4207. [680.7; 680.21(A); 680.23(B) and (F); 680.25(A); 680.42; 680.43; and 680.70]~~

~~TABLE E4202.1~~
~~ALLOWABLE APPLICATIONS FOR WIRING METHODS~~[a, b, c, d, e, f, g, h, k]

~~WIRING LOCATION OR PURPOSE (Application allowed where marked with an "A")~~	~~AC, FMC, NM, SR, SE~~	~~EMT~~	~~ENT~~	~~IMC~~[i], ~~RMC~~[i], ~~RNC~~[h]	~~LFMC~~	~~LFNMC~~	~~UF~~	~~MC~~[j]	~~FLEX CORD~~
~~Panelboard(s) that supply pool equipment from service equipment to panelboard~~	~~A[b, e] SR not permitted~~	~~A~~[c]	~~A~~[b]	~~A~~	—	~~A~~	~~A~~[e]	~~A~~[e]	—
~~Wet-niche and no-niche luminaires: from branch circuit OCPD to deck or junction box~~	~~AC~~[b] ~~only~~	~~A~~[c]	~~A~~[b]	~~A~~	—	~~A~~	—	~~A~~[b]	—
~~Wet-niche and no-niche luminaires: from deck or junction box to forming shell~~	—	—	—	~~A~~[d]	—	~~A~~	—	—	~~A~~[g]
~~Dry niche: from branch circuit OCPD to luminaires~~	~~AC~~[b] ~~only~~	~~A~~[c]	~~A~~[b]	~~A~~	—	~~A~~	—	~~A~~[b]	—
~~Pool-associated motors: from branch circuit OCPD to motor~~	~~A~~[b]	~~A~~[c]	~~A~~[b]	~~A~~	~~A~~[e]	~~A~~[e]	~~A~~[b]	~~A~~	~~A~~[g]
~~Packaged or self-contained outdoor spas and hot tubs with underwater luminaire: from branch circuit OCPD to spa or hot tub~~	~~AC~~[b] ~~only~~	~~A~~[c]	~~A~~[b]	~~A~~	~~A~~[f]	~~A~~[f]	—		~~A~~[g]
~~Packaged or self-contained outdoor spas and hot tubs without underwater luminaire: from branch circuit OCPD to spa or hot tub~~	~~A~~[b]	~~A~~[c]	~~A~~[b]	~~A~~	~~A~~[f]	~~A~~[f]	~~A~~[b]	~~A~~	~~A~~[g]
~~Indoor spas and hot tubs, hydromassage bathtubs, and other pool, spa or hot tub associated equipment: from branch circuit OCPD to equipment~~	~~A~~[b]	~~A~~[c]	~~A~~[b]	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~[g]
~~Connection at pool lighting transformers or power supplies~~	~~AC~~[b] ~~only~~	~~A~~[c]	~~A~~[b]	~~A~~	~~A~~[l, f]	~~A~~[f]	—	~~A~~[b]	—

~~For SI: 1 foot = 304.8 mm.~~

~~a. For all wiring methods, see Section E4205 for equipment grounding conductor requirements.~~
~~b. Limited to use within buildings.~~
~~c. Limited to use on or within buildings.~~
~~d. Metal conduit shall be constructed of brass or other approved corrosion-resistant metal.~~
~~e. Limited to where necessary to employ flexible connections at or adjacent to a pool motor.~~
~~f. Sections installed external to spa or hot tub enclosure limited to individual lengths not to exceed 6 feet. Length not limited inside spa or hot tub enclosure.~~
~~g. Flexible cord shall be installed in accordance with Section E4202.2.~~
~~h. Nonmetallic conduit shall be rigid polyvinyl chloride conduit Type PVC or reinforced thermosetting resin conduit Type RTRC.~~
~~i. Aluminum conduits shall not be permitted in the pool area where subject to corrosion.~~
~~j. Where installed as direct burial cable or in wet locations, Type MC cable shall be listed and identified for the location.~~
~~k. See Section E4202.3 for listed, double-insulated pool pump motors.~~
~~l. Limited to use in individual lengths not to exceed 6 feet. The total length of all individual runs of LFMC shall not exceed 10 feet.~~

~~E4202.2 Flexible cords.~~

~~Flexible cords used in conjunction with a pool, spa, hot tub or hydromassage bathtub shall be installed in accordance with the following:~~

1. ~~For other than underwater luminaires, fixed or stationary equipment shall be permitted to be connected with a flexible cord to facilitate removal or disconnection for maintenance or repair. For other than storable pools, the flexible cord shall not exceed 3 feet (914 mm) in length. Cords that supply swimming pool equipment shall have a copper equipment grounding conductor not smaller than 12 AWG and shall terminate in a grounding-type attachment plug. [680.7(A), (B), and (C); 680.21(A)(5)]~~

2. ~~Other than listed low-voltage lighting systems not requiring grounding, wet-niche luminaires that are supplied by a flexible cord or cable shall have all exposed noncurrent-carrying metal parts grounded by an insulated copper equipment grounding conductor that is an integral part of the cord or cable. Such grounding conductor shall be connected to a grounding terminal in the supply junction box, transformer enclosure, or other enclosure and shall be not smaller than the supply conductors and not smaller than 16 AWG. [680.23(B)(3)]~~

3. ~~A listed packaged spa or hot tub installed outdoors that is GFCI protected shall be permitted to be cord-and-plug-connected provided that such cord does not exceed 15 feet (4572 mm) in length. [680.42(A)(2)]~~

4. ~~A listed packaged spa or hot tub rated at 20 amperes or less and installed indoors shall be permitted to be cord-and-plug-connected to facilitate maintenance and repair. (680.43 Exception No. 1)~~

5. ~~For other than underwater and storable pool lighting luminaire, the requirements of Item 1 shall apply to any cord-equipped luminaire that is located within 16 feet (4877 mm) radially from any point on the water surface. [680.22(B)(5)]~~

~~E4202.3 Double insulated pool pumps.~~

~~A listed cord and plug-connected pool pump incorporating an approved system of double insulation that provides a means for grounding only the internal and nonaccessible, noncurrent-carrying metal parts of the pump shall be connected to any wiring method recognized in Chapter 38 that is suitable for the location. Where the bonding grid is connected to the equipment~~

~~grounding conductor of the motor circuit in accordance with Section E4204.2, Item 6.1, the branch circuit wiring shall comply with Sections E4202.1 and E4205.5. [680.21(B)]~~

~~SECTION E4203~~
~~EQUIPMENT LOCATION AND CLEARANCES~~

~~E4203.1 Receptacle outlets.~~
~~Receptacles outlets shall be installed and located in accordance with Sections E4203.1.1 through E4203.1.5. Distances shall be measured as the shortest path that an appliance supply cord connected to the receptacle would follow without penetrating a floor, wall, ceiling, doorway with hinged or sliding door, window opening, or other effective permanent barrier. [680.22(A)(5)]~~

~~E4203.1.1 Location.~~
~~Receptacles that provide power for water-pump motors or other loads directly related to the circulation and sanitation system shall be permitted to be located between 6 feet and 10 feet (1829 mm and 3048 mm) from the inside walls of pools and outdoor spas and hot tubs, where the receptacle is single and of the grounding type and protected by ground-fault circuit interrupters.~~

~~Other receptacles on the property shall be located not less than 6 feet (1829 mm) from the inside walls of pools and outdoor spas and hot tubs. [680.22(A)(2) and (A)(3)]~~

~~E4203.1.2 Where required.~~
~~At least one 125-volt, 15- or 20-ampere receptacle supplied by a general-purpose branch circuit shall be located a minimum of 6 feet (1829 mm) from and not more than 20 feet (6096 mm) from the inside wall of pools and outdoor spas and hot tubs. This receptacle shall be located not more than 6 feet, 6 inches (1981 mm) above the floor, platform or grade level serving the pool, spa or hot tub. [680.22(A)(1)]~~

~~E4203.1.3 GFCI protection.~~
~~All 15- and 20-ampere, single phase, 125-volt receptacles located within 20 feet (6096 mm) of the inside walls of pools and outdoor spas and hot tubs shall be protected by a ground-fault circuit-interrupter. Outlets supplying pool pump motors supplied from branch circuits rated at 120 volts through 240 volts, single phase, whether by receptacle or direct connection, shall be provided with ground-fault circuit-interrupter protection for personnel. [680.21(C) and 680.22(A)(4)]~~

~~E4203.1.4 Indoor locations.~~
~~Receptacles shall be located not less than 6 feet (1829 mm) from the inside walls of indoor spas and hot tubs. A minimum of one 125-volt receptacle shall be located between 6 feet (1829 mm) and 10 feet (3048 mm) from the inside walls of indoor spas or hot tubs. [680.43(A) and 680.43(A)(1)]~~

~~E4203.1.5 Indoor GFCI protection.~~
~~All 125-volt receptacles rated 30 amperes or less and located within 10 feet (3048 mm) of the inside walls of spas and hot tubs installed indoors, shall be protected by ground-fault circuit-interrupters. [680.43(A)(2)]~~

~~E4203.2 Switching devices.~~
~~Switching devices shall be located not less than 5 feet (1524 mm) horizontally from the inside~~

~~walls of pools, spas and hot tubs except where separated from the pool, spa or hot tub by a solid fence, wall, or other permanent barrier or the switches are listed for use within 5 feet (1524 mm). Switching devices located in a room or area containing a hydromassage bathtub shall be located in accordance with the general requirements of this code. [680.22(C); 680.43(C); and 680.72]~~

~~E4203.3 Disconnecting means.~~

~~One or more means to simultaneously disconnect all ungrounded conductors for all utilization equipment, other than lighting, shall be provided. Each of such means shall be readily accessible and within sight from the equipment it serves and shall be located at least 5 feet (1524 mm) horizontally from the inside walls of a pool, spa, or hot tub unless separated from the open water by a permanently installed barrier that provides a 5-foot (1524 mm) or greater reach path. This horizontal distance shall be measured from the water's edge along the shortest path required to reach the disconnect. (680.12)~~

~~E4203.4 Luminaires and ceiling fans.~~

~~Lighting outlets, luminaires, and ceiling-suspended paddle fans shall be installed and located in accordance with Sections E4203.4.1 through E4203.4.6. [680.22(B)]~~

~~E4203.4.1 Outdoor location.~~

~~In outdoor pool, outdoor spas and outdoor hot tubs areas, luminaires, lighting outlets, and ceiling-suspended paddle fans shall not be installed over the pool or over the area extending 5 feet (1524 mm) horizontally from the inside walls of a pool except where no part of the luminaire or ceiling-suspended paddle fan is less than 12 feet (3658 mm) above the maximum water level. [680.22(B)(1)]~~

~~E4203.4.2 Indoor locations.~~

~~In indoor pool areas, the limitations of Section E4203.4.1 shall apply except where the luminaires, lighting outlets and ceiling-suspended paddle fans comply with all of the following conditions:~~

1. ~~The luminaires are of a totally enclosed type;~~
2. ~~Ceiling-suspended paddle fans are identified for use beneath ceiling structures such as porches and patios.~~
3. ~~A ground-fault circuit interrupter is installed in the branch circuit supplying the luminaires or ceiling-suspended paddle fans; and~~
4. ~~The distance from the bottom of the luminaire or ceiling-suspended paddle fan to the maximum water level is not less than 7 feet, 6 inches (2286 mm). [680.22(B)(2)]~~

~~E4203.4.3 Low-voltage luminaires.~~

~~Listed low-voltage luminaires not requiring grounding, not exceeding the low-voltage contact limit, and supplied by listed transformers or power supplies that comply with Section E4206.1 shall be permitted to be located less than 1.5 m (5 ft) from the inside walls of the pool. [680.22(B)(6)]~~

~~E4203.4.4 Existing lighting outlets and luminaires.~~

~~Existing lighting outlets and luminaires that are located within 5 feet (1524 mm) horizontally~~

~~from the inside walls of pools and outdoor spas and hot tubs shall be permitted to be located not less than 5 feet (1524 mm) vertically above the maximum water level, provided that such luminaires and outlets are rigidly attached to the existing structure and are protected by a ground-fault circuit-interrupter. [680.22(B)(3)]~~

~~E4203.4.5 Indoor spas and hot tubs.~~

~~1. Luminaires, lighting outlets, and ceiling-suspended paddle fans located over the spa or hot tub or within 5 feet (1524 mm) from the inside walls of the spa or hot tub shall be not less than 7 feet, 6 inches (2286 mm) above the maximum water level and shall be protected by a ground-fault circuit interrupter. [680.43(B)(1)(b)]~~

~~Luminaires, lighting outlets, and ceiling-suspended paddle fans that are located 12 feet (3658 mm) or more above the maximum water level shall not require ground-fault circuit interrupter protection. [680.43(B)(1)(a)]~~

~~2. Luminaires protected by a ground-fault circuit interrupter and complying with Item 2.1 or 2.2 shall be permitted to be installed less than 7 feet, 6 inches (2286 mm) over a spa or hot tub.~~

~~2.1. Recessed luminaires shall have a glass or plastic lens and nonmetallic or electrically isolated metal trim, and shall be suitable for use in damp locations.~~

~~2.2. Surface-mounted luminaires shall have a glass or plastic globe and a nonmetallic body or a metallic body isolated from contact.Such luminaires shall be suitable for use in damp locations. [680.43(B)(1)(c)]~~

~~E4203.4.6 GFCI protection in adjacent areas.~~

~~Luminaires and outlets that are installed in the area extending between 5 feet (1524 mm) and 10 feet (3048 mm) from the inside walls of pools and outdoor spas and hot tubs shall be protected by ground-fault circuit-interrupters except where such fixtures and outlets are installed not less than 5 feet (1524 mm) above the maximum water level and are rigidly attached to the structure. [680.22(B)(4)]~~

~~E4203.5 Other outlets.~~

~~Other outlets such as for remote control, signaling, fire alarm and communications shall be not less than 10 feet (3048 mm) from the inside walls of the pool. Measurements shall be determined in accordance with Section E4203.1. [680.22(D)]~~

~~TABLE E4203.5 [Table 680.8(A)]~~
~~OVERHEAD CONDUCTOR CLEARANCES~~

-	~~INSULATED SUPPLY OR SERVICE DROP CABLES, 0-750 VOLTS TO GROUND, SUPPORTED ON AND CABLED TOGETHER WITH AN EFFECTIVELY GROUNDED BARE MESSENGER OR EFFECTIVELY GROUNDED NEUTRAL CONDUCTOR (feet)~~	~~ALL OTHER SUPPLY OR SERVICE DROP CONDUCTORS (feet)~~	
		~~Voltage to ground~~	
		~~0-15 kV~~	~~Greater than 15 to 50 kV~~

~~A. Clearance in any direction to the water level, edge of water surface, base of diving platform, or permanently anchored raft~~	~~22.5~~	~~25~~	~~27~~
~~B. Clearance in any direction to the diving platform~~	~~14.5~~	~~17~~	~~18~~

~~For SI: 1 foot = 304.8 mm.~~

~~E4203.6 Overhead conductor clearances.~~

~~Except where installed with the clearances specified in Table E4203.5, the following parts of pools and outdoor spas and hot tubs shall not be placed under existing service-drop conductors, overhead service conductor, or any other open overhead wiring; nor shall such wiring be installed above the following:~~

1. ~~Pools and the areas extending not less than 10 feet, (3048 mm) horizontally from the inside of the walls of the pool;~~
2. ~~Diving structures and the areas extending not less than 10 feet (3048 mm) horizontally from the outer edge of such structures.~~
3. ~~Observation stands, towers, and platforms and the areas extending not less than 10 feet (3048 mm) horizontally from the outer edge of such structures.~~

~~Overhead conductors of network-powered broadband communications systems shall comply with the provisions in Table E4203.5 for conductors operating at 0 to 750 volts to ground.~~

~~Utility-owned, -operated and -maintained communications conductors, community antenna system coaxial cables and the supporting messengers shall be permitted at a height of not less than 10 feet (3048 mm) above swimming and wading pools, diving structures, and observation stands, towers, and platforms. [680.8(A), (B), and (C)]~~

~~E4203.7 Underground wiring.~~

~~Underground wiring shall not be installed under or within the area extending 5 feet (1524 mm) horizontally from the inside walls of pools and outdoor hot tubs and spas except where the wiring is installed to supply pool, spa or hot tub equipment or where space limitations prevent wiring from being routed 5 feet (1524 mm) or more horizontally from the inside walls. Where installed within 5 feet (1524 mm) of the inside walls, the wiring method shall be a complete raceway system of rigid metal conduit, intermediate metal conduit or a nonmetallic raceway system. Metal conduit shall be corrosion resistant and suitable for the location. The minimum cover depth shall be in accordance with Table E4203.7. (680.10)~~

~~TABLE E4203.7 (680.10)~~
~~MINIMUM BURIAL DEPTHS~~

~~WIRING METHOD~~	**~~UNDERGROUND WIRING (inches)~~**

~~Rigid metal conduit~~	~~6~~
~~Intermediate metal conduit~~	~~6~~
~~Nonmetallic raceways listed for direct burial and under concrete exterior slab not less than 4 inches in thickness and extending not less than 6 inches (162 mm) beyond the underground installation~~	~~6~~
~~Nonmetallic raceways listed for direct burial without concrete encasement~~	~~18~~
~~Other approved raceways[a]~~	~~18~~

~~For SI: 1 inch = 25.4 mm.~~

~~a. Raceways approved for burial only where concrete-encased shall require a concrete envelope not less than 2 inches in thickness.~~

~~SECTION E4204~~
~~BONDING~~

~~E4204.1 Performance.~~
~~The equipotential bonding required by this section shall be installed to reduce voltage gradients in the prescribed areas of permanently installed swimming pools and spas and hot tubs other than the storable/portable type.~~

~~E4204.2 Bonded parts.~~
~~The parts of pools, spas, and hot tubs specified in Items 1 through 7 shall be bonded together using insulated, covered or bare solid copper conductors not smaller than 8 AWG or using rigid metal conduit of brass or other identified corrosion-resistant metal. An 8 AWG or larger solid copper bonding conductor provided to reduce voltage gradients in the pool, spa, or hot tub area shall not be required to be extended or attached to remote panelboards, service equipment, or electrodes. Connections shall be made by exothermic welding, by listed pressure connectors or clamps that are labeled as being suitable for the purpose and that are made of stainless steel, brass, copper or copper alloy, machine screw-type fasteners that engage not less than two threads or are secured with a nut, thread-forming machine screws that engage not less than two threads, or terminal bars. Connection devices or fittings that depend solely on solder shall not be used. Sheet metal screws shall not be used to connect bonding conductors or connection devices. [680.26(B)]~~

~~1. Conductive pool shells. Bonding to conductive pool shells shall be provided as specified in Item 1.1 or 1.2. Poured concrete, pneumatically applied or sprayed concrete, and concrete block with painted or plastered coatings shall be considered to be conductive materials because of their water permeability and porosity. Vinyl liners and fiberglass composite shells shall be considered to be nonconductive materials.~~

    ~~1.1. Structural reinforcing steel. Unencapsulated structural reinforcing steel shall be bonded together by steel tie wires or the equivalent. Where structural reinforcing steel is encapsulated in a nonconductive compound, a copper conductor grid shall be installed in accordance with Item 1.2.~~

    ~~1.2. Copper conductor grid. A copper conductor grid shall be provided and shall comply with Items 1.2.1 through 1.2.4:~~

~~1.2.1. It shall be constructed of minimum 8 AWG bare solid copper conductors bonded to each other at all points of crossing.~~

~~1.2.2. It shall conform to the contour of the pool .~~

~~1.2.3. It shall be arranged in a 12-inch (305 mm) by 12-inch (305 mm) network of conductors in a uniformly spaced perpendicular grid pattern with a tolerance of 4 inches (102 mm).~~

~~1.2.4. It shall be secured within or under the pool not more than 6 inches (152 mm) from the outer contour of the pool shell. [680.26(B)(1)]~~

~~2. Perimeter surfaces. The perimeter surface shall extend for 3 feet (914 mm) horizontally beyond the inside walls of the pool and shall include unpaved surfaces, poured concrete surfaces and other types of paving. Perimeter surfaces that extend less than 3 feet (914 mm) beyond the inside wall of the pool and that are separated from the pool by a permanent wall or building 5 feet (1524 mm) or more in height shall require equipotential bonding on the pool side of the permanent wall or building. Bonding to perimeter surfaces shall be provided as specified in Item 2.1 or 2.2 and shall be attached to the pool, spa, or hot tub reinforcing steel or copper conductor grid at a minimum of four points uniformly spaced around the perimeter of the pool, spa, or hot tub. For nonconductive pool shells, bonding at four points shall not be required.~~

~~**Exceptions:**~~

~~1. Equipotential bonding of perimeter surfaces shall not be required for spas and hot tubs where all of the following conditions apply:~~

~~1.1. The spa or hot tub is listed as a self-contained spa for aboveground use.~~

~~1.2. The spa or hot tub is not identified as suitable only for indoor use.~~

~~1.3. The installation is in accordance with the manufacturer’s instructions and is located on or above grade.~~

~~1.4. To top rim of the spa or hot tub is not less than 28 in. (711 mm) above all perimeter surfaces that are within 30 in. (762 mm), measured horizontally from the spa or hot tub. The height of nonconductive external steps for entry to or exit from the self-contained spa is not used to reduce or increase this rim height measurement.~~

~~2. The equipotential bonding requirements for perimeter surfaces shall not apply to a listed self-contained spa or hot tub located indoors and installed above a finished floor.~~

~~2.1. Structural reinforcing steel. Structural reinforcing steel shall be bonded in accordance with Item 1.1.~~

~~2.2. Alternate means. Where structural reinforcing steel is not available or is encapsulated in a nonconductive compound, a copper conductor(s) shall be used in accordance with Items 2.2.1 through 2.2.5:~~

~~2.2.1. At least one minimum 8 AWG bare solid copper conductor shall be provided.~~

~~2.2.2. The conductors shall follow the contour of the perimeter surface.~~

~~2.2.3. Splices shall be listed.~~

~~2.2.4. The required conductor shall be 18 to 24 inches (457 to 610 mm) from the inside walls of the pool.~~

~~2.2.5. The required conductor shall be secured within or under the perimeter surface 4 to 6 inches (102 mm to 152 mm) below the subgrade. [680.26(B)(2)]~~

~~3. Metallic components. All metallic parts of the pool structure, including reinforcing metal not addressed in Item 1.1, shall be bonded. Where reinforcing steel is encapsulated with a nonconductive compound, the reinforcing steel shall not be required to be bonded. [680.26(B)(3)]~~

~~4. Underwater lighting. All metal forming shells and mounting brackets of no-niche luminaires shall be bonded. [680.26(B)(4)]~~

~~**Exception:** Listed low-voltage lighting systems with nonmetallic forming shells shall not require bonding. [680.26(B)(4) Exception]~~

~~5. Metal fittings. All metal fittings within or attached to the pool structure shall be bonded. Isolated parts that are not over 4 inches (102 mm) in any dimension and do not penetrate into the pool structure more than 1 inch (25.4 mm) shall not require bonding. [680.26(B)(5)]~~

~~6. Electrical equipment. Metal parts of electrical equipment associated with the pool water circulating system, including pump motors and metal parts of equipment associated with pool covers, including electric motors, shall be bonded. [680.26(B)(6)]~~

~~**Exception:** Metal parts of listed equipment incorporating an approved system of double insulation shall not be bonded. [680.26(B)(6) Exception]~~

~~6.1. Double-insulated water pump motors. Where a double-insulated water pump motor is installed under the provisions of this item, a solid 8 AWG copper conductor of sufficient length to make a bonding connection to a replacement motor shall be extended from the bonding grid to an accessible point in the vicinity of the pool pump motor. Where there is no connection between the swimming pool bonding grid and the equipment grounding system for the premises, this bonding conductor shall be connected to the equipment grounding conductor of the motor circuit. [680.26(B)(6)(a)]~~

    - ~~6.2. Pool water heaters. For pool water heaters rated at more than 50 amperes and having specific instructions regarding bonding and grounding, only those parts designated to be bonded shall be bonded and only those parts designated to be grounded shall be grounded. [680.26(B)(6)(b)]~~

7. ~~All fixed metal parts including, but not limited to, metal-sheathed cables and raceways, metal piping, metal awnings, metal fences and metal door and window frames. [680.26(B)(7)]~~

    ~~Exceptions:~~

    1. ~~Those separated from the pool by a permanent barrier that prevents contact by a person shall not be required to be bonded. [680.26(B)(7) Exception No. 1]~~

    2. ~~Those greater than 5 feet (1524 mm) horizontally from the inside walls of the pool shall not be required to be bonded. [680.26(B)(7) Exception No. 2]~~

    3. ~~Those greater than 12 feet (3658 mm) measured vertically above the maximum water level of the pool, or as measured vertically above any observation stands, towers, or platforms, or any diving structures, shall not be required to be bonded. [680.26(B)(7) Exception No. 3]~~

~~E4204.3 Pool water.~~
~~Where none of the bonded parts is in direct connection with the pool water, the pool water shall be in direct contact with an approved corrosion-resistant conductive surface that exposes not less than 9 in.2 (5800 mm^2) of surface area to the pool water at all times. The conductive surface shall be located where it is not exposed to physical damage or dislodgement during usual pool activities, and it shall be bonded in accordance with Section E4204.2.~~

~~E4204.4 Bonding of outdoor hot tubs and spas.~~
~~Outdoor hot tubs and spas shall comply with the bonding requirements of Sections E4204.1 through E4204.3. Bonding by metal-to-metal mounting on a common frame or base shall be permitted. The metal bands or hoops used to secure wooden staves shall not be required to be bonded as required in Section E4204.2. [680.42 and 680.42(B)]~~

~~E4204.5 Bonding of indoor hot tubs and spas.~~
~~The following parts of indoor hot tubs and spas shall be bonded together:~~

1. ~~All metal fittings within or attached to the hot tub or spa structure. [680.43(D)(1)]~~

2. ~~Metal parts of electrical equipment associated with the hot tub or spa water circulating system, including pump motors unless part of a listed self-contained spa or hot tub. [680.43(D)(2)]~~

3. ~~Metal raceway and metal piping that are within 5 feet (1524 mm) of the inside walls of the hot tub or spa and that are not separated from the spa or hot tub by a permanent barrier. [680.43(D)(3)]~~

4. ~~All metal surfaces that are within 5 feet (1524 mm) of the inside walls of the hot tub or spa and that are not separated from the hot tub or spa area by a permanent barrier. [680.43(D)(4)]~~

   ~~**Exception:** Small conductive surfaces not likely to become energized, such as air and water jets and drain fittings, where not connected to metallic piping, towel bars, mirror frames, and similar nonelectrical equipment, shall not be required to be bonded. [680.43(D)(4) Exception]~~

5. ~~Electrical devices and controls that are not associated with the hot tubs or spas and that are located less than 5 feet (1524 mm) from such units. [680.43(D)(5)]~~

~~**E4204.5.1 Methods.**~~
~~All metal parts associated with the hot tub or spa shall be bonded by any of the following methods:~~

1. ~~The interconnection of threaded metal piping and fittings. [680.43(E)(1)]~~

2. ~~Metal-to-metal mounting on a common frame or base. [680.43(E)(2)]~~

3. ~~The provision of an insulated, covered or bare solid copper bonding jumper not smaller than 8 AWG.It shall not be the intent to require that the 8 AWG or larger solid copper bonding conductor be extended or attached to any remote panelboard, service equipment, or any electrode, but only that it shall be employed to eliminate voltage gradients in the hot tub or spa area as prescribed. [680.43(E)(3)]~~

~~**E4204.5.2 Connections.**~~
~~Connections to bonded parts shall be made in accordance with Section E3406.13.1.~~

~~SECTION E4205~~
~~GROUNDING~~

~~**E4205.1 Equipment to be grounded.**~~
~~The following equipment shall be grounded:~~

1. ~~Through-wall lighting assemblies and underwater luminaires other than those low-voltage lighting products listed for the application without a grounding conductor.~~

2. ~~All electrical equipment located within 5 feet (1524 mm) of the inside wall of the pool, spa or hot tub.~~

3. ~~All electrical equipment associated with the recirculating system of the pool, spa or hot tub.~~

4. ~~Junction boxes.~~

5. ~~Transformer and power supply enclosures.~~

6. ~~Ground-fault circuit-interrupters.~~

7. ~~Panelboards that are not part of the service equipment and that supply any electrical equipment associated with the pool, spa or hot tub. (680.7)~~

~~E4205.2 Luminaires and related equipment.~~

~~Other than listed low-voltage luminaires not requiring grounding, all through-wall lighting assemblies, wet-niche, dry-niche, or no-niche luminaires shall be connected to an insulated copper equipment grounding conductor sized in accordance with Table E3908.12 but not smaller than 12 AWG. The equipment grounding conductor between the wiring chamber of the secondary winding of a transformer and a junction box shall be sized in accordance with the overcurrent device in such circuit. The junction box, transformer enclosure, or other enclosure in the supply circuit to a wet-niche or no-niche luminaire and the field-wiring chamber of a dry-niche luminaire shall be grounded to the equipment grounding terminal of the panelboard. The equipment grounding terminal shall be directly connected to the panelboard enclosure. The equipment grounding conductor shall be installed without joint or splice. [680.23(F)(2) and 680.23(F)(2) Exception]~~

~~Exceptions:~~

1. ~~Where more than one underwater luminaire is supplied by the same branch circuit, the equipment grounding conductor, installed between the junction boxes, transformer enclosures, or other enclosures in the supply circuit to wet-niche luminaires, or between the field-wiring compartments of dry-niche luminaires, shall be permitted to be terminated on grounding terminals. [680.23(F)(2)(a)]~~

2. ~~Where an underwater luminaire is supplied from a transformer, ground-fault circuit-interrupter, clock-operated switch, or a manual snap switch that is located between the panelboard and a junction box connected to the conduit that extends directly to the underwater luminaire, the equipment grounding conductor shall be permitted to terminate on grounding terminals on the transformer, ground-fault circuit-interrupter, clock-operated switch enclosure, or an outlet box used to enclose a snap switch. [680.23(F)(2)(b)]~~

~~E4205.3 Nonmetallic conduit.~~

~~Where a nonmetallic conduit is installed between a forming shell and a junction box, transformer enclosure, or other enclosure, a 8 AWG insulated copper bonding jumper shall be installed in this conduit except where a listed low-voltage lighting system not requiring grounding is used. The bonding jumper shall be terminated in the forming shell, junction box or transformer enclosure, or ground-fault circuit-interrupter enclosure. The termination of the 8 AWG bonding jumper in the forming shell shall be covered with, or encapsulated in, a listed potting compound to protect such connection from the possible deteriorating effect of pool water. [680.23(B)(2)(b)]~~

~~E4205.4 Flexible cords.~~

~~Other than listed low-voltage lighting systems not requiring grounding, wet-niche luminaires that are supplied by a flexible cord or cable shall have all exposed noncurrent-carrying metal parts grounded by an insulated copper equipment grounding conductor that is an integral part of the cord or cable. This grounding conductor shall be connected to a grounding terminal in the supply junction box, transformer enclosure, or other enclosure. The grounding conductor shall not be smaller than the supply conductors and not smaller than 16 AWG. [680.23(B)(3)]~~

~~E4205.5 Motors.~~

~~Pool-associated motors shall be connected to an insulated copper equipment grounding conductor sized in accordance with Table E3908.12, but not smaller than 12 AWG. Where the branch circuit supplying the motor is installed in the interior of a one-family dwelling or in the interior of accessory buildings associated with a one-family dwelling, using a cable wiring method permitted by Table E4202.1, an uninsulated equipment grounding conductor shall be permitted provided that it is enclosed within the outer sheath of the cable assembly. [680.21(A)(1) and (A)(4)]~~

~~E4205.6 Feeders.~~

~~An equipment grounding conductor shall be installed with the feeder conductors between the grounding terminal of the pool equipment panelboard and the grounding terminal of the applicable service equipment. The equipment grounding conductor shall be insulated, shall be sized in accordance with Table E3908.12, and shall be not smaller than 12 AWG.~~

~~E4205.6.1 Separate buildings.~~

~~A feeder to a separate building or structure shall be permitted to supply swimming pool equipment branch circuits, or feeders supplying swimming pool equipment branch circuits, provided that the grounding arrangements in the separate building meet the requirements of Section E3607.3. The feeder equipment grounding conductor shall be an insulated conductor. (680.25(B)(2)]~~

~~E4205.7 Cord-connected equipment.~~

~~Where fixed or stationary equipment is connected with a flexible cord to facilitate removal or disconnection for maintenance, repair, or storage, as provided in Section E4202.2, the equipment grounding conductors shall be connected to a fixed metal part of the assembly. The removable part shall be mounted on or bonded to the fixed metal part. [680.7(C)]~~

~~E4205.8 Other equipment.~~

~~Other electrical equipment shall be grounded in accordance with Section E3908. (Article 250, Parts V, VI, and VII; and 680.6)~~

~~SECTION E4206~~
~~EQUIPMENT INSTALLATION~~

~~E4206.1 Transformers and power supplies.~~

~~Transformers and power supplies used for the supply of underwater luminaires, together with the transformer or power supply enclosure, shall be listed for swimming pool and spa use. The transformer or power supply shall incorporate either a transformer of the isolated-winding type with an ungrounded secondary that has a grounded metal barrier between the primary and secondary windings, or a transformer that incorporates an approved system of double insulation between the primary and secondary windings. [680.23(A)(2)]~~

~~E4206.2 Ground-fault circuit-interrupters.~~

~~Ground-fault circuit-interrupters shall be self-contained units, circuit-breaker types, receptacle types or other approved types. (680.5)~~

~~E4206.3 Wiring on load side of ground-fault circuit-interrupters and transformers.~~

~~For other than grounding conductors, conductors installed on the load side of a ground-fault circuit-interrupter or transformer used to comply with the provisions of Section E4206.4, shall~~

~~not occupy raceways, boxes, or enclosures containing other conductors except where the other conductors are protected by ground-fault circuit interrupters or are grounding conductors. Supply conductors to a feed-through type ground-fault circuit interrupter shall be permitted in the same enclosure. Ground-fault circuit interrupters shall be permitted in a panelboard that contains circuits protected by other than ground-fault circuit interrupters. [680.23(F)(3)]~~

~~E4206.4 Underwater luminaires.~~

~~The design of an underwater luminaire supplied from a branch circuit either directly or by way of a transformer or power supply meeting the requirements of Section E4206.1, shall be such that, where the fixture is properly installed without a ground-fault circuit-interrupter, there is no shock hazard with any likely combination of fault conditions during normal use (not relamping). In addition, a ground-fault circuit-interrupter shall be installed in the branch circuit supplying luminaires operating at more than the low-voltage contact limit, such that there is no shock hazard during relamping. The installation of the ground-fault circuit-interrupter shall be such that there is no shock hazard with any likely fault-condition combination that involves a person in a conductive path from any ungrounded part of the branch circuit or the luminaire to ground. Compliance with this requirement shall be obtained by the use of a listed underwater luminaire and by installation of a listed ground-fault circuit-interrupter in the branch circuit or a listed transformer or power supply for luminaires operating at more than the low-voltage contact limit. Luminaires that depend on submersion for safe operation shall be inherently protected against the hazards of overheating when not submerged. [680.23(A)(1), (A)(3), (A)(7) and (A)(8)]~~

~~E4206.4.1 Maximum voltage.~~

~~Luminaires shall not be installed for operation on supply circuits over 150 volts between conductors. [680.23(A)(4)]~~

~~E4206.4.2 Luminaire location.~~

~~Luminaires mounted in walls shall be installed with the top of the fixture lens not less than 18 inches (457 mm) below the normal water level of the pool, except where the luminaire is listed and identified for use at a depth of not less than 4 inches (102 mm) below the normal water level of the pool. A luminaire facing upward shall have the lens adequately guarded to prevent contact by any person or shall be listed for use without a guard. [680.23(A)(5) and (A)(6)]~~

~~E4206.5 Wet-niche luminaires.~~

~~Forming shells shall be installed for the mounting of all wet-niche underwater luminaires and shall be equipped with provisions for conduit entries. Conduit shall extend from the forming shell to a suitable junction box or other enclosure located as provided in Section E4206.9. Metal parts of the luminaire and forming shell in contact with the pool water shall be of brass or other approved corrosion-resistant metal. [680.23(B)(1)]~~

~~The end of flexible-cord jackets and flexible-cord conductor terminations within a luminaire shall be covered with, or encapsulated in, a suitable potting compound to prevent the entry of water into the luminaire through the cord or its conductors. If present, the grounding connection within a luminaire shall be similarly treated to protect such connection from the deteriorating effect of pool water in the event of water entry into the luminaire. [680.23(B)(4)]~~

~~Luminaires shall be bonded to and secured to the forming shell by a positive locking device that ensures a low-resistance contact and requires a tool to remove the luminaire from the forming shell. [680.23(B)(5)]~~

~~E4206.5.1 Servicing.~~

~~All wet-niche luminaires shall be removable from the water for inspection, relamping, or other maintenance. The forming shell location and length of cord in the forming shell shall permit personnel to place the removed luminaire on the deck or other dry location for such maintenance. The luminaire maintenance location shall be accessible without entering or going into the pool water. [680.23(B)(6)]~~

~~E4206.6 Dry-niche luminaires.~~

~~Dry-niche luminaires shall have provisions for drainage of water. Other than listed low-voltage luminaires not requiring grounding, a dry-niche luminaire shall have means for accommodating one equipment grounding conductor for each conduit entry. Junction boxes shall not be required but, if used, shall not be required to be elevated or located as specified in Section E4206.9 if the luminaire is specifically identified for the purpose. [680.23(C)(1) and (C)(2)]~~

~~E4206.7 No-niche luminaires.~~

~~No-niche luminaires shall be listed for the purpose and shall be installed in accordance with the requirements of Section E4206.5. Where connection to a forming shell is specified, the connection shall be to the mounting bracket. [680.23(D)]~~

~~E4206.8 Through-wall lighting assembly.~~

~~A through-wall lighting assembly shall be equipped with a threaded entry or hub, or a nonmetallic hub, for the purpose of accommodating the termination of the supply conduit. A through-wall lighting assembly shall meet the construction requirements of Section E4205.4 and be installed in accordance with the requirements of Section E4206.5 Where connection to a forming shell is specified, the connection shall be to the conduit termination point. [680.23(E)]~~

~~E4206.9 Junction boxes and enclosures for transformers or ground-fault circuit interrupters.~~

~~Junction boxes for underwater luminaires and enclosures for transformers and ground-fault circuit-interrupters that supply underwater luminaires shall comply with the following: [680.24(A)]~~

~~E4206.9.1 Junction boxes.~~

~~A junction box connected to a conduit that extends directly to a forming shell or mounting bracket of a no-niche luminaire shall be:~~

1. ~~Listed as a swimming pool junction box; [680.24(A)(1)]~~
2. ~~Equipped with threaded entries or hubs or a nonmetallic hub; [680.24(A)(1)(1)]~~
3. ~~Constructed of copper, brass, suitable plastic, or other approved corrosion-resistant material; [680.24(A)(1)(2)]~~
4. ~~Provided with electrical continuity between every connected metal conduit and the grounding terminals by means of copper, brass, or other approved corrosion-resistant metal that is integral with the box; and [680.24(A)(1)(3)]~~
5. ~~Located not less than 4 inches (102 mm), measured from the inside of the bottom of the box, above the ground level, or pool deck, or not less than 8 inches (203 mm) above the maximum pool water level, whichever provides the greatest elevation, and shall be located not less than 4 feet (1219 mm) from the inside wall of the pool,~~

~~unless separated from the pool by a solid fence, wall or other permanent barrier. Where used on a lighting system operating at the low-voltage contact limit or less, a flush deck box shall be permitted provided that an approved potting compound is used to fill the box to prevent the entrance of moisture; and the flush deck box is located not less than 4 feet (1219 mm) from the inside wall of the pool. [680.24(A)(2)]~~

~~E4206.9.2 Other enclosures.~~

~~An enclosure for a transformer, ground-fault circuit-interrupter or a similar device connected to a conduit that extends directly to a forming shell or mounting bracket of a no-niche luminaire shall be:~~

1. ~~Listed and labeled for the purpose, comprised of copper, brass, suitable plastic, or other approved corrosion-resistant material; [680.24(B)(1)]~~
2. ~~Equipped with threaded entries or hubs or a nonmetallic hub; [680.24(B)(2)]~~
3. ~~Provided with an approved seal, such as duct seal at the conduit connection, that prevents circulation of air between the conduit and the enclosures; [680.24(B)(3)]~~
4. ~~Provided with electrical continuity between every connected metal conduit and the grounding terminals by means of copper, brass or other approved corrosion-resistant metal that is integral with the enclosures; and [680.24(B)(4)]~~
5. ~~Located not less than 4 inches (102 mm), measured from the inside bottom of the enclosure, above the ground level or pool deck, or not less than 8 inches (203 mm) above the maximum pool water level, whichever provides the greater elevation, and shall be located not less than 4 feet (1219 mm) from the inside wall of the pool, except where separated from the pool by a solid fence, wall or other permanent barrier. [680.24(B)(2)]~~

~~E4206.9.3 Protection of junction boxes and enclosures.~~

~~Junction boxes and enclosures mounted above the grade of the finished walkway around the pool shall not be located in the walkway unless afforded additional protection, such as by location under diving boards or adjacent to fixed structures. [680.24(C)]~~

~~E4206.9.4 Grounding terminals.~~

~~Junction boxes, transformer and power supply enclosures, and ground-fault circuit-interrupter enclosures connected to a conduit that extends directly to a forming shell or mounting bracket of a no-niche luminaire shall be provided with grounding terminals in a quantity not less than the number of conduit entries plus one. [680.24(D)]~~

~~E4206.9.5 Strain relief.~~

~~The termination of a flexible cord of an underwater luminaire within a junction box, transformer or power supply enclosure, ground-fault circuit-interrupter, or other enclosure shall be provided with a strain relief. [680.24(E)]~~

~~E4206.10 Underwater audio equipment.~~

~~Underwater audio equipment shall be identified for the purpose. [680.27(A)]~~

~~E4206.10.1 Speakers.~~

~~Each speaker shall be mounted in an approved metal forming shell, the front of which is enclosed by a captive metal screen, or equivalent, that is bonded to and secured to the forming shell by a positive locking device that ensures a low-resistance contact and requires a tool to open for installation or servicing of the speaker. The forming shell shall be installed in a recess in the wall or floor of the pool. [680.27(A)(1)]~~

~~E4206.10.2 Wiring methods.~~

~~Rigid metal conduit of brass or other identified corrosion-resistant metal, rigid polyvinyl chloride conduit, rigid thermosetting resin conduit or liquid-tight flexible nonmetallic conduit (LFNC-B) shall extend from the forming shell to a suitable junction box or other enclosure as provided in Section E4206.9. Where rigid nonmetallic conduit or liquid-tight flexible nonmetallic conduit is used, an 8 AWG solid or stranded insulated copper bonding jumper shall be installed in this conduit with provisions for terminating in the forming shell and the junction box. The termination of the 8 AWG bonding jumper in the forming shell shall be covered with, or encapsulated in, a suitable potting compound to protect such connection from the possible deteriorating effect of pool water. [680.27(A)(2)]~~

~~E4206.10.3 Forming shell and metal screen.~~

~~The forming shell and metal screen shall be of brass or other approved corrosion-resistant metal. Forming shells shall include provisions for terminating an 8 AWG copper conductor. [680.27(A)(3)]~~

~~E4206.11 Electrically operated pool covers.~~

~~The electric motors, controllers, and wiring for pool covers shall be located not less than 5 feet (1524 mm) from the inside wall of the pool except where separated from the pool by a wall, cover, or other permanent barrier. Electric motors installed below grade level shall be of the totally enclosed type. The electric motor and controller shall be connected to a branch circuit protected by a ground-fault circuit-interrupter. The device that controls the operation of the motor for an electrically operated pool cover shall be located so that the operator has full view of the pool. [680.27(B)(1) and (B)(2)]~~

~~E4206.12 Electric pool water heaters.~~

~~Electric pool water heaters shall have the heating elements subdivided into loads not exceeding 48 amperes and protected at not more than 60 amperes. The ampacity of the branch-circuit conductors and the rating or setting of overcurrent protective devices shall be not less than 125 percent of the total nameplate load rating. (680.9)~~

~~E4206.13 Pool area heating.~~

~~The provisions of Sections E4206.13.1 through E4206.13.3 shall apply to all pool deck areas, including a covered pool, where electrically operated comfort heating units are installed within 20 feet (6096 mm) of the inside wall of the pool. [680.27(C)]~~

~~E4206.13.1 Unit heaters.~~

~~Unit heaters shall be rigidly mounted to the structure and shall be of the totally enclosed or guarded types. Unit heaters shall not be mounted over the pool or within the area extending 5 feet (1524 mm) horizontally from the inside walls of a pool. [680.27(C)(1)]~~

~~E4206.13.2 Permanently wired radiant heaters.~~

~~Electric radiant heaters shall be suitably guarded and securely fastened to their mounting devices. Heaters shall not be installed over a pool or within the area extending 5 feet (1524~~

~~mm) horizontally from the inside walls of the pool and shall be mounted not less than 12 feet (3658 mm) vertically above the pool deck. [680.27(C)(2)]~~

~~**E4206.13.3 Radiant heating cables prohibited.**~~
~~Radiant heating cables embedded in or below the deck shall be prohibited. [680.27(C)(3)]~~

~~SECTION E4207~~
~~STORABLE SWIMMING POOLS, STORABLE SPAS, AND STORABLE HOT TUBS~~

~~**E4207.1 Pumps.**~~
~~A cord and plug-connected pool filter pump for use with storable pools shall incorporate an approved system of double insulation or its equivalent and shall be provided with means for grounding only the internal and nonaccessible noncurrent-carrying metal parts of the appliance.~~

~~The means for grounding shall be an equipment grounding conductor run with the power-supply conductors in a flexible cord that is properly terminated in a grounding-type attachment plug having a fixed grounding contact. Cord and plug-connected pool filter pumps shall be provided with a ground-fault circuit interrupter that is an integral part of the attachment plug or located in the power supply cord within 12 inches (305 mm) of the attachment plug. (680.31)~~

~~**E4207.2 Ground-fault circuit-interrupters required.**~~
~~Electrical equipment, including power-supply cords, used with storable pools shall be protected by ground-fault circuit-interrupters. 125-volt, 15- and 20-ampere receptacles located within 20 feet (6096 mm) of the inside walls of a storable pool, storable spa, or storable hot tub shall be protected by a ground-fault circuit interrupter. In determining these dimensions, the distance to be measured shall be the shortest path that the supply cord of an appliance connected to the receptacle would follow without passing through a floor, wall, ceiling, doorway with hinged or sliding door, window opening, or other effective permanent barrier. (680.32)~~

~~**E4207.3 Luminaires.**~~
~~Luminaires for storable pools, storable spas, and storable hot tubs shall not have exposed metal parts and shall be listed for the purpose as an assembly. In addition, luminaires for storable pools shall comply with the requirements of Section E4207.3.1 or E4207.3.2. (680.33)~~

~~**E4207.3.1 Within the low-voltage contact limit.**~~
~~A luminaire installed in or on the wall of a storable pool shall be part of a cord and plug-connected lighting assembly. The assembly shall:~~

1. ~~Have a luminaire lamp that is suitable for the use at the supplied voltage;~~
2. ~~Have an impact-resistant polymeric lens, luminaire body, and transformer enclosure;~~
3. ~~Have a transformer meeting the requirements of section E4206.1 with a primary rating not over 150 volts; and~~
4. ~~Have no exposed metal parts. [680.33(A)]~~

~~**E4207.3.2 Over the low-voltage contact limit but not over 150 volts.**~~
~~A lighting assembly without a transformer or power supply, and with the luminaire lamp(s)~~

~~operating at over the low-voltage contact limit, but not over 150 volts, shall be permitted to be cord and plug-connected where the assembly is listed as an assembly for the purpose and complies with all of the following:~~

1. ~~It has an impact-resistant polymeric lens and luminaire body.~~
2. ~~A ground-fault circuit interrupter with open neutral conductor protection is provided as an integral part of the assembly.~~
3. ~~The luminaire lamp is permanently connected to the ground-fault circuit interrupter with open-neutral protection.~~
4. ~~It complies with the requirements of Section E4206.4.~~
5. ~~It has no exposed metal parts. [680.33(B)]~~

~~E4207.4 Receptacle locations.~~
~~Receptacles shall be located not less than 6 feet (1829 mm) from the inside walls of a storable pool, storable spa or storable hot tub. In determining these dimensions, the distance to be measured shall be the shortest path that the supply cord of an appliance connected to the receptacle would follow without passing through a floor, wall, ceiling, doorway with hinged or sliding door, window opening, or other effective permanent barrier. (680.34)~~

~~E4207.5 Clearances.~~
~~Overhead conductor installations shall comply with Section E4203.6 and underground conductor installations shall comply with Section E4203.7.~~

~~E4207.6 Disconnecting means.~~
~~Disconnecting means for storable pools and storable/portable spas and hot tubs shall comply with Section E4203.3.~~

~~E4207.7 Ground-fault circuit interrupters.~~
~~Ground-fault circuit interrupters shall comply with Section E4206.2.~~

~~E4207.8 Grounding of equipment.~~
~~Equipment shall be grounded as required by Section E4205.1.~~

~~E4207.9 Pool water heaters.~~
~~Electric pool water heaters shall comply with Section E4206.12.~~

~~SECTION E4208~~
~~SPAS AND HOT TUBS~~

~~E4208.1 Ground-fault circuit-interrupters.~~
~~The outlet(s) that supplies a self-contained spa or hot tub, or a packaged spa or hot tub equipment assembly, or a field-assembled spa or hot tub with a heater load of 50 amperes or less, shall be protected by a ground-fault circuit-interrupter. (680.44)~~

~~A listed self-contained unit or listed packaged equipment assembly marked to indicate that integral ground-fault circuit-interrupter protection is provided for all electrical parts within the unit~~

~~or assembly, including pumps, air blowers, heaters, lights, controls, sanitizer generators and wiring, shall not require that the outlet supply be protected by a ground-fault circuit interrupter. [680.44(A)]~~

~~E4208.2 Electric water heaters.~~

~~Electric spa and hot tub water heaters shall be listed and shall have the heating elements subdivided into loads not exceeding 48 amperes and protected at not more than 60 amperes. The ampacity of the branch-circuit conductors, and the rating or setting of overcurrent protective devices, shall be not less than 125 percent of the total nameplate load rating. (680.9)~~

~~E4208.3 Underwater audio equipment.~~

~~Underwater audio equipment used with spas and hot tubs shall comply with the provisions of Section E4206.10. [680.43(G)]~~

~~E4208.4 Emergency switch for spas and hot tubs.~~

~~A clearly labeled emergency shutoff or control switch for the purpose of stopping the motor(s) that provides power to the recirculation system and jet system shall be installed at a point that is readily accessible to the users, adjacent to and within sight of the spa or hot tub and not less than 5 feet (1524 mm) away from the spa or hot tub. This requirement shall not apply to single-family dwellings. (680.41)~~

~~SECTION E4209~~
~~HYDROMASSAGE BATHTUBS~~

~~E4209.1 Ground-fault circuit-interrupters.~~

~~Hydromassage bathtubs and their associated electrical components shall be supplied by an individual branch circuit(s) and protected by a readily accessible ground-fault circuit-interrupter. All 125-volt, single-phase receptacles not exceeding 30 amperes and located within 6 feet (1829 mm) measured horizontally of the inside walls of a hydromassage tub shall be protected by a ground-fault circuit interrupter(s). (680.71)~~

~~E4209.2 Other electric equipment.~~

~~Luminaires, switches, receptacles, and other electrical equipment located in the same room, and not directly associated with a hydromassage bathtub, shall be installed in accordance with the requirements of this code relative to the installation of electrical equipment in bathrooms. (680.72)~~

~~E4209.3 Accessibility.~~

~~Hydromassage bathtub electrical equipment shall be accessible without damaging the building structure or building finish. Where the hydromassage bathtub is cord- and plug-connected with the supply receptacle accessible only through a service access opening, the receptacle shall be installed so that its face is within direct view and not more than 12 inches (305 mm) from the plane of the opening. (680.73)~~

~~E4209.4 Bonding.~~

~~Both metal piping systems and grounded metal parts in contact with the circulating water shall be bonded together using an insulated, covered or bare solid copper bonding jumper not smaller than 8 AWG. The bonding jumper shall be connected to the terminal on the circulating pump motor that is intended for this purpose. The bonding jumper shall not be required to be connected to a double insulated circulating pump motor. The 8 AWG or larger solid copper~~

~~bonding jumper shall be required for equipotential bonding in the area of the hydromassage bathtub and shall not be required to be extended or attached to any remote panelboard, service equipment, or any electrode. Where a double-insulated circulating pump motor is used, the 8 AWG or larger solid copper bonding jumper shall be long enough to terminate on a replacement nondouble-insulated pump motor and shall be terminated to the equipment grounding conductor of the branch circuit for the motor. (680.74)~~

CHAPTER 43

CLASS 2 REMOTE-CONTROL, SIGNALING AND POWER-LIMITED CIRCUITS

Deleted. See the *North Carolina Electrical Code.*

~~SECTION E4301~~
~~GENERAL~~

~~E4301.1 Scope.~~
~~This chapter contains requirements for power supplies and wiring methods associated with Class 2 remote-control, signaling, and power-limited circuits that are not an integral part of a device or appliance. Other classes of remote-control, signaling and power-limited conductors shall comply with Article 725 of NFPA 70. (725.1)~~

~~E4301.2 Definitions.~~

~~CLASS 2 CIRCUIT.~~ ~~That portion of the wiring system between the load side of a Class 2 power source and the connected equipment. Due to its power limitations, a Class 2 circuit considers safety from a fire initiation standpoint and provides acceptable protection from electric shock. (725.2)~~

~~REMOTE-CONTROL CIRCUIT.~~ ~~Any electrical circuit that controls any other circuit through a relay or an equivalent device. (Article 100)~~

~~SIGNALING CIRCUIT.~~ ~~Any electrical circuit that energizes signaling equipment. (Article 100)~~

~~SECTION E4302~~
~~POWER SOURCES~~

~~E4302.1 Power sources for Class 2 circuits.~~
~~The power source for a Class 2 circuit shall be one of the following:~~

1. ~~A listed Class 2 transformer.~~
2. ~~A listed Class 2 power supply.~~
3. ~~Other listed equipment marked to identify the Class 2 power source.~~
4. ~~Listed information technology (computer) equipment limited power circuits.~~
5. ~~A dry-cell battery provided that the voltage is 30 volts or less and the capacity is equal to or less than that available from series connected No. 6 carbon zinc cells. [725.121(A)]~~

~~E4302.2 Interconnection of power sources.~~
~~A Class 2 power source shall not have its output connections paralleled or otherwise interconnected with another Class 2 power source except where listed for such interconnection. [725.121(B)]~~

~~SECTION E4303~~
~~WIRING METHODS~~

~~E4303.1 Wiring methods on supply side of Class 2 power source.~~
~~Conductors and equipment on the supply side of the power source shall be installed in accordance with the appropriate requirements of Chapters 34 through 41. Transformers or other devices supplied from electric light or power circuits shall be protected by an over-current device rated at not over 20 amperes. The input leads of a transformer or other power source supplying Class 2 circuits shall be permitted to be smaller than 14 AWG, if not over 12 inches (305 mm) long and if the conductor insulation is rated at not less than 600 volts. In no case shall such leads be smaller than 18 AWG. (725.127 and 725.127 Exception)~~

~~E4303.2 Wiring methods and materials on load side of the Class 2 power source.~~
~~Class 2 cables installed as wiring within buildings shall be listed as being resistant to the spread of fire and listed as meeting the criteria specified in Sections E4303.2.1 through E4303.2.3. Cables shall be marked in accordance with Section E4303.2.4. Cable substitutions as described in Table E4303.2 and wiring methods covered in Chapter 38 shall also be permitted. (725.130 (B); 725.135 (A), (C), (G) and (M); 725.154; Table 725.154; Figure 725.154 (A); and 725.179)~~

~~TABLE E4303.2~~
~~CABLE USES AND PERMITTED SUBSTITUTIONS~~
~~[Figure 725.154(A)]~~

~~CABLE TYPE~~	~~USE~~	~~PERMITTED SUBSTITUTIONS~~[a]
~~CL2P~~	~~Class 2 Plenum Cable~~	~~CMP, CL3P~~
~~CL2R~~	~~Class 2 Plenum Cable~~	~~CMP, CL3P, CL2P, CMR, CL3R~~
~~CL2~~	~~Class 2 Cable~~	~~CMP, CL3P, CL2P, CMR, CL3R, CL2R CMG, CM, CL3~~
~~CL2X~~	~~Class 2 Cable, Limited Use~~	~~CMP, CL3P CL2P, CMR, CL3R, CL2R, CMG, CM, CL3, CL2, CMX, CL3X~~

~~a. For identification of cables other than Class 2 cables, see NFPA 70.~~

~~E4303.2.1 Type CL2P cables.~~
~~Cables installed in ducts, plenums and other spaces used to convey environmental air shall be Type CL2P cables listed as being suitable for the use and listed as having adequate fire-resistant and low smoke-producing characteristics. [725.179(A)]~~

~~E4303.2.2 Type CL2 cables.~~
~~Cables for general-purpose use, shall be listed as being resistant to the spread of fire and listed for the use. [725.179 (C)]~~

~~E4303.2.3 Type CL2X cables.~~
~~Type CL2X limited-use cable shall be listed as being suitable for use in dwellings and for the use and in raceways and shall also be listed as being flame retardant. Cables with a diameter of less than 1/4 inch (6.4 mm) shall be permitted to be installed without a raceway. [725.179 (D)]~~

~~E4303.2.4 Type CL2R cables.~~
~~Cables installed in a vertical run in a shaft or installed from floor to floor shall be listed as suitable for use in a vertical run in a shaft or from floor to floor and shall also be listed as having fire-resistant characteristics capable of preventing fire from being conveyed from floor to floor. [725.179(B)]~~

> **~~Exception:~~** ~~CL2X and CL3X cables with a diameter of less than 1/4 inch (6.4 mm) and CL2 and CL3 cables shall be permitted in risers in one- and two-family dwelling units. [725.154 (G)]~~

~~E4303.2.5 Marking.~~
~~Cables shall be marked in accordance with Table E4303.2.5. Voltage ratings shall not be marked on cables.~~

~~Table E4303.2.5 [Table 725.179(K)]~~
~~CABLE MARKING~~

~~CABLE MARKING~~	**~~TYPE~~**
~~CL2P~~	~~Class 2 plenum cable~~
~~CL2R~~	~~Class 2 riser cable~~
~~CL2~~	~~Class 2 cable~~
~~CL2X~~	~~Class 2 cable, limited use~~

~~SECTION E4304~~
~~INSTALLATION REQUIREMENTS~~

~~E4304.1 Separation from other conductors.~~
~~In cables, compartments, enclosures, outlet boxes, device boxes, and raceways, conductors of Class 2 circuits shall not be placed in any cable, compartment, enclosure, outlet box, device box, raceway, or similar fitting with conductors of electric light, power, Class 1 and nonpower-limited fire alarm circuits. (725.136)~~

~~Exceptions:~~

1. ~~Where the conductors of the electric light, power, Class 1 and nonpower-limited fire alarm circuits are separated by a barrier from the Class 2 circuits. In enclosures, Class 2 circuits shall be permitted to be installed in a raceway within the enclosure to separate them from Class 1, electric light, power and nonpower-limited fire alarm circuits. [725.136(B)]~~

2. ~~Class 2 conductors in compartments, enclosures, device boxes, outlet boxes and similar fittings where electric light, power, Class 1 or nonpower-limited fire alarm~~

~~circuit conductors are introduced solely to connect to the equipment connected to the Class 2 circuits. The electric light, power, Class 1 and nonpower-limited fire alarm circuit conductors shall be routed to maintain a minimum of $^1/_4$ inch (6.4 mm) separation from the conductors and cables of the Class 2 circuits; or the electric light power, Class 1 and nonpower-limited fire alarm circuit conductors operate at 150 volts or less to ground and the Class 2 circuits are installed using Types CL3, CL3R, or CL3P or permitted substitute cables, and provided that these Class 3 cable conductors extending beyond their jacket are separated by a minimum of $^1/_4$ inch (6.4 mm) or by a nonconductive sleeve or nonconductive barrier from all other conductors. [725.136(D)]~~

~~E4304.2 Other applications.~~

~~Conductors of Class 2 circuits shall be separated by not less than 2 inches (51 mm) from conductors of any electric light, power, Class 1 or nonpower-limited fire alarm circuits except where one of the following conditions is met:~~

1. ~~All of the electric light, power, Class 1 and nonpower-limited fire alarm circuit conductors are in raceways or in metal-sheathed, metal-clad, nonmetallic-sheathed or Type UF cables.~~
2. ~~All of the Class 2 circuit conductors are in raceways or in metal-sheathed, metal-clad, nonmetallic-sheathed or Type UF cables. [725.136(I)]~~

~~E4304.3 Class 2 circuits with communications circuits.~~

~~Where Class 2 circuit conductors are in the same cable as communications circuits, the Class 2 circuits shall be classified as communications circuits and shall meet the requirements of Article 800 of NFPA 70. The cables shall be listed as communications cables or multipurpose cables.~~

~~Cables constructed of individually listed Class 2 and communications cables under a common jacket shall be permitted to be classified as communications cables. The fire-resistance rating of the composite cable shall be determined by the performance of the composite cable. [725.139(D)]~~

~~E4304.4 Class 2 cables with other circuit cables.~~

~~Jacketed cables of Class 2 circuits shall be permitted in the same enclosure or raceway with jacketed cables of any of the following:~~

1. ~~Power-limited fire alarm systems in compliance with Article 760 of NFPA 70.~~
2. ~~Nonconductive and conductive optical fiber cables in compliance with Article 770 of NFPA 70.~~
3. ~~Communications circuits in compliance with Article 800 of NFPA 70.~~
4. ~~Community antenna television and radio distribution systems in compliance with Article 820 of NFPA 70.~~

5. ~~Low-power, network-powered broadband communications in compliance with Article 830 of NFPA 70. [725.139(E)]~~

~~**E4304.5 Installation of conductors and cables.**~~

~~Cables and conductors installed exposed on the surface of ceilings and sidewalls shall be supported by the building structure in such a manner that they will not be damaged by normal building use. Such cables shall be supported by straps, staples, hangers, cable ties or similar fittings designed so as to not damage the cable. Nonmetallic cable ties and other nonmetallic accessories used to secure and support cables located in stud cavity and joist space plenums shall be listed as having low smoke and heat release properties. The installation shall comply with Table E3802.1 regarding cables run parallel with framing members and furring strips. The installation of wires and cables shall not prevent access to equipment nor prevent removal of panels, including suspended ceiling panels. Raceways shall not be used as a means of support for Class 2 circuit conductors, except where the supporting raceway contains conductors supplying power to the functionally associated equipment controlled by the Class 2 conductors. [300.22 (C) (1) and 725.24]~~

Part VI—Referenced Standards

CHAPTER 44

REFERENCED STANDARDS

This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section R102.4.

AAMA

American Architectural Manufacturers Association
1827 Walden Office Square, Suite 550
Schaumburg, IL 60173

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A440—11	North American Fenestration Standards/Specifications for Windows, Doors and Skylights	R308.6.9, R609.3, N1102.4.4 ~~3~~
450—10	Voluntary Performance Rating Method for Mulled Fenestration Assemblies	R609.8
506—11	Voluntary Specifications for Hurricane Impact and Cycle Testing of Fenestration Products	R609.6.1
711—13	Voluntary Specification for Self-adhering Flashing Used for Installation of Exterior Wall Fenestration Products	R703.4
712—11	Voluntary Specification for Mechanically Attached Flexible Flashing	R703.4
714—12	Voluntary Specification for Liquid Applied Flashing Used to Create a Water-resistive Seal around Exterior Wall Openings in Buildings	R703.4
AAMA/NPEA/ NSA 2100—12	Specifications for Sunrooms	R302.2.1.1

ACI

American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331

Standard reference number	Title	Referenced in code section number
318—14	Building Code Requirements for Structural Concrete	R301.2.2.2.4, R301.2.2.3.4, R402.2, Table R404.1.2(2), Table R404.1.2(5), Table R404.1.2(6), Table R404.1.2(7),

		Table R404.1.2(8), Table R404.1.2(9), R404.1.3, R404.1.3.1, R404.1.3.3, R404.1.3.4, R404.1.4.2, R404.5.1, R608.1, R608.1.1, R608.1.2, R608.2, R608.5.1, R608.6.1, R608.8.2, R608.9.2, R608.9.3
332—14	Code Requirements for Residential Concrete Construction	R402.2, R403.1, R404.1.3, R404.1.3.4, R404.1.4.2, R506.1
530—13	Building Code Requirements for Masonry Structures	R404.1.2, R606.1, R606.1.1, R606.12.1, R606.12.2.3.2, R606.12.2.3.1, R703.12
R606.12.3.1530.1—13	Specification for Masonry Structures	R404.1.2, R606.1, R606.1.1, R606.2.9, R606.2.12, R606.12.1, R606.12.2.3.2, R606.12.3.1, 703.12

ACCA

Air Conditioning Contractors of America
2800 Shirlington Road, Suite 300
Arlington, VA 22206

Standard reference number	Title	Referenced in code section number
Manual D—2011	Residential Duct Systems	M1601.1, M1602.2
Manual J—2011	Residential Load Calculation—Eighth Edition	~~N1103.6,~~ M1401.3
Manual S—13	Residential Equipment Selection	~~N1103.6,~~ M1401.3

AISI

American Iron and Steel Institute
25 Massachusetts Avenue, NW Suite 800
Washington, DC 20001

Standard reference number	Title	Referenced in code section number
AISI S100—12	North American Specification for the Design of Cold-formed Steel Structural Members, 2012	R505.1.3, R603.6, R608.9.2, R608.9.3, R804.3.6

AISI S200—12	North American Standard for Cold-formed Steel Framing—General Provisions 2012	R702.3.3
AISI S220—11	North American Standard for Cold-formed Steel Framing—Nonstructural Members	R702.3.3
AISI S230—07/ S3-12 (2012)	Standard for Cold-formed Steel Framing—Prescriptive Method for One- and Two-family Dwellings, 2007 with Supplement 3, dated 2012 (Reaffirmed 2012)	R301.1.1, R301.2.1.1, R301.2.2.3.1, R301.2.2.3.5, R603.6, R603.9.4.1, R603.9.4.2, R608.9.2, R608.9.3, Figure 608.9(11), R608.10

AMCA

Air Movement and Control Association
300 West University
Arlington Heights, IL 60004

Standard reference number	Title	Referenced in code section number
ANSI/AMCA 210-ANSI/ASHRAE 51—07	Laboratory Methods of Testing Fans for Aerodynamic Performance Rating	Table M1506.2

AMD

Association of Millwork Distributors Standards
10047 Robert Trent Parkway
New Port Richey, FL 34655-4649

Standard reference number	Title	Referenced in code section number
AMD 100—2013	Structural Performance Ratings of Side Hinged Exterior Door Systems and Procedures for Component Substitution	R609.3

ANCE

Association of the Electric Sector
Av. Lázaro Cardenas No. 869
Col. Nueva Industrial Vallejo
C.P. 07700 México D.F.

Standard reference number	Title	Referenced in code section number
UL/CSA/ANCE 60335-2—2012	Standard for Household and Similar Electric Appliances, Part 2: Particular Requirements for Motor-compressors	M1403.1, M1412.1, M1413.1

ANSI

American National Standards Institute
25 West 43rd Street, Fourth Floor
New York, NY 10036

Standard reference number	Title	Referenced in code section number

A108.1A—99	Installation of Ceramic Tile in the Wet-set Method, with Portland Cement Mortar	R702.4.1
A108.1B—99	Installation of Ceramic Tile, Quarry Tile on a Cured Portland Cement Mortar Setting Bed with Dry-set or Latex Portland Mortar	R702.4.1
A108.4—99	Installation of Ceramic Tile with Organic Adhesives or Water-Cleanable Tile-setting Epoxy Adhesive	R702.4.1
A108.5—99	Installation of Ceramic Tile with Dry-set Portland Cement Mortar or Latex Portland Cement Mortar	R702.4.1
A108.6—99	Installation of Ceramic Tile with Chemical-resistant, Water-cleanable Tile-setting and -grouting Epoxy	R702.4.1
A108.11—99	Interior Installation of Cementitious Backer Units	R702.4.1
A118.1—99	American National Standard Specifications for Dry-set Portland Cement Mortar	R702.4.1
A118.3—99	American National Standard Specifications for Chemical-resistant, Water-cleanable Tile-setting and -grouting Epoxy, and Water-cleanable Tile-setting Epoxy Adhesive.	R702.4.1
A118.4—99	American National Standard Specifications for Latex-Portland Cement Mortar	R606.2.10
A118.10—99	Specification for Load-bearing, Bonded, Waterproof Membranes for Thin-set Ceramic Tile and Dimension Stone Installation	P2709.2, P2709.2.4
A136.1—99	American National Standard Specifications for Organic Adhesives for Installation of Ceramic Tile	R702.4.1
A137.1—2012	American National Standard Specifications for Ceramic Tile	R702.4.1
LC1/CSA 6.26—13	Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST)	G2414.5.3
LC4/CSA 6.32—12	Press-connect Metallic Fittings for Use in Fuel Gas Distribution System	G2414.10.2
Z21.1—2010	Household Cooking Gas Appliances	G2447.1
Z21.5.1/CSA 7.1—14	Gas Clothes Dryers—Volume I—Type I Clothes Dryers	G2438.1
Z21.8—94 (R2002)	Installation of Domestic Gas Conversion Burners	G2443.1
Z21.10.1/CSA 4.1—12	Gas Water Heaters—Volume I—Storage Water Heaters with Input Ratings of 75,000 Btu per hour or Less	G2448.1
Z21.10.3/CSA 4.3—11	Gas Water Heaters—Volume III—Storage Water Heaters with Input Ratings above 75,000 Btu per hour, Circulating and Instantaneous	G2448.1
Z21.11.2—11	Gas-fired Room Heaters—Volume II—Unvented Room Heaters	G2445.1
Z21.13/CSA 4.9—11	Gas-fired Low-pressure Steam and Hot Water Boilers	G2452.1
Z21.15/CSA 9.1—09	Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves	Table G2420.1.1
Z21.22—99 (R2003)	Relief Valves for Hot Water Supply Systems—with Addenda Z21.22a—2000 (R2003) and 21.22b—2001 (R2003)	P2804.2, P2804.7
Z21.24/CGA 6.10—06	Connectors for Gas Appliances	G2422.1
Z21.40.1/		

CSA 2.91—96 (R2011)	Gas-fired, Heat-activated Air-conditioning and Heat Pump Appliances	G2449.1
Z21.40.2/ CSA 2.92—96 (R2011)	Air-conditioning and Heat Pump Appliances (Thermal Combustion)	G2449.1
Z21.42—2014	Gas-fired Illuminating Appliances	G2450.1
Z21.47/CSA 2.3—12	Gas-fired Central Furnaces	G2442.1
Z21.50/CSA 2.22—12	Vented Gas Fireplaces	G2434.1
Z21.56/CSA 4.7—13	Gas-fired Pool Heaters	G2441.1
Z21.58—95/CSA 1.6—13	Outdoor Cooking Gas Appliances	G2447.1
Z21.60/CSA 2.26—12	Decorative Gas Appliances for Installation in Solid Fuel-burning Fireplaces	G2432.1
Z21.75/CSA 6.27—07	Connectors for Outdoor Gas Appliances and Manufactured Homes	G2422.1
Z21.80—11	Line Pressure Regulators	G2421.1
ANSI/CSA America FCI—12	Stationary Fuel Cell Power Systems	M1903.1
Z21.84—12	Manually Listed, Natural Gas Decorative Gas Appliances for Installation in Solid Fuel-burning Fireplaces	G2432.1, G2432.2
Z21.86—08	Gas-fired Vented Space Heating Appliances	G2436.1, G2437.1, G2446.1
Z21.88/CSA 2.33—15	Vented Gas Fireplace Heaters	G2435.1
Z21.91—07	Ventless Firebox Enclosures for Gas-fired Unvented Decorative Room Heaters	G2445.7.1
Z21.97—12	Outdoor Decorative Appliances	G2454.1
Z83.6—90 (R1998)	Gas-fired Infrared Heaters	G2451.1
Z83.8/CSA 2.6—09	Gas-fired Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters and Gas-fired Duct Furnaces	G2444.1
Z83.19—01 (R2009)	Gas-fuel High-intensity Infrared Heaters	G2451.1
Z83.20—08	Gas-fired Low-intensity Infared Heaters Outdoor Decorative Appliances	G2451.1
Z97.1—2014	Safety Glazing Materials Used in Buildings—Safety Performance Specifications and Methods of Test	R308.1.1, R308.3.1

APA

APA—The Engineered Wood Association
7011 South 19th
Tacoma, WA 98466

Standard reference number	Title	Referenced in code section number
ANSI/A190.1—12	Structural Glued-laminated Timber	R502.1.3, R602.1.3, R802.1.2

ANSI/APA PRP 210—08	Standard for Performance-rated Engineered Wood Siding	R604.1, Table R703.3(1), R703.3.3
ANSI/APA PRG 320—2012	Standard for Performance-rated Cross Laminated Timber	R502.1.6, R602.1.6, R802.1.6
ANSI/APA PRR 410—2011	Standard for Performance-rated Engineered Wood Rim Boards	R502.1.7, R602.1.7, R802.1.7
APA E30—11	Engineered Wood Construction Guide	Table R503.2.1.1(1), R503.2.2, R803.2.2, R803.2.3

APSP

The Association of Pool and Spa Professionals
2111 Eisenhower Avenue
Alexandria, VA 22314

Standard reference number	Title	Referenced in code section number
APSP 15a—2013	American National Standard for Residential Swimming Pool and Spa Energy Efficiency	N1103.12

ASCE/SEI

American Society of Civil Engineers
Structural Engineering Institute
1801 Alexander Bell Drive
Reston, VA 20191

Standard reference number	Title	Referenced in code section number
5—13	Building Code Requirements for Masonry Structures	R404.1.2, R606.1, R606.1.1, R606.12.1, R606.12.2.3.1, R606.12.2.3.2, R606.12.3.1, R703.12
6—13	Specification for Masonry Structures	R404.1.2, R606.1, R606.1.1, R606.2.9, R606.2.12, R606.12.1, R606.12.2.3.1, R606.12.2.3.2, R606.12.3.1, R703.12
7—10	Minimum Design Loads for Buildings and Other Structures with Supplement No. 1	R301.2.1.1, R301.2.1.2, R301.2.1.2.1, R301.2.1.5, R301.2.1.5.1, Table

		R608.6(1), Table R608.6(2), Table R608.6(3), Table R608.6(4), Table R608.7(1A), Table R608.7(1B), Table R608.7(1C), R608.9.2, R608.9.3, R609.2, AH107.4.3
24—13	Flood-resistant Design and Construction	R301.2.4, R301.2.4.1, R322.1, R322.1.1, R322.1.6, R322.1.9, R322.2.2, R322.3.3
32—01	Design and Construction of Frost-protected Shallow Foundations	R403.1.4.1

ASHRAE

American Society of Heating, Refrigerating
and Air-Conditioning Engineers, Inc.
1791 Tullie Circle, NE
Atlanta, GA 30329

Standard reference number	Title	Referenced in code section number
ASHRAE—2013	ASHRAE Handbook of Fundamentals	N1102.1.5, Table N1105.5.2(1), P3001.2, P3101.4
~~ASHRAE 193—2010~~	~~Method of Test for Determining Air Tightness of HVAC Equipment~~	~~N1103.3.2.1~~
34—2013	Designation and Safety Classification of Refrigerants	M1411.1

ASME

American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016-5990

Standard reference number	Title	Referenced in code section number
ASME/A17.1/ CSA B44—2013	Safety Code for Elevators and Escalators	R321.1
A18.1—2008	Safety Standard for Platforms and Stairway Chair Lifts	R321.2
A112.1.2—2004	Air Gaps in Plumbing Systems	P2717.1, Table P2902.3, P2902.3.1

A112.1.3—2000 (Reaffirmed 2011)	Air Gap Fittings for Use with Plumbing Fixtures, Appliances and Appurtenances	Table P2701.1, P2717.1, Table P2902.3, P2902.3.1
A112.3.1—2007	Stainless Steel Drainage Systems for Sanitary, DWV, Storm and Vacuum Applications Above and Below Ground	Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3, Table P3302.1
A112.3.4—2013/ CSA B45.9—13	Macerating Toilet Systems and Related Components	Table P2701.1, P3007.5
A112.4.1—2009	Water Heater Relief Valve Drain Tubes	P2804.6.1
A112.4.2—2009	Water-closet Personal Hygiene Devices	P2722.5
A112.4.3—1999 (R2010)	Plastic Fittings for Connecting Water Closets to the Sanitary Drainage System	P3003.14
A112.4.14—2004 (R2010)	Manually Operated, Quarter-turn Shutoff Valves for Use in Plumbing Systems	Table P2903.9.4
A112.6.1M—1997 (R2008)	Floor-affixed Supports for Off-the-floor Plumbing Fixtures for Public Use	Table P2701.1, P2702.4
A112.6.2—2000 (R2010)	Framing-affixed Supports for Off-the-floor Water Closets with Concealed Tanks	Table P2701.1, P2702.4
A112.6.3—2001 (R2007)	Floor and Trench Drains	Table P2701.1
A112.14.1—03 (Reaffirmed 2008)	Backwater Valves	P3008.2
A112.18.1—2012/ CSA B125.1—2012	Plumbing Supply Fittings	Table P2701.1, P2708.5, P2722.1, P2722.3, P2727.2, P2902.2, Table P2903.9.4
A112.18.2—2011/ CSA B125.2—2011	Plumbing Waste Fittings	Table P2701.1, P2702.2
A112.18.3—2002 (Reaffirmed 2008)	Performance Requirements for Backflow Protection Devices and Systems in Plumbing Fixture Fittings	P2708.5, P2722.3
A112.18.6/ CSA B125.6—2009	Flexible Water Connectors	P2906.7
A112.19.1—2013/ CSA B45.2—2013	Enameled Cast-iron and Enameled Steel Plumbing Fixtures	Table P2701.1, P2711.1
A112.19.2—2013/ CSA B45.1—2013	Ceramic Plumbing Fixtures	Table P2701.1, P2705.1, P2711.1, P2712.1, P2712.2, P2712.9
A112.19.3—2008/ CSA B45.4—08 (R2013)	Stainless Steel Plumbing Fixtures	Table P2701.1, P2705.1, P2711.1, P2712.1
A112.19.5—2011/ CSA B45.15—2011	Flush Valves and Spuds for Water-closets, Urinals and Tanks	Table P2701.1
A112.19.7/2012 CSA B45.10—2012	Hydromassage Bathtub Systems	Table P2701.1
A112.19.12—2006	Wall-mounted and Pedestal-mounted, Adjustable and Pivoting Lavatory and Sink Carrier Systems	Table P2701.1, P2711.4, P2714.2
A112.19.14—2006 (R2011)	Six-Liter Water Closets Equipped with Dual Flushing Device	P2712.1
A112.19.15—2005	Bathtub/Whirlpool Bathtubs with Pressure-sealed Doors	Table P2701.1, P2713.2

A112.36.2m—1991 (R2008)	Cleanouts	P3005.2.10.2
B1.20.1—1983 (R2006)	Pipe Threads, General-purpose (Inch)	G2414.9, P3003.6.4, P3003.17.1, P3003.9.3
B16.3—2011	Malleable-iron-threaded Fittings, Classes 150 and 300	Table P2906.6
B16.4—2011	Gray-iron-threaded Fittings	Table P2906.6, Table P3002.3
B16.9—2007	Factory-made, Wrought-steel Buttwelding Fittings.	Table P2906.6
B16.11—2011	Forged Fittings, Socket-welding and Threaded .	Table P2906.6
B16.12—2009	Cast-iron-threaded Drainage Fittings	Table P3002.3
B16.15—2011	Cast-bronze-threaded Fittings	Table P2906.6, Table P3002.3
B16.18—2012	Cast-copper-alloy Solder Joint Pressure Fittings	Table P2906.6, Table P3002.3
B16.22—2001 (R2010)	Wrought-copper and Copper-alloy Solder Joint Pressure Fittings	Table P2906.6, Table P3002.3
B16.23—2002 (R2011)	Cast-copper-alloy Solder Joint Drainage Fittings (DWV)	Table P3002.3
B16.26—2011	Cast-copper-alloy Fittings for Flared Copper Tubes	Table P2906.6, Table P3002.3
B16.28—1994	Wrought-steel Buttwelding Short Radius Elbows and Returns	Table P2906.6
B16.29—2012	Wrought-copper and Wrought-copper-alloy Solder Joint Drainage Fittings (DWV)	Table P3002.3
B16.33—2012	Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 125 psig (Sizes $^{1}/_{2}$ through 2)	Table G2420.1.1
B16.34—2009	Valves—Flanged, Threaded and Welding End	Table P2903.9.4
B16.44—2002 (Reaffirmed 2007)	Manually Operated Metallic Gas Valves for Use in Above-ground Piping Systems up to 5 psi	Table G2420.1.1
B16.51—2011	Copper and Copper Alloy Press-Connect Pressure Fittings	Table 2906.6
B36.10M—2004	Welded and Seamless Wrought-steel Pipe	G2414.4.2
BPVC—2010/2011 addenda	ASME Boiler and Pressure Vessel Code (2007 Edition)	M2001.1.1, G2452.1
CSD-1—2011	Controls and Safety Devices for Automatically Fired Boilers	M2001.1.1, G2452.1
ASSE 1016/ASME 112.1016/ CSA B125.16—2011	Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations	Table P2701.1, P2708.4, P2722.2

ASSE

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Standard reference number	Title	Referenced in code section number
1001—2008	Performance Requirements for Atmospheric-type Vacuum Breakers	Table P2902.3, P2902.3.2
1002—2008	Performance Requirements for Anti-siphon Fill Valves for Water Closet Flush Tank	Table P2701.1, Table P2902.3, P2902.4.1
1003—2009	Performance Requirements for Water-pressure-reducing Valves for Domestic Water Distribution Systems	P2903.3.1

1008—2006	Performance Requirements for Plumbing Aspects of Residential Food Waste Disposer Units.	Table P2701.1
1010—2004	Performance Requirements for Water Hammer Arresters	P2903.5
1011—2004	Performance Requirements for Hose Connection Vacuum Breakers	Table P2902.3, P2902.3.2
1012—2009	Performance Requirements for Backflow Preventers with Intermediate Atmospheric Vent	Table P2902.3, P2902.3.3, P2902.5.1, P2902.5.5.3
1013—2009	Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers	Table P2902.3, P2902.3.5, P2902.5.1, P2902.5.5.3
1015—2009	Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies	Table P2902.3, P2902.3.6
ASSE 1016/ASME 112.1016/ CSA B125.16—2011	Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations	Table P2701.1, P2708.4, P2722.2
1017—2010	Performance Requirements for Temperature-actuated Mixing Valves for Hot Water Distribution Systems	P2724.1, P2802.1, P2803.2
1018—2010	Performance Requirements for Trap Seal Primer Valves; Potable Water Supplied	P3201.2.1, P3201.2.2
1019—2010	Performance Requirements for Freeze-resistant, Wall Hydrants, Vacuum Breaker, Draining Types	Table P2701.1, P2902.3.2
1020—2004	Performance Requirements for Pressure Vacuum Breaker Assembly	Table P2902.3, P2902.3.4
1023—2010	Performance Requirements for Hot Water Dispensers, Householdstorage-type—Electrical	Table P2701.1
1024—2004	Performance Requirements for Dual Check Backflow Preventers, Anti-siphontype, Residential Applications	Table P2902.3, P2902.3.7
1035—2008	Performance Requirements for Laboratory Faucet Backflow Preventers	Table P2902.3, P2902.3.2
1037—2010	Performance Requirements for Pressurized Flushing Devices (Flushometer) for Plumbing Fixtures	Table P2701.1
1044—2010	Performance Requirements for Trap Seal Primer Devices Drainage Types and Electronic Design Types	P3201.2.3
1047—2009	Performance Requirements for Reduced Pressure Detector Fire Protection Backflow Prevention Assemblies	Table P2902.3, P2902.3.5
1048—2009	Performance Requirements for Double Check Detector Fire Protection Backflow Prevention Assemblies	Table P2902.3, P2902.3.6
1050—2009	Performance Requirements for Stack Air Admittance Valves for Sanitary Drainage Systems	P3114.1
1051—2009	Performance Requirements for Individual and Branch-type Air Admittance Valves for Plumbing Drainage Systems	P3114.1

1052—2004	Performance Requirements for Hose Connection Backflow Preventers	Table P2701.1, Table P2902.3, P2902.3.2
1056—2010	Performance Requirements for Spill-resistant Vacuum Breakers	Table P2902.3, P2902.3.4
1060—2006	Performance Requirements for Outdoor Enclosures for Fluid-conveying Components	P2902.6.1
1061—2010	Performance Requirements for Removable and Nonremovable Push Fit Fittings	Table P2906.6
1062—2006	Performance Requirements for Temperature-actuated, Flow Reduction (TAFR) Valves for Individual Supply Fittings	Table P2701.1, P2724.2
1066—2009	Performance Requirements for Individual Pressure Balancing In-line Valves for Individual Fixture Fittings	P2722.4
1070—2004	Performance Requirements for Water-temperature-limiting Devices	P2713.3, P2721.2, P2724.1
1072—07	Performance Requirements for Barrier-type Floor Drain Trap Seal Protection Devices	P3201.2.4

ASTM

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Standard reference number	Title	Referenced in code section number
A 36/A 36M—08	Specification for Carbon Structural Steel	R606.15, R608.5.2.2
A 53/A 53M—12	Specification for Pipe, Steel, Black and Hot-dipped, Zinc-coated Welded and Seamless	R407.3, Table M2101.1, G2414.4.2, Table P2906.4, Table P2906.5, Table P3002.1(1)
A 74—13A	Specification for Cast-iron Soil Pipe and Fittings	Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3, P3005.2.6, Table P3302.1
A 106/A 106M—11	Specification for Seamless Carbon Steel Pipe for High-temperature Service	Table M2101.1, G2414.4.2
A 126—(2009)	Gray Iron Castings for Valves, Flanges and Pipe Fittings	Table P2903.9.4
A 153/A 153M—09	Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware	R317.3, Table R606.3.4.1, 703.6.3, R905.7.5, R905.8.6
A 167—99 (2009)	Specification for Stainless and Heat-resisting Chromium-nickel Steel Plate, Sheet and Strip	Table R606.3.4.1
A 240/A 240M—13A	Standard Specification for Chromium and Chromium-nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications	Table R905.10.3(1)

A 254—97 (2007)	Specification for Copper Brazed Steel Tubing	Table M2101.1, G2414.5.1
A 307—12	Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength	R608.5.2.2
A 312/A 312M—13A	Specification for Seamless, Welded and Heavily Cold Worked Austenitic Stainless Steel Pipes	Table P2906.4, Table P2906.5, Table P2906.6, P2905.12.2
A 463/A 463M—10	Standard Specification for Steel Sheet, Aluminum-coated by the Hot-dip Process	Table R905.10.3(2)
A 539—99	Specification for Electric-resistance-welded Coiled Steel Tubing for Gas and Fuel Oil Lines	M2202.1
A 615/A 615M—12	Specification for Deformed and Plain Billet-steel Bars for Concrete Reinforcement.	R402.3.1, R403.1.3.5.1, R404.1.3.3.7.1, R608.5.2.1
A 641/A 641M—09a	Specification for Zinc-coated (Galvanized) Carbon Steel Wire	Table R606.3.4.1
A 653/A 653M—11	Specification for Steel Sheet, Zinc-coated (Galvanized) or Zinc-iron Alloy-coated Galvanized) by the Hot-dip Process	R317.3.1, R505.2.2, R603.2.2, Table R606.3.4.1, R608.5.2.3, R804.2.2, R804.2.3, Table R905.10.3(1), Table R905.10.3(2), M1601.1.1
A 706/A 706M—09B	Specification for Low-alloy Steel Deformed and Plain Bars for Concrete Reinforcement.	R402.3.1, R403.1.3.5.1, R404.1.3.3.7.1, R608.5.2.1
A 755/A 755M—2011	Specification for Steel Sheet, Metallic Coated by the Hot-dip Process and Prepainted by the Coil-coating Process for Exterior Exposed Building Products	Table R905.10.3(2)
A 778—01 (2009e1)	Specification for Welded Unannealed Austenitic Stainless Steel Tubular Products	Table P2905.4, Table P2905.5, Table P2905.6
A 792/A 792M—10	Specification for Steel Sheet, 55% Aluminum-zinc Alloy-coated by the Hot-dip Process	R505.2.2, R603.2.2, R608.5.2.3, R804.2.2, Table 905.10.3(2)
A 875/A 875M—13	Specification for Steel Sheet, Zinc-5%, Aluminum Alloy-coated by the Hot-dip Process	R608.5.2.3, Table R905.10.3(2)
A 888—13A	Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Application	Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3, Table P3302.1
A 924/A 924M—13	Standard Specification for General Requirements for Steel Sheet, Metallic-coated by the Hot-Dip Process	Table R905.10.3(1)

A 996/A 996M—2009b	Specifications for Rail-steel and Axle-steel Deformed Bars for Concrete Reinforcement	Table R404.1.2(9), R402.3, R403.1.3.5.1, R404.1.3.3.7.1, R608.5.2.1, Table R608.5.4(2)
A 1003/A 1003M—13A	Standard Specification for Steel Sheet, Carbon, Metallic and Nonmetallic-coated for Cold-formed Framing Members	R505.2.1, R505.2.2, R603.2.1, R603.2.2, R804.2.1
B 32—08	Specification for Solder Metal	P3003.6.3
B 42—10	Specification for Seamless Copper Pipe, Standard Sizes	Table M2101.1, Table P2906.4, Table P2906.5, Table P3002.1(1)
B 43—09	Specification for Seamless Red Brass Pipe, Standard Sizes	Table M2101.1, Table P2906.4, Table P2906.5, Table P3002.1(1)
B 75—11	Specification for Seamless Copper Tube	Table M2101.1, Table P2905.4, Table P2906.5, Table P3002.1(1), Table P3002.1(2), Table P3002.2
B 88—09	Specification for Seamless Copper Water Tube	Table M2101.1, G2414.5.2, Table, P2906.4, Table P2905.6, Table P3002.1(1), Table P3002.1(2), Table P3002.2
B 101—12	Specification for Lead-coated Copper Sheet and Strip for Building Construction	Table R905.2.8.2, Table R905.10.3(1)
B 135—10	Specification for Seamless Brass Tube	Table M2101.1
B 209—10	Specification for Aluminum and Aluminum-alloy Sheet and Plate	Table 905.10.3(1)
B 227—10	Specification for Hard-drawn Copper-clad Steel Wire	R606.15
B 251—10	Specification for General Requirements for Wrought Seamless Copper and Copper-alloy Tube	Table M2101.1, Table P2906.4, Table P2906.5, Table P3002.1(1), Table P3002.1(2), Table P3002.2
B 302—12	Specification for Threadless Copper Pipe, Standard Sizes	Table M2101.1, Table P2906.4, Table P2906.5, Table P3002.1(1)
B 306—09	Specification for Copper Drainage Tube (DWV)	Table M2101.1, Table P3002.1(1), Table P3002.1(2)
B 370—12	Specification for Copper Sheet and Strip for Building Construction	Table R905.2.8.2, Table

		R905.10.3(1), Table P2701.1
B 447—12a	Specification for Welded Copper Tube	Table P2906.4, Table P2906.5
B 695—04 (2009)	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel	R317.3.1, R317.3.3
B 813—10	Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube	Table M2101.1, M2103.3, P2906.14, P3003.6.3
B 828—02 (2010)	Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings	M2103.3, P2906.14, P3003.6.3
C 4—2009	Specification for Clay Drain Tile and Perforated Clay Drain Tile	Table P3302.1
C 5—10	Specification for Quicklime for Structural Purposes	R702.2.1
C 14—11	Specification for Non-reinforced Concrete Sewer, Storm Drain and Culvert Pipe.	Table P3002.2
C 22/C 22M—00 (2010)	Specification for Gypsum	R702.2.1, R702.3.1
C 27—98 (2008)	Specification for Standard Classification of Fireclay and High-alumina Refractory Brick	R1001.5
C 28/C 28M—10	Specification for Gypsum Plasters	R702.2.1
C 33/C 33M—13	Specification for Concrete Aggregates	R403.4.1
C 34—12	Specification for Structural Clay Load-bearing Wall Tile	Table R301.2(1), R606.2.2
C 35/C35M—1995 (2009)	Specification for Inorganic Aggregates for Use in Gypsum Plaster	R702.2.1
C 55—2011	Specification for Concrete Building Brick	R202, Table R301.2(1), R606.2.1
C 56—12	Standard Specification for Structural Clay Nonloadbearing Tile	R606.2.2
C 59/C 59M—00 (2011)	Specification for Gypsum Casting Plaster and Molding Plaster	R702.2.1
C 61/C 61M—00 (2011)	Specification for Gypsum Keene's Cement	R702.2.1
C 62—13	Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)	R202, Table R301.2(1), R606.2.2
C 73—10	Specification for Calcium Silicate Face Brick (Sand Lime Brick)	R202, Table R301.2(1), R606.2.1
C 76—13A	Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe	Table P3002.2
C 90—13	Specification for Load-bearing Concrete Masonry Units	Table R301.2(1), 606.2.1
C 91—12	Specification for Masonry Cement	R702.2.2
C 94/C 94M—13	Standard Specification for Ready-mixed Concrete	R404.1.3.3.2, R608.5.1.2
C126—13	Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units	R606.2.2
C 129—11	Specification for Nonload-bearing Concrete Masonry Units	Table R301.2(1)

C 143/C 143M—12	Test Method for Slump of Hydraulic Cement Concrete	R404.1.3.3.4, R608.5.1.9
C 145—85	Specification for Solid Load-bearing Concrete Masonry Units	R202, Table R301.2(1)
C 150—12	Specification for Portland Cement	R608.5.1.1, R702.2.2
C 199—84 (2011)	Test Method for Pier Test for Refractory Mortar	R1001.5, R1001.8, R1003.12
C 203—05a (2012)	Standard Test Methods for Breaking Load and Flexural Properties of Block-type Thermal Insulation	Table R610.3.1
C 207—06 (2011)	Specification for Hydrated Lime for Masonry Purposes	Table R606.2.7
C 208—12	Specification for Cellulosic Fiber Insulating Board	R602.1.10, Table R602.3(1), Table R906.2
C 212-10	Standard Specification for Structural Clay Facing Tile	R602.2.2
C 216—13	Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)	R202, Table R301.2(1), R606.2.2
C 270—12a	Specification for Mortar for Unit Masonry	R606.2.7, R606.2.10
C 272/C 272M—12	Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions	Table R610.3.1
C 273/C 273M—11	Standard Test Method for Shear Properties of Sandwich Core Materials	Table R610.3.1
C 315—07 (2011)	Specification for Clay Flue Liners and Chimney Pots	R1001.8, R1003.11.1, Table R1003.14(1), G2425.12
C 406/C 406M—2010	Specifications for Roofing Slate	R905.6.4
C 411—11	Test Method for Hot-surface Performance of High-temperature Thermal Insulation	M1601.3
C 425—04 (2009)	Specification for Compression Joints for Vitrified Clay Pipe and Fittings	Table P3002.2, P3003.10, P3003.13
C 443—12	Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets	P3003.5, P3003.13
C 475/C 475—12	Specification for Joint Compound and Joint Tape for Finishing Gypsum Wallboard	R702.3.1
C 476—10	Specification for Grout for Masonry	R606.2.11
C 503—10	Standard Specification for Marble Dimension Stone	R606.2.4
C 514—04 (2009)el	Specification for Nails for the Application of Gypsum Wallboard	R702.3.1
C 552—12b	Standard Specification for Cellular Glass Thermal Insulation	Table R906.2
C 557—03 (2009)e01	Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing	R702.3.1
C 564—12	Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings	P3003.4.2, P3003.4.3, P3003.13
C 568—10	Standard Specification for Limestone Dimension Stone	R606.2.4
C 578—12b	Specification for Rigid, Cellular Polystyrene Thermal Insulation	R316.8, R403.3, R610.3.1, R703.11.2.1,

		Table R703.15.1, Table R703.15.2, Table R703.16.1, Table R703.16.2, Table R906.2
C 587—04(2009)	Specification for Gypsum Veneer Plaster	R702.2.1
C 595/C 595M—13	Specification for Blended Hydraulic Cements	R608.5.1.1, R702.2.2
C 615/C 615M—11	Standard Specification for Granite Dimension Stone	R606.2.4
C 616/C 615M—10	Standard Specification for Quartz Dimension Stone	R606.2.4
C 629—10	Standard Specification for Slate Dimension Stone	R606.2.4
C 631—09	Specification for Bonding Compounds for Interior Gypsum Plastering	R702.2.1
C 645—13	Specification for Nonstructural Steel Framing Members	R702.3.3
C 652—13	Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale)	R202, Table R301.2(1), R606.2.2
C 685/C 685M—11	Specification for Concrete Made by Volumetric Batching and Continuous Mixing	R404.1.3.3.2, R608.5.1.2
C 700—13	Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated	Table P3002.2, Table P3002.3, Table P3302.1
C 728—05 (2013)	Standard Specification for Perlite Thermal Insulation Board	Table R906.2
C 744—11	Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units	R606.2.1
C 836/C 836M—12	Specification for High Solids Content, Cold Liquid-applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course	R905.15.2
C 843—99 (2012)	Specification for Application of Gypsum Veneer Plaster	R702.2.1
C 844—04 (2010)	Specification for Application of Gypsum Base to Receive Gypsum Veneer Plaster	R702.2.1
C 847—12	Specification for Metal Lath	R702.2.1, R702.2.2
C 887—05 (2010)	Specification for Packaged, Dry, Combined Materials for Surface Bonding Mortar	R406.1, R606.2.8
C 897—05 (2009)	Specification for Aggregate for Job-mixed Portland Cement-based Plasters	R702.2.2
C 920—11	Standard Specification for Elastomeric Joint Sealants	R406.4.1
C 926—13	Specification for Application of Portland Cement-based Plaster	R702.2.2, R702.2.2.1, R703.7, R703.7.2.1, R703.7.4
C 933—13	Specification for Welded Wire Lath	R702.2.1, R702.2.2
C 946—10	Standard Practice for Construction of Dry-Stacked, Surface-Bonded Walls	R606.2.8
C 954—11	Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in (0.84 mm) or to 0.112 in. (2.84 mm) in Thickness	R505.2.5, R603.2.5, R702.3.5.1, R804.2.5
C 955—11C	Specification for Load-bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum	R702.3.3

	Panel Products and Metal Plaster Bases	
C 957—10	Specification for High-solids Content, Cold Liquid-applied Elastomeric Waterproofing Membrane for Use with Integral Wearing Surface	R905.15.2
C 1002—07	Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases	R702.3.1, R702.3.5.1
C 1029—13	Specification for Spray-applied Rigid Cellular Polyurethane Thermal Insulation	R905.14.2
C 1032—06 (2011)	Specification for Woven Wire Plaster Base	R702.2.1, R702.2.2
C 1047—10a	Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base	R702.2.1, R702.2.2, R702.3.1
C 1063—12D	Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-based Plaster	R702.2.2, R703.7
C 1088—13	Standard Specification for Thin Veneer Brick Units Made from Clay or Shale	R606.2.2
C 1107/C 1107M—13	Standard Specification for Packaged Dry, Hydraulic-cement Grout (Nonshrink)	R402.3.1
C 1116/C 116M—10A	Standard Specification for Fiber-reinforced Concrete and Shotcrete	R402.3.1
C 1157—11/C1157M—11	Standard Performance Specification for Hydraulic Cement	R608.5.1.1
C 1167—11	Specification for Clay Roof Tiles	R905.3.4
C 1173—10e1	Specification for Flexible Transition Couplings for Underground Piping Systems	P3003.3.1, P3003.5, P3003.6.1, P3003.10.1, P3003.12.1, P3003.12.2, P3003.13
C 1177/C 1177M—08	Specification for Glass Mat Gypsum Substrate for Use as Sheathing	R702.3.1, Table 906.2
C 1178/C 1178M—11	Specification for Glass Mat Water-resistant Gypsum Backing Panel	R702.3.1, R702.3.7, Table R702.4.2
C 1186—08 (2012)	Specification for Flat Nonasbestos Fiber Cement Sheets	R703.10.1, R703.10.2
C 1261—10	Specification for Firebox Brick for Residential Fireplaces	R1001.5, R1001.8
C 1277—12	Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings	P3003.4.3
C 1278/C 1278M—07a (2011)	Specification for Fiber-reinforced Gypsum Panels	R702.3.1, R702.3.7, Table R702.4.2, Table R906.2
C 1283—11	Practice for Installing Clay Flue Lining	R1003.9.1, R1003.12
C 1288—99 (2010)	Standard Specification for Discrete Nonasbestos Fiber-cement Interior Substrate Sheets	Table R503.2.1.1(1), Table R503.2.1.1(2),

		Table 602.3(2), Table R702.4.2
C 1289—13e1	Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board	R316.8, R703.11.2.1, Table R703.15.1, Table R703.15.2, Table R703.16.1, Table R703.16.2, Table R906.2
C 1325—08b	Standard Specification for Nonasbestos Fiber-mat Reinforced Cement Interior Substrate Sheets Backer Units	Table R702.4.2
C 1328/C 1328M—12	Specification for Plastic (Stucco) Cement	R702.2.2
C 1363—11	The Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus	N1101.10.4.1
C 1364—10B	Standard Specification for Architectural Cast Stone	R606.2.5
C 1386—07	Standard Specification for Precast Autoclaved Aerated Concrete (AAC) Wall Construction Units	R606.2.3
C 1396/C 1396M—2013	Specification for Gypsum Board	Table R602.3(1), R702.2.1, R702.2.2, R702.3.1, R702.3.7
C 1405—12	Standard Specification for Glazed Brick (Single Fired, Brick Units)	R606.2.2
C 1440—08	Specification for Thermoplastic Elastomeric (TPE) Gasket Materials for Drain, Waste and Vent (DWV), Sewer, Sanitary and Storm Plumbing Systems	P3003.13
C 1460—08	Specification for Shielded Transition Couplings for Use with Dissimilar DWV Pipe and Fittings Above Ground	P3003.18
C 1461—08	Specification for Mechanical Couplings Using Thermoplastic Elastomeric (TPE) Gaskets for Joining Drain, Waste and Vent (DWV) Sewer, Sanitary and Storm Plumbing Systems for Above and Below Ground Use	P3003.13
C 1492—03 (2009)	Specification for Concrete Roof Tile	R905.3.5
C 1513—2013	Standard Specification for Steel Tapping Screws for Cold-formed Steel Framing Connections	R505.2.5, R603.2.5, R702.3.8.1, Table R703.3(2), R804.2.5 Table R703.16.1, Table R703.16.2
C 1540—11	Specification for Heavy Duty Shielded Couplings Joining Hubless Cast-iron Soil Pipe and Fittings	P3003.4.3
C 1634—11	Standard Specification for Concrete Facing Brick	R606.2.1
C 1658/C 1658M—12	Standard Specification for Glass Mat Gypsum Panels	R702.3.1
C 1668—12	Standard Specification for Externally Applied Reflective Insulation Systems	M1601.3

	on Rigid Duct in Heating, Ventilation, and Air Conditioning (HVAC) Systems	
D 41—05	Specification for Asphalt Primer Used in Roofing, Dampproofing and Waterproofing	Table R905.9.2, Table R905.11.2
D 43—00 (2006)	Specification for Coal Tar Primer Used in Roofing, Dampproofing and Waterproofing	Table R905.9.2
D 226/D 226M—09	Specification for Asphalt-saturated (Organic Felt) Used in Roofing and Waterproofing	R703.2, R905.1.1, Table R905.1.1(1), R905.8.4, Table R905.9.2
D 227/D 227M—03 (2011)e1	Specification for Coal Tar Saturated (Organic Felt) Used in Roofing and Waterproofing	Table R905.9.2
D 312—00 (2006)	Specification for Asphalt Used in Roofing	Table R905.9.2
D 422—63 (2007)	Test Method for Particle-size Analysis of Soils	R403.1.8.1
D 449—03 (2008)	Specification for Asphalt Used in Dampproofing and Waterproofing	R406.2
D 450—07	Specification for Coal-tar Pitch Used in Roofing, Dampproofing and Waterproofing	Table R905.9.2
D 1227—95 (2007)	Specification for Emulsified Asphalt Used as a Protective Coating for Roofing	Table R905.9.2, Table R905.11.2, R905.15.2
D 1248—12	Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable	M1601.1.2
D 1527—99 (2005)	Specification for Acrylonitrile-butadiene-styrene (ABS) Plastic Pipe, Schedules 40 and 80	Table P2906.4
D1621—10	Standard Test Method for Compressive Properties of Rigid Cellular Plastics	Table R610.3.1
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D 1623—09	Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics	Table R610.3.1
D 1693—2013	Test Method for Environmental Stress-cracking of Ethylene Plastics	Table M2101.1
D 1784—11	Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds	M1601.1.2
D 1785—12	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120	Table P2906.4, Table AG101.1
D 1863/D 1863M—05 (2011)e1	Specification for Mineral Aggregate Used in Built-up Roofs	Table R905.9.2
D 1869—95 (2010)	Specification for Rubber Rings for Asbestos-cement Pipe	P2906.17, P3003.13
D 1970/D 1970M—2013	Specification for Self-adhering Polymer Modified Bitumen Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection	R905.1.1, R905.2.8.2, R905.16.4
D 2104—03	Specification for Polyethylene (PE) Plastic Pipe, Schedule 40	Table P2905.4
D 2126—09	Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging	Table R610.3.1
D 2178—04	Specification for Asphalt Glass Felt Used in Roofing and Waterproofing	Table R905.9.2

D 2235—04 (2011)	Specification for Solvent Cement for Acrylonitrile-butadiene-styrene (ABS) Plastic Pipe and Fittings	P2906.9.1.1, P3003.3.2
D 2239—12A	Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter	Table P2906.4, Table AG101.1
D 2241—09	Specification for Poly (Vinyl Chloride) (PVC) Pressure-rated Pipe (SDR-Series)	Table P2905.4, Table AG101.1
D 2282—99 (2005)	Specification for Acrylonitrile-butadiene-styrene (ABS) Plastic Pipe (SDR-PR)	Table P2905.4
D 2412—11	Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-plate Loading	M1601.1.2
D 2447—03	Specification for Polyethylene (PE) Plastic Pipe Schedules 40 and 80, Based on Outside Diameter	Table M2101.1
D 2464—06	Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80	Table P2906.6
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D 2468—96a	Specification for Acrylonitrile-butadiene-styrene (ABS) Plastic Pipe Fittings, Schedule 40	Table P2906.6
D 2513—2013e1	Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings	Table M2101.1, G2414.6, G2414.6.1, G2414.11, G2415.17.2
D 2559—12A	Standard Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior (West Use) Exposure Conditions	R610.3.3
D 2564—12	Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems	P2906.9.1.4, P3003.8.2, P3003.9.2
D 2609—02 (2008)	Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe	Table P2906.6
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D 2657—07	Standard Practice for Heat Fusion-joining of Polyolefin Pipe Fittings	M2105.11.1, P2906.3.1, P3003.12.1
D 2661—11	Specification for Acrylonitrile-butadiene-styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings	Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3, P3003.3.2
D 2665—12	Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings	Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3, Table AG101.1
D 2672—96a (2009)	Specification for Joints for IPS PVC Pipe Using Solvent Cement	Table P2906.4

D 2683—2010e1	Specification for Socket-type Polyethylene Fittings for Outside Diameter-controlled Polyethylene Pipe and Tubing	Table M2105.5, M2105.11.1, P3010.5
D 2729—11	Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings	P3009.11, Table P3302.1, Table AG101.1
D 2737—2012A	Specification for Polyethylene (PE) Plastic Tubing	Table P2906.4, Table AG101.1
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D 2824—06 (2012)e1	Specification for Aluminum-pigmented Asphalt Roof Coatings, Nonfibered, Asbestos Fibered and Fibered without Asbestos	Table R905.9.2, Table R905.11.2
D 2846/D 2846M—09BE1	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-water Distribution Systems	Table M2101.1, Table P2906.4, Table P2906.5, Table P2906.6, P2906.9.1.2, P2906.9.1.3, Table AG101.1
D 2855—96 (2010)	Standard Practice for Making Solvent-cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings	P3003.9.2
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D 3035—2012e1	Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based On Controlled Outside Diameter	Table M2105.4, Table AG101.1
D 3161/D 3161M—2013	Test Method for Wind Resistance of Asphalt Shingles (Fan Induced Method)	R905.2.4.1, Table R905.2.4.1, R905.16.7
D 3201—2013	Test Method for Hygroscopic Properties of Fire-retardant Wood and Wood-base Products	R802.1.5.9
D 3212—07	Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals	P3003.3.1, P3003.9.1, P3003.12.2

D 3261—12	Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing	Table M2105.5, M2105.11.1
D 3309—96a (2002)	Specification for Polybutylene (PB) Plastic Hot- and Cold-water Distribution System	Table M2101.1
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D 3737—2012	Practice for Establishing Allowable Properties for Structural Glued Laminated Timber (Glulam)	R502.1.3, R602.1.3, R802.1.2
D 3747—79 (2007)	Specification for Emulsified Asphalt Adhesive for Adhering Roof Insulation	Table R905.9.2, Table R905.11.2
D 3909/D 3909M—97b (2012)e1	Specification for Asphalt Roll Roofing (Glass Felt) Surfaced with Mineral Granules	R905.2.8.2, R905.5.4, Table R905.9.2
D 4022/D 4022M—2007 (2012)e1	Specification for Coal Tar Roof Cement, Asbestos Containing	Table R905.9.2
D 4068—09	Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water Containment Membrane	P2709.2, P2709.2.2
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D 5019—07a	Specification for Reinforced Nonvulcanized Polymeric Sheet Used in Roofing Membrane	R905.12.2
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D 5456—2013	Standard Specification for Evaluation of Structural Composite Lumber Products	R502.1.5, R602.1.5, R802.1.7
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D 5665—99a (2006)	Specification for Thermoplastic Fabrics Used in Cold-applied Roofing and Waterproofing	Table R905.9.2
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D 6162—2000a (2008)	Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements	Table R905.11.2
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D 6754/D 6745M—10	Standard Specification for Ketone-ethylene-ester-based Sheet Roofing	R905.13.2
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D 7032—10a	Standard Specification for Establishing Performance Ratings for Wood-plastic Composite Deck Boards and Guardrail Systems (Guards or Handrails)	R507.3, R507.3.1, 507.3.4, 507.3.4
D 7158—D 7158M—2011	Standard Test Method for Wind Resistance of Sealed Asphalt Shingles (Uplift Force/Uplift Resistance Method)	R905.2.4.1, Table R905.2.4.1
D 7254—07	Standard Specification for Polypropylene (PP) siding	Table R703.3(1), R703.14
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D 7793—13	Standard Specification for Insulated Vinyl Siding	R703.13, Table R703.3(1)
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E 96/E 96M—2013	Test Method for Water Vapor Transmission of Materials	R202, Table R610.3.1, M1411.6 M1601.4.6
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E 136—2012	Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C	R202, R302.11
E 283—04	Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen	N1102.4.6 ~~5~~

E 330—02	Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference	R609.4, R609.5, R612.4, R703.1.2
E 331—00 (2009)	Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference	R703.1.1
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E 970—2010	Test Method for Critical Radiant Flux of Exposed Attic Floor Insulation Using a Radiant Heat Energy Source	R302.10.5
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E 2570—07	Standard Test Methods for Evaluating Water-resistive Barrier (WRB) Coatings Used Under Exterior Insulation and Finish Systems (EIFS) or EIFS with Drainage	R703.9.2
E 2634—11	Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems	R404.1.3.3.6.1, R608.4.4
F 405—05	Specification for Corrugated Polyethylene (PE) Pipe and Fittings	Table P3009.11, Table P3302.1, Table AG101.1
F 409—12	Specification for Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings	Table P2701.1, P2702.2, P2702.3
F 437—09	Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80	Table P2906.6
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F 439—12	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80	Table P2906.6
F 441/F 441M—13	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80	Table P2906.4, Table P2906.5, Table AG101.1
F 442/F 442M—13	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)	Table P2906.4, Table P2906.5, Table AG101.1
F 477—10	Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe	P2906.17, P3003.13
F 493—10	Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings	P2906.9.1.2, P2906.9.1.3
F 628—08	Specification for Acrylonitrile-butadiene-styrene (ABS) Schedule 40 Plastic Drain, Waste and Vent Pipe with a Cellular Core	Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3, P3003.3.2, Table AG101.1
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F 714—13	Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter	Table P3002.2, P3010.4
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F 877—11A	Specification for Cross-linked Polyethylene (PEX) Plastic Hot- and Cold-water Distribution Systems	Table M2101.1, Table P2906.4, Table P2906.5, Table P2906.6
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F 1055—13	Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene Pipe and Tubing	Table M2105.5, M2105.11.2
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F 1282—10	Specification for Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe	Table M2101.1, Table P2906.4, Table P2906.5, Table P2906.6, P2906.11.1, Table AG101.1
F 1282—10	Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage	Table P3002.1(2), Table P3002.2,

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F 1488—09e1	Specification for Coextruded Composite Pipe	Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3009.11
F 1554—07a	Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength	R608.5.2.2
F 1667—11A e1	Specification for Driven Fasteners, Nails, Spikes and Staples	R317.3, R703.3.2, R703.6.3, Table R703.15.1, Table R703.15.2, R905.2.5
F 1807—13	Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing	Table M2101.1, Table P2906.6
F 1866—07	Specification for Poly (Vinyl Chloride) (PVC) Plastic Schedule 40 Drainage and DWV Fabricated Fittings	Table P3002.3
F 1924—12	Standard Specification for Plastic Mechanical Fittings for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing	M2105.11.1
F 1960—12	Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing	Table M2101.1, Table P2906.6
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F 1973—08	Standard Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA 11) Fuel Gas Distribution Systems	G2415.15.2
F 1974—09	Specification for Metal Insert Fittings for Polyethylene/Aluminum/Polyethylene and Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene Composite Pressure Pipe	P2506.11.1, Table P2906.6
F 1986—01 (2011)	Multilayer Pipe Type 2, Compression Joints for Hot and Cold Drinking Water Systems	Table P2906.4, Table P2906.5, Table P2906.6
F 2080—12	Specification for Cold-expansion Fittings with Metal Compression-sleeves for Cross-linked Polyethylene (PEX) Pipe	P2906.6
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F 2098—08	Standard Specification for Stainless Steel Clamps for Securing SDR9 Cross-linked Polyethylene (PEX) Tubing to Metal Insert and Plastic Insert Fittings	Table M2101.1, Table P2906.6
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F 2262—09	Standard Specification for Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene Tubing OD Controlled SDR9	Table P2906.4, Table P2906.5
F 2389—10	Standard for Pressure-rated Polypropylene (PP) Piping Systems	Table M2105.12.1, Table P2906.4, Table P2906.5, Table P2906.6, P2906.10.1, Table AG101.1
F 2434—09	Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for Polyethylene/Aluminum/Cross-linked Polyethylene (PEX-AL-PEX) Tubing	Table P2906.6
F 2623—08	Standard Specification for Polyethylene of Raised Temperature (PE-RT) SDRG Tubing	Table M2101.1, Table AG101.1
F 2735—09	Standard Specification for Plastic Insert Fittings for SDR9 Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing	Table M2101.1, Table P2906.6
F 2769—10	Polyethylene or Raised Temperature (PE-RT) Plastic Hot and Cold-Water Tubing and Distribution Systems	Table M2101.1, Table P2906.4, Table P2906.5, Table P2906.6, Table AG101.1
F 2806—10	Standard Specification for Acrylonitrile-butadiene-styrene (ABS) Plastic Pipe (Metric SDR-PR)	Table M2101.1
F 2855—12	Standard Specification for Chlorinated Poly (Vinyl Chloride)/ Aluminum/Chlorinated Poly (Vinyl Chloride) (CPVC AL CPVC) Composite Pressure Tubing	Table P2906.4, Table P2906.5, Table AG101.1
F 2969—12	Standard Specification for Acrylonitrile-butadiene-styrene (ABS) IPS Dimensioned Pressure Pipe	Table M2101.1

AWC

American Wood Council
222 Catocin Circle, Suite 201
Leesburg, VA 20175

Standard reference number	Title	Referenced in code section number
AWC STJR—2015	Span Tables for Joists and Rafters	R502.3, R802.4, R802.5
AWC WFCM—2015	Wood Frame Construction Manual for One- and Two-family Dwellings	R301.1.1, R301.2.1.1, R602.10.8.2, R608.9.2, Figure R608.9(9), R608.10
ANSI AWC NDS—2015	National Design Specification (NDS) for Wood Construction—with 2005 Supplement	R404.2.2, R502.2, Table R503.1, R602.3, R608.9.2, Table R703.15.1,

		Table R703.15.2, R802.2
AWC PWF—2015	Permanent Wood Foundation Design Specification	R317.3.2, R401.1, R404.2.3

AWPA

American Wood Protection Association
P.O. Box 361784
Birmingham, AL 35236-1784

Standard reference number	Title	Referenced in code section number
C1—03	All Timber Products—Preservative Treatment by Pressure Processes	R902.2
M4—11	Standard for the Care of Preservative-treated Wood Products	R317.1.1, R318.1.2
U1—14	USE CATEGORY SYSTEM: User Specification for Treated Wood Except Section 6 Commodity Specification H	R317.1, R402.1.2, R504.3, R703.6.3, R905.7.5, Table R905.8.5, R905.8.6

AWS

American Welding Society
8669 NW 36 Street, #130
Doral, FL 33166

Standard reference number	Title	Referenced in code section number
A5.8M/A5.8—2011	Specifications for Filler Metals for Brazing and Braze Welding	P3003.6.1
ANSI/AWS A5.31M/A5.31—2012	Specification for Fluxes for Brazing and Braze Welding Edition: 2nd	M2103.3, M2202.2, P2906.14, M2103.3

AWWA

American Water Works Association
6666 West Quincy Avenue
Denver, CO 80235

Standard reference number	Title	Referenced in code section number
C104/A21.4—08	Cement-mortar Lining for Ductile-iron Pipe and Fittings for Water	P2906.4
C110/A21.10—12	Ductile-iron and Gray-iron Fittings	Table P2906.6
C115/A21.15—11	Flanged Ductile-iron Pipe with Ductile-iron or Gray-iron Threaded Flanges	Table P2906.4
C151/A21.51—09	Ductile-iron Pipe, Centrifugally Cast, for Water	Table P2906.4
C153/A21.53—11	Ductile-iron Compact Fittings for Water Service	Table P2906.6
C500—09	Standard for Metal-seated Gate Valves for Water Supply Service	Table P2903.9.4
C504—10	Standard for Rubber-seated Butterfly Valves	Table P2903.9.4
C507—11	Standard for Ball Valves, 6 In. Through 60 In	Table P2903.9.4
C510—07	Double Check Valve Backflow Prevention Assembly	Table P2902.3, P2902.3.6

C511—07	Reduced-pressure Principle Backflow Prevention Assembly	Table P2902.3, P2902.3.5, P2902.5.1
C901—08	Polyethylene (PE) Pressure Pipe and Tubing $^1/_2$ in. (13 mm) through 3 in. (76 mm) for Water Service	P2906.4, Table AG101.1
C903—05	Polyethylene-aluminum-polyethylene & Crosslinked Polyethylene Composite Pressure Pipe, $^1/_2$ in. (12 mm) through 2 in. (50 mm), for Water Service	Table M2101
C904—06	Cross-linked Polyethylene (PEX) Pressure Pipe, $^1/_2$ in. (12 mm) through 3 in. (76 mm) for Water Service	P2906.4, Table AG101.1

CEN

European Committee for Standardization (EN)
Central Secretariat
Rue de Stassart 36
B-10 50 Brussels

Standard reference number	Title	Referenced in code section number
EN 15250-2007	Slow Heat Release Appliances Fired by Solid Fuel Requirements and Test Methods	R1002.5

CGSB

Canadian General Standards Board
Place du Portage 111, 6B1
11 Laurier Street
Gatineau, Quebec, Canada KIA 1G6

Standard reference number	Title	Referenced in code section number
CAN/CGSB-37.54—95	Polyvinyl Chloride Roofing and Waterproofing Membrane	.R905.13.2
37-GP-52M—(1984)	Roofing and Waterproofing Membrane, Sheet Applied, Elastomeric	R905.12.2
37-GP-56M—(1980)	Membrane, Modified Bituminous, Prefabricated and Reinforced for Roofing—with December 1985 Amendment	Table R905.11.2

CISPI

Cast Iron Soil Pipe Institute
5959 Shallowford Road, Suite 419
Chattanooga, TN 37421

Standard reference number	Title	Referenced in code section number
301—04a	Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications	Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3, Table P3302.1
310—04	Standard Specification for Coupling for Use in Connection with Hubless	P3003.4.3

	Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications	

CPA

Composite Panel Association
19465 Deerfield Avenue, Suite 306
Leesburg, VA 20176

Standard reference number	Title	Referenced in code section number
ANSI A135.4—2012	Basic Hardboard	Table R602.3(2)
ANSI A135.5—2012	Prefinished Hardboard Paneling	R702.5
ANSI A135.6—2012	Engineered Wood Siding	R703.5
ANSI A135.7—2012	Engineered Wood Trim	R703.5
A208.1—2009	Particleboard	R503.3.1, R602.1.9, R605.1

CPSC

Consumer Product Safety Commission
4330 East West Highway
Bethesda, MD 20814-4408

Standard reference number	Title	Referenced in code section number
16 CFR, Part 1201—(2002)	Safety Standard for Architectural Glazing	R308.1.1, R308.3.1, Table R308.3.1(1)
16 CFR, Part 1209—(2002)	Interim Safety Standard for Cellulose Insulation	R302.10.3
16 CFR, Part 1404—(2002)	Cellulose Insulation	R302.10.3

CSA

CSA Group
8501 East Pleasant Valley Road
Cleveland, OH 44131-5516

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A440—11	North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights	R308.6.9, R609.3, N1102.4.4 ~~3~~
ANSI/CSA America FCI—2012	Stationary Fuel Cell Power Systems	M1903.1
ASME A112.3.4—2013/ CSA B45.9—13	Macerating Toilet Systems and Related Components	Table P2701.1, P3007.5
ASME A112.18.1—2012/ CSA B125.1—2012	Plumbing Supply Fittings	Table P2701.1, P2708.4, P2708.5, P2722.1, P2722.2, P2722.3, P2902.2, Table P2903.9.4
ASME A112.18.2—2011/	Plumbing Waste Fittings	Table P2701.1, P2702.2

CSA B125.2—2011		
A112.18.6/ CSA B125.6—2009	Flexible Water Connectors	P2906.7
ASME A112.19.1—2013/ CSA B45.2—13	Enameled Cast-iron and Enameled Steel Plumbing Fixtures	Table 2701.1, P2711.1
ASME A112.19.2—2013/ CSA B45.1—13	Ceramic Plumbing Fixtures	Table P2701.1, P2705.1, P2711.1, P2712.1, P2712.2, P2712.9
ASME A112.19.3—2008/ CSA B45.4—08 (R2013)	Stainless Steel Plumbing Fixtures	Table P2701.1, P2705.1, P2711.1, P2712.1
ASSE 1016/ASME 112.1016/ CSA B125.16—2011	Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations	Table P2701.1, P2708.4, P2722.2
A112.19.5—2011/ CSA B45.15—2011	Flush Valves and Spuds for Water-closets, Urinals and Tanks	Table P2701.1
A112.19.7—2012/ CSA B45.10—2012	Hydromassage Bathtub Systems	Table P2701.1
ASME A17.1/ CSA B44—2013	Safety Code for Elevators and Escalators	R321.1
CSA 8—93	Requirements for Gas Fired Log Lighters for Wood Burning Fireplaces— with revisions through January 1999	G2433.1
A257.1M—2009	Circular Concrete Culvert, Storm Drain, Sewer Pipe and Fittings	Table P3002.2
A257.2M—2009	Reinforced Circular Concrete Culvert, Storm Drain, Sewer Pipe and Fittings	Table P3002.2, P3003.13
A257.3M—2009	Joints for Circular Concrete Sewer and Culvert Pipe, Manhole Sections and Fittings Using Rubber Gaskets	P3003.5, P3003.18
B64.1.1—11	Vacuum Breakers, Atmospheric Type (AVB)	Table P2902.3, P2902.3.2
B64.1.2—11	Pressure Vacuum Breakers (PVB)	Table P2902.3, P2902.3.4
B64.1.3—11	Spill Resistant Pressure Vacuum Breakers (SRPVB)	P2902.3.2
B64.2—11	Vacuum Breakers, Hose Connection Type (HCVP)	Table P2902.3, P2902.3.2
B64.2.1—11	Hose Connection Vacuum Breakers (HCVB) with Manual Draining Feature	Table P2902.3, P2902.3.2
B64.2.1.1—11	Hose Connection Dual Check Vacuum Breakers (HCDVB)	Table P2902.3, P2902.3.2
B64.2.2—11	Vacuum Breakers, Hose Connection Type (HCVP) with Automatic Draining Feature	Table P2902.3, P2902.3.2
B64.3—11	Dual Check Backflow Preventers with Atmospheric Port (DCAP)	Table P2902.3, P2902.5.1
B64.4—11	Backflow Preventers, Reduced Pressure Principle Type (RP)	Table P2902.3, P2902.3.5, P2903.5.1

B64.4.1—11	Reduced Pressure Principle for Fire Sprinklers (RPF)	Table P2902.3, P2902.3.5
B64.5—11	Double Check Backflow Preventers (DCVA)	Table P2902.3, P2902.3.6
B64.5.1—11	Double Check Valve Backflow Preventers, Type for Fire Systems (DCVAF)	Table P2902.3, P2902.3.6
B64.6—11	Dual Check Valve Backflow Preventers (DuC)	Table P2902.3, P2902.3.7
B64.7—11	Laboratory Faucet Vacuum Breakers (LFVB)	Table P2902.3, P2902.3.2
B125.3—12	Plumbing Fittings	Table 2701.1, P2713.3, P2721.2, Table P2902.3, P2902.4.1, Table P2903.9.4
B137.1—13	Polyethylene (PE) Pipe, Tubing and Fittings for Cold Water Pressure Services	Table P2906.4, Table P2906.6
B137.2—13	Polyvinylchloride PVC Injection-moulded Gasketed Fittings for Pressure Applications.	Table P2906.6
B137.3—13	Rigid Poly (Vinyl Chloride) (PVC) Pipe for Pressure Applications	Table P2906.4, Table 2906.6, P3003.9.2, Table AG101.1
B137.5—13	Cross-linked Polyethylene (PEX) Tubing Systems for Pressure Applications	Table P2906.4, Table P2906.5, Table P2906.6, Table AG101.1
B137.6—13	Chlorinated polyvinylchloride CPVC Pipe, Tubing and Fittings For Hot- and Cold-water Distribution Systems	Table P2906.4, Table P2906.5, Table 2906.6, Table AG101.1
B137.9—13	Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe Systems	Table M2101.1, P2506.11.1, Table P2906.4
B137.10—13	Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene (PE-AL-PE) Composite Pressure Pipe Systems	Table M2101.1, Table P2906.4, Table P2906.5, Table P2906.6, P2906.11.1
B137.11—13	Polypropylene (PP-R) Pipe and Fittings for Pressure Applications	Table P2906.4, Table 2906.5, Table P2906.6, Table AG101.1
B181.1—11	Acrylonitrile-butadiene-styrene (ABS) Drain, Waste and Vent Pipe and Pipe Fittings	Table P3002.1(1), Table P3002.1(2), Table P3002.3, P3003.3.2, P3003.8.2
B181.2—11	Polyvinylchloride (PVC) and chlorinated polyvinylchloride (CPVC) Drain, Waste and Vent Pipe and Pipe Fittings	Table P3002.1(1), Table P3002.1(2), P3003.9.2, P3003.14.2,P3008.2, Table P3302.1
B181.3—11	Polyolefin and polyvinylidene (PVDF) Laboratory Drainage Systems	Table P3002.1(1), Table P3002.1(2),

		Table P3002.2, Table P3002.3, P3003.11.1
B182.2—11	PSM Type polyvinylchloride (PVC) Sewer Pipe and Fittings	Table P3002.2, Table P3002.3, Table P3302.1
B182.4—11	Profile polyvinylchloride (PVC) Sewer Pipe & Fittings	Table P3002.2, Table P3002.3, Table P3302.1
B182.6—11	Profile Polyethylene (PE) Sewer Pipe and Fittings for leak-proof Sewer Applications	Table P3302.1
B182.8—11	Profile Polyethylene (PE) Storm Sewer and Drainage Pipe and Fittings	Table P3302.1
B356—10	Water Pressure Reducing Valves for Domestic Water Supply Systems	P2903.3.1
B483.1—14	Drinking Water Treatment Systems	P2909.1, P2909.2
B602—10	Mechanical Couplings for Drain, Waste and Vent Pipe and Sewer Pipe	P3003.3.1, P3003.4.3,P3003.5, P3003.9.1, P3003.10.1, P3003.12.2, P3003.13
CSA B45.5—11/ IAPMO Z124—11	Plastic Plumbing Fixtures	Table P2701.1, P2711.1, P2711.2, P2712.1
CSA C448 Series-02-CAN/CSA—2002	Design and Installation of Earth Energy Systems—First Edition; Update 2: October 2009; Consolidated Reprint 10/2009	Table M2105.4, Table M2105.5
O325—07	Construction Sheathing	R503.2.1, R602.1.8, R604.1, R803.2.1
O437-Series—93	Standards on OSB and Waferboard (Reaffirmed 2006)	R503.2.1, R602.1.8, R604.1, R803.2.1
UL/CSA/ANCE 60335-2-40—2012	Standard for Household and Similar Electrical Appliances, Part 2: Particular Requirements for Motor-compressors	M1403.1, M1412.1, M1413.1

CSSB

Cedar Shake & Shingle Bureau
P. O. Box 1178
Sumas, WA 98295-1178

Standard reference number	Title	Referenced in code section number
CSSB—97	Grading and Packing Rules for Western Red Cedar Shakes and Western Red Shingles of the Cedar Shake and Shingle Bureau	R702.6, R703.6, Table R905.7.4, Table R905.8.5

DASMA

Door and Access Systems Manufacturers Association International
1300 Summer Avenue
Cleveland, OH 44115-2851

Standard reference number	Title	Referenced in code section number

108—12	Standard Method for Testing Garage Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference	R609.14
115—12	Standard Method for Testing Garage Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure	R301.2.1.2

DOC

United States Department of Commerce
1401 Constitution Avenue, NW
Washington, DC 20230

Standard reference number	Title	Referenced in code section number
PS 1—09	Structural Plywood	R404.2.1, Table R404.2.3, R503.2.1, R602.1.8, R604.1, R610.3.2, R803.2.1
PS 2—10	Performance Standard for Wood-based Structural-use Panels	R404.2.1, Table R404.2.3, R503.2.1, R602.1.8, R604.1, R610.3.2, Table 610.3.2, R803.2.1
PS 20—05	American Softwood Lumber Standard	R404.2.1, R502.1.1, R602.1.1, R802.1.1

DOTn

Department of Transportation
1200 New Jersey Avenue SE
East Building, 2nd floor
Washington, DC 20590

Standard reference number	Title	Referenced in code section number
49 CFR, Parts 192.281(e) & 192.283 (b) (2009)	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards	G2414.6.1

FEMA

Federal Emergency Management Agency
500 C Street, SW
Washington, DC 20472

Standard reference number	Title	Referenced in code section number
FEMA TB-2—08	Flood Damage-resistant Materials Requirements	R322.1.8
FEMA TB-11—01	Crawlspace Construction for Buildings Located in Special Flood Hazard Area	R408.7

FM

Factory Mutual Global Research
Standards Laboratories Department
1301 Atwood Avenue, P. O. Box 7500
Johnson, RI 02919

Standard reference number	Title	Referenced in code section number
4450—(1989)	Approval Standard for Class 1 Insulated Steel Deck Roofs—with Supplements through July 1992	R906.1
4880—(2010)	American National Standard for Evaluating Insulated Wall or Wall and Roof/Ceiling Assemblies, Plastic Interior Finish Materials, Plastic Exterior Building Panels, Wall/Ceiling Coating Systems, Interior and Exterior Finish Systems	R316.6

GA

Gypsum Association
6525 Belcrest Road, Suite 480
Hyattsville, MD 20782

Standard reference number	Title	Referenced in code section number
GA-253—12	Application of Gypsum Sheathing	Table R602.3(1)

HPVA

Hardwood Plywood & Veneer Association
1825 Michael Faraday Drive
Reston, Virginia 20190-5350

Standard reference number	Title	Referenced in code section number
ANSI/HP-1—2013	Standard for Hardwood and Decorative Plywood .	R702.5

IAPMO

IAPMO
4755 E. Philadelphia Street
Ontario, CA 91761-USA

Standard reference number	Title	Referenced in code section number
CSA B45.5—11/ IAPMO Z124—11	Plastic Plumbing Fixtures	Table P2701.1, P2711.1, P2711.2, P2712.1

ICC

International Code Council, Inc.
500 New Jersey Avenue, NW
6th Floor
Washington, DC 20001

Standard reference number	Title	Referenced in code section number
IBC—15	International Building Code®	R101.2, R110.2, R202, R301.1.1, R301.1.3, R301.2.2.1.1,

		R301.2.2.1.2, R301.2.2.4, R301.3, R308.5, R320.1, R320.1.1, R403.1.8, Table R602.10.3(3), Table R606.12.2.1, R609.2, R802.1.5.4, R905.10.3, N1107.4, G2402.3
ICC/ANSI A117.1—09	Accessible and Usable Buildings and Facilities	R321.3
ICC 400—12	Standard on the Design and Construction of Log Structures	R301.1.1, 502.1.4, R602.1.4, R703.1, R802.1.3
ICC 500—14	ICC/NSSA Standard on the Design and Construction of Storm Shelters	R323.1
ICC 600—14	Standard for Residential Construction in High-wind Regions	R301.2.1.1
IECC—15	International Energy Conservation Code®	N1101.1 ~~2~~, ~~N1101.5~~, ~~N1101.13.1~~
IFC—15	International Fire Code®	R102.7, R324.2, M2201.7, G2402.3, G2412.2
IFGC—15	International Fuel Gas Code®	G2401.1, G2402.3, G2423.1
IMC—15	International Mechanical Code®	N1107.4 ~~3.2.1~~, N1103.6, G2402.3
IPC—15	International Plumbing Code®	Table R301.2(1), R903.4.1, G2402.3, R2601.1, Table P2902.3, P2902.5.5,
IPMC—15	International Property Maintenance Code®	R102.7
IPSDC—15	International Private Sewage Disposal Code®	R322.1.7
ISPSC—15	International Swimming Pool and Spa Code™	R326.1
ANSI/RESNET/ICC 301-14	Standard for the Calculation and Labeling of the Energy Performance of Low-Rise Residential Buildings using an Energy Rating Index	N1106.2 N1106.6.1 N1106.7.1

ISO

International Organization for Standardization
1, ch. de la Voie - Creuse
Case postale 56
CH-1211 Geneva 20, Switzerland

Standard reference number	Title	Referenced in code section number
8336—2009	Fibre-cement Flat Sheets-product Specification and Test Methods	Table R503.2.1.1(1),

		Table R503.2.1.1(2), Table R602.3(2), Table R702.4.2, R703.10.1, R703.10.2
15874—2002	Polypropylene Plastic Piping Systems for Hot and Cold Water Installations	Table M2101.1

MSS

Manufacturers Standardization Society of the Valve and Fittings Industry
127 Park Street, Northeast
Vienna, VA 22180

Standard reference number	Title	Referenced in code section number
SP-42—09	Corrosion Resistant Gate, Globe, Angle and Check Valves with Flanged and Butt Weld Ends (Glasses 150, 300 & 600) .	Table P2903.9.4
SP-58—09	Pipe Hangers and Supports—Materials, Design, Manufacture, Selection, Application and Installation	G2418.2
SP-67—11	Butterfly Valves	Table P2903.9.4
SP-70—11	Gray Iron Gate Valves, Flanged and Threaded Ends	Table P2903.9.4
SP-71—11	Gray Iron Swing Check Valves, Flanged and Threaded Ends	Table P2903.9.4
SP-72—10	Ball Valves with Flanged or Butt-Welding Ends for General Service	P2903.9.4
SP-78—11	Cast Iron Plug Valves, Flanged and Threaded Ends	Table P2903.9.4
SP-80—08	Bronze Gate, Globe, Angle and Check Valves	Table P2903.9.4
SP-110—10	Ball Valves, Threaded, Socket Welded, Solder Joint, Grooved and Flared Ends	Table P2903.9.4

NAIMA

North American Insulation Manufacturers Association
44 Canal Center Plaza, Suite 310
Alexandria, VA 22314

Standard reference number	Title	Referenced in code section number
AH 116—09	Fibrous Glass Duct Construction Standards, Fifth Edition	M1601.1.1

NFPA

National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02269

Standard reference number	Title	Referenced in code section number
13—13	Installation of Sprinkler Systems	R302.3
13D—13	Standard for the Installation of Sprinkler Systems in One- and Two-family Dwellings and Manufactured Homes	R302.13, R313.1.1, R313.2.1, R325.5, P2904.1, P2904.6.1
13R—13	Standard for the Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height	R325.5

31—11	Standard for the Installation of Oil-burning Equipment	M1701.1, M1801.3.1, M1805.3
58—14	Liquefied Petroleum Gas Code	G2412.2, G2414.6.2
70—14	National Electrical Code	E3401.1, E3401.2, E4301.1, Table E4303.2, E4304.3, E4304.4, R324.3
72—13	National Fire Alarm and Signaling Code	R314.1, R314.7.1
85—15	Boiler and Combustion Systems Hazards Code	G2452.1
211—13	Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances	R1002.5, G2427.5.5.1
259—13	Standard for Test Method for Potential Heat of Building Materials	R316.5.7, R316.5.8
275—13	Standard Method of Fire Tests for the Evaluation of Thermal Barriers	R316.4
286—15	Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth	R302.9.4, R316.6
501—13	Standard on Manufactured Housing	R202
720—15	Standard for the Installation of Carbon Monoxide (CO) Detectors and Warning Equipment	R315.6.1, R315.6.2
853—15	Standard on the Installation of Stationary Fuel Cell Power Systems	M1903.1

NSF

NSF International
789 N. Dixboro
Ann Arbor, MI 48105

Standard reference number	Title	Referenced in code section number
14—2011	Plastics Piping System Components and Related Materials	M1301.4, P2609.3, P2908.3
41—2011	Nonliquid Saturated Treatment Systems (Composting Toilets)	P2725.1
42—2011	Drinking Water Treatment Units—Anesthetic Effects	P2909.1, P2909.3
44—2012	Residential Cation Exchange Water Softeners	P2909.1, P2909.3
50—2012	Equipment for Swimming Pools, Hot Tubs and Other Recreational Water Facilities	P2911.8.1
53—2011A	Drinking Water Treatment Units—Health Effects	P2909.1, P2909.3
58—2012	Reverse Osmosis Drinking Water Treatment Systems	P2909.2, P2909.3
61—2012	Drinking Water System Components—Health Effects	P2609.5, P2722.1, P2903.9.4, P2906.4, P2906.5, P2906.6, P2908.3
350—2011	Onsite Residential and Commercial Water Reuse Treatment Systems	P2910.6.1
358-1—2011	Polyethylene Pipe and Fittings for Water-based Ground Source "Geothermal" Heat Pump Systems	M2105.4, M2105.5, Table AG101.1
358-2—2012	Polypropylene Pipe and Fittings for Water-based Ground Source "Geothermal" Heat Pump Systems	M2105.5
359—2012	Valves for Crosslinked Polyethylene (PEX) Water Distribution Tubing Systems	Table P2903.9.4

372—2010	Drinking Water Systems Components—Lead Content	P2906.2.1

PCA

Portland Cement Association
5420 Old Orchard Road
Skokie, IL 60077

Standard reference number	Title	Referenced in code section number
100—12	Prescriptive Design of Exterior Concrete Walls for One- and Two-family Dwellings (Pub. No. EB241)	R301.2.2.2.4, R301.2.2.3.4, R404.1.3, R404.1.3.2.1, R404.1.3.2.2, R404.1.3.4, R404.1.4.2, R608.1, R608.2, R608.5.1, R608.9.2, R608.9.3

SBCA

Structural Building Components Association
6300 Enterprise Lane
Madison, WI 53719

Standard reference number	Title	Referenced in code section number
BCSI—2013	Building Component Safety Information Guide to Good Practice for Handling, Installing, Restraining & Bracing of Metal Plate Connected Wood Trusses	502.11.2, 802.10.3
CFS-BCSI—2008	Cold-formed Steel Building Component Safety Information (CFSBCSI) Guide to Good Practice for Handling, Installing & Bracing of Cold-formed Steel Trusses	505.1.3, 804.3.6
FS100—12	Standard Requirements for Wind Pressure Resistance of Foam Plastic Insulating Sheathing Used in Exterior Wall Covering Assemblies	R316.8

SMACNA

Sheet Metal & Air Conditioning Contractors National Assoc. Inc.
4021 Lafayette Center Road
Chantilly, VA 22021

Standard reference number	Title	Referenced in code section number
SMACNA—10	Fibrous Glass Duct Construction Standards (2003)	M1601.1.1, M1601.4.1
SMACNA—15	HVAC Duct Construction Standards—Metal and Flexible 4th Edition (ANSI)	M1601.4.1

SRCC

Solar Rating & Certification Corporation
400 High Point Drive, Suite 400
Cocoa, FL 32926

Standard reference number	Title	Referenced in code section number
SRCC 100—13	Standard 100 for Solar Collectors	M2301.3.1
SRCC 300—13	Standard 300 for Solar Water Heating Systems	M2301.2.3, M2301.4, M2301.2.6, M2301.2.8
SRCC 600—13	Standard 600 for Solar Concentrating Collectors	M2301.3.1

TMS

The Masonry Society
105 South Sunset Street, Suite Q
Longmont, CO 80501

Standard reference number	Title	Referenced in code section number
402—2013	Building Code Requirements for Masonry Structures	R404.1.2, R606.1, R606.1.1, R606.2.3.2, R606.12.1, R606.12.2.3.1, R606.12.3.1, Table R703.4, 703.12
403—2013	Direct Design Handbook for Masonry Structures	R606.1, R606.1.1, R606.12.1, R606.12.3.1
602—2013	Specification for Masonry Structures	R404.1.2, R606.2.9, R606.2.12, R606.12.3.1, R703.12

TPI

Truss Plate Institute
218 N. Lee Street, Suite 312
Alexandria, VA 22314

Standard reference number	Title	Referenced in code section number
TPI 1—2014	National Design Standard for Metal-plate-connected Wood Truss Construction	R502.11.1, R802.10.2

UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062

Standard reference number	Title	Referenced in code section number

17—2008	Vent or Chimney Connector Dampers for Oil-fired Appliances— with revisions through January 2010	M1802.2.2
55A—04	Materials for Built-up Roof Coverings	R905.9.2
58—14	Liquefied Petroleum Gas Code	M2201.1
80—2007	Steel Tanks for Oil-burner Fuel—with revisions August 2009	M2201.1
103—2010	Factory-built Chimneys for Residential Type and Building Heating Appliances—with revisions through July 2012	R202, R1005.3, G2430.1
127—2011	Factory-built Fireplaces	R1001.11, R1004.1, R1004.4, R1004.5, R1005.4, G2445.7
174—04	Household Electric Storage Tank Water Heaters— with revisions through September 2012	M2005.1
180—2012	Liquid-level Indicating Gauges for Oil Burner Fuels and Other Combustible Liquids	M2201.5
181—05	Factory-made Air Ducts and Air Connectors—with revisions through May 2003	M1601.1.1, M1601.4.1
181A—2013	Closure Systems for Use with Rigid Air Ducts and Air Connectors— with revisions through December 1998	M1601.2, M1601.4.1
181B—2013	Closure Systems for Use with Flexible Air Ducts and Air Connectors— with revisions through August 2003	M1601.4.1
217—06	Single- and Multiple-station Smoke Alarms—with revisions through April 2012	R314.1.1, R315.1.1
263—2011	Standards for Fire Test of Building Construction and Materials	Table 302.1(1), Table R302.1(2), R302.2, R302.3, R302.4.1, R302.11.1, Table R312.1(1), R606.2.2
268—2009	Smoke Detectors for Fire Alarm Systems	R314.7.1, R314.7.4, R315.6.4
325—02	Door, Drapery, Gate, Louver and Window Operations and Systems— with revisions through June 2013	R309.4
343—2008	Pumps for Oil-burning Appliances—with revisions through June 2013	M2204.1
378—06	Draft Equipment—with revisions through January 2010	M1804.2.6
441—10	Gas Vents	G2426.1
508—99	Industrial Control Equipment—with revisions through March 2013	M1411.3.1
536—97	Flexible Metallic Hose—with revisions through June 2003	M2202.3
641—2010	Type L, Low-temperature Venting Systems— with revisions through May 2013	R202, R1003.11.5, M1804.2.4, G2426.1
651—2011	Schedule 40 and Schedule 80 Rigid PVC Conduit and Fittings— with revisions through March 2012	G2414.6.3

705—04	Standard for Power Ventilators—with revisions through March 2012	M1502.4.4
723—08	Standard for Test for Surface Burning Characteristics of Building Materials—with revisions through September 2010	R202, R302.9.3, R302.9.4, R302.10.1, R302.10.2, R316.3, R316.5.9, R316.5.11, R507.3.2, R802.1.5, M1601.3, M1601.5.2
726—95	Oil-fired Boiler Assemblies—with revisions through April 2011	M2001.1.1, M2006.1
727—06	Oil-fired Central Furnaces—with revisions through April 2010	M1402.1
729—03	Oil-fired Floor Furnaces—with revisions through August 2012	M1408.1
730—03	Oil-fired Wall Furnaces—with revisions through August 2012	M1409.1
732—95	Oil-fired Storage Tank Water Heaters—with revisions through April 2010	M2005.1
737—2011	Fireplaces Stoves	M1414.1, M1901.2
790—04	Standard Test Methods for Fire Tests of Roof Coverings—with revisions through October 2008	R302.2.2, R902.1
795—2011	Commercial-industrial Gas Heating Equipment—with Revisions through September 2012	G2442.1, G2452.1
834—04	Heating, Water Supply and Power Boilers—Electric—with revisions through January 2013	M2001.1.1
842—07	Valves for Flammable Fluids—with revisions through October 2012	M2204.2
858—05	Household Electric Ranges—with revisions through April 2012	M1901.2
875—09	Electric Dry-bath Heaters with revisions through November 2011	M1902.2
896—93	Oil-burning Stoves—with revisions through August 2012	M1410.1
923—2013	Microwave Cooking Appliances	M1504.1
959—2010	Medium Heat Appliance Factory-built Chimneys	R1005.6
1026—2012	Electric Household Cooking and Food Serving Appliances	M1901.2
1040—96	Fire Test of Insulated Wall Construction—with revisions through October 2012	R316.6
1042—2009	Electric Baseboard Heating Equipment—with Revisions through June 2013	M1405.1
1256—02	Fire Test of Roof Deck Construction—with revisions through January 2007	R906.1
1261—01	Electric Water Heaters for Pools and Tubs—with revisions through July 2012	M2006.1
1479—03	Fire Tests of Through-Penetration Firestops—with revisions through October 2012	R302.4.1.2
1482—2011	Solid-Fuel-type Room Heaters	R1002.2, R1002.5, M1410.1
1618—09	Wall Protectors, Floor Protectors, and Hearth Extensions—with revisions through May 2013	R1004.2, M1410.2
1693—2010	Electric Radiant Heating Panels and Heating Panel Sets—with revisions through October 2011	M1406.1
1703—02	Flat-plate Photovoltaic Modules and Panels—with revisions through November 2014	R324.3.1, R902.4, R905.16.5, R907.5

1715—97	Fire Test of Interior Finish Material—with revisions through January 2013	R316.6
1738—2010	Venting Systems for Gas-burning Appliances, Categories II, III and IV— with revisions Through May 2011	G2426.1
1741—2010	Inverters, Converters, Controllers and Interconnection System Equipment for use with Distributed Energy Resources	R324.3
1777—07	Chimney Liners—with revisions through July 2009	R1003.11.1, R1003.18, G2425.12, G2425.15.4, M1801.3.4
1995—2011	Heating and Cooling Equipment	M1402.1, M1403.1, M1407.1, M1412.1, M1413.1
1996—2009	Electric Duct Heaters—with revisions through November 2011	M1402.1, M1407.1
2034—08	Standard for Single- and Multiple-station Carbon Monoxide Alarms— with revisions through February 2009	R314.1.1, R315.1.1
2075—2013	Standard for Gas and Vapor Detectors and Sensors	R314.7.4, R315.6.1, R315.6.4
2158A—2010	Outline of Investigation for Clothes Dryer Transition Duct	M1502.4.3
2523—09	Standard for Solid Fuel-fired Hydronic Heating Appliances, Water Heaters and Boilers— with revisions through February 2013	M2005.1, M2001.1.1
UL/CSA/ANCE 60335-2-40—2012	Standard for Household and Similar Electrical Appliances, Part 2: Particular Requirements for Motor-compressors	M1403.1, M1412.1, M1413.1

ULC

ULC
7 Underwriters Road
Toronto, Ontario, Canada M1R 3B4

Standard reference number	Title	Referenced in code section number
CAN/ULC S 102.2—2010	Standard Methods for Test for Surface Burning Characteristics of Building Materials and Assemblies	R302.10.1, R302.10.2

WDMA

Window & Door Manufacturers Association
2025 M Street, NW Suite 800
Washington, DC 20036-3309

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S2/A440—11	North American Fenestration Standard/ Specifications for Windows, Doors and Skylights	R308.6.9, R609.3, N1102.4.4 ~~3~~
I.S. 11—13	Industry Standard Analytical Method for Design Pressure (DP) Ratings of Fenestration Products	R308.6.9.1, R609.3.1

NFRC

National Fenestration Rating Council, Inc.
6305 Ivy Lane, Suite 140
Greenbelt, MD 20770

Standard reference number	Title	Referenced in code section number
100—2009	Procedure for Determining Fenestration Products *U*-factors—Second Edition	N1101.10.3
200—2009	Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence—Second Edition	N1101.10.3
400—2009	Procedure for Determining Fenestration Product Air Leakage—Second Edition	N1102.4.4

CHAPTER 45

HIGH WIND ZONES

This chapter is a North Carolina addition and not part of the 2015 International Residential Code. There will be no underlined text.

SECTION R4501
GENERAL

R4501.1 General.
The provisions of this chapter shall be applicable to buildings constructed in high wind zones as noted by the text. These provisions shall be in addition to or in lieu of previous chapters.

R4501.2 Alternate construction.
In lieu of specific code requirements for structures in the 130, 140, and 150 miles per hour (58 m/s, 63 m/s and 67 m/s) wind zones, compliance with International Code Council *ICC 600 Standard for Residential Construction in High-Wind Regions* or AF&PA *Wood Frame Construction Manual for One- and Two-Family Dwellings* is acceptable.

SECTION R4502
DESIGN PRESSURE FOR DOORS AND WINDOWS

TABLE R4502(a)
DESIGN PRESSURES FOR DOORS AND WINDOWS[a, b, c, d]
POSITIVE AND NEGATIVE IN PSF

VELOCITY (mph)	MEAN ROOF HEIGHT (ft)		
	15	**25**	**35[e]**
130	25	29	32
140	31	35	39
150	37	43	47

For SI: 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 degree = 0.01745 rad.

a. Alternate pressures may be determined by using the *North Carolina Building Code*, ASCE-7, or the *International Building Code*.

b. If window or door is more than 4 feet from a corner, the pressure from this table shall be permitted to be multiplied by 0.87. This adjustment does not apply to garage doors.

c. For windows or doors in structures with a roof slope of 10 degrees (2:12) or less from the horizontal, the pressure from this table may be multiplied by 0.90.

d. Design pressure ratings based on the standards listed in Section R609 are adequate documentation of capacity to resist pressures from the table.

e. Where the mean roof height exceeds this table, values shall be determined by a design professional.

TABLE R4502(b)
DESIGN PRESSURES (IN PSF) GARAGE DOORS[a, b, c, d, e]

VELOCITY (mph)	MEAN ROOF HEIGHT (ft)		
	15	**25**	**35[f]**
130	20	23	26
140	25	29	32

150	30	35	39

For SI: 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 degree = 0.01745 rad.

a. The pressures in this table are for garage doors at least 9 feet by 7 feet and at least 2 feet from the corner.

b. Alternate design pressures may be determined by using the *North Carolina Building Code*, ASCE-7, or the *International Building Code*.

c. For doors in a structure with a roof slope of 10 degrees (2:12) or less from the horizontal the pressures from this table may be multiplied by 0.90.

d. Design pressure ratings based on tests done according to ASTM E330 are adequate documentation.

e. Garage doors on the ground level of a structure in a flood zone do not have to meet the above design pressures provided all of the following conditions are met:

  1. Structure is anchored to the girders and top of the piling to resist the forces given in Chapter 45.
  2. The garage door occurs below the top of the piling.
  3. Provide openings at the garage level that comply with either of the following options:
     - i. Design all exterior walls at the garage level to break away at 20 psf or less or;
     - ii. Provide openings (in walls at the garage level without the garage level without the garage door) equal to at least 20 percent of the total wall area from the ground to the roof.

f. Where the mean roof height exceeds this table, values shall be determined by a design professional.

SECTION R4503
FOOTINGS

R4503.1 General.

All exterior walls shall be supported on continuous concrete footings in the 140 and 150 mph (63 m/s and 67 m/s) wind zones. Exterior wall footings in the 130 mph (58 m/s) wind zone shall be constructed in accordance with Section R403.1.

Exception: Pile foundations shall be constructed in accordance with Chapter 46.

R4503.1.1 Footing size.

Footings shall be a minimum of 8 inches by 24 inches (203 mm by 610 mm) for houses 2 ½ stories and less. The footings for a three-story building shall be 10 inches by 24 inches (254 mm by 610 mm).

Exception: Alternate footing sizes are permitted when a footing mass equivalent is provided to resist uplift forces. See Figure R4503.1.1.

R4503.1.2 Footing reinforcement.

Footings shall be reinforced with three #4 bars or two #5 bars at 3 inches (76 mm) above the bottom of the footing. The bars shall be equally spaced with 3 inches (76 mm) clear minimum from the side of the footing. The bars shall be continuous or lapped 25 inches at all splices.

R4503.1.3 Interior piers and pier footings.

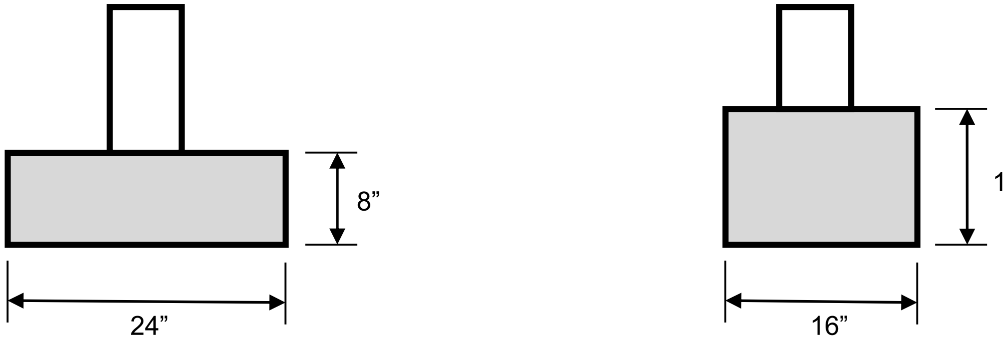
The dimensions for the interior piers and pier footings shall comply with Table R403.1(2).

R4503.1.4 Interior thickened slabs.

Monolithic slabs with integral footings resisting uplift shall be reinforced in accordance with Section R4503.1.2.

R4503.1.5 Interior foundation walls.

Interior foundation walls resisting uplift shall be reinforced in accordance with Section R4503.1.2.



24 inches x 8 inches = 192 square inches

16 inches x 12 inches = 192 square inches

For SI: 1 foot = 304.8 mm.

FIGURE R4503.1.1
ALTERNATE FOOTING SIZE

R4503.2 Pier and curtain wall footings.

Pier and curtain walls in the 140 and 150 mph (63 m/s and 67 m/s) wind zones shall be constructed in accordance with Sections R4503.2.1 and R4503.2.2 and Figures R4503.2(a) through R4503.2(d).

R4503.2.1 Enlarged footings at piers.

The curtain wall footing must meet the minimum projection requirements in Figure R403.1(1) and footing dimensions for the pier footings shall comply with Table R4503.2.1.

TABLE R4503.2.1
FOOTINGS TO RESIST UPLIFT FROM PIERS IN 140 AND 150 MPH WIND ZONES SUPPORTING GIRDERS IN EXTERIOR WALLS

	FOOTING SIZE GIRDER SPAN		
VELOCITY (mph)	**4’-0”**	**6’-0”**	**8’-0”**
140	2’-0” x 2’-0” x 10”	2’-4” x 2’-4” x 10”	2’-8” x 2’-8” x 10”
150	3’-0” x 3’-0” x 10”	3’-4” x 3’-4” x 12”	3’-8” x 3’-8” x 12”

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.
Note: See Table R403.1(2) for 130 mph wind zone.

R4503.2.2 Continuous width footings.

Uniform continuous width footings for pier and curtain wall foundations shall be a minimum of 8 inches (203 mm) thick and 24 inches (60 mm) wide. Footings shall be reinforced with three #4 bars (or two #5 bars) at 3 inches (76 mm) above the bottom of the footing. The bars shall be continuous or lapped 25 inches (635 mm) at all splices.

R4503.3 Footing dowels.

All footings shall have reinforcing dowel bars to match the vertical reinforcing bars in the foundation wall above. Dowels or threaded rods shall have a standard hook length of 12 times the bar diameter embedded in the footing and shall lap the wall or pier reinforcing at least 25 inches (635 mm).

R4503.4 Footing anchor bolts.

All anchor bolts shall have a standard hook length of 12 times the bolt diameter embedded in the footing or foundation wall. They shall not be permitted to be lapped.

Exceptions:

1. Anchor bolts in bond beams as permitted by Section R4504.2.1.1
2. Anchor bolts in slabs on grade as permitted by Section R4504.2.2

SECTION R4504
WALL AND FOUNDATION ANCHORAGE

R4504.1 Anchorage in the 130 mph wind zone.

Exterior walls of structures in the 130 mph (58 m/s) wind zone shall be anchored to the foundation wall or slab on grade with 1/2-inch (13 mm) anchor bolts, 4 feet (1219 mm) on center extended 15 inches (381 mm) into masonry and 7 inches (178 mm) into concrete and are exempt from the other requirements of this section.

R4504.2 Anchorage in the 140 and 150 mph wind zones.

Exterior walls of structures in the 140 and 150 mph (63 m/s and 67 m/s) wind zones shall be anchored to the footing to resist the forces specified in Section R4508.2, by the prescriptive requirements of this section and Figures R4504.2(a) through R4504.2(f), or as allowed by Section R4508.4.

R4504.2.1 Exterior foundation walls.

Vertical reinforcement bars shall be installed not more than 2 feet (51 mm) from each corner and at intervals not to exceed Table R4504.2.1 with all reinforced cells grouted solid. The reinforcement bars shall terminate in a bond beam in accordance with Section R4504.2.1.1 or continuous anchorage bolts shall terminate at the sill plate or exterior wall framing in accordance with Section R4504.2.1.2.

TABLE R4504.2.1
WALL REINFORCEMENT BARS OR CONTINUOUS ANCHORAGE BOLTS[a, b, c, d]

BAR/BOLT SIZE (inches)	5/8	1/2	3/8
MAXIMUM SPACING (inches)	96	72	42

For SI: 1 inch = 25.4 mm.

a. Applies to 140 and 150 mph wind zones.
b. Continuous anchorage from footing to girder or wall framing.
c. Applies to footing dowel bars, vertical reinforcement and anchor bolts.
d. Spacing may exceed the tabulated values by up to 8 inches provided the total number of required bars is installed.

R4504.2.1.1 Bond beams.

The top of a concrete or masonry foundation wall shall have a bond beam in accordance with Figure R4504.2(a). The bond beam shall be reinforced with one #5 bar. The bar shall be continuous or lapped 25 inches (635 mm) at all splices.

R4504.2.1.1.1. Bond beam plate anchorage.

A minimum of two 2 × 6 sill plates shall be anchored with 1/2-inch (13 mm) anchor bolts with 2 × 2 × 1/8 inch (51 × 51 × 3 mm) washers at intervals not to exceed Table R4504.2.1.1. An approved anchor from the sill plate to the wall framing shall be installed to resist the forces specified in Table R4508.2 or sheathing shall be fastened in accordance with Figure R4508.4(b). See Figure R4504.2(a).

TABLE R4504.2.1.1
ANCHOR BOLT SPACING[a]

WIND SPEED (mph)	140	150
MAXIMUM SPACING (inches)	21	18

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

a. Required spacing of 1/2-inch anchor bolts where a bond beam is required and for slab on grade with a single sole plate. See Figure R403.1(1) for 130 mph or less.

R4504.2.1.2 Continuous anchorage bolts.

A minimum of two 2 × 6 sill plates shall be anchored with continuous anchor bolts in accordance with Table R4504.2.1 with 2 × 2 × 1/8 inch (51 × 51 × 3 mm) washers. Where the vertical anchorage bolts terminate at the sill plate, an approved anchor from the sill plate to the wall framing shall be installed to resist the forces specified in Table R4508.2 or sheathing shall be fastened in accordance with Figure R4508.4(b). See Figure R4504.2(b)

Exception: Where the uplift anchorage bolts from Table R4504.2.1 are continuous from the footing to the exterior wall framing, a single 2 x 6 sill plate is permitted. See Figure R4504.2(c)

R4504.2.2 Exterior concrete slab-on-grade footings.

Anchorage shall be installed at intervals not to exceed Table R4504.2.1 and shall terminate in a minimum 2 × 4 double sole plate. See Figure 4504.2(d).

Exceptions:

1. Where the bolts terminate in a single sole plate, anchorage shall be installed at intervals not to exceed Table R4504.2.1.1. See Figure R4504.2(e).

2. Foundation anchorage spaced and installed in accordance with the manufacturer’s installation instructions that provides equivalent anchorage to resist the forces in Table R4508.2 shall be installed to provide continuous load path from the single sole plate to the wall.

R4504.2.3 Ground supported slab with masonry stem wall.

A minimum of two 2x sill plates shall be anchored with 1/2-inch (13 mm) continuous anchor bolts with 2 × 2 × 1/8 inch (51 × 51 × 3 mm) washers at intervals not to exceed Table R4504.2.1.1. An approved anchor from the sill plate to the wall framing shall be installed to resist the forces specified in Table R4508.2 or sheathing shall be fastened in accordance with Figure R4508.4(b). See Figure R4504.2(f).

SECTION R4505
WALL CONSTRUCTION

R4505.1 Construction.
Exterior walls of wood frame construction shall be in accordance with Figures R602.3(1) and R602.3(2). Components of exterior walls shall be fastened in accordance with Table R602.3(1). Walls of wood frame construction shall be designed and constructed in accordance with ANSI AWC "National Design Specification for Wood Construction," listed in Chapter 44.

Exterior walls subject to wind speeds of 130 mph (58 m/s) or greater as established in Table R301.2(1) shall be designed in accordance with accepted engineering practice. See Tables R4505(a) and R4505(b).

In bearing walls, studs which are not more than 10 feet (3048 mm) in length shall be spaced not more than is specified in Tables R4505(a) and R4505(b) for the corresponding stud size.

TABLE R4505(a)
STUDS IN 130, 140, AND 150 MPH ZONES

Requirements for Wood Stud In: Exterior Walls Supporting One Floor, Roof and Ceiling or Less/Exterior Nonloadbearing Walls in Two Story Structure or Less/Interior Walls Supporting One Floor, Roof and Ceiling or Less

		130 MPH		**130 MPH**		**140 MPH**		**150 MPH**	
STUD LENGTH	**STUD SPACING**	**2x4**	**2x6**	**2x4**	**2x6**	**2x4**	**2x6**	**2x4**	**2x6**
		Species: Spruce Pine Fir (South) without Structural Sheathing		Species: Spruce Pine Fir (South) with 3/8" Wood Structural Sheathing					
8	16	#2	Stud	Stud	Stud	Stud	Stud	#2	Stud
8	24	#2	Stud	#2	Stud	#2	Stud	#2	Stud
10	16	#2	Stud	#2	Stud	#2	Stud	#2	Stud
10	24	Design	#2	Design	#2	Design	#2	Design	#2
		Species: Spruce Pine Fir without Structural Sheathing		Species: Spruce Pine Fir with 3/8" Wood Structural Sheathing					
8	16	Stud	Stud	Stand	Stud	Stud	Stud	#3	Stud
8	24	#2	Stud	#3	Stud	#2	Stud	#2	Stud
10	16	#2	Stud	#2	Stud	#2	Stud	#2	Stud
10	24	Design	Stud	#2	Stud	Design	Stud	Design	Stud

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.
Explanation of Table Entries:
Design – Studs with this entry shall be in accordance with accepted engineering practice.
#2 – #2 Grade construction
#3 – #3 Grade
Stud – Stud grade
Standard – Standard grade
Utility – Utility grade
3/8″ wood structural sheathing shall be attached with 8d nails at 6″ at perimeter and 12″ at intermediate supports.
When a grade is specified in the table any grade above it in this list may be used.

TABLE R4505(b)
EXTERIOR WALLS FOR FIRST FLOOR OF THREE STORY

Exterior Bearing Walls[a,b,c,d,e] First Floor of Three Story		
	Spruce Pine Fir	
WIND ZONE (mph)	**2x4 @ 12” oc Structural Sheathing**	**3x4 or 2x6 @ 16” oc Structural Sheathing**
130	#2	Any grade
140	#2	Any grade
150	#2	Any grade

Exterior Nonbearing Walls[a,b,c,d,e,f] First Floor of Three Story			
	Spruce Pine Fir		
WIND ZONE (mph)	**2x4 @ 12” oc Blocking**	**2x4 @ 16” oc Blocking**	**3x4 or 2x6 @ 16” oc Structural Sheathing**
130	#2, Stud	#2	Any grade
140	#2, Stud	NP	Any grade
150	#2	NP	Any grade

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

a. Any grade = any grade except standard, utility and economy.
b. Corner bracing is required where blocking is specified.
c. 2 – 2x4s at 16 inches or 1 – 2x4 at 8 inches may be used where 3x4 at 16 inches is specified.
d. Refer to Sections R4506 and R4508.4 for sheathing requirements.
e. Bearing stud height is limited to 10 feet.
f. 2x full depth blocking at mid-height.

SECTION R4506
STRUCTURAL BRACING

R4506.1 Structural bracing in 130 mph wind zone.

Structural bracing in the 130 mph (58 m/s) wind zone shall comply with Section R602.10.3.

R4506.2 Structural bracing in 140 and 150 mph wind zones.

All stories shall be continuously sheathed with wood structural panels. All panels shall be fastened in accordance with Table R4506.2. Where sheathing is used to resist uplift, see Section R4508.4 for blocking requirements. Otherwise, blocking shall be installed if less than 50 percent of the wall length is sheathed. If a wall is sheathed less than 25 percent of its length, then that wall shall be designed in accordance with approved engineering practice.

TABLE R4506.2
PANEL FASTENER SPACING[a]

	Blocking Required	**No Blocking Required**
Center of Panel	6”	12”
Vertical Edge of Panel	6”	6”
Horizontal Edge of Panel	3”	3”

For SI: 1 inch = 25.4 mm.

a. Table based on 8d nails.

R4506.3 Gable endwalls.

Gable endwalls in the 130, 140 and 150 mph (58 m/s, 63 m/s and 67 m/s) wind zones shall either be supported by lateral bracing at the ceiling or have continuous studs from the floor to the roof. 2 × 4 studs at 16 inches (406 mm) on center are limited to 10 feet (3048 mm) in length between supports. Nonbearing 2 × 6 SPF#2 studs at 16 inches (406 mm) on center with 3/8-inch (9 mm) wood structural panel sheathing are limited to unsupported lengths of 18 feet (5486 mm) in 130 mph (58 m/s), 16 feet (4877 mm) in 140 mph (53 m/s) and 14 feet (4267 mm) in 150 mph (67 m/s) wind zones. Where open web trusses are installed, wood structural panel sheathing shall extend 12 inches (305 mm) beyond horizontal construction joints. Where the horizontal joint occurs over minimum 1 inch (25 mm) thick OSB or plywood or 2x rimboard,a minimum 1-1/2 inch (38 mm) overlap is required.

R4506.4 Lateral support at ceiling.
Where studs are not continuous, the ceiling must be used to support the endwall. 2 × 4 lateral bracing shall be installed on the top of ceiling joists or truss bottom chords at 8 feet (2438 mm) on center and extend 8 feet (2438 mm) inward from the gable endwall. See Figure R4506.7(a).

R4506.5 Full height studs.
Full height studs may be sized using the bracing at the ceiling to limit the stud length. See Figure R4506.5.

R4506.6 Cathedral endwalls.
Studs shall be continuous from the uppermost floor to either the ceiling or the roof.

R4506.7 Overhang at endwalls.
The overhang is limited to 12 inches (305 mm) where a laddered soffit is installed. The overhang may be increased to 24 inches (610 mm) where outlookers are framed over a dropped endwall into the first rafter or truss. See Figures R4506.7(a) and R4506.7(b). If the overhang exceeds 24 inches (610 mm), then the overhang shall be designed in accordance with approved engineering practice.

R4506.8 Roof sheathing attachment.
The roof sheathing panel edges shall be blocked and nailed at the end two rafter or truss spaces. See Figure R4506.8.

Exception: The panel edges need not be blocked where 2 × 4 diagonal braces are framed from the top of the endwall to the lateral bracing at the ceiling.

SECTION R4507
MASONRY WALL CONSTRUCTION

R4507.1 Reinforcement.
Masonry walls subject to wind speeds of 140 mph (63 m/s) or greater, as established in Table R301.2(1), shall be constructed in accordance with Table R4507.1 or the requirements of Figures R4507.1(a) and R4507.1(b) and this section. Additionally, the minimum area of reinforcement shall not be less than 0.002 times the gross cross-sectional area wall, not more than two-thirds of which may be used in either direction. No required vertical reinforcement shall be less than 3/8 inch (9.5 mm) in diameter. Principal wall reinforcement shall have a maximum spacing of 4 feet (1219 mm) on center.

For 130 mph (58 m/s) wind zones, see Figure R606.11(1) and Table R606.6.4.

TABLE R4507.1
H/T LATERAL SUPPORT RATIOS FOR UNREINFORCED EXTERIOR MASONRY WALLS[a,b,d,e]

	ULTIMATE WIND SPEED, MPH[c]

Wall Construction	**140**	**150**
Solid masonry units	13	11
Hollow concrete masonry units or masonry bonded hollow walls	9	8
Cavity walls identical wythes	The H/t ratio shall be 0.70 of the H/t ratio for single wythe walls. The *t*-value shall be the sum of the nominal thickness of the individual wythes.	
Cavity walls with wythes of different types or size masonry	The wall shall be designed based on ACI-530 or the H/t ratio may be 0.70 of the H/t ratio of a single wythe hollow wall. The *t*-value shall be the sum of the nominal thickness of the individual wythes.	

a. *H* = clear height or length between lateral supports.
t = nominal wall thickness.
b. All masonry units shall be laid in Type M, S or N mortar. Where Type N mortar is used and the wall spans in the vertical direction, the ratios shall be reduced by 10 percent.
c. Design based on partially enclosed building.
d. These values are based on using masonry cement mortar. If nonair-entrained Portland cement/lime mortar is used the values in the table may be increased by 1.25. Larger H/t ratios may be used if the design is done in accordance with ACI-530.
e. Larger H/t ratios may be used if the design is done in accordance with ACI-530.

SECTION 4508
ROOF TIE DOWN

R4508.1 Roof tie down.

Roof assemblies in the 130, 140 and 150 mph (58 m/s, 63 m/s and 67 m/s) wind zones as established in Table R301.2(1) shall have rafter or truss ties provided in accordance with either Table R4508.2 or the prescriptive requirements of Section R4508. Anchorage in the 130 mph (58 m/s) wind zone shall be continuous from the roof to the foundation wall or pier. Anchorage in the 140 and 150 mph (63 m/s and 67 m/s) wind zones shall be continuous from the roof to the footing. See Section R4504.

R4508.2 Considerations.

For trusses, the nailing requirements from Table R4508.2 shall include the nailing requirements for both rafters and ceiling joists. As an alternative to the anchorage requirements of Tables R602.3(1) and R4508.2, the anchorage for roof members may be based on a designed connection taking into account all horizontal and vertical forces. Forces for alternative anchorage design may result from wind uplift; wind lateral on roof; wind lateral on walls to be transferred to the top plate of the wall; roof/ceiling loads; and other loads depending on the specific building design. If roof members align with the studs, the connection may be made from the roof member directly to the studs. If the connection is from the roof member to the top plate, a double top plate is required and both connections must meet the requirements of Table R4508.2. Where ceiling joists are not parallel with and connect to the roof members, the anchorage requirements for each roof member shall be increased by 110 pound (50 kg). Hip end walls and hip rafters shall be anchored in accordance with this section.

TABLE R4508.2
ROOF TIE DOWN REQUIREMENTS ALONG EXTERIOR WALLS
(plf)[a,b,c,d]

WIND SPEED (mph)	**STRUCTURE WIDTH**

	24 feet	36 feet
130	240	345
140	330	470
150	430	615

For SI: 1 foot = 304.8 mm, 1 mile per hour = 0.R45 m/s.

a. Alternate to the requirements of this table or roof not covered by this table shall be designed in accordance with the *North Carolina Building Code* or ICC *Standard for Residential Construction in High-Wind Regions* (ICC 600).

b. See Section 4505 for material requirements in Coastal High Hazard Areas and Ocean Hazard Areas and Ocean Hazard Areas.

c. Roof slope 2:12 to 12:12.

d. The uplift load requirements may be interpolated for intermediate structure widths.

R4508.3 Anchorage from roof to wall.

One and one-half inch (38 mm) by 18 gage fabricated metal ties at 24 inches (610 mm) on center with five 8d nails at each end may be used to resist the uplift loads from the roof to the double top plate. Install one tie at each end of each rafter in 130mph (58 m/s) and two ties at each end of each rafter in140 mph (63 m/s) and 150 mph (67 m/s) wind zones. Truss anchorage shall be per designed specifications. See Figure R4508.3.

R4508.4 Anchorage using wood structural panels.

Wood structural panel sheathing may be used to resist both lateral load and uplift simultaneously. Panels shall be installed as follows:

1. Panels may be installed parallel or perpendicular to studs.

2. Panels shall be 3/8-inch (10 mm) minimum thickness.

3. Nail spacing shall be 8d at 6 inches (152 mm) on center along vertical edges of panel and 12 inches (305 mm) at intermediate vertical framing.

4. At double edge panel locations, the horizontal nail spacing shall be 8d staggered at 3 inches (76 mm) on center. See Figure R4508.4(b).

5. Where open web trusses are installed, panel shall extend 12 inches (305 mm) beyond horizontal construction joints and shall overlap girders their full depth. Where the horizontal joint occurs over minimum 1 inch (25 mm) thick OSB or plywood or 2x rimboard, a minimum 1-1/2 inch (38 mm) overlap is required. See Figure R4508.4(a).

6. Panel attachment to framing shall be as illustrated in Figure R4508.4(b).

7. Blocking shall be required at all joints if sheathing is used to resist uplift.

TABLE R4508.4
UPLIFT CAPACITY OF WOOD STRUCTURAL PANEL SHEATHING USED TO RESIST BOTH LATERAL LOAD AND UPLIFT[a]

VERTICAL NAIL SPACING	8D @ 6" EDGE AND 12" INTERMEDIATE		
Alternate nail spacing at top and bottom edges	6"	4"	3"
Uplift capacity (plf) nails – double row	240	474	710

For SI: 1 inch = 25.4 mm.

a. Tabulated values are for Spruce-Pine-Fir framing.

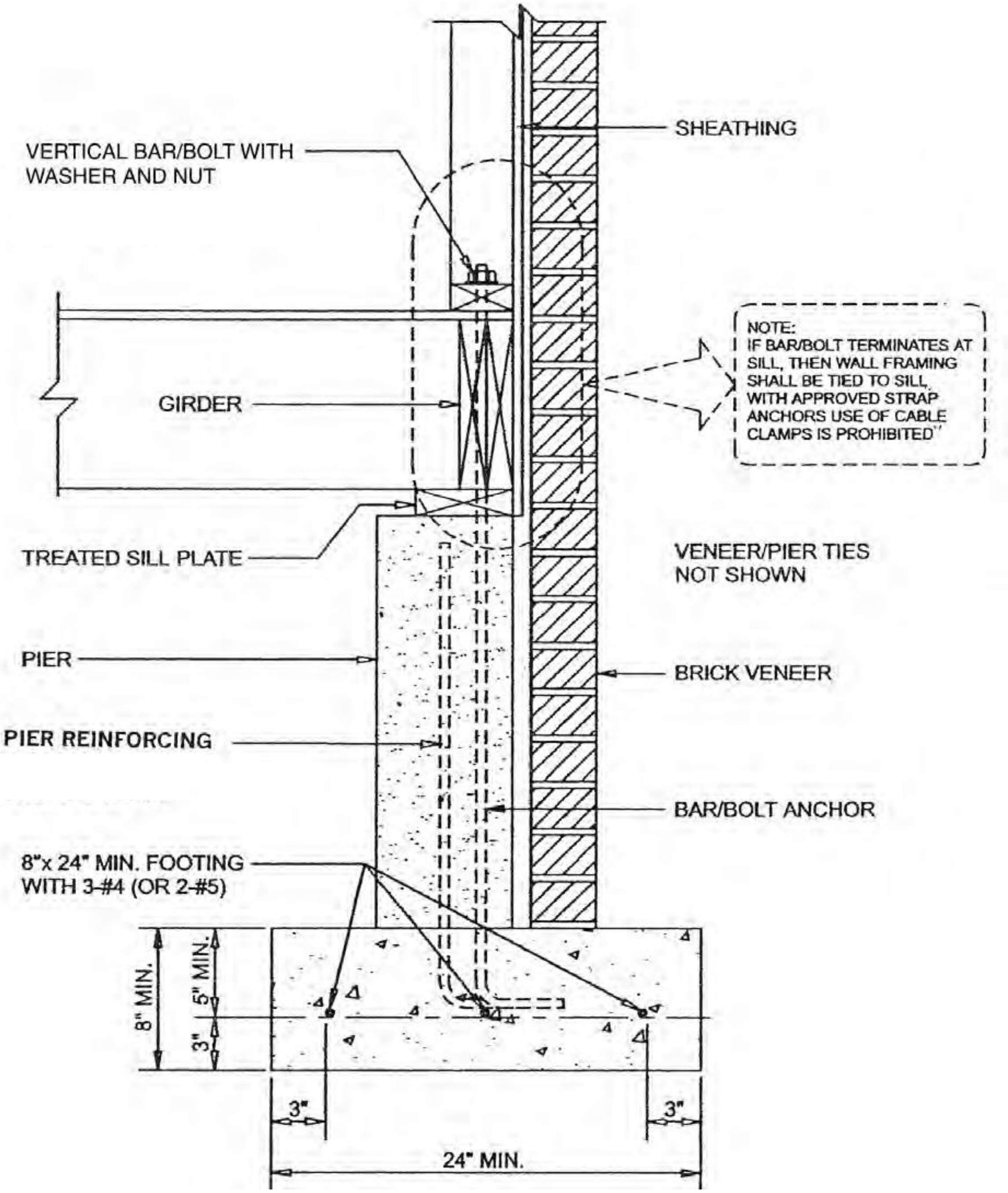


FIGURE R4503.2(a)
CONTINUOUS VENEER PIER/CURTAIN WALL

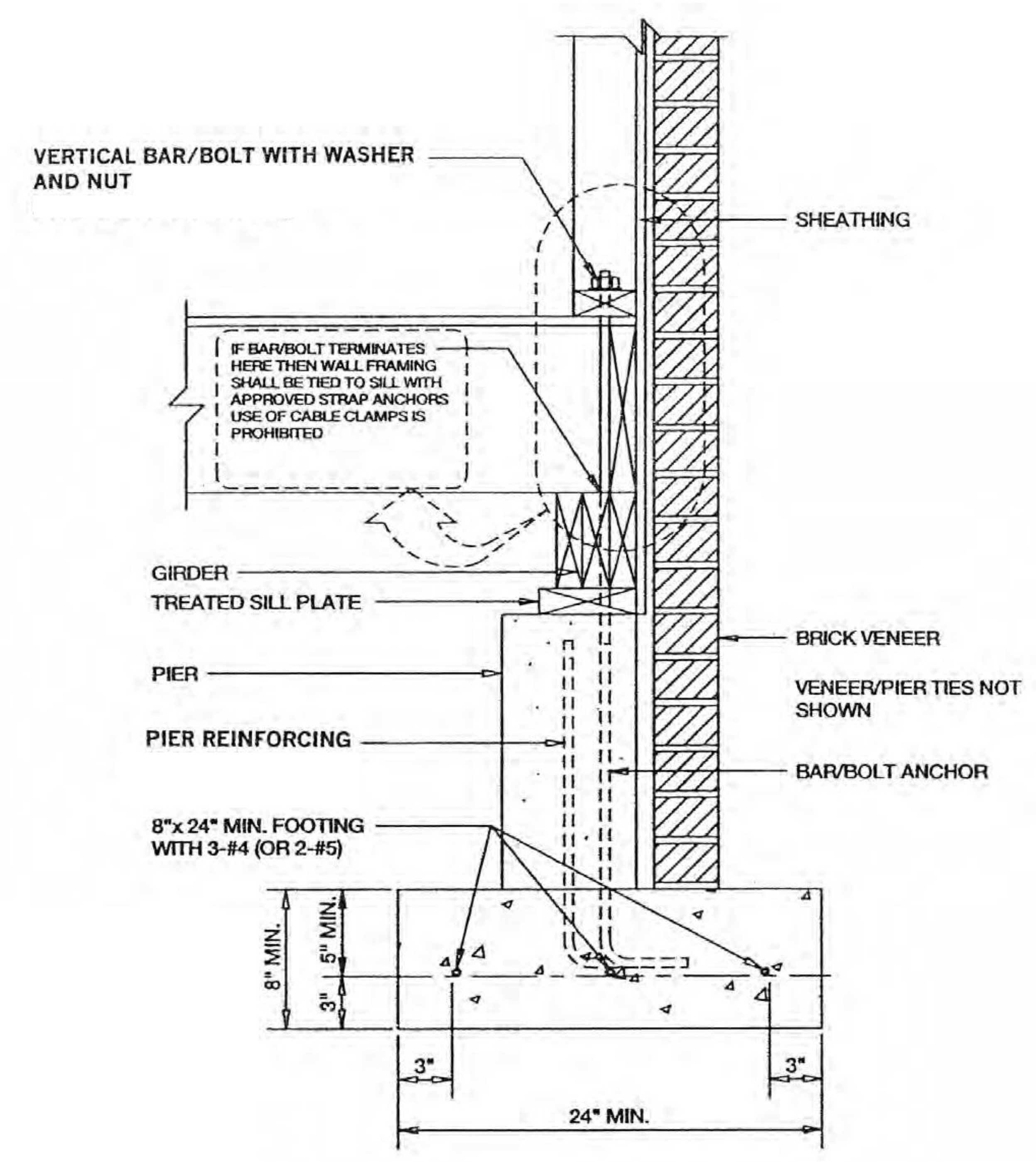
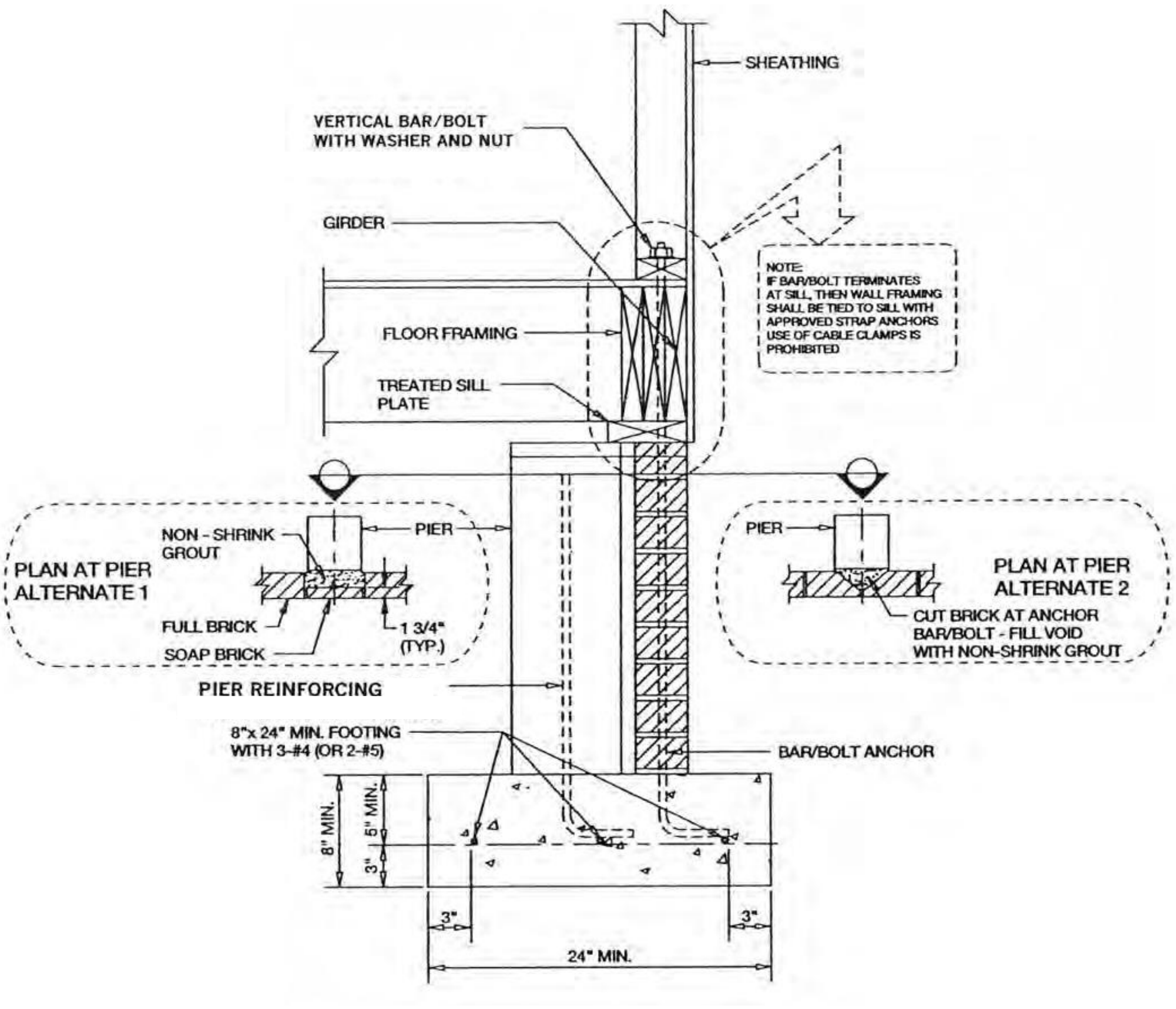


FIGURE R4503.2(b)
CONTINUOUS VENEER PIER/CURTAIN WALL



NOTE:
IF BAR/BOLT TERMINATES AT SILL, THEN WALL FRAMING SHALL BE TIED TO SILL WITH APPROVED STRAP ANCHORS USE OF CABLE CLAMPS IS PROHIBITED

FIGURE R4503.2(c)
VENEER SHIRT WALL
PIER/CURTAIN WALL

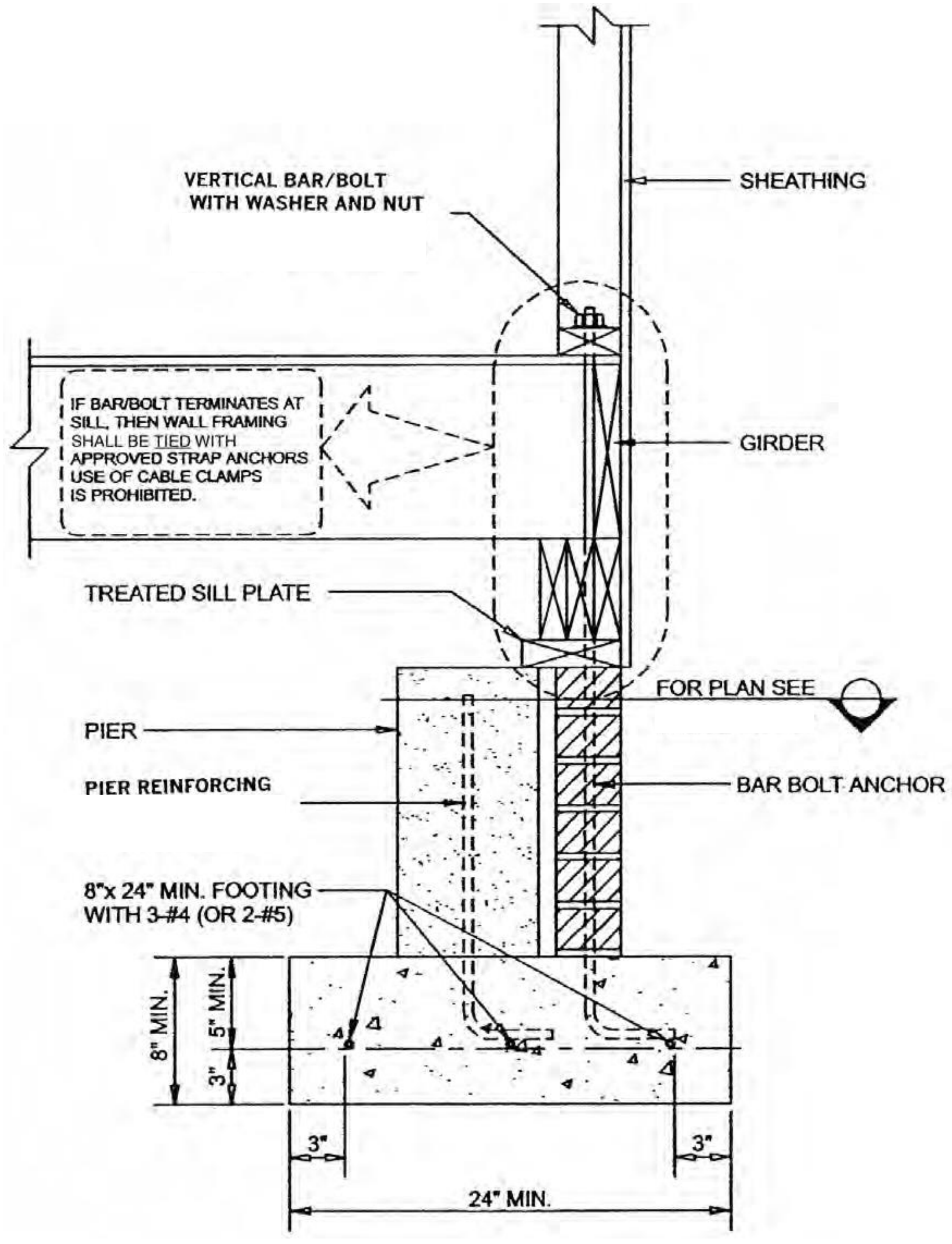


FIGURE R4503.2(d)
VENEER SHIRT WALL PIER/CURTAIN WALL

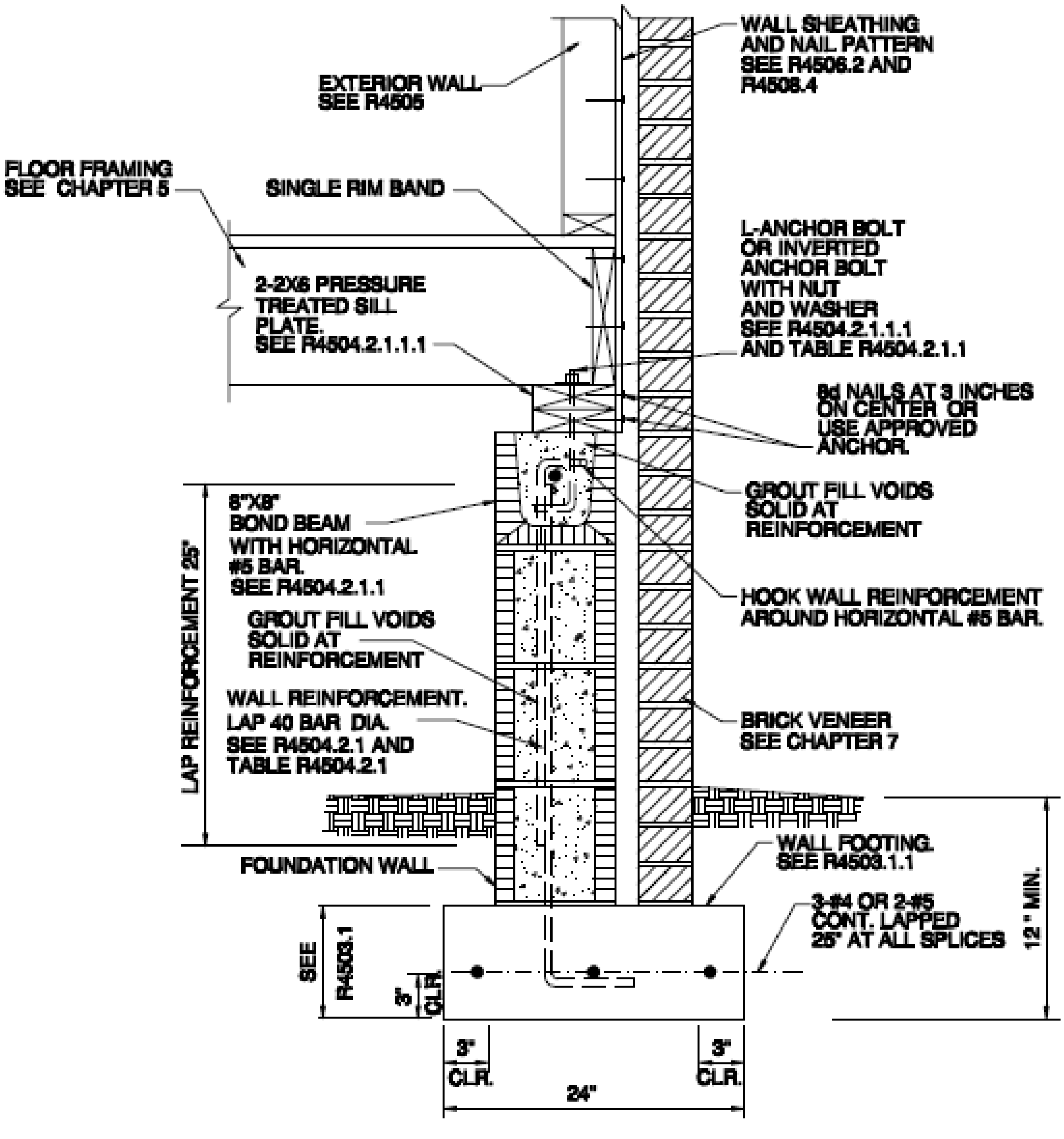


FIGURE R4504.2(a)
FOUNDATION WALL WITH BOND BEAM

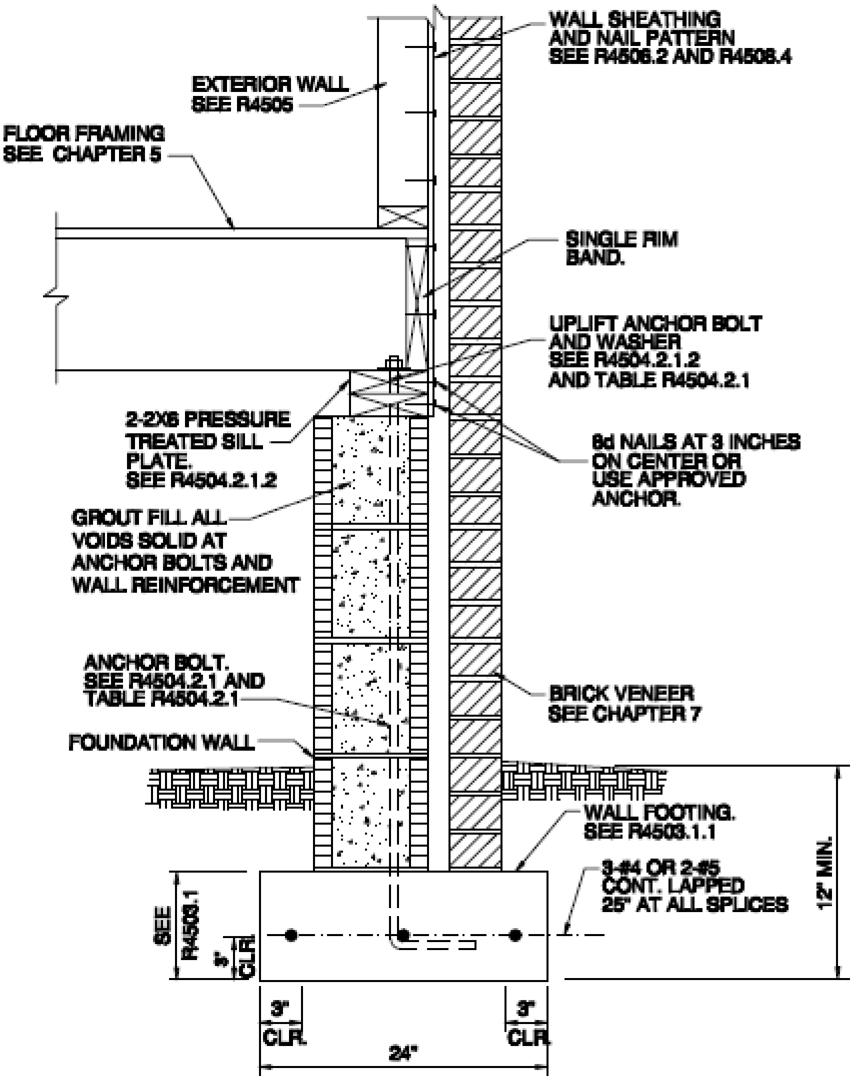


FIGURE R4504.2(b)
FOUNDATION WALL WITH UPLIFT ANCHOR
BOLTS FROM FOOTING TO SILL PLATE

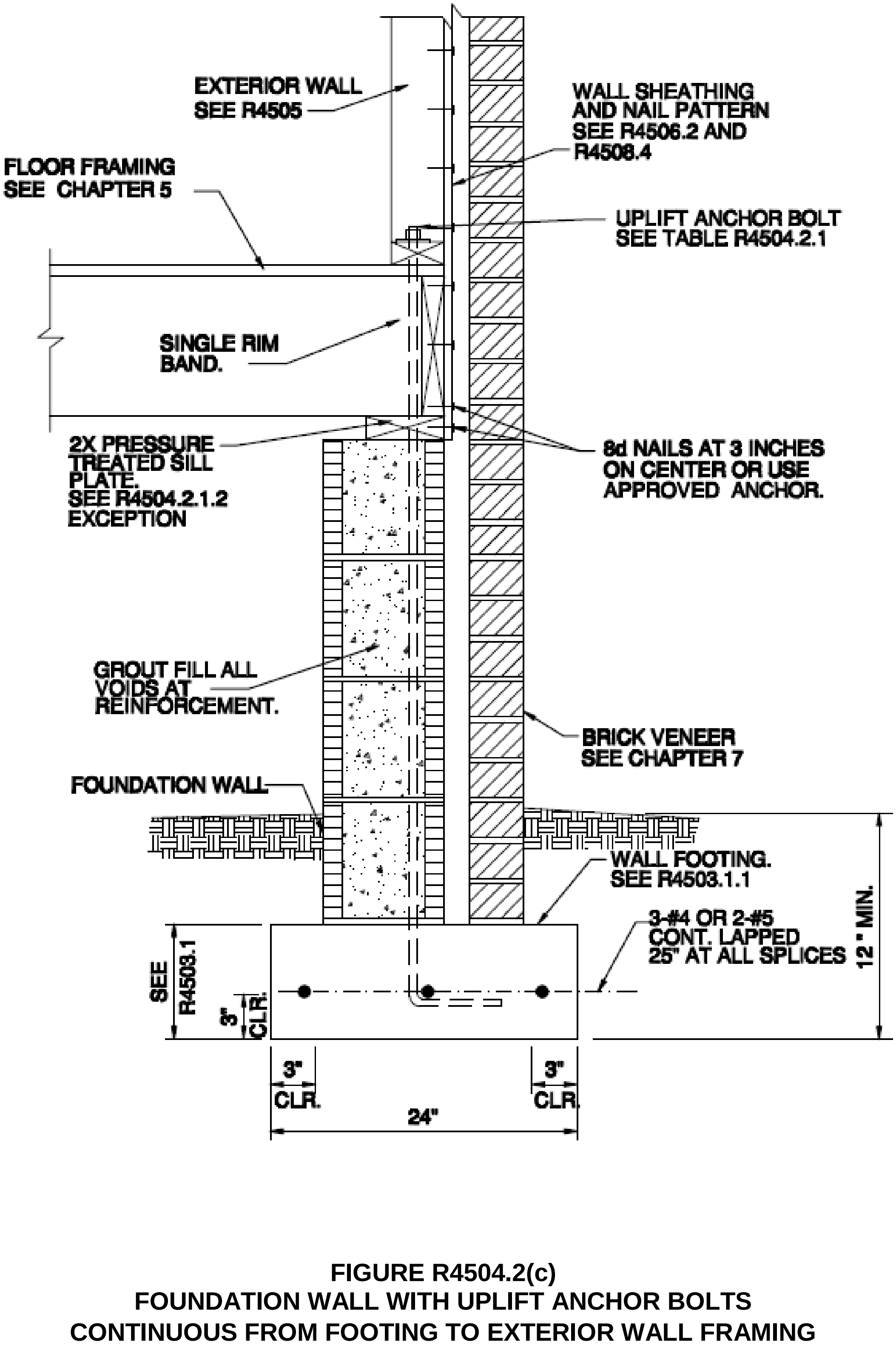


FIGURE R4504.2(c)
FOUNDATION WALL WITH UPLIFT ANCHOR BOLTS
CONTINUOUS FROM FOOTING TO EXTERIOR WALL FRAMING

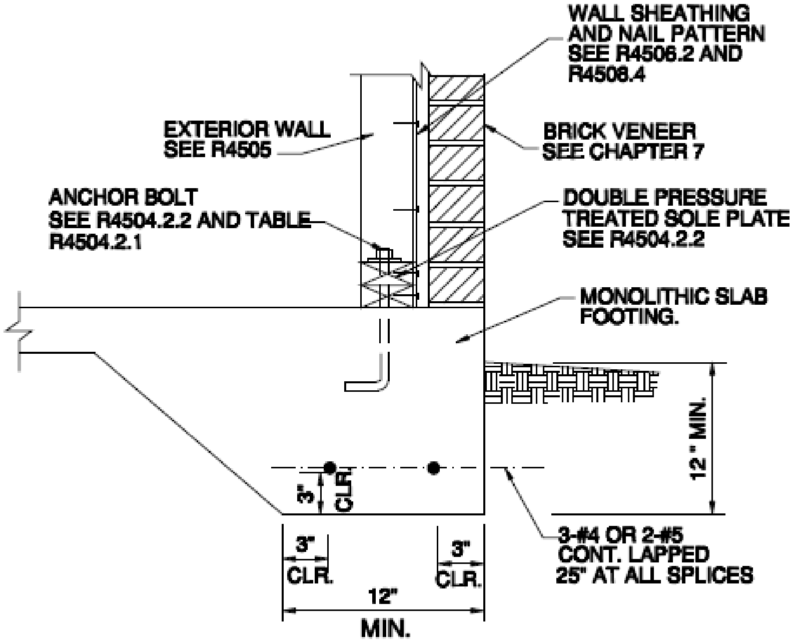


FIGURE R4504.2(d)
EXTERIOR CONCRETE SLAB ON GRADE FOOTING – DOUBLE SOLE PLATE

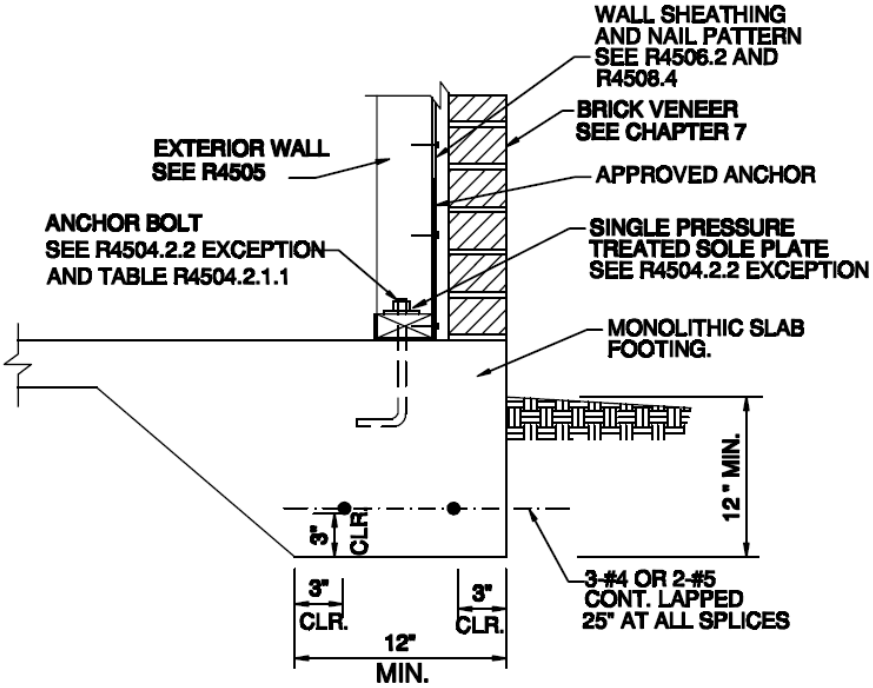


FIGURE R4504.2(e)
EXTERIOR CONCRETE SLAB ON GRADE FOOTING – SINGLE SOLE PLATE

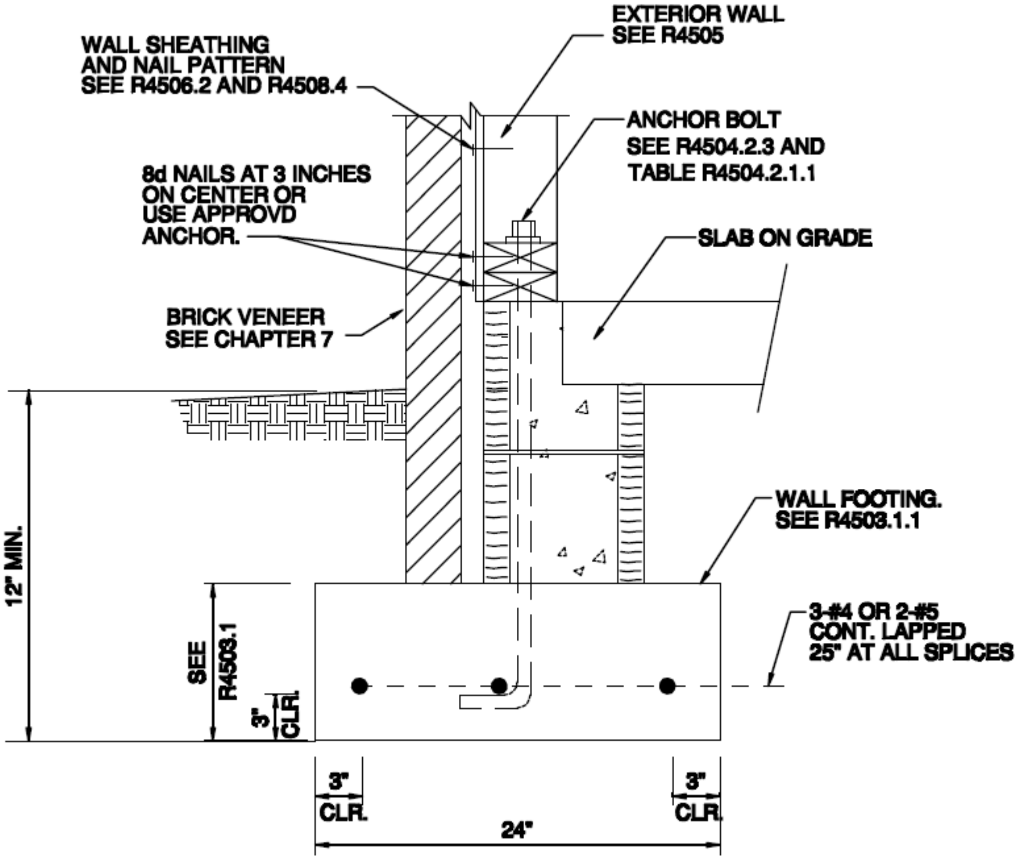


FIGURE R4504.2(f)
GROUND SUPPORTED SLAB WITH
MASONRY STEM WALL

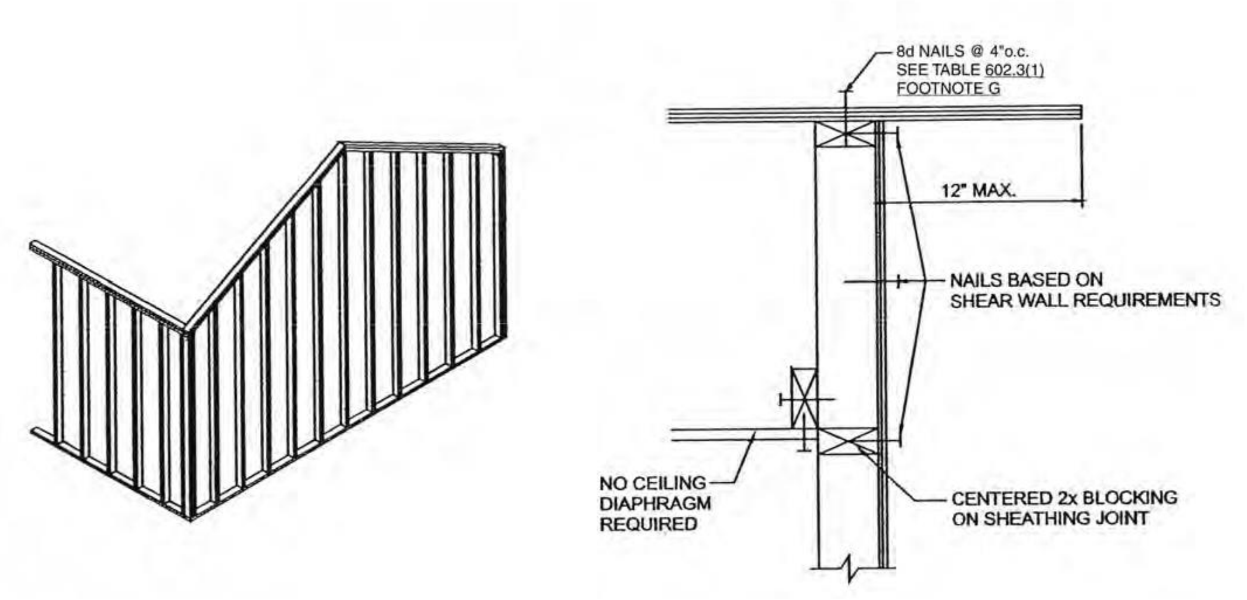
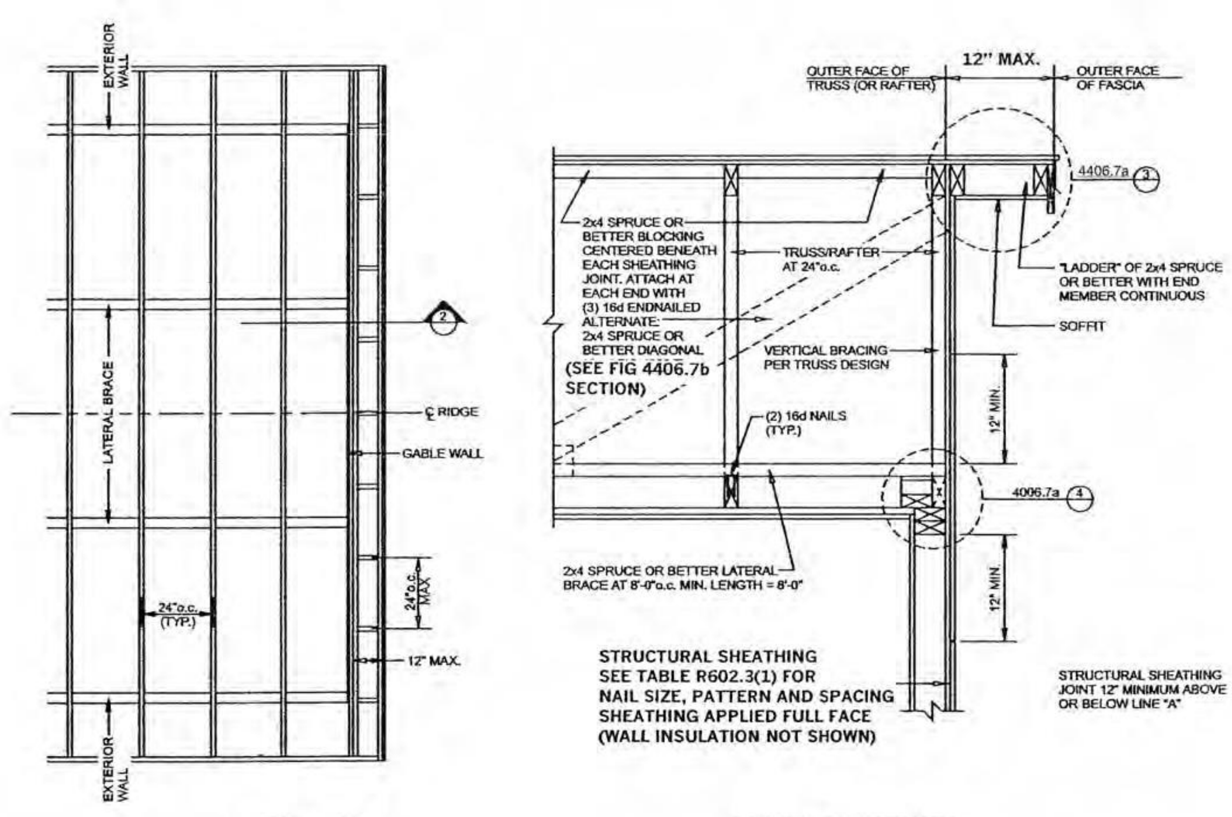


FIGURE R4506.5
GABLE ENDWALL BALLOON FRAMING PREFERRED METHOD

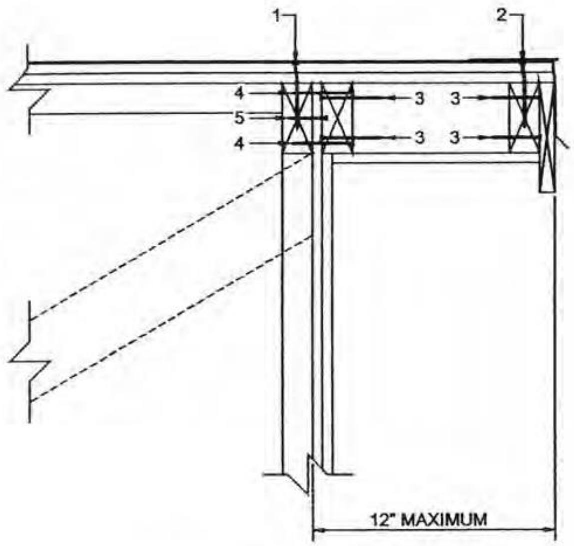


STRUCTURAL SHEATHING
SEE TABLE R602.3(1) FOR
NAIL SIZE, PATTERN AND SPACING
SHEATHING APPLIED FULL FACE
(WALL INSULATION NOT SHOWN)

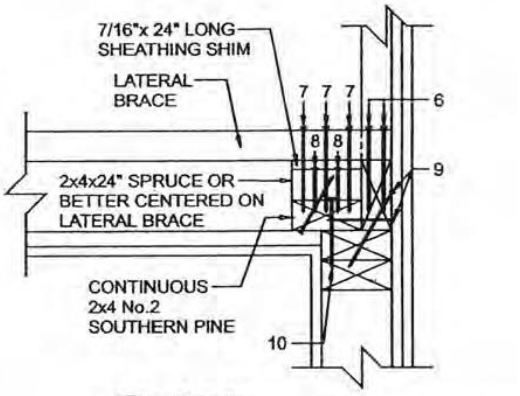
1) ROOF FRAMING PLAN

2) SECTION THRU "LADDER" SOFFIT

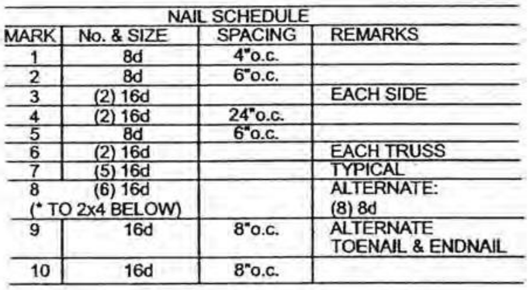
FIGURE R4506.7(a)
OVERHANG AT ENDWALLS



③ 4406.7a "LADDER" ATTACHMENT
NAILING DETAIL AT TOP OF GABLE



④ 4406.7a
NAILING DETAIL AT LATERAL BRACE



NAIL SCHEDULE			
MARK	No. & SIZE	SPACING	REMARKS
1	8d	4"o.c.	
2	8d	6"o.c.	
3	(2) 16d		EACH SIDE
4	(2) 16d	24"o.c.	
5	8d	6"o.c.	
6	(2) 16d		EACH TRUSS
7	(5) 16d		TYPICAL
8	(6) 16d (* TO 2x4 BELOW)		ALTERNATE: (8) 8d
9	16d	8"o.c.	ALTERNATE TOENAIL & ENDNAIL
10	16d	8"o.c.	

FIGURE R4506.7a—continued
OVERHANG AT ENDWALLS

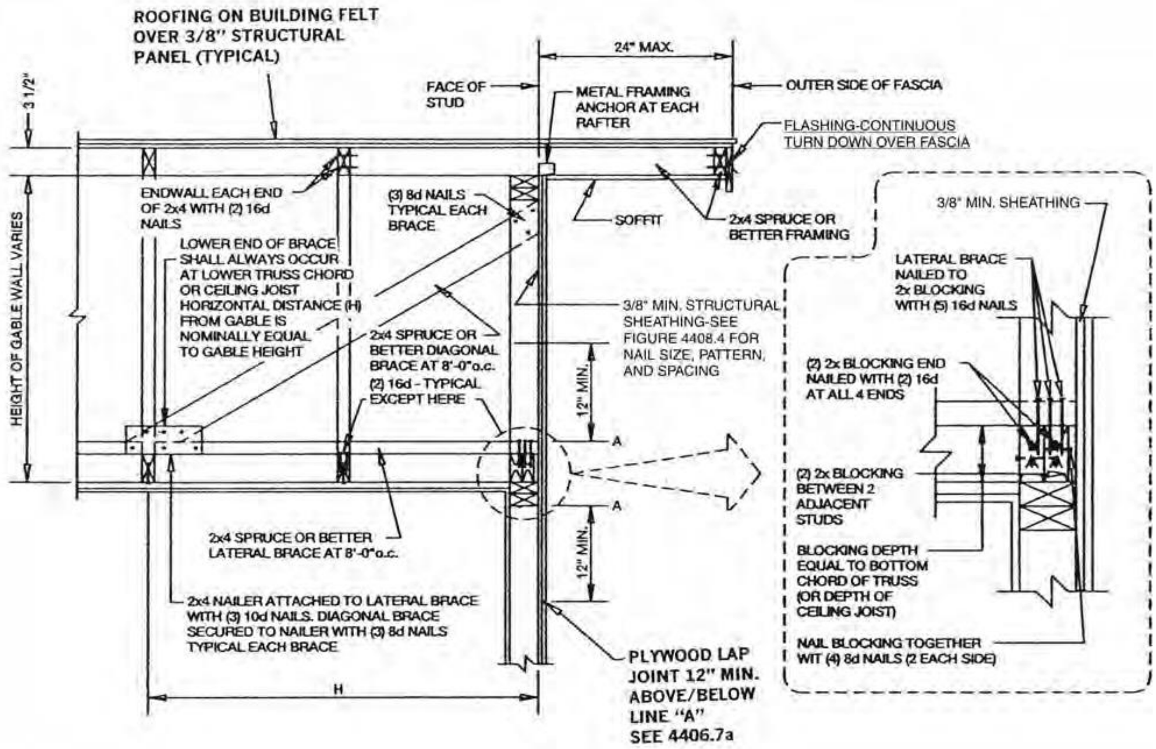
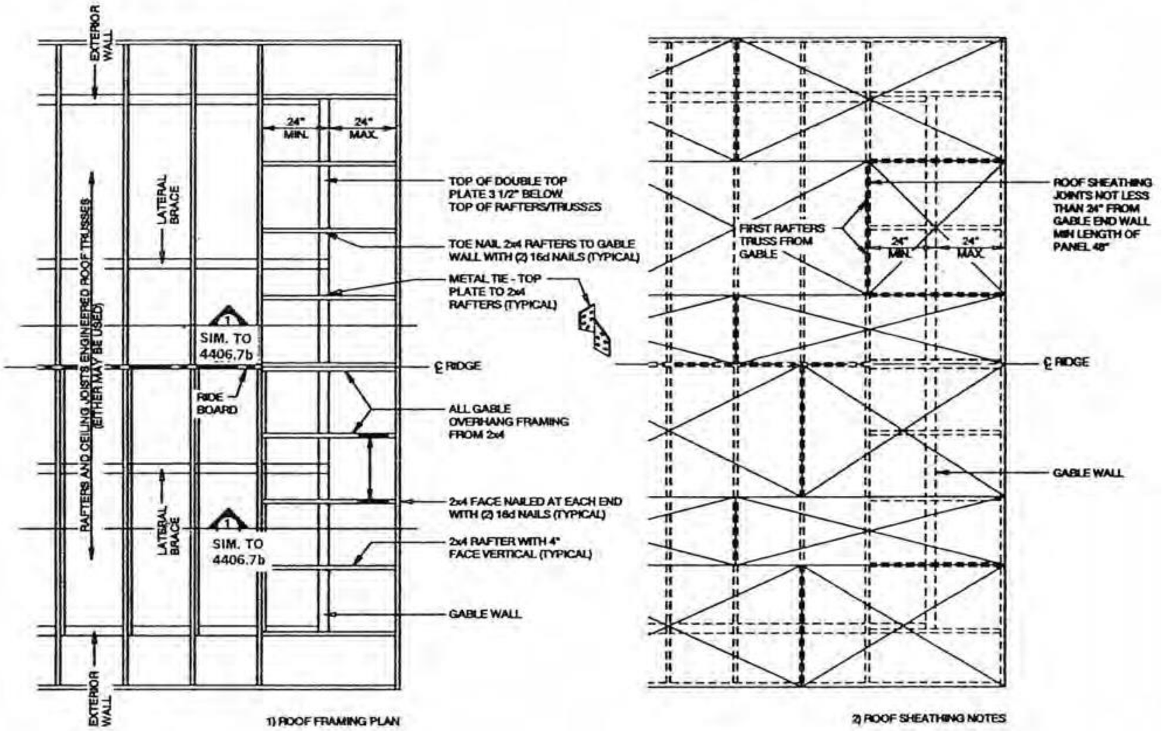


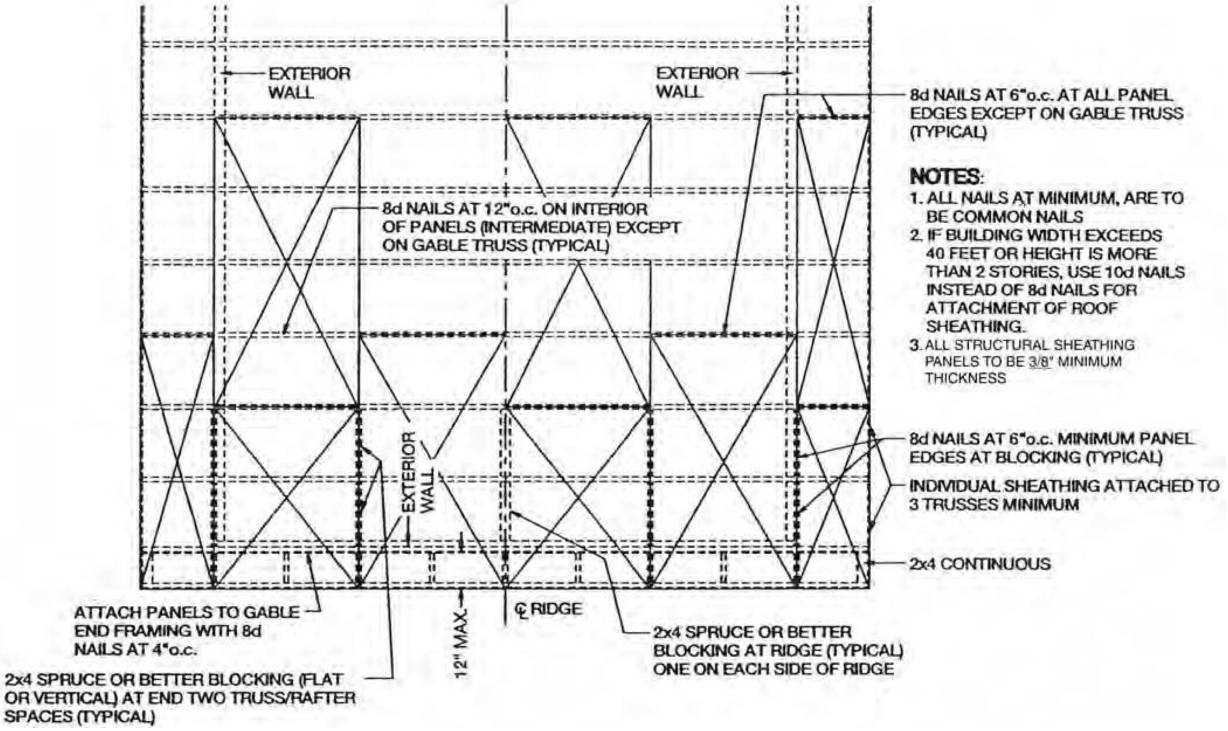
FIGURE R4506.7(b)
GABLE END OVERHANG



1) ROOF FRAMING PLAN

2) ROOF SHEATHING NOTES

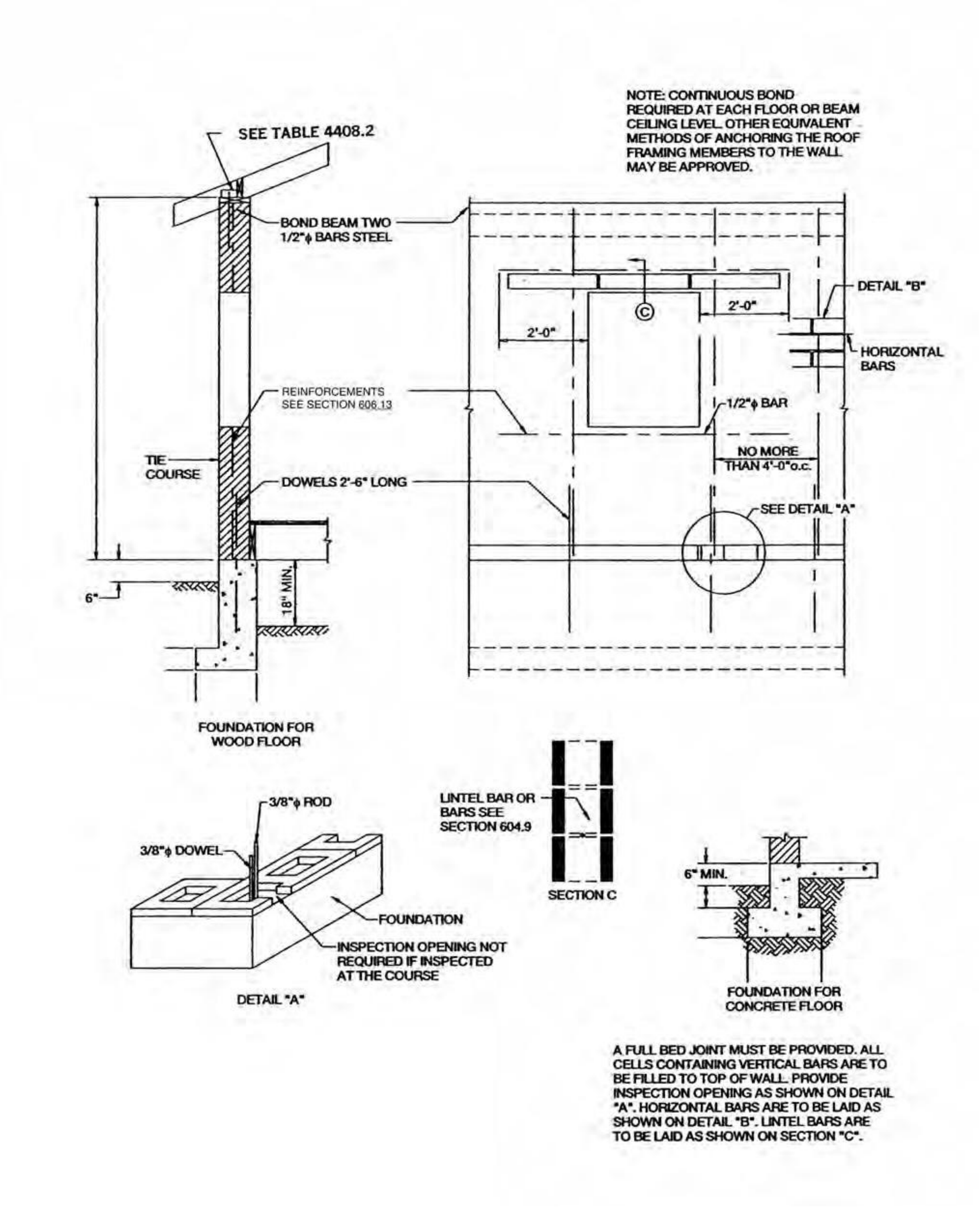
FIGURE R4506.7(c)
GABLE END OVERHANG



NOTES:

1. ALL NAILS AT MINIMUM, ARE TO BE COMMON NAILS
2. IF BUILDING WIDTH EXCEEDS 40 FEET OR HEIGHT IS MORE THAN 2 STORIES, USE 10d NAILS INSTEAD OF 8d NAILS FOR ATTACHMENT OF ROOF SHEATHING.
3. ALL STRUCTURAL SHEATHING PANELS TO BE 3/8" MINIMUM THICKNESS

FIGURE R4506.8
ROOF SHEATHING ATTACHMENT PLAN



NOTE: CONTINUOUS BOND REQUIRED AT EACH FLOOR OR BEAM CEILING LEVEL. OTHER EQUIVALENT METHODS OF ANCHORING THE ROOF FRAMING MEMBERS TO THE WALL MAY BE APPROVED.

A FULL BED JOINT MUST BE PROVIDED. ALL CELLS CONTAINING VERTICAL BARS ARE TO BE FILLED TO TOP OF WALL. PROVIDE INSPECTION OPENING AS SHOWN ON DETAIL "A". HORIZONTAL BARS ARE TO BE LAID AS SHOWN ON DETAIL "B". LINTEL BARS ARE TO BE LAID AS SHOWN ON SECTION "C".

FIGURE R4507.1(a)
REQUIREMENTS FOR REINFORCED GROUTED MASONRY CONSTRUCTION
WHERE WIND ZONES ARE 140 MPH OR GREATER

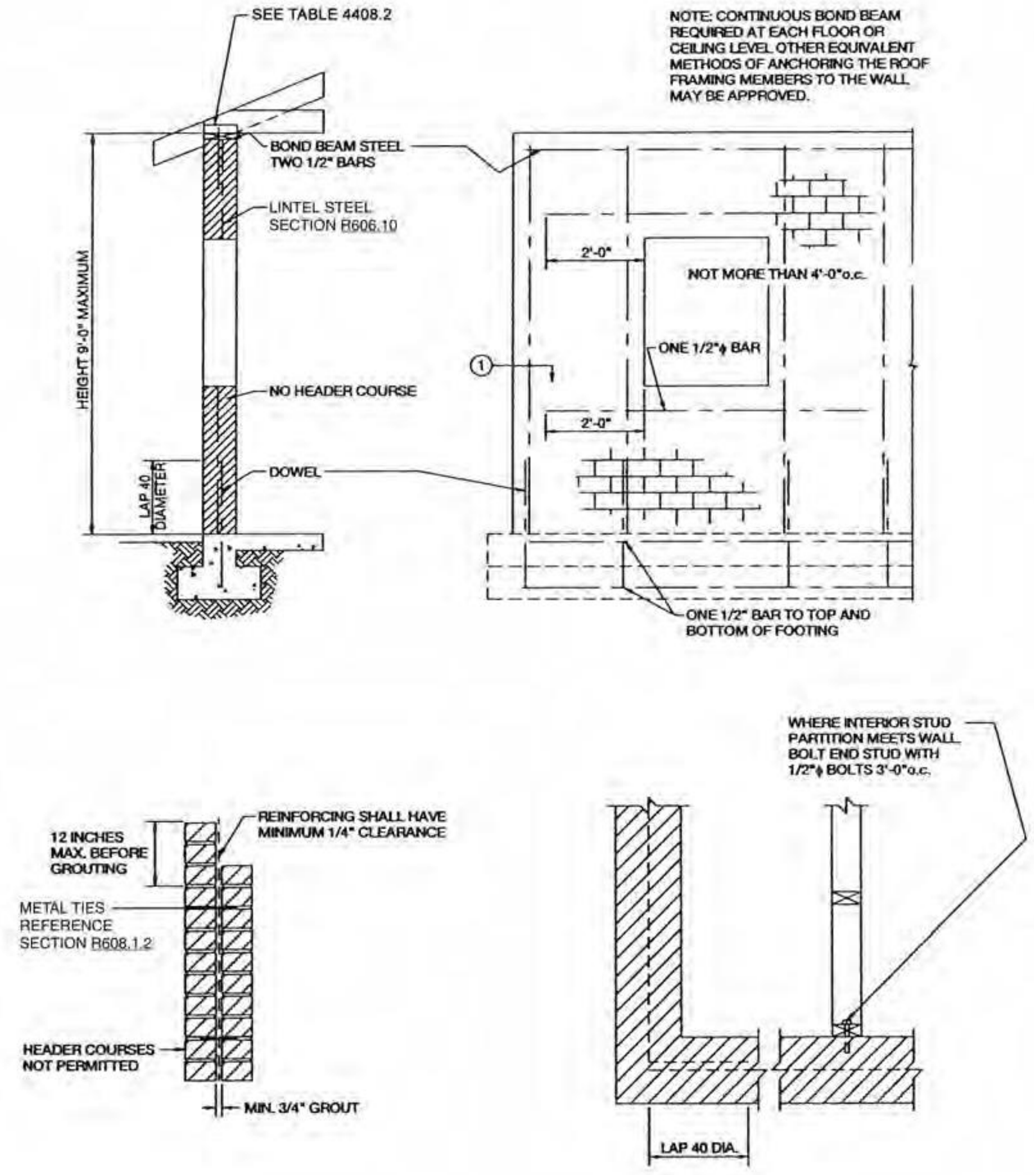


FIGURE R4507.1(b)
REQUIREMENTS FOR REINFORCED HOLLOW-UNIT MASONRY CONSTRUCTION WHERE WIND ZONES ARE 140 MPH OR GREATER

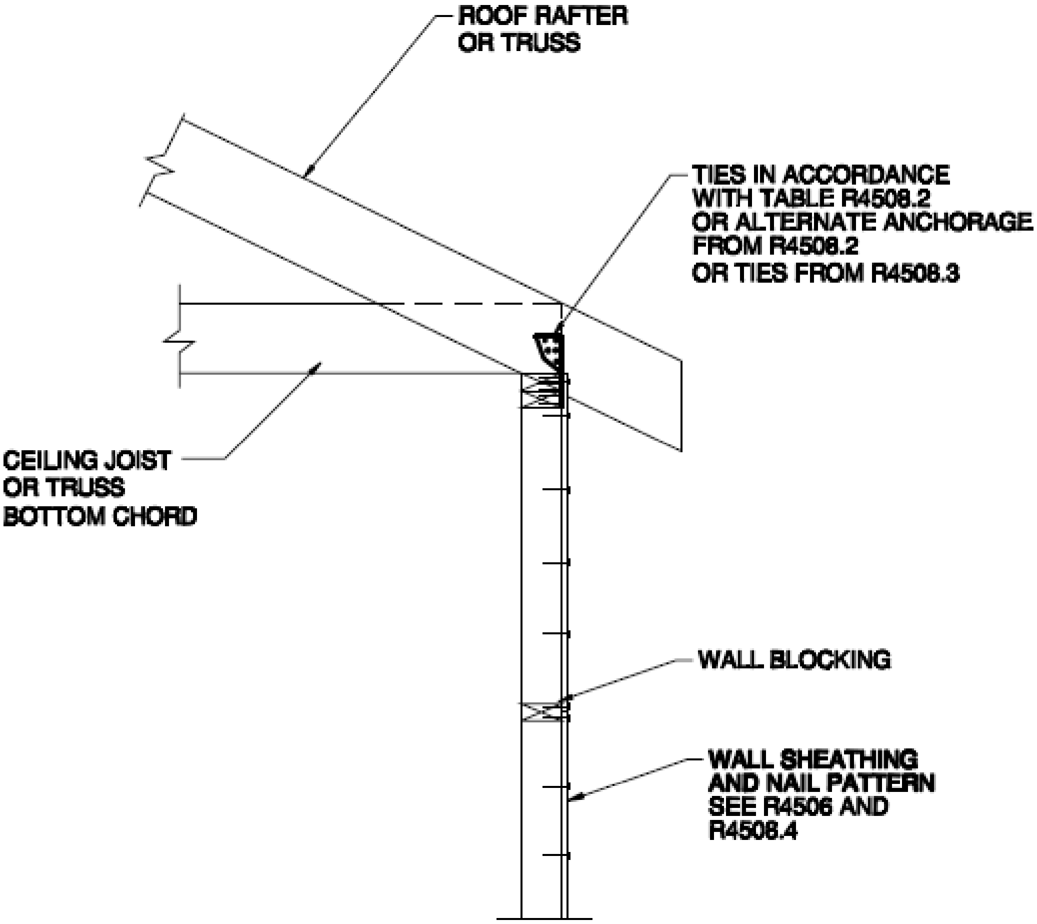


FIGURE R4508.3
ROOF RAFTER/TRUSS ANCHORAGE

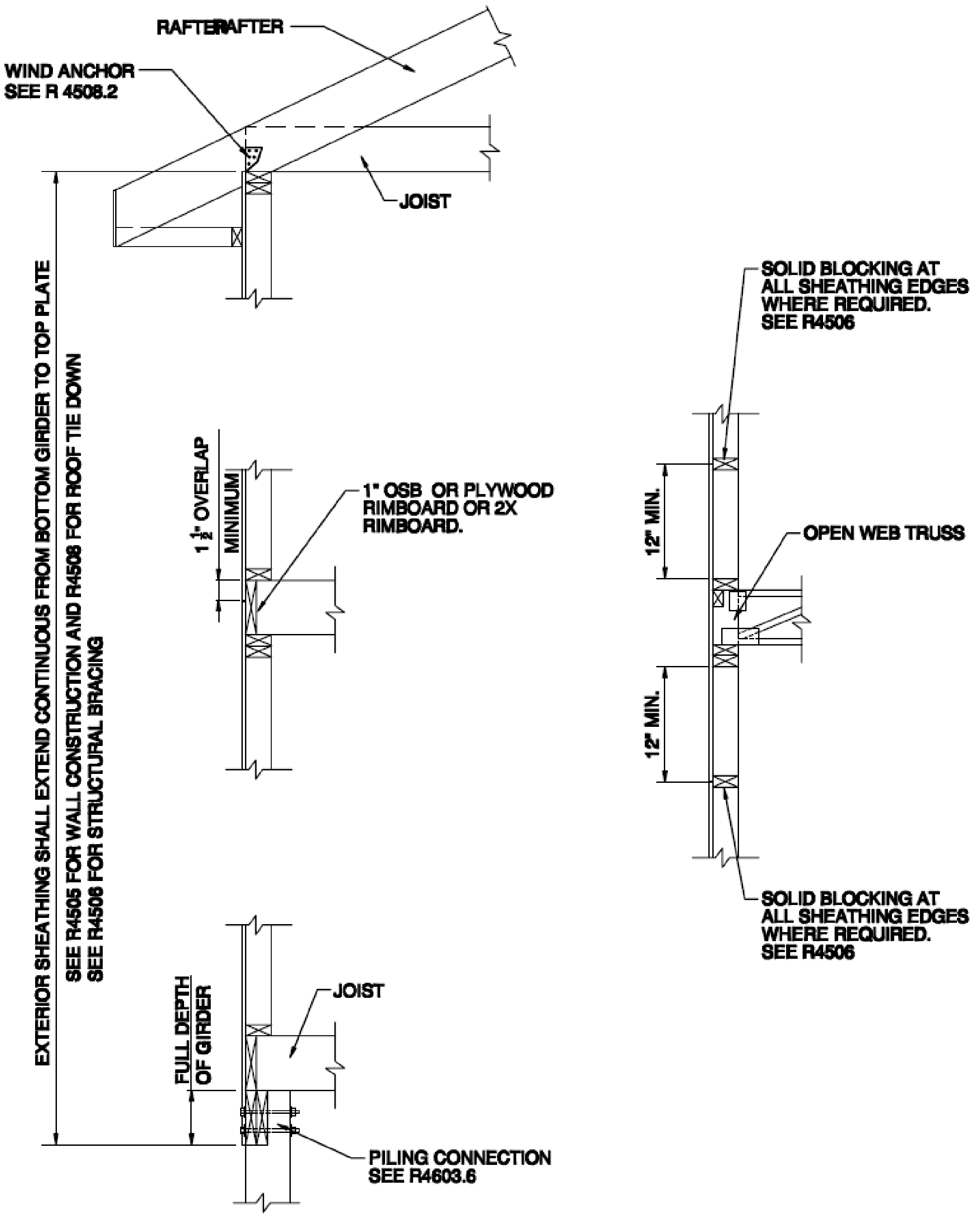


FIGURE R4508.4(a)
TWO STORY WALL SECTION - PANEL ATTACHMENT

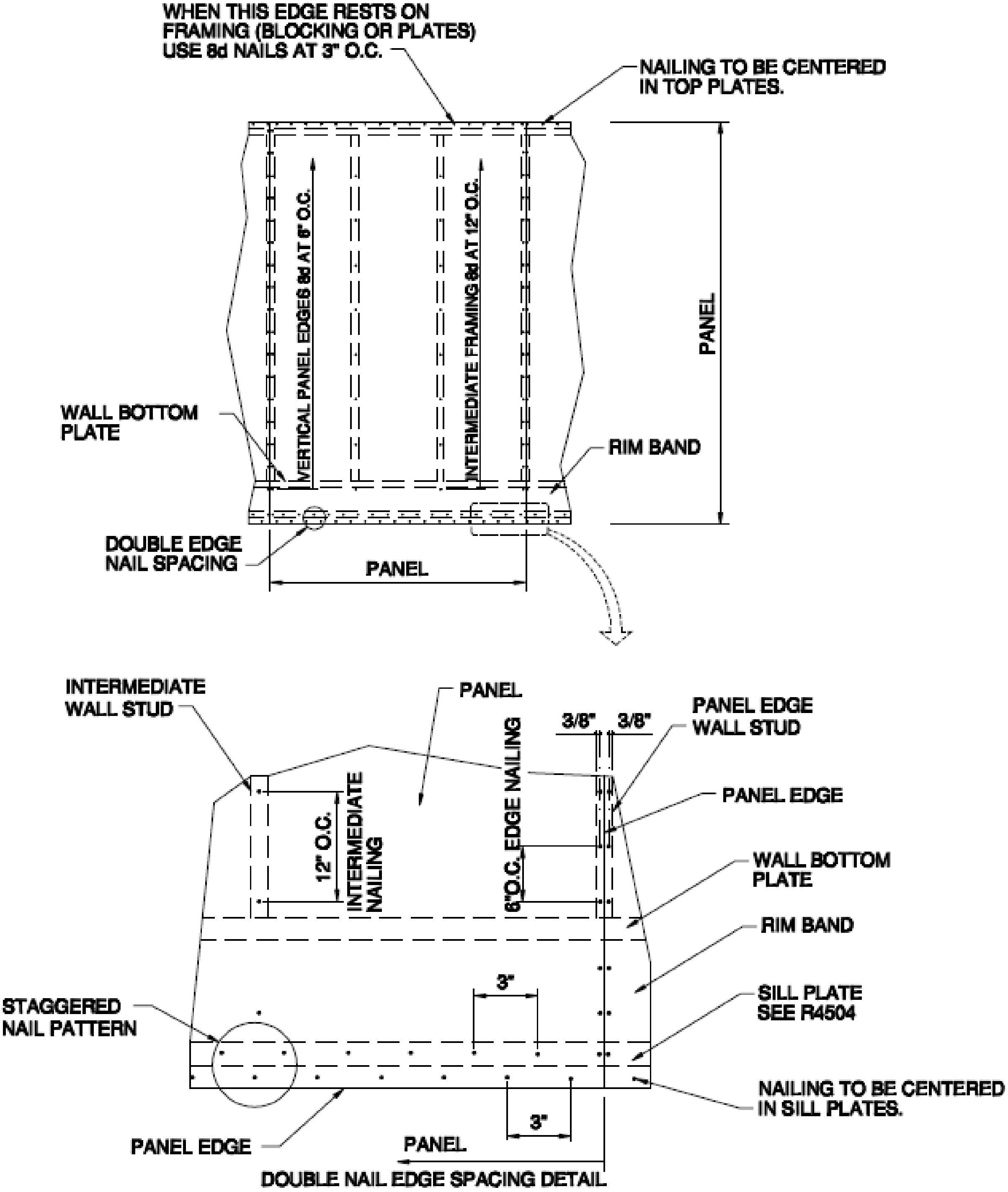


FIGURE R4508.4(b)
PANEL ATTACHMENT TO COUNTER UPLIFT HORIZONTAL OR VERTICAL

CHAPTER 46

COASTAL AND FLOOD PLAIN CONSTRUCTION STANDARDS

This chapter is a North Carolina addition and not part of the 2015 International Residential Code. There will be no underlined text.

SECTION R4601
PURPOSE, APPLICATION AND SCOPE

R4601.1. General.
The requirements set forth in this section shall apply to all construction located within areas identified by governmental agency (state and federal) as coastal high hazard areas, ocean hazard areas, the regulatory flood plain areas, and all areas designated as 150 mph (67 m/s) wind zone. See Table R301.2(1).

SECTION R4602
DEFINITIONS

BASE FLOOD ELEVATION. The peak water elevation in relation to MSL expected to be reached during a design flood which is established by the North Carolina Building Code Council as a flood having a 1 percent chance of being equaled or exceeded in any given year.

COASTAL HIGH HAZARD AREA. An area subject to coastal flooding and high velocity waters including storm wave wash, as shown by Federal Emergency Management Agency Maps and subject to the approval of the Building Code Council.

FLOOD PLAIN. Land below base flood elevation, which of record has in the past been flooded by storm water-surface runoffs, or tidal influx, and as defined by the Corps of Engineers' maps, the Federal Emergency Management Agency maps or as approved by the Building Code Council.

LOWEST FLOOR. The lowest floor of the lowest enclosed area (including basement). An unfinished or flood-resistant enclosure, usable solely for parking of vehicles, building access or storage in an area other than a basement area is not considered a building's lowest floor: provided

1. That the walls are substantially impermeable to the passage of water and the structural components have the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy, or

2. Construction shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing the entry and exit of flood waters.

MSL. Mean Sea Level as defined by National Geodetic Vertical Datum.

OCEAN HAZARD AREA. An area, as identified by the North Carolina Coastal Resources Commission, and subject to approval by the Building Code Council, near the shoreline of the Atlantic Ocean which has been identified as subject to at least one of the following hazards: (A) Historical or predicted future trends of long-term erosion, (B) erosion expected to occur during a coastal storm reaching the base flood elevation, or (C) shoreline fluctuations due to tidal inlets.

SECTION R4603
PILING STANDARDS

R4603.1. General.

All one- and two-family dwellings in areas identified as coastal high hazard areas or ocean hazard areas shall be constructed on a pile foundation of wood or concrete.

R4603.2 Concrete piles.

Concrete piles are permitted to be used if made and installed in accordance with the *North Carolina Building Code*, Chapter 18.

R4603.3 Size of wood piles.

Round timber piles shall not be less than 8 inches (203 mm) in diameter at building level and have a minimum tip diameter of 6 inches (152 mm). Square timber piles shall not be less than 8 inches square (0.005 m2), nominal. Piles supporting uncovered stairs, uncovered walkways and uncovered decks shall be 6 inches × 6 inches (153 mm × 153 mm) minimum, or if round, have a minimum tip diameter of 6 inches (153 mm). Piles supporting uncovered stairs, uncovered walkways and uncovered decks less than 5 feet (1524 mm) above grade are permitted to be 4 inches × 4 inches (102 mm × 102 mm) minimum.

R4603.4 Required depth of piles.

Pile tip shall extend to a depth of not less than 8 feet (2438 mm) below the natural grade or finished grade of the lot, whichever is lower. All pilings within the Ocean Hazard Area shall have a tip penetration of at least 5 feet (1524 mm) below mean sea level or 16 feet (4877 mm) below average original grade, whichever is least. Structures within Ocean Hazard Areas which are placed upon the site behind a line 60 times the annual erosion rate away from the most seaward line of stable natural vegetation are exempt from this additional tip penetration requirement.

R4603.5 Spacing of wood piles.

The maximum center-to-center spacing of wood piles shall not be more than 8 feet (2438 mm) on center under load-bearing sills, beams, or girders. For dwellings having more than two stories above piles or where the piling spacing exceeds 8 feet (2438 mm) on center, the pile foundation shall be designed by a *registered design professional.* Pile spacing in the nonload-bearing direction are permitted to be 12 feet (305 mm).

R4603.6 Tying and bracing of wood piles.

If sills, beams or girders are attached to the piling, a minimum of two 5/8-inch (16 mm) galvanized steel bolts per beam member shall be through bolted at each piling connection in accordance with Figure R4503.6 (a). When piling is notched so that the cross-section is reduced below 50 percent or is top bearing, sills, beams or girders shall be attached using 3/16 × 4 × 18-inch (5 × 102 × 467 mm) hot dip galvanized straps, one each side, bolted with two 5/8 inch (15.9 mm) galvanized through bolts in accordance with Figure R4603.6(b) and Figure R4503.6(c). At corners, girders shall be connected to the pile with a minimum 3/16 × 4 × 18-inch (5 × 102 × 467 mm) hot dip galvanized strap bolted with two 5/8 inch (15.9 mm) galvanized through bolts on the exterior and a minimum L4 x 3/16 x 1’-6” (102 × 5 × 467 mm) galvanized steel angle bolted with two 5/8 inch (15.9 mm) galvanized through bolts on the interior in accordance with Figure R4603.6(d).

Bracing of pile foundations is required where the clear height from ground to sill, beam or girder exceeds 10 feet (3048 mm) or the dwelling is more than one story above piles. A line of X-bracing is defined as a row of piles with X-bracing provided in at least two bays. A line of X-bracing shall be provided at all exterior pile lines. Where the perimeter lines of X-bracing exceed 40 feet (12 192 mm), an additional line of X-bracing shall be provided near the center of the building. See Figure R4603.6(e). X-bracing shall be with 2 × 10s through bolted with two 3/4-inch (19.1 mm) bolts at each end. The *code official* is permitted to accept alternate bracing designs if they bear the seal of a *registered design professional*.

R4603.7. Protection against decay.

The minimum net retention of preservatives shall be in accordance with AWPA U1.

R4603.8 Piling may be placed by auger, jetting or drop hammer.

Piling shall receive a final set by drop hammer or other approved methods, acceptable to the *code official* to ensure compaction of material at end bearing.

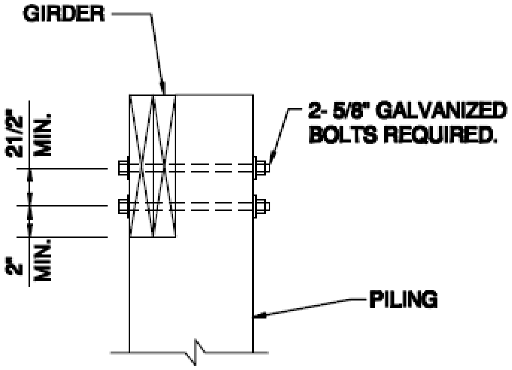


FIGURE R4603.6(a)
PILING NOTCHED LESS THAN 50%

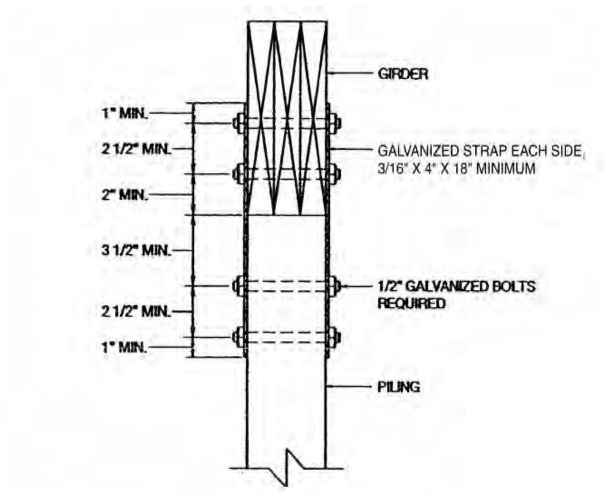


FIGURE R4603.6(b)
TOP MOUNTED GIRDER

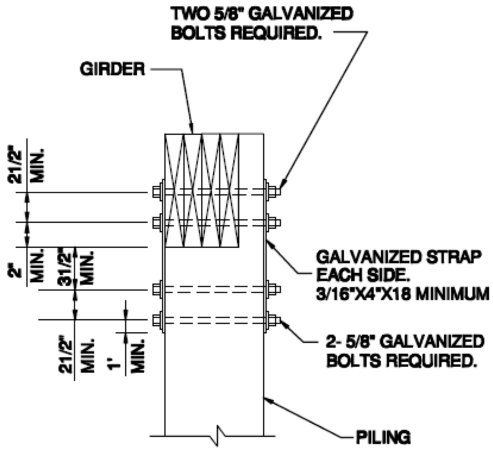


FIGURE R4603.6(c)
PILING NOTCHED MORE THAN 50%

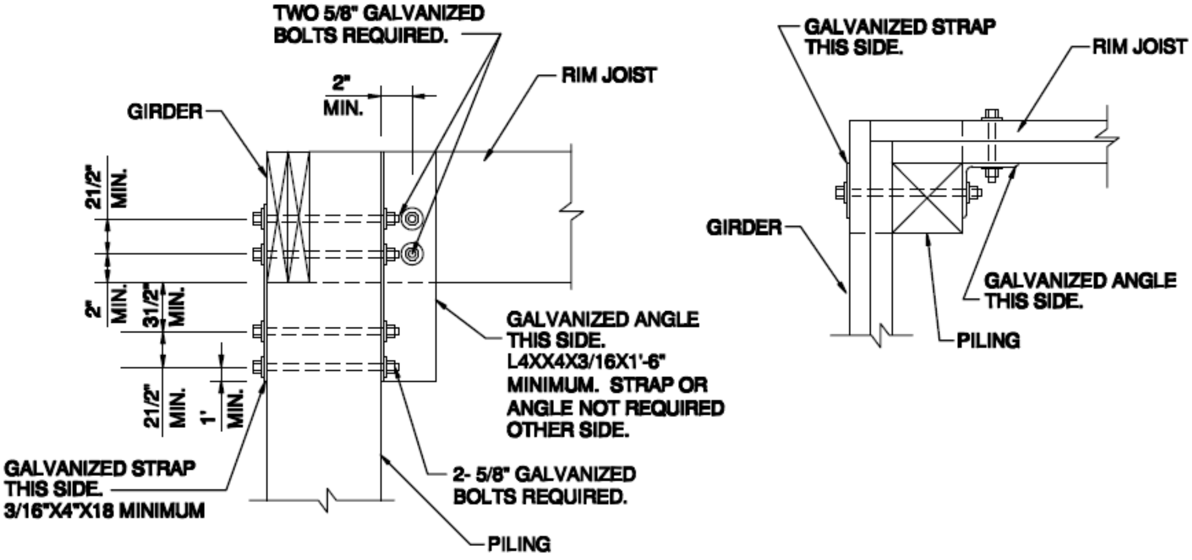


FIGURE R4603.6(d)
CORNER PILE CONNECTION

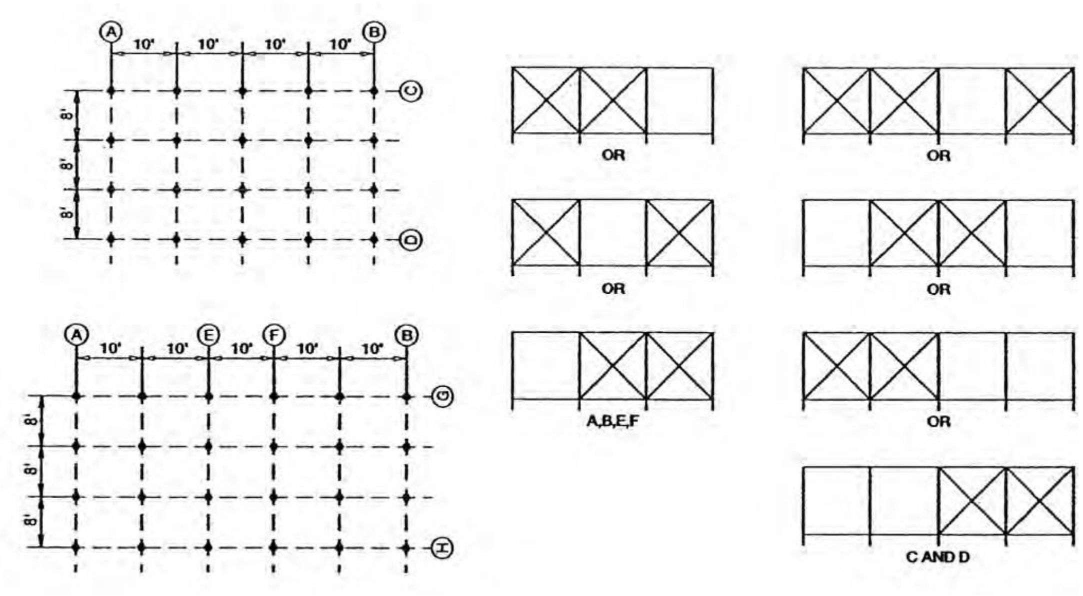


FIGURE R4603.6(e)

ELEVATIONS
(SHOWING POSSIBLE ARRANGEMENT OF X-BRACING IN LINE) (G AND H SIMILAR)

SECTION R4604
ELEVATION STANDARDS

R4604.1. Lowest structural member.

The lowest structural member, excluding pilings and bracing supporting the lowest habitable floor in the coastal high hazard area and ocean hazard area, shall be elevated above the base flood elevation.

R4604.2. First habitable floor.

The elevation of the first habitable floor of all structures in the regulatory flood plain except in the coastal high hazard areas shall be above the base flood elevation.

> **Exception:** This requirement does not apply to the addition, renovation or reconstruction to any building which was constructed prior to the initial Flood Insurance Study for that area if the addition, renovation or reconstruction does not exceed 50 percent of the present market value of the structure.

R4604.3. Walls below flood elevation.

Where walls are constructed below flood elevation in coastal high hazard area and ocean hazard area, they shall be constructed in a manner to eliminate wave forces on the piling.

SECTION R4605
CONSTRUCTION MATERIALS
AND METHODS STANDARDS

R4605.1. General.

The requirements of Sections R4605.2 through R4605.8 are applicable in the coastal high-hazard area, the ocean hazard area, and all areas defined as 150 mph (67 m/s) wind zone.

R4605.2. Roof anchorage.

Every rafter or roof truss shall be anchored to the bearing wall as required by Section R4508. At the ridges, rafters shall have a minimum 1 × 6 or 2 × 4 collar or wind beam. Every third rafter not to exceed 4 feet (1219 mm) on center shall be anchored vertically with minimum 1 × 6 or 2 × 4 from its midpoint to ceiling joists below.

R4605.3 Wood frame wall construction.

Maximum stud spacing shall be 16 inches o.c. (406 mm) for 2 × 4s and 24 inches (610 mm) for 2 × 6s. See Section R4505 for wall construction requirements. See Section R4508 for uplift anchorage requirements.

R4605.4. Design by registered design professional.

Equal or better methods of tying structures together and to foundations designed for a specific building by a *registered design professional* shall be accepted by the *code official*.

R4605.5. Fastener corrosion resistance.

In the coastal hazard area and the ocean hazard area, all metal connectors and fasteners outside of conditioned spaces shall be hot-dip galvanized steel after fabrication and meet ASTM A 153. Exposed metal connectors, such as tie-down straps on porches, decks, and areas under the structure, shall be a minimum 3/16-inch (5 mm) thick, and shall be hot-dip galvanized after fabrication and meet ASTM A 123 or ASTM A 153. Stainless steel light-gage metal connectors shall be permitted in exposed or partially exposed locations. Metal connectors of approved equivalent corrosion-resistant material are permitted to be accepted. See Table R4605.5.

R4605.6 Building anchorage.

1. For masonry buildings, the roof structure, including rafters and joists, shall be anchored to the wall in accordance with Section R606.11. All mortar used for masonry walls shall be Type M or S.
2. For masonry or wood frame buildings, all sills, beams or girders which resist uplift (including interior sills, beams, girders, and joists where the perimeter is unenclosed) shall be anchored to the footing in accordance with Section R4504. Footing dowel bars shall have an 8-inch (203 mm) hook.
3. Where wood partitions and masonry walls join, the stud abutting the masonry shall be double and bolted to the masonry with three 1/2-inch (13 mm) galvanized bolts.
4. Steel and wooden columns and posts, including porch columns, shall be anchored with metal ties and bolts to their foundations and to the members that they support.

R4605.7 Insulation.

Insulation installed in floors in exposed areas under buildings elevated on pilings shall be held in place with plywood with exterior glue or other material approved by the *code official*.

R4605.8 Accessory structures.

Detached accessory structures and out buildings shall be bolted to their foundation or otherwise constructed so as to prevent overturning.

TABLE R4605.5[a]
CORROSION RESISTANCE

	OPEN (exterior, porches, under house)	**EXPOSURE LEVEL VENTED/ENCLOSED (attic, floor trusses, enclosed crawl spaces and stud cavity)**	**CONDITIONED (heated/cooled living areas)**
Nails, staples, screws	Hot-dip galvanized	Hot-dip galvanized	-
Nuts, bolts, washers, tie rods	Hot-dip galvanized	Hot-dip galvanized	-
Steel connection plates & straps (3/16″ minimum thickness)	Hot-dip galvanized after fabrication	Hot-dip galvanized	-
Sheet metal connectors, wind anchors, joists hangers, steel joists and beams	Stainless steel or hot-dipped galvanized after fabrication	Hot-dip galvanized after plate fabrication or triple galvanized[b]	Hot-dip galvanized or triple galvanized[b]
Truss plates	Stainless steel or hot-dipped galvanized after fabrication	Hot-dip galvanized after fabrication, stainless steel, triple galvanized[b] or in accordance with TPI-1 of the Truss Plate Institute within 6′-0″ of a gable louver, ridge or soffit vent. Otherwise, standard galvanized[b].	Standard galvanized

a. Applies only to structures located in Coastal High-Hazard Area and Ocean High Hazard Area.
b. Triple galvanizing – G185, standard galvanizing – G60, both per ASTM A 653 / A 653M.

APPENDIX A

SIZING AND CAPACITIES OF GAS PIPING

(~~This appendix is informative and is not part of the *code*.~~ This appendix is an excerpt from the 2015 *International Fuel Gas Code*, coordinated with the section numbering of the *International Residential Code*.)

APPENDIX B

SIZING OF VENTING SYSTEMS SERVING APPLIANCES EQUIPPED WITH DRAFT HOODS, CATEGORY I APPLIANCES, AND APPLIANCES LISTED FOR USE WITH TYPE B VENTS

(~~This appendix is informative and is not part of the *code*.~~ This appendix is an excerpt from the 2015 *International Fuel Gas Code,* coordinated with the section numbering of the *International Residential Code.*)

APPENDIX C

EXIT TERMINALS OF MECHANICAL DRAFT AND DIRECT-VENT VENTING SYSTEMS

(~~This appendix is informative and is not part of the code.~~ This appendix is an excerpt from the 2015 *International Fuel Gas Code,* coordinated with the section numbering of the *International Residential Code.*)

APPENDIX D

RECOMMENDED PROCEDURE FOR SAFETY INSPECTION OF AN EXISTING APPLIANCE INSTALLATION

Deleted

~~(This appendix is not a part of the requirements of this code and is included for informational purposes only.)(This appendix is an excerpt from the 2015 International Fuel Gas Code, coordinated with thesection numbering of the International Residential Code.)~~

~~D.1 General.~~
~~The following procedure is intended as a guide to aid in determining that an appliance is properly installed and is in a safe condition for continued use. Where a gas supplier performs an inspection, their written procedures should be followed.~~

~~D.1.1 Application.~~
~~This procedure is intended for existing residential installations of a furnace, boiler, room heater, water heater, cooking appliance, fireplace appliance and clothes dryer. This procedure should be performed prior to any attempt to modify the appliance installation or building envelope.~~

~~D.1.2 Weatherization Programs.~~
~~Before a building envelope is to be modified as part of a weatherization program, the existing appliance installation should be inspected in accordance with these procedures. After all unsafe conditions are repaired, and immediately after the weatherization is complete, the appliance inspections in D.5.2 are to be repeated.~~

~~D.1.3 Inspection Procedure.~~
~~The safety of the building occupant and inspector are to be determined as the first step as described in D.2. Only after the ambient environment is found to be safe should inspections of gas piping and appliances be undertaken. It is recommended that all inspections described in D.3, D.4, and D.6, where the appliance is in the off mode, be completed and any unsafe conditions repaired or corrected before continuing with inspections of an operating appliance described in D.5 and D.6.~~

~~D.1.4 Manufacturer Instructions.~~
~~Where available, the manufacturer's installation and operating instructions for the installed appliances should be used as part of these inspection procedures to determine if it is installed correctly and is operating properly.~~

~~D.1.5 Instruments.~~
~~The inspection procedures include measuring for fuel gas and carbon monoxide (CO) and will require the use of a combustible gas detector (CGD) and a CO detector. It is recommended that both types of detectors be listed. Prior to any inspection, the detectors should be calibrated or~~

~~tested in accordance with the manufacturer's instructions. In addition, it is recommended that the detectors have the following minimum specifications.~~

~~(1) Gas Detector: The CGD should be capable of indicating the presence of the type of fuel gas for which it is to be used (e.g. natural gas or propane). The combustible gas detector should be capable of the following:~~

  ~~a. *PPM:* Numeric display with a parts per million (ppm) scale from 1ppm to 900 ppm in 1 ppm increments.~~

  ~~b. *LEL:* Numeric display with a percent lower explosive limit (% LEL) scale from 0 percent to 100 percent in 1 percent increments.~~

  ~~c. *Audio:* An audio sound feature to locate leaks.~~

~~(2) CO Detector: The CO detector should be capable of the following functions and have a numeric display scale as follows:~~

  ~~a. *PPM:* For measuring ambient room and appliance emissions a display scale in parts per million (ppm) from 0 to 1,000 ppm in 1 ppm increments.~~

  ~~b. *Alarm:* A sound alarm function where hazardous levels of ambient CO is found (see D.2 for alarm levels)~~

  ~~c. *Air Free:* Capable of converting CO measurements to an air free level in ppm. Where a CO detector is used without an air free conversion function, the CO air free can be calculated in accordance with footnote 3 in Table D.6.~~

~~D.2 Occupant and Inspector Safety.~~

~~Prior to entering a building, the inspector should have both a combustible gas detector (CGD) and CO detector turned on, calibrated, and operating. Immediately upon entering the building, a sample of the ambient atmosphere should be taken. Based on CGD and CO detector readings, the inspector should take the following actions:~~

~~(1) The CO detector indicates a carbon monoxide level of 70 ppm or greater~~ ~~[1]~~ ~~. The inspector should immediately notify the occupant of the need for themselves and any building occupant to evacuate; the inspector shall immediately evacuate and call 911.~~

~~(2) Where the CO detector indicates a reading between 30 ppm and 70 ppm~~ ~~[1]~~ ~~. The inspector should advise the occupant that high CO levels have been found and recommend that all possible sources of CO should be turned off immediately and windows and doors opened. Where it appears that the source of CO is a permanently installed appliance, advise the occupant to keep the appliance off and have the appliance serviced by a qualified servicing agent.~~

~~(3) Where CO detector indicates CO below 30 ppm~~ ~~[1]~~ ~~the inspection can continue.~~

~~(4) The CGD indicates a combustible gas level of 20% LEL or greater. The inspector should immediately notify the occupant of the need for themselves and any building occupant to evacuate; the inspector shall immediately evacuate and call 911.~~

~~(5) The CGD indicates a combustible gas level below 20% LEL, the inspection can continue.~~

~~If during the inspection process it is determined a condition exists that could result in unsafe appliance operation, shut off the appliance and advise the owner of the unsafe condition. Where a gas leak is found that could result in an unsafe condition, advise the owner of the unsafe condition and call the gas supplier to turn off the gas supply. The inspector should not continue a safety inspection on an operating appliance, venting system, and piping system until repairs have been made.~~

~~D.3 Gas Piping and Connection Inspections.~~

~~(1) Leak Checks. Conduct a test for gas leakage using either a non-corrosive leak detection solution or a CGD confirmed with a leak detection solution.~~

~~The preferred method for leak checking is by use of gas leak detection solution applied to all joints. This method provides a reliable visual indication of significant leaks.~~

~~The use of a CGD in its audio sensing mode can quickly locate suspect leaks but can be overly sensitive indicating insignificant and false leaks. All suspect leaks found through the use of a CGD should be confirmed using a leak detection solution.~~

~~Where gas leakage is confirmed, the owner should be notified that repairs must be made. The inspection should include the following components:~~

~~a. All gas piping fittings located within the appliance space.~~

~~b. Appliance connector fittings.~~

~~c. Appliance gas valve/regulator housing and connections.~~

~~(2) *Appliance Connector*. Verify that the appliance connection type is compliant with Section G2422 of the *International Fuel Gas Code*. Inspect flexible appliance connections to determine if they are free of cracks, corrosion and signs of damage. Verify that there are no uncoated brass connectors. Where connectors are determined to be unsafe or where an uncoated brass connector is found, the appliance shutoff valve should be placed in the off position and the owner notified that the connector must be replaced.~~

~~(3) *Piping Support*. Inspect piping to determine that it is adequately supported, that there is no undue stress on the piping, and if there are any improperly capped pipe openings.~~

~~(4) *Bonding*. Verify that the electrical bonding of gas piping is compliant with Section G2411 of the *International Fuel Gas Code*.~~

~~D.4 Inspections to be performed with the Appliance Not Operating.~~

~~The following safety inspection procedures are performed on appliances that are not operating. These inspections are applicable to all appliance installations.~~

~~(1) *Preparing for Inspection*. Shut off all gas and electrical power to the appliances located in the same room being inspected. For gas supply, use the shutoff valve in the supply line or at the manifold serving each appliance. For electrical power, place the circuit breaker in the off position or remove the fuse that serves each appliance. A lock type device or tag should be installed on each gas shutoff valve and at the electrical panel to indicate that the service has been shut off for inspection purposes.~~

~~(2) *Vent System Size and Installation*. Verify that the existing venting system size and installation are compliant with Chapter 5 of the *International Fuel Gas Code*. The size and installation of venting systems for other than natural draft and Category I appliances should be in compliance with the manufacturer's installation instructions. Inspect the venting system to determine that it is free of blockage, restriction, leakage, corrosion, and other deficiencies that could cause an unsafe condition. Inspect masonry chimneys to determine if they are lined. Inspect plastic venting system to determine that it is free of sagging and it is sloped in an upward direction to the outdoor vent termination.~~

~~(3) *Combustion Air Supply*. Inspect provisions for combustion air as follows:~~

~~a. *Non-Direct Vent Appliances*. Determine that non-direct vent appliance installations are compliant with the combustion air requirements in Section G2407 of the *International Fuel Gas Code*. Inspect any interior and exterior combustion air openings and any connected combustion air ducts to determine that there is no blockage, restriction, corrosion or damage. Inspect to determine that the upper horizontal combustion air duct is not sloped in a downward direction toward the air supply source.~~

~~b. *Direct Vent Appliances*. Verify that the combustion air supply ducts and pipes are securely fastened to direct vent appliance and determine that there are no separations, blockage, restriction, corrosion or other damage. Determine that the combustion air source is located in the outdoors or to areas that freely communicate to the outdoors.~~

~~c. *Unvented Appliances*. Verify that the total input of all unvented room heaters and gas-fired refrigerators installed in the same room or rooms that freely communicate with each other does not exceed 20 Btu/hr/ft^3.~~

~~(4) *Flooded Appliances*. Inspect the appliance for signs that the appliance may have been damaged by flooding. Signs of flooding include a visible water submerge line on the appliance housing, excessive surface or component rust, deposited debris on internal components, and mildew-like odor. Inform the owner that any part of the appliance control system and any appliance gas control that has been under water must be replaced. All flood-damaged plumbing, heating, cooling and electrical appliances should be replaced.~~

~~(5) *Flammable Vapors*. Inspect the room/space where the appliance is installed to determine if the area is free of the storage of gasoline or any flammable products such~~

~~as oil-based solvents, varnishes or adhesives. Where the appliance is installed where flammable products will be stored or used, such as a garage, verify that the appliance burner(s) is a minimum of 18” above the floor unless the appliance is listed as flammable vapor ignition resistant.~~

~~(6) *Clearances to Combustibles*. Inspect the immediate location where the appliance is installed to determine if the area is free of rags, paper or other combustibles. Verify that the appliance and venting system are compliant with clearances to combustible building components in accordance with Sections G2408.5, G2425.15.4, G2426.5, G2427.6.1, G2427.10.5 and other applicable sections of Section G2427.~~

~~(7) *Appliance Components.* Inspect internal components by removing access panels or other components for the following:~~

~~a. Inspect burners and crossovers for blockage and corrosion. The presence of soot, debris, and signs of excessive heating may indicate incomplete combustion due to blockage or improper burner adjustments.~~

~~c. Metallic and non-metallic hoses for signs of cracks, splitting, corrosion, and lose connections.~~

~~d. Signs of improper or incomplete repairs~~

~~e. Modifications that override controls and safety systems~~

~~f. Electrical wiring for loose connections; cracks, missing or worn electrical insulation; and indications of excessive heat or electrical shorting. Appliances requiring an external electrical supply should be inspected for proper electrical connection in accordance with the National Electric Code.~~

~~(8) *Placing Appliances Back in Operation*. Return all inspected appliances and systems to their preexisting state by reinstalling any removed access panels and components. Turn on the gas supply and electricity to each appliance found in safe condition. Proceed to the operating inspections in D.5 through D.6.~~

~~D.5 Inspections to be performed with the Appliance Operating.~~

~~The following safety inspection procedures are to be performed on appliances that are operating where there are no unsafe conditions or where corrective repairs have been completed.~~

~~**D.5.1 General Appliance Operation.**~~

~~(1) Initial Startup. Adjust the thermostat or other control device to start the appliance. Verify that the appliance starts up normally and is operating properly.~~

~~Determine that the pilot(s), where provided, is burning properly and that the main burner ignition is satisfactory, by interrupting and re-establishing the electrical supply to the appliance in any convenient manner. If the appliance is equipped with a continuous pilot(s), test all pilot safety devices to determine whether they are operating properly by~~

~~extinguishing the pilot(s) when the main burner(s) is off and determining, after 3 minutes, that the main burner gas does not flow upon a call for heat. If the appliance is not provided with a pilot(s), test for proper operation of the ignition system in accordance with the appliance manufacturer's lighting and operating instructions.~~

~~(2) Flame Appearance. Visually inspect the flame appearance for proper color and appearance. Visually determine that the main burner gas is burning properly (i.e., no floating, lifting, or flashback). Adjust the primary air shutter as required. If the appliance is equipped with high and low flame controlling or flame modulation, check for proper main burner operation at low flame.~~

~~(3) Appliance Shutdown. Adjust the thermostat or other control device to shut down the appliance. Verify that the appliance shuts off properly.~~

~~D.5.2 Test for Combustion Air and Vent Drafting for Natural Draft and Category I Appliances.~~

~~Combustion air and vent draft procedures are for natural draft and category I appliances equipped with a draft hood and connected to a natural draft venting system.~~

~~(1)*Preparing for Inspection*. Close all exterior building doors and windows and all interior doors between the space in which the appliance is located and other spaces of the building that can be closed. Turn on any clothes dryer. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers and any fireplace doors.~~

~~(2)*Placing the Appliance in Operation*. Place the appliance being inspected in operation. Adjust the thermostat or control so the appliance will operate continuously.~~

~~(3)*Spillage Test*. Verify that all appliances located within the same room are in their standby mode and ready for operation. Follow lighting instructions for each appliance as necessary. Test for spillage at the draft hood relief opening as follows:~~

~~a. After 5 minutes of main burner operation, check for spillage using smoke.~~

~~b. Immediately after the first check, turn on all other fuel gas burning appliances within the same room so they will operate at their full inputs and repeat the spillage test.~~

~~c. Shut down all appliances to their standby mode and wait for 15 minutes.~~

~~d. Repeat the spillage test steps a through c on each appliance being inspected.~~

~~(4)Additional Spillage Tests: Determine if the appliance venting is impacted by other door and air handler settings by performing the following tests.~~

~~a. Set initial test condition in accordance with D.5.2 (1).~~

~~b. Place the appliance(s) being inspected in operation. Adjust the thermostat or control so the appliance(s) will operate continuously.~~

c. ~~Open the door between the space in which the appliance(s) is located and the rest of the building. After 5 minutes of main burner operation, check for spillage at each appliance using smoke.~~

d. ~~Turn on any other central heating or cooling air handler fan that is located outside of the area where the appliances are being inspected. After 5 minutes of main burner operation, check for spillage at each appliance using smoke. The test should be conducted with the door between the space in which the appliance(s) is located and the rest of the building in the open and in the closed position.~~

~~(5)Return doors, windows, exhaust fans, fireplace dampers, and any other fuel gas burning appliance to their previous conditions of use.~~

~~(6)If, after completing the spillage test it is believed sufficient combustion air is not available, the owner should be notified that an alternative combustion air source is needed in accordance with Section G2407 of the *International Fuel Gas Code*. Where it is believed that the venting system does not provide adequate natural draft, the owner should be notified that alternative vent sizing, design or configuration is needed in accordance with Chapter 24 of the *International Fuel Gas Code*. If spillage occurs, the owner should be notified as to its cause, be instructed as to which position of the door (open or closed) would lessen its impact, and that corrective action by a HVAC professional should be taken.~~

~~D.6 Appliance-Specific Inspections.~~

~~The following appliance-specific inspections are to be performed as part of a complete inspection. These inspections are performed either with the appliance in the off or standby mode (indicated by "*OFF*") or on an appliance that is operating (indicated by "*ON*"). The CO measurements are to be undertaken only after the appliance is determined to be properly venting. The CO detector should be capable of calculating CO emissions in ppm air free.~~

~~(1)Forced Air Furnaces:~~

a. ~~OFF. Verify that an air filter is installed and that it is not excessively blocked with dust.~~

b. ~~OFF. Inspect visible portions of the furnace combustion chamber for cracks, ruptures, holes, and corrosion. A heat exchanger leakage test should be conducted.~~

c. ~~ON. Verify both the limit control and the fan control are operating properly. Limit control operation can be checked by blocking the circulating air inlet or temporarily disconnecting the electrical supply to the blower motor and determining that the limit control acts to shut off the main burner gas.~~

d. ~~ON. Verify that the blower compartment door is properly installed and can be properly re-secured if opened. Verify that the blower compartment door safety switch operates properly.~~

e. ~~*ON*. Check for flame disturbance before and after blower comes on which can indicate heat exchanger leaks.~~

~~f. *ON*. Measure the CO in the vent after 5 minutes of main burner operation. The CO should not exceed threshold in Table D.6.~~

~~(2)Boilers:~~

~~a. OFF and ON. Inspect for evidence of water leaks around boiler and connected piping.~~

~~b. ON. Verify that the water pumps are in operating condition. Test low water cutoffs, automatic feed controls, pressure and temperature limit controls, and relief valves in accordance with the manufacturer's recommendations to determine that they are in operating condition.~~

~~c. ON. Measure the CO in the vent after 5 minutes of main burner operation. The CO should not exceed threshold in Table D.6.~~

~~(3)Water Heaters:~~

~~a. *OFF*. Verify that the pressure-temperature relief valve is in operating condition. Water in the heater should be at operating temperature.~~

~~b. OFF. Verify that inspection covers, glass, and gaskets are intact and in place on a flammable vapor ignition resistant (FVIR) type water heater.~~

~~c. ON. Verify that the thermostat is set in accordance with the manufacturer's operating instructions and measure the water temperature at the closest tub or sink to verify that it is no greater than 120ºF.~~

~~d. OFF. Where required by the local building code in earthquake prone locations, inspect that the water heater is secured to the wall studs in two locations (high and low) using appropriate metal strapping and bolts.~~

~~e. ON. Measure the CO in the vent after 5 minutes of main burner operation. The CO should not exceed threshold in Table D.6.~~

~~(4)Cooking Appliances~~

~~a. *OFF*. Inspect oven cavity and range-top exhaust vent for blockage with aluminum foil or other materials.~~

~~b. *OFF*. Inspect cook top to verify that it is free from a build-up of grease.~~

~~c. *ON*. Measure the CO above each burner and at the oven exhaust vents after 5 minutes of burner operation. The CO should not exceed threshold in Table D.6.~~

~~(5)Vented Room Heaters~~

~~a. OFF. For built-in room heaters and wall furnaces, inspect that the burner compartment is free of lint and debris.~~

~~b. OFF. Inspect that furnishings and combustible building components are not blocking the heater.~~

~~a. ON. Measure the CO in the vent after 5 minutes of main burner operation. The CO should not exceed threshold in Table D.6.~~

~~(6)Vent-Free (unvented) Heaters~~

~~a. OFF. Verify that the heater input is a maximum of 40,000 Btu input, but not more than 10,000 Btu where installed in a bedroom, and 6,000 Btu where installed in a bathroom.~~

~~b. OFF. Inspect the ceramic logs provided with gas log type vent free heaters that they are properly located and aligned.~~

~~c. OFF. Inspect the heater that it is free of excess lint build-up and debris.~~

~~c. OFF. Verify that the oxygen depletion safety shutoff system has not been altered or bypassed.~~

~~d. ON. Verify that the main burner shuts down within 3 minutes by extinguishing the pilot light. The test is meant to simulate the operation of the oxygen depletion system (ODS).~~

~~e. ON. Measure the CO after 5 minutes of main burner operation. The CO should not exceed threshold in Table D.6.~~

~~(7)Gas Log Sets and Gas Fireplaces~~

~~a. OFF. For gas logs installed in wood burning fireplaces equipped with a damper, verify that the fireplace damper is in a fixed open position.~~

~~b. ON. Measure the CO in the firebox (log sets installed in wood burning fireplaces or in the vent (gas fireplace) after 5 minutes of main burner operation. The CO should not exceed threshold in Table D.6.~~

~~(8)Gas Clothes Dryer~~

~~a. *OFF*. Where installed in a closet, verify that a source of make-up air is provided and inspect that any make-up air openings, louvers, and ducts are free of blockage.~~

~~b. OFF. Inspect for excess amounts of lint around the dryer and on dryer components. Inspect that there is a lint trap properly installed and it does not have holes or tears. Verify that it is in a clean condition.~~

~~c. OFF. Inspect visible portions of the exhaust duct and connections for loose fittings and connections, blockage, and signs of corrosion. Verify that the duct termination is not blocked and that it terminates in an outdoor location. Verify that only approved~~

~~metal vent ducting material is installed (plastic and vinyl materials are not approved for gas dryers).~~

~~d. ON. Verify mechanical components including drum and blower are operating properly.~~

~~e. ON. Operate the clothes dryer and verify that exhaust system is intact and exhaust is exiting the termination.~~

~~f. ON. Measure the CO at the exhaust duct or termination after 5 minutes of main burner operation. The CO should not exceed threshold in Table D.6.~~

~~TABLE D.6~~
~~CO THRESHOLDS~~

~~Central Furnace (all categories)~~	~~400 ppm[1] air free[2, 3]~~
~~Floor Furnace~~	~~400 ppm air free~~
~~Gravity Furnace~~	~~400 ppm air free~~
~~Wall Furnace (BIV)~~	~~200 ppm air free~~
~~Wall Furnace (Direct Vent)~~	~~400 ppm air free~~
~~Vented Room Heater~~	~~200 ppm air free~~
~~Vent-Free Room Heater~~	~~200 ppm air free~~
~~Water Heater~~	~~200 ppm air free~~
~~Oven/Boiler~~	~~225 ppm as measured~~
~~Top Burner~~	~~25 ppm as measured (per burner)~~
~~Clothes Dryer~~	~~400 ppm air free~~
~~Refrigerator~~	~~25 ppm as measured~~
~~Gas Log (gas fireplace)~~	~~25 ppm as measured in vent~~
~~Gas Log (installed in wood -burning fireplace)~~	~~400 ppm air free in firebox~~

~~[1] Parts per million~~

~~[2] Air free emission levels are based on a mathematical equation (involving carbon monoxide and oxygen or carbon dioxide readings) to convert an actual diluted flue gas carbon monoxide testing sample to an undiluted air free flue gas carbon monoxide level utilized in the appliance certification standards. For natural gas or propane, using as-measured CO ppm and O2 percentage:~~

$$CO_{AFppm} = \left(\frac{20.9}{20.9 - O_2}\right) \times CO_{ppm}$$

~~Where:~~

~~CO_{AFppm} = Carbon monoxide, air-free ppm~~

~~CO_{ppm} = As-measured combustion gas carbon monoxide ppm~~

~~O2 = Percentage of oxygen in combustion gas, as a percentage~~

~~[3] An alternate method of calculating the CO air free when access to an oxygen meter is not available:~~

$$CO_{AFppm} = \left(\frac{UCO_2}{CO_2}\right) \times CO$$

~~Where:~~

~~UCO_2~~ = ~~Ultimate concentration of carbon dioxide for the fuel being burned in percent for natural gas (12.2 percent) and propane (14.0 percent)~~

~~CO_2~~ = ~~Measured concentration of carbon dioxide in combustion products in percent~~

~~CO~~ = ~~Measured concentration of carbon monoxide in combustion products in percent~~

APPENDIX E

(E-1 THROUGH E-4)

~~MANUFACTURED HOUSING USED AS DWELLINGS~~

RESIDENTIAL REQUIREMENTS FOR ENERGY CONSERVATION

This appendix is a North Carolina addition and not part of the 2015 International Residential Code. There will be no underlined text.

(The provisions contained in this appendix are adopted as part of this code.)

~~***(The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.)***~~

~~SECTION AE101~~
~~SCOPE~~

~~**AE101.1 General.**~~

~~These provisions shall be applicable only to a *manufactured home* used as a single *dwelling unit* installed on privately owned (nonrental) lots and shall apply to the following:~~

1. ~~Construction, *alteration* and repair of any foundation system that is necessary to provide for the installation of a *manufactured home* unit.~~

2. ~~Construction, installation, *addition*, *alteration*, repair or maintenance of the building service *equipment* that is necessary for connecting *manufactured homes* to water, fuel, or power supplies and sewage systems.~~

3. ~~*Alterations*, *additions* or repairs to existing *manufactured homes*. The construction, *alteration*, moving, demolition, repair and use of accessory buildings and structures, and their building service *equipment*, shall comply with the requirements of the codes adopted by this *jurisdiction*.~~

~~These provisions shall not be applicable to the design and construction of *manufactured homes* and shall not be deemed to authorize either modifications or *additions* to *manufactured homes* where otherwise prohibited.~~

~~**Exception:** In addition to these provisions, new and replacement *manufactured homes* to be located in flood hazard areas as established in Table R301.2(1) of the *International Residential Code* shall meet the applicable requirements of Section R322 of the *International Residential Code*.~~

~~SECTION AE102~~

~~APPLICATION TO EXISTING MANUFACTURED HOMES AND BUILDING SERVICE EQUIPMENT~~

~~**AE102.1 General.**~~

~~*Manufactured homes* and their building service *equipment* to which *additions*, *alterations* or repairs are made shall comply with all the requirements of these provisions for new facilities, except as specifically provided in this section.~~

~~**AE102.2 Additions, alterations or repairs.**~~

~~*Additions* made to a *manufactured home* shall conform to one of the following:~~

1. ~~Be certified under the National Manufactured Housing Construction and Safety Standards Act of 1974 (42 U.S.C. Section 5401, et seq.).~~

2. ~~Be designed and constructed to comply with the applicable provisions of the National Manufactured Housing Construction and Safety Standards Act of 1974 (42 U.S.C. Section 5401, et seq.).~~

3. ~~Be designed and constructed in compliance with the code adopted by this *jurisdiction*.~~

~~*Additions* shall be structurally separated from the *manufactured home*.~~

~~**Exception:** A structural separation need not be provided when structural calculations are provided to justify the omission of such separation.~~

~~*Alterations* or repairs may be made to any *manufactured home* or to its building service *equipment* without requiring the existing *manufactured home* or its building service *equipment* to comply with all the requirements of these provisions, provided the *alteration* or repair conforms to that required for new construction, and provided further that no hazard to life, health or safety will be created by such *additions*, *alterations* or repairs.~~

~~*Alterations* or repairs to an existing *manufactured home*, which are nonstructural and do not adversely affect any structural member or any part of the building or structure having required fire protection, may be made with materials equivalent to those of which the *manufactured home* structure is constructed, subject to approval by the *building official*.~~

> ~~**Exception:** The installation or replacement of glass shall be required for new installations.~~

~~Minor *additions*, *alterations* and repairs to existing building service *equipment* installations may be made in accordance with the codes in effect at the time the original installation was made, subject to the approval of the *building official*, and provided such *additions*, *alterations* and repairs will not cause the existing building service *equipment* to become unsafe, insanitary or overloaded.~~

~~**AE102.3 Existing installations.**~~

~~Building service *equipment* lawfully in existence at the time of the adoption of the applicable codes may have their use, maintenance or repair continued if the use, maintenance or repair is~~

~~in accordance with the original design and no hazard to life, health or property has been created by such building service *equipment*.~~

~~AE102.4 Existing occupancy.~~

~~*Manufactured homes* that are in existence at the time of the adoption of these provisions may have their existing use or occupancy continued if such use or occupancy was legal at the time of the adoption of these provisions, provided such continued use is not dangerous to life, health and safety.~~

~~The use or occupancy of any existing *manufactured home* shall not be changed unless evidence satisfactory to the *building official* is provided to show compliance with all applicable provisions of the codes adopted by this *jurisdiction*. Upon any change in use or occupancy, the *manufactured home* shall cease to be classified as such within the intent of these provisions.~~

~~AE102.5 Maintenance.~~

~~All *manufactured homes* and their building service *equipment*, existing and new, and all parts thereof, shall be maintained in a safe and sanitary condition. All devices or safeguards which are required by applicable codes or by the *Manufactured Home* Standards shall be maintained in conformance to the code or standard under which it was installed. The owner or the owner's designated agent shall be responsible for the maintenance of *manufactured homes*, accessory buildings, structures and their building service *equipment*. To determine compliance with this section, the *building official* may cause any *manufactured home*, accessory building or structure to be reinspected.~~

~~AE102.6 Relocation.~~

~~*Manufactured homes* which are to be relocated within this *jurisdiction* shall comply with these provisions.~~

~~SECTION AE201~~
~~DEFINITIONS~~

~~AE201.1 General.~~

~~For the purpose of these provisions, certain abbreviations, terms, phrases, words and their derivatives shall be construed as defined or specified herein.~~

~~**ACCESSORY BUILDING.** Any building or structure or portion thereto, located on the same property as a *manufactured home*, which does not qualify as a *manufactured home* as defined herein.~~

~~**BUILDING SERVICE EQUIPMENT.** Refers to the plumbing, mechanical and electrical *equipment*, including piping, wiring, fixtures and other accessories which provide sanitation, lighting, heating, ventilation, cooling, fire protection and facilities essential for the habitable occupancy of a *manufactured home* or accessory building or structure for its designated use and occupancy.~~

~~**MANUFACTURED HOME.** A structure transportable in one or more sections which, in the traveling mode, is 8 body feet (2438 body mm) or more in width or 40 body feet (12 192 body mm) or more in length or, when erected on site, is 320 or more square feet (30 m^2), and which is built on a permanent chassis and designed to be used as a *dwelling* with or without a permanent foundation when connected to the required utilities, and includes the plumbing,~~

~~heating, air-conditioning and electrical systems contained therein; except that such term shall include any structure which meets all the requirements of this paragraph, except the size requirements and with respect to which the manufacturer voluntarily files a certification required by the Secretary of the U.S. Department of Housing and Urban Development (HUD) and complies with the standards established under this title.~~

> ~~For mobile homes built prior to June 15, 1976, a *label* certifying compliance with the *Standard for Mobile Homes*, NFPA 501, ANSI 119.1, in effect at the time of manufacture, is required. For the purpose of these provisions, a mobile home shall be considered a *manufactured home*.~~

~~**MANUFACTURED HOME INSTALLATION.** Construction which is required for the installation of a *manufactured home*, including the construction of the foundation system, required structural connections thereto and the installation of on-site water, gas, electrical and sewer systems and connections thereto which are necessary for the normal operation of the *manufactured home*.~~

~~**MANUFACTURED HOME STANDARDS.** The *Manufactured Home Construction and Safety Standards* as promulgated by the HUD.~~

~~**PRIVATELY OWNED (NONRENTAL) LOT.** A parcel of real estate outside of a *manufactured home* rental community (park) where the land and the *manufactured home* to be installed thereon are held in common ownership.~~

~~SECTION AE301~~
~~PERMITS~~

~~AE301.1 Initial installation.~~

~~A *manufactured home* shall not be installed on a foundation system, reinstalled or altered without first obtaining a *permit* from the *building official*. A separate *permit* shall be required for each *manufactured home* installation. When *approved* by the *building official*, such *permit* may include accessory buildings and structures, and their building service *equipment*, when the accessory buildings or structures will be constructed in conjunction with the *manufactured home* installation.~~

~~AE301.2 Additions, alterations and repairs to a manufactured home.~~

~~A *permit* shall be obtained to alter, remodel, repair or add accessory buildings or structures to a *manufactured home* subsequent to its initial installation. *Permit* issuance and fees therefor shall be in conformance to the codes applicable to the type of work involved.~~

~~An *addition* made to a *manufactured home*, as defined in these provisions, shall comply with these provisions.~~

~~AE301.3 Accessory buildings.~~

~~Except as provided in Section AE301.1, *permits* shall be required for all accessory buildings and structures, and their building service *equipment*. *Permit* issuance and fees therefor shall be in conformance to the codes applicable to the types of work involved.~~

~~AE301.4 Exempted work.~~

~~A *permit* shall not be required for the types of work specifically exempted by the applicable codes. Exemption from the *permit* requirements of any of said codes shall not be deemed to~~

~~grant authorization for any work to be done in violation of the provisions of said codes or any other laws or ordinances of this *jurisdiction*.~~

~~SECTION AE302~~
~~APPLICATION FOR PERMIT~~

~~AE302.1 Application.~~
~~To obtain a *manufactured home* installation *permit*, the applicant shall first file an application, in writing, on a form furnished by the *building official* for that purpose. At the option of the *building official*, every such application shall:~~

1. ~~Identify and describe the work to be covered by the *permit* for which application is made.~~
2. ~~Describe the land on which the proposed work is to be done by legal description, street address or similar description that will readily identify and definitely locate the proposed building or work.~~
3. ~~Indicate the use or occupancy for which the proposed work is intended.~~
4. ~~Be accompanied by plans, diagrams, computations and specifications, and other data as required in Section AE302.2.~~
5. ~~Be accompanied by a soil investigation when required by Section AE502.2.~~
6. ~~State the valuation of any new building or structure; or any *addition*, remodeling or *alteration* to an existing building.~~
7. ~~Be signed by the permittee, or permittee's authorized agent, who may be required to submit evidence to indicate such authority.~~
8. ~~Give such other data and information as may be required by the *building official*.~~

~~AE302.2 Plans and specifications.~~
~~Plans, engineering calculations, diagrams and other data as required by the *building official* shall be submitted in not less than two sets with each application for a *permit*. The *building official* may require plans, computations and specifications to be prepared and designed by an engineer or architect licensed by the state to practice as such.~~

~~Where no unusual site conditions exist, the *building official* may accept *approved* standard foundation plans and details in conjunction with the manufacturer's *approved* installation instructions without requiring the submittal of engineering calculations.~~

~~AE302.3 Information on plans and specifications.~~
~~Plans and specifications shall be drawn to scale on substantial paper or cloth, and shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and shown in detail that it will conform to these provisions and all relevant laws, ordinances, rules and regulations. The *building official* shall determine what information is required on plans and specifications to ensure compliance.~~

~~SECTION AE303~~
~~PERMITS ISSUANCE~~

~~AE303.1 Issuance.~~
~~The application, plans and specifications, and other data filed by an applicant for *permit* shall be reviewed by the *building official*. Such plans may be reviewed by other departments of this *jurisdiction* to verify compliance with any applicable laws under their *jurisdiction*. If the *building official* finds that the work described in an application for a *permit*, and the plans, specifications and other data filed therewith, conform to the requirements of these provisions, and other data filed therewith conform to the requirements of these provisions and other pertinent codes, laws and ordinances, and that the fees specified in Section AE304 have been paid, the *building official* shall issue a *permit* therefor to the applicant.~~

~~When the *building official* issues the *permit* where plans are required, the *building official* shall endorse in writing or stamp the plans and specifications *APPROVED*. Such *approved* plans and specifications shall not be changed, modified or altered without authorization from the *building official*, and all work shall be done in accordance with the *approved* plans.~~

~~AE303.2 Retention of plans.~~
~~One set of *approved* plans and specifications shall be returned to the applicant and shall be kept on the site of the building or work at all times during which the work authorized thereby is in progress. One set of *approved* plans, specifications and computations shall be retained by the *building official* until final approval of the work.~~

~~AE303.3 Validity of permit.~~
~~The issuance of a *permit* or approval of plans and specifications shall not be construed to be a *permit* for, or an approval of, any violation of any of these provisions or other pertinent codes of any other ordinance of the *jurisdiction*. No *permit* presuming to give authority to violate or cancel these provisions shall be valid.~~

~~The issuance of a *permit* based on plans, specifications and other data shall not prevent the *building official* from thereafter requiring the correction of errors in said plans, specifications and other data, or from preventing building operations being carried on thereunder when in violation of these provisions or of any other ordinances of this *jurisdiction*.~~

~~AE303.4 Expiration.~~
~~Every *permit* issued by the *building official* under these provisions shall expire by limitation and become null and void if the work authorized by such *permit* is not commenced within 180 days from the date of such *permit*, or if the work authorized by such *permit* is suspended or abandoned at any time after the work is commenced for a period of 180 days. Before such work can be recommenced, a new *permit* shall be first obtained, and the fee therefor shall be one-half the amount required for a new *permit* for such work, provided no changes have been made or will be made in the original plans and specifications for such work, and provided further that such suspension or abandonment has not exceeded 1 year. In order to renew action on a *permit* after expiration, the permittee shall pay a new full *permit* fee.~~

~~Any permittee holding an unexpired *permit* may apply for an extension of the time within which work may commence under that *permit* when the permittee is unable to commence work within the time required by this section for good and satisfactory reasons. The *building official* may extend the time for action by the permittee for a period not exceeding 180 days upon~~

~~written request by the permittee showing that circumstances beyond the control of the permittee have prevented action from being taken. No *permit* shall be extended more than once.~~

~~AE303.5 Suspension or revocation.~~
~~The *building official* may, in writing, suspend or revoke a *permit* issued under these provisions whenever the *permit* is issued in error or on the basis of incorrect information supplied, or in violation of any ordinance or regulation or any of these provisions.~~

~~SECTION AE304~~
~~FEES~~

~~AE304.1 Permit fees.~~
~~The fee for each *manufactured home* installation *permit* shall be established by the *building official*.~~

~~When *permit* fees are to be based on the value or valuation of the work to be performed, the determination of value or valuation under these provisions shall be made by the *building official*. The value to be used shall be the total value of all work required for the *manufactured home* installation plus the total value of all work required for the construction of accessory buildings and structures for which the *permit* is issued, as well as all finish work, painting, roofing, electrical, plumbing, heating, air conditioning, elevators, fire-extinguishing systems and any other permanent *equipment* which is a part of the accessory building or structure. The value of the *manufactured home* itself shall not be included.~~

~~AE304.2 Plan review fees.~~
~~When a plan or other data are required to be submitted by Section AE302.2, a plan review fee shall be paid at the time of submitting plans and specifications for review. Said plan review fee shall be as established by the *building official*. Where plans are incomplete or changed so as to require additional plan review, an additional plan review fee shall be charged at a rate as established by the *building official*.~~

~~AE304.3 Other provisions.~~

~~AE304.3.1 Expiration of plan review.~~
~~Applications for which no *permit* is issued within 180 days following the date of application shall expire by limitation, and plans and other data submitted for review may thereafter be returned to the applicant or destroyed by the *building official*. The *building official* may extend the time for action by the applicant for a period not exceeding 180 days upon request by the applicant showing that circumstances beyond the control of the applicant have prevented action from being taken. No application shall be extended more than once. In order to renew action on an application after expiration, the applicant shall resubmit plans and pay a new plan review fee.~~

~~AE304.3.2 Investigation fees—work without a permit.~~

~~AE304.3.2.1 Investigation.~~
~~Whenever any work for which a *permit* is required by these provisions has been commenced without first obtaining said *permit*, a special investigation shall be made before a *permit* may be issued for such work.~~

~~AE304.3.2.2 Fee.~~
~~An investigation fee, in addition to the *permit* fee, shall be collected whether or not a *permit* is then or subsequently issued. The investigation fee shall be equal to the amount of the *permit* fee required. The minimum investigation fee shall be the same as the minimum fee established by the *building official*. The payment of such investigation fee shall not exempt any person from compliance with all other provisions of either these provisions or other pertinent codes or from any penalty prescribed by law.~~

~~AE304.3.3 Fee refunds.~~

~~AE304.3.3.1 Permit fee erroneously paid or collected.~~
~~The *building official* may authorize the refunding of any fee paid hereunder which was erroneously paid or collected.~~

~~AE304.3.3.2 Permit fee paid when no work done.~~
~~The *building official* may authorize the refunding of not more than 80 percent of the *permit* fee paid when no work has been done under a *permit* issued in accordance with these provisions.~~

~~AE304.3.3.3 Plan review fee.~~
~~The *building official* may authorize the refunding of not more than 80 percent of the plan review fee paid when an application for a *permit* for which a plan review fee has been paid is withdrawn or canceled before any plan reviewing is done.~~

~~The *building official* shall not authorize the refunding of any fee paid, except upon written application by the original permittee not later than 180 days after the date of the fee payment.~~

~~SECTION AE305~~
~~INSPECTIONS~~

~~AE305.1 General.~~
~~All construction or work for which a *manufactured home* installation *permit* is required shall be subject to inspection by the *building official*, and certain types of construction shall have continuous inspection by special inspectors as specified in Section AE306. A survey of the *lot* may be required by the *building official* to verify that the structure is located in accordance with the *approved* plans.~~

~~It shall be the duty of the *permit* applicant to cause the work to be accessible and exposed for inspection purposes. Neither the *building official* nor this *jurisdiction* shall be liable for expense entailed in the removal or replacement of any material required to allow inspection.~~

~~AE305.2 Inspection requests.~~
~~It shall be the duty of the person doing the work authorized by a *manufactured home* installation *permit* to notify the *building official* that such work is ready for inspection. The *building official* may require that every request for inspection be filed at least one working day before such inspection is desired. Such request may be in writing or by telephone at the option of the *building official*.~~

~~It shall be the duty of the person requesting any inspections required, either by these provisions or other applicable codes, to provide access to and means for proper inspection of such work.~~

~~AE305.3 Inspection record card.~~
~~Work requiring a *manufactured home* installation *permit* shall not be commenced until the *permit* holder or the *permit* holder's agent shall have posted an inspection record card in a conspicuous place on the premises and in such position as to allow the *building official* conveniently to make the required entries thereon regarding inspection of the work. This card shall be maintained in such position by the *permit* holder until final approval has been issued by the *building official*.~~

~~AE305.4 Approval required.~~
~~Work shall not be done on any part of the *manufactured home* installation beyond the point indicated in each successive inspection without first obtaining the approval of the *building official*. Such approval shall be given only after an inspection has been made of each successive step in the construction as indicated by each of the inspections required in Section AE305.5. There shall be a final inspection and approval of the *manufactured home* installation, including connections to its building service *equipment*, when completed and ready for occupancy or use.~~

~~AE305.5 Required inspections.~~

~~AE305.5.1 Structural inspections for the manufactured home installation.~~
~~Reinforcing steel or structural framework of any part of any *manufactured home* foundation system shall not be covered or concealed without first obtaining the approval of the *building official*. The *building official*, upon notification from the *permit* holder or the *permit* holder's agent, shall make the following inspections and shall either approve that portion of the construction as completed or shall notify the *permit* holder or the *permit* holder's agent wherein the same fails to comply with these provisions or other applicable codes:~~

1. ~~Foundation inspection: To be made after excavations for footings are completed and any required reinforcing steel is in place. For concrete foundations, any required forms shall be in place prior to inspection. All materials for the foundation shall be on the job, except where concrete from a central mixing plant (commonly termed "transit mixed") is to be used, the concrete materials need not be on the job. Where the foundation is to be constructed of *approved* treated wood, additional framing inspections as required by the *building official* may be required.~~

2. ~~Concrete slab or under-floor inspection: To be made after all in-slab or under-floor building service *equipment*, conduit, piping accessories and other ancillary *equipment* items are in place but before any concrete is poured or the *manufactured home* is installed.~~

3. ~~Anchorage inspection: To be made after the *manufactured home* has been installed and permanently anchored.~~

~~AE305.5.2 Structural inspections for accessory building and structures.~~
~~Inspections for accessory buildings and structures shall be made as set forth in this code.~~

~~AE305.5.3 Building service equipment inspections.~~
~~All building service *equipment* which is required as a part of a *manufactured home* installation, including accessory buildings and structures authorized by the same *permit*, shall be inspected by the *building official*. Building service *equipment* shall be inspected and tested as required by the applicable codes. Such inspections and testing shall be limited to site construction and shall not include building service *equipment* which is a part of the *manufactured home* itself. No portion of any building service *equipment* intended to be concealed by any permanent portion of the construction shall be concealed until inspected and *approved*. Building service *equipment* shall not be connected to a water, fuel or power supply, or sewer system, until authorized by the *building official*.~~

~~AE305.5.4 Final inspection.~~
~~When finish grading and the *manufactured home* installation, including the installation of all required building service *equipment*, is completed and the *manufactured home* is ready for occupancy, a final inspection shall be made.~~

~~AE305.6 Other inspections.~~
~~In addition to the called inspections specified in Section AE305.5.4, the *building official* may make or require other inspections of any construction work to ascertain compliance with these provisions or other codes and laws which are enforced by the code enforcement agency.~~

~~SECTION AE306~~
~~SPECIAL INSPECTIONS~~

~~AE306.1 General.~~
~~In addition to the inspections required by Section AE305, the *building official* may require the owner to employ a special inspector during construction of specific types of work as described in this code.~~

~~SECTION AE307~~
~~UTILITY SERVICE~~

~~AE307.1 General.~~
~~Utility service shall not be provided to any building service *equipment* which is regulated by these provisions or other applicable codes, and for which a *manufactured home* installation *permit* is required by these provisions, until *approved* by the *building official*.~~

~~SECTION AE401~~
~~OCCUPANCY CLASSIFICATION~~

~~AE401.1 Manufactured homes.~~
~~A *manufactured home* shall be limited in use to a single *dwelling unit*.~~

~~AE401.2 Accessory buildings.~~
~~Accessory buildings shall be classified as to occupancy by the *building official* as set forth in this code.~~

~~SECTION AE402~~
~~LOCATION ON PROPERTY~~

~~AE402.1 General.~~
~~*Manufactured homes* and accessory buildings shall be located on the property in accordance with applicable codes and ordinances of this *jurisdiction*.~~

~~SECTION AE501~~

~~DESIGN~~

~~AE501.1 General.~~
~~A *manufactured home* shall be installed on a foundation system which is designed and constructed to sustain within the stress limitations specified in this code and all loads specified in this code.~~

> **~~Exception:~~** ~~When specifically authorized by the *building official*, foundation and anchorage systems which are constructed in accordance with the methods specified in Section AE600 of these provisions, or in the HUD, *Permanent Foundations for Manufactured Housing,* 1984 Edition, Draft, shall be deemed to meet the requirements of this appendix.~~

~~AE501.2 Manufacturer's installation instructions.~~
~~The installation instructions as provided by the manufacturer of the *manufactured home* shall be used to determine permissible points of support for vertical loads and points of attachment for anchorage systems used to resist horizontal and uplift forces.~~

~~AE501.3 Rationality.~~
~~Any system or method of construction to be used shall submit to a rational analysis in accordance with well-established principles of mechanics.~~

~~SECTION AE502~~
~~FOUNDATION SYSTEMS~~

~~AE502.1 General.~~
~~Foundation systems designed and constructed in accordance with this section may be considered a permanent installation.~~

~~AE502.2 Soil classification.~~
~~The classification of the soil at each *manufactured home* site shall be determined when required by the *building official*. The *building official* may require that the determination be made by an engineer or architect licensed by the state to conduct soil investigations.~~

~~The classification shall be based on observation and any necessary tests of the materials disclosed by borings or excavations made in appropriate locations. Additional studies may be necessary to evaluate soil strength, the effect of moisture variation on soil-bearing capacity, compressibility and expansiveness.~~

~~When required by the *building official*, the soil classification design-bearing capacity and lateral pressure shall be shown on the plans.~~

~~AE502.3 Footings and foundations.~~

~~Footings and foundations, unless otherwise specifically provided, shall be constructed of materials specified by this code for the intended use and in all cases shall extend below the frost line. Footings of concrete and masonry shall be of solid material. Foundations supporting untreated wood shall extend at least 8 inches (203 mm) above the adjacent finish *grade*. Footings shall have a minimum depth below finished *grade* of 12 inches (305 mm) unless a greater depth is recommended by a foundation investigation.~~

~~Piers and bearing walls shall be supported on masonry or concrete foundations or piles, or other *approved* foundation systems which shall be of sufficient capacity to support all loads.~~

~~AE502.4 Foundation design.~~

~~When a design is provided, the foundation system shall be designed in accordance with the applicable structural provisions of this code and shall be designed to minimize differential settlement. Where a design is not provided, the minimum foundation requirements shall be as set forth in this code.~~

~~AE502.5 Drainage.~~

~~Provisions shall be made for the control and drainage of surface water away from the *manufactured home*.~~

~~AE502.6 Under-floor clearances—ventilation and access.~~

~~A minimum clearance of 12 inches (305 mm) shall be maintained beneath the lowest member of the floor support framing system. Clearances from the bottom of wood floor joists or perimeter joists shall be as specified in this code.~~

~~Under-floor spaces shall be ventilated with openings as specified in this code. If combustion air for one or more heat-producing *appliance* is taken from within the under-floor spaces, ventilation shall be adequate for proper *appliance* operation.~~

~~Under-floor access openings shall be provided. Such openings shall be not less than 18 inches (457 mm) in any dimension and not less than 3 square feet (0.279 m^2) in area, and shall be located so that any water supply and sewer drain connections located under the *manufactured home* are accessible.~~

~~SECTION AE503~~

~~SKIRTING AND PERIMETER ENCLOSURES~~

~~AE503.1 Skirting and permanent perimeter enclosures.~~

~~Skirting and permanent perimeter enclosures shall be installed only where specifically required by other laws or ordinances. Skirting, when installed, shall be of material suitable for exterior exposure and contact with the ground. Permanent perimeter enclosures shall be constructed of materials as required by this code for regular foundation construction.~~

~~Skirting shall be installed in accordance with the skirting manufacturer's installation instructions. Skirting shall be adequately secured to ensure stability, minimize vibration and susceptibility to wind damage, and compensate for possible frost heave.~~

~~AE503.2 Retaining walls.~~
~~Where retaining walls are used as a permanent perimeter enclosure, they shall resist the lateral displacements of soil or other materials and shall conform to this code as specified for foundation walls. Retaining walls and foundation walls shall be constructed of *approved* treated wood, concrete, masonry or other *approved* materials or combination of materials as for foundations as specified in this code. Siding materials shall extend below the top of the exterior of the retaining or foundation wall, or the joint between the siding and enclosure wall shall be flashed in accordance with this code.~~

~~SECTION AE504~~
~~STRUCTURAL ADDITIONS~~

~~AE504.1 General.~~
~~Accessory buildings shall not be structurally supported by or attached to a *manufactured home* unless engineering calculations are submitted to substantiate any proposed structural connection.~~

> ~~**Exception:** The *building official* may waive the submission of engineering calculations if it is found that the nature of the work applied for is such that engineering calculations are not necessary to show conformance to these provisions.~~

~~SECTION AE505~~
~~BUILDING SERVICE EQUIPMENT~~

~~AE505.1 General.~~
~~The installation, *alteration*, repair, replacement, *addition* to or maintenance of the building service *equipment* within the *manufactured home* shall conform to regulations set forth in the *Manufactured Home* Standards. Such work which is located outside the *manufactured home* shall comply with the applicable codes adopted by this *jurisdiction*.~~

~~SECTION AE506~~
~~EXITS~~

~~AE506.1 Site development.~~
~~Exterior stairways and ramps which provide egress to the public way shall comply with the applicable provisions of this code.~~

~~AE506.2 Accessory buildings.~~
~~Every accessory building or portion thereof shall be provided with exits as required by this code.~~

~~SECTION AE507~~
~~OCCUPANCY, FIRE SAFETY AND ENERGY CONSERVATION STANDARDS~~

~~AE507.1 General.~~
~~*Alterations* made to a *manufactured home* subsequent to its initial installation shall conform to the occupancy, fire safety and energy conservation requirements set forth in the *Manufactured Home* Standards.~~

~~SECTION AE600~~
~~SPECIAL REQUIREMENTS FOR FOUNDATION SYSTEMS~~

~~AE600.1 General.~~
~~This section is applicable only where specifically authorized by the *building official*.~~

~~SECTION AE601~~
~~FOOTINGS AND FOUNDATIONS~~

~~AE601.1 General.~~
~~The capacity of individual load-bearing piers and their footings shall be sufficient to sustain all loads specified in this code within the stress limitations specified in this code. Footings, unless otherwise *approved* by the *building official*, shall be placed level on firm, undisturbed soil or an engineered fill which is free of organic material, such as weeds and grasses. Where used, an engineered fill shall provide a minimum load-bearing capacity of not less than 1,000 pounds per square foot (48 kN/m^2). Continuous footings shall conform to the requirements of this code. Section AE502 of these provisions shall apply to footings and foundations constructed under the provisions of this section.~~

~~SECTION AE602~~
~~PIER CONSTRUCTION~~

~~AE602.1 General.~~
~~Piers shall be designed and constructed to distribute loads evenly. Multiple-section homes may have concentrated roof loads which will require special consideration. Load-bearing piers may be constructed utilizing one of the following methods listed. Such piers shall be considered to resist only vertical forces acting in a downward direction. They shall not be considered as providing any resistance to horizontal loads induced by wind or earthquake forces.~~

1. ~~A prefabricated load-bearing device that is listed and *labeled* for the intended use.~~

2. ~~Mortar shall comply with ASTM C 270, Type M, S or N; this may consist of one part Portland cement, one-half part hydrated lime and four parts sand by volume.Lime shall not be used with plastic or waterproof cement.~~

3. ~~A cast-in-place concrete pier with concrete having specified compressive strength at 28 days of 2,500 pounds per square inch (17 225 kPa).~~

~~Alternative materials and methods of construction may be used for piers which have been designed by an engineer or architect licensed by the state to practice as such.~~

~~Caps and leveling spacers may be used for leveling of the *manufactured home*. Spacing of piers shall be as specified in the manufacturer's installation instructions, if available, or by an *approved* designer.~~

~~SECTION AE603~~
~~HEIGHT OF PIERS~~

~~AE603.1 General.~~

~~Piers constructed as indicated in Section AE602 may have heights as follows:~~

1. ~~Except for corner piers, piers 36 inches (914 mm) or less in height may be constructed of masonry units, placed with cores or cells vertically. Piers shall be installed with their long dimension at right angles to the main frame member they support and shall have a minimum cross-sectional area of 128 square inches (82 560 mm^2). Piers shall be capped with minimum 4-inch (102 mm) *solid masonry* units or equivalent.~~

2. ~~Piers between 36 and 80 inches (914 and 2032 mm) in height and all corner piers greater than 24 inches (610 mm) in height shall be at least 16 inches by 16 inches (406 mm by 406 mm) consisting of interlocking masonry units and shall be fully capped with minimum 4-inch (102 mm) *solid masonry* units or equivalent.~~

3. ~~Piers greater than 80 inches (2032 mm) in height may be constructed in accordance with the provisions of Item 2, provided the piers shall be filled solid with grout and reinforced with four continuous No. 5 bars. One bar shall be placed in each corner cell of hollow masonry unit piers or in each corner of the grouted space of piers constructed of *solid masonry* units.~~

4. ~~Cast-in-place concrete piers meeting the same size and height limitations of Items 1, 2 and 3 may be substituted for piers constructed of masonry units.~~

~~SECTION AE604~~
~~ANCHORAGE INSTALLATIONS~~

~~AE604.1 Ground anchors.~~

~~Ground anchors shall be designed and installed to transfer the anchoring loads to the ground. The load-carrying portion of the ground anchors shall be installed to the full depth called for by the manufacturer's installation instructions and shall extend below the established frost line into undisturbed soil.~~

~~Manufactured ground anchors shall be listed and installed in accordance with the terms of their listing and the anchor manufacturer's instructions, and shall include the means of attachment of ties meeting the requirements of Section AE605. Ground anchor manufacturer's installation instructions shall include the amount of preload required and load capacity in various types of soil. These instructions shall include tensioning adjustments which may be needed to prevent damage to the *manufactured home*, particularly damage that can be caused by frost heave. Each ground anchor shall be marked with the manufacturer's identification and listed model identification number which shall be visible after installation. Instructions shall accompany each listed ground anchor specifying the types of soil for which the anchor is suitable under the requirements of this section.~~

~~Each *approved* ground anchor, when installed, shall be capable of resisting an allowable working load at least equal to 3,150 pounds (14 kN) in the direction of the tie plus a 50-percent overload [4,725 pounds (21 kN) total] without failure. Failure shall be considered to have occurred when the anchor moves more than 2 inches (51 mm) at a load of 4,725 pounds (21 kN) in the direction of the tie installation. Those ground anchors which are designed to be~~

~~installed so that loads on the anchor are other than direct withdrawal shall be designed and installed to resist an applied design load of 3,150 pounds (14 kN) at 40 to 50 degrees from vertical or within the angle limitations specified by the home manufacturer without displacing the tie end of the anchor more than 4 inches (102 mm) horizontally. Anchors designed for the connection of multiple ties shall be capable of resisting the combined working load and overload consistent with the intent expressed herein.~~

~~When it is proposed to use ground anchors and the *building official* has reason to believe that the soil characteristics at a given site are such as to render the use of ground anchors advisable, or when there is doubt regarding the ability of the ground anchors to obtain their listed capacity, the *building official* may require that a representative field installation be made at the site in question and tested to demonstrate ground-anchor capacity. The *building official* shall approve the test procedures.~~

~~AE604.2 Anchoring equipment.~~

~~Anchoring *equipment*, when installed as a permanent installation, shall be capable of resisting all loads as specified within these provisions. When the stabilizing system is designed by an engineer or architect licensed by the state to practice as such, alternative designs may be used, providing the anchoring *equipment* to be used is capable of withstanding a load equal to 1.5 times the calculated load. All anchoring *equipment* shall be listed and *labeled* as being capable of meeting the requirements of these provisions. Anchors as specified in this code may be attached to the main frame of the *manufactured home* by an *approved* $^{3}/_{16}$-inch-thick (4.76 mm) slotted steel plate anchoring device. Other anchoring devices or methods meeting the requirements of these provisions may be permitted when *approved* by the *building official*.~~

~~Anchoring systems shall be so installed as to be permanent. Anchoring *equipment* shall be so designed to prevent self-disconnection with no hook ends used.~~

~~AE604.3 Resistance to weather deterioration.~~

~~All anchoring *equipment*, tension devices and ties shall have a resistance to deterioration as required by this code.~~

~~AE604.4 Tensioning devices.~~

~~Tensioning devices, such as turnbuckles or yoke-type fasteners, shall be ended with clevis or welded eyes.~~

~~SECTION AE605~~

~~TIES, MATERIALS AND INSTALLATION~~

~~AE605.1 General.~~

~~Steel strapping, cable, chain or other *approved* materials shall be used for ties. All ties shall be fastened to ground anchors and drawn tight with turnbuckles or other adjustable tensioning devices or devices supplied with the ground anchor. Tie materials shall be capable of resisting an allowable working load of 3,150 pounds (14 kN) with no more than 2-percent elongation and shall withstand a 50-percent overload [4,750 pounds (21 kN)]. Ties shall comply with the weathering requirements of Section AE604.3. Ties shall connect the ground anchor and the main structural frame. Ties shall not connect to steel outrigger beams which fasten to and intersect the main structural frame unless specifically stated in the manufacturer's installation~~

~~instructions. Connection of cable ties to main frame members shall be $^{5}/_{8}$-inch (15.9 mm) closed-eye bolts affixed to the frame member in an *approved* manner. Cable ends shall be secured with at least two U-bolt cable clamps with the "U" portion of the clamp installed on the short (dead) end of the cable to ensure strength equal to that required by this section.~~

~~Wood floor support systems shall be fixed to perimeter foundation walls in accordance with provisions of this code. The minimum number of ties required per side shall be sufficient to resist the wind load stated in this code. Ties shall be as evenly spaced as practicable along the length of the *manufactured home* with the distance from each end of the home and the tie nearest that end not exceeding 8 feet (2438 mm). When continuous straps are provided as vertical ties, such ties shall be positioned at rafters and studs. Where a vertical tie and diagonal tie are located at the same place, both ties may be connected to a single anchor, provided the anchor used is capable of carrying both loads. Multiple-section *manufactured homes* require diagonal ties only. Diagonal ties shall be installed on the exterior main frame and slope to the exterior at an angle of 40 to 50 degrees from the vertical or within the angle limitations specified by the home manufacturer. Vertical ties which are not continuous over the top of the *manufactured home* shall be attached to the main frame.~~

~~SECTION AE606~~
~~REFERENCED STANDARDS~~

~~ASTM C 270—04~~	~~Specification for Mortar for Unit Masonry~~	~~AE602~~
~~NFPA 501—03~~	~~Standard on Manufactured Housing~~	~~AE201~~

APPENDIX E-1 Energy Efficiency Certificate (Section N1101.14)

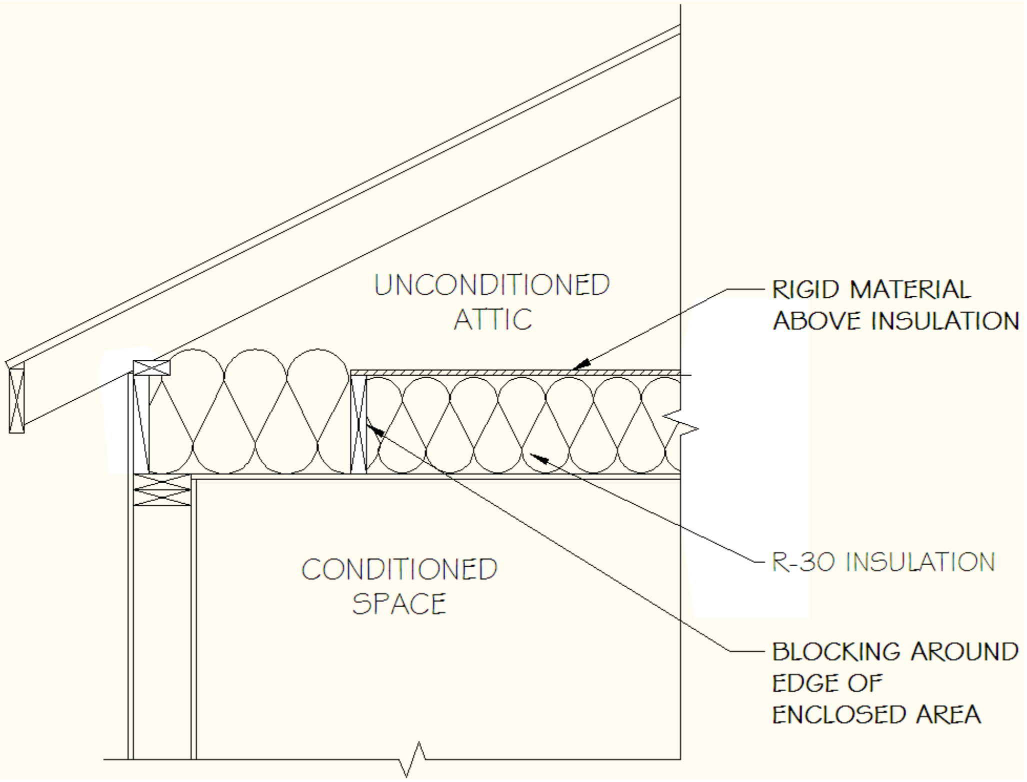
ENERGY EFFICIENCY CERTIFICATE **N1101.14**	
Builder, Permit Holder or Registered Design Professional **Print Name:** **Signature:**	
Property Address:	
Date:	
Insulation Rating - List the value covering largest area to all that apply	**R-Value**
Ceiling/roof:	**R-**
Wall:	**R-**
Floor:	**R-**
Closed Crawl Space Wall:	**R-**
Closed Crawl Space Floor:	**R-**
Slab:	**R-**
Basement Wall:	**R-**
Fenestration:	
U-Factor	
Solar Heat Gain Coefficient(SHGC)	
Building Air Leakage	

☐☐Visually inspected according to N1102.4.2.1 OR	
☐☐Building Air Leakage Test Results (Sec. N1102.4.2.2) ACH50 [Target: 5.0] or CFM50/SFSA [Target: 0.30]	
Name of Tester / Company: Date: Phone:	
Ducts:	
Insulation	R-
Total Duct Leakage Test Result (Sect. N1103.3.3) Circle one: Total duct leakage test (CFM25 Total/100SF) [Target: 5] Or Duct leakage to the outside test (CFM25 Total/100SF) [Target: 4]	
Name of Tester or Company: Date: Phone:	
Certificate to be displayed permanently	

APPENDIX E-2
INSULATION AND AIR SEALING DETAILS

APPENDIX E-2.1

N1102.2.1 Ceilings with attic spaces: Exception for fully enclosed attic floor systems

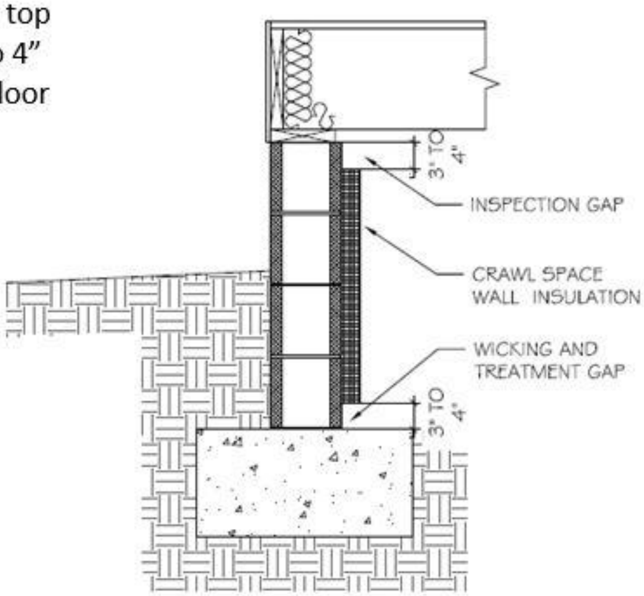


SECTION VIEW OF CEILING WITH ATTIC SPACE

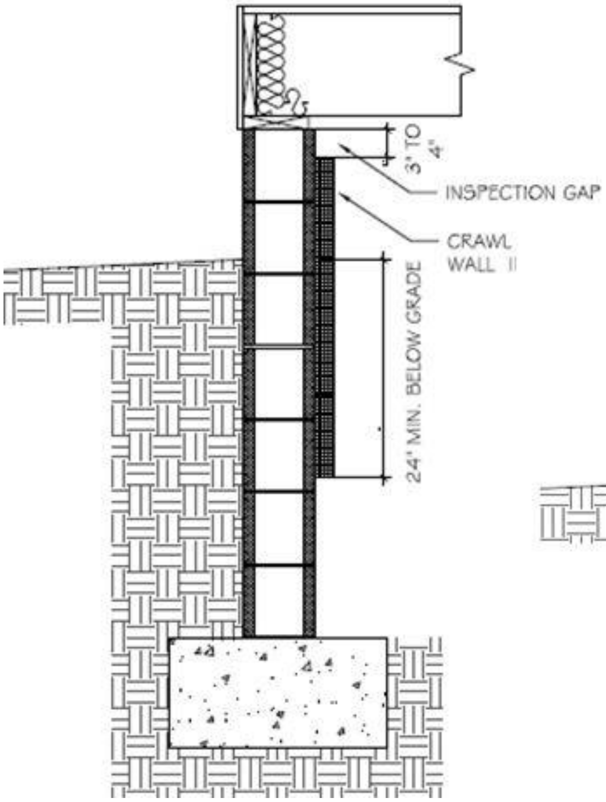
APPENDIX E-2.2

N1102.2.11 Closed crawl space walls. Insulation illustrations

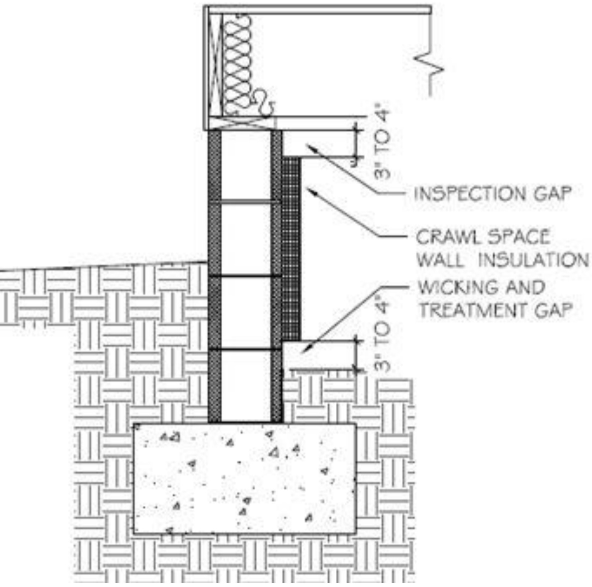
Foam or porous insulation has 3" to 4" top inspection gap and extends down 3" to 4" above top of wall footing or concrete floor



Foam or porous insulation has 3" to 4" top inspection gap and extends down 24" below grade

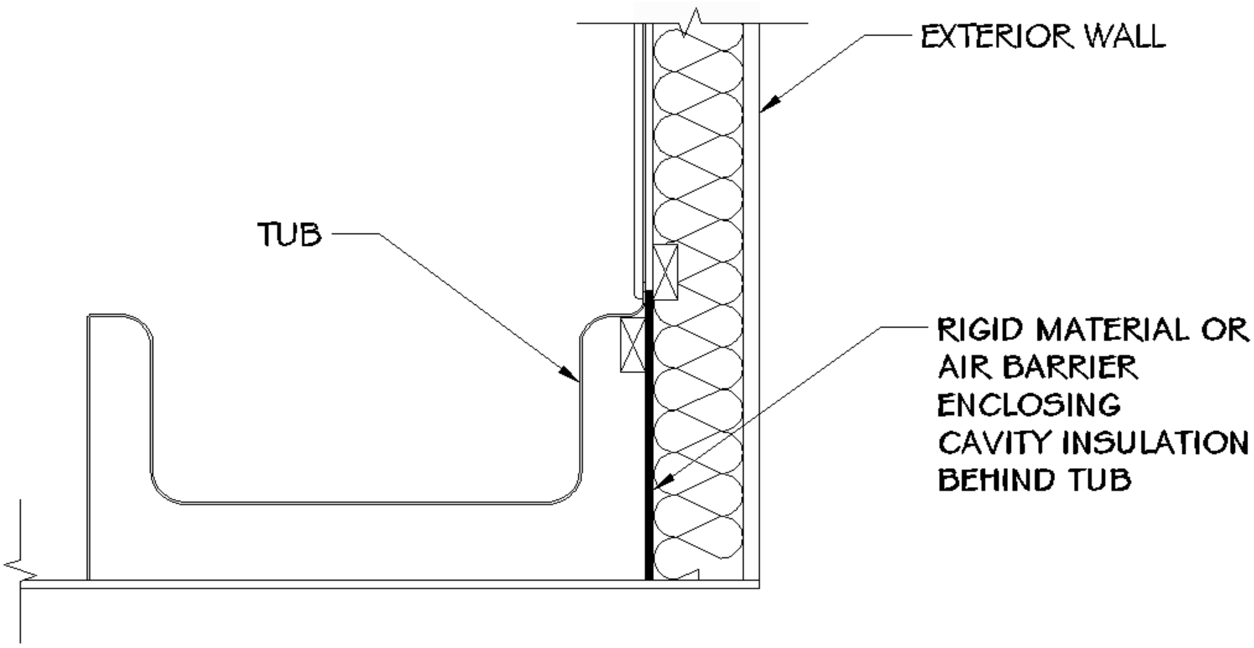


Foam or porous insulation has 3" to 4" top inspection gap and extends down 3" to 4" above interior ground surface



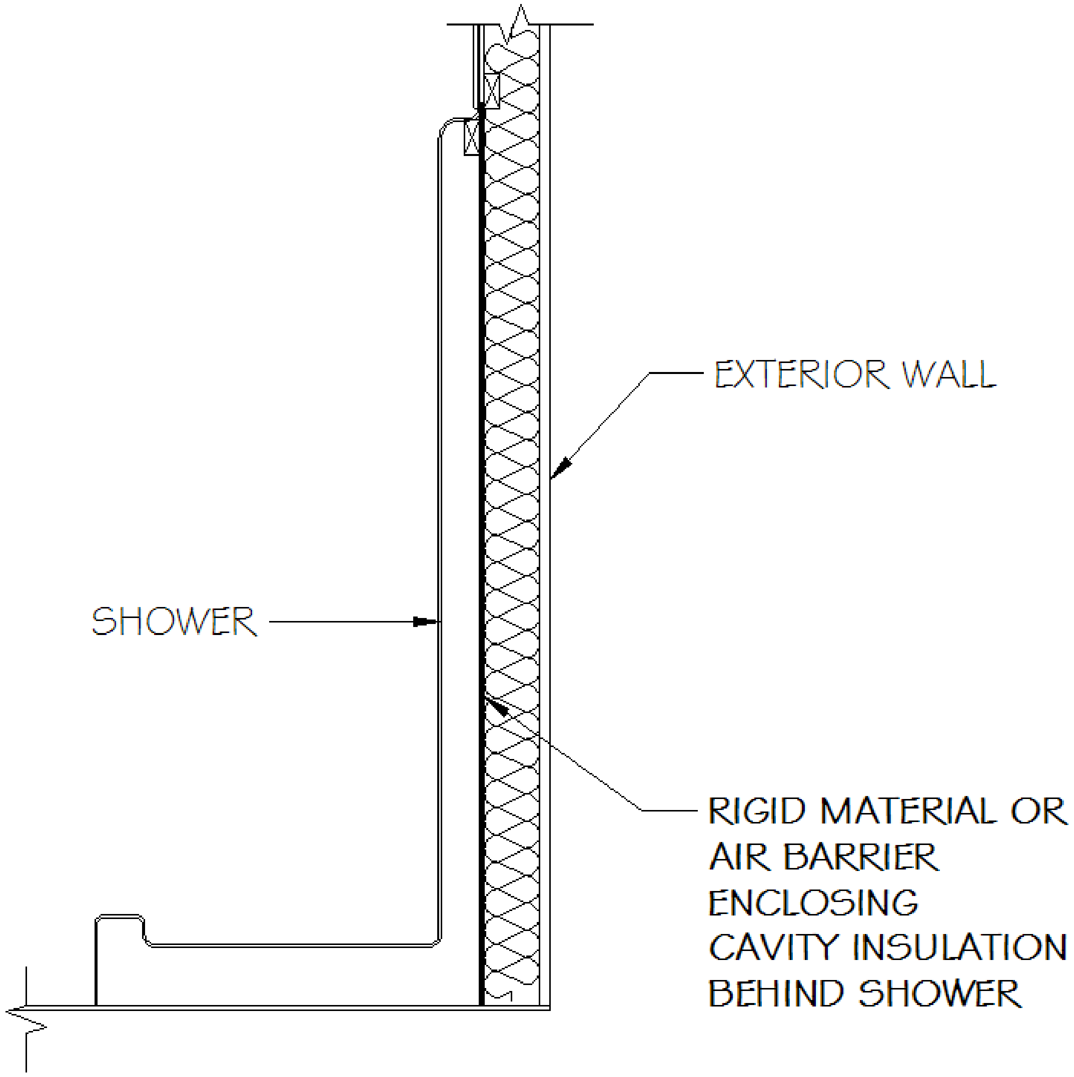
APPENDIX E-2.3

N1102.2.14 Framed cavity walls. Insulation enclosure – 1. Tubs



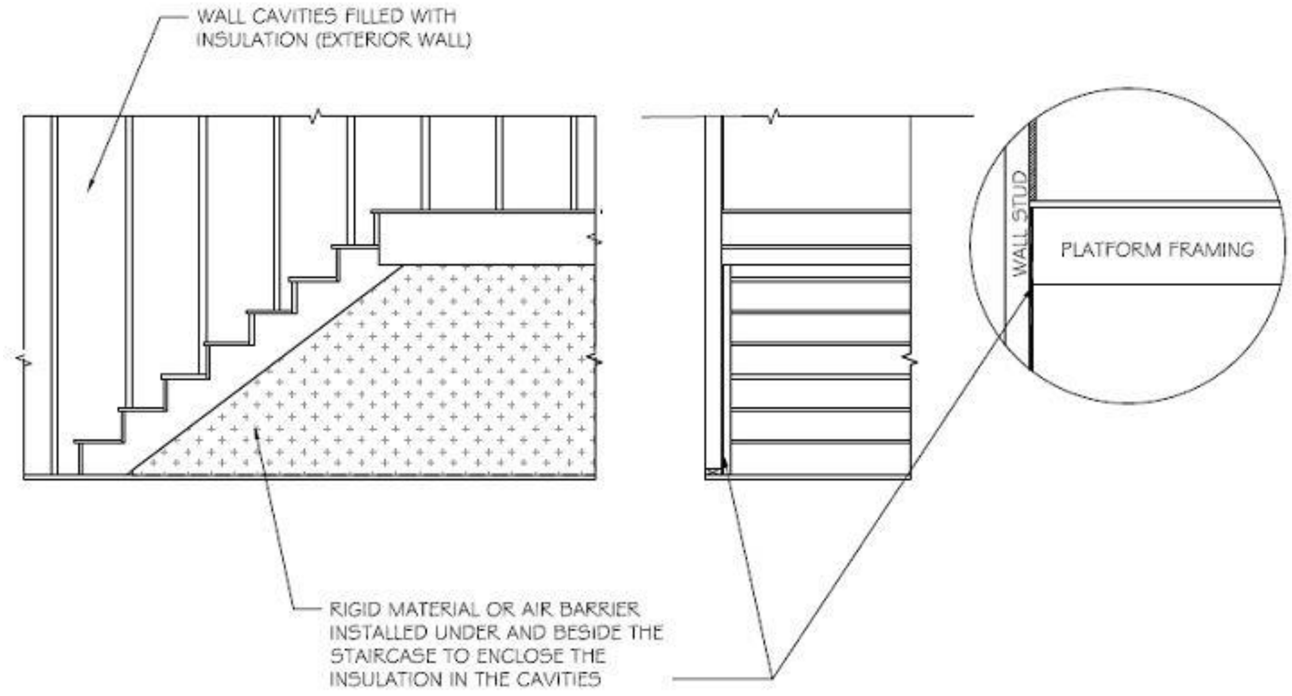
SECTION VIEW OF BATH TUB ON EXTERIOR WALL

N1102.2.14 Framed cavity walls. Insulation enclosure – 2. Showers



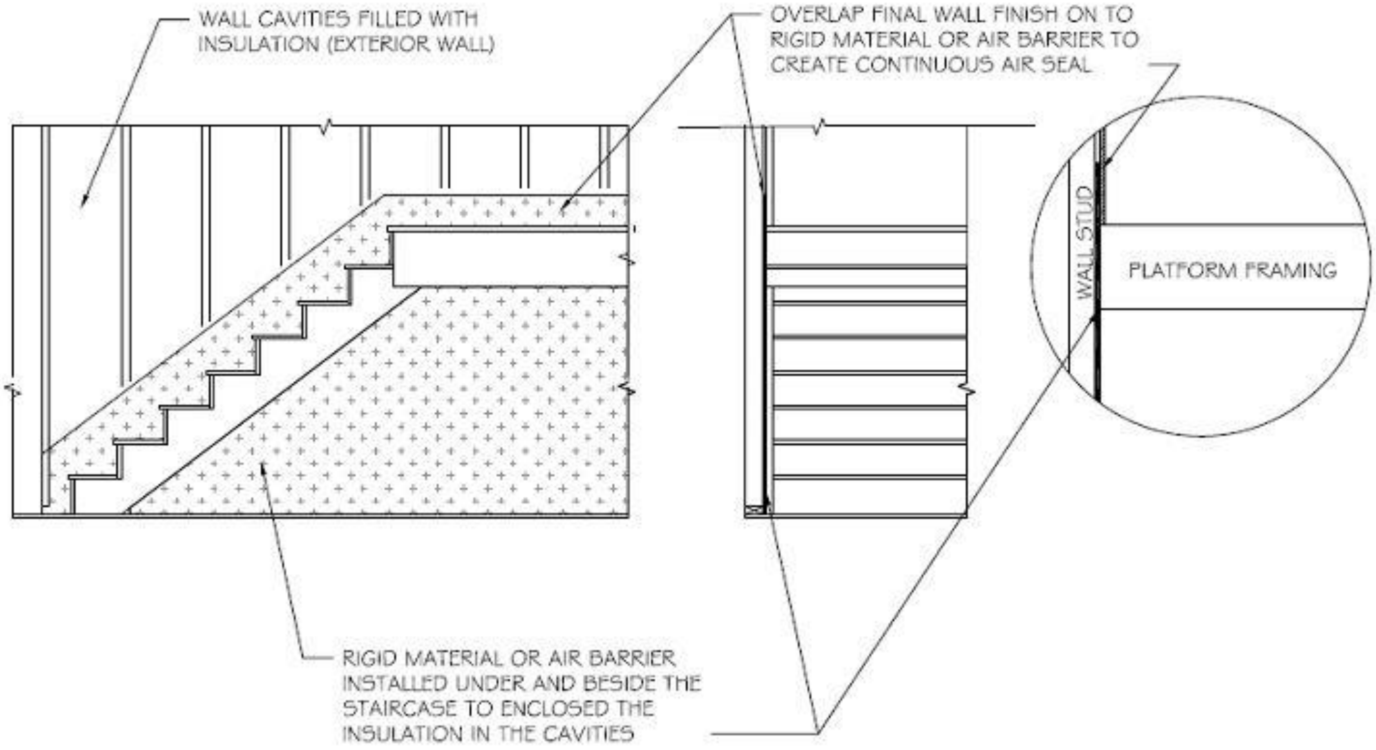
SECTION VIEW OF SHOWER ON EXTERIOR WALL

N1102.2.14 Framed cavity walls. Insulation enclosure – 3. Stairs



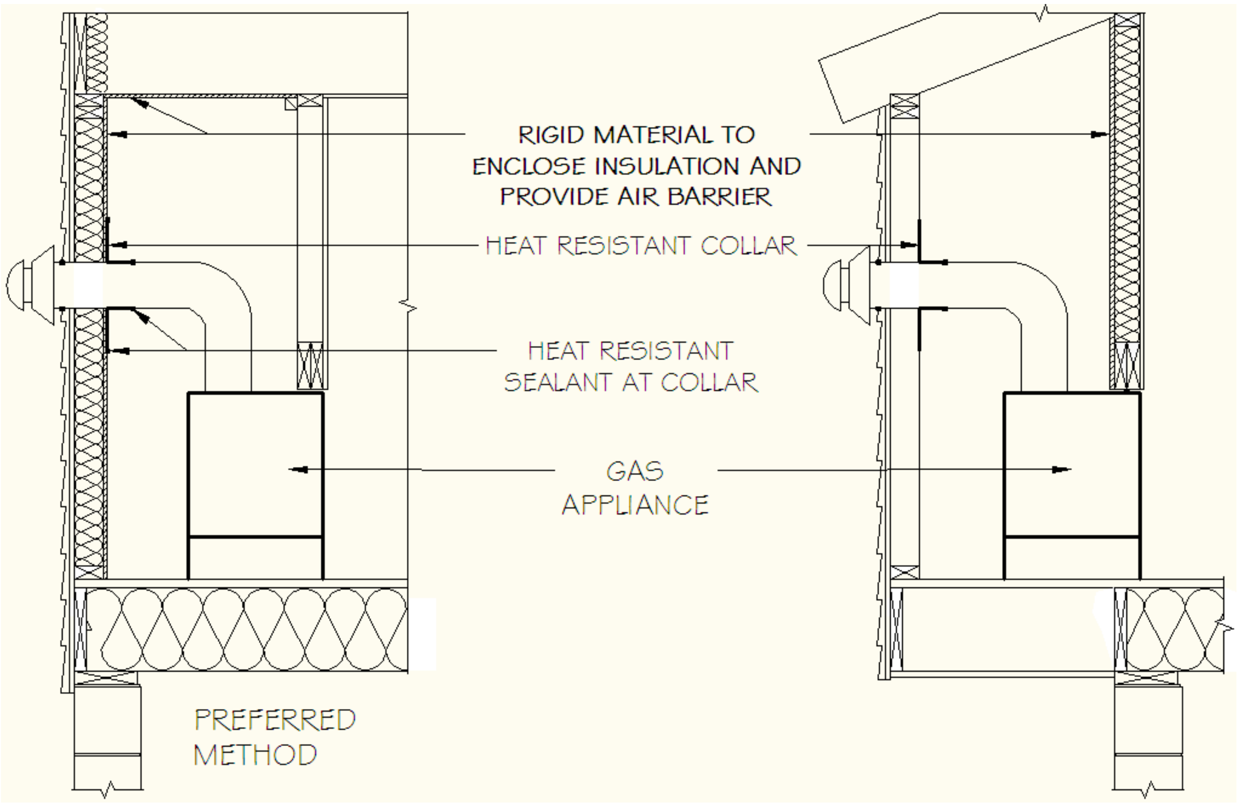
SECTION VIEW OF INTERIOR STAIRCASE ON EXTERIOR WALL (OPTION 1)

N1102.2.14 Framed cavity walls. Insulation enclosure – 3. Stairs



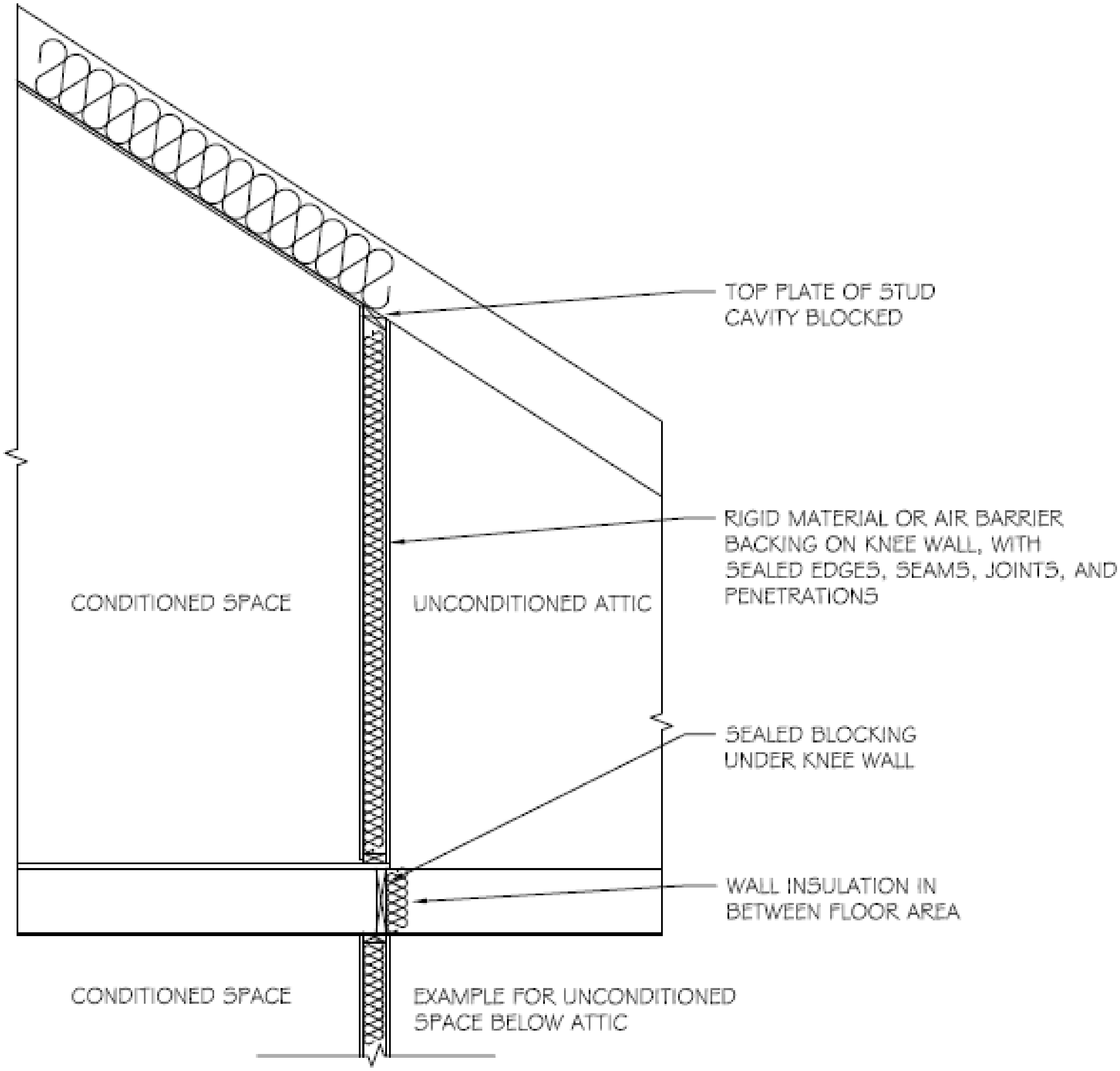
SECTION VIEW OF INTERIOR STAIRCASE ON EXTERIOR WALL (OPTION 2)

N1102.2.14 Framed cavity wall. Insulation enclosure – 4. Direct vent gas fireplace



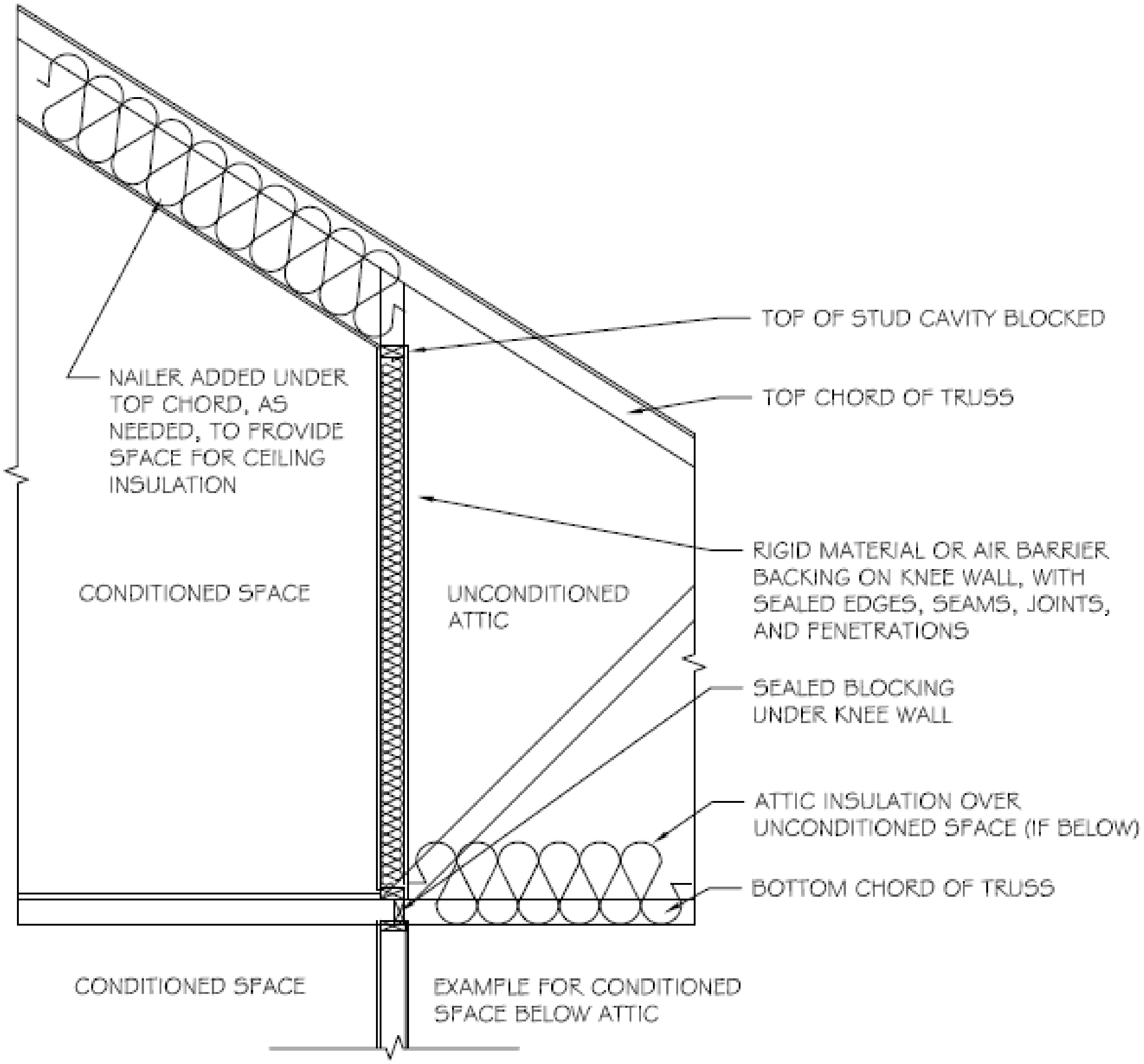
SECTION VIEW OF DIRECT VENT GAS FIREPLACE

N1102.2.15 Framed cavity walls. Insulation enclosure – 5. Walls that adjoin attic spaces



SECTION VIEW OF WALL ADJOINING ATTIC SPACE WITH STICK FRAMED ROOF

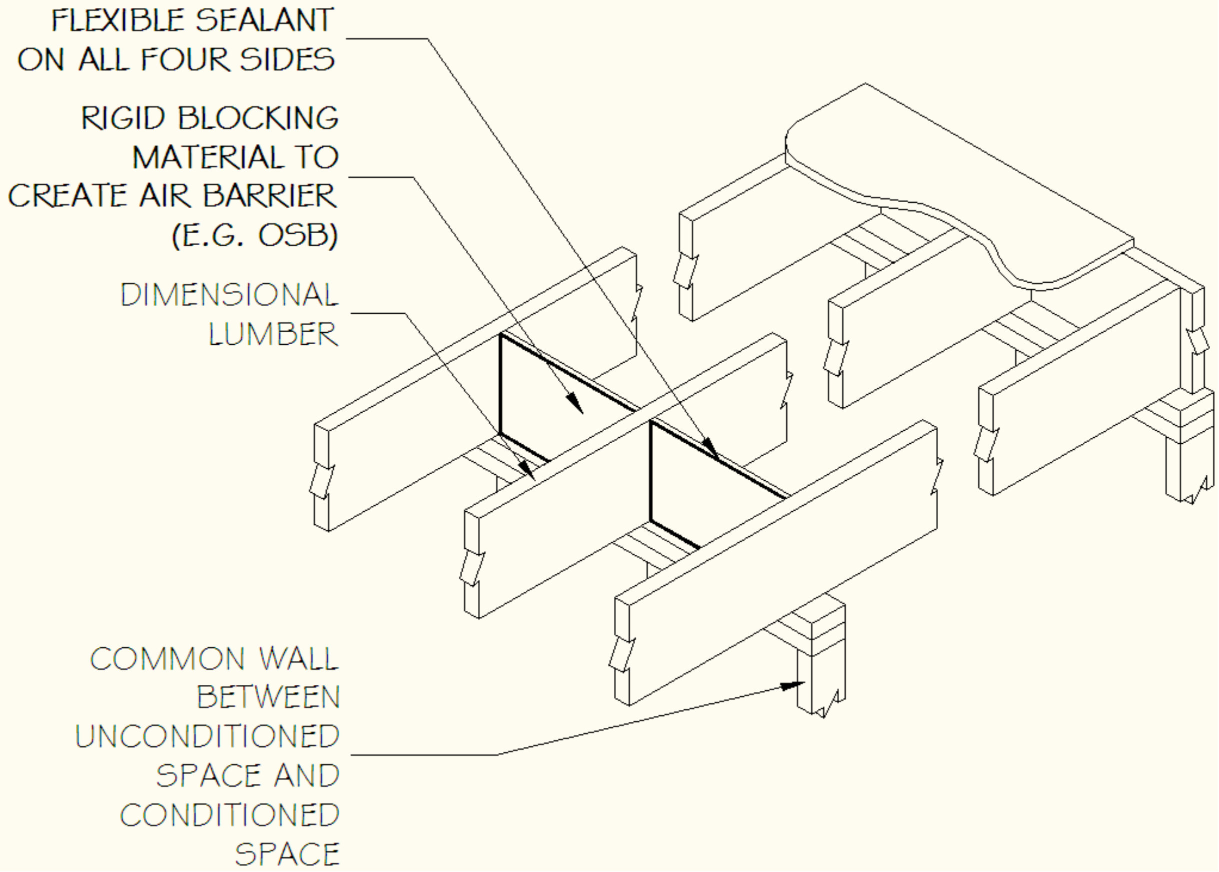
N1102.2.15 Framed cavity walls. Insulation enclosure – 5. Walls that adjoin attic spaces



SECTION VIEW OF WALL ADJOINING ATTIC SPACE WITH TRUSS ROOF

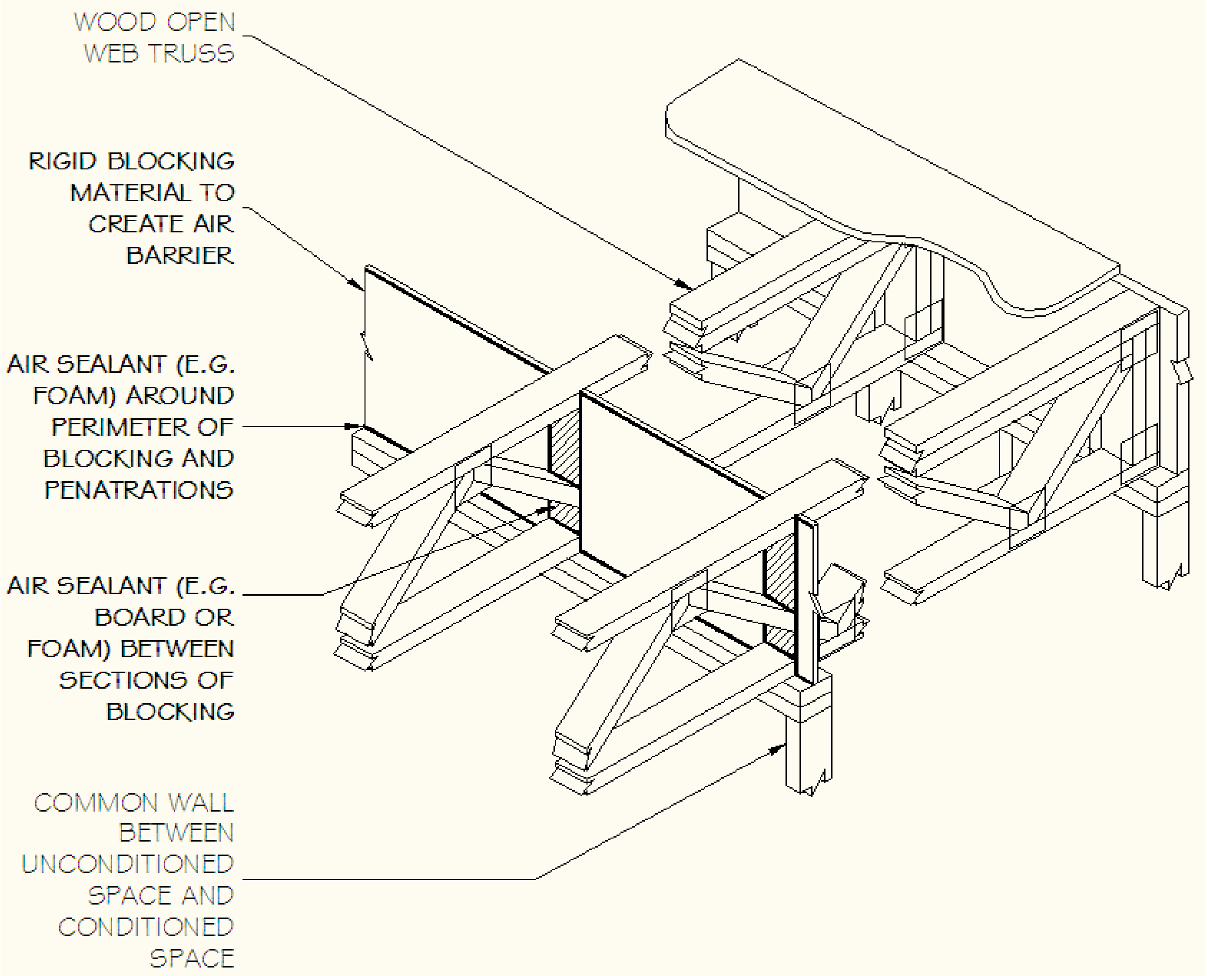
APPENDIX E-2.4

N1102.4.1 Building thermal envelope. – 1. Block and seal floor/ceiling systems



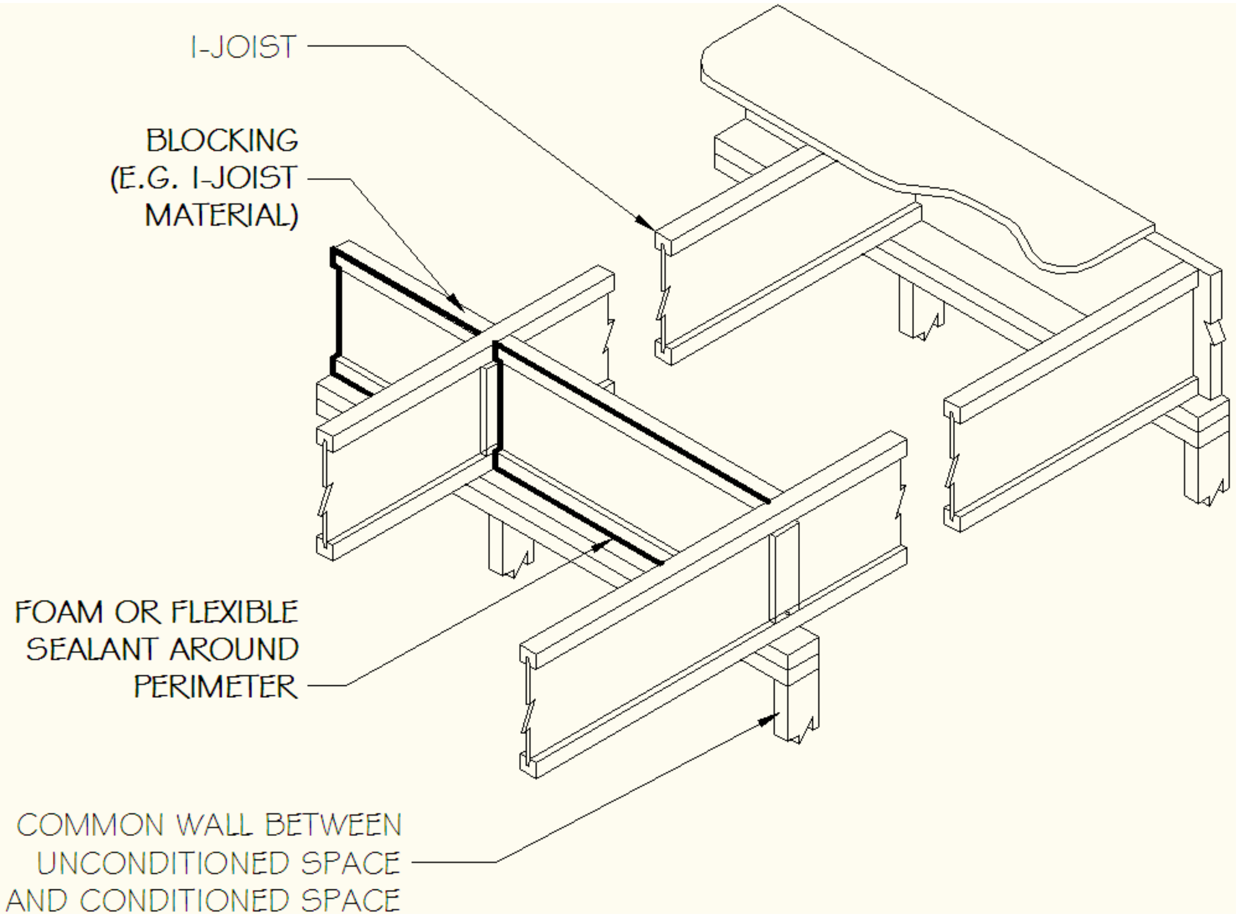
ISOMETRIC VIEW OF DIMENSIONAL LUMBER FLOOR/CEILING SYSTEM ABOVE COMMON WALL BETWEEN UNCONDITIONED AND CONDITIONED SPACE

N1102.4.1 Building thermal envelope. – 1. Block and seal floor/ceiling systems



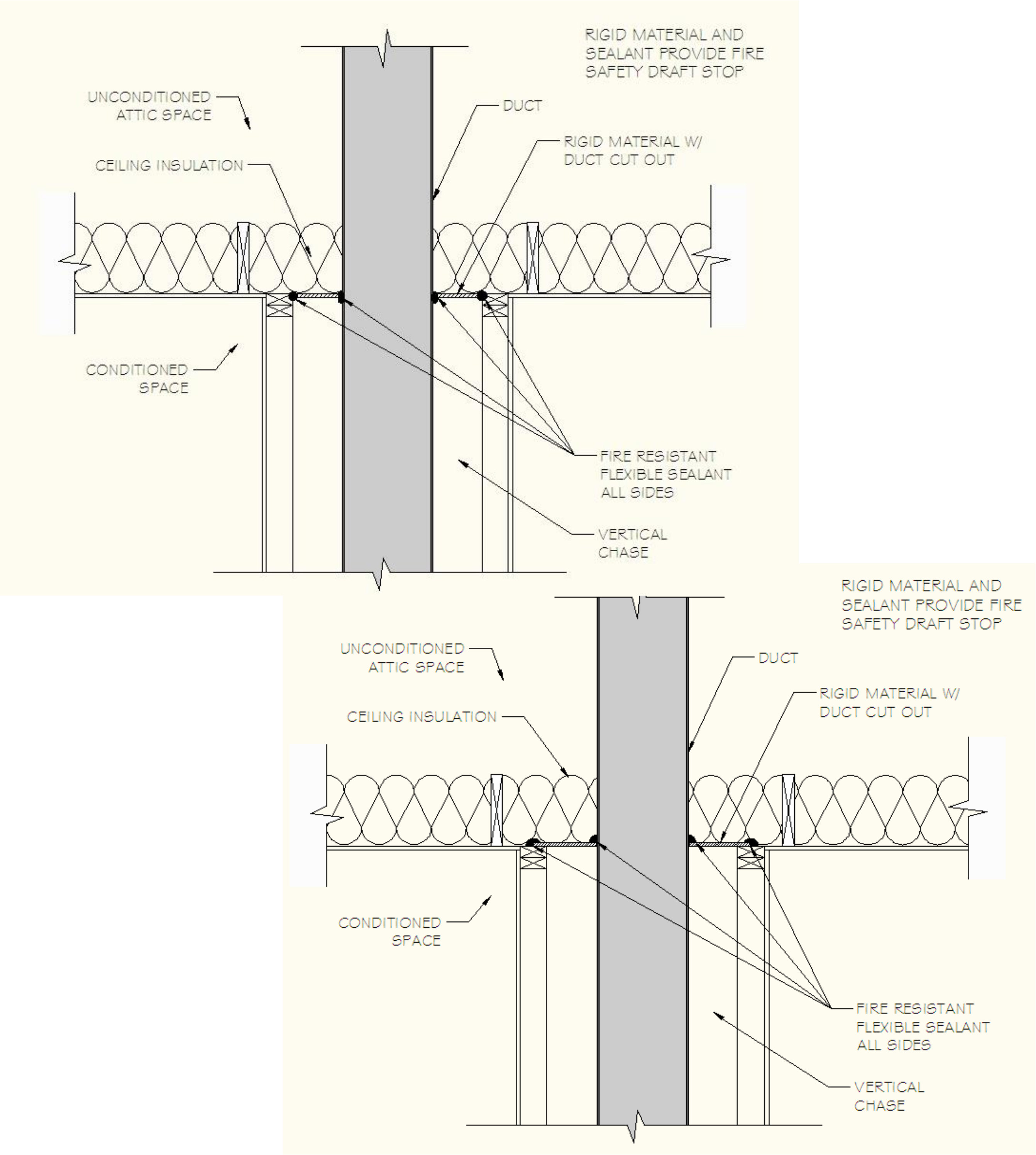
ISOMETRIC VIEW OF WOOD TRUSS FLOOR/CEILING SYSTEM ABOVE COMMON WALL BETWEEN UNCONDITIONED AND CONDITIONED SPACE

N1102.4.1 Building thermal envelope. – 1. Block and seal floor/ceiling systems



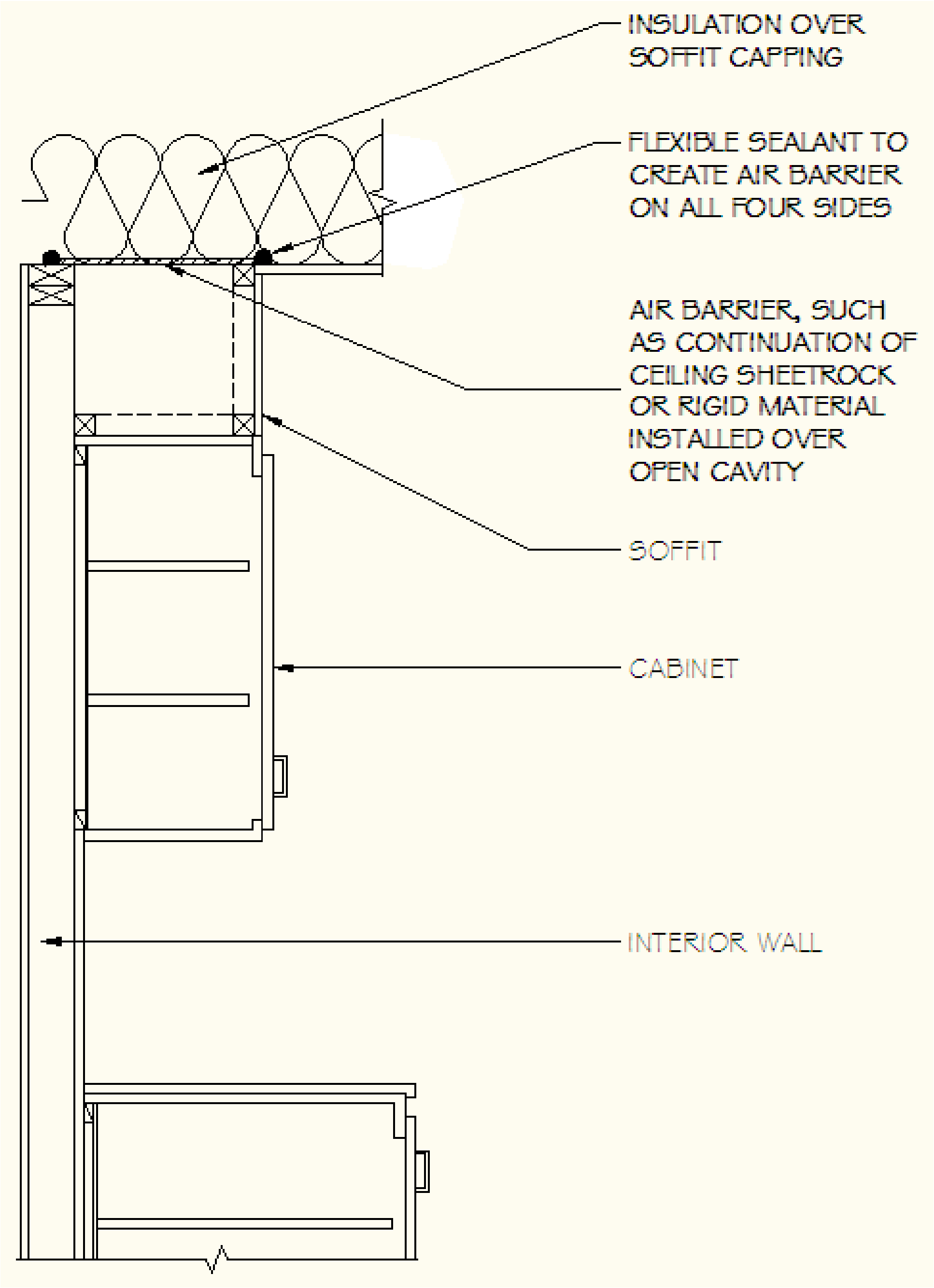
ISOMETRIC VIEW OF I-JOIST FLOOR/CEILING SYSTEM ABOVE COMMON WALL BETWEEN UNCONDITIONED AND CONDITIONED SPACE

N1102.4.1 Building thermal envelope – 2. Cap and seal shafts and chases



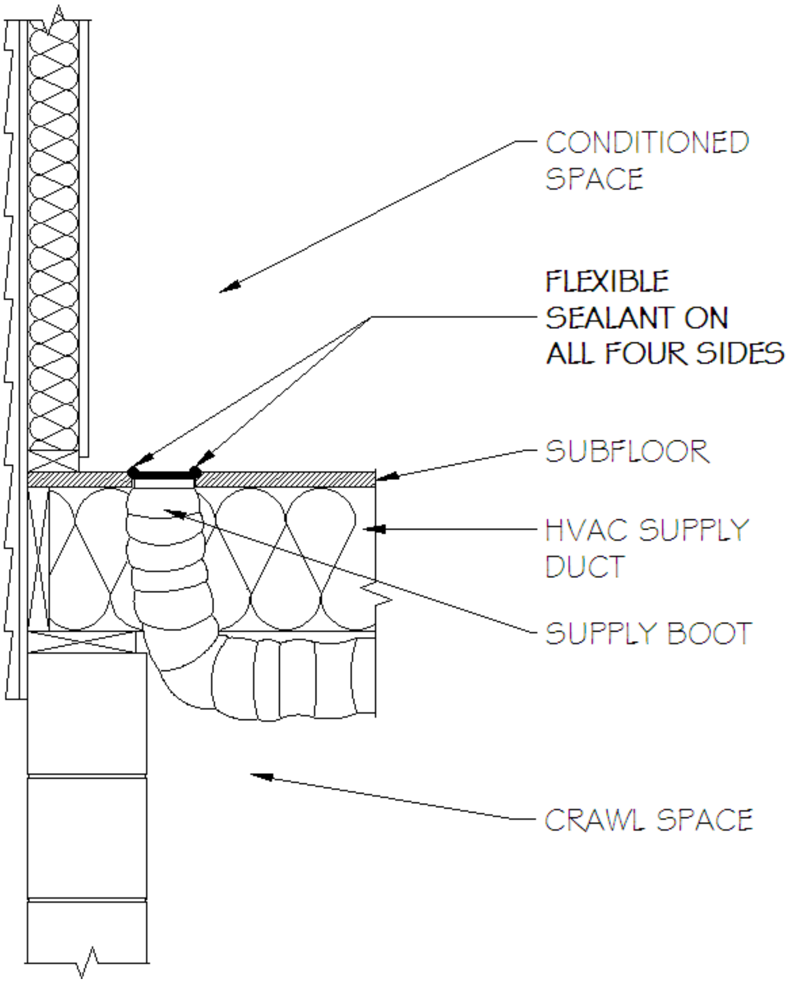
SECTION VIEWS OF DUCT PENETRATING INTO ATTIC

N1102.4.1 Building thermal envelope. – 3. Cap and seal soffit or dropped ceiling



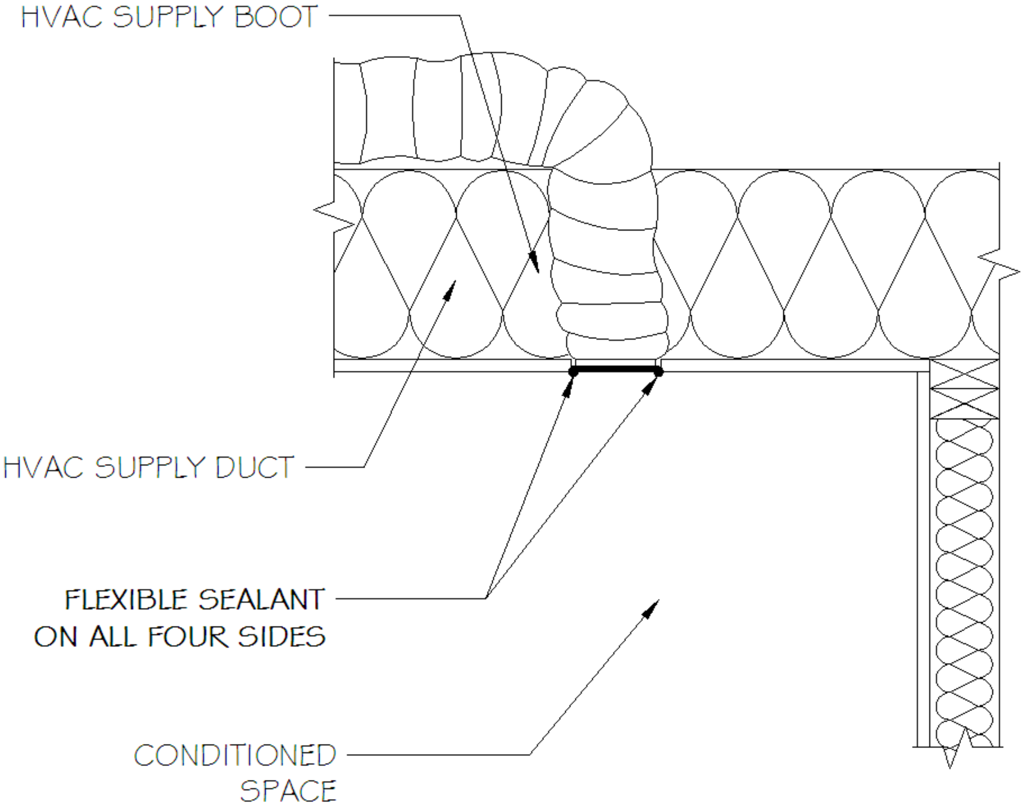
SECTION VIEW OF SOFFIT OVER CABINET

N1102.4.1 Building thermal envelope. – 4. Seal HVAC boot penetration – floor



SECTION VIEW OF FLOOR HVAC BOOT PENETRATION

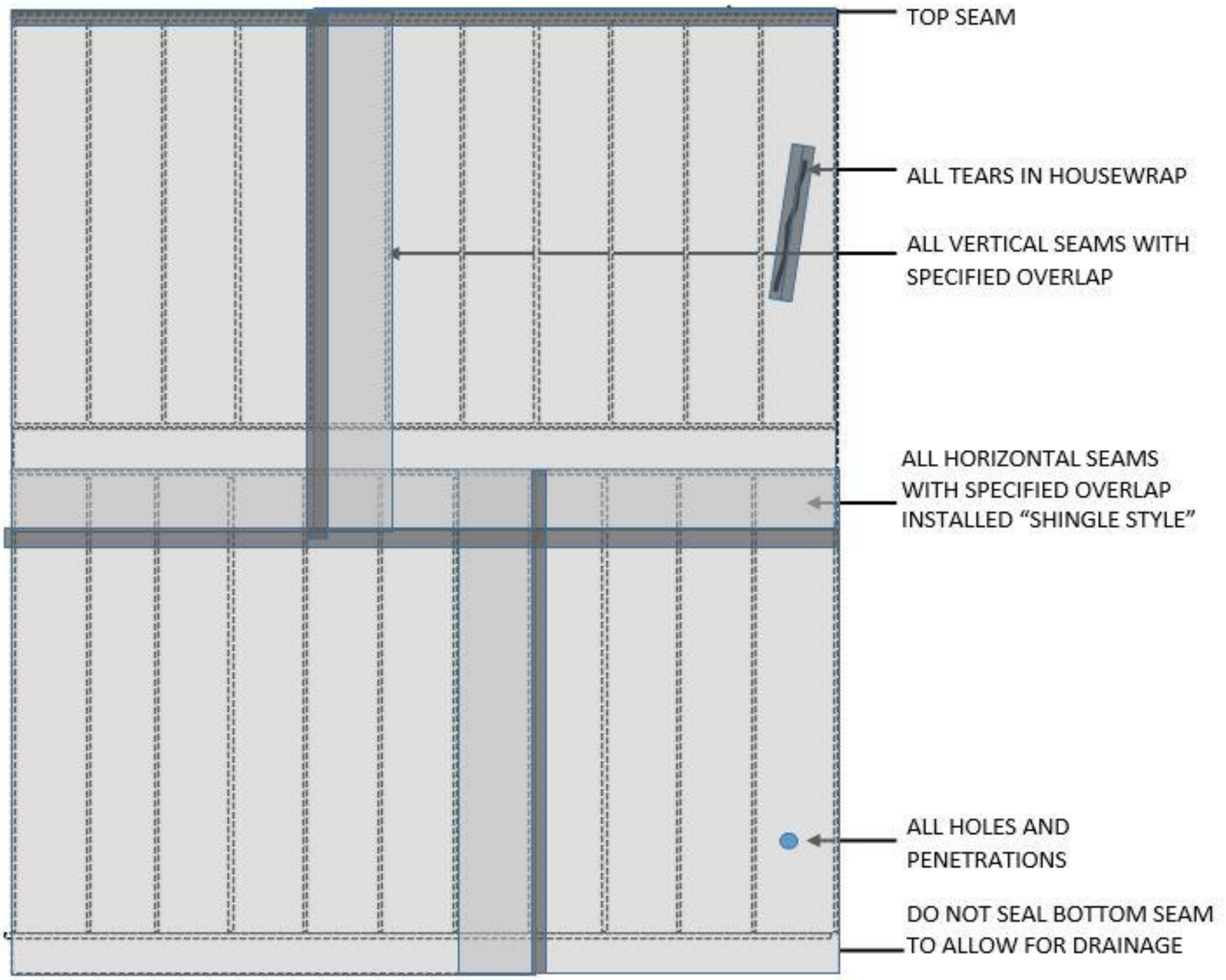
N1102.4.1 Building thermal envelope. – 4. Seal HVAC boot penetration – ceiling



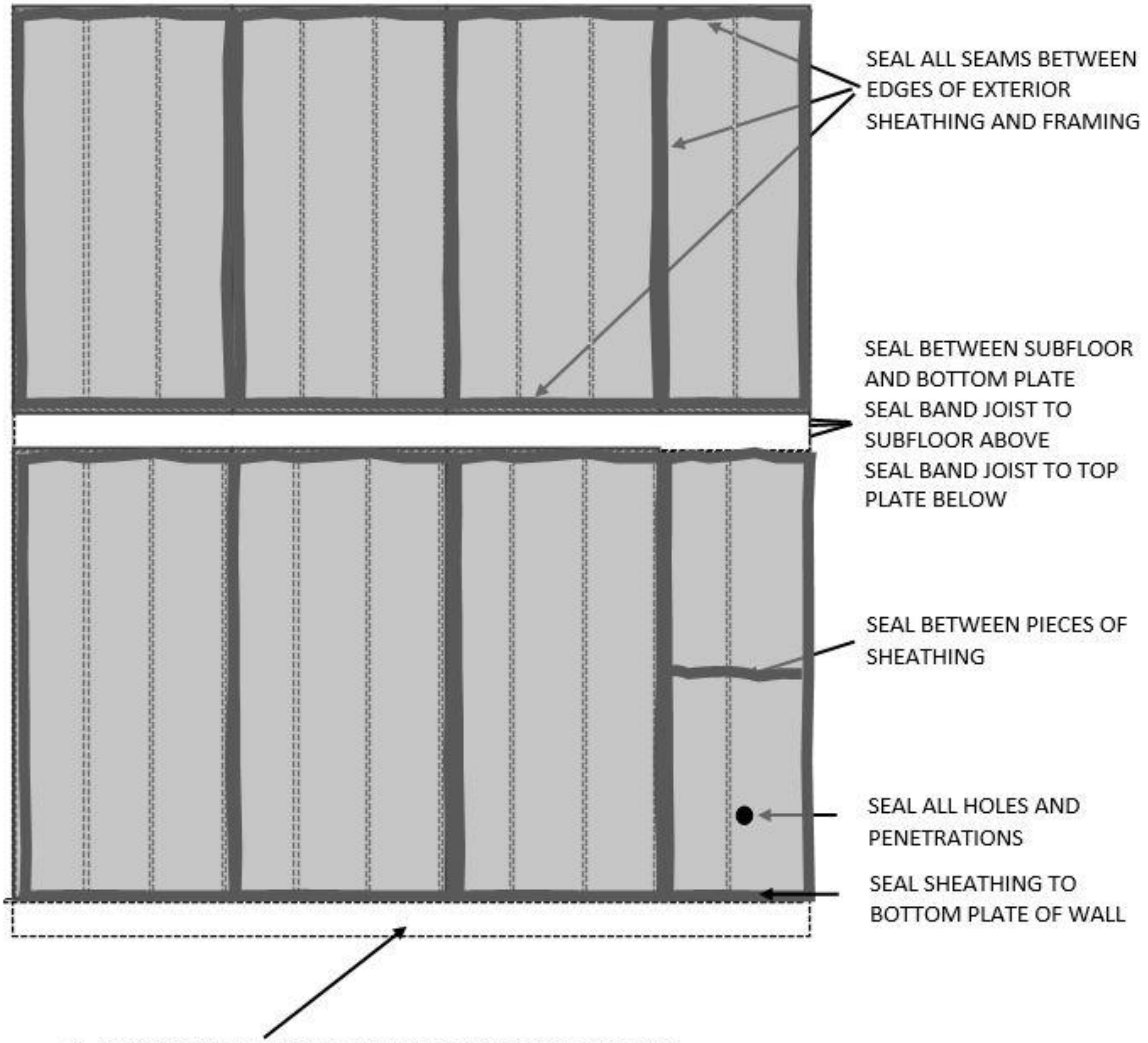
SECTION VIEW OF CEILING HVAC BOOT PENETRATION

N1102.4.1 Building thermal envelope. – 5. Sealed exterior air barrier with housewrap

Follow manufacturer's instructions for sealing air barrier-rated housewrap, including choice of materials, to provide an exterior air barrier at the following locations:

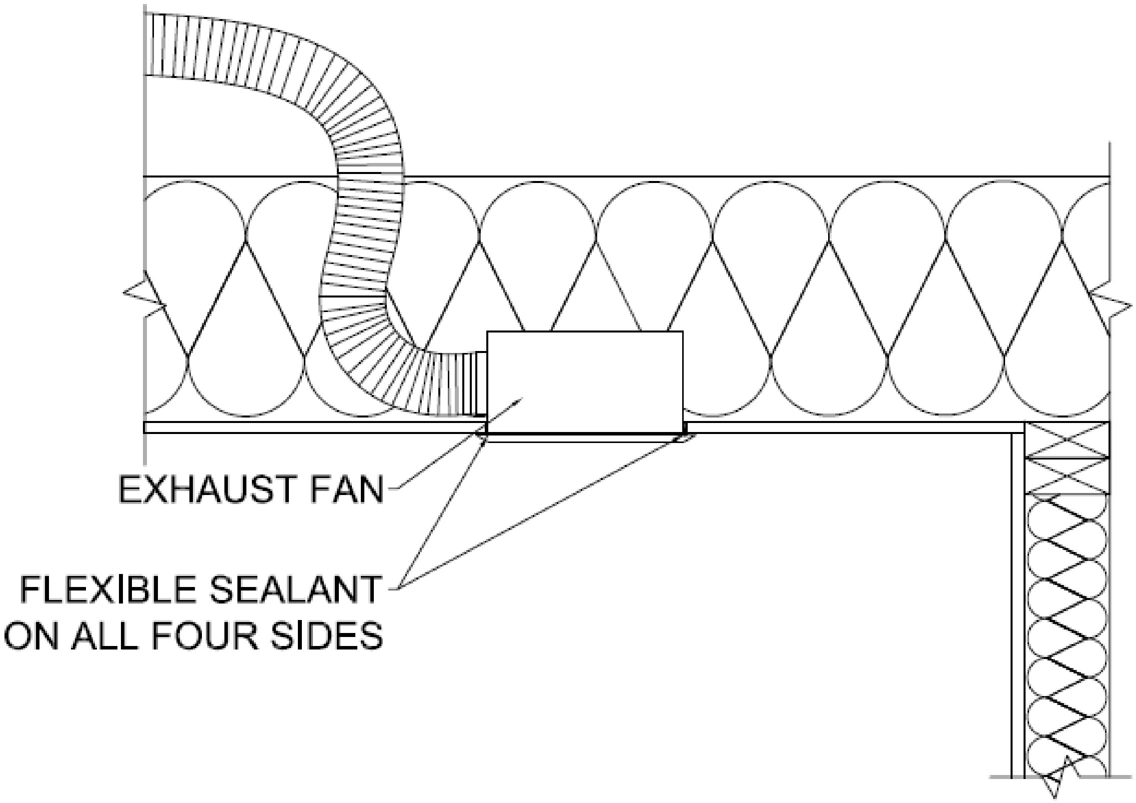


N1102.4.1 Building thermal envelope. – 5. Sealed exterior air barrier with sheathing



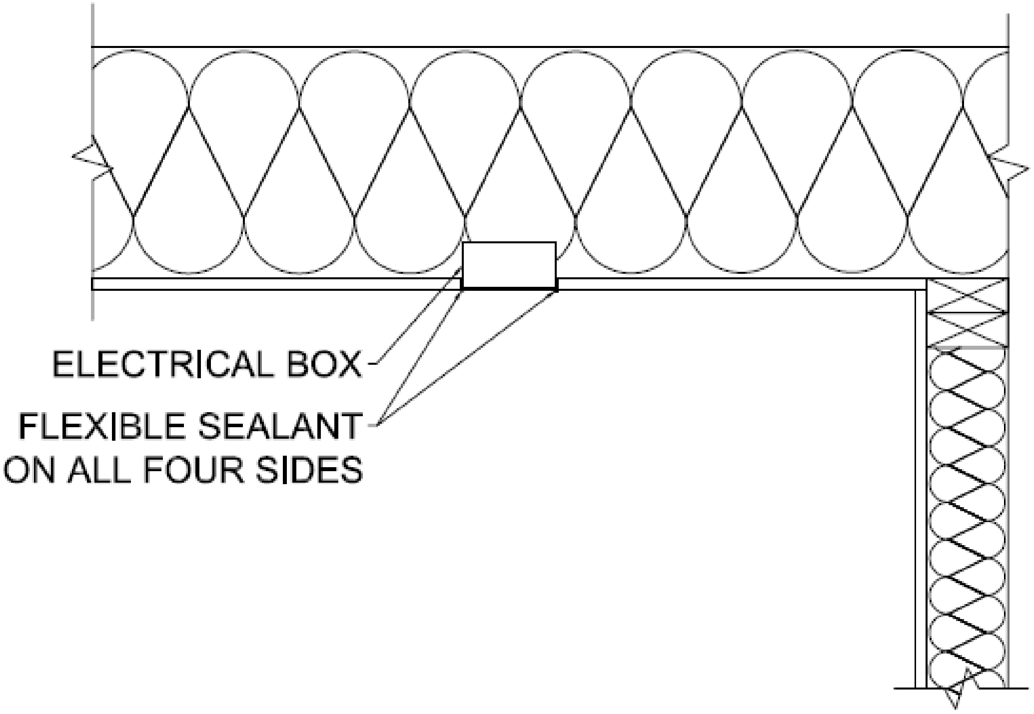
1) IF FIRST FLOOR IS SLAB-ON-GRADE, INSTALL SEAL SEALER UNDER BOTTOM PLATE OF EXTERIOR WALL.
2) IF FIRST FLOOR IS OVER UNCONDITIONED CRAWL SPACE OR BASEMENT, INSTALL SEAL SEALER UNDER BOTTOM PLATE AND SEAL SUBFLOOR TO BAND JOIST.
3) IF FIRST FLOOR IS OVER CONDITIONED BASEMENT OR CLOSED CRAWL SPACE WITH CRAWL SPACE WALL INSULATION BELOW, SEAL BETWEEN SUBFLOOR AND BOTTOM PLATE, SEAL BAND JOIST TO SUBFLOOR ABOVE, AND SEAL BAND JOIST TO TOP PLATE BELOW.

N1102.4.2.1 Visual inspection option. – Table N1102.4.2 Seal ceiling mechanical box penetrations



CEILING EXHAUST

N1102.4.2.1 Visual inspection option. – Table N1102.4.2 Seal ceiling electrical box penetrations



CEILING ELECTRICAL BOX

APPENDIX E-3: SAMPLE WORKSHEETS FOR RESIDENTIAL AIR AND DUCT LEAKAGE TESTING

APPENDIX 3A

Air sealing: Visual inspection option (Section N1102.4.2.1)

Sample Worksheet

N1102.4.2 Air sealing. Building envelope air tightness shall be demonstrated by Section N1102.4.2.1 or N1102.4.2.2:

N1102.4.2.1 Visual inspection option. Building envelope tightness shall be considered acceptable when items providing insulation enclosure in N1102.2.14 and enclosure and air sealing in N1102.2.15 and air sealing in N1102.4.1 are addressed and when the items listed in Table N1102.4.2, applicable to the method of construction, are certified by the builder, permit holder or registered design professional via the certificate in Appendix E-1.

TABLE N1102.4.2
AIR BARRIER INSPECTION

COMPONENT	**CRITERIA**
Ceiling/attic	Sealants or gaskets provide a continuous air barrier system joining the top plate of framed walls with either the ceiling drywall or the top edge of wall drywall to prevent air leakage. Top plate penetrations are sealed. For ceiling finishes that are not air barrier systems such as tongue-and-groove planks, air barrier systems,(for example, taped house wrap), shall be used above the finish Note: It is acceptable that sealants or gaskets applied as part of the application of the drywall will not be observable by the code official
Walls	Sill plate is gasketed or sealed to subfloor or slab.
Windows and doors	Space between window and exterior door jambs and framing is sealed.
Floors (including above-garage and cantilevered floors)	Air barrier system is installed at any exposed edge of insulation.
Penetrations	Utility penetrations through the building thermal envelope, including those for plumbing, electrical wiring, ductwork, security and fire alarm wiring, and control wiring, shall be sealed.
Garage separation	Air sealing is provided between the garage and conditioned spaces. An air barrier system shall be installed between the ceiling system above the garage and the ceiling system of interior spaces.
Ceiling penetrations	Ceiling electrical box penetrations and ceiling mechanical box penetrations shall be caulked, gasketed, or sealed at the penetration of the ceiling finish. See Appendix E-2.4. **Exception**— ceiling electrical boxes and ceiling mechanical boxes not penetrating the building thermal envelope

Recessed lighting	Recessed light fixtures are air tight, IC rated, and sealed to drywall. **Exception**— fixtures in conditioned space.

Property Address:

____

N1102.4.2.1 Visual Inspection Option

The inspection information including tester name, date, and contact shall be included on the certificate described in Section N1101.14.

____

____

Signature   Date

APPENDIX E-3B

Air sealing: Testing option (Section N1102.4.2.2)

Sample Worksheet

N1102.4.2 Air sealing. Building envelope air tightness shall be demonstrated by Section N1102.4.2.1 or N1102.4.2.2:

N1102.4.2.2 Testing option. Building envelope tightness shall be considered acceptable when items providing insulation enclosure in N1102.2.14 and enclosure and air sealing in N1102.2.15 and air sealing in N1102.4.1 are addressed and when tested air leakage is less than or equal to one of the two following performance measurements:

1. 0.30 CFM50/Square Foot of Surface Area (SFSA) or
2. Five (5) air changes per hour (ACH50)

When tested with a blower door fan assembly, at a pressure of 33.5 psf (50 Pa). A single point depressurization, not temperature corrected, test is sufficient to comply with this provision, provided that the blower door fan assembly has been certified by the manufacturer to be capable of conducting tests in accordance with ASTM E779-03. 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. Testing shall be reported by the permit holder, a NC licensed general contractor, a NC licensed HVAC contractor, a NC licensed Home Inspector, a registered design professional, a *certified BPI Envelope Professional* or a *certified HERS rater.*

During testing:

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, backdraft, and flue dampers;
3. Interior doors shall be open;
4. Exterior openings for continuous ventilation systems, air intake ducted to the return side of the conditioning system, and energy or heat recovery ventilators shall be closed and sealed;
5. Heating and cooling system(s) shall be turned off; and
6. Supply and return registers shall not be sealed.

The air leakage information, including building air leakage result, tester name, date, and contact information, shall be included on the certificate described in Section N1101.14.

For Test Criteria 1 above, the report shall be produced in the following manner: Perform the blower door test and record the *CFM50*___________. Calculate the total square feet of surface area for the building thermal envelope, all floors, ceilings, and walls (this includes windows and doors) and record the area_______________. Divide *CFM50* by the total square feet and record the result below. If the result is less than or equal to **[0.30 CFM50/SFSA]** the envelope tightness is acceptable; or

For Test Criteria 2 above, the report shall be produced in the following manner: Perform a blower door test and record the *CFM50*___________. Multiply the CFM50 by 60 minutes to create CFHour50 and record _______________. Then calculate the total conditioned volume of the home and record_________________. Divide the CFH50 by the total volume and record the result below. If the result is less than or equal to **[5 ACH50]** the envelope tightness is acceptable.

Property Address:
____

Fan attachment location______________________Company Name________________________

Contact Information:____

____

Signature of Tester Date

Permit Holder, NC Licensed General Contractor, NC Licensed HVAC Contractor,
NC Licensed Home Inspector, Registered Design Professional,
Certified BPI Envelope Professional, or Certified HERS Rater **(circle one)**

APPENDIX E-3C

Duct sealing. Duct air leakage test (Section N1103.3.2 &Section N1103.3.3)

Sample Worksheet

N1103.3.2 Sealing (Mandatory Requirements). Ducts, air handlers, filter boxes, and building cavities used as ducts shall be sealed. Joints and seams shall comply with either the *International Mechanical Code* or *International Residential Code*, as applicable.

N1103.3.3 Duct leakage (Prescriptive) and duct testing (Mandatory). Duct testing and duct leakage shall be verified by compliance with either Section N1103.3.3.1 or N1103.3.3.2. Duct testing shall be verified using one of the two following methods:

N1103.3.3.1 Total Duct leakage. Total duct leakage less than or equal to 5 CFM (12 L/min) per 100 ft^2 (9.29 m^2) of conditioned floor area served by that system 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.

During testing:
1. Block, if present, ventilation air duct(s) connected to the conditioning system.
2. The duct air leakage testing equipment shall be attached to the largest return in the system or to the air handler.
3. The filter shall be removed and the air handler power shall be turned off.
4. Supply boots or registers and return boxes or grilles shall be taped, plugged, or otherwise sealed air tight.
5. The hose for measuring the 25 Pascals of pressure differential shall be inserted into the boot of the supply that is nominally closest to the air handler.
6. Specific instructions from the duct testing equipment manufacturer shall be followed to reach duct test pressure and measure duct air leakage.

N1103.3.3.2 Duct Leakage to the Outside. Conduct the test using fan pressurization of distribution system and building at a fixed reference pressure for combined supply and return leaks. Duct leakage to the outside shall be less than or equal to 4 CFM (12 L/min) per 100 ft^2 (9.29 m^2) of conditioned floor area served by that system when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the entire system, relative to the outside, including the manufacturer’s air handler enclosure.

During testing:

1. Block, if present, the ventilation air duct(s) connected to the conditioning system.
2. The duct air leakage testing equipment shall be attached to the largest return in the system or to the air handler.
3. The filter shall be removed and the air handler power shall be turned off.
4. Supply boots or registers and return boxes or grilles shall be taped, plugged, or otherwise sealed air tight or as tight as possible.
5. The hose for measuring the 25 Pascals of pressure differential shall be inserted into the boot of the supply that is nominally closest to the air handler.
6. Open all interconnecting doors in the building, close dampers for fireplaces and other operable dampers.
7. Set up an envelope air moving/ flow-regulating/ flow measurement assembly, such as a blower door, following the manufacturer’s prescribed procedure.

8. Specific instructions from the duct testing equipment manufacturer shall be followed to reach duct test pressure and measure duct air leakage used in combination with a blower door. Typical steps are as follows:
   a. Depressurize the ductwork system to 25 Pa using the measurement hose in Step 5 above.
   b. Depressurize the house to 25 Pa using an envelope air moving/ flow-regulating/ flow measurement assembly, such as a blower door.
   c. Correct the duct pressure to measure 0 Pa of pressure differential between the house and the ductwork system.
   d. Read the CFM of duct leakage using the procedures for the specific equipment being used. (Note that most automatically calculating pressure gauges cannot compute the CFM25 automatically with a duct-to-house difference in pressure of 0 Pa, so the gauge setting should be set to read CFM instead of CFM25).

Testing shall be performed and reported by the permit holder, a NC licensed general contractor, a NC licensed HVAC contractor, a NC licensed Home Inspector, a registered design professional, a certified BPI Envelope Professional or a certified HERS rater. A single point depressurization, not temperature corrected, test is sufficient to comply with this provision, provided that the duct testing fan assembly(s) has been certified by the manufacturer to be capable of conducting tests in accordance with ASTM E1554-07.

The duct leakage information, including duct leakage test selected and result, tester name, date, and contact information, shall be included on the certificate described in Section N1101.14.

For the Test Criteria, the report shall be produced in the following manner: perform the HVAC system air leakage test and record the CFM25. Calculate the total square feet of Conditioned Floor Area (CFA) served by that system. Multiply CFM25 by 100, divide the result by the CFA and record the result. If the result is less than or equal to 5 CFM25/100SF for the “Total duct leakage test” or less than or equal to 4 CFM25/100SF for the “Duct leakage to the outside” test, then the HVAC system air tightness is acceptable.

Complete one duct leakage report for each HVAC system serving the home:

Property Address:____

Test Performed: Total duct leakage or Duct leakage to the outside **(circle one)**
HVAC System Number: __________ Describe area of home served: ______________________
CFM25 Total __________. Conditioned Floor Area (CFA) served by system: ___________ s.f.
CFM25 x 100 divided by CFA = _____ CFM25/100SF (e.g. 100 CFM25x100/ 2,000 CFA = 5 CFM25/100SF)
Fan attachment location ____________________
Company Name ____

Contact Information:____

____

____ ______________________________
Signature of Tester Date

Permit Holder, NC Licensed General Contractor, NC Licensed HVAC Contractor, NC Licensed Home Inspector,
Registered Design Professional,
Certified BPI Envelope Professional, or Certified HERS Rater **(circle one)**

APPENDIX E-4 ADDITIONAL VOLUNTARY CRITERIA FOR INCREASING ENERGY EFFICIENCY (High Efficiency Residential Option)

1. **Introduction.** The increased energy efficiency measures identified in this appendix are strictly voluntary at the option of the permit holder and have been evaluated to be the most cost effective measures for achieving an additional 10-15% energy efficiency beyond the code minimums.

2. **Requirements**: Follow all sections of Chapter 11 of the North Carolina Residential Code, Chapter 11, except the following.
    a. Instead of using Table N1102.1.2 in Section N1102.1.2, use Table E-4A shown below.

TABLE E-4A
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION U-FACTOR[b,j]	SKYLIGHT[b] U-FACTOR	GLAZED FENESTRATION SHGC [b,k]	CEILING R-VALUE[m]	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE[i]	FLOOR R-VALUE	BASEMENT [c,o] WALL R-VALUE	SLAB[d] R-VALUE	CRAWL SPACE[c] WALL R-VALUE
3	0.32	0.55	0.25	38 or 30 ci [l]	19, 13+5, or 15+3[h]	5/13 or 5/10ci	19	5/13[f]	**5**	5/13
4	0.32	0.55	0.25	38 or 30 ci [l]	19, 13+5, or 15+3[h]	5/13 or 5/10ci	19	10/15	10	10/15
5	0.32	0.55	(NR)	38 or 30 ci [l]	19, 13+5, or 15+3[h]	13/17 or 13/12.5 ci	30[g]	10/15	10	10/19

For SI: 1 foot = 304.8 mm.

a. R-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall not be less than the *R*-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

c. "10/15" means R-10 continuous insulated sheathing on the interior or exterior of the home or R-15 cavity insulation at the interior of the basement wall or crawl space wall. "

d. For monolithic slabs, insulation shall be applied from the inspection gap downward to the bottom of the footing or a maximum of 24 inches below grade whichever is less. For floating slabs, insulation shall extend to the bottom of the foundation wall or 24 inches, whichever is less. (See Appendix O) R-5 shall be added to the required slab edge *R*-values for heated slabs.

e. Deleted.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure N1101.7 and Table N1101.7.

g. Or insulation sufficient to fill the framing cavity, R-19 minimum.

h. The first value is cavity insulation, the second value is continuous insulation, so "13+5" means R-13 cavity insulation plus R-5 continuous insulation. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

j. In addition to the exemption in Section N1102.3.3, a maximum of two glazed fenestration product assemblies having a U-factor no greater than 0.55 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.

k. In addition to the exemption in Section N1102.3.3, a maximum of two glazed fenestration product assemblies having a SHGC no greater than 0.70 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.

l. R-30 shall be deemed to satisfy the ceiling insulation requirement wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Otherwise R-38 insulation is required where adequate clearance exists or insulation must extend to either the insulation baffle or within 1" of the attic roof deck.
m. Table value required except for roof edge where the space is limited by the pitch of the roof, there the insulation must fill the space up to the air baffle.
n. R -19 fiberglass batts compressed and installed in a nominal 2 × 6 framing cavity is deemed to comply. Fiberglass batts rated R-19 or higher compressed and installed in a 2x4 wall is not deemed to comply.
o. Basement wall meeting the minimum mass wall specific heat content requirement may use the mass wall R-value as the minimum requirement.

b. Instead of using Table N1102.1.4 in Section N1102.1.4, use Table E-4B to find the maximum U-factors for building components.

TABLE E-4B
EQUIVALENT U-FACTORS[a]

CLIMATE ZONE	FENESTRATION U-FACTOR [d]	SKYLIGHT U-FACTOR	CEILING U-FACTOR	FRAME WALL U-FACTOR	MASS WALL U-FACTOR[b]	FLOOR U-FACTOR	BASEMENT WALL U-FACTOR[c]	CRAWL SPACE WALL U-FACTOR
3	0.32	0.55	0.030	0.061	0.141	0.047	0.091	0.136
4	0.32	0.55	0.030	0.061	0.141	0.047	0.059	0.065
5	0.32	0.55	0.030	0.061	0.082	0.033	0.059	0.065

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.
b. When more than half the insulation is on the interior, the mass wall U-factors shall be a maximum of 0.07 in Climate Zone 3, 0.07 in Climate Zone 4, and 0.054 in Climate Zone 5.
c. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure N1101.10 (R301.1) and Table N1101.10 (R301.1).
d. A maximum of two glazed fenestration product assemblies having a U-factor no greater than 0.55 and a SHGC no greater than 0.70 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.

c. For compliance with Section N1102.4 Air leakage control (Mandatory Requirements), Sections N1102.4.1 (Building thermal envelope) and N1102.4.2.2 (Testing option) must be followed, with the maximum leakage rate shown below. Section N1102.4.2.1 (Visual inspection option) cannot be used to show compliance.
    i. 0.24 CFM50/Square Foot of Surface Area (SFSA) or
    ii. Four (4) air changes per hour (ACH50)

d. Instead of using the duct leakage value for maximum leakage shown in Section N1103.3.3 use the following:
    1. **N1103.3.3.1 Total Duct Leakage**. Total duct leakage less than or equal to 4 CFM (113 L/min) per 100 ft^2 (9.29 m^2) of conditioned floor area served by that system 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.
    2. **N1103.3.3.2 Duct Leakage to the Outside.** Conduct the test using fan pressurization of distribution system and building at a fixed reference pressure for combined supply and return leak. Duct leakage to the outside shall be less than or equal to 3 CFM (85 L/min) per 100 ft^2 (9.29 m^2) of conditioned floor area served by that system when tested at a

pressure differential of 0.1 inches w.g. (25 Pa) across the entire system, relative to the outside, including the manufacturer's air handler enclosure.

e. For compliance with Section N1104.1 (Lighting equipment), the home must comply with the following:
Not less than 90 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps or not less than 90 percent of the permanently installed lighting fixtures shall contain only high-efficacy lamps.

Table E-4C: Sample Confirmation Form for ADDITIONAL VOLUNTARY CRITERIA FOR INCREASING ENERGY EFFICIENCY (High Efficiency Residential Option)

North Carolina Energy Conservation Code: High Efficiency Residential Option **Insulation and Fenestration Values (Notes correlate to Table N1102.1.2)**				**Proposed Project Values**
Climate Zone	**3**	**4**	**5**	-
Fenestration U-Factor [b,j]	**0.32**	**0.32**	**0.32**	-
Skylight U-Factor [b]	0.55	0.55	0.55	-
Glazed Fenestration SHGC [b,k]	**0.25**	**0.25**	(NR)	-
Ceiling R-value [m]	38 or 30 ci [l]	38 or 30 ci [l]	38 or 30 ci [l]	-
Wood Frame Wall R-value [h]	19, 13+5, or 15+3	19, 13+5, or 15+3	19, 13+5, or 15+3	-
Mass Wall R-value [i]	5/13 or 5/10ci	5/13 or 5/10ci	13/17 or 13/12.5 ci	-
Floor R-value	19	19	30[g]	-
Basement Wall R-value [c,o]	5 /13[f]	10/15	10/15	-
Slab R-value and Depth [d]	5	10	10	-
Crawl Space Wall R-value [c]	5/13	10/15	10/19	-
-	** Note: ci = continuous insulation*			

High Efficacy Lighting	-
% of lighting that is high efficacy according to N1104.1. (90% required)	-
Building Air Leakage	-
Building Air Leakage Test according to N1102.4.2.2 (check box). Show test value:	-
ACH50 [Target: 4.0], or	-
CFM50/SFSA [Target: 0.24]	-
Name of Tester / Company:	-
Date: Phone:	-
Duct Insulation and Sealing	-
Insulation Value	R-
Duct Leakage Test Result (Sect. N1103.3.3)	☐ Total duct leakage or ☐ Duct leakage to the exterior
(CFM25 Total/100SF) [Target: 4 Total/ 3 To exterior]	-
Name of Tester or Company:	-
Date: Phone:	-

E-4D:

SAMPLE WORKSHEETS FOR RESIDENTIAL AIR AND DUCT LEAKAGE TESTING

E-4D.1

Air sealing: Testing (Section N1102.4.2.2)

Sample Worksheet for Alternative Residential Energy Code for Higher Efficiency

Air sealing. Building envelope air tightness shall be demonstrated by Section N1102.4.2.2:

Air sealing: Testing ~~option~~ (Section N1102.4.2.2)

Sample Worksheet for Alternative Residential Energy Code for Higher Efficiency

N1102.4.2.2 Testing. Building envelope tightness shall be considered acceptable when items providing insulation enclosure in N1102.2.14 and enclosure air sealing in N1102.2.15 and air sealing in N1102.4.1 are addressed and when tested air leakage is less than or equal to one of the two following performance measurements:

1. 0.24 CFM50 (6.8 L/min)/Square Foot of Surface Area (SFSA) or
2. Four (4) air changes per hour (ACH50)

When tested with a blower door fan assembly, at a pressure of 0.2 inches water gauge (50 Pa), a single point depressurization, not temperature corrected, test is sufficient to comply with this provision, provided that the blower door fan assembly has been certified by the manufacturer to be capable of conducting tests in accordance with ASTM E779-03. 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. Testing shall be reported by the permit holder, a NC licensed general contractor, a NC licensed HVAC contractor, a NC licensed Home Inspector, a registered design professional, a certified *BPI Envelope Professional* or a certified *HERS rater*.

During testing:

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, backdraft, and flue dampers;
3. Interior doors shall be open;
4. Exterior openings for continuous ventilation systems, air intake ducted to the return side of the conditioning system, and energy or heat recovery ventilators shall be closed and sealed;
5. Heating and cooling system(s) shall be turned off; and
6. Supply and return registers shall not be sealed.

The air leakage information, including building air leakage result, tester name, date, and contact information, shall be included on the certificate described in Section N1101.14.

For Test Criteria 1 above, the report shall be produced in the following manner: Perform the blower door test and record the *CFM50*___________. Calculate the total square feet of surface area for the building thermal envelope, all floors, ceilings, and walls (this includes windows and doors) and record the area______________. Divide *CFM50* by the total square feet and record the result below. If the result is less than or equal to **[0.24 CFM50/SFSA]** the envelope tightness is acceptable; or

For Test Criteria 2 above, the report shall be produced in the following manner: Perform a blower door test and record the *CFM50* = ___________. Multiply the CFM50 by 60 minutes to create CF/Hour50 and record = ______________. Then calculate the total conditioned volume of the home and record = __________________ cubic feet. Divide the CF/Hour50 by the total volume and record the result = _____________________ ACH50. If the result is less than or equal to **[4 ACH50]** the envelope tightness is acceptable.

Property Address: ____

Fan attachment location _________________________ Company Name ___________________________

Contact Information: ____

____

____

Signature of Tester Date

Permit Holder, NC Licensed General Contractor, NC Licensed HVAC Contractor,
NC Licensed Home Inspector, Registered Design Professional,
Certified BPI Envelope Professional, or Certified HERS Rater **(circle one)**

E-4D.2

Duct sealing. Duct air leakage test (Section N1103.3.3)
Sample Worksheet for Alternative Residential Energy Code for Higher Efficiency

N1103.3.3 Duct leakage (Prescriptive) and Duct Testing (Mandatory). Duct testing and duct leakage shall be verified by compliance with either Section N1103.3.3.1 or N1103.3.3.2. Duct testing shall be performed and reported by the permit holder, a NC licensed general contractor, a NC licensed HVAC contractor, a NC licensed Home Inspector, a registered design professional, a certified BPI Envelope Professional or a certified HERS rater. A single point depressurization, not temperature corrected, test is sufficient to comply with this provision, provided that the duct testing fan assembly(s) has been certified by the manufacturer to be capable of conducting tests in accordance with ASTM E1554-07.

The duct leakage information, including duct leakage test selected and result, tester name, date, and contact information, shall be included on the certificate described in Section N1101.3.

For the Test Criteria, the report shall be produced in the following manner: perform the HVAC system air leakage test and record the CFM25. Calculate the total square feet of Conditioned Floor Area (CFA) served by that system. Multiply CFM25 by 100, divide the result by the CFA and record the result. If the result is less than or equal to 4 CFM25/100SF for the "Total duct leakage test or less than or equal to 3 CFM25/100SF for the 'Duct leakage to the outside" test, then the HVAC system air tightness is acceptable.

Exceptions to testing requirements:

1. Duct systems or portions thereof inside the building thermal envelope shall not be required to be leak tested.
2. Installation of a partial system as part of replacement, renovation or addition does not require a duct leakage test.

1103.3.3.1 Total Duct Leakage. Total duct leakage less than or equal to 4 CFM (113 L/min) per 100 ft^2 (9.29 m^2) of conditioned floor area served by that system 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. During testing:

1. Block, if present, ventilation air duct(s) connected to the conditioning system.
2. The duct air leakage testing equipment shall be attached to the largest return in the system or to the air handler.
3. The filter shall be removed and the air handler power shall be turned off.
4. Supply boots or registers and return boxes or grilles shall be taped, plugged, or otherwise sealed air tight.
5. The hose for measuring the 25 Pascals of pressure differential shall be inserted into the boot of the supply that is nominally closest to the air handler.
6. Specific instructions from the duct testing equipment manufacturer shall be followed to reach duct test pressure and measure duct air leakage.

1103.3.3.2 Duct Leakage to the Outside. Conduct the test using fan pressurization of distribution system and building at a fixed reference pressure for combined supply and return leak. Duct leakage to the outside shall be less than or equal to 3 CFM (85 L/min) per 100 ft2 (9.29 m2) of conditioned floor area served by that system when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the entire system, relative to the outside, including the manufacturer's air handler enclosure.

During testing:

1. Block, if present, the ventilation air duct(s) connected to the conditioning system.
2. The duct air leakage testing equipment shall be attached to the largest return in the system or to the air handler.
3. The filter shall be removed and the air handler power shall be turned off.
4. Supply boots or registers and return boxes or grilles shall be taped, plugged, or otherwise sealed air tight or as tight as possible.
5. The hose for measuring the 25 Pascals of pressure differential shall be inserted into the boot of the supply that is nominally closest to the air handler.
6. Open all interconnecting doors in the building, close dampers for fireplaces and other operable dampers.
7. Set up an envelope air moving/ flow-regulating/ flow measurement assembly, such as a blower door, following

the manufacturer’s prescribed procedure.

8. Specific instructions from the duct testing equipment manufacturer shall be followed to reach duct test pressure and measure duct air leakage used in combination with a blower door. Typical steps are as follows:

    a. Depressurize the ductwork system to 25 Pa using the measurement hose in Step 5 above.

    b. Depressurize the house to 25 Pa using an envelope air moving/ flow-regulating/ flow measurement assembly, such as a blower door.

    c. Correct the duct pressure to measure 0 Pa of pressure differential between the house and the ductwork system.

    d. Read the CFM of duct leakage using the procedures for the specific equipment being used. (Note that most automatically calculating pressure gauges cannot compute the CFM25 automatically with a duct-to-house difference in pressure of 0 Pa, so the gauge setting should be set to read CFM instead of CFM25).

Complete one duct leakage report for each HVAC system serving the home:

Property Address: ____

HVAC System Number: __________ Describe area of home served: ______________________

CFM25 Total __________. Conditioned Floor Area (CFA) served by system: ___________ s.f.

CFM25 x 100 divided by CFA = ____ CFM25/100 SF

(e.g. 50 CFM25 x 100/ 2,000 CFA = 2.5 CFM25/100SF)

Fan attachment location ____________________

Company Name ____

Contact Information: ____

____

____ __________________________________

Signature of Tester Date

Permit Holder, NC Licensed General Contractor, NC Licensed HVAC Contractor,
NC Licensed Home Inspector, Registered Design Professional,
Certified BPI Envelope Professional, or Certified HERS Rater **(circle one)**

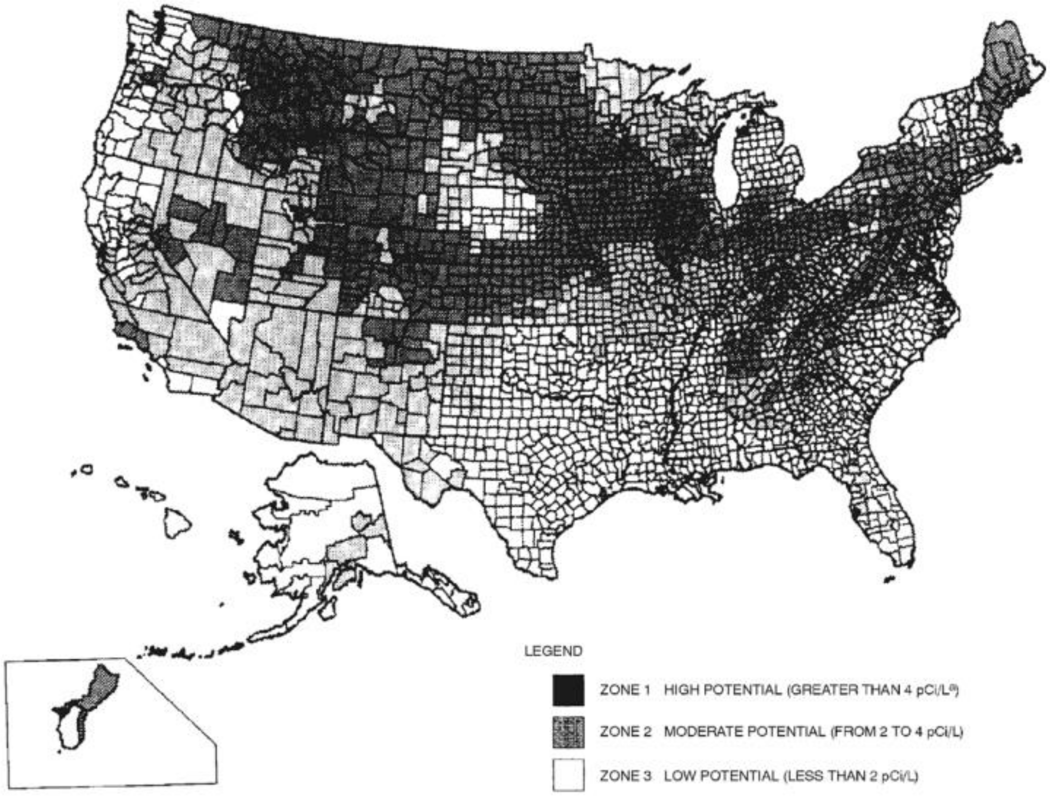
APPENDIX F

PASSIVE RADON GAS CONTROLS

Deleted

~~(The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.)~~

~~SECTION AF101~~
~~SCOPE~~



~~a. pCi/L standard for picocuries per liter of radon gas. The U.S. Environmental Protection Agency (EPA) recommends that homes that measure 4 pCi/L and greater be mitigated.~~

~~The EPA and the U.S. Geological Survey have evaluated the radon potential in the United States and have developed a map of radon zones designed to assist *building officials* in deciding whether radon-resistant features are applicable in new construction.~~

~~The map assigns each of the 3,141 counties in the United States to one of three zones based on radon potential. Each zone designation reflects the average short-term radon measurement that can be expected to be measured in a building without the implementation of radon-control methods. The radon zone designation of highest priority is Zone 1. Table AF101 lists the Zone 1 counties illustrated on the map. More detailed information can be obtained from state-specific booklets (EPA-402-R-93-021 through 070) available through State Radon Offices or from EPA Regional Offices.~~

~~FIGURE AF101~~
~~EPA MAP OF RADON ZONES~~

~~TABLE AF101(1)~~
~~HIGH RADON-POTENTIAL (ZONE 1) COUNTIES~~[a]

~~ALABAMA~~
~~Calhoun~~
~~Clay~~
~~Cleburne~~
~~Colbert~~
~~Coosa~~
~~Franklin~~
~~Jackson~~
~~Lauderdale~~
~~Lawrence~~
~~Limestone~~
~~Madison~~
~~Morgan~~
~~Talladega~~
~~CALIFORNIA~~
~~Santa Barbara~~
~~Ventura~~
~~COLORADO~~
~~Adams~~
~~Arapahoe~~
~~Baca~~
~~Bent~~
~~Boulder~~
~~Chaffee~~
~~Cheyenne~~
~~Clear Creek~~
~~Crowley~~
~~Custer~~
~~Delta~~
~~Denver~~
~~Dolores~~
~~Douglas~~
~~El Paso~~
~~Elbert~~
~~Fremont~~
~~Garfield~~
~~Gilpin~~
~~Grand~~
~~Gunnison~~
~~Huerfano~~
~~Jackson~~
~~Jefferson~~
~~CONNECTICUT~~
~~Fairfield~~
~~Middlesex~~
~~New Haven~~
~~New London~~
~~GEORGIA~~
~~Cobb~~
~~De Kalb~~
~~Fulton~~
~~Gwinnett~~
~~IDAHO~~
~~Benewah~~
~~Blaine~~
~~Boise~~
~~Bonner~~
~~Boundary~~
~~Butte~~
~~Camas~~
~~Clark~~
~~Clearwater~~
~~Custer~~
~~Elmore~~
~~Fremont~~
~~Gooding~~
~~Idaho~~
~~Kootenai~~
~~Latah~~
~~Lemhi~~
~~Shoshone~~
~~Valley~~
~~ILLINOIS~~
~~Adams~~
~~Boone~~
~~Brown~~
~~Bureau~~
~~Calhoun~~
~~Carroll~~
~~Cass~~
~~Champaign~~
~~Coles~~
~~De Kalb~~
~~De Witt~~
~~Morgan~~
~~Moultrie~~
~~Ogle~~
~~Peoria~~
~~Piatt~~
~~Pike~~
~~Putnam~~
~~Rock Island~~
~~Sangamon~~
~~Schuyler~~
~~Scott~~
~~Stark~~
~~Stephenson~~
~~Tazewell~~
~~Vermilion~~
~~Warren~~
~~Whiteside~~
~~Winnebago~~
~~Woodford~~
~~INDIANA~~
~~Adams~~
~~Allen~~
~~Bartholomew~~
~~Benton~~
~~Blackford~~
~~Boone~~
~~Carroll~~
~~Cass~~
~~Clark~~
~~Clinton~~
~~De Kalb~~
~~Decatur~~
~~Delaware~~
~~Elkhart~~
~~Fayette~~
~~Fountain~~
~~Fulton~~
~~Grant~~
~~Hamilton~~
~~Hancock~~
~~Harrison~~
~~Hendricks~~
~~Wabash~~
~~Warren~~
~~Washington~~
~~Wayne~~
~~Wells~~
~~White~~
~~Whitley~~
~~IOWA~~
~~All Counties~~
~~KANSAS~~
~~Atchison~~
~~Barton~~
~~Brown~~
~~Cheyenne~~
~~Clay~~
~~Cloud~~
~~Decatur~~
~~Dickinson~~
~~Douglas~~
~~Ellis~~
~~Ellsworth~~
~~Finney~~
~~Ford~~
~~Geary~~
~~Gove~~
~~Graham~~
~~Grant~~
~~Gray~~
~~Greeley~~
~~Hamilton~~
~~Haskell~~
~~Hodgeman~~
~~Jackson~~
~~Jewell~~
~~Johnson~~
~~Kearny~~
~~Kingman~~
~~Kiowa~~
~~Lane~~
~~Leavenworth~~
~~Lincoln~~
~~Logan~~
~~Trego~~
~~Wallace~~
~~Washington~~
~~Wichita~~
~~Wyandotte~~
~~KENTUCKY~~
~~Adair~~
~~Allen~~
~~Barren~~
~~Bourbon~~
~~Boyle~~
~~Bullitt~~
~~Casey~~
~~Clark~~
~~Cumberland~~
~~Fayette~~
~~Franklin~~
~~Green~~
~~Harrison~~
~~Hart~~
~~Jefferson~~
~~Jessamine~~
~~Lincoln~~
~~Marion~~
~~Mercer~~
~~Metcalfe~~
~~Monroe~~
~~Nelson~~
~~Pendleton~~
~~Pulaski~~
~~Robertson~~
~~Russell~~
~~Scott~~
~~Taylor~~
~~Warren~~
~~Woodford~~
~~MAINE~~
~~Androscoggin~~
~~Aroostook~~
~~Cumberland~~
~~Franklin~~
~~Hancock~~
~~Hillsdale~~
~~Jackson~~
~~Kalamazoo~~
~~Lenawee~~
~~St. Joseph~~
~~Washtenaw~~
~~MINNESOTA~~
~~Becker~~
~~Big Stone~~
~~Blue Earth~~
~~Brown~~
~~Carver~~
~~Chippewa~~
~~Clay~~
~~Cottonwood~~
~~Dakota~~
~~Dodge~~
~~Douglas~~
~~Faribault~~
~~Fillmore~~
~~Freeborn~~
~~Goodhue~~
~~Grant~~
~~Hennepin~~
~~Houston~~
~~Hubbard~~
~~Jackson~~
~~Kanabec~~
~~Kandiyohi~~
~~Kittson~~
~~Lac Qui Parle~~
~~Le Sueur~~
~~Lincoln~~
~~Lyon~~
~~Mahnomen~~
~~Marshall~~
~~Martin~~
~~McLeod~~
~~Meeker~~
~~Mower~~
~~Murray~~
~~Nicollet~~
~~Watonwan~~
~~Wilkin~~
~~Winona~~
~~Wright~~
~~Yellow Medicine~~
~~MISSOURI~~
~~Andrew~~
~~Atchison~~
~~Buchanan~~
~~Cass~~
~~Clay~~
~~Clinton~~
~~Holt~~
~~Iron~~
~~Jackson~~
~~Nodaway~~
~~Platte~~
~~MONTANA~~
~~Beaverhead~~
~~Big Horn~~
~~Blaine~~
~~Broadwater~~
~~Carbon~~
~~Carter~~
~~Cascade~~
~~Chouteau~~
~~Custer~~
~~Daniels~~
~~Dawson~~
~~Deer Lodge~~
~~Fallon~~
~~Fergus~~
~~Flathead~~
~~Gallatin~~
~~Garfield~~
~~Glacier~~
~~Granite~~
~~Hill~~
~~Jefferson~~
~~Judith Basin~~
~~Lake~~
~~Lewis and Clark~~

~~Kiowa~~
~~Kit Carson~~
~~Lake~~
~~Larimer~~
~~Las Animas~~
~~Lincoln~~
~~Logan~~
~~Mesa~~
~~Moffat~~
~~Montezuma~~
~~Montrose~~
~~Morgan~~
~~Otero~~
~~Ouray~~
~~Park~~
~~Phillips~~
~~Pitkin~~
~~Prowers~~
~~Pueblo~~
~~Rio Blanco~~
~~San Miguel~~
~~Summit~~
~~Teller~~
~~Washington~~
~~Weld~~
~~Yuma~~

~~Douglas~~
~~Edgar~~
~~Ford~~
~~Fulton~~
~~Greene~~
~~Grundy~~
~~Hancock~~
~~Henderson~~
~~Henry~~
~~Iroquois~~
~~Jersey~~
~~Jo Daviess~~
~~Kane~~
~~Kendall~~
~~Knox~~
~~La Salle~~
~~Lee~~
~~Livingston~~
~~Logan~~
~~Macon~~
~~Marshall~~
~~Mason~~
~~McDonough~~
~~McLean~~
~~Menard~~
~~Mercer~~

~~Henry~~
~~Howard~~
~~Huntington~~
~~Jay~~
~~Jennings~~
~~Johnson~~
~~Kosciusko~~
~~LaGrange~~
~~Lawrence~~
~~Madison~~
~~Marion~~
~~Marshall~~
~~Miami~~
~~Monroe~~
~~Montgomery~~
~~Noble~~
~~Orange~~
~~Putnam~~
~~Randolph~~
~~Rush~~
~~Scott~~
~~Shelby~~
~~St. Joseph~~
~~Steuben~~
~~Tippecanoe~~
~~Tipton~~
~~Union~~
~~Vermillion~~

~~Marion~~
~~Marshall~~
~~McPherson~~
~~Meade~~
~~Mitchell~~
~~Nemaha~~
~~Ness~~
~~Norton~~
~~Osborne~~
~~Ottawa~~
~~Pawnee~~
~~Phillips~~
~~Pottawatomie~~
~~Pratt~~
~~Rawlins~~
~~Republic~~
~~Rice~~
~~Riley~~
~~Rooks~~
~~Rush~~
~~Saline~~
~~Scott~~
~~Sheridan~~
~~Sherman~~
~~Smith~~
~~Stanton~~
~~Thomas~~

~~Kennebec~~
~~Lincoln~~
~~Oxford~~
~~Penobscot~~
~~Piscataquis~~
~~Somerset~~
~~York~~
~~MARYLAND~~
~~Baltimore~~
~~Calvert~~
~~Carroll~~
~~Frederick~~
~~Harford~~
~~Howard~~
~~Montgomery~~
~~Washington~~
~~MASS.~~
~~Essex~~
~~Middlesex~~
~~Worcester~~
~~MICHIGAN~~
~~Branch~~
~~Calhoun~~
~~Cass~~

~~Nobles~~
~~Norman~~
~~Olmsted~~
~~Otter Tail~~
~~Pennington~~
~~Pipestone~~
~~Polk~~
~~Pope~~
~~Ramsey~~
~~Red Lake~~
~~Redwood~~
~~Renville~~
~~Rice~~
~~Rock~~
~~Roseau~~
~~Scott~~
~~Sherburne~~
~~Sibley~~
~~Stearns~~
~~Steele~~
~~Stevens~~
~~Swift~~
~~Todd~~
~~Traverse~~
~~Wabasha~~
~~Wadena~~
~~Waseca~~
~~Washington~~

~~Madison~~
~~McCone~~
~~Meagher~~
~~Missoula~~
~~Park~~
~~Phillips~~
~~Pondera~~
~~Powder River~~
~~Powell~~
~~Prairie~~
~~Ravalli~~
~~Richland~~
~~Roosevelt~~
~~Rosebud~~
~~Sanders~~
~~Sheridan~~
~~Silver Bow~~
~~Stillwater~~
~~Teton~~
~~Toole~~
~~Valley~~
~~Wibaux~~
~~Yellowstone~~

~~(continued)~~

~~TABLE AF101(1)—continued~~

~~HIGH RADON-POTENTIAL (ZONE 1) COUNTIES~~[a]

~~NEBRASKA~~
~~Adams~~
~~Boone~~
~~Boyd~~
~~Burt~~
~~Butler~~
~~Cass~~
~~Cedar~~
~~Clay~~
~~Colfax~~
~~Cuming~~
~~Dakota~~
~~Dixon~~
~~Dodge~~
~~Douglas~~
~~Fillmore~~
~~Franklin~~
~~Frontier~~
~~Furnas~~

~~Morris~~
~~Somerset~~
~~Sussex~~
~~Warren~~
~~NEW MEXICO~~
~~Bernalillo~~
~~Colfax~~
~~Mora~~
~~Rio Arriba~~
~~San Miguel~~
~~Santa Fe~~
~~Taos~~
~~NEW YORK~~
~~Albany~~
~~Allegany~~
~~Broome~~
~~Cattaraugus~~
~~Cayuga~~
~~Chautauqua~~

~~Columbiana~~
~~Coshocton~~
~~Crawford~~
~~Darke~~
~~Delaware~~
~~Fairfield~~
~~Fayette~~
~~Franklin~~
~~Greene~~
~~Guernsey~~
~~Hamilton~~
~~Hancock~~
~~Hardin~~
~~Harrison~~
~~Holmes~~
~~Huron~~
~~Jefferson~~
~~Knox~~
~~Licking~~

~~Lehigh~~
~~Luzerne~~
~~Lycoming~~
~~Mifflin~~
~~Monroe~~
~~Montgomery~~
~~Montour~~
~~Northampton~~
~~Northumberland~~
~~Perry~~
~~Schuylkill~~
~~Snyder~~
~~Sullivan~~
~~Susquehanna~~
~~Tioga~~
~~Union~~
~~Venango~~
~~Westmoreland~~
~~Wyoming~~

~~Union~~
~~Walworth~~
~~Yankton~~
~~TENNESEE~~
~~Anderson~~
~~Bedford~~
~~Blount~~
~~Bradley~~
~~Claiborne~~
~~Davidson~~
~~Giles~~
~~Grainger~~
~~Greene~~
~~Hamblen~~
~~Hancock~~
~~Hawkins~~
~~Hickman~~
~~Humphreys~~
~~Jackson~~

~~Fairfax~~
~~Falls Church~~
~~Fluvanna~~
~~Frederick~~
~~Fredericksburg~~
~~Giles~~
~~Goochland~~
~~Harrisonburg~~
~~Henry~~
~~Highland~~
~~Lee~~
~~Lexington~~
~~Louisa~~
~~Martinsville~~
~~Montgomery~~
~~Nottoway~~
~~Orange~~
~~Page~~
~~Patrick~~

~~Crawford~~
~~Dane~~
~~Dodge~~
~~Door~~
~~Fond du Lac~~
~~Grant~~
~~Green~~
~~Green Lake~~
~~Iowa~~
~~Jefferson~~
~~Lafayette~~
~~Langlade~~
~~Marathon~~
~~Menominee~~
~~Pepin~~
~~Pierce~~
~~Portage~~
~~Richland~~
~~Rock~~

~~Gage~~
~~Gosper~~
~~Greeley~~
~~Hamilton~~
~~Harlan~~
~~Hayes~~
~~Hitchcock~~
~~Hurston~~
~~Jefferson~~
~~Johnson~~
~~Kearney~~
~~Knox~~
~~Lancaster~~
~~Madison~~
~~Nance~~
~~Nemaha~~
~~Nuckolls~~
~~Otoe~~
~~Pawnee~~
~~Phelps~~
~~Pierce~~
~~Platte~~
~~Polk~~
~~Red Willow~~
~~Richardson~~
~~Saline~~
~~Sarpy~~
~~Saunders~~
~~Seward~~
~~Stanton~~
~~Thayer~~
~~Washington~~
~~Wayne~~
~~Webster~~
~~York~~
~~**NEVADA**~~
~~Carson City~~
~~Douglas~~
~~Eureka~~
~~Lander~~
~~Lincoln~~
~~Lyon~~
~~Mineral~~
~~Pershing~~
~~White Pine~~
~~**NEW HAMPSHIRE**~~
~~Carroll~~
~~**NEW JERSEY**~~
~~Hunterdon~~
~~Mercer~~
~~Monmouth~~

~~Chemung~~
~~Chenango~~
~~Columbia~~
~~Cortland~~
~~Delaware~~
~~Dutchess~~
~~Erie~~
~~Genesee~~
~~Greene~~
~~Livingston~~
~~Madison~~
~~Onondaga~~
~~Ontario~~
~~Orange~~
~~Otsego~~
~~Putnam~~
~~Rensselaer~~
~~Schoharie~~
~~Schuyler~~
~~Seneca~~
~~Steuben~~
~~Sullivan~~
~~Tioga~~
~~Tompkins~~
~~Ulster~~
~~Washington~~
~~Wyoming~~
~~Yates~~
~~**N. CAROLINA**~~
~~Alleghany~~
~~Buncombe~~
~~Cherokee~~
~~Henderson~~
~~Mitchell~~
~~Rockingham~~
~~Transylvania~~
~~Watauga~~
~~**N. DAKOTA**~~
~~All Counties~~
~~**OHIO**~~
~~Adams~~
~~Allen~~
~~Ashland~~
~~Auglaize~~
~~Belmont~~
~~Butler~~
~~Carroll~~
~~Champaign~~
~~Clark~~
~~Clinton~~
~~P~~

~~Logan~~
~~Madison~~
~~Marion~~
~~Mercer~~
~~Miami~~
~~Montgomery~~
~~Morrow~~
~~Muskingum~~
~~Perry~~
~~Pickaway~~
~~Pike~~
~~Preble~~
~~Richland~~
~~Ross~~
~~Seneca~~
~~Shelby~~
~~Stark~~
~~Summit~~
~~Tuscarawas~~
~~Union~~
~~Van Wert~~
~~Warren~~
~~Wayne~~
~~Wyandot~~
~~**PENNSYLVANIA**~~
~~Adams~~
~~Allegheny~~
~~Armstrong~~
~~Beaver~~
~~Bedford~~
~~Berks~~
~~Blair~~
~~Bradford~~
~~Bucks~~
~~Butler~~
~~Cameron~~
~~Carbon~~
~~Centre~~
~~Chester~~
~~Clarion~~
~~Clearfield~~
~~Clinton~~
~~Columbia~~
~~Cumberland~~
~~Dauphin~~
~~Delaware~~
~~Franklin~~
~~Fulton~~
~~Huntingdon~~
~~Indiana~~
~~Juniata~~
~~Lackawanna~~

~~York~~
~~**RHODE ISLAND**~~
~~Kent~~
~~Washington~~
~~**S. CAROLINA**~~
~~Greenville~~
~~**S. DAKOTA**~~
~~Aurora~~
~~Beadle~~
~~Bon Homme~~
~~Brookings~~
~~Brown~~
~~Brule~~
~~Buffalo~~
~~Campbell~~
~~Charles Mix~~
~~Clark~~
~~Clay~~
~~Codington~~
~~Corson~~
~~Davison~~
~~Day~~
~~Deuel~~
~~Douglas~~
~~Edmunds~~
~~Faulk~~
~~Grant~~
~~Hamlin~~
~~Hand~~
~~Hanson~~
~~Hughes~~
~~Hutchinson~~
~~Hyde~~
~~Jerauld~~
~~Kingsbury~~
~~Lake~~
~~Lincoln~~
~~Lyman~~
~~Marshall~~
~~McCook~~
~~McPherson~~
~~Miner~~
~~Minnehaha~~
~~Moody~~
~~Perkins~~
~~Potter~~
~~Roberts~~
~~Sanborn~~
~~Spink~~
~~Stanley~~
~~Sully~~
~~Turner~~

~~Jefferson~~
~~Knox~~
~~Lawrence~~
~~Lewis~~
~~Lincoln~~
~~Loudon~~
~~Marshall~~
~~Maury~~
~~McMinn~~
~~Meigs~~
~~Monroe~~
~~Moore~~
~~Perry~~
~~Roane~~
~~Rutherford~~
~~Smith~~
~~Sullivan~~
~~Trousdale~~
~~Union~~
~~Washington~~
~~Wayne~~
~~Williamson~~
~~Wilson~~
~~UTAH~~
~~Carbon~~
~~Duchesne~~
~~Grand~~
~~Piute~~
~~Sanpete~~
~~Sevier~~
~~Uintah~~
~~**VIRGINIA**~~
~~Alleghany~~
~~Amelia~~
~~Appomattox~~
~~Augusta~~
~~Bath~~
~~Bland~~
~~Botetourt~~
~~Bristol~~
~~Brunswick~~
~~Buckingham~~
~~Buena Vista~~
~~Campbell~~
~~Chesterfield~~
~~Clarke~~
~~Clifton Forge~~
~~Covington~~
~~Craig~~
~~Cumberland~~
~~Danville~~
~~Dinwiddie~~

~~Pittsylvania~~
~~Powhatan~~
~~Pulaski~~
~~Radford~~
~~Roanoke~~
~~Rockbridge~~
~~Rockingham~~
~~Russell~~
~~Salem~~
~~Scott~~
~~Shenandoah~~
~~Smyth~~
~~Spotsylvania~~
~~Stafford~~
~~Staunton~~
~~Tazewell~~
~~Warren~~
~~Washington~~
~~Waynesboro~~
~~Winchester~~
~~Wythe~~
~~**WASHINGTON**~~
~~Clark~~
~~Ferry~~
~~Okanogan~~
~~Pend Oreille~~
~~Skamania~~
~~Spokane~~
~~Stevens~~
~~**W. VIRGINIA**~~
~~Berkeley~~
~~Brooke~~
~~Grant~~
~~Greenbrier~~
~~Hampshire~~
~~Hancock~~
~~Hardy~~
~~Jefferson~~
~~Marshall~~
~~Mercer~~
~~Mineral~~
~~Monongalia~~
~~Monroe~~
~~Morgan~~
~~Ohio~~
~~Pendleton~~
~~Pocahontas~~
~~Preston~~
~~Summers~~
~~Wetzel~~
~~**WISCONSIN**~~
~~Buffalo~~

~~Shawano~~
~~St. Croix~~
~~Vernon~~
~~Walworth~~
~~Washington~~
~~Waukesha~~
~~Waupaca~~
~~Wood~~
~~**WYOMING**~~
~~Albany~~
~~Big Horn~~
~~Campbell~~
~~Carbon~~
~~Converse~~
~~Crook~~
~~Fremont~~
~~Goshen~~
~~Hot Springs~~
~~Johnson~~
~~Laramie~~
~~Lincoln~~
~~Natrona~~
~~Niobrara~~
~~Park~~
~~Sheridan~~
~~Sublette~~
~~Sweetwater~~
~~Teton~~
~~Uinta~~
~~Washakie~~

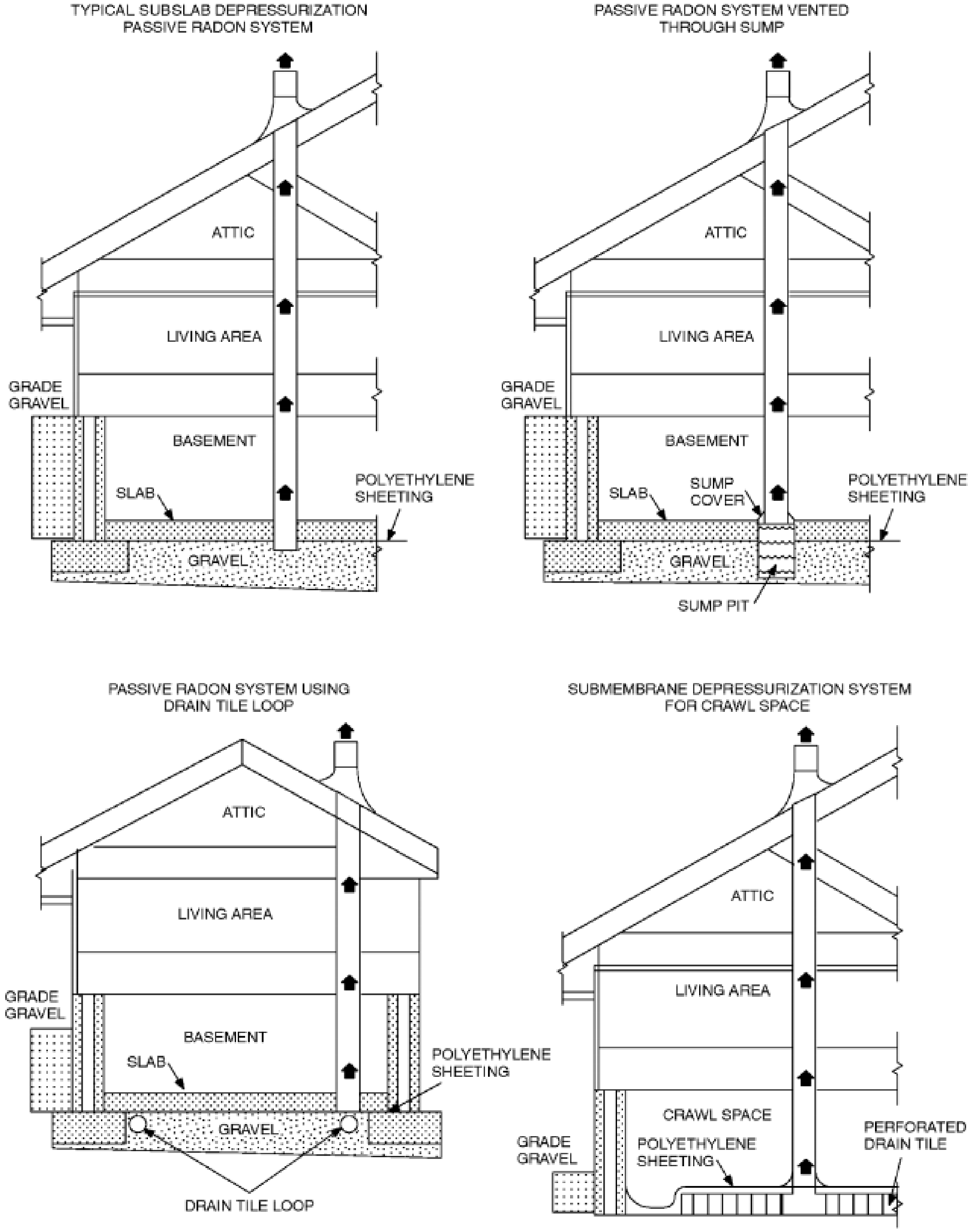
~~Lancaster~~
~~Lebanon~~

~~a. The EPA recommends that this county listing be supplemented with other available State and local data to further understand the radon potential of a Zone 1 area.~~

~~**AF101.1 General.**~~
~~This appendix contains requirements for new construction in *jurisdictions* where radon-resistant construction is required. These requirements are intended to provide a passive means of resisting radon gas entry and prepare the *dwelling* for post-construction radon mitigation, if necessary (see Figure AF102). Active construction techniques, rather than passive techniques, shall be permitted to be used where approved.~~

~~Inclusion of this appendix by *jurisdictions* shall be determined through the use of locally available data or determination of Zone 1 designation in Figure AF101 and Table AF101(1).~~

~~SECTION AF102~~
~~DEFINITIONS~~



~~FIGURE AF102~~
~~RADON-RESISTANT CONSTRUCTION DETAILS FOR FOUR FOUNDATION TYPES~~

~~AF102.1 General.~~

~~For the purpose of these requirements, the terms used shall be defined as follows:~~

~~**DRAIN TILE LOOP.** A continuous length of drain tile or perforated pipe extending around all or part of the internal or external perimeter of a *basement* or crawl space footing.~~

~~**ENCLOSED CRAWL SPACE.** A crawl space that is enclosed with foundation walls inclusive of any windows, doors, access openings and required vents.~~

~~**GAS-PERMEABLE LAYER.** A gas-permeable layer shall consist of one of the following:~~

1. ~~A uniform layer of clean aggregate that is not less than 4 inches (102 mm) thick. The aggregate shall consist of material that will pass through a 2-inch (51 mm) sieve and be retained by a $^{1}/_{4}$-inch (6.4 mm) sieve.~~

2. ~~A uniform layer of sand (native or fill) that is not less than 4 inches (102 mm) thick and that is overlain by a soil gas collection mat or soil gas matting installed in accordance with the manufacturer's instructions.~~

~~**RADON GAS.** A naturally occurring, chemically inert, radioactive gas.~~

~~**SOIL-GAS-RETARDER.** A continuous membrane of 6-mil (0.15 mm) polyethylene used to retard the flow of soil gases into a *dwelling*.~~

~~**SUBMEMBRANE DEPRESSURIZATION SYSTEM.** A system designed to achieve lower submembrane air pressure relative to basement or crawl space air pressure by use of a vent drawing air from beneath the soil-gas-retarder membrane.~~

~~**SUBSLAB DEPRESSURIZATION SYSTEM (Passive).** A system designed to achieve lower subslab air pressure relative to indoor air pressure by use of a vent pipe drawing air from beneath concrete floor slabs or other floor assemblies that are in contact with the ground.~~

~~**VENT PIPE.** Not less than a 3-inch-diameter (76 mm) ABS or PVC gas-tight pipe extending from the gas permeable layer through the roof.~~

~~SECTION AF103~~
~~PASSIVE RADON-RESISTANT SYSTEM REQUIREMENTS~~

~~**AF103.1 General.**~~
~~The following components of a passive submembrane or subslab depressurization system shall be installed during construction.~~

~~**AF103.2 Entry routes.**~~
~~Potential radon entry routes shall be closed in accordance with Sections AF103.2.1 through AF103.2.8.~~

~~**AF103.2.1 Floor openings.**~~
~~Openings around bathtubs, showers, water closets, pipes, wires or other objects that~~

~~penetrate concrete slabs, or other floor assemblies, shall be filled with a polyurethane caulk or expanding foam applied in accordance with the manufacturer's instructions.~~

~~AF103.2.2 Sumps.~~
~~Sumps open to soil or serving as the termination point for subslab or exterior drain tile loops shall be covered with a gasketed or sealed lid. Sumps used as the suction point in a subslab depressurization system shall have a lid designed to accommodate the vent pipe. Sumps used as a floor drain shall have a lid equipped with a trapped inlet.~~

~~AF103.2.3 Foundation walls.~~
~~Hollow block masonry foundation walls shall be constructed with a continuous course of *solid masonry*, one course of masonry grouted solid, or a solid concrete beam at or above *grade.* Where a brick veneer or other masonry ledge is installed, the course immediately below that ledge shall be *solid masonry*, one course of masonry grouted solid, or a solid concrete beam. Joints, cracks or other openings around penetrations of both exterior and interior surfaces of foundation walls below *grade* shall be filled with polyurethane caulk.~~

~~AF103.2.4 Dampproofing.~~
~~The exterior surfaces of foundation walls below *grade* shall be dampproofed in accordance with Section R406.~~

~~AF103.2.5 Air-conditioning systems.~~
~~Entry points, joints or other openings into air-conditioning systems in enclosed crawl spaces shall be sealed.~~

> ~~**Exception:** Systems with gasketed seams or that are otherwise sealed by the manufacturer.~~

~~AF103.2.6 Ducts.~~
~~Ductwork passing through or beneath a slab within a *dwelling* shall be of seamless material unless the air-conditioning system is designed to maintain continuous positive pressure within such ducting. Joints in such ductwork shall be sealed.~~

~~Ductwork located in enclosed crawl spaces shall have seams and joints sealed by closure systems in accordance with Section M1601.4.1.~~

~~AF103.2.7 Crawl space access.~~
~~Access doors and other openings or penetrations between *basements* and adjoining crawl spaces shall be closed, gasketed or sealed.~~

~~AF103.3 Basements or enclosed crawl spaces with soil floors.~~
~~In *dwellings* with *basements* or enclosed crawl spaces with soil floors, the following components of a passive submembrane depressurization system shall be installed during construction.~~

> ~~**Exception:** *Basements* or enclosed crawl spaces that are provided with a continuously operated mechanical exhaust system in accordance with Section R408.3.~~

~~AF103.3.1 Soil-gas-retarder.~~
~~The soil in *basements* and enclosed crawl spaces shall be covered with a soil-gas-retarder. The soil-gas-retarder shall be lapped not less than 12 inches (305 mm) at joints and shall~~

~~extend to foundation walls enclosing the *basement* or crawl space. The soil-gas-retarder shall fit closely around any pipe, wire or other penetrations of the material. Punctures or tears in the material shall be sealed or covered with additional sheeting.~~

~~AF103.3.2 "T" fitting and vent pipe.~~

~~A 3- or 4-inch "T" fitting shall be inserted beneath the soil-gas-retarder and be connected to a vent pipe. The vent pipe shall extend through the *conditioned space* of the *dwelling* and terminate not less than 12 inches (305 mm) above the roof in a location not less than 10 feet (3048 mm) away from any window or other opening into the *conditioned spaces* of the building that is less than 2 feet (610 mm) below the exhaust point.~~

~~AF103.4 Basements or enclosed crawl spaces with concrete floors or other floor systems and slab-on-grade dwellings.~~

~~The following components of a passive subslab depressurization system shall be installed during construction in slab-on-*grade dwellings* or in *dwellings* with *basements* or crawl spaces with concrete or other floor systems.~~

~~AF103.4.1 Sub-slab preparation.~~

~~A layer of gas-permeable material shall be placed under concrete slabs and other floor systems that directly contact the ground and are within the walls of the dwelling.~~

~~AF103.4.2 Soil-gas-retarder.~~

~~A soil-gas-retarder shall be placed on top of the gas-permeable layer prior to casting the slab or placing the floor assembly. The soil-gas-retarder shall cover the entire floor area with separate sections lapped not less than 12 inches (305 mm). The soil-gas-retarder shall fit closely around any pipe, wire, or other penetrations of the material. Punctures or tears in the material shall be sealed or covered.~~

~~AF103.4.3 "T" fitting and vent pipe.~~

~~Before a slab is cast or other floor system is installed, a "T" fitting shall be inserted below the slab or other floor system and the soil-gas-retarder. The "T" fitting shall be connected to a vent pipe. The vent pipe shall extend through the *conditioned space* of the *dwelling* and terminate not less than 12 inches (305 mm) above the roof in a location not less than 10 feet (3048 mm) away from any window or other opening into the *conditioned spaces* of the building that is less than 2 feet (610 mm) below the exhaust point.~~

~~AF103.5 Drain tile and sump used for depressurization.~~

~~As an alternative to inserting a vent pipe into a "T" fitting, a vent pipe shall be permitted to be inserted directly into an interior perimeter drain tile loop or through a sump cover where the drain tile or sump is exposed to the gas-permeable layer.~~

~~AF103.6 Multiple vent pipes.~~

~~In *dwellings* where interior footings or other barriers separate the gas-permeable layer, each area shall be fitted with an individual vent pipe. Vent pipes shall connect to a single vent that terminates above the roof or each individual vent pipe shall terminate separately above the roof.~~

~~AF103.7 Combination foundations.~~

~~Where *basement* or crawl space floors are on different levels, each level shall have a separate vent pipe. Multiple vent pipes shall be permitted to be connected to a single vent pipe that terminates above the roof.~~

~~AF103.8 Vent pipe drainage.~~

~~Components of the radon vent pipe system shall be installed to provide positive drainage to the ground beneath the soil-gas-retarder.~~

~~AF103.9 Vent pipe identification.~~

~~Exposed and visible interior vent pipes shall be identified with not less than one *label* on each floor and in accessible *attics*. The *label* shall read:"Radon Reduction System."~~

~~AF103.10 Power source and access for future radon fan.~~

~~To provide for future installation of a radon fan, an electrical circuit terminated in an *approved* box shall be installed during construction in the anticipated location of the radon fans. An accessible clear space 24 inches (610 mm) in diameter by 3 feet (914 mm) in height adjacent to the vent pipe shall be provided at the anticipated location of a future radon fan.~~

APPENDIX G

PIPING STANDARDS FOR VARIOUS APPLICATIONS

(The provisions contained in this appendix are adopted as part of this code.)

APPENDIX H

PATIO COVERS

Deleted

~~(The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.)~~

~~SECTION AH101~~
~~GENERAL~~

~~AH101.1 Scope.~~
~~Patio covers shall conform to the requirements of Sections AH101 through AH106.~~

~~AH101.2 Permitted uses.~~
~~Patio covers shall be permitted to be detached from or attached to *dwelling units*. Patio covers shall be used only for recreational, outdoor living purposes, and not as carports, garages, storage rooms or habitable rooms.~~

~~SECTION AH102~~
~~DEFINITION~~

~~AH102.1 General.~~
~~The following word and term shall, for the purposes of this appendix, have the meaning shown herein.~~

~~PATIO COVER.~~ ~~A structure with open or glazed walls that is used for recreational, outdoor living purposes associated with a dwelling unit.~~

~~SECTION AH103~~
~~EXTERIOR WALLS AND OPENINGS~~

~~AH 103.1 Enclosure walls.~~
~~Enclosure walls shall be permitted to be of any configuration, provided the open or glazed area of the longer wall and one additional wall is equal to at least 65 percent of the area below a minimum of 6 feet, 8 inches (2032 mm) of each wall, measured from the floor. Openings shall be permitted to be enclosed with any of the following:~~

1. ~~Insect screening.~~
2. ~~Approved translucent or transparent plastic not more than 0.125 inch (3.2 mm) in thickness.~~
3. ~~Glass conforming to the provisions of Section R308.~~
4. ~~Any combination of the foregoing.~~

~~AH103.2 Light, ventilation and emergency egress.~~
~~Exterior openings required for light and ventilation shall be permitted to open into a patio structure conforming to Section AH101, provided that the patio structure shall be unenclosed if such openings are serving as emergency egress or rescue openings from sleeping rooms. Where such exterior openings serve as an exit from the *dwelling unit*, the patio structure, unless unenclosed, shall be provided with exits conforming to the provisions of Section R311 of this code.~~

~~SECTION AH104~~
~~HEIGHT~~

~~AH104.1 Height.~~
~~Patio covers are limited to one-story structures not exceeding 12 feet (3657 mm) in height.~~

~~SECTION AH105~~
~~STRUCTURAL PROVISIONS~~

~~AH105.1 Design loads.~~
~~Patio covers shall be designed and constructed to sustain, within the stress limits of this code, all dead loads plus a vertical live load of not less than 10 pounds per square foot (0.48 kN/m^2), except that snow loads shall be used where such snow loads exceed this minimum. Such covers shall be designed to resist the minimum wind loads set forth in Section R301.2.1.~~

~~AH105.2 Footings.~~
~~In areas with a frostline depth of zero as specified in Table R301.2(1), a patio cover shall be permitted to be supported on a slab-on-*grade* without footings, provided the slab conforms to the provisions of Section R506, is not less than 3.5 inches (89 mm) thick and the columns do not support live and dead loads in excess of 750 pounds (3.34 kN) per column.~~

~~SECTION AH106~~
~~SPECIAL PROVISIONS FOR ALUMINUM SCREEN ENCLOSURES IN HURRICANE-PRONE REGIONS~~

~~AH106.1 General.~~
~~Screen enclosures in *hurricane-prone regions* shall be in accordance with the provisions of this section.~~

~~AH106.1.1 Habitable spaces.~~
~~Screen enclosures shall not be considered *habitable spaces*.~~

~~AH106.1.2 Minimum ceiling height.~~
~~Screen enclosures shall have a ceiling height of not less than 7 feet (2134 mm).~~

~~AH106.2 Definition.~~
~~The following word and term shall, for the purposes of this appendix, have the meaning shown herein.~~

~~SCREEN ENCLOSURE.~~ ~~A building or part thereof, in whole or in part self-supporting, and having walls of insect screening, and a roof of insect screening, plastic, aluminum or similar lightweight material.~~

~~AH106.3 Screen enclosures.~~

~~Screen enclosures shall comply with Sections AH106.3.1 and AH106.3.2.~~

~~AH106.3.1 Thickness.~~

~~Actual wall thickness of extruded aluminum members shall be not less than 0.040 inch (1.02 mm).~~

~~AH106.3.2 Density.~~

~~Screen density shall be not more than 20 threads per inch by 20 threads per inch mesh.~~

~~AH106.4 Design.~~

~~The structural design of screen enclosures shall comply with Sections AH106.4.1 through AH106.4.3.~~

~~TABLE AH106.4(1)~~

~~DESIGN WIND PRESSURES FOR SCREEN ENCLOSURE FRAMING~~[~~a, b, e, f, g, h~~]

~~LOAD CASE~~	~~WALL~~	~~ULTIMATE DESIGN WIND SPEED, V_{ult} (mph)~~									
		~~100~~	~~105~~	~~110~~	~~120~~	~~130~~	~~140~~	~~150~~	~~160~~	~~170~~	~~180~~
		~~Exposure Category B Design Pressure (psf)~~									
~~A~~[~~c~~]	~~Windward and leeward walls (flow thru) and windward wall (nonflow thru) *L/W* = 0-1~~	~~6~~	~~7~~	~~8~~	~~9~~	~~11~~	~~13~~	~~14~~	~~16~~	~~18~~	~~21~~
~~A~~[~~c~~]	~~Windward and leeward walls (flow thru) and windward wall (nonflow thru) *L/W* = 2~~	~~7~~	~~8~~	~~9~~	~~11~~	~~12~~	~~14~~	~~16~~	~~19~~	~~21~~	~~24~~
~~B~~[~~d~~]	~~Windward: Nongable roof~~	~~9~~	~~10~~	~~11~~	~~13~~	~~15~~	~~18~~	~~21~~	~~23~~	~~26~~	~~30~~
~~B~~[~~d~~]	~~Windward: Gable roof~~	~~11~~	~~13~~	~~14~~	~~16~~	~~19~~	~~22~~	~~26~~	~~29~~	~~33~~	~~37~~
~~-~~	**~~ROOF~~**										
~~All~~[~~e~~]	~~Roof-screen~~	~~2~~	~~3~~	~~3~~	~~3~~	~~4~~	~~4~~	~~5~~	~~6~~	~~7~~	~~7~~
~~All~~[~~e~~]	~~Roof-solid~~	~~7~~	~~8~~	~~8~~	~~10~~	~~12~~	~~13~~	~~15~~	~~18~~	~~20~~	~~22~~

~~For SI: 1 mile per hour = 0.44 m/s, 1 pound per square foot = 0.0479 kPa, 1 foot = 304.8 mm.~~

~~a. Design pressure shall be not less than 10 psf in accordance with Section AH106.4.1.~~

~~b. Loads are applicable to screen enclosures with a mean roof height of 30 feet or less in Exposure B. For screen enclosures of different heights or exposure, the pressures given shall be adjusted by multiplying the table pressure by the adjustment factor given in Table AH106.4(2).~~

~~c. For Load Case A flow thru condition, the pressure given shall be applied simultaneously to both the upwind and downwind screen walls acting in the same direction as the wind. The structure shall also be analyzed for wind~~

~~coming from the opposite direction. For the nonflow thru condition, the screen enclosure wall shall be analyzed for the load applied acting toward the interior of the enclosure.~~

~~d. For Load Case B, the table pressure multiplied by the projected frontal area of the screen enclosure is the total drag force, including drag on screen surfaces parallel to the wind, that must be transmitted to the ground. Use Load Case A for members directly supporting the screen surface perpendicular to the wind. Load Case B loads shall be applied only to structural members that carry wind loads from more than one surface.~~

~~e. The roof structure shall be analyzed for the pressure given occurring both upward and downward.~~

~~f. Table pressures are MWFRS loads. The design of solid roof panels and their attachments shall be based on component and cladding loads for enclosed or partially enclosed structures as appropriate.~~

~~g. Table pressures apply to 20-inch by 20-inch by 0.013-inch mesh screen. For 18-inch by 14-inch by 0.013-inch mesh screen, pressures on screen surfaces shall be permitted to be multiplied by 0.88. For screen densities greater than 20 inches by 20 inches by 0.013 inch, pressures for enclosed buildings shall be used.~~

~~h. Linear interpolation shall be permitted.~~

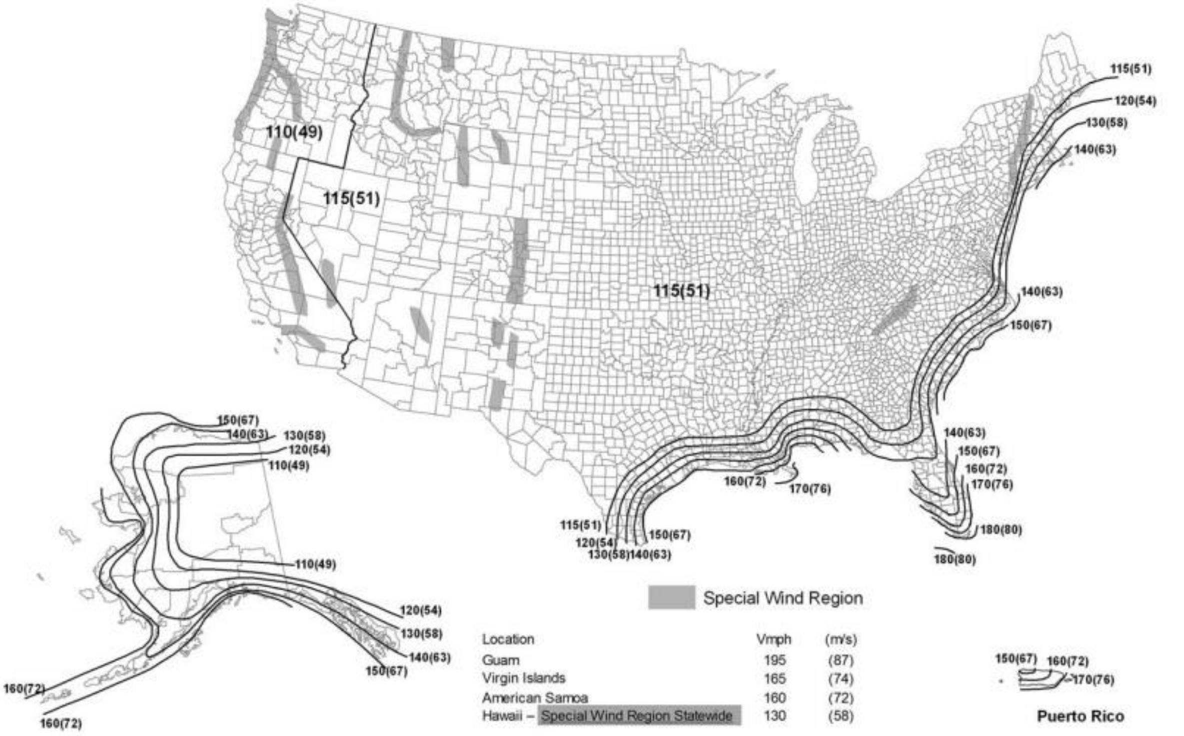
~~TABLE AH106.4(2)~~
~~ADJUSTMENT FACTOR FOR BUILDING HEIGHT AND EXPOSURE~~

~~MEAN ROOF HEIGHT (feet)~~	~~EXPOSURE~~		
	~~B~~	~~C~~	~~D~~
~~15~~	~~1.00~~	~~1.21~~	~~1.47~~
~~20~~	~~1.00~~	~~1.29~~	~~1.55~~
~~25~~	~~1.00~~	~~1.35~~	~~1.61~~
~~30~~	~~1.00~~	~~1.40~~	~~1.66~~
~~35~~	~~1.05~~	~~1.45~~	~~1.70~~
~~40~~	~~1.09~~	~~1.49~~	~~1.74~~
~~45~~	~~1.12~~	~~1.53~~	~~1.78~~
~~50~~	~~1.16~~	~~1.56~~	~~1.81~~
~~55~~	~~1.19~~	~~1.59~~	~~1.84~~
~~60~~	~~1.22~~	~~1.62~~	~~1.87~~

~~For SI: 1 foot = 304.8 mm.~~

~~AH106.4.1 Wind load.~~

~~Structural members supporting screen enclosures shall be designed to support the minimum wind loads given in Tables AH106.4(1) and AH106.4(2) for the ultimate design wind speed,~~ ~~V_{ult}~~~~, determined from Figure AH106.4.1. Where any value is less than 10 pounds per square foot (psf) (0.479 kN/m^2) use 10 pounds per square foot (0.479 kN/m^2).~~



Location	Vmph	(m/s)
Guam	195	(87)
Virgin Islands	165	(74)
American Samoa	160	(72)
Hawaii – Special Wind Region Statewide	130	(58)

Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

~~FIGURE AH106.4.1~~
~~ULTIMATE DESIGN WIND SPEEDS FOR PATIO COVERS AND SCREEN ENCLOSURES~~

~~AH106.4.2 Deflection limit.~~

~~For members supporting screen surfaces only, the total load deflection shall not exceed *l*/60. Screen surfaces shall be permitted to include not more than 25-percent solid flexible finishes.~~

~~AH106.4.3 Roof live load.~~

~~The roof live load shall be not less than 10 psf (0.479 kN/m^2).~~

~~AH106.5 Footings.~~

~~In areas with a frost line depth of zero, a screen enclosure shall be permitted to be supported on a concrete slab-on-*grade* without footings, provided the slab conforms to the provisions of Section R506, is not less than 3$^1/_2$ inches (89 mm) thick and the columns do not support loads in excess of 750 pounds (3.36 kN) per column.~~

APPENDIX I

PRIVATE SEWAGE DISPOSAL

Deleted

~~(The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.)~~

~~SECTION AI101~~
~~GENERAL~~

~~AI101.1 Scope.~~
~~Private sewage disposal systems shall conform to the~~ *~~International Private Sewage Disposal Code.~~*

APPENDIX J

EXISTING BUILDINGS AND STRUCTURES

Deleted. See *North Carolina Existing Building Code.*

~~***(The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.)***~~

~~SECTION AJ101~~
~~PURPOSE AND INTENT~~

~~**AJ101.1 General.**~~
~~The purpose of these provisions is to encourage the continued use or reuse of legally existing buildings and structures. These provisions are intended to permit work in existing buildings that is consistent with the purpose of this code. Compliance with these provisions shall be deemed to meet the requirements of this code.~~

~~**AJ101.2 Classification of work.**~~
~~For purposes of this appendix, work in existing buildings shall be classified into the categories of repair, renovation, *alteration* and reconstruction. Specific requirements are established for each category of work in these provisions.~~

~~**AJ101.3 Multiple categories of work.**~~
~~Work of more than one category shall be part of a single work project. Related work permitted within a 12-month period shall be considered to be a single work project. Where a project includes one category of work in one building area and another category of work in a separate and unrelated area of the building, each project area shall comply with the requirements of the respective category of work. Where a project with more than one category of work is performed in the same area or in related areas of the building, the project shall comply with the requirements of the more stringent category of work.~~

~~SECTION AJ102~~
~~COMPLIANCE~~

~~**AJ102.1 General.**~~
~~Regardless of the category of work being performed, the work shall not cause the structure to become unsafe or adversely affect the performance of the building; shall not cause an existing mechanical or plumbing system to become unsafe, hazardous, insanitary or overloaded; and unless expressly permitted by these provisions, shall not make the building any less compliant with this code or to any previously *approved* alternative arrangements than it was before the work was undertaken.~~

~~**AJ102.2 Requirements by category of work.**~~
~~Repairs shall conform to the requirements of Section AJ301. Renovations shall conform to the requirements of Section AJ401. *Alterations* shall conform to the requirements of Section AJ501 and the requirements for renovations. Reconstructions shall conform to the requirements of Section AJ601 and the requirements for *alterations* and renovations.~~

~~AJ102.3 Smoke detectors.~~

~~Regardless of the category of work, smoke detectors shall be provided where required by Section R314.3.1.~~

~~AJ102.4 Replacement windows.~~

~~Regardless of the category of work, where an existing window, including the sash and glazed portion, or safety glazing is replaced, the replacement window or safety glazing shall comply with the requirements of Sections AJ102.4.1 through AJ102.4.3, as applicable.~~

~~AJ102.4.1 Energy efficiency.~~

~~Replacement windows shall comply with the requirements of Chapter 11.~~

~~AJ102.4.2 Safety glazing.~~

~~Replacement glazing in hazardous locations shall comply with the safety glazing requirements of Section R308.~~

~~AJ102.4.3 Emergency escape and rescue openings.~~

~~Where windows are required to provide emergency escape and rescue openings, replacement windows shall be exempt from the maximum sill height requirements of Section R310.1 and the requirements of Sections R310.1.1, R310.1.2, R310.1.3 and R310.2 provided that the replacement window meets the following conditions:~~

1. ~~The replacement window is the manufacturer’s largest standard size window that will fit within the existing frame or existing rough opening. The replacement window shall be permitted to be of the same operating style as the existing window or a style that provides for an equal or greater window opening area than the existing window.~~

2. ~~The replacement window is not part of a change of occupancy.~~

3. ~~Window opening control devices complying with ASTM F 2090 shall be permitted for use on windows required to provide emergency escape and rescue openings.~~

~~AJ102.4.4 Window control devices.~~

~~Where window fall prevention devices complying with ASTM F 2090 are not provided, window opening control devices complying with ASTM F 2090 shall be installed where an existing window is replaced and where all of the following apply to the replacement window:~~

1. ~~The window is operable.~~

2. ~~The window replacement includes replacement of the sash and the frame.~~

3. ~~The top of the sill of the window opening is at a height less than 24 inches (610 mm) above the finished floor.~~

4. ~~The window will permit openings that will allow passage of a 4-inch-diameter (102 mm) sphere where the window is in its largest opened position.~~

5. ~~The vertical distance from the top of the sill of the window opening to the finished grade or other surface below, on the exterior of the building, is greater than 72 inches (1829 mm).~~

~~The window opening control device, after operation to release the control device allowing the window to fully open, shall not reduce the minimum net clear opening area of the window unit.~~

~~**AJ102.5 Flood hazard areas.**~~

~~Work performed in existing buildings located in a flood hazard area as established by Table R301.2(1) shall be subject to the provisions of Section R105.3.1.1.~~

~~**AJ102.6 Equivalent alternatives.**~~

~~Work performed in accordance with the *International Existing Building Code* shall be deemed to comply with the provisions of this appendix. These provisions are not intended to prevent the use of any alternative material, alternative design or alternative method of construction not specifically prescribed herein, provided that any alternative has been deemed to be equivalent and its use authorized by the *building official*.~~

~~**AJ102.7 Other alternatives.**~~

~~Where compliance with these provisions or with this code as required by these provisions is technically infeasible or would impose disproportionate costs because of construction or dimensional difficulties, the building official shall have the authority to accept alternatives. These alternatives include materials, design features and operational features.~~

~~**AJ102.8 More restrictive requirements.**~~

~~Buildings or systems in compliance with the requirements of this code for new construction shall not be required to comply with any more restrictive requirement of these provisions.~~

~~**AJ102.9 Features exceeding code requirements.**~~

~~Elements, components and systems of existing buildings with features that exceed the requirements of this code for new construction, and are not otherwise required as part of *approved* alternative arrangements or deemed by the *building official* to be required to balance other building elements not complying with this code for new construction, shall not be prevented by these provisions from being modified as long as they remain in compliance with the applicable requirements for new construction.~~

~~SECTION AJ103~~
~~PRELIMINARY MEETING~~

~~**AJ103.1 General.**~~

~~If a building *permit* is required at the request of the prospective *permit* applicant, the *building official* or his or her designee shall meet with the prospective applicant to discuss plans for any proposed work under these provisions prior to the application for the *permit*. The purpose of this preliminary meeting is for the *building official* to gain an understanding of the prospective applicant's intentions for the proposed work, and to determine, together with the prospective applicant, the specific applicability of these provisions.~~

~~SECTION AJ104~~
~~EVALUATION OF AN EXISTING BUILDING~~

~~AJ104.1 General.~~

~~The *building official* shall have the authority to require an existing building to be investigated and evaluated by a registered *design professional* in the case of proposed reconstruction of any portion of a building. The evaluation shall determine the existence of any potential nonconformities to these provisions, and shall provide a basis for determining the impact of the proposed changes on the performance of the building. The evaluation shall use the following sources of information, as applicable:~~

1. ~~Available documentation of the existing building.~~

    ~~1.1 .Field surveys.~~

    ~~1.2 .Tests (nondestructive and destructive).~~

    ~~1.3 .Laboratory analysis.~~

~~Exception:~~ ~~Detached one- or two-family dwellings that are not irregular buildings under Section R301.2.2.2.5 and are not undergoing an extensive reconstruction shall not be required to be evaluated.~~

~~SECTION AJ105~~
~~PERMIT~~

~~AJ105.1 Identification of work area.~~

~~The work area shall be clearly identified on the *permits* issued under these provisions.~~

~~SECTION AJ201~~
~~DEFINITIONS~~

~~AJ201.1 General.~~

~~For purposes of this appendix, the terms used are defined as follows.~~

~~ALTERATION.~~ ~~The reconfiguration of any space; the *addition* or elimination of any door or window; the reconfiguration or extension of any system; or the installation of any additional *equipment*.~~

~~CATEGORIES OF WORK.~~ ~~The nature and extent of construction work undertaken in an existing building. The categories of work covered in this appendix, listed in increasing order of stringency of requirements, are repair, renovation, *alteration* and reconstruction.~~

~~DANGEROUS.~~ ~~Where the stresses in any member; the condition of the building, or any of its components or elements or attachments; or other condition that results in an overload exceeding 150 percent of the stress allowed for the member or material in this code.~~

~~EQUIPMENT OR FIXTURE.~~ ~~Any plumbing, heating, electrical, ventilating, air-conditioning, refrigerating and fire protection *equipment*; and elevators, dumb waiters, boilers, pressure vessels, and other mechanical facilities or installations that are related to building services.~~

~~**LOAD-BEARING ELEMENT.** Any column, girder, beam, joist, truss, rafter, wall, floor or roof sheathing that supports any vertical load in addition to its own weight, or any lateral load.~~

~~**MATERIALS AND METHODS REQUIREMENTS.** Those requirements in this code that specify material standards; details of installation and connection; joints; penetrations; and continuity of any element, component or system in the building. The required quantity, fire resistance, flame spread, acoustic or thermal performance, or other performance attribute is specifically excluded from materials and methods requirements.~~

~~**RECONSTRUCTION.** The reconfiguration of a space that affects an exit, a renovation or *alteration* where the work area is not permitted to be occupied because existing means-of-egress and fire protection systems, or their equivalent, are not in place or continuously maintained; or there are extensive *alterations* as defined in Section AJ501.3.~~

~~**REHABILITATION.** Any repair, renovation, *alteration* or reconstruction work undertaken in an existing building.~~

~~**RENOVATION.** The change, strengthening or *addition* of load-bearing elements; or the refinishing, replacement, bracing, strengthening, upgrading or extensive repair of existing materials, elements, components, *equipment* or fixtures. Renovation does not involve reconfiguration of spaces. Interior and exterior painting are not considered refinishing for purposes of this definition, and are not renovation.~~

~~**REPAIR.** The patching, restoration or minor replacement of materials, elements, components, *equipment* or fixtures for the purposes of maintaining those materials, elements, components, *equipment* or fixtures in good or sound condition.~~

~~**WORK AREA.** That portion of a building affected by any renovation, *alteration* or reconstruction work as initially intended by the owner and indicated as such in the *permit*. Work area excludes other portions of the building where incidental work entailed by the intended work must be performed, and portions of the building where work not initially intended by the owner is specifically required by these provisions for a renovation, *alteration* or reconstruction.~~

~~SECTION AJ301~~
~~REPAIRS~~

~~**AJ301.1 Materials.**~~
~~Except as otherwise required herein, work shall be done using like materials or materials permitted by this code for new construction.~~

~~**AJ301.1.1 Hazardous materials.**~~
~~Hazardous materials no longer permitted, such as asbestos and lead-based paint, shall not be used.~~

~~**AJ301.1.2 Plumbing materials and supplies.**~~
~~The following plumbing materials and supplies shall not be used:~~

1. ~~All-purpose solvent cement, unless *listed* for the specific application.~~

2. ~~Flexible traps and tailpieces, unless *listed* for the specific application.~~
3. ~~Solder having more than 0.2 percent lead in the repair of potable water systems.~~

~~**AJ301.2 Water closets.**~~
~~Where any water closet is replaced with a newly manufactured water closet, the replacement water closet shall comply with the requirements of Section P2903.2.~~

~~**AJ301.3 Electrical.**~~
~~Repair or replacement of existing electrical wiring and *equipment* undergoing repair with like material shall be permitted.~~

~~**Exceptions:**~~

1. ~~Replacement of electrical receptacles shall comply with the requirements of Chapters 34 through 43.~~
2. ~~Plug fuses of the Edison-base type shall be used for replacements only where there is not evidence of overfusing or tampering in accordance with the applicable requirements of Chapters 34 through 43.~~
3. ~~For replacement of nongrounding-type receptacles with grounding-type receptacles and for branch circuits that do not have an *equipment* grounding conductor in the branch circuitry, the grounding conductor of a grounding-type receptacle outlet shall be permitted to be grounded to any accessible point on the grounding electrode system, or to any accessible point on the grounding electrode conductor, as allowed and described in Chapters 34 through 43.~~

~~SECTION AJ401~~
~~RENOVATIONS~~

~~**AJ401.1 Materials and methods.**~~
~~The work shall comply with the materials and methods requirements of this code.~~

~~**AJ401.2 Door and window dimensions.**~~
~~Minor reductions in the clear opening dimensions of replacement doors and windows that result from the use of different materials shall be allowed, whether or not they are permitted by this code.~~

~~**AJ401.3 Interior finish.**~~
~~Wood paneling and textile wall coverings used as an interior finish shall comply with the flame spread requirements of Section R302.9.~~

~~**AJ401.4 Structural.**~~
~~Unreinforced masonry buildings located in Seismic Design Category D_2 or E shall have parapet bracing and wall anchors installed at the roofline whenever a reroofing *permit* is issued. Such parapet bracing and wall anchors shall be of an *approved* design.~~

~~SECTION AJ501~~
~~ALTERATIONS~~

~~**AJ501.1 Newly constructed elements.**~~
~~Newly constructed elements, components and systems shall comply with the requirements of this code.~~

~~**Exceptions:**~~

1. ~~Openable windows may be added without requiring compliance with the light and *ventilation* requirements of Section R303.~~

2. ~~Newly installed electrical *equipment* shall comply with the requirements of Section AJ501.5.~~

~~**AJ501.2 Nonconformities.**~~
~~The work shall not increase the extent of noncompliance with the requirements of Section AJ601, or create nonconformity to those requirements that did not previously exist.~~

~~**AJ501.3 Extensive alterations.**~~
~~Where the total area of all of the work areas included in an *alteration* exceeds 50 percent of the area of the *dwelling unit*, the work shall be considered to be a reconstruction and shall comply with the requirements of these provisions for reconstruction work.~~

~~**Exception:** Work areas in which the *alteration* work is exclusively plumbing, mechanical or electrical shall not be included in the computation of the total area of all work areas.~~

~~**AJ501.4 Structural.**~~
~~The minimum design loads for the structure shall be the loads applicable at the time the building was constructed, provided that a dangerous condition is not created. Structural elements that are uncovered during the course of the *alteration* and that are found to be unsound or dangerous shall be made to comply with the applicable requirements of this code.~~

~~**AJ501.5 Electrical equipment and wiring.**~~

~~**AJ501.5.1 Materials and methods.**~~
~~Newly installed electrical *equipment* and wiring relating to work done in any work area shall comply with the materials and methods requirements of Chapters 34 through 43.~~

~~**Exception:** Electrical *equipment* and wiring in newly installed partitions and ceilings shall comply with the applicable requirements of Chapters 34 through 43.~~

~~**AJ501.5.2 Electrical service.**~~
~~Service to the *dwelling unit* shall be not less than 100 ampere, three-wire capacity and service *equipment* shall be dead front having no live parts exposed that could allow accidental contact. Type “S” fuses shall be installed where fused *equipment* is used.~~

~~**Exception:** Existing service of 60 ampere, three-wire capacity, and feeders of 30 ampere or larger two- or three-wire capacity shall be accepted if adequate for the electrical load being served.~~

~~AJ501.5.3 Additional electrical requirements.~~

~~Where the work area includes any of the following areas within a *dwelling unit*, the requirements of Sections AJ501.5.3.1 through AJ501.5.3.5 shall apply.~~

~~AJ501.5.3.1 Enclosed areas.~~

~~Enclosed areas other than closets, kitchens, *basements*, garages, hallways, laundry areas and bathrooms shall have not less than two duplex receptacle outlets, or one duplex receptacle outlet and one ceiling- or wall-type lighting outlet.~~

~~AJ501.5.3.2 Kitchen and laundry areas.~~

~~Kitchen areas shall have not less than two duplex receptacle outlets. Laundry areas shall have not less than one duplex receptacle outlet located near the laundry *equipment* and installed on an independent circuit.~~

~~AJ501.5.3.3 Ground-fault circuit-interruption.~~

~~Ground-fault circuit-interruption shall be provided on newly installed receptacle outlets if required by Chapters 34 through 43.~~

~~AJ501.5.3.4 Lighting outlets.~~

~~Not less than one lighting outlet shall be provided in every bathroom, hallway, stairway, attached garage and detached garage with electric power to illuminate outdoor entrances and exits, and in utility rooms and *basements* where these spaces are used for storage or contain *equipment* requiring service.~~

~~AJ501.5.3.5 Clearance.~~

~~Clearance for electrical service *equipment* shall be provided in accordance with Chapters 34 through 43.~~

~~AJ501.6 Ventilation.~~

~~Reconfigured spaces intended for occupancy and spaces converted to habitable or occupiable space in any work area shall be provided with *ventilation* in accordance with Section R303.~~

~~AJ501.7 Ceiling height.~~

~~*Habitable spaces* created in existing *basements* shall have ceiling heights of not less than 6 feet, 8 inches (2032 mm), except that the ceiling height at obstructions shall be not less than 6 feet 4 inches (1930 mm) from the *basement* floor. Existing finished ceiling heights in nonhabitable spaces in *basements* shall not be reduced.~~

~~AJ501.8 Stairs.~~

~~AJ501.8.1 Stair width.~~

~~Existing *basement* stairs and handrails not otherwise being altered or modified shall be permitted to maintain their current clear width at, above and below existing handrails.~~

~~AJ501.8.2 Stair headroom.~~

~~Headroom height on existing *basement* stairs being altered or modified shall not be reduced~~

~~below the existing stairway finished headroom. Existing *basement* stairs not otherwise being altered shall be permitted to maintain the current finished headroom.~~

~~**AJ501.8.3 Stair landing.**~~

~~Landings serving existing *basement* stairs being altered or modified shall not be reduced below the existing stairway landing depth and width. Existing *basement* stairs not otherwise being altered shall be permitted to maintain the current landing depth and width.~~

~~SECTION AJ601~~

~~RECONSTRUCTION~~

~~**AJ601.1 Stairways, handrails and guards.**~~

~~**AJ601.1.1 Stairways.**~~

~~Stairways within the work area shall be provided with illumination in accordance with Section R303.6.~~

~~**AJ601.1.2 Handrails.**~~

~~Every required exit stairway that has four or more risers, is part of the means of egress for any work area, and is not provided with at least one handrail, or in which the existing handrails are judged to be in danger of collapsing, shall be provided with handrails designed and installed in accordance with Section R311 for the full length of the run of steps on not less than one side.~~

~~**AJ601.1.3 Guards.**~~

~~Every open portion of a stair, landing or balcony that is more than 30 inches (762 mm) above the floor or *grade* below, is part of the egress path for any work area, and does not have *guards*, or in which the existing *guards* are judged to be in danger of collapsing, shall be provided with *guards* designed and installed in accordance with Section R312.~~

~~**AJ601.2 Wall and ceiling finish.**~~

~~The interior finish of walls and ceilings in any work area shall comply with the requirements of Section R302.9. Existing interior finish materials that do not comply with those requirements shall be removed or shall be treated with an *approved* fire-retardant coating in accordance with the manufacturer's instructions to secure compliance with the requirements of this section.~~

~~**AJ601.3 Separation walls.**~~

~~Where the work area is in an attached *dwelling unit*, walls separating *dwelling units* that are not continuous from the foundation to the underside of the roof sheathing shall be constructed to provide a continuous fire separation using construction materials consistent with the existing wall or complying with the requirements for new structures. Performance of work shall be required only on the side of the wall of the *dwelling unit* that is part of the work area.~~

~~**AJ601.4 Ceiling height.**~~

~~*Habitable spaces* created in existing *basements* shall have ceiling heights of not less than 6 feet, 8 inches (2032 mm), except that the ceiling height at obstructions shall be not less than 6 feet 4 inches (1930 mm) from the *basement* floor. Existing finished ceiling heights in nonhabitable spaces in *basements* shall not be reduced.~~

APPENDIX K

SOUND TRANSMISSION

~~(The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.)~~

(The provisions contained in this appendix are adopted as part of this code.)

APPENDIX L

PERMIT FEES

Deleted

~~*(The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.)*~~

~~**TOTAL VALUATION**~~	~~FEE~~
~~$1 to $ 500~~	~~$24~~
~~$501 to $2,000~~	~~$24 for the first $500; plus $3 for each additional $100 or fraction thereof, up to and including $2,000~~
~~$2,001 to $40,000~~	~~$69 for the first $2,000; plus $11 for each additional $1,000 or fraction thereof, up to and including $40,000~~
~~$40,001 to $100,000~~	~~$487 for the first $40,000; plus $9 for each additional $1,000 or fraction thereof, up to and including $100,000~~
~~$100,001 to $500,000~~	~~$1,027 for the first $100,000; plus $7 for each additional $1,000 or fraction thereof, up to and including $500,000~~
~~$500,001 to $1,000,000~~	~~$3,827 for the first $500,000; plus $5 for each additional $1,000 or fraction thereof, up to and including $1,000,000~~
~~$1,000,001 to $5,000,000~~	~~$6,327 for the first $1,000,000; plus $3 for each additional $1,000 or fraction thereof, up to and including $5,000,000~~
~~$5,000,001 and over~~	~~$18,327 for the first $5,000,000; plus $1 for each additional $1,000 or fraction thereof~~

APPENDIX M

~~HOME DAY CARE—R-3 OCCUPANCY~~

WOOD DECKS

This appendix is a North Carolina addition and not part of the 2015 International Residential Code. There will be no underlined text.
(The provisions contained in this appendix are adopted as part of this code.)

~~***(The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.)***~~

~~SECTION AM101~~
~~GENERAL~~

~~**AM101.1 General.**~~
~~This appendix shall apply to a home day care operated within a *dwelling*. It is to include buildings and structures occupied by persons of any age who receive custodial care for less than 24 hours by individuals other than parents or guardians or relatives by blood, marriage, or adoption, and in a place other than the home of the person cared for.~~

~~SECTION AM102~~
~~DEFINITION~~

~~**EXIT ACCESS.** That portion of a means-of-egress system that leads from any occupied point in a building or structure to an exit.~~

~~SECTION AM103~~
~~MEANS OF EGRESS~~

~~**AM103.1 Exits required.**~~
~~If the occupant load of the residence is more than nine, including those who are residents, during the time of operation of the day care, two exits are required from the ground-level *story*. Two exits are required from a home day care operated in a *manufactured home* regardless of the occupant load. Exits shall comply with Section R311.~~

~~**AM103.1.1 Exit access prohibited.**~~
~~An exit access from the area of day care operation shall not pass through bathrooms, bedrooms, closets, garages, fenced rear *yards* or similar areas.~~

~~**Exception:** An exit may discharge into a fenced *yard* if the gate or gates remain unlocked during day care hours. The gates may be locked if there is an area of refuge~~

~~located within the fenced *yard* and more than 50 feet (15 240 mm) from the *dwelling*.~~

~~The area of refuge shall be large enough to allow 5 square feet (0.5 m^2) per occupant.~~

~~AM103.1.2 Basements.~~

~~If the *basement* of a *dwelling* is to be used in the day care operation, two exits are required from the *basement* regardless of the occupant load. One of the exits may pass through the *dwelling* and the other must lead directly to the exterior of the *dwelling*.~~

> ~~**Exception:** An emergency and escape window complying with Section R310 and which does not conflict with Section AM103.1.1 may be used as the second means of egress from a *basement*.~~

~~AM103.1.3 Yards.~~

~~If the *yard* is to be used as part of the day care operation it shall be fenced.~~

~~AM103.1.3.1 Type of fence and hardware.~~

~~The fence shall be of durable materials and be at least 6 feet (1529 mm) tall, completely enclosing the area used for the day care operations. Each opening shall be a gate or door equipped with a self-closing and self-latching device to be installed at a minimum of 5 feet (1528 mm) above the ground.~~

> ~~**Exception:** The door of any *dwelling* which forms part of the enclosure need not be equipped with self-closing and self-latching devices.~~

~~AM103.1.3.2 Construction of fence.~~

~~Openings in the fence, wall or enclosure required by this section shall have intermediate rails or an ornamental pattern that do not allow a sphere 4 inches (102 mm) in diameter to pass through. In addition, the following criteria must be met:~~

1. ~~The maximum vertical clearance between *grade* and the bottom of the fence, wall or enclosure shall be 2 inches (51 mm).~~
2. ~~Solid walls or enclosures that do not have openings, such as masonry or stone walls, shall not contain indentations or protrusions, except for tooled masonry joints.~~
3. ~~Maximum mesh size for chain link fences shall be 1$^1/_4$ inches (32 mm) square, unless the fence has slats at the top or bottom which reduce the opening to no more than 1$^3/_4$ inches (44 mm). The wire shall be not less than 9 gage [0.148 inch (3.8 mm)].~~

~~AM103.1.3.3 Decks.~~

~~Decks that are more than 12 inches (305 mm) above *grade* shall have a guard in compliance with Section R312.~~

~~AM103.2 Width and height of an exit.~~

~~The minimum width of a required exit is 36 inches (914 mm) with a net clear width of 32 inches (813 mm). The minimum height of a required exit is 6 feet, 8 inches (2032 mm).~~

~~AM103.3 Type of lock and latches for exits.~~

~~Regardless of the occupant load served, exit doors shall be openable from the inside without the use of a key or any special knowledge or effort. When the occupant load is 10 or less, a night latch, dead bolt or security chain may be used, provided such devices are openable from the inside without the use of a key or tool, and mounted at a height not to exceed 48 inches (1219 mm) above the finished floor.~~

~~AM103.4 Landings.~~

~~Landings for stairways and doors shall comply with Section R311, except that landings shall be required for the exterior side of a sliding door when a home day care is being operated in a Group R-3 occupancy.~~

~~SECTION AM104~~
~~SMOKE DETECTION~~

~~AM104.1 General.~~

~~Smoke detectors shall be installed in *dwelling* units used for home day care operations. Detectors shall be installed in accordance with the approved manufacturer's instructions. If the current smoke detection system in the *dwelling* is not in compliance with the currently adopted code for smoke detection, it shall be upgraded to meet the currently adopted code requirements and Section AM103 before day care operations commence.~~

~~AM104.2 Power source.~~

~~Required smoke detectors shall receive their primary power from the building wiring when that wiring is served from a commercial source and shall be equipped with a battery backup. The detector shall emit a signal when the batteries are low. Wiring shall be permanent and without a disconnecting switch other than those required for overcurrent protection. Required smoke detectors shall be interconnected so if one detector is activated, all detectors are activated.~~

~~AM104.3 Location.~~

~~A detector shall be located in each bedroom and any room that is to be used as a sleeping room, and centrally located in the corridor, hallway or area giving access to each separate sleeping area. When the *dwelling* unit has more than one *story*, and in *dwellings* with *basements*, a detector shall be installed on each *story* and in the *basement*. In *dwelling* units where a *story* or *basement* is split into two or more levels, the smoke detector shall be installed on the upper level, except that when the lower level contains a sleeping area, a detector shall be installed on each level. When sleeping rooms are on the upper level, the detector shall be placed at the ceiling of the upper level in close proximity to the stairway. In *dwelling* units where the ceiling height of a room open to the hallway serving the bedrooms or sleeping areas exceeds that of the hallway by 24 inches (610 mm) or more, smoke detectors shall be installed in the hallway and the adjacent room. Detectors shall sound an alarm audible in all sleeping areas of the *dwelling* unit in which they are located.~~

SECTION AM101
GENERAL

AM101.1 General.

A deck is an exposed exterior wood floor structure which is permitted to be attached to the structure or freestanding. Roofed porches (open or screened-in) are permitted to be constructed using these provisions.

AM101.2 Deck design.

Computer deck design programs are permitted to be accepted by the code official.

SECTION AM102
FOOTINGS

AM102.1 Footings.

Support posts shall be supported by a minimum footing in accordance with Figure AM102.1(1) and Table AM102.1. Minimum footing depth shall be 12 inches (305 mm) below finished grade in accordance with Section R403.1.4. Tributary area is calculated as shown in Figure AM102.1(2).

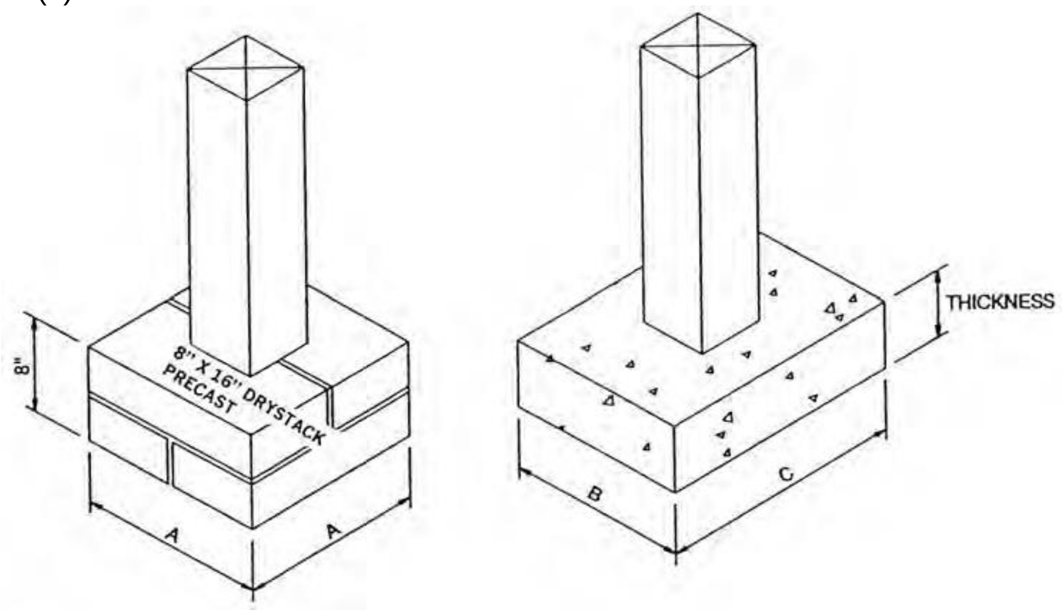


FIGURE AM102.1(1)
SUPPORT POST FOOTING

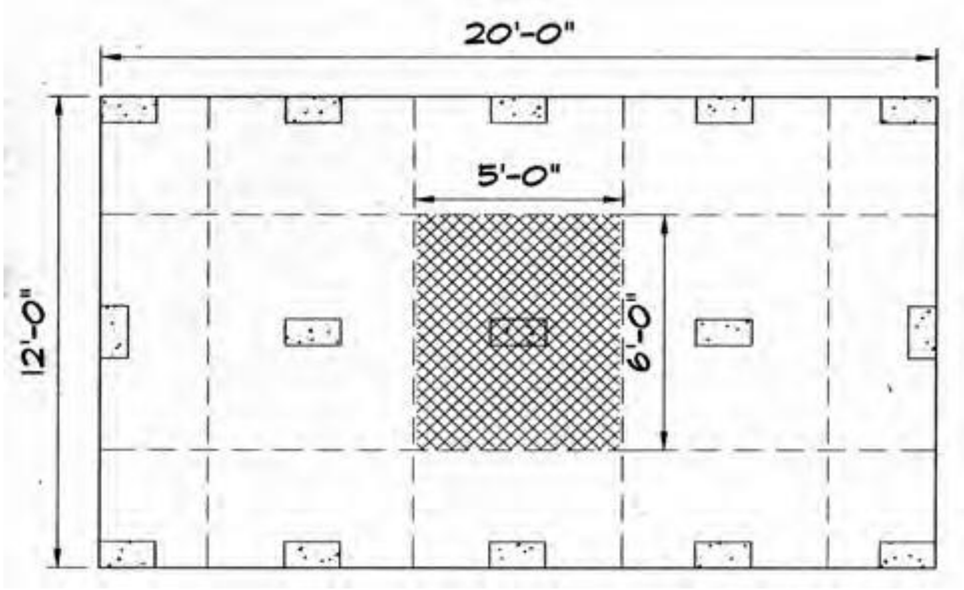
TABLE AM102.1
FOOTING TABLE[a,b,c]

SIZE (inches)		TRIBUTARY AREA	THICKNESS (inches)	
A x A	**B x C**	**(sq. ft.)**	**Precast**	**Cast-In-Place**
8 x 16	8 x 16	36	4	6
12 x 12	12 x 12	40	4	6
16 x 16	16 x 16	70	8	8
-	16 x 24	100	-	8
-	24 x 24	150	-	8

For SI: 1 inch = 25.4 mm, 1 square foot = 0.0929m^2.

a. Footing values are based on single floor and roof loads.

b. Support post must rest in center 1/3 of footing.
c. Top of footing shall be level for full bearing support of post.



For SI: 1 inch = 25.4 mm, 1 square foot = 0.0929m^2.

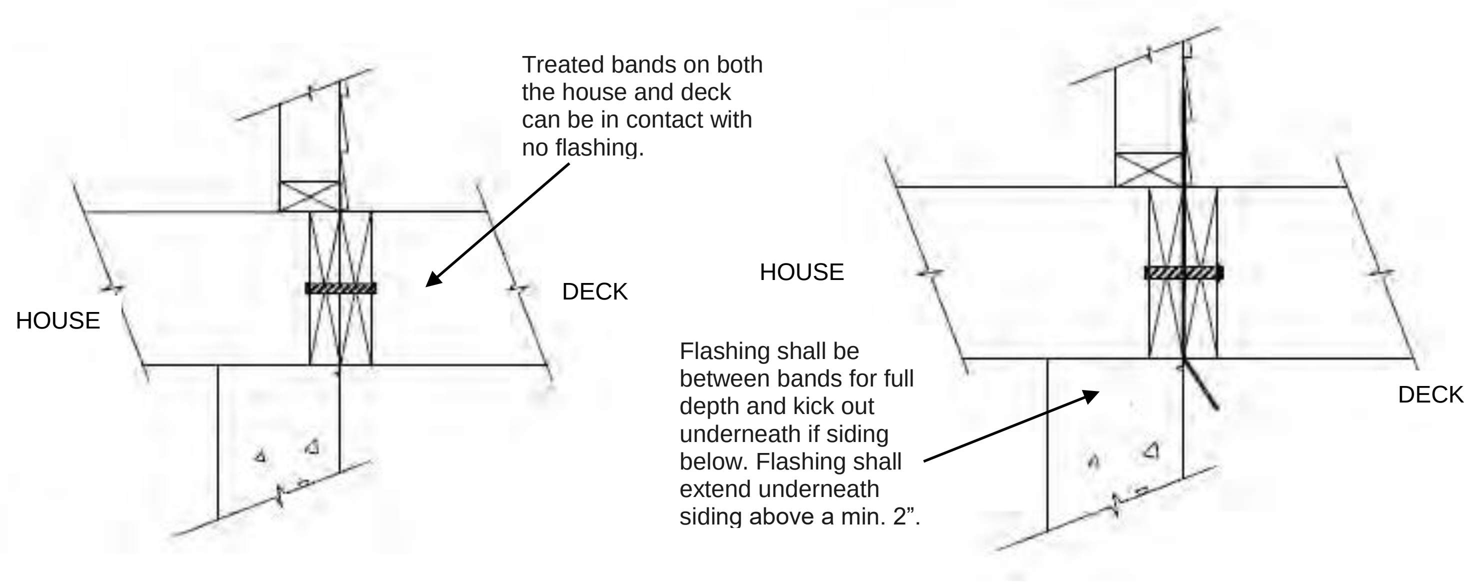
Note: Tributary area of shaded section on the free standing deck shown is 5’ x 6’ = 30 sq. ft.(2.79 m^2) Code will require a minimum footing of 8” x 16” (203 mm x 406 mm) in accordance with Table AM102.1.

FIGURE AM102.1(2)
CALCULATED TRIBUTARY AREA

SECTION AM103
FLASHING

AM103.1 Flashing.

When attached to a structure, the structure to which attached shall have a treated wood band for the length of the deck, or corrosion-resistant flashing shall be used to prevent moisture from coming in contact with the untreated framing of the structure. Aluminum flashing shall not be used in conjunction with deck construction. The deck band and the structure band shall be constructed in contact with each other except on brick veneer structures and where plywood sheathing is required and properly flashed. Siding shall not be installed between the structure and the deck band. If attached to a brick structure, neither the flashing nor a treated band for brick structure is required. In addition, the treated deckband shall be constructed in contact with the brick veneer. Flashing shall be installed per Figure AM103.1.



NO FLASHING - TREATED **FLASHING BETWEEN**

For SI: 1 inch = 25.4 mm

FIGURE AM103.1
FLASHING FOR DECK ATTACHED TO STRUCTURE

SECTION AM104

DECK ATTACHMENT

AM104.1 Deck attachment.
When a deck is supported at the structure by attaching the deck to the structure, Tables AM104.1(1) and AM104.1(2) shall apply for attaching the deck band to the structure.

TABLE AM104.1(1)
DECK ATTACHMENT FOR ALL STRUCTURES EXCEPT BRICK VENEER

FASTENERS	8' MAX JOIST SPAN[a]	16' MAX JOIST SPAN[a]
5/8" Hot dip galvanized bolts with nut and washer[b] **and** 12d Common hot dip galvanized nails[c]	1 @ 3'-6" o.c. **and** 2 @ 8" o.c.	1 @ 1'-8" o.c. **and** 3 @ 6" o.c.
OR		
Self-Drilling Screw Fastener[d]	12" o.c. staggered	6" o.c. staggered

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

a. Attachment interpolation between 8 foot and 16 foot joists span is allowed.

b. Minimum edge distance for bolts is 2 ½ inches.

c. Nails must penetrate the supporting structure band a minimum of 1 ½ inches.

d. Self-drilling screw fastener having a minimum shank diameter of 0.195 inches and a length long enough to penetrate through the supporting structure band. The structure band shall have a minimum depth of 1-1/8 inches. Screw shall be evaluated by an approved testing agency for allowable shear load for Southern Pine to Southern Pine lumber of 250 pounds and shall have a corrosion resistant finish equivalent to hot dip galvanized. Minimum edge distance for screws is 1-7/16 inches. A maximum of ½ inch thick wood structural panel is permitted to be located between the deck ledger and the structure band.

TABLE AM104.1(2)
DECK ATTACHMENT FOR BRICK VENEER STRUCTURES

FASTENERS	8’ MAX JOIST SPAN[a]	16’ MAX JOIST SPAN[a]
5/8” Hot dip galvanized bolts with nut and washer[b]	1 @ 2’-4” o.c.	1 @ 1’-4” o.c.

For SI: 1 inch = 25.4, 1 foot = 304.8 mm
a. Attachment interpolation between 8 foot and 16 foot joist span is allowed.
b. Minimum edge distance for bolts is 21/2 inches.

AM104.1.1 Masonry ledge support.

If the deck band is supported by a minimum of 1/2 inch (13 mm) masonry ledge along the foundation wall, 5/8 inch (16 mm) hot dip galvanized bolts with washers spaced at 48 inches (1219 mm) o.c. are permitted to be used for support.

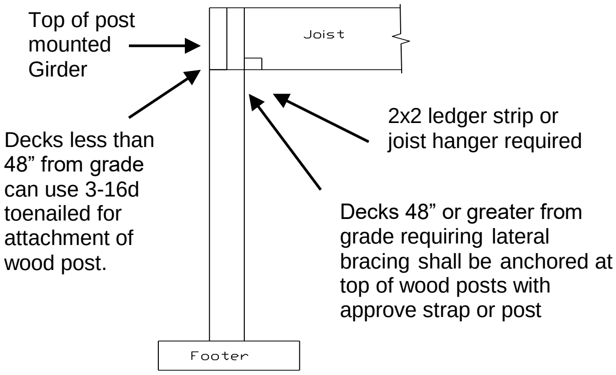
AM104.1.2 Other means of support.

Joist hangers or other means of attachment are permitted to be connected to the house band and shall be properly flashed.

SECTION AM105
GIRDER SUPPORT AND SPAN

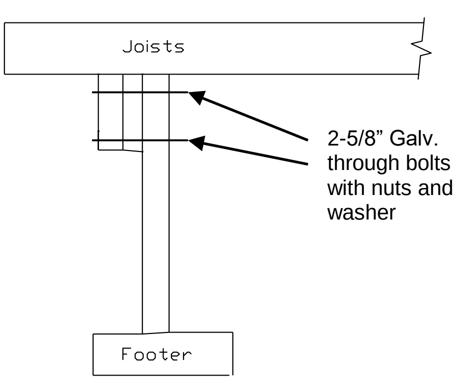
AM105.1 General.

Girders shall bear directly on the support post with the post attached at top to prevent lateral displacement or be connected to the side of the posts with two 5/8 inch (16 mm) hot dip galvanized bolts with nut and washer. Girder support is permitted to be installed in accordance with Figure AM105.1(1) for top mount; Figure AM105.1(2) for side mount and Figure AM105.1(3) for split girders. See Figure AM105.1(4) for cantilevered girders.



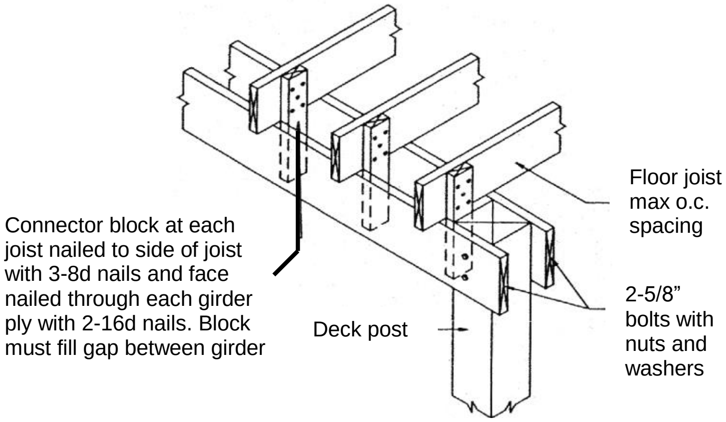
For SI: 1 inch = 25.4 mm.

FIGURE AM105.1(1)
TOP MOUNT/FLUSH GIRDER



For SI: 1 inch = 25.4 mm

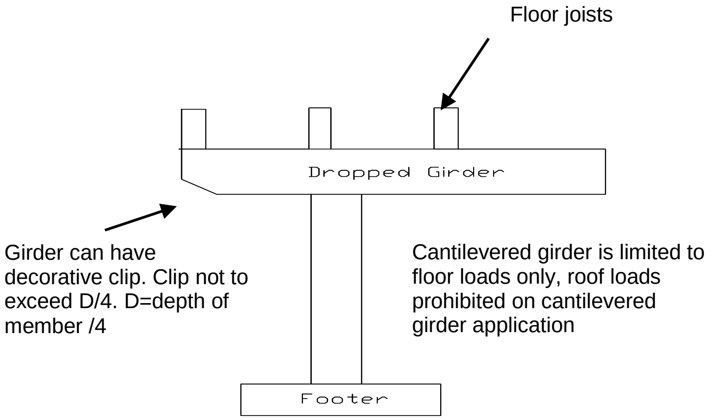
FIGURE AM105.1(2)
SIDE MOUNT DROPPED GIRDER



Split girder limited to floor loads only and cantilever girder ends allowed per Figure AM105.1(4)

For SI: 1 inch = 25.4 mm.

FIGURE AM105.1(3)
SPLIT GIRDER



For SI: 1 inch = 25.4 mm.

FIGURE AM105.1(4)
CANTILIEVERED DROPPED GIRDER

AM105.2 Girder span for uncovered porches and decks.
Maximum allowable spans for wood deck girders, as shown in Figure AM105.2, shall be in accordance with Table AM105.2. Girder plies shall be fastened with two rows of 10d (3-inch × 0.128-inch) nails minimum at 16 inches (406 mm) on center along each edge. Girders shall be

permitted to cantilever at each end up to one-fourth of the actual beam span. Splices of multispan beams shall be located at interior post locations.

TABLE AM105.2
DECK GIRDER SPAN LENGTHS[a, b] (ft. - in.)

SPECIES[c]	SIZE[d]	DECK JOIST SPAN LESS THAN OR EQUAL TO: (feet)						
		6	8	10	12	14	16	18
Southern pine	2 – 2 × 6	6-11	5-11	5-4	4-10	4-6	4-3	4-0
	2 – 2 × 8	8-9	7-7	6-9	6-2	5-9	5-4	5-0
	2 – 2 × 10	10-4	9-0	8-0	7-4	6-9	6-4	6-0
	2 – 2 × 12	12-2	10-7	9-5	8-7	8-0	7-6	7-0
	3 – 2 × 6	8-2	7-5	6-8	6-1	5-8	5-3	5-0
	3 – 2 × 8	10-10	9-6	8-6	7-9	7-2	6-8	6-4
	3 – 2 × 10	13-0	11-3	10-0	9-2	8-6	7-11	7-6
	3 – 2 × 12	15-3	13-3	11-10	10-9	10-0	9-4	8-10
Douglas fir-larch[e], hem-fir[e], spruce-pine-fir[e], redwood, western cedars, ponderosa pine[f], red pinef	3 × 6 or 2 – 2 x 6	5-5	4-8	4-2	3-10	3-6	3-1	2-9
	3 × 8 or 2 – 2 × 8	6-10	5-11	5-4	4-10	4-6	4-1	3-8
	3 × 10 or 2 – 2 × 10	8-4	7-3	6-6	5-11	5-6	5-1	4-8
	3 × 12 or 2 – 2 × 12	9-8	8-5	7-6	6-10	6-4	5-11	5-7
	4 × 6	6-5	5-6	4-11	4-6	4-2	3-11	3-8
	4 × 8	8-5	7-3	6-6	5-11	5-6	5-2	4-10
	4 × 10	9-11	8-7	7-8	7-0	6-6	6-1	5-8
	4 × 12	11-5	9-11	8-10	8-1	7-6	7-0	6-7
	3 – 2 × 6	7-4	6-8	6-0	5-6	5-1	4-9	4-6
	3 – 2 × 8	9-8	8-6	7-7	6-11	6-5	6-0	5-8
	3 – 2 × 10	12-0	10-5	9-4	8-6	7-10	7-4	6-11
	3 – 2 × 12	13-11	12-1	10-9	9-10	9-1	8-6	8-1

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound = 0.454 kg.

a. Ground snow load, live load = 40 psf, dead load = 10 psf, $L/\Delta = 360$ at main span, $L/\Delta = 180$ at cantilever with a 220-pound point load applied at the end.

b. Girders supporting deck joists from one side only.

c. No. 2 grade, wet service factor.

d. Girder depth shall be greater than or equal to depth of joists with a flush beam condition.

e. Includes incising factor.

f. Northern species. Incising factor not included.

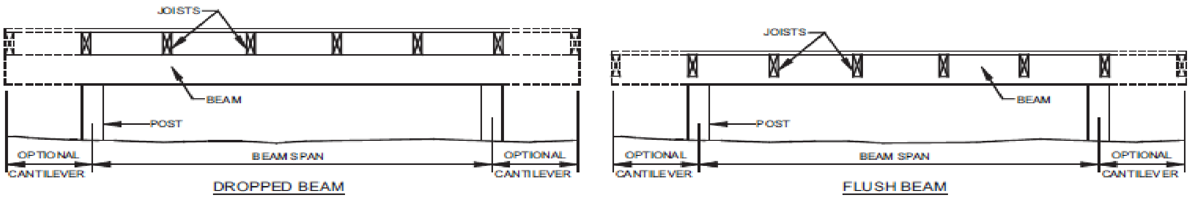


FIGURE AM105.2
TYPICAL DECK GIRDER SPANS

AM105.3 Girder span for roofed porches and decks.
Girder spans for covered decks shall be in accordance with Tables R602.7(1) and (2).

SECTION AM106
JOIST SPANS AND CANTILEVERS

AM106.1 Joist spans for uncovered porches and decks.
Maximum allowable spans for wood deck joists, as shown in Figure AM106.1, shall be in accordance with Table AM106.1. Deck joists shall be permitted to cantilever not greater than one-fourth of the actual, adjacent joist span.

TABLE AM106.1
DECK JOIST SPANS FOR COMMON LUMBER SPECIES[f] (ft. - in.)

SPECIES[a]	SIZE	SPACING OF DECK JOISTS WITH NO CANTILEVER[b] (inches)			SPACING OF DECK JOISTS WITH CANTILEVERS[c] (inches)		
		12	16	24	12	16	24
Southern pine	2 × 6	9-11	9-0	7-7	6-8	6-8	6-8
	2 × 8	13-1	11-10	9-8	10-1	10-1	9-8
	2 × 10	16-2	14-0	11-5	14-6	14-0	11-5
	2 × 12	18-0	16-6	13-6	18-0	16-6	13-6
Douglas fir-larch[d], hem-fir[d] spruce-pine-fir[d]	2 × 6	9-6	8-8	7-2	6-3	6-3	6-3
	2 × 8	12-6	11-1	9-1	9-5	9-5	9-1
	2 × 10	15-8	13-7	11-1	13-7	13-7	11-1
	2 × 12	18-0	15-9	12-10	18-0	15-9	12-10
Redwood, western cedars, ponderosa pine[e], red pine[e]	2 × 6	8-10	8-0	7-0	5-7	5-7	5-7
	2 × 8	11-8	10-7	8-8	8-6	8-6	8-6
	2 × 10	14-11	13-0	10-7	12-3	12-3	10-7
	2 × 12	17-5	15-1	12-4	16-5	15-1	12-4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound = 0.454 kg.

a. No. 2 grade with wet service factor.

b. Ground snow load, live load = 40 psf, dead load = 10 psf, L/D = 360.

c. Ground snow load, live load = 40 psf, dead load = 10 psf, L/D = 360 at main span, L/D = 180 at cantilever with a 220-pound point load applied to end.

d. Includes incising factor.

e. Northern species with no incising factor

f. Cantilevered spans not exceeding the nominal depth of the joist are permitted.

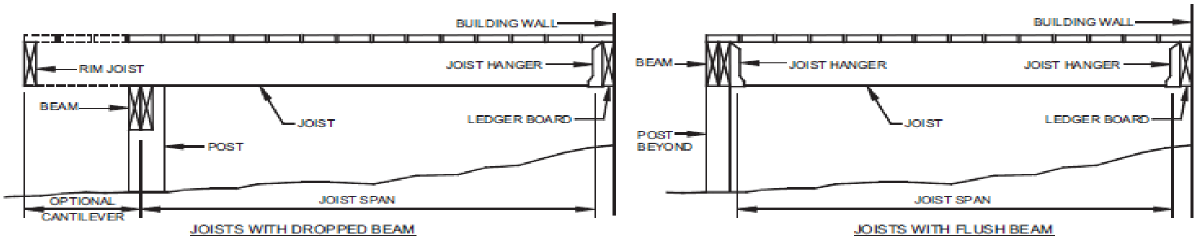


FIGURE AM106.1
TYPICAL DECK JOIST SPANS

AM106.1.1 Lateral restraint at supports.

Joist ends and bearing locations shall be provided with lateral restraint to prevent rotation. Where lateral restraint is provided by joist hangers or blocking between joists, their depth shall equal not less than 60 percent of the joist depth. Where lateral restraint is provided by rim joists, they shall be secured to the end of each joist with not less than (3) 10d (3-inch × 0.128-inch) nails or (3) No. 10 × 3-inch (76 mm) long wood screws.

AM106.2.Roofed porches and decks.

Joists spans shall be in accordance with Table R502.3.1(2) with 40 lbs per sq. ft. live load and 10 lbs per sq. ft. dead load. Cantilevered floor joists shall be in accordance with Table R502.3.3 (1).

SECTION AM107
FLOOR DECKING

AM107.1 Floor decking.

Floor decking shall be No. 2 grade treated Southern Pine or equivalent. The minimum floor decking thickness shall be in accordance with Table AM107.1.

TABLE AM107.1
FLOOR DECKING THICKNESS

SPACING	DECKING (nominal)
12” o.c.	1” S4S
16” o.c.	1” T&G
19.2” o.c.	1 ¼” S4S
24”-36” o.c.	2” S4S

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

SECTION AM108
POST HEIGHT

AM108.1 Post height.

Maximum height of deck support posts shall be in accordance with Table AM108.1.

TABLE AM108.1
DECK SUPPORT POST HEIGHT

POST SIZE[a]	MAXIMUM POST HEIGHT[b,c]
4” x 4”	8’-0”
6” x 6”	20’-0”

For SI: 1 inch = 25.4, 1 foot = 304.8 mm
a. This table is based on No. 2 Southern Pine posts.
b. From top of footing to bottom of girder.
c. Decks with post heights exceeding these requirements shall be designed by a registered design professional.

SECTION AM109
DECK BRACING

AM109.1 Deck bracing.

Decks shall be braced to provide lateral stability. Lateral stability shall be provided in accordance with one of the methods in Sections AM109.1.1 through AM109.1.5.

AM109.1.1. Lateral bracing not required.
When the deck floor height is less than 4 feet (1219 mm) above finished grade as shown in Figure AM109.1(1) and the deck is attached to the structure in accordance with Section AM104, lateral bracing is not required. Lateral bracing is not required for freestanding decks with a deck floor height 30 inches (762 mm) or less above finished grade.

AM109.1.2. Knee bracing.
4x4 wood knee braces are permitted to be provided on each column in both directions. The knee braces shall attach to each post at a point not less than 1/3 of the post length from the top of the post, and the braces shall be angled between 45 degrees (0.79 rad) and 60 degrees (1.05 rad) from the horizontal. Knee braces shall be bolted to the post and the girder/double band with one 5/8 inch (16 mm) hot dip galvanized bolt with nut and washer at both ends of the brace as shown in Figure AM109.1(2)

AM109.1.3. Post embedment.
For free standing decks without knee braces or diagonal bracing, lateral stability is permitted to be provided by embedding the post in accordance with Figure AM109.1(3) and Table AM109.1.

TABLE AM109.1
POST EMEBEDMENT FOR FREE STANDING DECKS

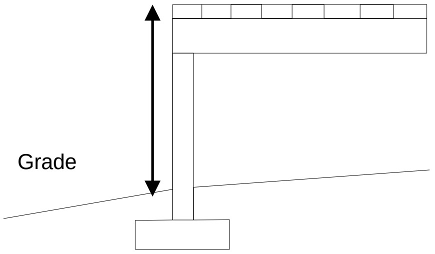
POST SIZE	MAXIMUM TRIBUTARY AREA	MAXIMUM POST HEIGHT	EMPEDMENT DEPTH	CONCRETE DIAMETER
4” x 4”	48 SF	4’-0”	2’-6”	1’-0”
6” x 6”	120 SF	6’-0”	3’-6”	1’-8”

For SI: 1 inch = 25.4 mm, 1 square foot = 0.0929m^2.

AM109.1.4. Cross bracing.
2x6 diagonal vertical cross bracing is permitted to be provided in two perpendicular directions for free standing decks or parallel to the structure at the exterior column line for attached decks. The 2x6 bracing shall be attached to the posts with one 5/8 inch (16 mm)

hot dip galvanized bolt with nut and washer at each end of each bracing member per Figure AM109.1(4).

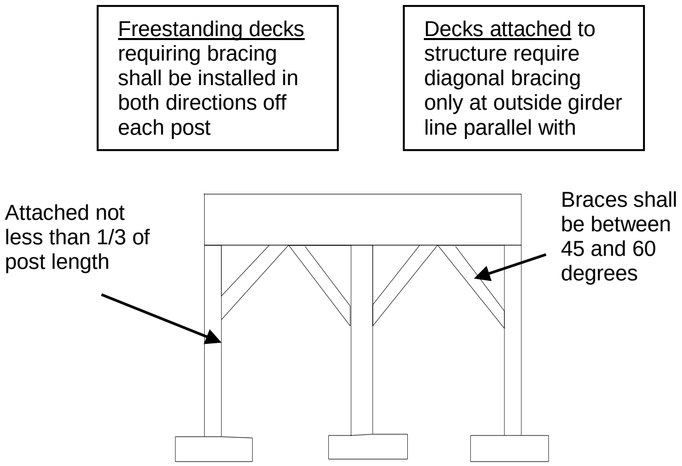
AM109.1.5. Piles in coastal regions.
For embedment of piles in coastal regions, see Chapter 46.



Less than 4' (decking to grade) and attached to structure no bracing required

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

FIGURE AM109.1(1)
NO LATERAL BRACING



Freestanding decks requiring bracing shall be installed in both directions off each post

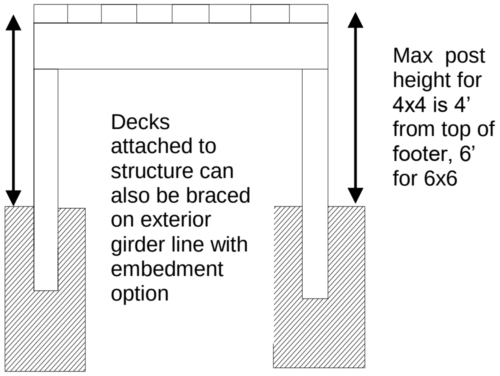
Decks attached to structure require diagonal bracing only at outside girder line parallel with

Attached not less than 1/3 of post length

Braces shall be between 45 and 60 degrees

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

FIGURE AM109.1(2)
KNEE BRACING

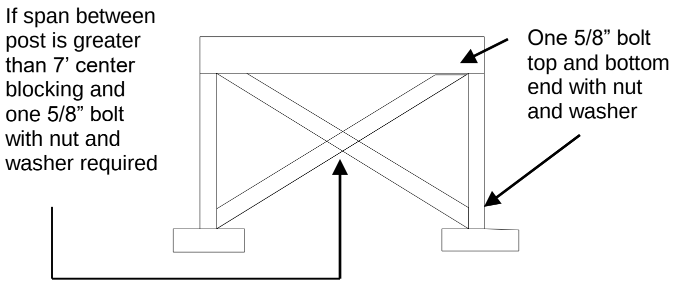


Decks attached to structure can also be braced on exterior girder line with embedment option

Max post height for 4x4 is 4' from top of footer, 6' for 6x6

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

FIGURE AM109.1(3)
POST EMBEDMENT



If span between post is greater than 7' center blocking and one 5/8" bolt with nut and washer required

One 5/8" bolt top and bottom end with nut and washer

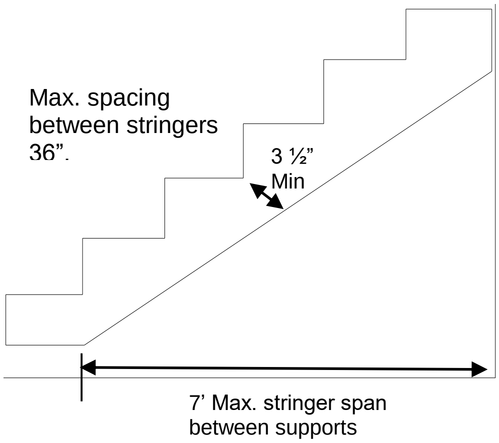
For SI: 1 inch = 25.4, 1 foot = 304.8 mm.

FIGURE AM109.1(4)
CROSS BRACING

SECTION AM110
STAIRS

AM110.1 Stair construction.

Stringer spans shall be no greater than 7 feet (2134 mm) between supports. Spacing between stringers shall be based upon decking material used in accordance with AM107.1. Each stringer shall have a minimum of 3 ½ inches (89 mm) between step cut and back of stringer. If used, suspended headers shall be attached with 3/8 inch (9.5 mm) galvanized bolts with nuts and washers to securely support stringers at the top. See Figure AM 110.1.

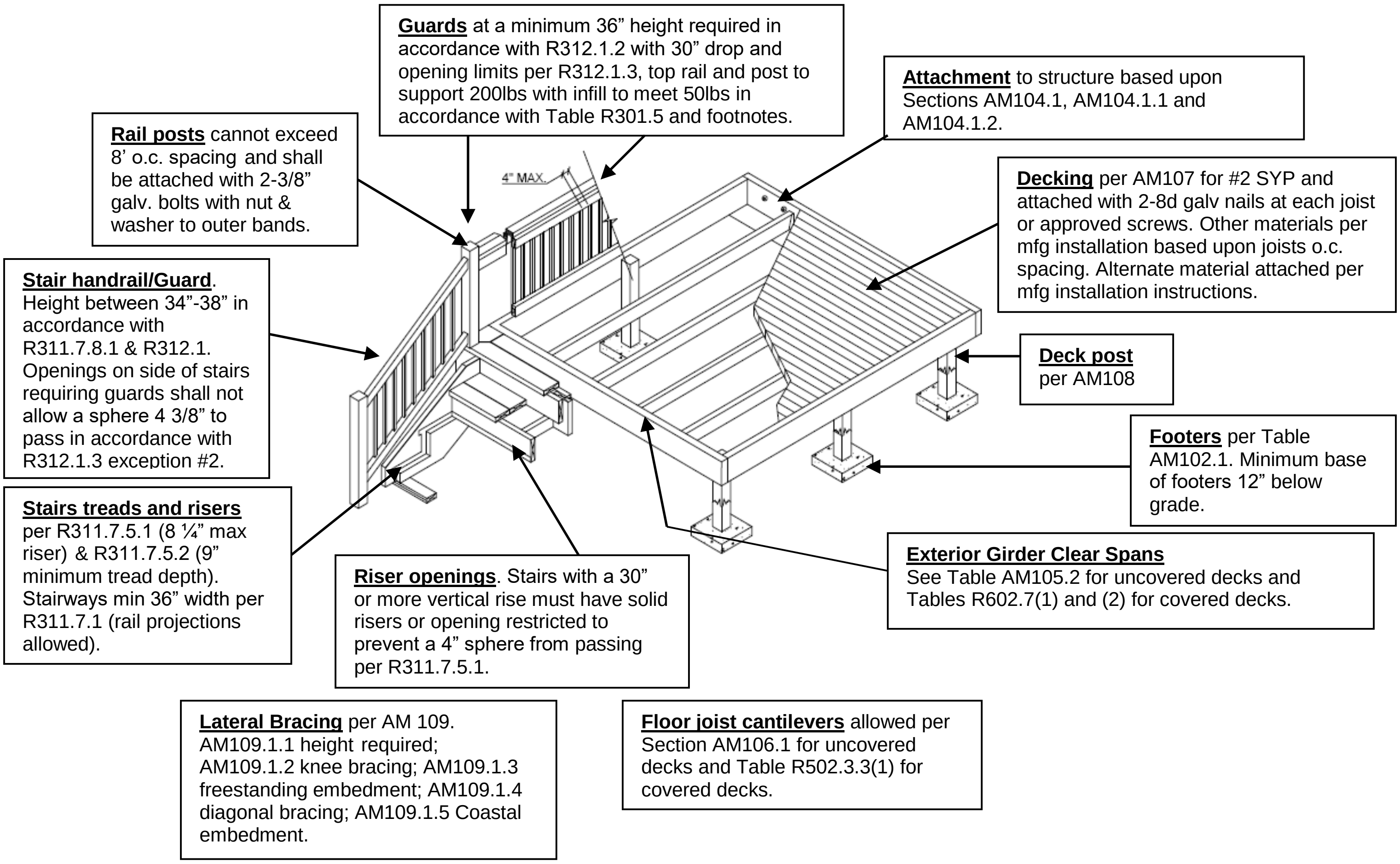


For SI: 1 inch = 25.4, 1 foot = 304.8 mm.

FIGURE AM110.1
STAIR STRINGER

SECTION AM111
HANDRAILS, GUARDS AND GENERAL

AM111.1 Handrails, guards and general.
Deck handrails, guards and general construction shall be as shown in Figure AM111.1.



Guards at a minimum 36" height required in accordance with R312.1.2 with 30" drop and opening limits per R312.1.3, top rail and post to support 200lbs with infill to meet 50lbs in accordance with Table R301.5 and footnotes.

Attachment to structure based upon Sections AM104.1, AM104.1.1 and AM104.1.2.

Rail posts cannot exceed 8' o.c. spacing and shall be attached with 2-3/8" galv. bolts with nut & washer to outer bands.

Decking per AM107 for #2 SYP and attached with 2-8d galv nails at each joist or approved screws. Other materials per mfg installation based upon joists o.c. spacing. Alternate material attached per mfg installation instructions.

Stair handrail/Guard. Height between 34"-38" in accordance with R311.7.8.1 & R312.1. Openings on side of stairs requiring guards shall not allow a sphere 4 3/8" to pass in accordance with R312.1.3 exception #2.

Deck post per AM108

Footers per Table AM102.1. Minimum base of footers 12" below grade.

Stairs treads and risers per R311.7.5.1 (8 ¼" max riser) & R311.7.5.2 (9" minimum tread depth). Stairways min 36" width per R311.7.1 (rail projections allowed).

Riser openings. Stairs with a 30" or more vertical rise must have solid risers or opening restricted to prevent a 4" sphere from passing per R311.7.5.1.

Exterior Girder Clear Spans See Table AM105.2 for uncovered decks and Tables R602.7(1) and (2) for covered decks.

Lateral Bracing per AM 109. AM109.1.1 height required; AM109.1.2 knee bracing; AM109.1.3 freestanding embedment; AM109.1.4 diagonal bracing; AM109.1.5 Coastal embedment.

Floor joist cantilevers allowed per Section AM106.1 for uncovered decks and Table R502.3.3(1) for covered decks.

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

FIGURE AM111.1
DECK CONSTRUCTION

SECTION AM112
WALKWAYS IN OCEAN HAZARD AREAS

AM112.1 Walkways over dunes.
Walkways over dunes in ocean hazard areas shall be constructed as shown in Figure AM112.1.

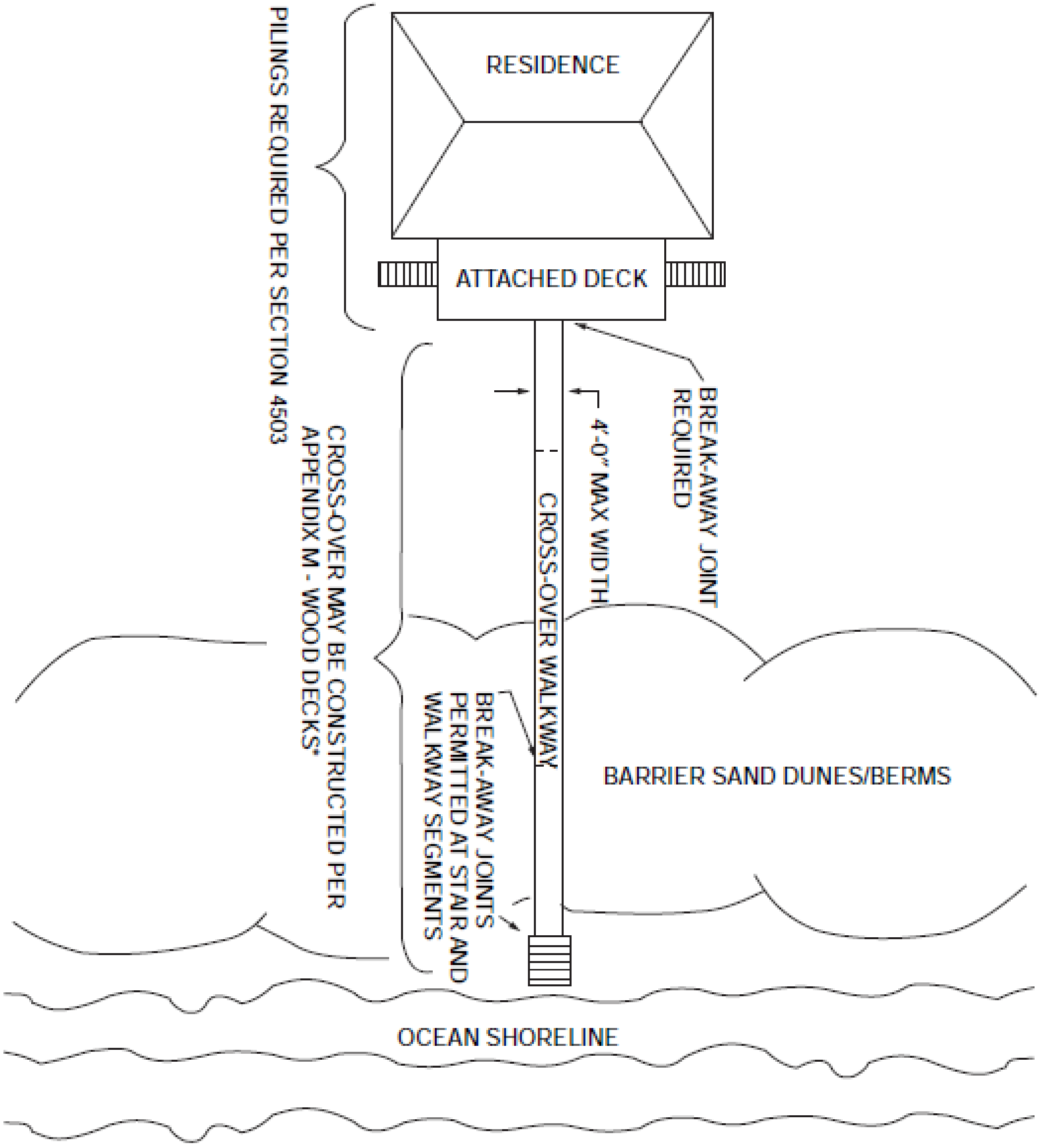


FIGURE AM112.1
WALKWAYS OVER DUNES OR BERMS IN OCEAN HAZARD AREAS

For SI: 1 inch = 25.4, 1 foot = 304.8 mm.
* Posts for walkways over dunes or berms shall be embedded a minimum depth of 4′ - 0″ and post heights shall be limited to 5′- 0″ above grade for 4×4 and 10′ - 0″ above grade for 6 × 6.Walkways or portions of walkways over 4′ 0″ in width shall comply with the requirements of Chapters 45 and 46.Maximum walkway surface height is 30″ above grade without guard rails.
**Walkway stair runs are permitted to be greater than 12′ without a landing.
***Open risers permitted on ocean shoreline stair.
****Horizontal guards permitted to have maximum 18 inch opening on cross-over walkway and ocean shoreline stair.

APPENDIX N

VENTING METHODS

(~~This appendix is informative and is not part of the code.~~ This appendix provides examples of various venting methods.)

APPENDIX O

~~AUTOMATIC VEHICULAR GATES~~

FOAM PLASTIC DIAGRAMS

This appendix is a North Carolina addition and not part of the 2015 International Residential Code. There will be no underlined text.
(The provisions contained in this appendix are adopted as part of this code.)

~~***(The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.)***~~

~~SECTION AO101~~
~~GENERAL~~

~~**AO101.1 General.**~~
~~The provisions of this appendix shall control the design and construction of automatic vehicular gates installed on the lot of a one- or two-family dwelling.~~

~~SECTION AO102~~
~~DEFINITION~~

~~**AO102.1 General.**~~
~~For the purposes of these requirements, the term used shall be defined as follows and as set forth in Chapter 2.~~

~~**VEHICULAR GATE.** A gate that is intended for use at a vehicular entrance or exit to the lot of a one- or two-family dwelling, and that is not intended for use by pedestrian traffic.~~

~~SECTION AO103~~
~~AUTOMATIC VEHICULAR GATES~~

~~**AO103.1 Vehicular gates intended for automation.**~~
~~Vehicular gates intended for automation shall be designed, constructed and installed to comply with the requirements of ASTM F 2200.~~

~~**AO103.2 Vehicular gate openers.**~~
~~Vehicular gate openers, where provided, shall be listed in accordance with UL 325.~~

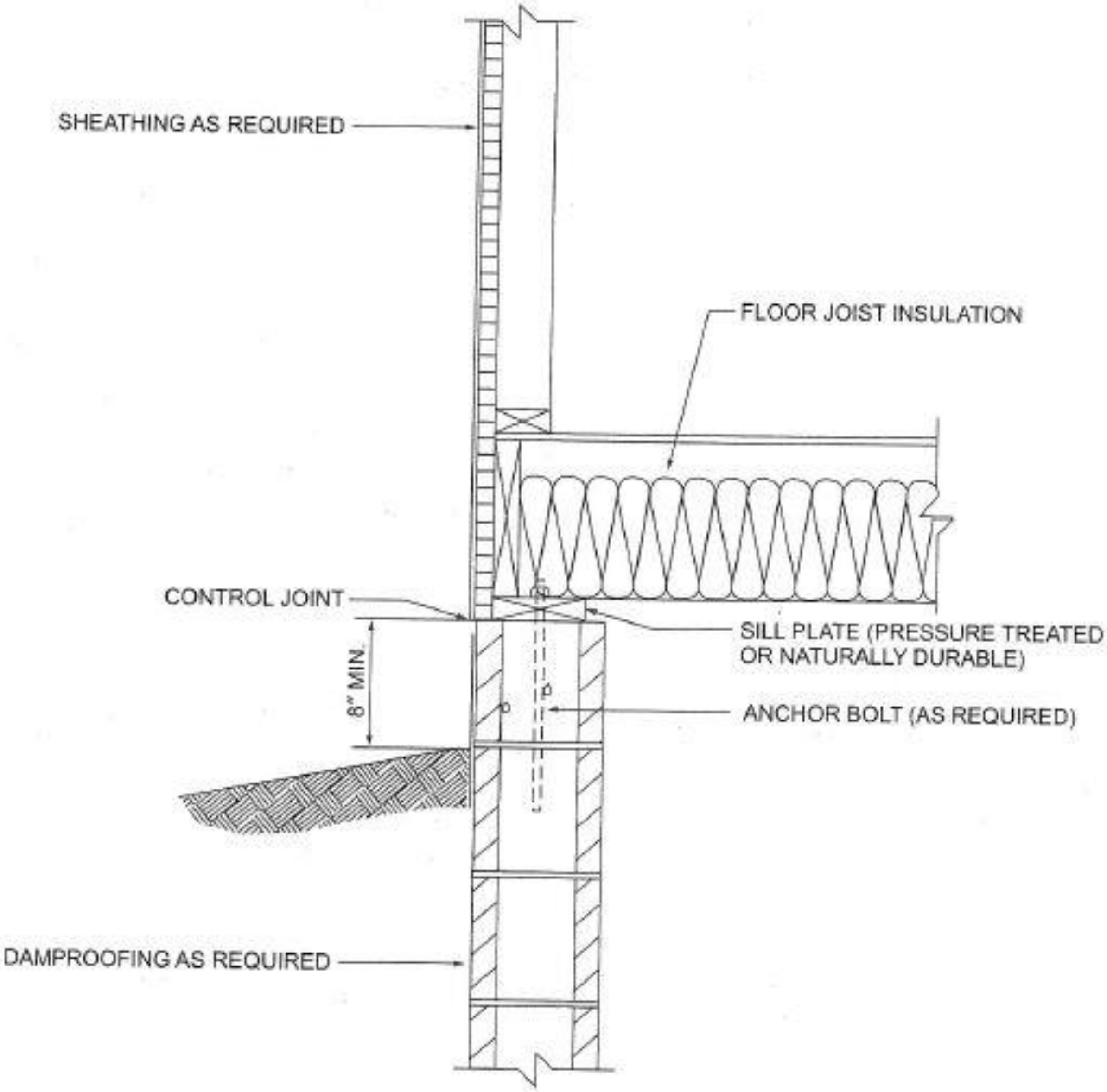


FIGURE O-1
FOUNDATION WALL

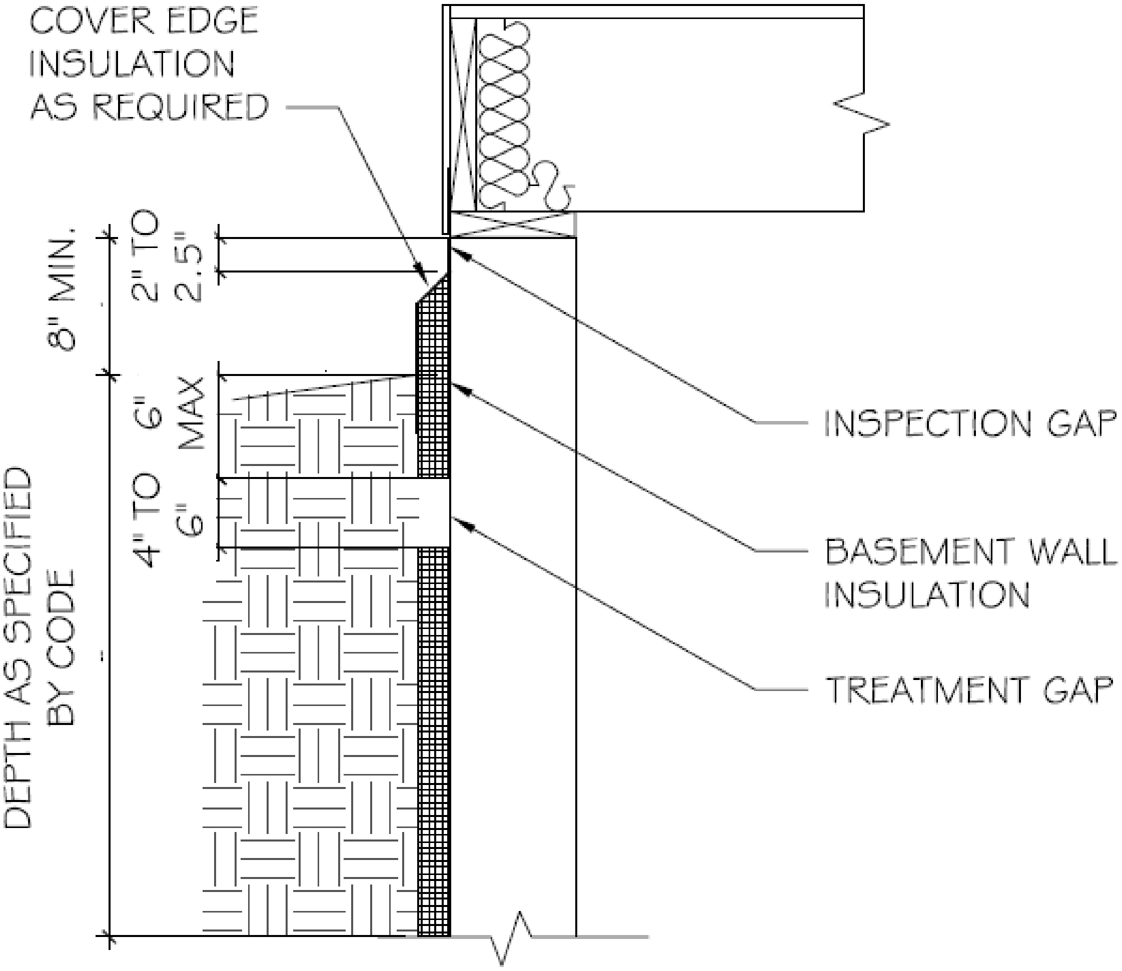
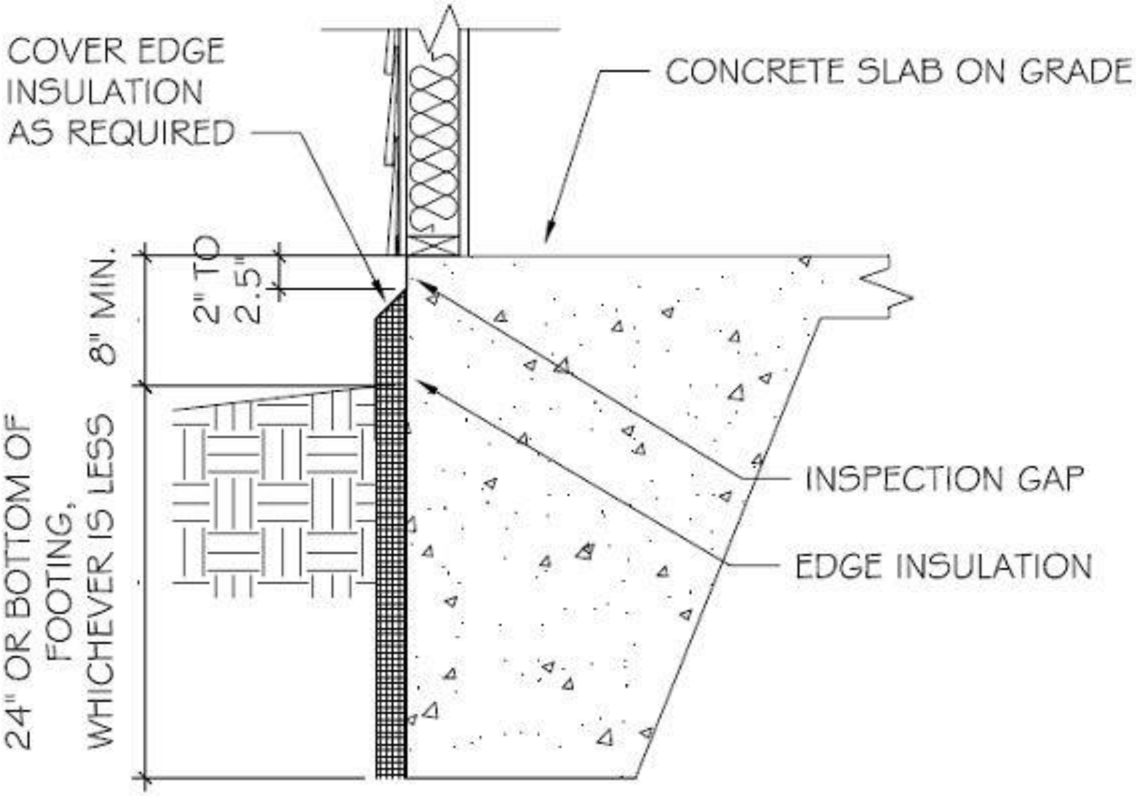


FIGURE O-2
BASEMENT WALL

N1102.2.9 Basement walls with exterior foam insulation. Insulation illustrations – Section view of exterior foam insulation location for basement walls
(Includes detailing from N1102.2.11)



SECTION VIEW OF MONOLITHIC SLAB-ON-GRADE INSULATION

FIGURE O-3
FRAME WALL

N1102.2.10 Slab insulation details. Insulation illustrations

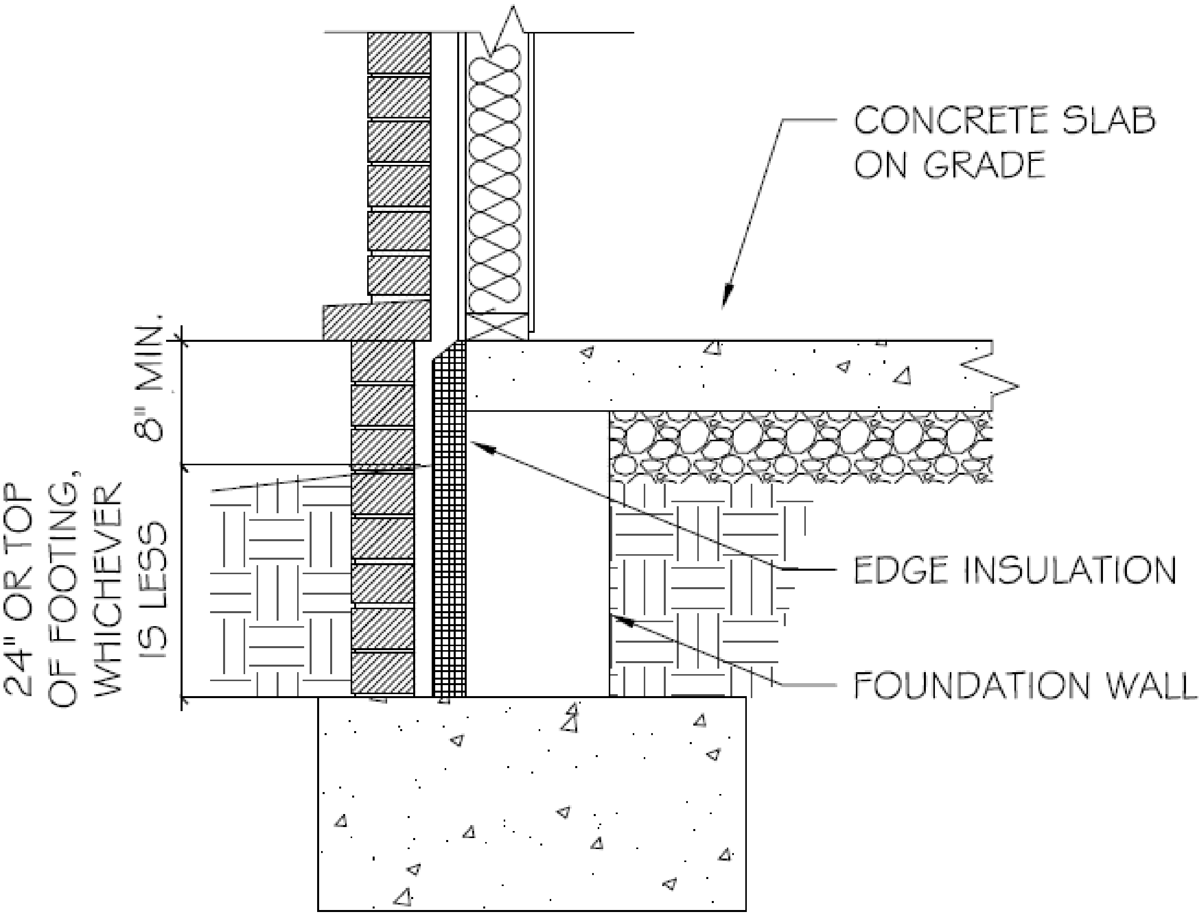


FIGURE O-4
FRAME WALL

N1102.2.10 Slab insulation details. Insulation illustrations - Example for slab edge insulation location behind brick, stone, or masonry facing (Other options may also compliant)

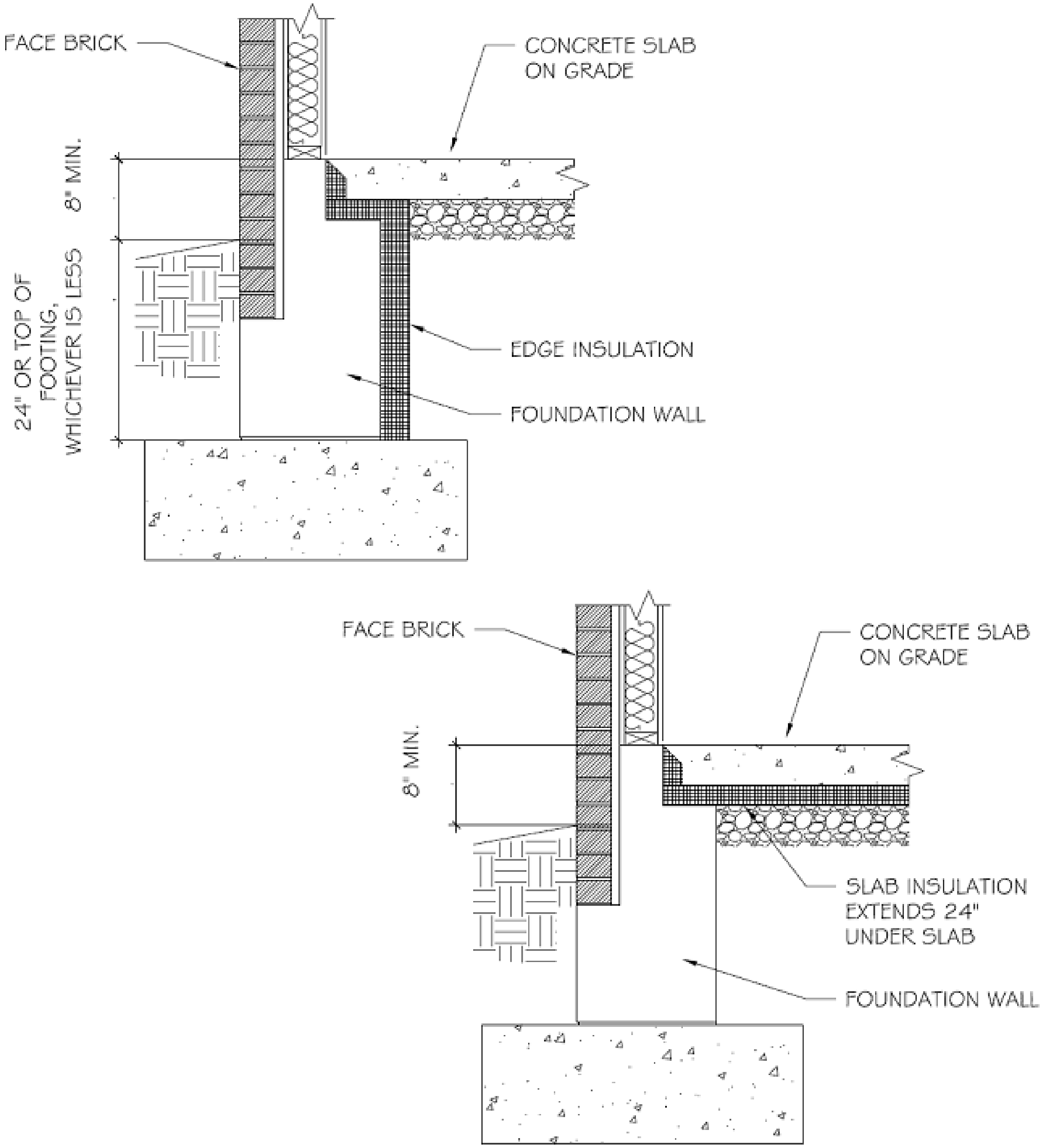


FIGURE O-5
FRAME WALL

N1102.2.10 Slab insulation details. Insulation illustrations – Examples for slab insulation location for floating slab with stem wall

APPENDIX P

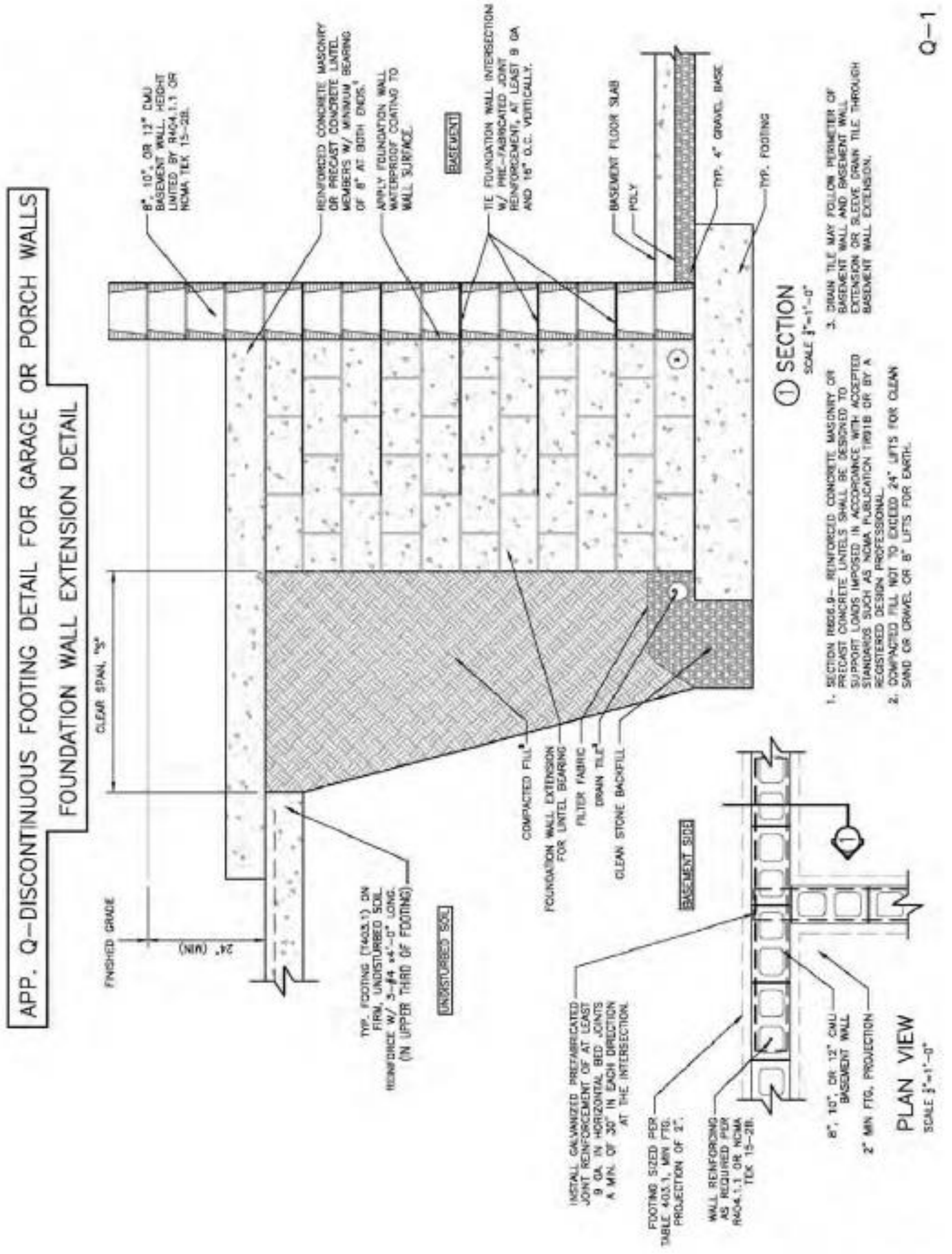
SIZING OF WATER PIPING SYSTEM

~~*(The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.)*~~

(The provisions contained in this appendix are adopted as part of this code.)

APPENDIX Q

This appendix is a North Carolina addition to the 2015 International Residential Code. There will be no underlined text.
(The provisions contained in this appendix are adopted as part of this code.)

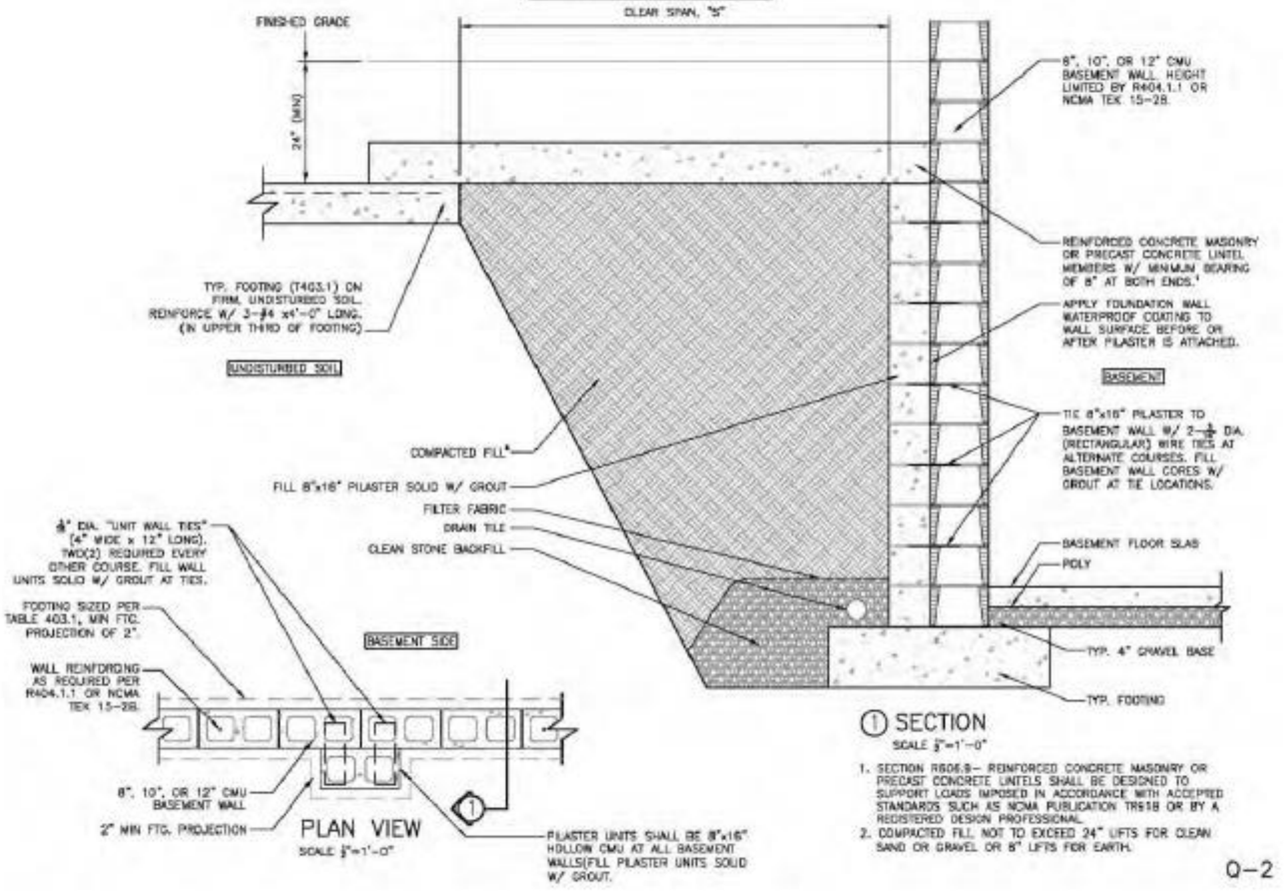


APP. Q–DISCONTINUOUS FOOTING DETAIL FOR GARAGE OR PORCH WALLS
FOUNDATION WALL EXTENSION DETAIL

1. SECTION R606.9– REINFORCED CONCRETE MASONRY OR PRECAST CONCRETE LINTELS SHALL BE DESIGNED TO SUPPORT LOADS IMPOSED IN ACCORDANCE WITH ACCEPTED STANDARDS SUCH AS NCMA PUBLICATION TR91B OR BY A REGISTERED DESIGN PROFESSIONAL.
2. COMPACTED FILL NOT TO EXCEED 24" LIFTS FOR CLEAN SAND OR GRAVEL OR 8" LIFTS FOR EARTH.
3. DRAIN TILE MAY FOLLOW PERIMETER OF BASEMENT WALL AND BASEMENT WALL EXTENSION OR SLEEVE DRAIN TILE THROUGH BASEMENT WALL EXTENSION.

APP. Q–DISCONTINUOUS FOOTING DETAIL FOR GARAGE OR PORCH WALLS

PILASTER DETAIL



① SECTION
SCALE 3/8"=1'–0"

PLAN VIEW
SCALE 3/8"=1'–0"

1. SECTION R606.9– REINFORCED CONCRETE MASONRY OR PRECAST CONCRETE LINTELS SHALL BE DESIGNED TO SUPPORT LOADS IMPOSED IN ACCORDANCE WITH ACCEPTED STANDARDS SUCH AS NCMA PUBLICATION TR91B OR BY A REGISTERED DESIGN PROFESSIONAL.
2. COMPACTED FILL NOT TO EXCEED 24" LIFTS FOR CLEAN SAND OR GRAVEL OR 8" LIFTS FOR EARTH.

APPENDIX R

LIGHT STRAW-CLAY CONSTRUCTION

Deleted

~~The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.~~

~~SECTION AR101~~
~~GENERAL~~

~~AR101.1 Scope.~~
~~This appendix shall govern the use of light straw-clay as a nonbearing building material and wall infill system.~~

~~SECTION AR102~~
~~DEFINITIONS~~

~~AR102.1 General.~~
~~The following words and terms shall, for the purposes of this appendix, have the meanings shown herein. Refer to Chapter 2 of the~~ *~~International Residential Code~~* ~~for general definitions.~~

~~CLAY.~~ ~~Inorganic soil with particle sizes of less than 0.00008 inch (0.002 mm) having the characteristics of high to very high dry strength and medium to high plasticity.~~

~~CLAY SLIP.~~ ~~A suspension of clay soil in water.~~

~~CLAY SOIL.~~ ~~Inorganic soil containing 50 percent or more clay by volume.~~

~~INFILL.~~ ~~Light straw-clay that is placed between the structural members of a building.~~

~~LIGHT STRAW-CLAY.~~ ~~A mixture of straw and clay compacted to form insulation and plaster substrate between or around structural and nonstructural members in a wall.~~

~~NONBEARING.~~ ~~Not bearing the weight of the building other than the weight of the light straw-clay itself and its finish.~~

~~STRAW.~~ ~~The dry stems of cereal grains after the seed heads have been removed.~~

~~VOID.~~ ~~Any space in a light straw-clay wall in which a 2-inch (51 mm) sphere can be inserted.~~

~~SECTION AR103~~
~~NONBEARING LIGHT STRAW-CLAY CONSTRUCTION~~

~~AR103.1 General.~~

~~Light straw-clay shall be limited to infill between or around structural and nonstructural wall framing members.~~

~~AR103.2 Structure.~~

~~The structure of buildings using light straw-clay shall be in accordance with the *International Residential Code* or shall be in accordance with an *approved* design by a registered *design professional*.~~

~~AR103.2.1 Number of stories.~~

~~Use of light straw-clay infill shall be limited to buildings that are not more than one *story above grade plane*.~~

> ~~**Exception:** Buildings using light straw-clay infill that are greater than one *story above grade plane* shall be in accordance with an approved design by a registered *design professional.*~~

~~AR103.2.2 Bracing.~~

~~Wind and seismic bracing shall be in accordance with Section R602.10 and shall use Method LIB. The required length of bracing shall comply with Section R602.10.3, with the additional requirements that Table 602.10.3(3) shall be applicable to buildings in Seismic Design Category C, and that the minimum total length of bracing in Table R602.10.3(3) shall be increased by 90 percent. In lieu of these prescriptive requirements, wind and seismic bracing shall be in accordance with an *approved* design by a registered *design professional*. Walls with light straw-clay infill shall not be sheathed with solid sheathing.~~

~~AR103.2.3 Weight of light straw-clay.~~

~~Light straw-clay shall be deemed to have a design dead load of 40 pounds per cubic foot (640 kg per cubic meter) unless otherwise demonstrated to the *building official*.~~

~~AR103.2.4 Reinforcement of light straw-clay.~~

~~Light straw-clay shall be reinforced as follows:~~

1. ~~Vertical reinforcing shall be not less than nominal 2-inch by 6-inch (51 mm by 152 mm) wood members at not more than 32 inches (813 mm) on center where the vertical reinforcing is nonload bearing and at 24 inches (610 mm) on center where it is load bearing. The vertical reinforcing shall not exceed an unrestrained height of 10 feet (3048 mm) and shall be attached at top and bottom in accordance with Chapter 6 of the this code. In lieu of these requirements, vertical reinforcing shall be in accordance with an *approved* design by a registered *design professional*.~~

2. ~~Horizontal reinforcing shall be installed in the center of the wall at not more than 24 inches (610 mm) on center and shall be secured to vertical members. Horizontal reinforcing shall be of any of the following: $^{3}/_{4}$-inch (19.1 mm) bamboo, $^{1}/_{2}$-inch (12.7 mm) fiberglass rod, 1-inch (25 mm) wood dowel or nominal 1-inch by 2-inch (25 mm by 51 mm) wood.~~

~~AR103.3 Materials.~~

~~The materials used in light straw-clay construction shall be in accordance with Sections AR103.3.1 through AR103.3.4.~~

~~AR103.3.1 Straw.~~

~~Straw shall be wheat, rye, oats, rice or barley, and shall be free of visible decay and insects.~~

~~AR103.3.2 Clay soil.~~

~~Suitability of clay soil shall be determined in accordance with the Figure 2 Ribbon Test or the Figure 3 Ball Test of the Appendix to ASTM E 2392/ E 2392M.~~

~~AR103.3.3 Clay slip.~~

~~Clay slip shall be of sufficient viscosity such that a finger dipped in the slip and withdrawn remains coated with an opaque coating.~~

~~AR103.3.4 Light straw-clay mixture.~~

~~Light straw-clay shall contain not less than 65 percent and not more than 85 percent straw, by volume of bale-compacted straw to clay soil. Loose straw shall be mixed and coated with clay slip such that there is not more than 5 percent uncoated straw.~~

~~AR103.4 Wall construction.~~

~~Light straw-clay wall construction shall be in accordance with the requirements of Sections AR103.4.1 through AR103.4.7.~~

~~AR103.4.1 Light straw-clay maximum thickness.~~

~~Light straw-clay shall be not more than 12 inches (305 mm) thick, to allow adequate drying of the installed material.~~

~~AR103.4.2 Distance above grade.~~

~~Light straw-clay and its exterior finish shall be not less than 8 inches (203 mm) above exterior finished *grade*.~~

~~AR103.4.3 Moisture barrier.~~

~~An *approved* moisture barrier shall separate the bottom of light straw-clay walls from any masonry or concrete foundation or slab that directly supports the walls. Penetrations and joints in the barrier shall be sealed with an *approved* sealant.~~

~~AR103.4.4 Contact with wood members.~~

~~Light straw-clay shall be permitted to be in contact with untreated wood members.~~

~~AR103.4.5 Contact with nonwood structural members.~~

~~Nonwood structural members in contact with light straw-clay shall be resistant to corrosion or shall be coated to prevent corrosion with an *approved* coating.~~

~~AR103.4.6 Installation.~~

~~Light straw-clay shall be installed in accordance with the following:~~

1. ~~Formwork shall be sufficiently strong to resist bowing where the light straw-clay is compacted into the forms.~~

2. ~~Light straw-clay shall be uniformly placed into forms and evenly tamped to achieve stable walls free of voids. Light straw-clay shall be placed in lifts of not more than 6 inches (152 mm) and shall be thoroughly tamped before additional material is added.~~

3. ~~Formwork shall be removed from walls within 24 hours after tamping, and walls shall remain exposed until moisture content is in accordance with Section AR103.5.1. Visible voids shall be patched with light straw-clay prior to plastering.~~

~~AR103.4.7 Openings in walls.~~

~~Openings in walls shall be in accordance with the following:~~

1. ~~Rough framing for doors and windows shall be fastened to structural members in accordance with the *International Residential Code*. Windows and doors shall be flashed in accordance with the *International Residential Code*.~~

2. ~~An *approved* moisture barrier shall be installed at window sills in light straw-clay walls prior to installation of windows.~~

~~AR103.5 Wall finishes.~~

~~The interior and exterior surfaces of light straw-clay walls shall be protected with a finish in accordance with Sections AR103.5.1 through AR103.5.5.~~

~~AR103.5.1 Moisture content of light straw-clay prior to application of finish.~~

~~Light straw-clay walls shall be dry to a moisture content of not more than 20 percent at a depth of 4 inches (102 mm), as measured from each side of the wall, prior to the application of finish on either side of the wall. Moisture content shall be measured with a moisture meter equipped with a probe that is designed for use with baled straw or hay.~~

~~AR103.5.2 Plaster finish.~~

~~Exterior plaster finishes shall be clay plaster or lime plaster. Interior plaster finishes shall be clay plaster, lime plaster or gypsum plaster. Plasters shall be permitted to be applied directly to the surface of the light straw-clay walls without reinforcement, except that the juncture of dissimilar substrates shall be in accordance with Section AR103.5.3. Plasters shall have a thickness of not less than $^1/_2$ inch (12.7 mm) and not more than 1 inch (25 mm) and shall be installed in not less than two coats. Exterior clay plaster shall be finished with a lime-based or silicate-mineral coating.~~

~~AR103.5.3 Separation of wood and plaster.~~

~~Where wood framing occurs in light straw-clay walls, such wood surfaces shall be separated from exterior plaster with No.15 asphalt felt, Grade D paper or other approved material except where the wood is preservative treated or naturally durable.~~

~~**Exception:** Exterior clay plasters shall not be required to be separated from wood.~~

~~AR103.5.4 Bridging across dissimilar substrates.~~

~~Bridging shall be installed across dissimilar substrates prior to the application of plaster. Acceptable bridging materials include: expanded metal lath, woven wire mesh, welded wire mesh, fiberglass mesh, reed matting or burlap. Bridging shall extend not less than 4 inches (102 mm), on both sides of the juncture.~~

~~AR103.5.5 Exterior siding.~~

~~Exterior wood, metal or composite material siding shall be spaced not less than $^{3}/_{4}$ inch (19.1 mm) from the light straw-clay such that a ventilation space is created to allow for moisture diffusion. The siding shall be fastened to wood furring strips in accordance with the manufacturer's instructions. Furring strips shall be spaced not more than 32 inches (813 mm) on center, and shall be securely fastened to the vertical wall reinforcing or structural framing. Insect screening shall be provided at the top and bottom of the ventilation space. An air barrier consisting of not more than $^{3}/_{8}$-inch-thick (9.5 mm) clay plaster or lime plaster shall be applied to the light straw-clay prior to the application of siding.~~

~~SECTION AR104~~
~~THERMAL INSULATION~~

~~AR104.1 R-value.~~

~~Light straw-clay, where installed in accordance with this appendix, shall be deemed to have an *R*-value of 1.6 per inch.~~

~~SECTION AR105~~
~~REFERENCED STANDARD~~

~~ASTM E 2392/ E 2392M—10~~	~~Standard Guide for Design of Earthen Wall Building Systems~~	~~AR103.3.2~~

APPENDIX S

STRAWBALE CONSTRUCTION

Deleted

~~***The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.***~~

~~SECTION AS101~~
~~GENERAL~~

~~**AS101.1 Scope.**~~
~~This appendix provides prescriptive and performance-based requirements for the use of baled straw as a building material. Other methods of strawbale construction shall be subject to approval in accordance with Section 104.11 of this code. Buildings using strawbale walls shall comply with the this code except as otherwise stated in this appendix.~~

~~SECTION AS102~~
~~DEFINITIONS~~

~~**AS102.1 Definitions.**~~
~~The following words and terms shall, for the purposes of this appendix, have the meanings shown herein. Refer to Chapter 2 of the *International Residential Code* for general definitions.~~

~~**BALE.** Equivalent to straw bale.~~

~~**CLAY.** Inorganic soil with particle sizes less than 0.00008 inch (0.002 mm) having the characteristics of high to very high dry strength and medium to high plasticity.~~

~~**CLAY SLIP.** A suspension of clay particles in water.~~

~~**FINISH.** Completed compilation of materials on the interior or exterior faces of stacked *bales*.~~

~~**FLAKE.** An intact section of compressed *straw* removed from an untied *bale*.~~

~~**LAID FLAT.** The orientation of a bale with its largest faces horizontal, its longest dimension parallel with the wall plane, its *ties* concealed in the unfinished wall and its *straw* lengths oriented across the thickness of the wall.~~

~~**LOAD-BEARING WALL.** A strawbale wall that supports more than 100 pounds per linear foot (1459 N/m) of vertical load in addition its own weight.~~

~~**MESH.** An openwork fabric of linked strands of metal, plastic, or natural or synthetic fiber, embedded in plaster.~~

~~**NONSTRUCTURAL WALL.** Walls other than load-bearing walls or shear walls.~~

~~**ON-EDGE.** The orientation of a *bale* with its largest faces vertical, its longest dimension parallel with the wall plane, its *ties* on the face of the wall and its *straw* lengths oriented vertically.~~

~~**PIN.** A vertical metal rod, wood dowel or bamboo, driven into the center of stacked bales, or placed on opposite surfaces of stacked bales and through-tied.~~

~~**PLASTER.** Gypsum or cement plaster, as defined in Sections R702 and AS104, or clay plaster, soil-cement plaster, lime plaster or cement-lime plaster as defined in Section AS104.~~

~~**PRECOMPRESSION.** Vertical compression of stacked bales before the application of finish.~~

~~**REINFORCED PLASTER.** A plaster containing mesh reinforcement.~~

~~**RUNNING BOND.** The placement of *straw bales* such that the head joints in successive courses are offset not less than one-quarter the bale length.~~

~~**SHEAR WALL.** A strawbale wall designed and constructed to resist lateral seismic and wind forces parallel to the plane of the wall in accordance with Section AS106.13.~~

~~**SKIN.** The compilation of plaster and reinforcing, if any, applied to the surface of stacked bales.~~

~~**STRUCTURAL WALL.** A wall that meets the definition for a load-bearing wall or shear wall.~~

~~**STACK BOND.** The placement of straw bales such that head joints in successive courses are vertically aligned.~~

~~**STRAW.** The dry stems of cereal grains after the seed heads have been removed.~~

~~**STRAW BALE.** A rectangular compressed block of straw, bound by ties.~~

~~**STRAWBALE.** The adjective form of straw bale.~~

~~**STRAW-CLAY.** Loose straw mixed and coated with clay slip.~~

~~**TIE.** A synthetic fiber, natural fiber or metal wire used to confine a straw bale.~~

~~**TRUTH WINDOW.** An area of a strawbale wall left without its finish, to allow view of the straw otherwise concealed by its finish.~~

~~SECTION AS103~~
~~BALES~~

~~**AS103.1 Shape.**~~

~~Bales shall be rectangular in shape.~~

~~**AS103.2 Size.**~~

~~Bales shall have a height and thickness of not less than 12 inches (305 mm), except as otherwise permitted or required in this appendix. Bales used within a continuous wall shall be of consistent height and thickness to ensure even distribution of loads within the wall system.~~

~~AS103.3 Ties.~~

~~Bales shall be confined by synthetic fiber, natural fiber or metal ties sufficient to maintain required bale density. Ties shall be not less than 3 inches (76 mm) and not more than 6 inches (152 mm) from the two faces without ties and shall be spaced not more than 12 inches (305 mm) apart. Bales with broken ties shall be retied with sufficient tension to maintain required bale density.~~

~~AS103.4 Moisture content.~~

~~The moisture content of bales at the time of application of the first coat of plaster or the installation of another finish shall not exceed 20 percent of the weight of the bale. The moisture content of bales shall be determined by use of a moisture meter designed for use with baled straw or hay, equipped with a probe of sufficient length to reach the center of the bale. Not less than 5 percent and not less than 10 bales used shall be randomly selected and tested.~~

~~AS103.5 Density.~~

~~Bales shall have a dry density of not less than 6.5 pounds per cubic foot (104 kg/cubic meter). The dry density shall be calculated by subtracting the weight of the moisture in pounds (kg) from the actual bale weight and dividing by the volume of the bale in cubic feet (cubic meters). Not less than 2 percent and not less than five bales to be used shall be randomly selected and tested on site.~~

~~AS103.6 Partial bales.~~

~~Partial bales made after original fabrication shall be retied with ties complying with Section AR103.3.~~

~~AS103.7 Types of straw.~~

~~Bales shall be composed of straw from wheat, rice, rye, barley or oat.~~

~~AS103.8 Other baled material.~~

~~The dry stems of other cereal grains shall be acceptable where approved by the building official.~~

~~SECTION AS104~~
~~FINISHES~~

~~AS104.1 General.~~

~~Finishes applied to strawbale walls shall be any type permitted by this code, and shall comply with this section and with Chapters 3 and 7 of this code unless stated otherwise in this section.~~

~~AS104.2 Purpose, and where required.~~

~~Strawbale walls shall be finished so as to provide mechanical protection, fire resistance and protection from weather and to restrict the passage of air through the bales, in accordance with this appendix and this code. Vertical strawbale wall surfaces shall receive a coat of plaster not less than $^3/_8$ inch (10 mm) thick, or greater where required elsewhere in this appendix, or shall fit tightly against a solid wall panel. The tops of strawbale walls shall receive a coat of plaster not less than $^3/_8$ inch (10 mm) thick where straw would otherwise be exposed.~~

~~**Exception:** Truth windows shall be permitted where a fire-resistance rating is not required. Weather-exposed truth windows shall be fitted with a weather-tight cover. Interior truth windows in Climate Zones 5, 6, 7, 8 and Marine 4 shall be fitted with an air-tight cover.~~

~~AS104.3 Vapor retarders.~~

~~Class I and II vapor retarders shall not be used on a strawbale wall, nor shall any other material be used that has a vapor permeance rating of less than 3 perms, except as permitted or required elsewhere in this appendix.~~

~~AS104.4 Plaster.~~

~~Plaster applied to bales shall be any type described in this section, and as required or limited in this appendix. Plaster thickness shall not exceed 2 inches (51 mm).~~

~~AS104.4.1 Plaster and membranes.~~

~~Plaster shall be applied directly to strawbale walls to facilitate transpiration of moisture from the bales, and to secure a mechanical bond between the skin and the bales, except where a membrane is allowed or required elsewhere in this appendix.~~

~~AS104.4.2 Lath and mesh for plaster.~~

~~The surface of the straw bales functions as lath, and other lath or mesh shall not be required, except as required for out-of-plane resistance by Table AS105.4 or for structural walls by Tables AS106.12 and AS106.13(1).~~

~~AS104.4.3 Clay plaster.~~

~~Clay plaster shall comply with Sections AS104.4.3.1 through AS104.4.3.6.~~

~~AS104.4.3.1 General.~~

~~Clay plaster shall be any plaster having a clay or clay-soil binder. Such plaster shall contain sufficient clay to fully bind the plaster, sand or other inert granular material, and shall be permitted to contain reinforcing fibers. Acceptable reinforcing fibers include chopped straw, sisal and animal hair.~~

~~AS104.4.3.2 Lath and mesh.~~

~~Clay plaster shall not be required to contain reinforcing lath or mesh except as required in Tables AS105.4 and AS106.13(1). Where provided, mesh shall be natural fiber, corrosion-resistant metal, nylon, high-density polypropylene or other approved material.~~

~~AS104.4.3.3 Thickness and coats.~~

~~Clay plaster shall be not less than 1 inch (25 mm) thick, except where required to be thicker for structural walls as described elsewhere in this appendix, and shall be applied in not less than two coats.~~

~~AS104.4.3.4 Rain-exposed.~~

~~Clay plaster, where exposed to rain, shall be finished with lime wash, lime plaster, linseed oil or other *approved* erosion-resistant finish.~~

~~AS104.4.3.5 Prohibited finish coat.~~

~~Plaster containing Portland cement shall not be permitted as a finish coat over clay plasters.~~

~~AS104.4.3.6 Plaster additives.~~
~~Additives shall be permitted to increase plaster workability, durability, strength or water resistance.~~

~~AS104.4.4 Soil-cement plaster.~~
~~Soil-cement plaster shall comply with Sections AS104.4.4.1 through AS104.4.4.3.~~

~~AS104.4.4.1 General.~~
~~Soil-cement plaster shall be composed of soil (free of organic matter), sand and not less than 10 percent and not more than 20 percent Portland cement by volume, and shall be permitted to contain reinforcing fibers.~~

~~AS104.4.4.2 Lath and mesh.~~
~~Soil-cement plaster shall use any corrosion-resistant lath or mesh permitted by this code, or as required in Section AS106 where used on structural walls.~~

~~AS104.4.4.3 Thickness.~~
~~Soil-cement plaster shall be not less than 1 inch (25 mm) thick.~~

~~AS104.4.5 Gypsum plaster.~~
~~Gypsum plaster shall comply with Section R702. Gypsum plaster shall be limited to use on interior surfaces of nonstructural walls, and as an interior finish coat over a structural plaster that complies with this appendix.~~

~~AS104.4.6 Lime plaster.~~
~~Lime plaster shall comply with Sections AS104.4.6.1 and AS104.4.6.3.~~

~~AS104.4.6.1 General.~~
~~Lime plaster is any plaster with a binder that is composed of calcium hydroxide (CaOH) including Type N or S hydrated lime, hydraulic lime, natural hydraulic lime or quicklime. Hydrated lime shall comply with ASTM C 206. Hydraulic lime shall comply with ASTM C 1707. Natural hydraulic lime shall comply with ASTM C 141 and EN 459. Quicklime shall comply with ASTM C 5.~~

~~AS104.4.6.2 Thickness and coats.~~
~~Lime plaster shall be not less than $^7/_8$ inch (22 mm) thick, and shall be applied in not less than three coats.~~

~~AS104.4.6.3 On structural walls.~~
~~Lime plaster on strawbale structural walls in accordance with Table AS106.12 or Table AS106.13(1) shall use a binder of hydraulic or natural hydraulic lime.~~

~~AS104.4.7 Cement-lime plaster.~~
~~Cement-lime plaster shall be plaster mixes CL, F or FL, as described in ASTM C 926.~~

~~AS104.4.8 Cement plaster.~~
~~Cement plaster shall conform to ASTM C 926 and shall comply with Sections R703.6.2, R703.6.4 and R703.6.5, except that the amount of lime in plaster coats shall be not less~~

~~than 1 part lime to 6 parts cement to allow a minimum acceptable vapor permeability. The combined thickness of plaster coats shall be not more than 1 $^1/_2$ inches (38 mm) thick.~~

~~SECTION AS105~~

~~STRAWBALE WALLS—GENERAL~~

~~AS105.1 General.~~

~~Strawbale walls shall be designed and constructed in accordance with this section. Strawbale structural walls shall be in accordance with the additional requirements of Section AS106.~~

~~AS105.2 Building requirements for use of strawbale nonstructural walls.~~

~~Buildings using strawbale nonstructural walls shall be subject to the following limitations and requirements:~~

1. ~~Number of stories: not more than one, except that two stories shall be allowed with an *approved* engineered design.~~

2. ~~Building height: not more than 25 feet (7620 mm).~~

3. ~~Wall height: in accordance with Table AS105.4.~~

4. ~~Braced wall panel length, and increase in Seismic Design Categories C, D_0, D_1 and D_2: the required length of bracing for buildings using strawbale nonstructural walls shall comply with Section R602.10.3 of this code, with the additional requirements that Table 602.10.3(3) shall be applicable to buildings in Seismic Design Category C, and that the minimum total length of braced wall panels in Table R602.10.3(3) shall be increased by 60 percent.~~

~~AS105.3 Sill plates.~~

~~Sill plates shall support and be flush with each face of the straw bales above and shall be of naturally durable or preservative-treated wood where required by this code. Sill plates shall be not less than nominal 2 inches by 4 inches (51 mm by 102 mm) with anchoring complying with Section R403.1.6 and the additional requirements of Tables AS105.4 and AS106.6(1), where applicable.~~

~~AS105.4 Out-of-plane resistance and unrestrained wall dimensions.~~

~~Strawbale walls shall employ a method of out-of-plane resistance in accordance with Table AS105.4, and comply with its associated limits and requirements.~~

~~TABLE AS105.4~~

~~OUT-OF-PLANE RESISTANCE AND UNRESTRAINED WALL DIMENSIONS~~

~~METHOD OF OUT-OF-PLANE RESISTANCE~~[a]	~~FOR WIND DESIGN SPEEDS (mph)~~	~~FOR SEISMIC DESIGN CATEGORIES~~	~~UNRESTRAINED WALL DIMENSIONS, H~~[b]		~~MESH STAPLE SPACING AT BOUNDARY RESTRAINTS~~
			~~Absolute limit in feet~~	~~Limit based on bale thickness T~~[c] ~~in feet (mm)~~	

~~Nonplaster finish or unreinforced plaster~~	~~≤ 100~~	~~A, B, C, D_0~~	~~$H \leq 8$~~	~~$H \leq 5T$~~	~~None required~~
~~Pins per Section AS105.4.2~~	~~≤ 100~~	~~A, B, C, D_0~~	~~$H \leq 12$~~	~~$H \leq 8T$~~	~~None required~~
~~Pins per Section AS105.4.2~~	~~≤ 110~~	~~A, B, C, D_0, D_1, D_2~~	~~$H \leq 10$~~	~~$H \leq 7T$~~	~~None required~~
~~Reinforced[c] clay plaster~~	~~≤ 110~~	~~A, B, C, D_0, D_1, D_2~~	~~$H \leq 10$~~	~~$H \leq 8T^{0.5}$ ($H \leq 140T^{0.5}$)~~	~~≤ 6 inches~~
~~Reinforced[c] clay plaster~~	~~≤ 110~~	~~A, B, C, D_0, D_1, D_2~~	~~$10 < H \leq 12$~~	~~$H \leq 8T^{0.5}$ ($H \leq 140T^{0.5}$)~~	~~≤ 4 inches[e]~~
~~Reinforced[c] cement, cement-lime, lime or soil-cement plaster~~	~~≤ 110~~	~~A, B, C, D_0, D_1, D_2~~	~~$H \leq 10$~~	~~$H \leq 9T^{0.5}$ ($H \leq 157T^{0.5}$)~~	~~≤ 6 inches~~
~~Reinforced[c] cement, cement-lime, lime or soil-cement plaster~~	~~≤ 120~~	~~A, B, C, D_0, D_1, D_2~~	~~$H \leq 12$~~	~~$H \leq 9T^{0.5}$ ($H \leq 157T^{0.5}$)~~	~~≤ 4 inches[e]~~

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

~~a. Finishes applied to both sides of stacked bales. Where different finishes are used on opposite sides of a wall, the more restrictive requirements shall apply.~~

~~b. *H* = Stacked bale height in feet (mm) between sill plate and top plate or other *approved* horizontal restraint, or the horizontal distance in feet (mm) between *approved* vertical restraints. For load-bearing walls, *H* refers to vertical height only.~~

~~c. *T* = Bale thickness in feet (mm).~~

~~d. Plaster reinforcement shall be any mesh allowed in Table AS106.16 for the matching plaster type, and with staple spacing in accordance with this table. Mesh shall be installed in accordance with Section AS106.9.~~

~~e. Sill plate attachment shall be with $^{5}/_{8}$-inch anchor bolts or approved equivalent at not more than 48 inches on center where staple spacing is required to be ≤ 4 inches~~

~~AS105.4.1 Determination of out-of-plane loading.~~

~~Out-of-plane loading for the use of Table AS105.4 shall be in terms of the design wind speed and seismic design category as determined in accordance with Sections R301.2.1 and R301.2.2 of this code.~~

~~AS105.4.2 Pins.~~

~~Pins used for out-of-plane resistance shall comply with the following or shall be in accordance with an *approved* engineered design. Pins shall be external, internal or a combination of the two.~~

1. ~~Pins shall be $^{1}/_{2}$-inch-diameter (12.7 mm) steel, $^{3}/_{4}$-inch-diameter (19.1 mm) wood or $^{1}/_{2}$-inch-diameter (12.7 mm) bamboo.~~
2. ~~External pins shall be installed vertically on both sides of the wall at a spacing of not more than 24 inches (610 mm) on center. External pins shall have full lateral bearing on the sill plate and the top plate or roof-bearing element, and shall be tightly tied through the wall to an opposing pin with ties spaced not more than 32 inches (813 mm) apart and not more than 8 inches (203 mm) from each end of the pins.~~

3. ~~Internal pins shall be installed vertically within the center third of the bales, at spacing of not more than 24 inches (610 mm) and shall extend from top course to bottom course. The bottom course shall be similarly connected to its support and the top course shall be similarly connected to the roof- or floor-bearing member above with pins or other *approved* means. Internal pins shall be continuous or shall overlap through not less than one bale course.~~

~~AS105.5 Connection of light-framed walls to strawbale walls.~~

~~*Light-framed* walls perpendicular to, or at an angle to a straw bale wall assembly, shall be fastened to the bottom and top wood members of the strawbale wall in accordance with requirements for wood or cold-formed steel *light-framed* walls in this code, or the abutting stud shall be connected to alternating straw bale courses with a 1/2-inch diameter (12.7 mm) steel, 3/4-inch-diameter (19.1 mm) wood or 5/8-inch-diameter (15.9 mm) bamboo dowel, with not less than 8-inch (203 mm) penetration.~~

~~AS105.6 Moisture control.~~

~~Strawbale walls shall be protected from moisture intrusion and damage in accordance with Sections AS105.6.1 through AS105.6.8.~~

~~AS105.6.1 Water-resistant barriers and vapor permeance ratings.~~

~~Plastered bale walls shall be constructed without any membrane barrier between straw and plaster to facilitate transpiration of moisture from the bales, and to secure a structural bond between straw and plaster, except as permitted or required elsewhere in this appendix. Where a water-resistant barrier is placed behind an exterior finish, it shall have a vapor permeance rating of not less than 5 perms, except as permitted or required elsewhere in this appendix.~~

~~AS105.6.2 Vapor retarders.~~

~~Wall finishes shall have an equivalent vapor permeance rating of a Class III vapor retarder on the interior side of exterior strawbale walls in Climate Zones 5, 6, 7, 8 and Marine 4, as defined in Chapter 11. Bales in walls enclosing showers or steam rooms shall be protected on the interior side by a Class I or Class II vapor retarder.~~

~~AS105.6.3 Penetrations in exterior strawbale walls.~~

~~Penetrations in exterior strawbale walls shall be sealed with an *approved* sealant or gasket on the exterior side of the wall in all climate zones, and on the interior side of the wall in Climate Zones 5, 6, 7, 8 and Marine 4, as defined in Chapter 11.~~

~~AS105.6.4 Horizontal surfaces.~~

~~Bale walls and other bale elements shall be provided with a water-resistant barrier at weather-exposed horizontal surfaces. The water-resistant barrier shall be of a material and installation that will prevent water from entering the wall system. Horizontal surfaces shall include exterior window sills, sills at exterior niches and buttresses. The finish material at such surfaces shall be sloped not less than 1 unit vertical in 12 units horizontal (8-percent slope) and shall drain away from bale walls and elements. Where the water-resistant barrier is below the finish material, it shall be sloped not less than 1 unit vertical in 12 units~~

~~horizontal (8-percent slope) and shall drain to the outside surface of the bales wall's vertical finish.~~

~~AS105.6.5 Separation of bales and concrete.~~

~~A sheet or liquid-applied Class II *vapor retarder* shall be installed between bales and supporting concrete or masonry. The bales shall be separated from the vapor retarder by not less than $^3/_4$ inch (19.1 mm), and that space shall be filled with an insulating material such as wood or rigid insulation, or a material that allows vapor dispersion such as gravel, or other approved insulating or vapor dispersion material. Sill plates shall be installed at this interface in accordance with Section AS105.3. Where bales abut a concrete or masonry wall that retains earth, a Class II vapor retarder shall be provided between such wall and the bales.~~

~~AS105.6.6 Separation of bales and earth.~~

~~Bales shall be separated from earth by not less than 8 inches (203 mm).~~

~~AS105.6.7 Separation of exterior plaster and earth.~~

~~Exterior plaster applied to straw bales shall be located not less than 6 inches (102 mm) above earth or 3 inches (51 mm) above paved areas.~~

~~AS105.6.8 Separation of wood and plaster.~~

~~Where wood framing or wood sheathing occurs on the exterior face of strawbale walls, such wood surfaces shall be separated from exterior plaster with two layers of Grade D paper, No. 15 asphalt felt or other *approved* material in accordance with Section R703.6.3.~~

~~Exceptions:~~

1. ~~Where the wood is preservative treated or *naturally durable* and is not greater than $1^1/_2$ inches (38 mm) in width.~~

2. ~~Clay plaster shall not be required to be separated from untreated wood that is not greater than $1^1/_2$ inches (38 mm) in width.~~

~~AS105.7 Inspections.~~

~~The *building official* shall inspect the following aspects of strawbale construction in accordance with Section R109.1:~~

1. ~~Sill plate anchors, as part of and in accordance with Section R109.1.1.~~

2. ~~Mesh placement and attachment, where mesh is required by this appendix.~~

3. ~~*Pins*, where required by and in accordance with Section AS105.4.~~

~~SECTION AS106~~
~~STRAWBALE WALLS—STRUCTURAL~~

~~AS106.1 General.~~

~~Plastered strawbale walls shall be permitted to be used as structural walls in one-story buildings in accordance with the prescriptive provisions of this section.~~

~~AS106.2 Loads and other limitations.~~

~~Live and dead loads and other limitations shall be in accordance with Section R301 of the *International Residential Code*. Strawbale wall dead loads shall not exceed 60 psf (2872 N/m^2) per face area of wall.~~

~~AS106.3 Foundations.~~

~~Foundations for plastered strawbale walls shall be in accordance with Chapter 4.~~

~~AS106.4 Configuration of bales.~~

~~Bales in strawbale structural walls shall be laid flat or on-edge and in a running bond or stack bond, except that bales in structural walls with unreinforced plasters shall be laid in a running bond only.~~

~~AS106.5 Voids and stuffing.~~

~~Voids between bales in strawbale *structural walls* shall not exceed 4 inches (102 mm) in width, and such voids shall be stuffed with flakes of straw or straw-clay, before application of finish.~~

~~AS106.6 Plaster on structural walls.~~

~~Plaster on *load-bearing* walls shall be in accordance with Table AS106.12. Plaster on shear walls shall be in accordance with Table AS106.13(1).~~

~~AS106.6.1 Compressive strength.~~

~~For plaster on strawbale structural walls, the building official is authorized to require a 2-inch (51mm) cube test conforming to ASTM C 109 to demonstrate a minimum compressive strength in accordance with Table AS106.6.1.~~

~~TABLE AS106.6.1~~
~~MINIMUM COMPRESSIVE STRENGTH FOR PLASTERS ON STRUCTURAL WALLS~~

~~PLASTER TYPE~~	~~MINIMUM COMPRESSIVE STRENGTH (psi)~~
~~Clay~~	~~100~~
~~Soil-cement~~	~~1000~~
~~Lime~~	~~600~~
~~Cement-lime~~	~~1000~~
~~Cement~~	~~1400~~

~~For SI: 1 pound per square inch = 6894.76 N/m^2.~~

~~AS106.7 Straightness of plaster.~~

~~Plaster on strawbale structural walls shall be straight, as a function of the bale wall surfaces they are applied to, in accordance with all of the following:~~

1. ~~As measured across the face of a bale, straw bulges shall not protrude more than $^{3}/_{4}$ inch (19.1 mm) across 2 feet (610 mm) of its height or length.~~
2. ~~As measured across the face of a bale wall, straw bulges shall not protrude from the vertical plane of a bale wall more than 2 inches (51 mm) over 8 feet (2438 mm).~~
3. ~~The vertical faces of adjacent bales shall not be offset more than $^{3}/_{8}$ inch (9.5 mm).~~

~~AS106.8 Plaster and membranes.~~

~~Strawbale structural walls shall not have a membrane between straw and plaster, or shall have attachment through the bale wall from one plaster skin to the other in accordance with an *approved* engineered design.~~

~~AS106.9 Mesh.~~

~~Mesh in plasters on strawbale structural walls, and where required by Table AS105.4, shall be installed in accordance with Sections AS106.9.1 through AS106.9.4.~~

~~AS106.9.1 Mesh laps.~~

~~Mesh required by Table AS105.4 or AS106.12 shall be installed with not less than 4-inch (102 mm) laps. Mesh required by Table AS106.13(1) or in walls designed to resist wind uplift of more than 100 plf (1459 N/m), shall run continuous vertically from sill plate to the top plate or roof-bearing element, or shall lap not less than 8 inches (203 mm). Horizontal laps in such mesh shall be not less than 4 inches (102 mm).~~

~~AS106.9.2 Mesh attachment.~~

~~Mesh shall be attached with staples to top plates or roof-bearing elements and to sill plates in accordance with all of the following:~~

1. ~~**Staples.** Staples shall be pneumatically driven, stainless steel or electro-galvanized, 16 gage with 1$^{1}/_{2}$-inch (38 mm) legs, $^{7}/_{16}$-inch (11.1 mm) crown; or manually driven, galvanized, 15 gage with 1-inch (25 mm) legs. Other staples shall be permitted to be used as designed by a registered design professional. Staples into preservative-treated wood shall be stainless steel.~~
2. ~~**Staple orientation.** Staples shall be firmly driven diagonally across mesh intersections at the required spacing.~~
3. ~~**Staple spacing.** Staples shall be spaced not more than 4 inches (102 mm) on center, except where a lesser spacing is required by Table AS106.13(1) or Section AS106.14, as applicable.~~

~~AS106.9.3 Steel mesh.~~

~~Steel mesh shall be galvanized, and shall be separated from preservative-treated wood by Grade D paper, No. 15 roofing felt or other *approved* barrier.~~

~~AS106.9.4 Mesh in plaster.~~

~~Required mesh shall be embedded in the plaster except where staples fasten the mesh to horizontal boundary elements.~~

~~AS106.10 Support of plaster skins.~~

~~Plaster *skins* on strawbale structural walls shall be continuously supported along their bottom edge. Acceptable supports include: a concrete or masonry stem wall, a concrete slab-on-grade, a wood-framed floor blocked with an *approved* engineered design or a steel angle anchored with an *approved* engineered design. A weep screed as described in Section R702.8.2.1 is not an acceptable support.~~

~~AS106.11 Transfer of loads to and from plaster skins.~~

~~Where plastered strawbale walls are used to support superimposed vertical loads, such loads shall be transferred to the plaster *skins* by continuous direct bearing or by an *approved* engineered design. Where plastered strawbale walls are used to resist in-plane lateral loads, such loads shall be transferred to the reinforcing mesh from the structural member or assembly above and to the sill plate in accordance with Table AS106.13(3).~~

~~AS106.12 Load-bearing walls.~~

~~Plastered strawbale walls shall be permitted to be used as load-bearing walls in one-*story* buildings to support vertical loads imposed in accordance with Section R301, in accordance with and not more than the allowable bearing capacities indicated in Table AS106.12.~~

~~TABLE AS106.12~~
~~ALLOWABLE SUPERIMPOSED VERTICAL LOADS (LBS/FOOT) FOR PLASTERED LOAD-BEARING STRAWBALE WALLS~~

~~WALL DESIGNATION~~	**~~PLASTER~~**[a] **~~(both sides) Minimum thickness in inches each side~~**	**~~MESH~~**[b]	**~~STAPLES~~**[c]	**~~ALLOWABLE BEARING CAPACITY~~**[d] **~~(plf)~~**
~~A~~	~~Clay $1\frac{1}{2}$~~	~~None required~~	~~None required~~	~~400~~
~~B~~	~~Soil-cement 1~~	~~Required~~	~~Required~~	~~800~~
~~C~~	~~Lime $\frac{7}{8}$~~	~~Required~~	~~Required~~	~~500~~
~~D~~	~~Cement-lime $\frac{7}{8}$~~	~~Required~~	~~Required~~	~~800~~
~~E~~	~~Cement $\frac{7}{8}$~~	~~Required~~	~~Required~~	~~800~~

~~For SI: 1 inch = 25.4mm, 1 pound per foot = 14.5939 N/m.~~

~~a. Plasters shall conform to Sections AS104.4.3 through AS104.4.8, AS106.7 and AS106.10.~~

~~b. Any metal mesh allowed by this appendix and installed in accordance with Section AS106.9.~~

~~c. In accordance with Section AS106.9.2, except as required to transfer roof loads to the plaster skins in accordance with Section AS106.11.~~

~~d. For walls with a different plaster on each side, the lower value shall be used.~~

~~AS106.12.1 Precompression of load-bearing strawbale walls.~~

~~Prior to application of plaster, walls designed to be load bearing shall be precompressed by a uniform load of not less than 100 plf (1459 N/m).~~

~~AS106.12.2 Concentrated loads.~~

~~Concentrated loads shall be distributed by structural elements capable of distributing the loads to the bearing wall within the allowable bearing capacity listed in Table AS106.12 for the plaster type used.~~

~~AS106.13 Braced panels.~~

~~Plastered strawbale walls shall be permitted to be used as braced wall panels for one-story buildings in accordance with Section R602.10 of the *International Residential Code*, and with Tables AS106.13(1), AS106.13(2) and AS106.13(3). Wind design criteria shall be in accordance with Section R301.2.1. Seismic design criteria shall be in accordance with Section R301.2.2.~~

~~TABLE AS106.13(1)~~
~~PLASTERED STRAWBALE BRACED WALL PANEL TYPES~~

~~WALL DESIGNATION~~	~~PLASTER~~[a] ~~(both sides)~~		~~SILL PLATES~~[b] ~~(nominal size in inches)~~	~~ANCHOR BOLT~~[c] ~~SPACING (inches on center)~~	~~MESH~~[d] ~~(inches)~~	~~STAPLE SPACING~~[e] ~~(inches on center)~~
	~~Type~~	~~Thickness (minimum in inches each side)~~				
~~A1~~	~~Clay~~	~~1.5~~	~~2 × 4~~	~~32~~	~~None~~	~~None~~
~~A2~~	~~Clay~~	~~1.5~~	~~2 × 4~~	~~32~~	~~2 × 2 high-density polypropylene~~	~~2~~
~~A3~~	~~Clay~~	~~1.5~~	~~2 × 4~~	~~32~~	~~2 × 2 × 14 gage~~	~~4~~
~~B~~	~~Soil-cement~~	~~1~~	~~4 × 4~~	~~24~~	~~2 × 2 × 14 gage~~	~~2~~
~~C1~~	~~Lime~~	~~7/8~~	~~2 × 4~~	~~32~~	~~17-gage woven wire~~	~~3~~
~~C2~~	~~Lime~~	~~7/8~~	~~4 × 4~~	~~24~~	~~2 × 2 × 14 gage~~	~~2~~
~~D1~~	~~Cement-lime~~	~~7/8~~	~~4 × 4~~	~~32~~	~~17 gage woven wire~~	~~2~~
~~D2~~	~~Cement-lime~~	~~7/8~~	~~4 × 4~~	~~24~~	~~2 × 2 × 14 gage~~	~~2~~
~~E1~~	~~Cement~~	~~7/8~~	~~4 × 4~~	~~32~~	~~2 × 2 × 14 gage~~	~~2~~
~~E2~~	~~Cement~~	~~1.5~~	~~4 × 4~~	~~24~~	~~2 × 2 × 14 gage~~	~~2~~

~~SI: 1 inch = 25.4 mm~~

~~a. Plasters shall conform with Sections AS104.4.3 through AS104.4.8, AS106.7, AS106.8 and AS106.12.~~

~~b. Sill plates shall be Douglas fir-larch or southern pine and shall be *preservative treated* where required by the *International Residential Code*.~~

~~c. Anchor bolts shall be in accordance with Section AS106.13.3 at the spacing shown in this table.~~

~~d. Installed in accordance with Section AS106.9.~~

~~e. Staples shall be in accordance with Section AS106.9.2 at the spacing shown in this table.~~

~~TABLE AS106.13(2)~~
~~BRACING REQUIREMENTS FOR STRAWBALE BRACED WALL PANELS BASED ON WIND SPEED~~

~~• EXPOSURE CATEGORY B~~[d] ~~• 25-FOOT MEAN ROOF HEIGHT~~ ~~• 10-FOOT EAVE-TO-RIDGE HEIGHT~~[d] ~~• 10-FOOT WALL HEIGHT~~[d] ~~• 2 BRACED WALL LINES~~[d]			~~MINIMUM TOTAL LENGTH (FEET) OF STRAWBALE BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE~~[a, b, c, d]		
~~Basic wind speed (mph)~~	**~~Story location~~**	**~~Braced wall line spacing (feet)~~**	**~~Strawbale braced wall panel~~[e] ~~A2, A3~~**	**~~Strawbale braced wall panel~~[e] ~~C1, C2, D1~~**	**~~Strawbale braced wall panel~~[e] ~~D2, E1, E2~~**
~~≤ 85~~	~~One-story building~~	~~10~~	~~6.4~~	~~3.8~~	~~3.0~~
		~~20~~	~~8.5~~	~~5.1~~	~~4.0~~
		~~30~~	~~10.2~~	~~6.1~~	~~4.8~~
		~~40~~	~~13.3~~	~~6.9~~	~~5.5~~
		~~50~~	~~16.3~~	~~7.7~~	~~6.1~~
		~~60~~	~~19.4~~	~~8.3~~	~~6.6~~
~~≤ 90~~	~~One-story building~~	~~10~~	~~6.4~~	~~3.8~~	~~3.0~~
		~~20~~	~~9.0~~	~~5.4~~	~~4.3~~
		~~30~~	~~11.2~~	~~6.4~~	~~5.1~~
		~~40~~	~~15.3~~	~~7.4~~	~~5.9~~
		~~50~~	~~18.4~~	~~8.1~~	~~6.5~~
		~~60~~	~~21.4~~	~~8.8~~	~~7.0~~
~~≤ 100~~	~~One-story building~~	~~10~~	~~7.1~~	~~4.3~~	~~3.4~~
		~~20~~	~~10.2~~	~~6.1~~	~~4.8~~
		~~30~~	~~14.3~~	~~7.2~~	~~5.7~~
		~~40~~	~~18.4~~	~~8.1~~	~~6.5~~
		~~50~~	~~22.4~~	~~9.0~~	~~7.1~~
		~~60~~	~~26.5~~	~~9.8~~	~~7.8~~
~~≤ 110~~	~~One-story building~~	~~10~~	~~7.8~~	~~4.7~~	~~3.7~~
		~~20~~	~~12.2~~	~~6.6~~	~~5.3~~
		~~30~~	~~17.3~~	~~7.9~~	~~6.3~~
		~~40~~	~~22.4~~	~~9.0~~	~~7.1~~
		~~50~~	~~26.5~~	~~9.8~~	~~7.8~~
		~~60~~	~~31.6~~	~~11.4~~	~~8.5~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 mile per hour = 0.447 m/s.~~

~~a. Linear interpolation shall be permitted.~~

~~b. All *braced wall panels* shall be without openings and shall have an aspect ratio (H:L) ≤ 2:1.~~

~~c. Tabulated minimum total lengths are for *braced wall lines* using single braced wall panels with an aspect ratio (H:L) ≤ 2:1, or using multiple *braced wall panels* with *aspect ratios* (H:L) ≤ 1:1. For *braced wall lines* using two or more *braced wall panels* with an aspect ratio (H:L) > 1:1, the minimum total length shall be multiplied by the largest *aspect ratio* (H:L) of braced wall panels in that line.~~

~~d. Subject to applicable wind adjustment factors associated with "All methods" in Table R602.10.3(2)~~

~~e. Strawbale braced panel types indicated shall comply with Sections AS106.13.1 through AS106.13.3 and with Table AS106.13(1).~~

~~TABLE AS106.13(3)~~
~~BRACING REQUIREMENTS FOR STRAWBALE BRACED WALL PANELS BASED ON~~

~~SEISMIC DESIGN CATEGORY~~

~~• SOIL CLASS D~~~~[d]~~ ~~• WALL HEIGHT = 10 FEET~~~~[d]~~ ~~• 15 PSF ROOF-CEILING DEAD LOAD~~~~[d]~~ ~~• BRACED WALL LINE SPACING ≤ 25 FEET~~~~[d]~~			~~MINIMUM TOTAL LENGTH (FEET) OF STRAWBALE BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE~~~~[a, b, c, d]~~	
~~Seismic Design Category~~	**~~Story location~~**	**~~Braced wall line length (feet)~~**	**~~Strawbale Braced Wall Panele A2, C1, C2, D1~~**	**~~Strawbale Braced Wall Panele B, D2, E1, E2~~**
~~C~~	~~One-story building~~	~~10~~	~~5.7~~	~~4.6~~
		~~20~~	~~8.0~~	~~6.5~~
		~~30~~	~~9.8~~	~~7.9~~
		~~40~~	~~12.9~~	~~9.1~~
		~~50~~	~~16.1~~	~~10.4~~
~~D_0~~	~~One-story building~~	~~10~~	~~6.0~~	~~4.8~~
		~~20~~	~~8.5~~	~~6.8~~
		~~30~~	~~10.9~~	~~8.4~~
		~~40~~	~~14.5~~	~~9.7~~
		~~50~~	~~18.1~~	~~11.7~~
~~D_1~~	~~One-story building~~	~~10~~	~~6.3~~	~~5.1~~
		~~20~~	~~9.0~~	~~7.2~~
		~~30~~	~~12.1~~	~~8.8~~
		~~40~~	~~16.1~~	~~10.4~~
		~~50~~	~~20.1~~	~~13.0~~
~~D_2~~	~~One-story building~~	~~10~~	~~7.1~~	~~5.7~~
		~~20~~	~~10.1~~	~~8.1~~
		~~30~~	~~15.1~~	~~9.9~~
		~~40~~	~~20.1~~	~~13.0~~
		~~50~~	~~25.1~~	~~16.3~~

~~For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 pound per square foot = 0.0479 kPa.~~

~~a. Linear interpolation shall be permitted.~~

~~b. *Braced wall panels* shall be without openings and shall have an *aspect ratio* (H:L) ≤ 2:1.~~

~~c. Tabulated minimum total lengths are for *braced wall lines* using single *braced wall panels* with an *aspect ratio* (H:L) ≤ 2:1, or using multiple *braced wall panels* with *aspect ratios* (H:L) ≤ 1:1. For *braced wall lines* using two or more *braced wall panels* with an aspect ratio (H:L) > 1:1, the minimum total length shall be multiplied by the largest *aspect ratio* (H:L) of *braced wall panels* in that line.~~

~~d. Subject to applicable seismic adjustment factors associated with "All methods" in Table R602.10.3(4), except "Wall dead load."~~

~~e. Strawbale *braced wall panel* types indicated shall comply with Sections AS106.13.1 through AS106.13.3 and Table AS106.13(1).~~

~~AS106.13.1 Bale wall thickness.~~
~~The thickness of the stacked bale wall without its plaster shall be not less than 15 inches (381 mm).~~

~~AS106.13.2 Sill plates.~~
~~Sill plates shall be in accordance with Table AS106.13(1).~~

~~AS106.13.3 Sill plate fasteners.~~

~~Sill plates shall be fastened with not less than $^5/_8$-inch-diameter (15.9 mm) steel anchor bolts~~

~~with 3-inch by 3-inch by $^{3}/_{16}$-inch (76.2 mm by 76.2 mm by 4.8 mm) steel washers, with not less than 7-inch (177.8 mm) embedment in a concrete or masonry foundation, or shall be an approved equivalent, with the spacing shown in Table AS106.13(1). Anchor bolts or other fasteners into framed floors shall be of an approved engineered design.~~

~~AS106.14 Resistance to wind uplift forces.~~

~~Plaster mesh in *skins* of strawbale walls that resist uplift forces from the roof assembly, as determined in accordance with Section R802.11, shall be in accordance with all of the following:~~

1. ~~Plaster shall be any type and thickness allowed in Section AS104.~~
2. ~~Mesh shall be any type allowed in Table AS106.13(1), and shall be attached to top plates or roof-bearing elements and to sill plates in accordance with Section AS106.9.2.~~
3. ~~Sill plates shall be not less than nominal 2-inch by 4-inch (51 mm by 102 mm) with anchoring complying with Section R403.1.6.~~
4. ~~Mesh attached with staples at 4 inches (51 mm) on center shall be considered to be capable of resisting uplift forces of 100 plf (1459 N/m) for each plaster skin.~~
5. ~~Mesh attached with staples at 2 inches (51 mm) on center shall be considered to be capable of resisting uplift forces of 200 plf (2918 N/m) for each plaster skin.~~

~~SECTION AS107~~

~~FIRE RESISTANCE~~

~~AS107.1 Fire-resistance rating.~~

~~Strawbale walls shall be considered to be nonrated, except for walls constructed in accordance with Section AS107.1.1 or AS107.1.2. Alternately, fire-resistance ratings of strawbale walls shall be determined in accordance with Section R302 of the *International Residential Code*.~~

~~AS107.1.1 One-hour rated clay plastered wall.~~

~~One-hour fire-resistance-rated nonload-bearing clay plastered strawbale walls shall comply with all of the following:~~

1. ~~Bales shall be laid flat or on-edge in a running bond.~~
2. ~~Bales shall maintain thickness of not less than 18 inches (457 mm).~~
3. ~~Gaps shall be stuffed with straw-clay.~~
4. ~~Clay plaster on each side of the wall shall be not less than 1 inch (25 mm) thick and shall be composed of a mixture of 3 parts clay, 2 parts chopped straw and 6 parts sand, or an alternative approved clay plaster.~~
5. ~~Plaster application shall be in accordance with Section AS104.4.3.3 for the number and thickness of coats.~~

~~AS107.1.2 Two-hour rated cement plastered wall.~~
~~Two-hour fire-resistance-rated nonload-bearing cement plastered strawbale walls shall comply with all of the following:~~

1. ~~Bales shall be laid flat or on-edge in a running bond.~~

2. ~~Bales shall maintain a thickness of not less than 14 inches (356 mm).~~

3. ~~Gaps shall be stuffed with straw-clay.~~

4. ~~$1^1/_2$-inch (38 mm) by 17-gage galvanized woven wire mesh shall be attached to wood members with $1^1/_2$-inch (38 mm) staples at 6 inches (152 mm) on center. 9 gage U-pins with not less than 8-inch (203 mm) legs shall be installed at 18 inches (457 mm) on center to fasten the mesh to the bales.~~

5. ~~Cement plaster on each side of the wall shall be not less than 1 inch (25 mm) thick.~~

6. ~~Plaster application shall be in accordance with Section AS104.4.8 for the number and thickness of coats.~~

~~AS107.2 Openings in rated walls.~~
~~Openings and penetrations in bale walls required to have a fire-resistance rating shall satisfy the same requirements for openings and penetrations as prescribed in the *International Residential Code*.~~

~~AS107.3 Clearance to fireplaces and chimneys.~~
~~Strawbale surfaces adjacent to fireplaces or chimneys shall be finished with not less than 3/8-inch (10 mm) thick plaster of any type permitted by this appendix. Clearance from the face of such plaster to fireplaces and chimneys shall be maintained as required from fireplaces and chimneys to combustibles in Chapter 10, or as required by manufacturer's instructions, whichever is more restrictive.~~

~~SECTION AS108~~
~~THERMAL INSULATION~~

~~AS108.1 R-value.~~
~~The unit *R*-value of a strawbale wall with bales laid flat is R-1.3 per inch of bale thickness. The unit *R*-value of a strawbale wall with bales on-edge is R-2 per inch of bale thickness.~~

~~SECTION AS109~~
~~REFERENCED STANDARDS~~

~~ASTM~~

~~C 5—10~~	~~Standard Specification for Quicklime for Structural Purposes~~	~~AS104.4.6.1~~

~~C 109/C 109M—12~~	~~Standard Test Method for Compressive Strength of Hydraulic Cement Mortars~~	~~AS106.6.1~~
~~C 141/C 141M—09~~	~~Standard Specification for Hydrated Hydraulic Lime for Structural Purposes~~	~~AS104.4.6.1~~
~~C 206—03~~	~~Standard Specification for Finishing Hydrated Lime~~	~~AS104.4.6.1~~
~~C 926—12a~~	~~Standard Specification for Application of Portland Cement Based Plaster~~	~~AS104.4.7,~~ ~~AS104.4.8~~
~~C 1707—11~~	~~Standard Specification for Pozzolanic Hydraulic Lime for Structural Purposes~~	~~AS104.4.6.1~~
~~EN~~		
~~459—2010~~	~~Part 1: Building Lime. Definitions, Specifications and Conformity Criteria; Part 2: Test Methods~~	~~AS104.4.6.1~~

APPENDIX T

RECOMMENDED PROCEDURE FOR WORST-CASE TESTING OF ATMOSPHERIC VENTING SYSTEMS UNDER N1102.4 OR N1105 CONDITIONS ≤ 5ACH$_{50}$

Deleted

~~*(This appendix is informative and is not part of the code.)*~~

~~SECTION T101~~
~~SCOPE~~

~~**T101.1 General.**~~
~~This appendix is intended to provide guidelines for worst-case testing of atmospheric venting systems. Worst-case testing is recommended to identify problems that weaken draft and restrict combustion air.~~

~~SECTION T202~~
~~GENERAL DEFINITIONS~~

~~**COMBUSTION APPLIANCE ZONE (CAZ).** A contiguous air volume within a building that contains a Category I or II atmospherically vented appliance or a Category III or IV direct-vent or integral vent appliance drawing combustion air from inside the building or dwelling unit. The CAZ includes, but is not limited to, a mechanical closet, a mechanical room or the main body of a house or dwelling unit.~~

~~**DRAFT.** The pressure difference existing between the *appliance* or any component part and the atmosphere that causes a continuous flow of air and products of *combustion* through the gas passages of the *appliance* to the atmosphere.~~

> ~~**Mechanical or induced draft.** The pressure difference created by the action of a fan, blower or ejector that is located between the *appliance* and the *chimney* or vent termination.~~
>
> ~~**Natural draft.** The pressure difference created by a vent or *chimney* because of its height and the temperature difference between the *flue* gases and the atmosphere.~~

~~**SPILLAGE.** Combustion gases emerging from an appliance or venting system into the combustion appliance zone during burner operation.~~

~~SECTION T301~~
~~TESTING PROCEDURE~~

~~T301.1 Worst-case testing of atmospheric venting systems.~~
~~Buildings or dwelling units containing a Category I or II atmospherically vented appliance; or a Category III or IV direct- vent or integral vent appliance drawing combustion air from inside of the building or dwelling unit, shall have the Combustion Appliance Zone (CAZ) tested for spillage, acceptable draft and carbon monoxide (CO) in accordance with this Section. Where required by the~~ ~~*code official*~~~~, testing shall be conducted by an~~ ~~*approved*~~ ~~third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the~~ ~~*code official*~~~~. Testing shall be performed at any time after creation of all penetrations of the~~ ~~*building thermal envelope*~~ ~~and prior to final inspection.~~

> **~~Exception:~~** ~~Buildings or dwelling units containing only Category III or IV direct-vent or integral vent appliances that do not draw combustion air from inside of the building or dwelling unit.~~
>
> ~~The enumerated test procedure as follows shall be complied with during testing:~~

1. ~~Set combustion appliances to the pilot setting or turn off the service disconnects for combustion appliances. Close exterior doors and windows and the fireplace damper. With the building or dwelling unit in this configuration, measure and record the baseline ambient pressure inside the building or dwelling unit CAZ. Compare the baseline ambient pressure of the CAZ to that of the outside ambient pressure and record the difference (Pa).~~

2. ~~Establish worst case by turning on the~~ ~~*clothes dryer*~~ ~~and all exhaust fans. Close interior doors that make the CAZ pressure more negative. Turn on the air handler, where present, and leave on if, as a result, the pressure in the CAZ becomes more negative. Check interior door positions again, closing only the interior doors that make the CAZ pressure more negative. Measure net change in pressure from the CAZ to outdoor ambient pressure, correcting for the base ambient pressure inside the home. Record "worst case depressurization" pressure and compare to Table T301.1(1).~~

   ~~Where CAZ depressurization limits are exceeded under worst-case conditions in accordance with Table T301.1(1), additional combustion air shall be provided or other modifications to building air-leakage performance or exhaust appliances such that depressurization is brought within the limits prescribed in Table T301.1(1).~~

3. ~~Measure worst-case spillage, acceptable draft and carbon monoxide (CO) by firing the fuel-fired appliance with the smallest Btu capacity first.~~

   a. ~~Test for spillage at the draft diverter with a mirror or smoke puffer. An appliance that continues to spill flue gases for more than 60 seconds fails the spillage test.~~

   b. ~~Test for CO measuring undiluted flue gases in the throat or flue of the appliance using a digital gauge in parts per million (ppm) at the 10-minute mark. Record CO ppm readings to be compared with Table T301.1(3) upon completion of Step 4. Where the spillage test fails under worst case, go to Step 4.~~

~~c. Where spillage ends within 60 seconds, test for acceptable draft in the connector not less than 1 foot (305 mm), but not more than 2 feet (610 mm) downstream of the draft diverter. Record draft pressure and compare to Table T301.1(2).~~

~~d. Fire all other CONNECTED appliances simultaneously and test again at the draft diverter of each appliance for spillage, CO and acceptable draft using procedures 3a through 3c.~~

~~4. Measure spillage, acceptable draft, and carbon monoxide (CO) under natural conditions—without *clothes dryer* and exhaust fans on—in accordance with the procedure outlined in Step 3, measuring the net change in pressure from worst case condition in Step 3 to natural in the CAZ to confirm the worst case depressurization taken in Step 2. Repeat the process for each appliance, allowing each vent system to cool between tests.~~

~~5. Monitor indoor ambient CO in the breathing zone continuously during testing, and abort the test where indoor ambient CO exceeds 35 ppm by turning off the appliance, ventilating the space, and evacuating the building. The CO problem shall be corrected prior to completing combustion safety diagnostics.~~

~~6. Make recommendations based on test results and the retrofit action prescribed in Table T301.1(3).~~

~~TABLE T301.1(1)~~
~~CAZ DEPRESSURIZATION LIMITS~~

~~VENTING CONDITION~~	~~LIMIT (Pa)~~
~~Category I, atmospherically vented water heater~~	~~–2.0~~
~~Category I or II atmospherically vented boiler or furnace common vented with a Category I atmospherically vented water heater~~	~~–3.0~~
~~Category I or II atmospherically vented boiler or furnace, equipped with a flue damper, and common vented with a Category I atmospherically vented water heater~~	~~–5.0~~
~~Category I or II atmospherically vented boiler or furnace alone~~	
~~Category I or II atmospherically vented, fan-assisted boiler or furnace common vented with a Category I atmospherically vented water heater~~	
~~Decorative vented, gas appliance~~	
~~Power vented or induced-draft boiler or furnace alone, or fan-assisted water heater alone~~	~~–15.0~~
~~Category IV direct-vented appliances and sealed combustion appliances~~	~~–50.0~~

~~For SI: 6894.76 Pa = 1.0 psi.~~

~~TABLE T301.1(2)~~
~~ACCEPTABLE DRAFT TEST CORRECTION~~

~~OUTSIDE TEMPERATURE (°F)~~	~~MINIMUM DRAFT PRESSURE REQUIRED (Pa)~~
~~< 10~~	~~–2.5~~
~~10 – 90~~	~~(Outside Temperature ÷ 40) – 2.75~~

~~> 90~~	~~–0.5~~

~~For SI: 6894.76 Pa = 1.0 psi.~~

~~TABLE T301.1(3)~~
~~ACCEPTABLE DRAFT TEST CORRECTION~~

~~CARBON DIOXIDE LEVEL (ppm)~~	~~AND OR~~	~~SPILLAGE AND ACCEPTABLE DRAFT TEST RESULTS~~	~~RETROFIT ACTION~~
~~0 – 25~~	~~and~~	~~Passes~~	~~Proceed with work~~
~~25 < × ≤ 100~~	~~and~~	~~Passes~~	~~Recommend that CO problem be resolved~~
~~25 < × ≤ 100~~	~~and~~	~~Fails in worst case only~~	~~Recommend an appliance service call and repairs to resolve the problem~~
~~100 < × ≤ 400~~	~~or~~	~~Fails under natural conditions~~	~~**Stop!** Work shall not proceed until appliance is serviced and problem resolved~~
~~> 400~~	~~and~~	~~Passes~~	~~**Stop!** Work shall not proceed until appliance is serviced and problem resolved~~
~~> 400~~	~~and~~	~~Fails under any condition~~	~~**Emergency!** Shut off fuel to appliance and call for service immediately~~

APPENDIX U

SOLAR-READY PROVISIONS—DETACHED ONE- AND TWO-FAMILY DWELLINGS, MULTIPLE SINGLE-FAMILY DWELLINGS (TOWNHOUSES)

Deleted

~~***(The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.)***~~

~~SECTION U101~~
~~SCOPE~~

~~**U101.1 General.**~~
~~These provisions shall be applicable for new construction where solar-ready provisions are required.~~

~~SECTION U102~~
~~GENERAL DEFINITIONS~~

~~**SOLAR-READY ZONE.** A section or sections of the roof or building overhang designated and reserved for the future installation of a solar photovoltaic or solar thermal system.~~

~~SECTION U103~~
~~SOLAR-READY ZONE~~

~~**U103.1 General.**~~
~~New detached one- and two-family dwellings, and multiple single-family dwellings (townhouses) with not less than 600 square feet (55.74 m^2) of roof area oriented between 110 degrees and 270 degrees of true north shall comply with sections U103.2 through U103.8.~~

~~**Exceptions:**~~

1. ~~New residential buildings with a permanently installed on-site renewable energy system.~~
2. ~~A building with a solar-ready zone that is shaded for more than 70 percent of daylight hours annually.~~

~~**U103.2 Construction document requirements for solar ready zone.**~~
~~Construction documents shall indicate the solar- ready *zone*.~~

~~U103.3 Solar-ready zone area.~~

~~The total solar-ready *zone* area shall be not less than 300 square feet (27.87 m^2) exclusive of mandatory access or set back areas as required by the *International Fire Code*. New multiple single-family dwellings (townhouses) three stories or less in height above grade plane and with a total floor area less than or equal to 2,000 square feet (185.8 m^2) per dwelling shall have a solar-ready *zone* area of not less than 150 square feet (13.94 m^2). The solar-ready *zone* shall be composed of areas not less than 5 feet (1.52 m) in width and not less than 80 square feet (7.44 m^2) exclusive of access or set back areas as required by the *International Fire Code*.~~

~~U103.4 Obstructions.~~

~~Solar-ready *zones* shall be free from obstructions, including but not limited to vents, chimneys, and roof-mounted equipment.~~

~~U103.5 Roof load documentation.~~

~~The structural design loads for roof dead load and roof live load shall be clearly indicated on the construction documents.~~

~~U103.6 Interconnection pathway.~~

~~Construction documents shall indicate pathways for routing of conduit or plumbing from the solar-ready *zone* to the electrical service panel or service hot water system.~~

~~U103.7 Electrical service reserved space.~~

~~The main electrical service panel shall have a reserved space to allow installation of a dual pole circuit breaker for future solar electric installation and shall be labeled "For Future Solar Electric." The reserved space shall be positioned at the opposite (load) end from the input feeder location or main circuit location.~~

~~U103.8 Construction documentation certificate.~~

~~A permanent certificate, indicating the solar-ready *zone* and other requirements of this section, shall be posted near the electrical distribution panel, water heater or other conspicuous location by the builder or registered design professional.~~

APPENDIX V

SWIMMING POOLS, SPAS AND HOT TUBS

This appendix is a North Carolina addition and not part of the 2015 International Residential Code. There will be no underlined text.

(The provisions contained in this appendix are adopted as part of this code.)

SECTION AV101
GENERAL

AV101.1 General.
The provisions of this appendix shall control the design and construction of swimming pools, spas and hot tubs installed in or on the *lot* of a one- or two-family dwelling.

AV101.2 Pools in flood hazard areas.
Pools that are located in flood hazard areas established by Table R301.2(1), including above-ground pools, on-ground pools and in-ground pools that involve placement of fill, shall comply with Sections AV101.2.1 or AV101.2.2.

> **Exception:** Pools located in riverine flood hazard areas which are outside of designated floodways.

AV101.2.1 Pools located in designated floodways.
Where pools are located in designated floodways, documentation shall be submitted to the *building official*, which demonstrates that the construction of the pool will not increase the design flood elevation at any point within the *jurisdiction*.

AV101.2.2 Pools located where floodways have not been designated.
Where pools are located where design flood elevations are specified but floodways have not been designated, the applicant shall provide a floodway analysis that demonstrates that the proposed pool will not increase the design flood elevation more than 1 foot (305 mm) at any point within the *jurisdiction*.

SECTION AV102
DEFINITIONS

AV102.1 General.
For the purposes of these requirements, the terms used shall be defined as follows and as set forth in Chapter 2.

ABOVE-GROUND/ON-GROUND POOL. See “Swimming pool.”

BARRIER. A fence, wall, building wall or combination thereof which completely surrounds the swimming pool and obstructs access to the swimming pool.

HOT TUB. See “Swimming pool.”

IN-GROUND POOL. See "Swimming pool."

RESIDENTIAL. That which is situated on the premises of a detached one- or two-family dwelling or a one-family *townhouse* not more than three stories in height.

SPA, NONPORTABLE. See "Swimming pool."

SPA, PORTABLE. A nonpermanent structure intended for recreational bathing, in which all controls, water-heating and water-circulating *equipment* are an integral part of the product.

SWIMMING POOL. Any structure intended for swimming or recreational bathing that contains water over 24 inches (610 mm) deep. This includes in-ground, above-ground and on-ground swimming pools, hot tubs and spas.

SWIMMING POOL, INDOOR. A swimming pool which is totally contained within a structure and surrounded on all four sides by the walls of the enclosing structure.

SWIMMING POOL, OUTDOOR. Any swimming pool which is not an indoor pool.

SECTION AV103
SWIMMING POOLS

AV103.1 In-ground pools.

In-ground pools shall be designed and constructed in conformance with ANSI/NSPI-5 as listed in Section AV108.

AV103.2 Above-ground and on-ground pools.

Aboveground and on-ground pools shall be designed and constructed in conformance with ANSI/NSPI-4 as listed in Section AV108.

AV103.3 Pools in flood hazard areas.

In flood hazard areas established by Table R301.2(1), pools in coastal high hazard areas shall be designed and constructed in conformance with ASCE 24.

SECTION AV104
SPAS AND HOT TUBS

AV104.1 Permanently installed spas and hot tubs.

Permanently installed spas and hot tubs shall be designed and constructed in conformance with ANSI/NSPI-3 as listed in Section AV108.

AV104.2 Portable spas and hot tubs.

Portable spas and hot tubs shall be designed and constructed in conformance with ANSI/NSPI-6 as listed in Section AV108.

SECTION AV105
BARRIER REQUIREMENTS

AV105.1 Application.

The provisions of this chapter shall control the design of barriers for residential swimming pools, spas and hot tubs. These design controls are intended to provide protection against potential drownings and near drownings by restricting access to swimming pools, spas and hot tubs.

AV105.2 Outdoor swimming pool.
An outdoor swimming pool, including an in-ground, above-ground or on-ground pool, hot tub or spa shall be surrounded by a barrier which shall comply with the following:

1. The top of the barrier shall be at least 48 inches (1219 mm) above *grade* measured on the side of the barrier which faces away from the swimming pool. The maximum vertical clearance between grade and the bottom of the barrier shall be 2 inches (51 mm) or 4 inches (102 mm) where concrete or fixed solid material is used measured on the side of the barrier which faces away from the swimming pool. Where the top of the pool structure is above grade, such as an above-ground pool, the barrier may be at ground level, such as the pool structure, or mounted on top of the pool structure. Where the barrier is mounted on top of the pool structure, the maximum vertical clearance between the top of the pool structure and the bottom of the barrier shall be 4 inches (102 mm).

2. Openings in the barrier shall not allow passage of a 4-inch-diameter (102 mm) sphere.

3. Solid barriers which do not have openings, such as a masonry or stone wall, shall not contain indentations or protrusions except for normal construction tolerances and tooled masonry joints.

4. Where the barrier is composed of horizontal and vertical members and the distance between the tops of the horizontal members is less than 45 inches (1143 mm), the horizontal members shall be located on the swimming pool side of the fence. Spacing between vertical members shall not exceed 13/4 inches (44 mm) in width. Where there are decorative cutouts within vertical members, spacing within the cutouts shall not exceed 13/4 inches (44 mm) in width.

5. Where the barrier is composed of horizontal and vertical members and the distance between the tops of the horizontal members is 45 inches (1143 mm) or more, spacing between vertical members shall not exceed 4 inches (102 mm). Where there are decorative cutouts within vertical members, spacing within the cutouts shall not exceed 13/4 inches (44 mm) in width.

6. Maximum mesh size for chain link fences shall be a 21/4-inch (57 mm) square unless the fence has slats fastened at the top or the bottom which reduce the openings to not more than 13/4 inches (44 mm).

7. Where the barrier is composed of diagonal members, such as a lattice fence, the maximum opening formed by the diagonal members shall not be more than 13/4 inches (44 mm).

8. Access gates shall comply with the requirements of Section AV105.2, Items 1 through 7, and shall be equipped to accommodate a locking device. Pedestrian access gates shall open outward away from the pool and shall be self-closing and have a self-latching

device. Gates other than pedestrian access gates shall have a self-latching device. Where the release mechanism of the self-latching device is located less than 54 inches (1372 mm) from the bottom of the gate, the release mechanism and openings shall comply with the following:

    8.1. The release mechanism shall be located on the pool side of the gate at least 3 inches (76 mm) below the top of the gate; and

    8.2 The gate and barrier shall have no opening larger than 1/2 inch (12.7 mm) within 18 inches (457 mm) of the release mechanism.

9. Where a wall of a *dwelling* serves as part of the barrier, one of the following conditions shall be met:

    9.1. The pool shall be equipped with a powered safety cover in compliance with ASTM F 1346; or

    9.2. Doors with direct access to the pool through that wall shall be equipped with an alarm which produces an audible warning when the door and/or its screen, if present, are opened. The alarm shall be listed and *labeled* in accordance with UL 2017. The deactivation switch(es) shall be located at least 54 inches (1372 mm) above the threshold of the door; or

    9.3. Other means of protection, such as self-closing doors with self-latching devices, which are *approved* by the governing body, shall be acceptable as long as the degree of protection afforded is not less than the protection afforded by Item 9.1 or 9.2 described above.

10. Where an above-ground pool structure is used as a barrier or where the barrier is mounted on top of the pool structure, and the means of access is a ladder or steps:

    10.1. The ladder or steps shall be capable of being secured, locked or removed to prevent access; or

    10.2. The ladder or steps shall be surrounded by a barrier which meets the requirements of Section AV105.2, Items 1 through 9. When the ladder or steps are secured, locked or removed, any opening created shall not allow the passage of a 4-inch-diameter (102 mm) sphere.

AV105.3 Indoor swimming pool.

Walls surrounding an indoor swimming pool shall comply with Section AV105.2, Item 9.

AV105.4 Prohibited locations.

Barriers shall be located to prohibit permanent structures, *equipment* or similar objects from being used to climb them.

AV105.5 Barrier exceptions.

Spas or hot tubs with a safety cover which complies with ASTM F 1346, as listed in Section AV107, shall be exempt from the provisions of this appendix.

SECTION AV106
ENTRAPMENT PROTECTION FOR SWIMMING POOL AND SPA SUCTION OUTLETS

AV106.1 General.
Suction outlets shall be designed and installed in accordance with ANSI/APSP-7.

SECTION AV107
ABBREVIATIONS

AV107.1 General.

ANSI—American National Standards Institute
11 West 42nd Street
New York, NY 10036

APSP—Association of Pool and Spa Professionals
NSPI—National Spa and Pool Institute
2111 Eisenhower Avenue
Alexandria, VA 22314

ASCE—American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, VA 98411-0700

ASTM—ASTM International
100 Barr Harbor Drive,
West Conshohocken, PA 19428

UL—Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062-2096

SECTION AV108
STANDARDS

AV108.1 General.

ANSI/NSPI

ANSI/NSPI-3-99 Standard for
Permanently Installed Residential Spas AV104.1

ANSI/NSPI-4-07 Standard for Above-ground/
On-ground Residential Swimming Pools AV103.2

ANSI/NSPI-5-2003 Standard for
Residential In-ground Swimming Pools. AV103.1

ANSI/NSPI-6-99 Standard for
Residential Portable Spas AV104.2

ANSI/APSP

ANSI/APSP-7-06 Standard for Suction Entrapment
avoidance in Swimming Pools, Wading Pools, Spas,

Hot Tubs and Catch Basins. AV106.1

ASCE

ASCE/SEI-24-05 Flood Resistant
Design and Construction AV103.3

ASTM
ASTM F 1346-91 (2003) Performance
Specification for Safety Covers and Labeling
Requirements for All Covers for Swimming Pools,

Spas and Hot Tubs AV105.2, AV105.5

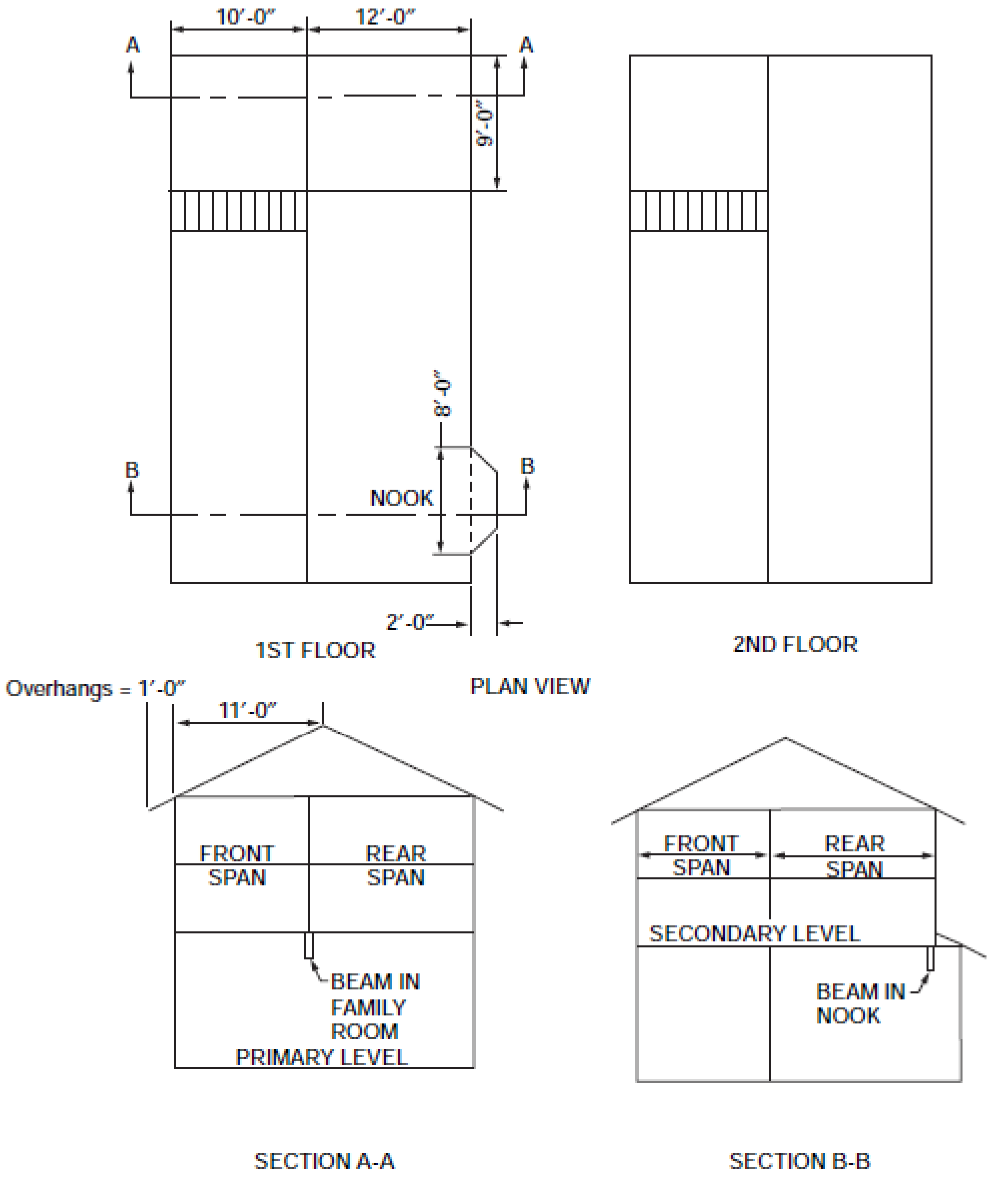
UL

UL 2017-2000 Standard for General-purpose
Signaling Devices and Systems—with Revisions
through June 2004. . . . . AV105.2

APPENDIX W

BASIC LOAD ESTIMATING

This appendix is a North Carolina addition and not part of the 2015 International Residential Code. There will be no underlined text.
(The provisions contained in this appendix are adopted as part of this code.)



For SI: 1 inch = 25.4, 1 foot = 304.8 mm, 1 square foot = 0.0929m2.
ASSUMPTIONS (sleeping area live load; roof or stick frame rafters with no interior bearing):

Loads
Secondary floor level is 30# L.L. + 10# D.L. = 40#/sq. ft.
Attic level is 20# live load + 10# dead load = 30#/sq. ft.
Nook ceiling is 10# dead load (No attic storage) = 10#/sq. ft.
Wall load
Studs @ 16", 1/2" gypsum = 8#/sq. ft.
Roof load
20# live load + 10# dead load = 30#/sq. ft.

EXAMPLE OF LOAD ESTIMATING
LOAD ON BEAM IN FAMILY ROOM

Loads in Section A - A as follows: **Total Loads**
(in pounds/linear foot)

$$\text{2nd floor load} = \frac{\text{(front joist span + rear joist span)}}{2} \text{ x 2nd floor (dead load + live load) = LOAD/linear ft}$$

$$= \frac{(10 + 12)}{2} \text{ x } (10 + 30) = \frac{(22)}{2} \text{ x } (40) = 11 \text{ x } 40 = \mathbf{440} \text{ pounds/linear ft}$$

Interior wall load = Wall Weight per Square foot x Wall Height = LOAD/linear foot

= 8 pounds/sq. ft. × 8ft. = = **64** pounds/linear ft
(Wall weight can vary. Verify actual weight of materials used)

$$\text{Attic load} = \frac{\text{(front joist span + rear joist span)}}{2} \text{ x attic (dead load + live load) = LOAD/linear ft}$$

$$= \frac{(10 + 12)}{2} \text{ x } (10 + 20) = \frac{(22)}{2} \text{ x } (30) = 11 \text{ x } 30 = \underline{\mathbf{330}} \text{ pounds/linear ft}$$

Roof load: No roof load is transmitted to the beam in the family room. Roof Load = **0**

Total Load on Beam in Family Room = **834** pounds/1ft.

Beam span in family room is 9 feet and total estimated load is 834#/linear foot:

By using Table W-1, the required beam is 4 @ 2 × 12 SPF

OR

By using Table W-2, the required minimum flitch beam is 2@2 × 8 with 5/8″×7″ steel plate bolted with 1/2″ bolts spaced at 2′ o.c.

EXAMPLE OF LOAD ESTIMATING
LOAD ON BEAM IN NOOK AREA

Loads in Section B - B as follows: **Total Loads**
(in pounds/linear foot)

$$\text{2nd floor load} = \frac{(\text{front joist span} + \text{rear joist span})}{2} \times \text{2nd floor (dead load + live load)} = \text{LOAD/linear ft}$$

$$= \frac{(0 + 12)}{2} \times (10 + 30) = \frac{(12)}{2} \times (40) = 6 \times 40 = \mathbf{240}\ \text{pounds/linear ft}$$

Exterior wall load = Wall Weight per Square foot x Wall Height = LOAD/linear foot

= 8 pounds/sq. ft. × 8ft. = = **64** pounds/linear ft
(Wall weight can vary. Verify actual weight of materials used)

$$\text{Attic load} = \frac{(\text{front joist span} + \text{rear joist span})}{2} \times \text{attic (dead load + live load)} = \text{LOAD/linear ft}$$

$$= \frac{(0 + 12)}{2} \times (10 + 20) = \frac{(12)}{2} \times (30) = 6 \times 30 = \mathbf{180}\ \text{pounds/linear ft}$$

$$\text{Roof load} = \left(\frac{(\overset{\text{front}}{\text{rafter span}} + \overset{\text{rear}}{\text{rafter span}})}{2} + \text{overhang}\right) \times \text{roof(dead load+live load)=LOAD/linear ft}$$

$$= \left(\frac{(11+11)}{2}+1\right) \times (10 + 20) = \left(\frac{(22)}{2}+1\right) \times (30) = 12 \times 30 = \mathbf{360}\ \text{pounds/linear ft}$$

$$\text{Nook Ceiling load} = \frac{(\text{joist span} + \text{joist span})}{2} \times \text{ceiling(dead load+live load)=LOAD/linear ft}$$

$$= \frac{(0+2)}{2} \times (10 + 0) = \frac{(2)}{2} \times (10) = 1 \times 10 = \mathbf{10}\ \text{pounds/linear ft}$$

$$\text{Nook Roof load} = \frac{(\text{rafter span} + \text{rafter span})}{2} \times \text{roof(dead load+live load)=LOAD/linear ft}$$

$$= \frac{(0+2)}{2} \times (10 + 20) = \frac{(2)}{2} \times (30) = 1 \times 30 = \underline{\mathbf{30}}\ \text{pounds/linear ft}$$

Total Load on Beam in Nook = **884** pounds/1ft.

Beam span in nook is 8 feet and total estimated load is 884#/linear foot:

By using Table W-1, the required beam is 4 @ 2 × 12 Southern pine or 4 @ 2 × 12 Spruce-pine-fir

OR
By using Table W-2, the required minimum flitch beam is 2@2 × 8 with 1/2″×7″ steel plate bolted with 1/2″ bolts spaced at 2′ o.c.

TABLE W-1
WOOD BEAMS AND GIRDERS ALLOWABLE LOADS IN POUNDS PER LINEAR FOOT [1, 2, 3, 4]

2X8 (1 ½” X 7 ¼”)						
Span L [6] (feet)	**Spruce-Pine-Fir [5]**			**Southern Pine**		
	2 ply	**3 ply**	**4 ply**	**2 ply**	**3 ply**	**4 ply**
3	1305	1956	2610	1692	2538	3383
4	979	1468	1958	1013	1519	2026
5	736	1104	1472	648	972	1296
6	511	767	1022	450	675	900
7	375	563	751	331	496	661
8	287	431	575	253	380	506
9	227	341	454	200	300	400
10	184	276	368	162	243	324
12	114	172	228	113	169	225
14	72	108	144	72	108	144

2X10 (1 ½” X 9 ¼”)						
Span L [6] (feet)	**Spruce-Pine-Fir [5]**			**Southern Pine**		
	2 ply	**3 ply**	**4 ply**	**2 ply**	**3 ply**	**4 ply**
3	1665	2498	3330	2158	3238	4317
4	1249	1873	2498	1426	2139	2852
5	999	1499	1998	913	1369	1825
6	763	1144	1525	634	951	1268
7	560	840	1120	466	698	931
8	429	643	858	357	535	713
9	339	508	678	282	423	563
10	275	412	549	228	342	456
12	191	286	381	158	238	317
14	140	210	280	116	175	233

2X12 (1 ½” X 11 ¼”)						
Span L [6] (feet)	**Spruce-Pine-Fir [5]**			**Southern Pine**		
	2 ply	**3 ply**	**4 ply**	**2 ply**	**3 ply**	**4 ply**
3	2025	3038	4050	2625	3938	5250
4	1519	2278	3038	1969	2953	3938
5	1215	1823	2430	1266	1898	2531
6	1013	1519	2025	879	1318	1756
7	753	1130	1507	646	969	1291
8	577	856	1154	494	742	989
9	456	684	911	391	586	781
10	369	554	738	316	475	633
12	256	385	513	220	330	439
14	188	283	377	161	242	323

Table W-1 Notes:

1. Lumber grade is #2 intended for an in-service moisture content of 19% or less.
2. Deflection is limited to L/360.
3. Load duration factor used in calculations is 1.0.
4. Adequate bearing and lateral support for the member must be provided. Support for the member ends must provide a continuous load path from the bearing to the foundation.

5. Values tabulated are for Spruce-Pine-Fir, not Spruce-Pine-Fir (South). Values tabulated for Southern Pine are based on design values published by the American Wood Council in an addendum to NDS dated March 2013.
6. Span, L, is clear span. Effective span for bending and deflection is clear span plus 3 inches.

Table W-2
FLITCH PLATE BEAM ALLOWABLE LOADS IN POUNDS PER LINEAR FOOT [1,2,3, 4,5]

(2) 2x6 with Plate Indicated

Span (ft.)[6]	Plate Size / (Beam Weight per Foot)				
	¼”x5” Plate (8 lb./ft.)	$^3/_8$”x5” Plate (10 lb./ft.)	½”x5” Plate (13 lb./ft.)	$^5/_8$”x5” Plate (15 lb./ft.)	¾”x5” Plate (17 lb./ft.)
6’-0”	643	825	1006	1188	1370
7’-0”	473	606	739	873	1006
8’-0”	362	464	566	668	771
9’-0”	272	348	425	502	579
10’-0”	198	254	310	366	422
11’-0”	149	191	233	275	317
12’-0”	115	147	179	212	244

(2) 2x8 with Plate Indicated

Span(ft.)[6]	Plate Size / (Beam Weight per Foot)				
	¼”x7” Plate (11 lb./ft.)	$^3/_8$”x7” Plate (14 lb./ft.)	½”x7” Plate (17 lb./ft.)	$^5/_8$”x7” Plate (20 lb./ft.)	¾”x7” Plate (23 lb./ft.)
6’-0”	1150	1499	1849	2199	2549
7’-0”	845	1102	1359	1615	1872
8’-0”	647	843	1040	1237	1434
9’-0”	511	666	822	977	1133
10’-0”	414	540	666	792	917
11’-0”	342	446	550	654	758
12’-0”	287	375	462	550	637
13’-0”	230	300	369	439	509
14’-0”	184	240	296	352	408
15’-0”	150	195	240	286	331
16’-0”	123	161	198	236	273

(2) 2x10 with Plate Indicated

Span (ft.)	Plate Size / (Beam Weight per Foot)				
	¼”x9” Plate (14 lb./ft.)	$^3/_8$”x9” Plate (18 lb./ft.)	½”x9” Plate (22 lb./ft.)	$^5/_8$”x9” Plate (26 lb./ft.)	¾”x9” Plate (30 lb./ft.)
6’-0”	1642	2145	2649	3153	3657
7’-0”	1206	1576	1946	2317	2687
8’-0”	923	1207	1490	1774	2057
9’-0”	730	954	1177	1401	1625
10’-0”	591	772	954	1135	1317
11’-0”	488	638	788	938	1088
12’-0”	410	536	662	788	914
13’-0”	350	457	564	672	779
14’-0”	302	394	487	579	672

15’-0”	263	343	424	504	585
16’-0”	231	302	373	443	514
17’-0”	204	267	330	393	456
18’-0”	182	238	294	350	406
19’-0”	155	203	250	298	345
20’-0”	133	174	214	255	296

(2) 2x12 with Plate Indicated					
Span (ft.)	**Plate Size / (Beam Weight per Foot)**				
	¼”x11” Plate (18 lb./ft.)	**⅜”x11” Plate (22 lb./ft.)**	**½”x11” Plate (27 lb./ft.)**	**⅝”x11” Plate (32 lb./ft.)**	**¾”x11” Plate (36 lb./ft.)**
6’-0”	2297	3006	3715	4425	5134
7’-0”	1688	2209	2730	3251	3772
8’-0”	1292	1691	2090	2489	2888
9’-0”	1021	1336	1651	1966	2282
10’-0”	827	1082	1338	1593	1848
11’-0”	683	894	1105	1316	1527
12’-0”	574	752	929	1106	1283
13’-0”	489	640	791	943	1094
14’-0”	422	552	682	813	943
15’-0”	367	481	594	708	821
16’-0”	323	423	522	622	722
17’-0”	286	374	463	551	639
18’-0”	255	334	413	492	570
19’-0”	229	300	371	441	512
20’-0”	207	271	334	398	462
21’-0”	188	245	303	361	419
22’-0”	171	224	276	329	382
23’-0”	156	205	253	301	349
24’-0”	140	183	226	269	312

Table W-2 Notes

1. Lumber species and grade is #2 Southern Pine intended for an in-service moisture content of 19% or less. Design values used were published by the American Wood Council in an addendum to NDS dated March 2013. For Spruce-Pine-Fir lumber using the tabulated flitch plate allowable loads will be slightly conservative.
2. Tabulated values are based on ASTM A36 structural steel plate.
3. Deflection is limited to L/360.
4. Load duration factor used in calculations is 1.0.
5. Adequate bearing and lateral support for the member must be provided. Support for the member ends must provide a continuous load path from the bearing to the foundation.

Span, L, is center to center of supports. Wood side plates and steel flitch plates shall be continuous throughout the span.