NFPA 501

Standard on Manufactured Housing

2005 Edition

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An International Codes and Standards Organization

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NFPA 501

Standard on

Manufactured Housing

2005 Edition

This edition of NFPA 501, *Standard on Manufactured Housing*, was prepared by the Technical Committees on Manufactured Housing, released by the Technical Correlating Committee on Manufactured Housing, and acted on by NFPA at its November Association Technical Meeting held November 13–17, 2004, in Miami Beach, FL. It was issued by the Standards Council on January 14, 2005, with an effective date of February 7, 2005, and supersedes all previous editions.

This edition of NFPA 501 was approved as an American National Standard on February 7, 2005.

Origin and Development of NFPA 501

The 1997 edition of NFPA 501, *Standard on Manufactured Housing*, was based on the 1977 edition of NFPA 501B, *Standard for Mobile Homes*. The 1977 criteria were updated to include current technology and references, and the format was updated to conform with the NFPA *Manual of Style*.

This document was also based on the federal Manufactured Home Construction and Safety Standards, which, when originally established by the U.S. Department of Housing and Urban Development (HUD), were based on the 1977 edition of NFPA 501B. The scope of this document was to establish the minimum criteria for manufactured housing. Additional criteria were derived from earlier editions of NFPA 501B, *Standard for Mobile Homes,* and the current HUD regulations to address any future application for manufactured homes in the international marketplace. The current HUD regulations only address those structures sold within the United States. Information from NFPA 501 has already been used to update the Federal Manufactured Housing Construction and Safety Standards as administered by HUD.

The majority of the revisions to the 1999 edition were minor in nature and pertained to editorial clarification and revisions. There were significant revisions in the provisions on smoke detectors and smoke alarms. The revisions updated these provisions in order to recognize the current requirements of *NFPA 72®*, *National Fire Alarm Code®*. Revisions were also made to the electrical chapter so that it was in agreement with the provisions of NFPA 70, *National Electrical Code®*.

The 2000 edition was the first complete edition to be revised following HUD's selection of NFPA to develop revisions to the federal regulations (24 CFR 3280) for manufactured homes. Approximately 100 changes were accepted for that edition. Revisions updated the reference standards, updated plumbing provisions, revised load testing for trusses, and added requirements for smoke detection installations for multistory units and those with basements.

The 2003 edition continued its improvement and focused on NFPA's suite of manufactured housing documents, and was reviewed and revised based on some likely changes expected to emanate from the Manufactured Housing Improvement Act (MHIA) of 2000. Changes were incorporated that further reflected the desire to provide a more responsible approach to consumer concerns such as ensuring that consumer manual criteria reflect the proper reference in the CFR, that labels are attached to clearly visible locations, and that issues as diverse as the accessibility of manufactured housing units and the strengthening of criteria for handrails and guards were addressed. Other changes included improvements to the requirement for multi-story and multi-section homes, including the addition of an entirely new chapter on special construction considerations.

The 2005 edition incorporates a number of technical changes. New requirements are provided for stairs, materials of construction, energy conservation, water heaters, and supply ducts. Changes also have been made regarding the types of plumbing materials to be used and the installation practices regarding plumbing. In addition, reference standards have been updated as has certain terminology.

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David Hilton Goins, *Chair*
North Carolina Department of Insurance, NC [E]

William C. Farish, Fleetwood Homes, CA [M]
Danny D. Ghorbani, Manufactured Housing Association for Regulatory Reform, DC [M]
Martin C. Gilchrist, Urban Research & Development Corporation, PA [SE]
Christopher P. Jones, Christopher P. Jones & Associates, NC [E]
Rep. FEMA/Federal Insurance & Mitigation Administration
John V. Loscheider, Loscheider Engineering Company, WA [E]
Rep. Building Seismic Safety Council/Code Resource Support Committee
Mark C. Orellana, Penn Township, Indiana Fire Department, IN [E]
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John Pabian, Underwriters Laboratories Inc., IL [RT]
Jake Pauls, Jake Pauls Consulting Services in Building Use & Safety, MD [C]
Rep. American Public Health Association
George N. Porter, Manufactured Housing Resources, DE [IM]
Janet Potter, Manufactured Home Owners Association of America, NC [C]
Michael J. Slifka, PFS Corporation, WI [RT]
Nader Tomasbi, Liberty Homes, Inc., IN [M]
Frank Walter, Manufactured Housing Institute, VA [M]

Alternates

C. Edgar Bryant, Champion Enterprises, Inc., MI [M]
(Alt. to W. C. Farish)
Clarence Cook, Shelby Township, MI [C]
(Alt. to J. Potter)
Margaret R. Figueroa, Underwriters Laboratories Inc., IL [RT]
(Alt. to J. Pabian)
Stanley C. Harbuck, School of Building Inspection, UT [C]
(Alt. to J. Pauls)
David K. Low, Greenhorne & O'Mara, Inc., VA [E]
(Alt. to C. P. Jones)
Mark A. Nunn, Manufactured Housing Institute, VA [M]
(Alt. to F. Walter)

Nonvoting

John Lake, Marion County Fire Rescue, FL [E]
Rep. TC on Fire Safety for Manufactured Housing
Richard A. Mancini, Rhode Island State Building Commission, RI [E]
Rep. TC on Plumbing for Manufactured Housing
Robert A. McCullough, Ocean County Construction Inspection Department, NJ [E]
Rep. TC on Electrical for Manufactured Housing
Jerome L. McHale, Federation of Manufactured Home Owners of Florida, Inc., FL [C]
Rep. TC on Administration for Manufactured Housing
Raymond F. Tucker, Consulting Professional Engineer/RADCO, CA [RT]
Rep. TC on Structural for Manufactured Housing
Michael L. Zieman, RADCO, CA [RT]
Rep. TC on Mechanical for Manufactured Housing

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Danny D. Ghorbani, Manufactured Housing Association for Regulatory Reform, DC [M]
Martin C. Gilchrist, Urban Research & Development Corporation, PA [SE]
David Hilton Goins, North Carolina Department of Insurance, NC [E]
Doug Gorman, Home-Mart, Incorporated, OK [M]
Rep. Manufactured Housing Association of Oklahoma
Jeffrey T. Inks, National Association of Home Builders, DC [U]
Rep. National Association of Home Builders
Christopher P. Jones, Christopher P. Jones & Associates, NC [E]
Rep. FEMA/Federal Insurance & Mitigation Administration
Jake Pauls, Jake Pauls Consulting Services in Building Use & Safety, MD [C]
Rep. American Public Health Association
Raymond F. Tucker, Consulting Professional Engineer/RADCO, CA [RT]

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Alternates

Stanley C. Harbuck, School of Building Inspection, UT [C]
(Alt. to J. Pauls)
David K. Low, Greenhorne & O'Mara, Inc., VA [E]
(Alt. to C. P. Jones)
Frank Walter, Manufactured Housing Institute, VA [M]
(Alt. to D. D. Ghorbani)
Michael L. Zieman, RADCO, CA [RT]
(Alt. to R. F. Tucker)

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Ocean County Construction Inspection Department, NJ [E]
Rep. International Association of Electrical Inspectors

Thomas R. Brandt, Fairmont Homes Inc., IN [M]
C. Edgar Bryant, Champion Enterprises, Inc., MI [M]
Thomas L. Harman, University of Houston/Clear Lake, TX [SE]
Daniel J. Kissane, Pass & Seymour/Legrand, NY [M]
Robert L. La Rocca, Underwriters Laboratories Inc., NY [RT]
Kent Pribyl, Nebraska Public Service Commission, NE [E]
Clifford L. Rediger, Independent Electrical Contractors Training Fund, CO [IM]
Rep. Independent Electrical Contractors, Inc.
Frank Whittaker, Jr., City of Roanoke, VA [E]
Michael L. Zieman, RADCO, CA [RT]

Alternate

David R. Keller, Champion Enterprises, Inc., MI [M]
(Alt. to C. E. Bryant)

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Jim Blair, Foremost Insurance Group, MI [I]
Kenneth E. Gaiser, City of Jackson Fire Department, MI [E]
Rep. International Association of Fire Chiefs
William M. Hug, Cavco Industries, LLC, AZ [M]
M. L. "Larry" Maruskin, U.S. Department of Homeland Security, MD [C]
Richard A. Mendlen, U.S. Department of Housing & Urban Development, DC [E]
Dennis L. Pitts, American Forest & Paper Association, TX [M]
Rep. American Forest & Paper Association
James V. Ryan, Potomac, MD [SE]
Michael J. Slifka, PFS Corporation, WI [RT]
Randy E. Vogt, State of Minnesota, MN [E]
Richard Weinert, State of California, CA [E]
Robert A. Wessel, Gypsum Association, DC [M]
A. Elwood Willey, FIREPRO Incorporated, MA [SE]

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Alternates

Dennis Mapalo, State of California, CA [E]
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Jeffrey B. Stone, American Forest & Paper Association, FL [M]
(Alt. to D. L. Pitts)

Kirsten Paoletti, NFPA Staff Liaison

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RADCO, CA [RT]

Devra R. Bachrach, Natural Resources Defense Council (NRDC), CA [C]
Larry Boyce, NORDYNE, MO [M]
John M. Halliwill, International Association of Plumbing & Mechanical Officials, CA [E]
Rep. International Association of Plumbing & Mechanical Officials
Jordan Heiman, Jordan L. Heiman Inc., MO [SE]
Michael Lubliner, Washington State University Energy Program, WA [U]
Rep. Northwest Energy Efficiency Alliance
John Mikel, Skyline Corporation, IN [M]
Ivan T. Smith, Greenstone Industries, Inc., FL [M]
John R. Stevens, U.S. Department of Housing & Urban Development, DC [E]
Frank Walter, Manufactured Housing Institute, VA [M]
Alan Zimmerman, York International UPG/Evcon, KS [M]

Alternates

Denise Beach, National Propane Gas Association, DC [IM]
(Voting Alt. to NPGA Rep.)
Michael T. Kobel, International Association of Plumbing & Mechanical Officials, CA [E]
(Alt. to J. M. Halliwill)
Jeffrey T. Legault, Skyline Corporation, IN [M]
(Alt. to J. Mikel)
Mark A. Nunn, Manufactured Housing Institute, VA [M]
(Alt. to F. Walter)

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Technical Committee on Plumbing for Manufactured Housing (MAN-PLU)

Richard A. Mancini, *Chair*
Rhode Island State Building Commission, RI [E]

Marguerite E. Carroll, Underwriters Laboratories Inc., CA [RT]
John M. Halliwill, International Association of Plumbing & Mechanical Officials, CA [E]
William C. Masters, Homes of Merit, Inc., FL [M]
James R. Paschal, NSF International, MI [RT]
Kent Pribyl, Nebraska Public Service Commission, NE [E]
David Viola, Plumbing Manufacturers Institute, IL [M]
Rep. Plumbing Manufacturers Institute
Michael L. Zieman, RADCO, CA [RT]

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Alternate

Michael T. Kobel, International Association of Plumbing & Mechanical Officials, CA [E]
(Alt. to J. M. Halliwill)

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Technical Committee on Structural for Manufactured Housing (MAN-STR)

Raymond F. Tucker, *Chair*
Consulting Professional Engineer/RADCO, CA [RT]

John G. Bradfield, Composite Panel Association, MD [U]
Bill Broecker, Foremost Corporation of America, MI [I]
C. Edgar Bryant, Champion Enterprises, Inc., MI [M]
William C. Farish, Fleetwood Homes, CA [M]
Evor F. Johns, Progressive Engineering, Inc., IN [SE]
Christopher P. Jones, Christopher P. Jones & Associates, NC [E]
Rep. FEMA/Federal Insurance & Mitigation Administration
Michael A. Kinard, Kinro Incorporated, TX [M]
John V. Loscheider, Loscheider Engineering Company, WA [E]
Rep. Building Seismic Safety Council/Code Resource Support Committee
Harry W. (Hank) Martin, American Iron and Steel Institute, CA [M]
Rep. American Iron and Steel Institute
Richard A. Mendlen, U.S. Department of Housing & Urban Development, DC [E]
John Pabian, Underwriters Laboratories Inc., IL [RT]
Kanti Patel, Maryland Codes Administration, MD [E]
Jeffrey B. Stone, American Forest & Paper Association, FL [M]
Rep. American Forest & Paper Association
John W. Weldy, NTA Incorporated, IN [RT]

Alternates

Gary L. Heroux, Composite Panel Association (CPA), MD [U]
(Alt. to J. G. Bradfield)
David R. Keller, Champion Enterprises, Inc., MI [M]
(Alt. to C. E. Bryant)
David K. Low, Greenhorne & O'Mara, Inc., VA [E]
(Alt. to C. P. Jones)
Dennis L. Pitts, American Forest & Paper Association, TX [M]
(Alt. to J. B. Stone)
Jason Smart, Institute for Business & Home Safety, FL [I]
(Voting Alt. to IBHS Rep.)
Robert J. Wills, American Iron and Steel Institute, AL [M]
[Alt. to H. W. (Hank) Martin]
Patrick Zeeveld, Underwriters Laboratories Inc., IL [RT]
(Alt. to J. Pabian)

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Standard on

Manufactured Housing

2005 Edition

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Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for mandatory extracts are given in Chapter 14 and those for nonmandatory extracts are given in Annex D. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 14 and Annex D.

Chapter 1 General

1.1 Scope. This standard shall cover all the equipment and installations used in the design, construction, transportation, fire safety, plumbing, heat-producing, and electrical systems of manufactured homes that are designed to be used as dwelling units. This standard shall, to the maximum extent possible, establish performance requirements. In certain instances, however, the use of specific requirements is necessary.

1.2 Definitions. The following definitions are common to all chapters of this standard and are in addition to the definitions provided in individual chapters.

1.2.1 Administrative Regulations. Regulations promulgated by the regulatory agency for administration and enforcement of the provisions of this standard.

1.2.2* Approved. Acceptable to the authority having jurisdiction.

1.2.3* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

1.2.4 Bay Window. A window assembly whose maximum horizontal projection is no more than 2 ft (610 mm) from the plane of an exterior wall and is elevated above the floor level of the home.

1.2.5 Certification Label. The approved form of manufacturer certification that is permanently affixed to each transportable section of each manufactured home that is subject to this standard *(see Section 1.11).*

1.2.6 Dwelling Unit. One or more habitable rooms, designed to be occupied by one or more persons, with facilities for living, sleeping, cooking, and eating.

1.2.7 Equipment. Materials, appliances, devices, fixtures, fittings, or accessories used in the construction of manufactured homes and in the fire safety, plumbing, heat-producing, and electrical systems of manufactured homes.

1.2.8 Federal Manufactured Home Construction and Safety Standard. A standard either promulgated or adopted under authority of the *National Manufactured Housing Construction and Safety Standards Act of 1974* (PL 93-383, as amended).

1.2.9 Installations. All arrangements and methods of construction, as well as fire safety, plumbing, heat-producing, and electrical systems used in manufactured homes.

1.2.10 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is 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.

1.2.11 Length of a Manufactured Home. A manufactured home's largest overall length in the traveling mode, including cabinets and other projections which contain interior space. Length does not include bay windows, roof projections, overhangs, or eaves under which there is no interior space, nor does it include drawbars, couplings, or hitches.

1.2.12* 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 that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

1.2.13 Manufacturer. Any person engaged in manufacturing or assembling manufactured homes, including any person engaged in importing manufactured homes for resale.

1.2.14 Manufactured Home. A structure, transportable in one or more sections, which, in the traveling mode, is 8 body-ft (2.4 m) or more in width or 40 body-ft (12.2 m) or more in length or, when erected on site, is 320 ft^2 (29.7 m^2) or more 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 plumbing, heating, air-conditioning, and electrical systems contained therein; except that such terms 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

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regulatory agency. Calculations used to determine the number of square feet in a structure are based on the structure's exterior dimensions, measured at the largest horizontal projections when erected on site. These dimensions include all expandable rooms, cabinets, and other projections containing interior space, but do not include bay windows.

1.2.15 Manufactured Home Construction. All activities relating to the assembly and manufacture of a manufactured home, including but not limited to those relating to durability, quality, and safety.

1.2.16 Manufactured Home Safety. The performance of a manufactured home in such a manner that the public is protected against any unreasonable risk of the occurrence of accidents or any unreasonable risk of death or injury to the user or to the public if such accidents do occur due to the design or construction of the manufactured home.

1.2.17 Modular Home. A home constructed, all or in part, in accordance with a standard adopted, administered, and enforced by the regulatory agency, or under reciprocal agreement with the regulatory agency, for conventional site-built dwellings.

1.2.18 Multi-Wide. A manufactured home that is made up of two or more transportable sections.

1.2.19 Registered Engineer or Architect. A person licensed to practice engineering or architecture in a state, subject to all laws and limitations imposed by the state's Board of Engineering and Architecture Examiners. A registered engineer or architect is engaged in the professional practice of rendering service or creative work that requires education, training, and experience in engineering sciences and special knowledge of mathematical, physical, and engineering sciences for the purpose of securing compliance with specifications and design in such professional or creative work as consultation, investigation, evaluation, planning or design, and supervision of construction.

1.2.20 Regulatory Agency. The agency adopting, administering, and enforcing this standard.

1.2.21 Shall. Indicates a mandatory requirement.

1.2.22 Should. Indicates a recommendation or that which is advised but not required.

1.2.23 Single-Wide. A manufactured home that is made up of a single, transportable section.

1.2.24 State. Includes all 50 individual states that make up the United States, the District of Columbia, the Commonwealth of Puerto Rico, Guam, the U.S. Virgin Islands, and American Samoa.

1.2.25 Width of a Manufactured Home. A manufactured home's largest overall width in the traveling mode, including cabinets and other projections that contain interior space. Width does not include bay windows, roof projections, overhangs, or eaves under which there is no interior space.

1.3 Consumer Manual Requirements. Consumer manuals shall be in accordance with 24 CFR 3282, "Manufactured Home Procedural and Enforcement Regulations," Section 3282.207.

1.4 Incorporation by Reference. The specifications, standards, and codes, or portions thereof, of the following organizations, where they are specified in this standard, shall be incorporated by reference. Where two or more referenced standards are equivalent in application, the manufacturer shall have the option to incorporate into the manufactured home design and construction the referenced standard of their choosing.

Exception: When reference standards and this standard are inconsistent, the requirements of this standard shall prevail to the extent of the inconsistency.

AA — Aluminum Association, 900 19th Street NW, Suite 300, Washington, DC 20006
AAMA — American Architectural Manufacturers Association, 1327 Jonas Drive, Ann Arbor, MI 48105
AF&PA — American Forest and Paper Association, 111 19th Street NW, Suite 800, Washington, DC 20036 [previously named (N)FPA National Forest Products Association]
AGA — American Gas Association, 400 N. Capitol Street NW, Washington, DC 20001
AISC — American Institute of Steel Construction, One East Wacker Drive, Suite 3100, Chicago, IL 60601
AISI — American Iron and Steel Institute, 1101 17th Street NW, Suite 1300, Washington, DC 20036
AITC — American Institute of Timber Construction, 7012 S. Revac Parkway, Suite 140, Englewood, CO 80112
ANSI — American National Standards Institute, 25 West 43rd Street, New York, NY 10036
APA — The Engineered Wood Association, 7011 South 19th Street, Tacoma, WA 98466-5399
ARI — Air Conditioning and Refrigeration Institute, 1501 Wilson Boulevard, 6th Floor, Arlington, VA 22209-2403
ASCE — American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400
ASHRAE — American Society of Heating, Refrigeration and Air Conditioning Engineers, 1791 Tullie Circle NE, Atlanta, GA 30329
ASME — American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990
ASSE — American Society of Sanitary Engineering, 28901 Clemens Road, Suite 100, Westlake, OH 44145
ASTM — American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959
CISPI — Cast Iron Soil Pipe Institute, 5959 Shallowford Road, Suite 419, Chattanooga, TN 37421
CSA International, 8501 East Pleasant Valley Road, Cleveland, OH 44131
DOC — U.S. Department of Commerce, National Institute of Standards and Technology, Office of Engineering Standards, Room A-166, Technical Building, Washington, DC 20234
FS — Federal Specifications, General Services Administration, Specifications Branch, Room 6039, GSA Building, Seventh and D Streets SW, Washington, DC 20407
HPVA — Hardwood Plywood and Veneer Association, P.O. Box 2789, Reston, VA 22090 [previously named (HPMA) Hardwood Plywood Manufacturers Association]
HUD-FHA — Department of Housing and Urban Development, 451 Seventh Street SW, Washington, DC 20410
HUD — USER, Department of Housing and Urban Development, HUD User, P.O. Box 280, Germantown, MD 20874
IAPMO — International Association of Plumbing and Mechanical Officials, 5001 E. Philadelphia St., Ontario, CA 91761-2816
IITRI — IIT Research Institute, 10 West 35th Street, Chicago, IL 60616
MIL — Military Specifications and Standards, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120
NFPA — National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471
NFRC — National Fenestration Rating Council, 8484 Georgia Avenue, Suite 320, Silver Spring, MD 20910

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NPA — National Particleboard Association, 18928 Premiere Court, Gaithersburg, MD 20879
NSF — NSF International, P.O. Box 130140, Ann Arbor, MI 48113-0140
SAE — Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096
SJI — Steel Joist Institute, 1205 48th Avenue North, Suite A, Myrtle Beach, SC 29577
TPI — Truss Plate Institute, 583 D'Onofrio Drive, Suite 200, Madison, WI 53719
UL — Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096
WDMA — Window and Door Manufacturers Association, 1400 E. Touhy Avenue, Suite 470, Des Plaines, IL 60018

1.5 Data Plate. Each manufactured home shall bear a data plate affixed in a permanent manner near the main electrical panel or in another readily accessible and visible location. Each data plate either shall be made of a material that will receive typed information, as well as preprinted information, that can be cleaned of ordinary smudges or household dirt without removing information contained on the data plate; or it shall be covered in a permanent manner with materials that will make it possible to clean the data plate of ordinary dirt and smudges without obscuring the information. *(See 6.5.3.5.)* Each data plate shall contain not less than the following information:

(1) Name and address of the manufacturing plant where the manufactured home was manufactured
(2) Serial number and model designation of the unit and the date the unit was manufactured
(3) The statement: "This manufactured home is designed to comply with the NFPA Standard 501 in effect at the time of manufacture."
(4) A list of the certification label(s) number(s) that is affixed to each transportable manufactured section in accordance with Section 1.11
(5) A list of major factory-installed equipment, including the manufacturer's name and the model designation of each appliance
(6) Reference to the roof load zone and wind load zone for which the home is designed and duplicates of the wind zone and roof load zone maps shown in Figure 6.5.3.1(a) and Figure 6.5.3.3.1. (This information shall be permitted to be combined with the heating/cooling certificate and insulation zone map required by Sections 8.10 and 8.11.)
(7) The statement: "This home has _____ has not _____ (appropriate blank to be checked by manufacturer) been equipped with storm shutters or other protective coverings for windows and exterior door openings. For homes designed to be located in Wind Zones II, III, and IV, which have not been provided with shutters or equivalent covering devices, it is strongly recommended that the home be made ready to be equipped with these devices in accordance with the method recommended in the manufacturer's printed instructions."
(8) The statement: "Design approval by . . ." followed by the name of the agency that approved the design

1.6 Serial Number. A serial number that will identify the manufacturer and the state where the manufactured home is manufactured shall be stamped into the foremost cross member. Letters and numbers shall be ⅜ in. (9.5 mm) minimum in height. Numbers shall not be stamped into the hitch assembly or drawbar.

1.7 Excluded Structures. Certain structures shall be permitted to be exempted from this standard by the regulatory agency as modular homes under 24 CFR 3282.12, "Excluded Structures — Modular Homes."

1.8 Waivers.

1.8.1 Where any material piece of equipment or system does not meet precise requirements or specifications defined in this standard, the manufacturer shall be permitted to submit a written application to the regulatory agency for a waiver of the precise requirement or specification.

1.8.2 The written application for a waiver shall identify the specific provisions of this standard for which a waiver is requested, the specific alternative to the precise requirement or specification that is proposed by the manufacturer, and any supporting data.

1.8.3 The regulatory agency shall be permitted to require, at the manufacturer's expense, additional data, engineering calculations, and testing to demonstrate that the alternative proposed by the manufacturer will produce the equivalent safety and performance of the precise requirement or specification requested to be waived.

1.8.4 The regulatory agency shall issue written approval or disapproval of waiver applications within 30 calendar days from receipt of the application and any data, calculations, or test results requested under the authority of 1.8.3.

1.8.5 A copy of the written approval of a manufacturer's application for a waiver of precise requirements or specifications defined in this standard shall be included as an attachment to the consumer manual required by Section 1.3.

1.9 Interpretive Bulletins.

1.9.1 The regulatory agency shall be permitted to issue interpretive bulletins for the following purposes:

(1) To clarify the meaning of any administrative regulation adopted by the regulatory agency related to the administration and enforcement of this standard
(2) To clarify the meaning of any precise requirement or specification identified in this standard

1.9.2 Interpretive bulletins issued by the regulatory agency shall be uniquely identified by the year issued and the sequential number of the information bulletin issued within that year, beginning with the number 1.

1.9.3 Copies of interpretive bulletins issued by the regulatory agency shall be provided by first class mail to the addresses on record with the regulatory agency for each manufacturer and to each design approval agency, inspection agency, state agency, or other agency that is identified by administrative regulations.

1.9.4 Until modified or revoked by a subsequent interpretive bulletin, interpretive bulletins issued by the regulatory agency shall have the same weight and effect as the precise requirements and specifications of this standard or the administrative regulations.

1.10 Use of Alternative Construction. Applications for regulatory agency approval of alternative construction methods shall be made in accordance with Section 1.8.

1.11 Certification Label.

1.11.1 A permanent label shall be affixed to each transportable section of each manufactured home subject to this

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standard. This label shall be separate and distinct from the data plate required by Section 1.5.

1.11.2 The label shall be approximately 2 in. × 4 in. (50 mm × 100 mm) in size and shall be permanently attached to the manufactured home by means that render it difficult to remove without defacing it. The label shall be etched on a 0.32 in. thick (8.2 mm) aluminum plate or other material identified by the administrative regulations. The label shall be etched or stamped with a sequence of letters identifying the production inspection agency, followed by a series of sequential numbers in a manner identified in the administrative regulations.

1.11.3 The label shall read as follows:

"As evidenced by this label, No. (e.g., ABC 000001), the manufacturer certifies to the best of the manufacturer's knowledge and belief that this manufactured home has been constructed and inspected in accordance with the requirements of the (regulatory agency name) and is in conformance with the edition of NFPA 501 in effect on the date of manufacture. See data plate."

1.11.4* The label shall be located at the taillight end of each transportable section of the manufactured home approximately 1 ft (300 mm) up from the floor and 1 ft (300 mm) in from the road side, or as near that location on a permanent part of the exterior of the manufactured home section as practicable. When locating the label on the taillight end of a transportable section will prevent the label from being visible after the manufactured home section is installed at the installation site, the label shall be installed on a permanent part of the exterior of the manufactured home section, in a visible location as specified in the approved design.

Chapter 2 Referenced Publications (Reserved)

Chapter 3 Reserved

Chapter 4 Planning Considerations

4.1 Scope. The purpose of this chapter shall be to state the planning requirements of manufactured homes to ensure the adequacy of architectural planning considerations that assist in determining a safe and healthful environment.

4.2 Special Definitions. The following definitions shall be applicable to this chapter.

4.2.1 Gross Floor Area. All wall-to-wall space, including recessed entries not to exceed 5 ft^2 (0.46 m^2) and areas under built-in vanities and similar furniture. Where the ceiling height is less than that specified in Section 4.4, the floor area under such ceilings shall not be included. Floor area of closets shall not be included in the gross floor area.

4.2.2 Habitable Room. A room or enclosed floor space arranged for living, eating, food preparation, or sleeping purposes, not including bathrooms, foyers, hallways, and other accessory floor space.

4.2.3 Laundry Area. An area containing or designed to contain a laundry tray, clothes washer, and/or clothes dryer.

4.3 Light and Ventilation.

4.3.1 Lighting. Each habitable room shall be provided with exterior windows and/or doors having a total glazed area of not less than 8 percent of the gross floor area.

4.3.1.1 Kitchens, bathrooms, toilet compartments, laundry areas, and utility rooms shall be permitted to be provided with artificial light in lieu of windows.

4.3.1.2 In bathrooms, ceiling-mounted lighting fixtures and wall-mounted lighting fixtures shall not be controlled by the same switch.

4.3.1.3 Linear fluorescent fixtures shall utilize T-8 lamps or lamps of equal or greater efficiency.

4.3.1.4 Rooms and areas shall be permitted to be combined for the purpose of providing the required natural lighting, provided that at least one-half of the common wall area is open and unobstructed and the open area is at least equal to 10 percent of the combined floor area or 25 ft^2 (2.3 m^2), whichever is greater.

4.3.1.5 Required glazed openings shall be permitted to face into a roofed porch where the porch abuts a street, yard, or court and the longer side of the porch is at least 65 percent open and unobstructed and the ceiling height is not less than 7 ft (2.1 m).

4.3.2 Whole-House Ventilation. Each manufactured home shall be provided with whole-house ventilation having a minimum capacity of 0.035 $ft^3/min \cdot ft^2$ (10.8 $L/min \cdot m^2$) of interior floor space or its hourly average equivalent. This ventilation capacity shall be in addition to any openable window area. In no case shall the installed ventilation capacity of the system be less than 50 cfm (1440 L/min) nor more than 90 cfm (2520 L/min).

4.3.2.1 The ventilation capacity shall be permitted to be provided by a mechanical system, or a combination passive and mechanical system. The ventilation system or provisions for ventilation shall not create a positive pressure in U_0 value Zone 2 and Zone 3 or a negative pressure condition in U_0 value Zone 1 in excess of 0.03 in. of water (7 Pa).

4.3.2.2 The ventilation system or provisions for ventilation shall exchange air directly with the exterior of the home, except it shall not draw or expel air with the space underneath the home. The ventilation system or provisions for ventilation shall not draw or expel air into the floor, wall, or ceiling/roof systems, even if those systems are vented. The ventilation system shall be designed to ensure that outside air is distributed to all bedrooms and main living areas. The combined use of undercut doors or transom grilles connecting those areas to the room where the mechanical system is located shall be deemed acceptable.

4.3.2.3 The ventilation system or a portion thereof shall be permitted to be integral with the home's heating or cooling system. The system shall be capable of operating independently of the heating or cooling modes. A ventilation system that is integral with the heating or cooling system shall be listed as part of the heating and cooling system or listed as suitable for use therewith.

4.3.2.4 The ventilation system or portion thereof shall also be permitted to be one of the bathroom exhaust fans required by 4.3.3.3 provided the following criteria are met:

(1) Maximum zone rating of 1.0
(2) Designed for continuous operation and a minimum 10-year life

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4.3.2.5 A mechanical ventilation system, or mechanical portion thereof, shall be provided with a manual control, and shall be permitted to be provided with automatic timers or humidistats.

4.3.2.6 Instructions for correctly operating and maintaining whole-house ventilation systems shall be included with the homeowner's manual. The instructions shall encourage occupants to operate these devices whenever the home is occupied and to refer to the whole-house ventilation labeled control. The whole-house ventilation label shall be permanent, shall state "Whole-House Ventilation," and shall be attached to the whole-house ventilation control.

4.3.3 Additional Ventilation.

4.3.3.1 At least half of the minimum required glazed area in 4.3.1 shall be openable directly to the outside of the manufactured home for unobstructed ventilation. These same ventilation requirements shall apply to rooms combined in accordance with 4.3.1.4.

4.3.3.2 Kitchens shall be provided with a mechanical ventilation system that is capable of exhausting 100 cfm (2830 L/min) to the outside of the home. The exhaust fan shall be located as close as possible to the range or cooktop, but in no case shall it be farther than 10 ft (3.1 m) horizontally from the range or cooktop.

4.3.3.3 Each bathroom and separate toilet compartment shall be provided with a mechanical ventilation system capable of exhausting 50 cfm (1415 L/min) to the outside of the home. A separate toilet compartment shall be permitted to be provided with 1.5 ft^2 (0.14 m^2) of openable glazed area in place of mechanical ventilation.

Exception: Openable glazed area shall not be permitted to replace mechanical ventilation in U_O value Zone 3.

4.4 Ceiling Heights.

4.4.1 Every habitable room and bathroom shall have a minimum ceiling height of not less than 7 ft (2.1 m) for a minimum of 50 percent of the room's floor area. The remaining area shall be permitted to have a ceiling with a minimum height of 5 ft (1.5 m). Minimum height under dropped ducts, beams, and other similar projections shall be 6 ft 4 in. (1.9 m).

4.4.2 Hallways and foyers shall have a minimum ceiling height of 6 ft 6 in. (2 m).

4.5 Exit Facilities — Exterior Doors.

4.5.1 Number and Location of Exterior Doors. Manufactured homes shall have a minimum of two exterior doors remotely located from each other.

4.5.1.1 Required egress doors shall not be located in rooms where a lockable interior door must be used in order to exit.

4.5.1.2 In order for exit doors to be considered remote from each other, they shall comply with 4.5.1.2.1 through 4.5.1.2.4.

4.5.1.2.1 Doors. The two required exit doors shall not be in the same room or in a group of rooms that are not defined by fixed walls.

4.5.1.2.2 Single-Wide Units. Doors shall not be less than 12 ft (3.7 m) c-c from each other, as measured in any straight line direction, regardless of the length of path of travel between doors.

4.5.1.2.3 Multi-Wide Units. Doors shall not be less than 20 ft (6.1 m) c-c from each other, as measured in any straight line direction, regardless of the length of path of travel between doors.

4.5.1.2.4 Access. One of the required exit doors shall be accessible from the doorway of each bedroom without traveling more than 35 ft (10.7 m). The travel distance to the exit door shall be measured on the floor or other walking surface along the centerline of the natural path of travel starting at the center of the bedroom door, curving around any corners or permanent obstructions with a 1 ft clearance therefrom, and ending at the center of the exit door.

4.5.1.2.5 If an exit door is not accessible without traveling more than 35 ft (10.7 m) as required by 4.5.1.2.4, a fire sprinkler system that complies with Section 5.10 shall be required.

4.5.2 Door Design and Construction.

4.5.2.1 Exterior swinging doors shall be constructed in accordance with Section 7.5. Exterior sliding glass doors shall be constructed in accordance with Section 7.3.

4.5.2.2* All exterior swinging doors shall provide a minimum 28 in. wide × 74 in. high (710 mm × 1880 mm) opening. All exterior sliding glass doors shall provide a minimum 28 in. wide × 72 in. high (710 mm × 1830 mm) opening. Door seals shall be permitted to reduce the opening, either vertically or horizontally, a maximum of 1 in. (25.4 mm).

4.5.2.3 Each swinging exterior door, other than screen or storm doors, shall have a key-operated lock that has a deadlocking latch or a key-operated dead bolt with a passage latch. Locks shall not require the use of a key for operation from the inside.

4.5.2.4 All exterior doors, including storm and screen doors, that open outward shall be provided with a safety door check.

4.6 Exit Facilities — Egress Windows and Devices.

4.6.1 Every room designed expressly for sleeping purposes, unless it has an exit door *(see Section 4.5)*, shall have at least one outside window or approved exit device meeting the requirements of Section 7.4.

4.6.2 The bottom of the window opening shall not be more than 36 in. (914 mm) above the floor.

4.6.3 Locks, latches, operating handles, tabs, and any other window screen or storm window devices that need to be operated in order to permit exiting shall not be located in excess of 54 in. (1370 mm) from the finished floor.

4.6.4 Integral rolled-in screens shall not be permitted in an egress window unless the window is of the hinged type.

4.7 Interior Privacy. Bathroom and toilet compartment doors shall be equipped with a privacy lock.

4.8 Interior Passage Doors.

4.8.1* All interior swinging doors shall have a minimum clear opening width of 27 in. (686 mm).

4.8.2 Interior doors having passage hardware without a privacy lock, or with a privacy lock not engaged, shall open from either side by a single movement in any direction of the hardware mechanism.

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4.8.3 When provided, each privacy lock on interior doors shall have an emergency release on the outside to permit entry when the lock has been locked by a locking knob, lever, button, or other locking device from the inside.

4.9 Room Requirements.

4.9.1 Every manufactured home shall have at least one living area with not less than 150 ft^2 (13.9 m^2) of gross floor area.

4.9.2 Rooms designed for sleeping purposes shall have a minimum gross square foot floor area, as follows:

(1) All bedrooms shall have at least 50 ft^2 (4.6 m^2) of floor area.
(2) Bedrooms designed for two or more people shall have 70 ft^2 (6.5 m^2) of floor area plus 50 ft^2 (4.6 m^2) for each person in excess of two.
(3) Every room designed for sleeping purposes shall have accessible clothes hanging space with a minimum inside depth of 22 in. (560 mm) and shall be equipped with a rod and shelf.

4.10 Minimum Room Dimensions. The gross floor area required by 4.9.1 and 4.9.2 shall have no clear horizontal dimension less than 5 ft (1.5 m). *(See 4.2.1 for a definition of gross floor area.)*

4.11* Bathroom Passage Doors. All single-section bathroom passage doors shall have a minimum clear opening width of 23 in. (584 mm), and multi-section bathroom passage doors shall have a minimum clear opening width of 27 in. (686 mm).

4.11.1 Toilet Compartments. Each toilet compartment shall have a minimum width of 30 in. (760 mm), with a minimum clear space of 21 in. (530 mm) in front of each toilet. Toilets located adjacent to a wall shall have the centerline of the toilet located a minimum of 15 in. (380 mm) from the wall. Toilets located adjacent to a tub shall have the centerline of the toilet located a minimum of 12 in. (300 mm) from the outside edge of the tub.

4.12* Hallways. Hallways shall have a minimum horizontal dimension of 28 in. (710 mm) for single-section homes, and a minimum horizontal dimension of 36 in. (910 mm) for multi-section homes, measured from the interior finished surface of one wall to the interior finished surface of the opposite wall. Where appliances are installed in a laundry area, the measurement shall be taken from the front of the appliance to the opposite finished interior surface. Where appliances are not installed and a laundry area is provided, the area shall have a minimum clear depth of 27 in. (690 mm) in addition to the 28 in. (710 mm) required for passage. In addition, a notice of the available clearance for washer/dryer units shall be posted in the laundry area. Minor protrusions into the minimum hallway width by doorknobs, trim, smoke detectors, or light fixtures shall be permitted.

4.13 Glass and Glazed Openings.

4.13.1 Windows and Sliding Glass Doors. All windows and sliding glass doors shall meet the requirements of Section 7.3.

4.13.2 Safety Glazing. Glazing in hazardous locations shall meet the requirements of 4.13.2.1 and those of 4.13.2.2 or 4.13.2.3.

4.13.2.1 Safety Glazing Materials. Safety glazing material shall meet the test requirements of CPSC 16 CFR 1201, "Safety Glazing Test Standard," or ANSI Z97.1, *Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings.*

4.13.2.2 Hazardous Location Glazing. Where located and subject to human impact loads, except as outlined in 4.13.2.3, safety glazing shall be installed in the following hazardous locations:

(1) Glazing in ingress and egress doors, except jalousies.
(2) Glazing in fixed and sliding panels of sliding-type doors.
(3) Glazing in storm-type doors.
(4) Glazing in unframed side-hinged swinging doors.
(5) Glazing in doors and fixed panels less than 60 in. (1524 mm) above the room floor level that enclose bathtubs, showers, hydromassage tubs, hot tubs, whirlpools, saunas, and steam rooms.
(6) Glazing within 12 in. (305 mm) horizontally and 60 in. (1524 mm) vertically, adjacent to and in the same plane of a door. The 12 in. (305 mm) dimension is measured from the edge of the door in the closed position. The 60 in. (1524 mm) dimension is measured from the room floor level.
(7) Glazing within 36 in. (914 mm) of an interior room walking surface that meets all of the following criteria:
    (a) Individual glazed panel exceeds 9 ft^2 (0.836 m^2) in exposed area.
    (b) The bottom edge of the exposed glazing is less than 19 in. (483 mm) above the room floor level.
    (c) The top edge of the exposed glazing is greater than 36 in. (914 mm) above the room floor level.
(8) Glazing in guardrails and railings.

4.13.2.3 Locations Not Considered Hazardous. The following are not required to meet the requirements of 4.13.2.2:

(1) Openings in doors through which a 3 in. (76 mm) sphere is unable to pass
(2) Leaded and decorative glazed panels
(3) Glazing as outlined in 4.13.2.2(6), where an intervening wall or other permanent barrier exists between the door and the glazing
(4) Glazing as outlined in 4.13.2.2(7), where a protective bar or member is installed horizontally between 34 in. (864 mm) and 38 in. (965 mm) above the room floor level. The bar or member shall be a minimum 1½ in. (38 mm) in height and capable of withstanding a horizontal load of 50 lb per linear foot (74.5 kg/m)
(5) Mirrors hung or mounted on a flush door surface or solid wall surface

4.14 Landings.

4.14.1 General. A minimum dimension of travel distance of a landing shall be 3 ft (914 mm). The minimum width of a landing shall not be less than the stairway or door that it serves. Landings shall be located as required by Section 4.14.

4.14.1.1 Landings for Stairways. There shall be a floor or landing at the top and bottom of each stairway.

Exception: At the top of an interior flight of basement stairs, provided a door does not swing over the stairs.

4.14.1.2 Doors. A landing or floor shall be located on each side of an interior doorway. The maximum threshold height above the floor or landing shall be ½ in. (13 mm) provided that thresholds more than ¼ in. (6 mm) above the adjacent floor shall be beveled with a slope not steeper than 1 in 2.

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4.15 Handrails.

4.15.1 General. A minimum of one handrail meeting the requirements of this section shall be installed on all stairways consisting of two or more risers. Single-riser stairs not at doors shall also have a minimum of one handrail located along the normal path of travel and complying with 4.15.3.2. Handrails shall be securely attached to structural framing members. A minimum space of 1½ in. (38 mm) shall be provided between the adjoining wall surface and the handrail.

4.15.2 Handrail Height. Handrails shall be installed between 34 in. (864 mm) and 38 in. (965 mm) measured vertically from the leading edge of the stairway treads except that handrails installed up to 42 in. (1067 mm) high shall be permitted if serving as the upper rails of guards required by Section 4.16.

4.15.3 Continuity.

4.15.3.1 Required handrails shall be continuous from a point directly above the leading edge of the lowest stair tread to a point directly above the leading edge of the landing or floor surface at the top of the stairway. If the handrail is extended at the top of the stairway flight, the extension shall parallel the floor or landing surface and shall be at the same height as the handrail is above the leading edges of the treads. If the handrail is extended at the base of the stair, it shall continue to slope parallel to the stair flight for a distance of one tread depth, measured horizontally, before being terminated or returned or extended horizontally. The ends of handrails shall return into a wall, or terminate in a safety terminal or newel post.

4.15.3.2 Continuity of Required Handrails Serving Single-Riser Stairs. Handrails serving single-riser stairs shall, at a minimum, extend from a point between 34 in. (864 mm) and 38 in. (965 mm) above the finished floor or landing and a minimum of 11 in. (279 mm), measured horizontally, beyond the face of the riser, to a point between 34 in. (864 mm) and 38 in. (965 mm) above the finished floor or landing and directly above the riser. The ends of handrails shall return into a wall and terminate in a safety terminal or newel post. Acceptable equivalent measures shall include other rails or features providing similar visual cueing for the step and graspability as required by 4.15.4.

4.15.4 Graspability. Required handrails shall, if circular in cross section, have a minimum 1¼ in. (32 mm) and a maximum 2 in. (51 mm) diameter dimension. Handrails with a noncircular cross section shall have a perimeter dimension of at least 4 in. (102 mm) and not more than 6¼ in. (159 mm) with a maximum cross-section dimension of not more than 2¼ in. (57 mm). A handrail shape that provides equivalent graspability shall be accepted. The handgrip portion of the handrail shall have a smooth surface. Edges shall have a minimum ⅛ in. (3.2 mm) radius. Handrails shall be continuously graspable along their entire length except that brackets or balusters are not considered obstructions to graspability if they do not project horizontally beyond the sides of the handrail within 1½ in. (38 mm) of the bottom of the handrail.

4.15.5 Handrails shall be designed to resist a load of 20 lb/ft (0.29 kN/m) applied in any direction at the top and to transfer this load through the supports to the structure. All handrails shall be able to resist a single concentrated load of 200 lb (0.89 kN), applied in any direction at any point along the top, and have attachment devices and supporting structures to transfer this loading to appropriate structural elements of the building. This load shall not be required to be assumed to act concurrently with the loads specified in this section.

4.16 Guards.

4.16.1 Porches, balconies, or raised floor surfaces located more than 30 in. (762 mm) above the floor or grade below shall have guards not less than 36 in. (914 mm) in height. Open sides of stairs with a total rise of more than 30 in. (762 mm) above the floor or grade below shall have guards not less than 34 in. (864 mm) in height measured vertically from the nosing of the treads. Balconies and porches on the second floor or higher shall have guards a minimum of 42 in. (1067 mm) in height.

4.16.2 Guard Opening Limitations. Required guards on open sides of stairways, raised floor areas, balconies, and porches shall have intermediate rails or ornamental closures that do not allow passage of a sphere 4 in. (100 mm) in diameter. Required guards shall not be constructed with horizontal rails or other ornamental pattern that results in a ladder effect.

4.16.2.1 The triangular openings formed by the riser, tread and bottom rail of a guard at the open side of the stairway shall be permitted to be of such a size that a sphere 6 in. (152 mm) cannot pass through.

4.16.2.2 Guard systems shall be designed to resist a load of 20 lb/ft (0.29 kN/m) applied in any direction at the top and to transfer this load through the supports to the structure. All guard systems shall be able to resist a single concentrated load of 200 lb (0.89 kN), applied in any direction at any point along the top and have attachment devices and supporting structures to transfer this loading to appropriate structural elements of the building. This load shall not be required to be assumed to act concurrently with the loads specified in this section.

4.17 Stairway Illumination. All interior and exterior stairways shall be provided with a means to illuminate the stair, including the landings and treads. Interior stairs shall be provided with an artificial light source located in the immediate vicinity of each landing at the top and bottom of the stair. For interior stairs the artificial light sources shall be capable of illuminating treads and landings to levels not be less than 10 footcandles (108 lx) measured at the center of treads and landings. Exterior stairs shall be provided with an artificial light source located in the immediate vicinity of the top landing of the stair.

Exception No. 1: An artificial light source is not required at the top and bottom landing, provided an artificial light source is located directly over each stair section.

Exception No. 2: Illumination measurements are not required where the installed artificial light sources are designed for a minimum of two incandescent lamps with a total rating, per light fixture, of at least 120 watts and not less than two such light fixtures are provided for each story-height portion of a stairway.

Exception No. 3: Illumination measurements are not required where the installed artificial light sources are designed for fluorescent or other lamp types capable of providing a minimum light output equivalent to that from 240 watts of incandescent lamps for each story-height portion of a stairway.

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Chapter 5 Fire Safety

5.1 Scope. The purpose of this chapter shall be to set forth requirements that will ensure reasonable fire safety to the occupants by reducing fire hazards and providing methods for early detection.

5.2 Definitions. The following definitions shall be applicable to Chapters 5, 10, and 11.

5.2.1 Combustible Material. Any material not meeting the definition of limited-combustible or noncombustible material.

5.2.2 Flame Spread Index. The measurement of the propagation of flame on the surface of materials or their assemblies as determined by recognized standard tests conducted as required by this chapter.

5.2.3 Interior Finish. The surface material of walls, fixed or movable partitions, ceilings, columns, and other exposed interior surfaces affixed to the home's structure, including any materials such as paint or wallpaper and the substrate to which they are applied. Interior finish shall not include the following: (1) trim and sealant 2 in. (50 mm) or less in width adjacent to the cooking range and in furnace and water heater spaces, provided it is installed in accordance with the requirements of 5.3.2.3 or 5.3.2.4, and trim 6 in. (152 mm) or less in width in all other areas; (2) windows and frames; (3) single doors and frames and a series of doors and frames not exceeding 5 ft (1.5 m) in width; (4) skylights and frames; (5) casings around doors, windows, and skylights not exceeding 4 in. (102 mm) in width; (6) furnishings that are not permanently affixed to the home's structure; (7) baseboards not exceeding 6 in. (152 mm) in height; (8) light fixtures, cover plates of electrical receptacle outlets, switches, and other devices; (9) decorative items attached to walls and partitions (e.g., pictures, decorative objects, etc.) constituting no more than 10 percent of the aggregate wall surface area in any room or space not more than 32 ft^2 (3.0 m^2) in surface area, whichever is less; (10) plastic light diffusers, when suspended from a material that meets the interior finish provisions of 5.3.2; (11) coverings and surfaces of exposed wood beams; (12) decorative items that include the following: (a) nonstructural beams not exceeding 6 in. (152 mm) in depth and 6 in. (152 mm) in width and spaced not closer than 4 ft (1.2 m) on center; (b) nonstructural latticework; (c) mating and closure molding; (d) other items not affixed to the home's structure.

5.2.4 Limited-Combustible. A material that meets the following criteria: 5/16 in. (8 mm), or thicker, gypsum board, and the definition of Section 2-1 of NFPA 220, *Standard on Types of Building Construction*, which states: A building construction material not complying with the definition of noncombustible material that, in the form in which it is used, has a potential heat value not exceeding 3500 Btu/lb (8136 kJ/kg), where tested in accordance with NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, and complies with (a) or (b): (a) Materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of 1/8 in. (3.2 mm) that has a flame spread index not greater than 50; and (b) Materials, in the form and thickness used, other than as described in (a), having neither a flame spread index greater than 25 nor evidence of continued progressive combustion and of such composition that surfaces that would be exposed by cutting through the material on any plane would have neither a flame spread index greater than 25 nor evidence of continued progressive combustion. (Materials subject to increase in combustibility or flame spread index beyond the limits herein established through the effects of age, moisture, or other atmospheric condition shall be considered combustible.)

5.2.5 Noncombustible Material. A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. Materials that are reported as passing ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, shall be considered noncombustible materials.

5.2.6 Notification Appliance. A fire alarm system component such as a bell, horn, speaker, light, or text display that produces audible, tactile, or visible outputs, or any combination thereof.

5.2.7 Single-Station Alarm. A detector comprising an assembly incorporating a sensor, control components, and an alarm notification appliance in one unit operated from a power source either located in the unit or obtained at the point of installation.

5.2.8 Single-Station Alarm Device. An assembly incorporating the smoke detector sensor, the electrical control equipment, and the alarm-sounding device in one unit.

5.2.9 Smoke Alarm. A single or multiple station alarm responsive to smoke.

5.2.10 Smoke Detector. A device that detects visible or invisible particles of combustion.

5.2.11 Visible Notification Appliance. A notification appliance that alerts by the sense of light.

5.3 Flame-Spread Limitations and Fire Protection Requirements.

5.3.1 Establishment of Flame-Spread Index.

5.3.1.1 The surface flame-spread index of interior-finish material shall not exceed the values shown in 5.3.2 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*. A radiant panel index of the same value shall be permitted to be determined in accordance with ASTM E 162, *Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source*.

5.3.1.2 The following materials shall not need to be tested to establish their flame-spread index unless a lower rating is required.

(1) Flame-Spread Index — 76 to 200:
   (a) 0.035 in. (0.9 mm), or thicker, high-pressure laminated plastic panel countertop
   (b) 1/4 in. (6 mm), or thicker, unfinished plywood with phenolic or urea glue
   (c) Unfinished dimension lumber [1 in. (25 mm), or thicker, nominal boards]
   (d) 3/8 in. (10 mm) or thicker unfinished particle board with phenolic or urea binder
   (e) The following materials, either natural gum–varnished or latex- or alkyd-painted:
      i. 1/4 in. (6 mm), or thicker, plywood
      ii. 3/8 in. (10 mm), or thicker, particleboard
      iii. 1 in. (25 mm), or thicker, nominal board

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(f) 5⁄16 in. (8 mm) gypsum board with decorative wallpaper
(g) 1⁄4 in. (6 mm), or thicker, unfinished hardboard
(h) 1⁄4 in. (6 mm), or thicker, unfinished wood structural panels with phenolic or other exterior glue

(2) Flame-Spread Index — 25 to 200:
(a) Painted metal
(b) Mineral-based acoustic tile
(c) 5⁄16 in. (8 mm), or thicker, unfinished gypsum wallboard (both latex- or alkyd-painted)
(d) Ceramic tile

Use of these material applications shall not waive the requirements of 5.3.3 or Section 5.4.

5.3.2 Flame-Spread Index Requirements.

5.3.2.1 The interior finish of walls, columns, and partitions shall not have a flame-spread index exceeding 200, except as otherwise specified herein.

5.3.2.2 Ceiling interior finish shall not have a flame-spread index exceeding 75.

5.3.2.3 Walls adjacent to or enclosing a furnace or water heater, and the ceilings above them, shall have an interior finish with a flame-spread index not exceeding 25.

Exception: Sealants and other trim materials 2 in. (50 mm) or less in width that are used to finish adjacent surfaces within these spaces, provided that all joints are completely supported by framing members or by materials having a flame-spread index not exceeding 25.

5.3.2.4* Exposed interior finishes adjacent to the cooking range shall have a flame-spread index not exceeding 50. *(See Section 5.4.)*

Exception: Backsplashes not exceeding 6 in. (152 mm) in height and sealants and other trim materials 2 in. (50 mm) or less in width that are used to finish adjacent surfaces provided that all joints are completely supported by a framing member.

5.3.2.5 Kitchen cabinet doors, countertops, backsplashes, exposed bottoms, and end panels shall have a flame-spread index not exceeding 200.

Exception: Cabinet rails, stiles, mullions, and top strips.

5.3.2.6 Finished surfaces of plastic bathtubs, shower units, and tub or shower doors shall have a flame-spread index not exceeding 200.

5.3.3 Fire-Protective Requirements.

5.3.3.1 Materials used to surface the following areas shall be limited-combustible materials [e.g., 5⁄16 in. (8 mm) gypsum board]:

(1) Exposed wall adjacent to the cooking range *(See 5.3.2.4.)*
(2) Exposed bottoms and sides of kitchen cabinets, as required by Section 5.4
(3) Interior walls and ceilings enclosing furnace and/or water heater spaces
(4) Combustible doors that provide interior or exterior access to furnace and/or water heater spaces

5.3.3.1.1 The surface of combustible doors shall be permitted to be interrupted for louvers ventilating the enclosure. However, the louvers shall not be constructed of a material of greater combustibility than the door itself (e.g., plastic louvers on a wooden door).

5.3.3.2 No burner of a surface cooking unit shall be closer than 12 horizontal in. (305 mm) to a window or an exterior door with glazing.

5.4 Kitchen Cabinet Protection.

5.4.1 The bottom and sides of combustible kitchen cabinets located over cooking ranges to a horizontal distance of 6 in. (152 mm) from the outside edge of the cooking range shall be protected with at least 5⁄16 in. (8 mm) thick gypsum board or equivalent limited-combustible material.

Exception: 1 in. (25 mm) nominal framing members and trim shall be exempted from this requirement.

5.4.2 The cabinet area located over the cooking range or cooktops shall be protected by a metal hood (26-gauge sheet metal, 0.017 stainless steel, 0.024 aluminum, or 0.020 copper), with not less than a 3 in. (76 mm) eyebrow projecting horizontally from the front cabinet face. The 5⁄16 in. (8 mm) thick gypsum board or equivalent limited-combustible material that is above the top of the hood shall be permitted to be supported by the hood. A 3⁄8 in. (10 mm) enclosed air space shall be provided between the bottom surface of the cabinet and the gypsum board or equivalent material. The hood shall be at least as wide as the cooking range.

5.4.3 The 3 in. (76 mm) metal eyebrow required by 5.4.2 shall project from the front and rear cabinet faces when there is no adjacent surface behind the range, or 5⁄16 in. (8 mm) thick gypsum board or equivalent limited-combustible material shall be extended to cover all exposed rear surfaces of the cabinet.

5.4.4 The metal hood required by 5.4.2 shall not be required where an oven of equivalent metal protection or a microwave cooking appliance meeting the requirements of UL 923, *Microwave Cooking Appliances,* is installed between the cabinet and the range, and all exposed cabinet surfaces are protected as described in 5.4.1.

5.4.5 When a manufactured home is designed for the future installation of a cooking range, the metal hood and cabinet protection required by 5.4.1 and 5.4.2 and the wall-surfacing protection behind the range required by Section 5.3 shall be installed in the factory.

5.4.6 Ranges shall have a vertical clearance above the cooking top of not less than 24 in. (610 mm) to the bottom of combustible cabinets.

5.5 Carpeting. Carpeting shall not be used in a space or compartment designed to contain only a furnace and/or water heater. Carpeting shall be permitted to be used in other areas where a furnace or water heater is installed, provided that it is not located under the furnace or water heater.

5.6 Fireblocking.

5.6.1* General. Fireblocking shall comply with Section 5.6. The integrity of all fireblocking materials shall be maintained.

5.6.2 Fireblocking Materials. Fireblocking shall consist of the materials listed in 5.6.2.1 through 5.6.2.4.

5.6.2.1 Minimum 1 in. (25 mm) nominal lumber, 23⁄32 in. (18 mm) wood structural panel or 5⁄16 in. (8 mm) thick gypsum board, or the equivalent, shall be allowed.

5.6.2.2 Mineral wool or unfaced glass fiber batts or blankets shall be allowed as fireblocking where the material fills the entire cross section of the concealed space to a minimum

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height of 16 in. (406 mm) measured vertically. The mineral wool or unfaced glass fiber batts or blankets shall be installed so as to be retained securely in place.

5.6.2.3 Loose-fill insulation shall be allowed as fireblocking where it has been specifically tested in the form and manner intended for use to demonstrate its ability to remain in place and to retard the spread of fire and hot gases.

5.6.2.4 Other materials shall be allowed if listed or approved.

5.6.3 Fireblocking Locations.

5.6.3.1 Fireblocking shall be installed in concealed spaces of stud walls, partitions, and furred spaces at the floor and ceiling levels. Concealed spaces shall not communicate between floor levels. Concealed spaces shall not communicate between a ceiling level and a concealed roof area, or an attic space.

5.6.3.2 Fireblocking shall be installed at the interconnection of a concealed vertical space and a concealed horizontal space that occurs in the following:

(1) Between a concealed wall cavity and the ceiling joists above
(2) At soffits, drop ceilings, cover ceilings and similar locations

5.6.3.3 Fireblocking shall be installed around the openings for pipes, vents, and other penetrations in walls, floors, and ceilings of furnace and water heater spaces. Fireblocking shall completely fill the opening around the penetration or shall completely fill the cavity or concealed space into which the penetration is made. Pipes, vents, and other penetrations that cannot be moved freely within their openings shall be considered fireblocked. Materials used to fireblock heat-producing vent penetrations shall be noncombustible or limited-combustible types.

5.6.4 Draftstopping.

5.6.4.1 When there is usable space both above and below the concealed space of a floor/ceiling assembly, draftstops shall be installed so that the area of the concealed space does not exceed 1000 ft^2 (93 m^2).

5.6.4.2 Draftstopping shall divide the concealed space into approximately equal areas.

5.6.4.3 Where the assembly is enclosed by a floor membrane above and a ceiling membrane below, draftstopping shall be provided in the floor/ceiling assemblies:

(1) When the ceiling is suspended under the floor framing
(2) When the floor framing is constructed of truss type open-web or perforated members

5.6.4.4 Draftstopping materials shall not be less than ⅜ in. (10 mm) gypsum board, ⅜ in. (10 mm) wood structural panels, ⅜ in. (10 mm) Type 2-M-W particleboard, or other approved materials adequately supported.

5.6.4.5 Draftstopping shall be installed parallel to the floor framing members.

5.6.4.6 The integrity of all draftstops shall be maintained.

5.7 Requirements for Thermal Insulating Materials.

5.7.1 Insulating Materials Other Than Foam Plastic.

5.7.1.1 General. Exposed and concealed thermal insulation materials, other than foam plastic, shall have a flame-spread index of 25 or less, and a smoke-developed index of 450 or less when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*. Tested materials shall include any facings. Materials and methods complying with 5.7.1.1.1, 5.7.1.1.2, and 5.7.1.2 shall be accepted.

5.7.1.1.1 The flame-spread and smoke-developed limitations shall not apply to coverings and facings of insulation batts or blankets installed in concealed spaces where the facings are in substantial contact with the unexposed surface of wall, floor, or ceiling finish.

5.7.1.1.2 Cellulose loose-fill insulation that is not spray applied or self-supporting and that complies with 5.7.1.2 shall not be required to have a flame-spread index of 25 or less.

5.7.1.2 Loose-fill Insulation.

5.7.1.2.1 Loose-fill insulation, other than cellulose loose-fill insulation, that cannot be mounted in the NFPA 255 test apparatus without a screen or other artificial support, shall have a flame-spread index of 25 or less and a smoke-developed index of 450 or less when tested in accordance with CAN/ULC-S102.2-M88. Cellulose loose fill shall comply with 5.7.1.2.2.

5.7.1.2.2 Cellulose loose-fill insulation shall comply with, and each package shall be labeled in accordance with, CPSC, 16 CFR, Parts 1209 and 1404.

5.7.1.3 Attic Locations. Exposed insulation installed in attics on the floor or ceiling forming the lower boundary of the attic shall have a critical radiant flux of not less than 0.12 watt/cm^2 when tested in accordance with NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*.

5.7.2 Foam Plastic.

5.7.2.1 General. Foam plastic thermal insulating materials shall not be used within the cavity of walls (not including doors) or ceilings or be exposed to the interior of the home unless one of the following conditions exists:

(1) The foam plastic insulating material is protected by an interior finish of 5/16 in. (8 mm) thick gypsum board or equivalent limited-combustible material for all cavities where the material is to be installed.
(2) The foam plastic is used as a sheathing or siding backerboard, and it has the following characteristics:
    (a) Flame-spread index of 75 or less and a smoke-developed index of 450 or less (not including outer covering or sheathing)
    (b) Does not exceed ⅜ in. (10 mm) in thickness
    (c) Is separated from the interior of the manufactured home by a minimum of 2 in. (50 mm) of mineral fiber insulation or an equivalent thermal barrier
(3) The foam plastic insulating material has been previously accepted by the regulatory agency for use in wall and/or ceiling cavities of manufactured homes, and the insulating material is installed in accordance with any restrictions imposed at the time of that acceptance.
(4) The foam plastic insulating material has been tested as required for its location in wall and/or ceiling cavities in accordance with testing procedures described in the Illinois Institute of Technology Research Institute (IITRI) report J-6461, "Development of Mobile Home Fire Test Methods to Judge the Fire-Safe Performance of Foam Plastic," or other full-scale fire tests accepted by the regulatory agency, and it is installed in a manner consistent

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with the way the material was installed in the foam plastic test module. The materials shall be capable of meeting the acceptance criteria required in 5.7.1.1 through 5.7.1.3 for their locations.

5.7.2.2 Wall Assemblies. The foam plastic system shall demonstrate equivalent or superior performance to the control module, as determined by the following:

(1) Time it takes to reach flashover [1112°F (600°C)] in the upper part of the room
(2) Time it takes to reach an oxygen (O_2) level of 14 percent (rate of O_2 depletion), a carbon monoxide (CO) level of 1 percent, a carbon dioxide (CO_2) level of 6 percent, and a smoke level of 0.26 optical density/meter measured at 5 ft (1.5 m) high in the doorway
(3) Rate of change concentration for O_2, CO, CO_2, and smoke measured 3 in. (76 mm) below the top of the doorway

5.7.2.3 Ceiling Assemblies. A minimum of three valid tests of the foam plastic system and one valid test of the control module shall be evaluated to determine if the foam plastic system demonstrates equivalent or superior performance to the control module. Individual factors to be evaluated include intensity of cavity fire (temperature-time) and post-test damage.

5.7.2.4 Post-Test Damage Assessment for Wall and Ceiling Assemblies. The overall performance of each total system also shall be evaluated in determining the acceptability of a particular foam plastic insulating material.

5.7.3 All foam plastic thermal insulating materials used in manufactured housing shall have a flame-spread index of 75 or less (not including outer covering or sheathing) and a maximum smoke-developed index of 450.

5.8 Fire Warning Equipment.

5.8.1 General. Approved, single-station smoke alarms or smoke detectors shall be installed in a manufactured home as specified in Section 5.8. Smoke detection systems installed in conformance with *NFPA 72, National Fire Alarm Code*, shall be acceptable.

5.8.2 Installation. Smoke alarms and smoke detectors shall be installed in accordance with the manufacturers' listing and instructions and shall comply with the following parameters.

5.8.2.1 Flat Ceilings. Smoke alarms or smoke detectors mounted on a flat ceiling shall be located no closer than 4 in. (102 mm) from the adjoining wall surface.

5.8.2.2* Sloped Ceilings (Peaked Ceilings). Smoke alarms or smoke detectors mounted on a peaked ceiling shall be located within 36 in. (914 mm) horizontally of the peak, but not closer than 4 in. (102 mm) vertically to the peak.

5.8.2.3* Sloped Ceilings (Shed Ceilings). Smoke alarms or smoke detectors mounted on a sloped ceiling having a rise greater than 1 ft in 8 ft (1 m in 8 m) horizontally shall be located within 36 in. (914 mm) of the high side of the ceiling, but not closer than 4 in. (102 mm) from the adjoining wall surface.

5.8.2.4* Wall Mounting. Smoke alarms or smoke detectors mounted on walls shall be located not closer than 4 in. (102 mm) from the adjoining ceiling surface, not farther than 12 in. (305 mm) from the adjoining ceiling surface, and not farther from the adjoining ceiling than specified in the manufacturers' installation instructions.

5.8.2.5 Electrical Connection. Smoke alarms designed to receive their primary power from an alternating current power source shall be mounted on an electrical outlet box and connected by a permanent wiring method in accordance with this standard. There shall be no switches in the circuit between smoke alarms or smoke detectors and the overcurrent protective device of that circuit. Smoke alarms or smoke detectors shall not receive their power from a circuit that is protected by a ground-fault circuit-interrupter.

5.8.3 Location.

5.8.3.1 General Location. Single-station smoke alarms or smoke detectors shall be installed in the following locations:

(1)*In all sleeping rooms.
(2) Outside of each separate sleeping area. In home designs that do not permit compliance with the requirements of 5.8.3.2, the smoke alarm or smoke detector shall be permitted to be placed in a common area adjacent to the sleeping area.
(3) On each additional story of the manufactured home.

5.8.3.2 Specific Location Requirements. Specific locations for smoke alarms or smoke detectors shall be as follows:

(1) Smoke alarms or smoke detectors shall be located in areas where ambient conditions are within the limits specified by the manufacturer.
(2)*Smoke alarms or smoke detectors installed within 20 ft (6.1 m) horizontal path of a cooking appliance shall be equipped with an alarm silencing means or shall be of the photoelectric type.
(3) Smoke alarms or smoke detectors shall not be installed within 36 in. (914 mm) from a door to a bathroom or kitchen or the supply grille of a forced air heating or cooling system.
(4)*A manufactured home designed for the future installation of a roof-mounted evaporative cooler or other equipment discharging conditioned air through a ceiling grille into the living area shall not have smoke alarms or smoke detectors installed within 36 in. (914 mm) horizontal path of the future discharge opening.
(5) Where there are stairs leading to other occupied levels, a smoke alarm or smoke detector shall be located near the top of each stairway so that smoke rising in the stairway cannot be prevented from reaching the smoke alarm or smoke detector by an intervening door or obstruction. For stairways leading up from a basement, smoke alarms or smoke detectors shall be located on the basement ceiling near the entry to the stairs.
(6) A manufactured home designed for installation over a basement shall be provided with a junction box for the installation and interconnection of the smoke alarms or smoke detectors, as required by Section 5.8.

5.8.4 Visible Notification Appliances. If provided, visible notification appliances installed for the hearing impaired shall comply with the following requirements. Visible notification appliances shall not be required to operate from a secondary power source.

(1) Visible notification devices shall be installed that produce at least 110 cd at the pillow in sleeping rooms and 15 cd in all other spaces.
(2) Visible notification appliances located on the ceiling over the bed and within 16 ft (4.88 m) of a sleeping occupant, having a light output rating of at least 177 cd, shall be acceptable.

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(3) Visible notification appliances in a sleeping room mounted more than 24 in. (610 m) below the ceiling and within 16 ft (4.88 m) of the pillow, having a minimum rating of 110 cd, shall be acceptable.

5.8.5 Interconnection. Smoke alarms shall be interconnected such that the operation of any one smoke alarm shall cause the alarm to sound in all smoke alarms within the manufactured home.

5.8.6 Power Supplies.

5.8.6.1 Smoke alarms shall receive their primary power from one of the following:

(1) An alternating current power source, along with a secondary battery source capable of operating the device for at least 7 days in the normal condition, followed by 4 minutes of alarm
(2) A nonreplaceable primary battery capable of operating the device for at least 10 years, followed by 4 minutes of alarm, followed by a trouble alarm for 7 days

5.8.6.2 Smoke detectors shall be connected to central controls for power, signal processing, and activation of notification appliances.

5.8.7 Maintenance, Testing, and Information.

5.8.7.1 Following installation, smoke alarms shall be functionally tested in accordance with the alarm manufacturers' instructions.

5.8.7.2 Fire warning equipment shall be provided with a convenient means for testing its operation by the homeowner.

5.8.7.3 Home manufacturers shall provide specific smoke alarm or smoke detector manufacturer instructions to the following:

(1) The manufactured home installer, homeowner, or other responsible parties for the inspection and testing of smoke alarms or smoke detectors during manufactured home installation
(2) The homeowner, describing the operation, maintenance, method, and frequency of testing of the smoke alarms
(3) The homeowner, that unless otherwise recommended by the manufacturer, smoke alarms shall be replaced when they fail to respond to tests. Smoke alarms shall not remain in service longer than 10 years from the date of installation
(4) The homeowner, describing the installation requirements of smoke alarms or smoke detectors as required by 5.8.3.2(6)

5.8.8 Labeling and Listing. Smoke alarms or smoke detectors shall be listed and approved to standards that verify the required performance. Smoke alarms conforming to ANSI/UL 217, *Single and Multiple Station Smoke Alarms*; smoke detectors conforming to ANSI/UL 268, *Smoke Detectors for Fire Protective Signaling Systems*; and visible signaling appliances conforming to ANSI/UL 1971, *Signaling Devices for Hearing Impaired*, shall be considered acceptable.

5.9 Fire Testing. All fire testing conducted in accordance with this chapter shall be performed by nationally recognized testing laboratories with expertise in fire technology. In case of dispute, the regulatory agency shall determine if a particular agency is qualified to perform such fire tests.

5.10 Fire Sprinkler System.

5.10.1 This section establishes minimum requirements when a fire sprinkler system is installed in a manufactured home. Unless the authority having jurisdiction requires a fire sprinkler system for all detached one- and two-family dwellings, these requirements for sprinkler systems are voluntary.

5.10.2 When an automatic fire sprinkler system is installed in a manufactured home, it shall be designed, installed, and tested in accordance with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*.

5.10.3 The manufacturer shall permanently affix the certificate shown in Figure 5.10.3 adjacent to the data plate.

5.10.4 Home manufacturers shall provide specific instructions to setup crews or other responsible parties for the inspection and testing of the fire sprinkler system during manufactured home setup. The manufacturer shall specify on the certificate required by 5.10.3 the minimum required water supply in both pressure (psi, bar) and flow (gpm, L/min).

5.10.5 Upon final connection at the home site of the fire sprinkler system to the water supply per the manufacturer's instructions, the adequacy of the water supply shall be verified, and the system shall be tested per NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*. The site installer shall insert its company name and address, along with the date, on the certificate, per 5.10.3.

5.10.6 Home manufacturers shall provide the homeowner with the following information describing the fire sprinkler system:

(1) Equipment and specifications
(2) Design information
(3) Operation
(4) Method and frequency of system testing
(5) Proper fire sprinkler maintenance

5.11 Attached Garages.

5.11.1 When a manufactured home is constructed for the attachment of a site built garage, provision will be made to provide fire separation between the garage and the manufactured home.

5.11.1.1 As a minimum, the garage shall be separated from the dwelling unit and its attic by not less than ½ in. (13 mm) gypsum board applied to the garage side and the separation shall be continuous from the bottom of the floor to the underside of the roof deck. The design approval and the manufacturer's installation instructions shall include provision for equivalent vertical separation between the garage and the space below the manufactured home floor system.

5.11.2 Openings between the garage directly into a room designated for sleeping purposes shall not be permitted. Other openings between the garage and the manufactured home shall be equipped with solid wood doors not less than 1⅜ in. (35 mm) in thickness, solid or honeycomb steel doors not less than 1⅜ in. (35 mm) in thickness, or 20-minute fire-rated doors, and all doors shall be self-closing.

5.11.3 Ducts penetrating the walls or ceilings separating the manufactured home from the garage shall be constructed of a minimum No. 26 gauge steel or other approved material and shall have no openings in the garage.

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NFPA RESIDENTIAL FIRE SPRINKLER SYSTEM CERTIFICATION AND INFORMATION

Note: This label contains important information about the fire sprinkler system installed in this structure.
Homeowner: Do not remove, alter, or cover this label.

GENERAL INFORMATION

(1) Name and address of home manufacturer: _____

_____

Manufactured home serial number: _____

(2) Name and address of residential fire sprinkler system installer (factory installation if different from the home manufacturer):

_____

_____

Date of factory installation: _____

The residential fire sprinkler system installed in this dwelling is in compliance with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes,* in effect on the date of installation indicated above. This system has been verified through hydraulic analysis based on the operating characteristics of the specific components utilized. Note: The manufactured home installer must complete testing required by NFPA 13D at the home site.

Warning: When necessary, replace components only with identical components or those determined to have equivalent performance characteristics with respect to flows and pressures.

SPRINKLERS INSTALLED IN THIS STRUCTURE

					Required Flow Rate	
Manufacturer	Model	Year	Temp. (°F)	Design Coverage	Single Sprinkler	Multiple Sprinklers
1. _____	_____	_____	_____	____ ft × ____ ft	___ gpm @ ___ psi	___ gpm @ ___ psi
2. _____	_____	_____	_____	____ ft × ____ ft	___ gpm @ ___ psi	___ gpm @ ___ psi
3. _____	_____	_____	_____	____ ft × ____ ft	___ gpm @ ___ psi	___ gpm @ ___ psi

MINIMUM WATER SUPPLY REQUIRED

Warning: For this system to operate properly, the following minimum supply of water must be available at the point of connection to the residential fire sprinkler system:

_____ gpm @ not less than _____ psi for not less than _____ minutes

The fire sprinkler system has been completed on site in accordance with the home manufacturer's installation instructions, and the above listed required water supply is available.

Name and address of site installer: _____ Date: _____

CONTROL VALVES

Warning: This structure contains a residential fire sprinkler system. Do not alter or make additions to the water supply without first contacting the home manufacturer.

The **control valve(s)** on the water supply to the residential fire sprinkler system must be in the **full open position** for the system to operate properly. If the valves must be closed temporarily to service the system, **notify local authorities having jurisdiction** and verify that they are **left fully open** and secured when service is complete.

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FIGURE 5.10.3 Fire Sprinkler System Certification and Information for Manufactured Homes.

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Chapter 6 Body and Frame Construction Requirements

6.1 Scope. This chapter shall cover the minimum requirements for materials, products, equipment, and workmanship needed to ensure that the manufactured home will provide the following:

(1) Structural strength and rigidity
(2) Protection against corrosion, decay, insects, rodents, and other similar destructive forces
(3) Protection against hazards of windstorm
(4) Resistance to the elements
(5) Durability and economy of maintenance

6.2 Definitions. The following definitions shall be applicable to Chapter 6 only.

6.2.1 Anchoring Equipment. Straps, cables, turnbuckles, and chains, including tensioning devices, that are used with ties to secure a manufactured home to ground anchors.

6.2.2 Anchoring System. A combination of ties, anchoring equipment, and ground anchors that will, when properly designed and installed, resist overturning and lateral movement of the manufactured home from wind forces.

6.2.3 Footing. That portion of the support system that transmits loads directly to the soil.

6.2.4 Ground Anchor. Any device at the manufactured home stand designed to transfer manufactured home anchoring loads to the ground.

6.2.5 Load.

6.2.5.1 Dead Load. The weight of all permanent construction, including walls, floors, roof, partitions, and fixed service equipment.

6.2.5.2 Live Load. The weight superimposed by the use and occupancy of the manufactured home.

6.2.5.3 Wind Load. The lateral or vertical pressure or uplift on the manufactured home due to wind blowing in any direction.

6.2.6 Main Frame. The structural component on which the body of the manufactured home is mounted.

6.2.7 Pier. That portion of the support system between the footing and the manufactured home, exclusive of caps and shims.

6.2.8 Sheathing. Material that is applied on the exterior side of a building frame under the exterior weather-resistant covering.

6.2.8.1 Wood Structural Panel. A panel manufactured from veneers; or wood strands or wafers; or a combination of veneer and wood strands or wafers bonded together with waterproof synthetic resins or other suitable bonding systems, including composite panels, oriented strand board, and plywood. [***5000:***3.3.389.3]

6.2.8.1.1 Composite Wood Structural Panel. A structural panel that is made of layers of veneer and wood-based material. [***5000:***3.3.389.3.1]

6.2.8.1.2 Oriented Strand Board (OSB) Wood Structural Panel. A mat-formed wood structural panel product composed of thin, rectangular wood strands or wafers arranged in oriented layers and bonded with waterproof adhesive. [***5000:***3.3.389.3.2]

6.2.8.1.3 Plywood Wood Structural Panel. A wood structural panel comprised of plies of wood veneer arranged in cross-aligned layers. [***5000:***3.3.389.3.3]

6.2.9 Stabilizing Devices. All components of the anchoring and support systems, including piers, footings, ties, anchoring equipment, ground anchors, and any other equipment that supports the manufactured home and secures it to the ground.

6.2.10 Support System. A combination of footings, piers, caps, and shims that will, when properly installed, support the manufactured home.

6.2.11 Tie. Straps, cable, or securing devices used to connect the manufactured home to ground anchors.

6.2.11.1 Diagonal Tie. A tie intended to primarily resist horizontal forces, but which also can be used to resist vertical forces.

6.2.11.2 Vertical Tie. A tie intended to resist uplifting or overturning forces.

6.3 General Requirements.

6.3.1 Minimum Requirements. The design and construction of a manufactured home shall conform with the provisions of this standard. Requirements for any size, weight, or quality of material modified by the terms "of minimum," "not less than," "at least," and similar expressions, are minimum standards. The manufacturer or installer shall be permitted to exceed these standards, provided such deviation does not result in any inferior installation or defeat the purpose and intent of this standard.

6.3.2 Construction. All construction methods shall be in conformance with accepted engineering practices to ensure durable, livable, and safe housing and shall demonstrate acceptable workmanship that reflects a journeyman quality of work.

6.3.3 Structural Analysis. The strength and rigidity of the component parts and/or the integrated structure shall be determined by engineering analysis or by suitable load tests to simulate the actual loads and conditions of application that can occur. *(See Chapters 7 and 12.)*

6.3.4 New Materials and Methods.

6.3.4.1 Any new material or method of construction not provided for in this standard and any material or method of questioned suitability proposed for use in the manufacture of the structure shall nevertheless conform in performance to the requirements of this standard.

6.3.4.2 Unless based on accepted engineering design for the use indicated, all new manufactured home materials, equipment, systems, or methods of construction not provided for in this standard shall be subjected to the tests specified in 6.3.6.

6.3.5 Allowable Design Stress. The design stresses of all materials shall conform to accepted engineering practices. The use of materials not certified with a strength or stress grade shall be limited to the minimum allowable stresses under accepted engineering practices.

6.3.6 Alternate Test Procedures. In the absence of recognized testing procedures either in these standards or the applicable provisions of those standards incorporated by reference, the

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manufacturer shall develop or cause to be developed testing procedures to demonstrate the structural properties and significant characteristics of the material, assembly, subassembly component, or member. Such testing procedures shall become part of the manufacturer's approved design.

6.3.6.1 Such tests shall be witnessed by an independent, licensed, professional engineer or architect or by a recognized testing organization.

6.3.6.2 Copies of the test results shall be kept on file by the manufactured home manufacturer.

6.4 Minimum Standards. Structural design and construction in manufactured homes shall conform to applicable standards in Table 6.4 unless otherwise specified in this standard. When more than one standard is referenced, compliance with any one such standard shall meet the requirements of this standard.

Table 6.4 Materials and Methods for Construction

Materials	Reference Standards
Steel	
Specification for Structural Steel Buildings — Allowable Stress Design and Plastic Design (The following parts of this reference standard shall not be applicable: 1.3.3, 1.3.4, 1.3.5, 1.3.6, 1.4.6, 1.5.1.5, 1.5.5, 1.6, 1.7, 1.8, 1.9, 1.10.4 through 1.10.7, 1.10.9, 1.11, 1.13, 1.14.5, 1.17.7 through 1.17.9, 1.19.1, 1.19.3, 1.20, 1.21, 1.23.7, 1.24, 1.25.1 through 1.25.5, 1.26.4, 2.3, 2.4, 2.8 through 2.10.)	AISC-ASD, 1989
Cold-formed Steel Design Manual (The following parts of this reference standard shall not be applicable: 3.1.2, 4.2.1, 4.2.4.)	AISI-SG 673, 1986 edition, with 1989 addendum
Standard Specification for Strapping, Flat Steel, and Seals	ASTM D 3953-97
Wood and Wood Products	
Basic Hardboard	ANSI/AHA A 135.4-1995
Prefinished Hardboard Paneling	ANSI/AHA A 135.5-1995
Hardboard Siding	ANSI/AHA A 135.6-1998
Hardwood and Decorative Plywood	ANSI/HPVA HP-1-2000
Structural Design Guide for Hardwood Plywood	HPVA HP-SG-96
Voluntary Product Standard PS 1-95, *Construction and Industrial Plywood*	USDOC PS-1-95
Voluntary Product Standard PS 2-92, *Performance Standard for Wood-Based Structural-Use Panels*	USDOC PS-2-92
Engineered Wood Construction Guide	APA E-30S-2003
Design and Fabrication of All-Plywood Beams, Supp. 5	APA H-815E-1995
Plywood Design Specification	APA Y-510T-1999
Design and Fabrication of Glued Plywood-Lumber Beams, Supp. 2	APA S-812R-1998
Design and Fabrication of Plywood Sandwich Panels, Supp. 4	APA U-814H-1993
PRP-108, Performance Standards and Policies for Structural Use Panels	APA E445S-2002
Design and Fabrication of Plywood Stressed-Skin Panels, Supp. 3	APA U-813L-1996
Design Capacities of APA Performance Rated Structural-Use Panels	APA N 375B-2001
Allowable Stress Design (ASD) Manual for Engineered Wood Construction, including:	AFPA T101-01
ANSI/AF&PA National Design Specification® (NDS®) for Wood Construction, 2001 Edition	
NDS® Supplement: Design Values for Wood Construction, 2001 Edition	
ASD Manual for Engineered Wood Construction, 2001 Edition	
ASD/LRFD Special Design Provisions for Wind and Seismic, 2001 Edition	
ASD Supplement: Structural Lumber, 2001 Edition	
ASD Supplement: Structural Glued Laminated Timber, 2001 Edition	
ASD Supplement: Wood Structural Panels, 2001 Edition	
ASD Supplement: Timber Poles and Piles, 2001 Edition	
ASD Supplement: Wood Structural Panel Shear Wall and Diaphragm, 2001 Edition	
ASD Guideline: Metal Plate Connected Wood Trusses, 2001 Edition	

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Table 6.4 *Continued*

Materials	Reference Standards
ASD Guideline: Pre-Engineered Metal Connectors, 2001 Edition	
ASD Guideline: Structural Composite Lumber, 2001 Edition	
ASD Guideline: Wood I-Joists, 2001 Edition	
Wood Structural Design Data, 1986 edition with 1992 revisions	AFPA T05
American Softwood Lumber Standard	USDOC PS-20-99
Span Tables for Joists and Rafters	AFPA T03-93
Specifications for Metal Plate Connected Wood Trusses	TPI-95
Mat-formed Wood Particleboard	ANSI A 208.1-1999
Architectural and Wood Flush Doors	ANSI/WDMA I.S.1-A-97
Voluntary Specifications for Aluminum, Vinyl, PVC, and Wood Windows and Glass Doors	ANSI/AAMA/WDMA 101/I.S.2-97
Water-Repellent Preservative Non-Pressure Treatment for Millwork	WDMA I.S.4-00
Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials	ASTM D 4442-92 (1997)
Standard Test Methods for Use and Calibration of Hand-Held Moisture Meters	ASTM D 4444-92 (1998)
Medium Density Fiberboard for Interior Use (MDF)	ANSI A 208.2-94
Other	
Standard Specification for Gypsum Wallboard	ASTM C 36-01
Residential Asphalt Roofing Manual	ARMA 1997
Fasteners	
Power-Driven Staples and Nails for Use in All Types of Building Construction	NER-272-97
Unclassified	
Minimum Design Loads for Buildings and Other Structures	SEI/ASCE 7-02
Performance Standard for Wood-Based Structural-Use Panels	USDOC PS-2-92
Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Building	ANSI Z 97.1-1984

6.4.1 Dimension and board lumber shall not exceed 19 percent moisture content at time of installation.

6.4.2 Materials and methods of construction utilized in the design and construction of manufactured homes that are covered by the standards in Table 6.4, or any applicable portion thereof, shall comply with the requirements of this standard.

6.4.3 Engineering analysis and testing methods contained in the references in Table 6.4 shall be utilized to judge conformance with accepted engineering practices required in 6.3.3.

6.4.4 Materials and methods of installation conforming to the standards in Table 6.4 shall be considered acceptable when installed in conformance with the requirements of Chapter 6.

6.4.5 Materials meeting the standards in Table 6.4 (or the applicable portion thereof) shall be considered acceptable unless otherwise specified herein or substantial doubt exists as to conformance.

6.4.6 Wood products shall be identified as complying with the appropriate standards in Table 6.4.

6.5 Structural Design Requirements.

6.5.1 General. Each manufactured home shall be designed and constructed as a completely integrated structure capable of sustaining the design load requirements of this standard, and shall be capable of transmitting these loads to stabilizing devices without exceeding the allowable stresses or deflections. Roof framing shall be securely fastened to wall framing, walls to floor structure, and floor structure to chassis to secure and maintain continuity between the floor and chassis, so as to resist wind overturning, uplift, and sliding as imposed by design loads in this part. In multistory construction, each story shall be securely fastened to the story above and/or below to provide continuity and resist design loads in this part. Uncompressed finished flooring greater than ⅛ in. (3 mm) in thickness shall not extend beneath load-bearing walls that are fastened to the floor structure.

6.5.2 Design Loads.

6.5.2.1 Design Dead Loads. Design dead loads shall be the actual dead load supported by the structural assembly under consideration.

6.5.2.2 Design Live Loads. The design live loads and wind and snow loads shall be as specified in Section 6.5 and shall be considered to be uniformly distributed. The roof live load or snow load shall not be considered as acting simultaneously with the wind load, and the roof live or snow load and floor live loads shall not be considered as resisting the overturning moment due to wind.

6.5.2.3 When engineering calculations are performed, allowable unit stresses shall be permitted to be increased as provided in the documents referenced in Table 6.4, except as otherwise indicated in 6.4.2 and 6.6.1.

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6.5.2.4 Whenever the roof slope does not exceed 20 degrees, the design horizontal wind loads required by 6.5.3.1 shall be permitted to be determined without including the vertical roof projection of the manufactured home. However, regardless of the roof slope of the manufactured home, the vertical roof projection shall be included when determining the wind loading for split level or clerestory-type roof systems.

6.5.3 Wind, Snow, and Roof Loads.

6.5.3.1 Wind Loads — Design Requirements. The manufactured home, each of its wind-resisting parts (including, but not limited to, shear walls, diaphragms, ridge beams, and their fastening and anchoring systems), and its components and cladding materials (including, but not limited to, roof trusses, wall studs, exterior sheathing, roofing and siding materials, exterior glazing, and their connections and fasteners) shall be designed by a professional engineer or architect to resist the following:

(1) The design wind pressures for Exposure C specified in SEI/ASCE 7-02, *Minimum Design Loads for Buildings and Other Structures*, a design wind speed of 90 mph (145 km/hr) for Wind Zone I; 110 mph (177 km/hr), as specified for Wind Zone II; 130 mph (210 km/hr), as specified for Wind Zone III; or 150 mph (242 km/hr), as specified for Wind Zone IV *[see Figure 6.5.3.1(a)]*.
(2) Not more than 60 percent of the dead load of the structure shall be permitted to be used to resist the wind pressures in Table 6.5.3.1.

6.5.3.2 Wind Loads — Zone Designations. The wind zone and specific wind design load requirements shall be determined by the fastest basic wind speed (mph or km/hr) within each zone and the intended location, based on Figure 6.5.3.1(a).

6.5.3.2.1 Wind Zone I — 90 mph (145 km/hr). Wind Zone I shall consist of those areas shown in Figure 6.5.3.1(a) that are not identified in 6.5.3.2.2, 6.5.3.2.3, or 6.5.3.2.5 as being within Wind Zone II, Wind Zone III, or Wind Zone IV, respectively.

6.5.3.2.2 Wind Zone II — 110 mph (177 km/hr). The following areas listed by state and county or city shall be deemed to be within Wind Zone II in accordance with Figure 6.5.3.1(a):

(1) Alabama — Autauga, Barbour, Bibb, Bullock, Butler, Chambers, Chilton, Choctaw, Clarke, Coffee, Conecuh, Coosa, Covington, Crenshaw, Dale, Dallas, Elmore, Escambia, Geneva, Greene, Hale, Henry, Houston, Lee, Lowndes, Macon, Marengo, Monroe, Montgomery, Perry, Pike, Russell, Sumter, Tallapoosa, Washington, Wilcox
(2) Connecticut — Fairfield, Hartford, Litchfield, New Haven, Tolland, Windham
(3) Delaware — Kent, Sussex
(4) Florida — Alachua, Baker, Bradford, Clay, Columbia, De Soto, Gadsden, Gilchrist, Glades, Hamilton, Hardee, Highlands, Jefferson, Lafayette, Lake, Leon, Madison, Marion, Orange, Osceola, Putnam, Polk, Seminole, Sumter, Suwannee, Union
(5) Georgia — Appling, Atkinson, Bacon, Baker, Baldwin, Ben Hill, Berrien, Bibb, Bleckley, Brantley, Brooks, Bulloch, Burke, Calhoun, Candler, Charlton, Chattahoochee, Clay, Clinch, Coffee, Colquitt, Columbia, Cook, Crawford, Crisp, Decatur, Dodge, Dooly, Dougherty, Early, Echols, Effingham, Emanuel, Evans, Glascock, Grady, Hancock, Harris, Houston, Irwin, Jeff Davis, Jefferson, Jenkins, Johnson, Jones, Lamar, Lanier, Laurens, Lee, Long, Lowndes, Macon, Marion, McDuffie, Meriwether, Miller, Mitchell, Monroe, Montgomery, Muscogee, Peach, Pierce, Pike, Pulaski, Quitman, Randolph, Richmond, Schley, Screven, Seminole, Stewart, Sumter, Talbot, Tattnall, Taylor, Telfair, Terrell, Thomas, Tift, Toombs, Treutlen, Troup, Turner, Twiggs, Upson, Ware, Warren, Washington, Wayne, Webster, Wheeler, Wilcox, Wilkinson, Worth
(6) Hawaii — the entire state
(7) Louisiana — Parishes of Acadia, Allen, Ascension, Avoyelles, Beauregard, Calcasieu, Catahoula, Concordia, East Baton Rouge, East Feliciana, Evangeline, Iberville, Jefferson Davis, Livingston, Pointe Coupee, Rapides, St. Helena, St. Landry, St. Martin, Tangipahoa, Vermilion, Vernon, Washington, West Baton Rouge, West Feliciana
(8) Maine — Androscoggin, Cumberland, Hancock, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, York
(9) Maryland — Caroline, Dorchester, Queen Annes, Talbot, Wicomico
(10) Massachusetts — Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Suffolk, Worcester
(11) Mississippi — Adams, Amite, Claiborne, Clarke, Copiah, Covington, Forrest, Franklin, Hinds, Jasper, Jefferson, Jefferson Davis, Jones, Kemper, Lamar, Lauderdale, Lawrence, Leake, Lincoln, Marion, Neshoba, Newton, Noxubee, Pike, Rankin, Scott, Simpson, Smith, Walthall, Wayne, Wilkinson, Winston
(12) New Hampshire — Cheshire, Hillsborough, Merrimack, Rockingham, Strafford
(13) New Jersey — Bergen, Burlington, Camden, Cumberland, Essex, Gloucester, Hudson, Mercer, Middlesex, Monmouth, Morris, Passaic, Salem, Somerset, Union
(14) New York — Bronx, Kings, New York, Putnam, Queens, Richmond, Rockland, Westchester
(15) North Carolina — Bertie, Bladen, Cumberland, Duplin, Edgecombe, Gates, Greene, Halifax, Harnett, Hertford, Hoke, Johnston, Lenoir, Martin, Nash, Northampton, Pitt, Robeson, Sampson, Scotland, Wayne, Wilson
(16) Pennsylvania — none
(17) Rhode Island — Providence
(18) South Carolina — Aiken, Allendale, Bamberg, Barnwell, Berkeley, Calhoun, Chesterfield, Clarendon, Colleton, Darlington, Dillon, Dorchester, Fairfield, Florence, Hampton, Jasper, Kershaw, Lancaster, Lee, Lexington, Marion, Marlboro, Orangeburg, Richland, Sumter, Williamsburg
(19) Texas — Angelina, Atascosa, Austin, Bastrop, Bee, Brooks, Burleson, Caldwell, Colorado, De Witt, Duval, Fayette, Fort Bend, Goliad, Gonzales, Grimes, Guadalupe, Hardin, Harris, Hidalgo, Jackson, Jasper, Jim Hogg, Jim Wells, Karnes, Lavaca, Lee, Liberty, Live Oak, McMullen, Montgomery, Newton, Orange, Polk, San Jacinto, Starr, Trinity, Tyler, Victoria, Walker, Waller, Washington, Webb, Wharton, Wilson, Zapata
(20) Virginia — The counties of Gloucester, Isle of Wight, James City, Lancaster, Mathews, Middlesex, Northumberland, Southampton, Surry, York; the cities of Chesapeake, Hampton, Newport News, Norfolk, Portsmouth, Suffolk, Virginia Beach, Williamsburg

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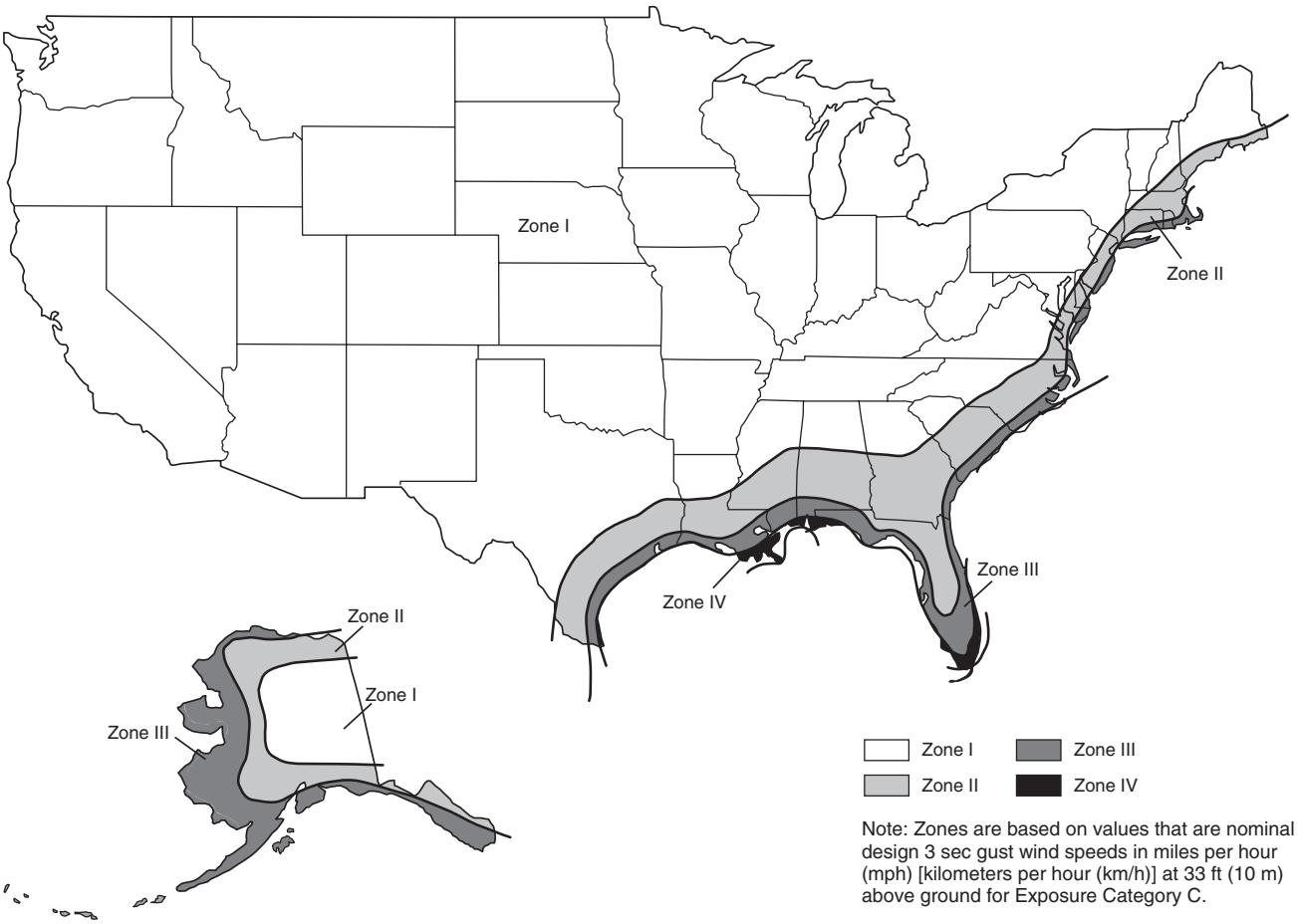


FIGURE 6.5.3.1(a) Basic Wind Zone Map. [Source: Based on Figure 11-18 in FEMA 55 (same as Figure 6-1 in SEI/ASCE 7); used with permission of ASCE.]

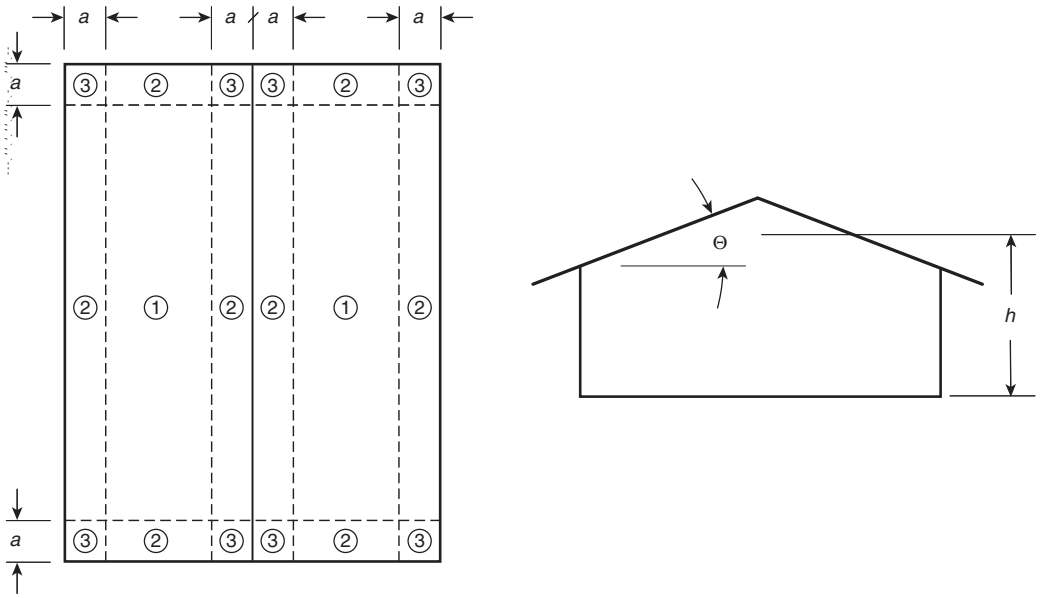


FIGURE 6.5.3.1(b) Roof Zones for Components and Cladding. (Reprinted with permission of ASCE. For hip roofs, see Figure 6-11C in SEI/ASCE 7.)

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6.5.3.2.3 Wind Zone III — 130 mph (210 km/hr). The following areas shall be considered to be within Wind Zone III in accordance with Figure 6.5.3.1(a):

(1) States and Territories. The following states and territories:
   (a) The coastal regions of Alaska (as determined by the 110 mph isotach on the SEI/ASCE 7-02 map)
   (b) American Samoa

(2) Local Governments. The following local governments are listed by state and county:
   (a) Alabama — Baldwin, Mobile
   (b) Connecticut — Middlesex, New London
   (c) Florida — Bay, Brevard, Calhoun, Charlotte, Citrus, Collier, DeSoto, Dixie, Duval, Escambia, Flagler, Franklin, Gulf, Hendry, Hernando, Hillsborough, Holmes, Indian River, Jackson, Lee, Levy, Liberty, Manatee, Nassau, Okaloosa, Okeechobee, Pasco, Pinellas, Santa Rosa, Sarasota, St. Johns, St. Lucie, Taylor, Volusia, Wakulla, Walton, Washington
   (d) Georgia — Bryan, Camden, Chatham, Glynn, Liberty, McIntosh
   (e) Louisiana — Parishes of Assumption, Iberia, Lafayette, Orleans, St. Charles, St. James, St. John the Baptist, St. Martin, St. Tammany
   (f) Maryland — Somerset, Worchester
   (g) Massachusetts — Barnstable, Bristol, Dukes, Nantucket, Plymouth
   (h) Mississippi — George, Greene, Hancock, Harrison, Pearl River, Perry, Stone
   (i) New Jersey — Atlantic, Cape May, Ocean
   (j) New York — Nassau, Suffolk
   (k) North Carolina — Beaufort, Camden, Chowan, Columbus, Craven, Currituck, Dare, Hyde, Jones, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrrell, Washington
   (l) Rhode Island — Bristol, Kent, Newport, Washington
   (m) South Carolina — Beaufort, Charleston, Georgetown, Horry
   (n) Texas — Brazoria, Calhoun, Chambers, Galveston, Jefferson, Kenedy, Kleberg, Matagorda, Nueces, Refugio, San Patricio, Willacy
   (o) Virginia — Accomack, Northampton

Table 6.5.3.1 Design Wind Pressures Anchorage for Lateral and Vertical Stability

	Main Wind Force Resisting System[a]						
			Horizontal Pressure (psf)		Vertical Pressure (psf)		
Basic Wind Speed	Load Direction	Roof Pitch	Wall	Roof	Windward	Leeward	Windward Overhang
Wind Zone I — 90 mph (145 km/hr)	Transverse	≤3:12	13.8	−4.2	−13.9	−9.6	−21.4
		5:12	15.2	0.0	−10.1	−10.1	−17.6
		≥7:12[b]	14.4	10.0	5.9	−9.3	−6.9
	Longitudinal	Singlewide	12.9	−6.5	−15.8	−9.4	−23.3
		Multiwide	11.6	−5.6	−14.3	−8.8	−21.8
Wind Zone II — 110 mph (177 km/hr)	Transverse	≤3:12	20.5	−6.3	−20.8	−14.4	−32.0
		5:12	22.7	0.0	−15.1	−15.1	−26.3
		≥7:12[b]	21.6	14.8	8.9	−14.0	−10.3
	Longitudinal	Singlewide	19.3	−9.6	−23.7	−14.1	−34.9
		Multiwide	17.4	−8.4	−21.6	−13.1	−32.7
Wind Zone III — 130 mph (210 km/hr)	Transverse	≤3:12	28.7	−8.8	−29.0	−20.2	−44.6
		5:12	31.8	0.0	−21.0	−21.1	−36.7
		≥7:12[b]	30.2	20.8	12.5	−19.6	−14.5
	Longitudinal	Singlewide	27.0	−13.4	−33.1	−19.7	−48.7
		Multiwide	24.2	−11.6	−30.1	−18.4	−45.7
Wind Zone IV — 150 mph (242 km/hr)	Transverse	≤3:12	38.2	−11.8	−38.6	−26.8	−59.4
		5:12	42.2	0.0	−28.1	−28.0	−48.9
		≥7:12	40.2	27.6	16.6	−26.0	−19.2
	Longitudinal	Singlewide	36.0	−17.9	−44.0	−26.2	−64.8
		Multiwide	32.3	−15.6	−40.0	−24.6	−60.8

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Table 6.5.3.1 *Continued*

	Components and Cladding							
	Wind Zone I — 90 mph (145 km/hr) (psf)		**Wind Zone II — 110 mph (177 km/hr) (psf)**		**Wind Zone III — 130 mph (210 km/hr) (psf)**		**Wind Zone IV — 150 mph (242 km/hr) (psf)**	
Walls[c]								
Walls interior zone	17.7	−19.1	26.4	−28.6	36.8	−39.9	49.0	−53.1
Walls within 3 ft of corners	17.7	−23.6	26.4	−35.2	36.8	−49.2	49.0	−65.6
Roofs — Slopes up to and including 6:12[d]								
Roof interior zone (z–1)	10.2	−16.1	15.1	−24.1	21.2	−33.6	28.2	−44.8
Within 3 ft of roof edge (z–2)	10.2	−28.2	15.1	−42.1	21.2	−56.8	28.2	−78.2
Within 3 ft of roof corners (z–3)	10.2	−41.6	15.1	−62.2	21.2	−86.9	28.2	−115.7
Roof overhang int. (z–2)	−32.9		−49.1		−68.6		−91.4	
Roof overhang corner (z–3)	−55.3		82.6		−115.3		−153.5	
Roofs — Slopes greater than 6:12[d]								
Roof interior zone (z–1)	16.1	−17.7	24.1	−26.4	33.6	−37.3	44.8	−49.0
Within 3 ft of roof edge (z–2)	16.1	−20.6	24.1	−30.9	33.6	−43.1	44.8	−57.2
Within 3 ft of roof corners (z–3)	16.1	−20.6	24.1	−30.9	33.6	−43.1	44.8	−57.2
Roof overhang interior (z–2)	−29.9		−44.6		−62.3		−83.0	
Roof overhang corner (z–3)	−29.9		−44.6		−62.3		−83.0	

For SI units, 1 psf = 0.04788 kN/m^2.

Notes:

(1) Plus sign (+) means pressures are acting toward or on the structure; minus sign (–) means pressures are acting away from the structure; plus-minus sign (±) means pressures can act in either direction, toward or away from the structure.

(2) See 6.6.1 for provisions for support and anchoring systems.

(3) Pressures shown are applied to the horizontal and vertical projections, for Exposure C, and a mean roof height of 15 ft (4.5 m). For a roof height of 25 ft (7.6 m), multiply the table values by 1.11.

(4) Design values in this table are applicable only to roof slopes between 10 degrees (nominal 2:12 slope) and 45 degrees (nominal 12:12 slope). For roof slopes between those shown, linear interpolation shall be permitted.

(5) The design uplift pressures are the same whether they are applied normal to the surface of the roof or to the horizontal projection of the roof.

(6) Shingle roof coverings that are secured with six fasteners per shingle through an underlayment that is cemented to a ⅜ in. (10 mm) structural rated roof sheathing need not be evaluated for the design wind pressures of Wind Zone II, III, or IV.

(7) Structural rated roof sheathing that is at least ⅜ in. (10 mm) in thickness, installed with the long dimension perpendicular to roof framing supports, and secured with fasteners at 4 in. (102 mm) on center within 3.0 ft (0.9 m) of each gable end or endwall if no overhanging is provided, and 6 in. (152 mm) on center in all other areas, need not be evaluated for the design wind pressures of Wind Zone II, III, or IV.

(8) Exterior coverings that are secured at 6 in. (152 mm) on center to a ⅜ in. (10 mm) structural rated sheathing that is fastened to wall framing members at 6 in. (152 mm) on center need not be evaluated for the design wind pressures of Wind Zone II, III, or IV.

(9) One-piece metal roofings, tested without structural sheathing, using the design wind pressures specified in the table for components and cladding (exterior roof coverings), are allowed to be used without structural sheathing.

(10) The edge distance shall be equal to 2a, where for widths of 30 ft (9 m) or less, a = 3 ft (0.9 m), and for widths greater than 30 ft (9 m), a = 10 percent of the least horizontal dimension, or 0.4 times the mean roof height, whichever is smaller, but not less than either 4 percent of the least horizontal dimension or 3 ft (0.9 m).

(11) Components and cladding include roof trusses, exterior roof coverings, sheathing and fastening; wall studs; exterior windows and sliding glass doors (glazing and framing); and exterior coverings, sheathings and fastening.

[a]Main wind force resisting system includes shearwalls, diaphragms, their fastening and anchorage systems, ridge beams, and other main roof support beams (beams supporting expanding room sections, etc.).

[b]The total horizontal load shall not be less than that determined by assuming the horizontal roof projections are equal to zero.

[c]For sliding glass doors with opening widths of 72 in. (1.82 m) or greater, the pressures in the table may be multiplied by 0.92.

[d]See Figure 6.5.3.1(b) for explanation of roof zones.

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6.5.3.2.4 Wind Zone IV – 150 mph (242 km/hr). The following areas shall be considered to be within Wind Zone IV in accordance with Figure 6.5.3.1(a):

(1) The following territories: all of the U.S. Territories of Guam, Northern Mariana Islands, Puerto Rico, Trust Territory of the Pacific Islands, and the United States Virgin Islands
(2) The following local governments are listed by state and county:
   (a) Florida — Broward, Martin, Miami-Dade, Monroe, Palm Beach
   (b) Louisiana — Parishes of Cameron, Lafourche, Plaquemines, St. Bernard, St. Mary, Terrebonne, Vermilion
   (c) Mississippi — Jackson
   (d) North Carolina — Brunswick, Carteret
   (e) Texas — Cameron

6.5.3.2.5 Local Requirements. For areas where recognized wind mapping data indicate wind speeds in excess of those identified in this standard, the federal regulatory agency shall consider processing through rule making for the purpose of adopting more stringent requirements of the state and local area.

6.5.3.3 Snow and Roof Loads.

6.5.3.3.1 Flat, curved, and pitched roofs shall be designed to resist the live loads shown in Table 6.5.3.3.1 and Figure 6.5.3.3.1, based on the roof load zone areas established in 6.5.3.3.1.1 through 6.5.3.3.1.3, applied downward on the horizontal projection as appropriate for the design zone marked on the manufactured home.

6.5.3.3.1.1* Middle Roof Load Zone. The counties in each state shown in Table 6.5.3.3.1.1 shall be deemed to be within the Middle Roof Load Zone.

Table 6.5.3.3.1 Roof Load Zones

Zone	Pressure	
	psf	kPa
North zone	40	1.9
Middle zone	30	1.4
South zone	20	1.0

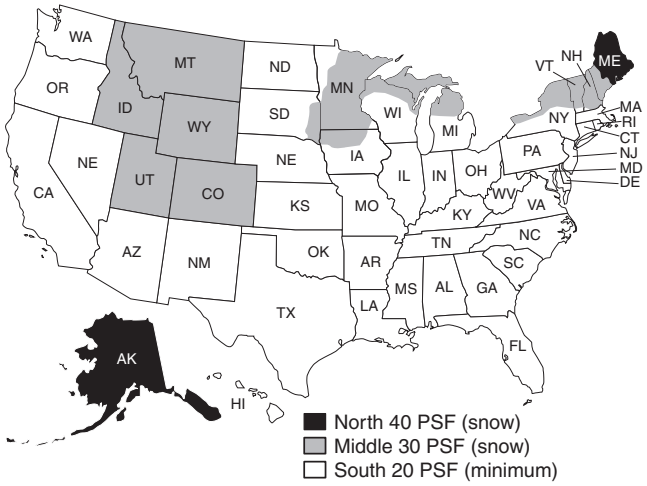


FIGURE 6.5.3.3.1 Roof Load Zone Map.

Table 6.5.3.3.1.1 Middle Roof Load Zones

State	Counties				
Colorado	All counties				
Idaho	All counties				
Iowa	Hancock	Mitchell	Hamilton	Buena Vista	Hardin
	Lyon	Howard	Webster	Cherokee	Worth
	Osceola	Chickasaw	Calhoun	Plymouth	Palo Alto
	Dickinson	Butler	Sac	Sioux	Crawford
	Emmet	Floyd	Ida	O'Brien	Wright
	Kossuth	Cerro Gordo	Humboldt	Clay	Pocahontas
	Winnebago	Franklin			
Maine	Franklin	Kennebec	Lincoln	Cumberland	York
	Oxford	Androscoggin	Sagadahoc		
Massachusetts	Essex				
Michigan	Houghton	Iron	Presque Isle	Wexford	Gogebic
	Baraga	Dickinson	Charlevoix	Benzie	Leelanau
	Marquette	Menominee	Montmorency	Grand Traverse	Antrim
	Alger	Delta	Alpena	Kalkaska	Missaukee
	Luce	Schoolcraft	Alcona	Oscoda	Emmet
	Chippewa	Mackinac	Ogemaw	Otsego	Ontonagon
	Keweenaw	Cheboygan	Roscommon		

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Table 6.5.3.3.1 *Continued*

State	Counties				
Minnesota	Koochiching	Stearns	Renville	Sibley	Scott
	Itasca	Swift	McLeod	Nicollet	Ramsey
	Hubbard	Kandiyohi	Carver	Blue Earth	Pope
	Cass	Meeker	Dakota	Martin	Le Sueur
	Crow Wing	Wright	Goodhue	Watonwan	Hennepin
	Aitkin	Lac qui Parle	Wabasha	Brown	Stevens
	St. Louis	Chippewa	Winona	Redwood	Grant
	Lake	Yellow Medicine	Fillmore	Lyon	Washington
	Cook	Mille Lacs	Mower	Lincoln	Waseca
	Carlton	Kanabec	Olmsted	Pipestone	St. Croix
	Pine	Benton	Dodge	Murray	Douglas
	Wadena	Isanti	Rice	Cottonwood	Chisago
	Todd	Sherburne	Steele	Jackson	Faribault
	Morrison	Anoka	Freeborn	Nobles	Rock
Montana	All counties				
New Hampshire	Coos	Belknap	Sullivan	Hillsborough	Carroll
	Grafton	Strafford	Rockingham	Cheshire	Merrimack
New York	St. Lawrence	Herkimer	Onondaga	Genesee	Washington
	Franklin	Lewis	Madison	Orleans	Schenectady
	Clinton	Oswego	Cayuga	Niagara	Livingston
	Essex	Jefferson	Seneca	Erie	Saratoga
	Hamilton	Oneida	Wayne	Wyoming	Montgomery
	Warren	Fulton	Ontario	Monroe	Yates
South Dakota	Grant	Brookings	Hanson	Lincoln	Kingsbury
	Codington	Miner	Minnehaha	Yankton	McCook
	Deuel	Lake	Hutchinson	Union	Clay
	Hamlin	Moody	Turner		
Utah	All counties				
Vermont	Franklin	Orleans	Caledonia	Addison	Lamoille
	Grand Isle	Essex	Washington	Rutland	Chittenden
	Orange	Windsor			
Wisconsin	Douglas	Oconto	Pepin	Lincoln	Marinette
	Bayfield	Menominee	Pierce	Oneida	Buffalo
	Ashland	Langlade	Dunn	Polk	Taylor
	Iron	Marathon	Eau Claire	Burnett	Door
	Vilas	Clark	Chippewa	Washburn	Price
	Forest	Jackson	Rusk	Sawyer	Barron
	Florence	Trempealeau			
Wyoming	All counties				

6.5.3.3.1.2* North Roof Load Zone. The following counties in each listed state shall be deemed to be within the North Roof Load Zone.

(1) Maine — Aroostook, Piscataquis, Somerset, Penobscot, Waldo, Knox, Hancock, Washington

(2) Alaska — All counties (i.e., boroughs)

6.5.3.3.1.3 South Roof Load Zone. The states and counties that are not listed for the Middle Roof Load Zone, 6.5.3.3.1.1, or the North Roof Load Zone, 6.5.3.3.1.2, shall be deemed to be within the South Roof Load Zone.

6.5.3.3.2 Eaves and cornices shall be designed for a net uplift pressure of 2.5 times the design uplift wind pressures cited in 6.5.3.1.

6.5.3.4 Consideration of Local Requirements. For exposures in areas (mountainous or other) where recognized snow records or wind records indicate significant differences from the loads stated in 6.5.3.3, the federal regulatory agency shall consider establishing more stringent requirements for homes known to be destined for such areas by proceeding through rule making for the purpose of adopting more stringent requirements for the local conditions.

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For snow loads, such requirements shall be based on a snow load of 0.6 of the ground snow load for areas exposed to wind and a roof snow load of 0.8 of the ground snow load for sheltered areas.

6.5.3.5 Data Plate Requirements. The data plate posted in the manufactured home *(see Section 1.5)* shall designate the wind and roof load zones or, if designed for higher loads, the actual design external snow and wind loads for which the home has been designed. The data plate shall include reproductions of Figure 6.5.3.1(a) and Figure 6.5.3.3.1 with any related information. The load zone maps shall be not less than 3½ in. × 2¼ in. (89 mm × 57 mm).

6.5.4 Design Load Deflection.

6.5.4.1 When a structural assembly is subjected to total design loads, but not including dead load, the deflection for structural framing members shall not exceed the following (where L equals the clear span between supports or two times the length of a cantilever):

(1) Floor — $L/240$
(2) Roof and ceiling — $L/180$
(3) Headers, beams, and girders (vertical load) — $L/180$
(4) Walls and partitions — $L/180$

6.5.4.2 The allowable eave or cornice deflection for uplift shall be measured at the design uplift pressure cited in 6.5.3.1. The allowable deflection shall be $(2 \times L_c)/180$, where L_c is the measured horizontal eave projection from the wall.

6.5.5 Fastening of Structural Systems.

6.5.5.1 Roof framing shall be securely fastened to wall framing, walls to floor structure, and floor structure to chassis to secure and maintain continuity between the floor and chassis, so as to resist wind overturning, uplift, and sliding as specified in this section. In multistory construction, each story shall be securely fastened to the story above and/or below to provide continuity and resist design loads in this section. The number and type of fasteners used shall be capable of transferring all forces between elements being joined.

6.5.5.2 For Wind Zones II, III, and IV, roof framing members shall be securely fastened at the vertical bearing points to resist design overturning, uplift, and sliding forces. When engineered connectors are not installed, roof framing members shall be secured at the vertical bearing points to wall framing members (studs), and wall framing members (studs) shall be secured to floor framing members with 0.016 in. (0.4 mm) base metal minimum steel strapping or engineered connectors, or by a combination of 0.016 in. (0.4 mm) base metal minimum steel strapping or engineered connectors and structural-rated wall sheathing that overlaps the roof and floor system. Steel strapping or engineered connectors shall be installed at a maximum spacing of 24 in. (610 mm) on center in Wind Zones III and IV.

Exception: Where substantiated by structural analysis, the 0.016 in. (0.4 mm) base metal minimum steel strapping or engineered connectors shall be permitted to be omitted when the structural rated sheathing that overlaps either the roof or floor system is capable of sustaining the applied loads.

6.5.6 Walls. The walls shall be of sufficient strength to withstand the load requirements as defined in 6.5.3 for this part, without exceeding the deflections as specified in 6.5.4. The connections between the bearing walls, floor, and roof framework members shall be fabricated in such a manner as to provide support for the material used to enclose the manufactured home and to provide for transfer of all lateral and vertical loads to the floor and chassis.

6.5.6.1 Studs shall not be notched or drilled in the middle one-third of their length.

Exception: Where substantiated by engineering analysis or tests.

6.5.6.2 Interior walls and partitions shall be constructed with structural capacity adequate for the intended purpose and shall be capable of resisting a horizontal load of not less than 5 lb/ft^2 (24 kg/m^2). An allowable stress increase of 1.33 times the permitted published design values shall be permitted to be used in the design of wood-framed interior partitions. Finish of walls and partitions shall be securely fastened to wall framing.

6.5.7 Floors.

6.5.7.1 Floor assemblies, including stairways, landings, decks, and porches provided by the manufacturer, shall be designed in accordance with accepted engineering practice standards to support a minimum uniform live load of 40 lb/ft^2 (1.92 kN/m^2) plus the dead load of the materials. Exterior balconies shall be designed to support a minimum uniform live load of 60 lb/ft^2 (2.88 kN/m^2), plus the dead load of the materials. In addition (but not simultaneously), floors shall be able to support a 200 lb (90.7 kg) concentrated load on a 1 in. (25 mm) diameter disc at the most critical location, with a maximum deflection not to exceed ⅛ in. (3 mm) relative to floor framing. Perimeter wood joists of more than 6 in. (152 mm) depth shall be stabilized against overturning from superimposed loads in accordance with the following:

(1) At ends, by solid blocking not less than 2 in. (50 mm) in thickness by full depth of joist or by connecting to a continuous header not less than 2 in. (50 mm) in thickness and not less than the depth of the joist with connecting devices
(2) At 8 ft (2.4 m) maximum intermediate spacing, by solid blocking or by wood cross-bridging of not less than 1 in. × 3 in. (25 mm × 76 mm), metal cross-bridging of equal strength, or other approved methods

6.5.7.2 Wood, wood fiber, or wood-structural panel floors or subfloors in kitchens, bathrooms (including toilet compartments), laundry rooms, water heater compartments, and any other areas subject to excessive moisture shall be moisture resistant or shall be made moisture resistant by sealing or by an overlay of nonabsorbent material applied with water-resistant adhesive.

6.5.7.2.1 Application of any of the following methods shall be considered to be in accordance with this requirement:

(1) Sealing the floor with a water-resistant sealer.
(2) Installing an overlay of a nonabsorbent floor-covering material applied with water-resistant adhesive.
(3) Direct application of a water-resistant sealer to the exposed wood floor area when covered with a nonabsorbent overlay.
(4) The use of a nonabsorbent floor covering, which shall be permitted to be installed without a continuous application of a water-resistant adhesive or sealant when the floor covering meets the following criteria:
    (a) The covering is a continuous membrane with any seams or patches seam-bonded or welded to preserve the continuity of the floor covering.

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(b) The floor is protected at all penetrations in these areas by sealing with a compatible water-resistant adhesive or sealant to prevent moisture from migrating under the nonabsorbent floor covering.
(c) The covering is fastened around the perimeter of the subfloor in accordance with the floor-covering manufacturer's instructions.
(d) The covering is designed to be installed to prevent moisture penetration without the use of a water-resistant adhesive or sealer, except as required in 6.5.7.
    i. The vertical edges of penetrations for plumbing shall be covered with a moisture-resistant adhesive or sealant.
    ii. The vertical penetrations located under the bottom plates of perimeter walls of rooms, areas, or compartments shall not be required to be sealed; these vertical penetrations shall not include walls or partitions within the rooms or areas.

6.5.7.3 Wood panel products used as floor or subfloor materials on the exterior of the home, such as in recessed entry ways, shall be rated for exterior exposure and shall be protected from moisture by sealing or applying nonabsorbent overlay with water-resistant adhesive.

6.5.7.4 Carpet or carpet pads shall not be installed under concealed spaces subject to excessive moisture, such as plumbing fixture spaces or floor areas under installed laundry equipment. Carpet shall be permitted to be installed in laundry spaces, provided the following apply:

(1) The appliances are not provided.
(2) The conditions of 6.5.7.2 are followed.
(3) Instructions are provided to remove carpet when appliances are installed.

6.5.7.5 Except where substantiated by engineering analysis or tests, the following requirements shall apply:

(1) Notches on the ends of joists shall not exceed one-fourth the joist depth.
(2) Holes bored in joists shall not be within 2 in. (51 mm) of the top or bottom of the joist, and the diameter of any such hole shall not exceed one-third the depth of the joist.
(3) Notches in the top or bottom of the joists shall not exceed one-sixth the depth and shall not be located in the middle third of the span.

6.5.7.6 Bottom board material (with or without patches) shall meet or exceed the level of 48 in./lb (1219 mm/0.45 kg) of puncture resistance as tested by the Beach Puncture Test in accordance with ASTM D 781, *Standard Test Methods for Puncture and Stiffness of Paperboard, and Corrugated and Solid Fiberboard.*

6.5.7.6.1 The material shall be suitable for patches, and the patch life shall be equivalent to the material life. Patch installation instructions shall be included in the manufactured home manufacturer's instructions.

6.5.7.6.2 The bottom board material shall be tight fitted against all penetrations.

6.5.8 Roofs.

6.5.8.1 Roofs shall be of sufficient strength to withstand the load requirements as defined in 6.5.2 and 6.5.3, without exceeding the deflections specified in 6.5.4. The connections between roof framework members and bearing walls shall be fabricated to provide for the transfer of design vertical and horizontal loads to the bearing walls and resistance to uplift forces.

6.5.8.2 Roofing membranes shall be of sufficient rigidity to prevent deflection that could lead to ponding of water or separation of seams due to wind, snow, ice, erection, or transportation forces.

6.5.8.3 Cutting of roof framework members for passage of electrical, plumbing, or mechanical systems shall not be permitted except where substantiated by engineering analysis.

6.5.8.4 All roof penetrations for electrical, plumbing, or mechanical systems shall be properly flashed and sealed. In addition, where a metal roof membrane is penetrated, a wood backer shall be installed. The backer plate shall be not less than 5⁄16 in. (8 mm) plywood, with exterior glues, secured to the roof framing system beneath the metal roof, and shall be of a size to ensure that all screws securing the flashing are held by the backer plate.

6.5.8.5 The entire roof assembly, or portions thereof, including, but not limited to, dormers, gables, crickets, hinged roof sections, connections between sections, sheathing, roof coverings, underlayments, flashings, and eaves and overhangs shall be permitted to be assembled and installed on site provided that the requirements in 6.5.8.5.1 through 6.5.8.5.5 are met.

6.5.8.5.1 Approved installation instructions shall be provided that include requirements for the following items:

(1) Materials, installation, and structural connections complying with Section 6.5
(2) Installation and fastening of sheathing and roof coverings
(3) Installation of appliance vent systems per Section 10.9
(4) Installation of plumbing vents as required by Section 10.9
(5) Installation of attic ventilation per 8.4.4

6.5.8.5.2 The installation instructions specified in 6.5.8.5.1 shall include drawings, details, and instructions as necessary to ensure that the on-site work complies with the approved design.

6.5.8.5.3 The installation instructions specified in 6.5.8.5.1 shall provide for on-site inspection of the work in stages that shall assure inspection before any work is concealed.

6.5.8.5.4 Listed trusses shall be provided as required by the approved design and installation instructions.

6.5.8.5.5 Temporary weather protection shall be provided per 6.7.5.

6.5.9 Frame Construction. The frame shall be capable of transmitting all design loads to stabilizing devices without exceeding the allowable load and deflections of this section. The frame also shall be capable of withstanding the effects of transportation shock and vibration without degradation, as required by Chapter 12.

6.5.9.1 Welded Connections.

6.5.9.1.1 All welds shall be made in accordance with the applicable provisions of AISC-S335, *Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design;* AISI-SG 971, *Specification for the Design of Cold-Formed Steel Structural Members*; and ASCE 8, *Design of Cold-Formed Stainless Steel Structural Members.*

6.5.9.1.2 Regardless of the provisions of any reference standard contained in this chapter, deposits of weld slag or flux shall be required to be removed only from welded joints at the following locations:

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(1) Drawbar and coupling mechanisms
(2) Main member splices
(3) Spring hanger to main member connections

6.5.9.2 Protection of Metal Frames Against Corrosion. Metal frames shall be made corrosion resistant or be protected against corrosion. Metal frames shall be permitted to be protected against corrosion by painting.

6.6 Windstorm Protection.

6.6.1 Provisions for Support and Anchoring Systems. Each manufactured home shall have provisions for support and anchoring or foundation systems that, when properly designed and installed, will resist overturning and lateral movement (sliding) of the manufactured home, as imposed by the respective design loads. The resistance shall be determined by the simultaneous application of the horizontal drag and uplift wind loads, in accordance with 6.5.3.1. The basic allowable stresses of materials required to resist overturning and lateral movement shall not be increased in the design and proportioning of these members. No additional shape or location factors shall be needed to be applied in the design of the tie-down system. No more than 60 percent of the dead load of the structure shall be permitted to be used to resist these wind loading effects in all wind zones.

6.6.1.1 The provisions of Section 6.6 shall be followed, and the support and anchoring systems shall be designed by a registered professional engineer or architect.

6.6.1.2 The manufacturer of each manufactured home shall be required to make provisions for the support and anchoring systems, but shall not be required to provide the anchoring equipment or stabilizing devices. When the manufacturer's installation instructions provide for the main frame structure to be used as the points for connection of diagonal ties, no specific connecting devices shall need to be provided on the main frame structure.

6.6.2 Contents of Instructions.

6.6.2.1 The manufacturer shall provide printed instructions with each manufactured home that specify the location and required capacity of stabilizing devices on which the design is based. In addition to the printed instructions, each column support pier location required along the marriage line(s) of multisection manufactured homes shall be identified by paint, label, decal, stencil, or other acceptable method at each pier location. Such location identifications shall be visible after the home is installed. The manufacturer shall provide drawings and specifications, certified by a registered professional engineer or architect, that indicate at least one acceptable system of anchoring, including the details or required straps or cables, their end connections, and all other devices needed to transfer the wind loads from the manufactured home to an anchoring or foundation system.

6.6.2.2 For anchoring systems, the instructions shall indicate the following:

(1) Minimum anchor capacity shall be required.
(2) Anchors shall be certified by a professional engineer, architect, or a nationally recognized testing laboratory as to their resistance, based on the maximum angle of diagonal tie and/or vertical tie loading *(see 6.6.3)* and angle of anchor installation, and type of soil in which the anchor is to be installed.
(3) Ground anchors shall be embedded below the frost line and be at least 12 in. (305 mm) above the water table.
(4) Ground anchors shall be installed to their full depth, and stabilizer plates shall be installed to provide added resistance to overturning or sliding forces.
(5) Anchoring equipment shall be certified by a registered professional engineer or architect to resist these specified forces in accordance with testing procedures in ASTM D 3953, *Standard Specification for Strapping, Flat Steel, and Seals.*

6.6.3 Design Criteria. The provisions made for anchoring systems shall be based on the following design criteria for manufactured homes:

(1) The minimum number of ties provided per side of each home shall resist design wind loads required in 6.5.3.1.
(2) Ties shall be as evenly spaced as practicable along the length of the manufactured home, with not more than 2 ft (610 mm) open-end spacing on each end.
(3) Vertical ties or straps shall be positioned at studs. Where a vertical tie and a diagonal tie are located at the same place, both ties shall be permitted to be connected to a single anchor, provided that the anchor used is capable of carrying both loadings simultaneously.
(4) Add-on sections of expandable manufactured homes shall have provisions for vertical ties at the exposed ends.

6.6.4 Requirements for Ties. Manufactured homes in Wind Zone I shall require only diagonal ties. These ties shall be placed along the main frame and below the outer side walls. All manufactured homes designed to be located in Wind Zones II, III, and IV shall have both vertical and diagonal ties below the outer side walls.

6.6.5 Protection Requirements. Protection shall be provided at sharp corners where the anchoring system requires the use of external straps or cables. Protection also shall be provided to minimize damage to siding by the cable or strap.

6.6.6 Anchoring Equipment — Load Resistance. Anchoring equipment shall be capable of resisting an allowable working load equal to or exceeding 3150 lb (1430 kg) and withstanding a 50 percent overload for a total of 4725 lb (2140 kg) without failure of either the anchoring equipment or the attachment point on the manufactured home.

6.6.7 Anchoring Equipment — Weatherization. Anchoring equipment exposed to weathering shall have a resistance to weather deterioration at least equivalent to that provided by a coating of zinc on steel of not less than 0.30 oz/ft^2 (9 g/m^2) of surface coated, and in accordance with the following:

(1) Slit or cut edges of zinc-coated steel strapping shall not need to be zinc-coated.
(2) Type 1, Finish B, Grade 1 steel strapping, 1¼ in. (32 mm) wide and 0.04 in. (1 mm) in thickness, certified by a registered professional engineer or architect as conforming with ASTM D 3953, *Standard Specification for Strapping, Flat Steel, and Seals.*

6.7 Resistance to Elements and Use.

6.7.1 Exterior coverings shall be of moisture- and weather-resistant materials attached with corrosion-resistant fasteners to resist wind, snow, and rain. Metal coverings and exposed metal structural members shall be of corrosion-resistant materials or shall be protected to resist corrosion. All joints between portions of the exterior covering shall be designed and

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assembled to protect against the infiltration of air and water, except for any designed ventilation of wall or roof cavity.

6.7.2 Joints between dissimilar materials and joints between exterior coverings and frames of openings shall be protected with a compatible sealant suitable to resist infiltration of air or water.

6.7.3 Where adjoining materials or assemblies of materials are of such nature that separation can occur due to expansion, contraction, wind loads, or other loads induced by erection or transportation, sealants shall be of a type that maintains protection against infiltration or penetration by air, moisture, or vermin.

6.7.4 Exterior surfaces shall be sealed to resist the entrance of rodents.

6.7.5 Multi-section and single-family attached dwelling units shall not be required to comply with the factory installation of weather-resistant exterior finishes for those areas left open for field connection of the sections provided the following conditions are satisfied:

(1) Temporary weather protection for exposed, unprotected construction is provided in accordance with methods to be included in the approved design.
(2) Methods for on-site completion and finishing of these elements are included in the approved design.
(3) Complete installation instructions for finishing these elements are provided.

6.8 Formaldehyde Emission Controls for Certain Wood Products.

6.8.1 Formaldehyde Emission Levels. All plywood and particleboard materials bonded with a resin system or coated with a surface finish containing formaldehyde shall not exceed the following formaldehyde emission levels when installed in manufactured homes:

(1) Plywood materials shall not emit formaldehyde in excess of 0.2 parts per million (ppm), as measured by the air chamber test method specified in Section 7.6.
(2) Particleboard used as flooring materials (manufactured home decking — MHD) shall not emit formaldehyde in excess of 0.20 parts per million (ppm) as specified in ANSI A 208.1, *Mat-formed Wood Particleboard*, Table B, and as measured by the air chamber test specified in Section 7.6.
(3) Particleboard materials used in applications other than flooring shall not emit formaldehyde in excess of 0.30 ppm as specified in ANSI A 208.1, *Mat-formed Wood Particleboard*, Table A, and as measured by the air chamber test specified in Section 7.6.
(4) Medium density fiberboard (MDF) shall not emit formaldehyde in excess of 0.3 ppm, as specified in ANSI A 208.2, *Medium Density Fiberboard for Interior Use (MDF)*, measured by the air chamber test specified in Section 7.6.

6.8.2 Product Certification and Continuing Qualification. All plywood and particleboard materials bonded with a resin system or coated with a surface finish containing formaldehyde, other than an exclusively phenol-formaldehyde resin system or finish, that are installed in manufactured homes shall be certified by a nationally recognized testing laboratory as complying with 6.8.1.

6.8.2.1 Separate certification shall be done for each plant where the particleboard is produced or where the plywood or particleboard is surface-finished.

6.8.2.2 To certify plywood or particleboard, the testing laboratory shall witness or conduct the air chamber test specified in Section 7.6 on randomly selected panels initially and at least quarterly thereafter.

6.8.2.3 The testing laboratory shall approve a written quality control plan for each plant where the particleboard is produced or finished or where the plywood is finished. The quality control plan shall be designed to ensure that all panels comply with 6.8.1. The plan shall establish ongoing procedures to identify increases in the formaldehyde emission characteristics of the finished product resulting from the following changes in production:

(1) In the case of plywood
  (a) The facility where the unfinished panels are produced is changed.
  (b) The thickness of the panels is changed so that the panels are thinner.
  (c) The grooving pattern on the panels is changed so that the grooves are deeper or closer together.
(2) In the case of particleboard
  (a) The resin formulation is changed so that the formaldehyde-to-urea ratio is increased.
  (b) The amount of formaldehyde resin used is increased.
  (c) The press time is decreased.
(3) In the case of plywood or particleboard
  (a) The finishing or top coat is changed, and the new finishing or top coat has a greater formaldehyde content.
  (b) The amount of finishing or top coat used on the panels is increased, provided that such finishing or top coat contains formaldehyde.

6.8.2.4 The testing laboratory shall periodically visit the plant to monitor quality control procedures to ensure that all certified panels meet the standard.

6.8.2.5 To maintain its certification, plywood or particleboard shall be tested by the air chamber test specified in Section 7.6 whenever one of the following events occurs:

(1) In the case of particleboard, the resin formulation is changed so that the formaldehyde-to-urea ratio is increased.
(2) In the case of particleboard or plywood, the finishing or top coat is changed, and the new finishing or top coat contains formaldehyde.
(3) In the case of particleboard or plywood, the testing laboratory determines that an air chamber test is necessary to ensure that panels comply with 6.8.1.

6.8.2.6 In the event that an air chamber test measures levels of formaldehyde from plywood or particleboard in excess of those permitted under 6.8.1, the tested product's certification shall immediately lapse as of the date of production of the tested panels. No panel produced on the same date as the tested panels, or on any day thereafter, shall be used or certified for use in manufactured homes, unless in accordance with 6.8.2.6.1 and 6.8.2.6.2.

6.8.2.6.1 A new product certification shall be permitted to be obtained by testing randomly selected panels that were produced on any day following the date of production of the tested panels. If such panels pass the air chamber test specified in Section 7.6, the plywood or particleboard produced on that day and subsequent days shall be permitted to be used and certified for use in manufactured homes.

6.8.2.6.2 Plywood or particleboard produced on the same day as the tested panels, and panels produced on subsequent

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days, if not certified pursuant to 6.8.2, shall be permitted to be used in manufactured homes only under the following circumstances:

(1) Each panel is treated with a scavenger, sealant, or other means of reducing formaldehyde emissions that does not adversely affect the structural quality of the product.
(2) Panels randomly selected from the treated panels are tested by and pass the air chamber test specified in Section 7.6.

6.8.3 Panel Identification. Each plywood and particleboard panel bonded or coated with a resin system containing formaldehyde, other than an exclusively phenol-formaldehyde resin system, that is installed in manufactured homes shall be stamped or labeled so as to identify the product manufacturer, date of production and/or lot number, and the testing laboratory certifying compliance with this section.

6.8.4 Treatment after Certification. If certified plywood or particleboard subsequently is treated with paint, varnish, or any other substance containing formaldehyde, the certification shall no longer be valid. In such a case, each stamp or label placed on the panels pursuant to 6.8.3 shall be obliterated. The treated panels shall be permitted to be recertified and reidentified in accordance with 6.8.2 and 6.8.3.

Chapter 7 Testing

7.1 Structural Load Tests. Every structural assembly tested shall be capable of meeting the proof load test or the ultimate load test.

7.1.1* Proof Load Tests. Every structural assembly tested shall be capable of sustaining its dead load plus superimposed live loads equal to 1.75 times the required live loads for a period of 12 hours without failure. Tests shall be conducted with loads applied and deflections recorded in ¼ design live load increments at 10-minute intervals until 1.25 times design live load plus dead load has been reached. Additional load shall then be applied continuously until 1.75 times design live load plus dead load has been reached. Assembly failure shall be considered as design live load deflection (or residual deflection measured 12 hours after live load removal) that is greater than the limits set in 6.5.4, rupture, fracture, or excessive yielding. Design live load deflection criteria shall not apply when the structural assembly being evaluated does not include structural framing members. An assembly to be tested shall be of the minimum quality of materials and workmanship of the production. Each test assembly, component, or subassembly shall be identified as to type and quality or grade of material. All assemblies, components, or subassemblies qualifying under this test shall be subject to a continuing qualification testing program acceptable to the regulatory agency.

7.1.2* Ultimate Load Tests. Ultimate load tests shall be performed on a minimum of three assemblies or components to generally evaluate the structural design. Every structural assembly or component tested shall be capable of sustaining its total dead load plus the design live load increased by a factor of safety of at least 2.5. A factor of safety greater than 2.5 shall be used when required by an applicable reference standard in Section 6.4. Tests shall be conducted with loads applied and deflections recorded in ¼ design live load increments at 10-minute intervals until 1.25 times design live load plus dead load has been reached. Additional loading shall then be applied continuously until failure occurs, or the total of the factor of safety times the design live load plus the dead load is reached. Assembly failure shall be considered as design live load deflection greater than the limits set in 6.5.4, rupture, fracture, or excessive yielding. Design live load deflection criteria shall not apply when the structural assembly being evaluated does not include structural framing members. Assemblies to be tested shall be representative of average quality or materials and workmanship of the production. Each test assembly, component, or subassembly shall be identified as to type and quality or grade of material. All assemblies, components, or subassemblies qualifying under this test shall be subject to a periodic qualification testing program acceptable to the regulatory agency.

7.2 Test Procedure for Roof Trusses.

7.2.1 Roof Load Tests. The roof truss test procedure for vertical loading conditions shall be those described in 7.2.2 through 7.2.6. Where roof trusses act as support for other members, have eave or cornice projections, or support concentrated loads, roof trusses shall be tested for those conditions.

7.2.2 General. Trusses shall be permitted to be tested in a truss test fixture that replicates the design loads and actual support points and does not restrain horizontal movement. When tested singly or in groups of two or more trusses, trusses shall be mounted on supports and positioned as intended to be installed in the manufactured home to give the required clear span distance (L) and eave or cornice distance (L_0), if applicable, as specified in the design. Truss tests shall be performed on a minimum of three trusses to evaluate the design.

7.2.2.1 When trusses are tested singly, trusses shall be positioned in a test fixture with supports properly located and have the roof loads evenly applied, as shown in Figure 7.2.2.1.

7.2.2.2 When tested in groups of two or more, the top chords shall be permitted to be sheathed with nominal ¼ in. × 12 in. (6 mm × 305 mm) plywood strips. The plywood strips shall be at least long enough to cover the top chords of the trusses at the designated design truss spacing. Adjacent plywood strips shall be separated by at least ⅛ in. (3 mm). The plywood strips shall be nailed with 4d nails or equivalent staples no closer than 8 in. (203 mm) on center along the top chord. The bottom chords of the adjacent trusses shall be permitted to be one of the following:

(1) Unbraced
(2) Laterally braced together (not cross-braced) with 1 in. × 2 in. (25 mm × 51 mm) stripping no closer than 24 in. (610 mm) on center, nailed with only one 6d nail at each truss, as shown in Figure 7.2.2.2

7.2.3 Measuring and Loading Methods. Deflections of each truss shall be measured relative to a fixed reference datum. Deflections shall be measured at the free end of an eave or cornice projection and at as many bottom chord panel points as necessary to obtain an accurate representation of the deflected truss(es) but shall be measured at least at the truss midspan, at each panel point, and at midspan between each panel point. Deflections shall be read and recorded to the nearest millimeter (1/32 in). Dead load shall be applied to the top and bottom chord, and live load applied to the top chord, through a suitable hydraulic, pneumatic, or mechanical system or weights to simulate design loads. Load unit weights for uniformly distributed top chord loads shall be separated so that arch action does not occur and shall be spaced not more than 12 in. (305 mm) on center so as to simulate uniform loading. Bottom chord loading shall be spaced as uniformly as practical. Truss gravity loads shall be calculated based on the overall truss length (horizontal projection), including eave or cornice projections.

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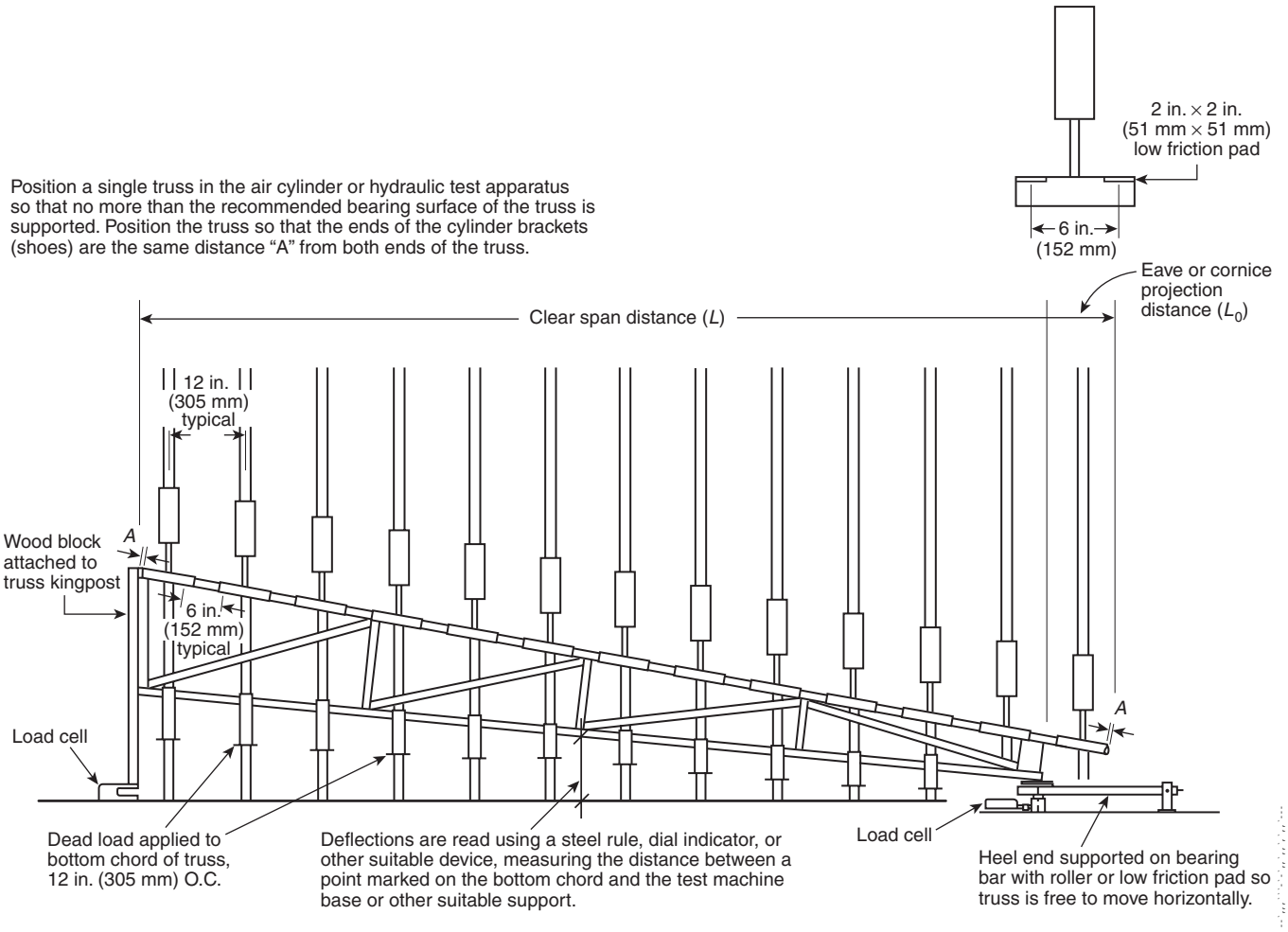


FIGURE 7.2.2.1 Test Fixture for Testing Trusses Singly.

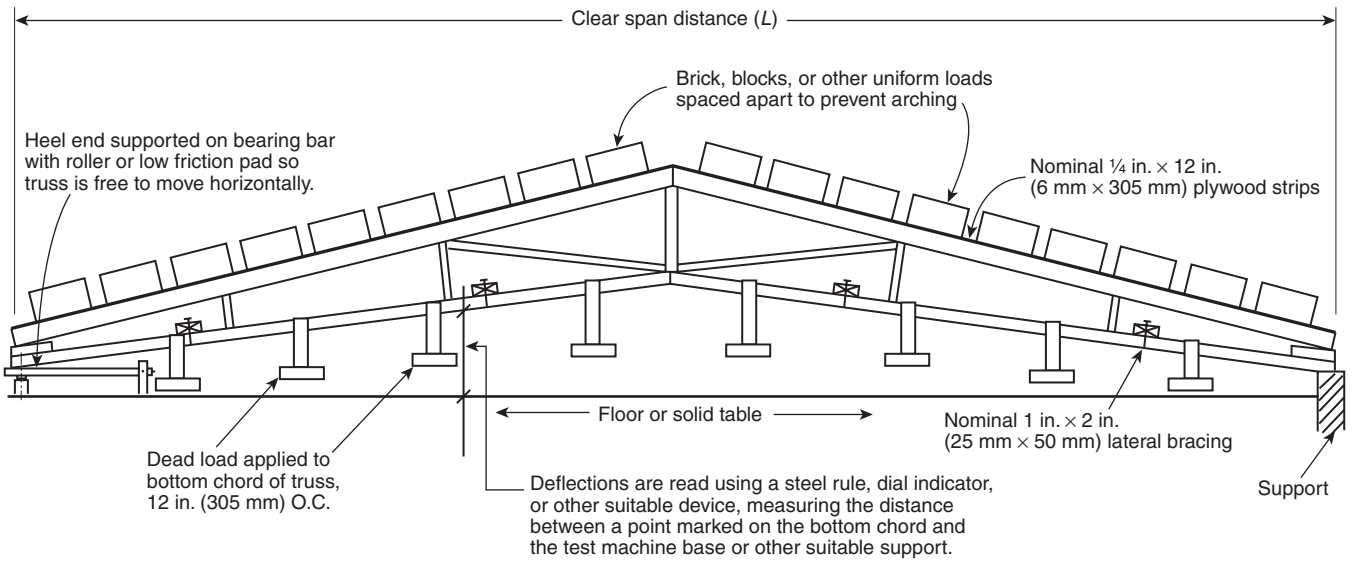


FIGURE 7.2.2.2 Test Setup for Roof Trusses Tested in Groups of Two or More.

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7.2.4 General Test Procedures. General test procedures shall be those described in 7.2.4.1 through 7.2.4.5.

7.2.4.1 Dead Load. Measure and record initial elevation of the truss(es) in the test position at no load. Apply dead loads to the top and bottom chord of the truss that are representative of the weights of materials to be supported by the truss. The actual ceiling/roof assembly dead loads shall be used with a minimum of 4 psf (192 Pa) on the top chord and 2 psf (96 Pa) on the bottom chord. Greater dead loads shall be applied to the top and bottom chords, if required, to represent the actual loads. Dead loads to be applied to the truss test assembly shall be permitted to include only the weights of materials supported by the truss and not the weight of the truss itself. However, readings from load cells (when used) on which the test truss rests shall reflect the sum of the applied load plus the weight of the truss. Apply dead loads and hold for 5 minutes. Measure and record the deflections.

7.2.4.2 Live Load. Maintaining the dead loads, apply live load to the top chord in approximate ¼ live load increments until dead load plus 1.25 times the live load is reached. Measure and record the deflections at a minimum of 1 minute after each live load increment has been applied and 5 minutes after full live load has been reached. Apply incremental loads at a uniform rate such that approximately one-half hour is required to reach full design live load.

7.2.4.3 Recovery Phase. Remove the total live load (1.25 times the roof live load). Measure and record the deflections 5 minutes after the total live load has been removed.

7.2.4.4 Overload Phase. Additional loading shall then be applied continuously until the dead load plus 2.5 times the design live load is reached. This overload condition shall be maintained for 5 minutes.

7.2.4.5 Acceptance Criteria. The truss design shall be considered to have passed if all of the following conditions are met:

(1) No-load to dead-load deflection shall be less than $L/480$ for simply supported clear spans and less than $L_0/180$ for eave and cornice projections.
(2) Dead load to design live load deflections shall be less than $L/180$ for simply supported clear spans and less than $L_0/90$ for eave and cornice projections.
(3) The truss shall recover to at least $L/480$ for simply supported clear spans and $L_0/180$ for eave and cornice projections within 5 minutes after the total live load has been removed.
(4) The truss shall maintain the overload condition for 5 minutes without rupture or fracture.

7.2.5 Uplift Loads. This test shall be required only for truss designs that may be critical under uplift load conditions.

7.2.5.1 Place the truss in the test fixture and position it as intended to be installed in the manufactured home, as shown in Figure 7.2.5.1. Position the load measurement devices to register the wind uplift loads that will be applied to the top chord of the truss. The uplift loads shall be applied through tension devices not wider than 1 in. (25 mm) and spaced not greater than 6 in. (152 mm) on center so as to simulate uniform loading. Gravity and wind uplift load tests may be performed on the same truss in this single setup mode. Measure and record initial elevation of the bottom chord of the truss in the test position at the midspan of the truss, at each panel point, and midspan between each panel point, as well as at the end of the eave or cornice projections greater than 12 in. (305 mm). Eave or cornice projection loads are applied separately for eaves or cornice projections greater than 12 in. (305 mm). For eave or cornice projections greater than 12 in. (305 mm), the additional required load shall be applied to the eave simultaneously with the main body load. For eave or cornice projections 12 in. (305 mm) or less, add the additional required load to the main body load and apply it to the entire top chord.

7.2.5.2 Apply the uplift load to the top chord of the truss. The net uplift load for the clear span and eave or cornice projections shall be determined by subtracting the minimum dead load from the uplift load provided in Table 6.5.3.1. Measure and record the deflection 5 minutes after the net uplift load has been applied. Design load deflection shall be less than $L/180$ for simply supported clear span and less than $L_0/90$ for eave or cornice projections.

7.2.5.3 Continue to load the truss to 2.5 times the net uplift load. Maintain the full load for 1 minute and inspect the truss for rupture or fracture.

7.2.5.4 The uplift load tests shall be performed on a minimum of three single trusses to evaluate the truss design.

7.2.6 Follow-Up Testing. Follow-up testing procedures shall include the following.

7.2.6.1 Production trusses qualifying under these test procedures shall be subject to a continuing witnessed independent third party or an approved testing program as specified in 7.2.6.3. Manufacturers of listed or labeled trusses shall follow an in-house quality control program approved by an independent third party, as specified in 7.2.7. Home manufacturers producing trusses that are not listed or labeled, for their own use, shall be subject to a follow-up testing program, as specified in 7.2.6.3, and a truss certification program, as specified in 7.2.7.

7.2.6.2 Truss designs that are qualified but not in production are not subject to follow-up testing until produced. When the truss design is brought into production, a follow-up test is to be performed if the truss design has been out of production for more than 6 months.

7.2.6.3 The frequency of truss manufacturers' quality control follow-up testing for trusses shall be one test in 4000 trusses or once every 6 months, whichever is more frequent, for every truss design produced.

7.2.7 Truss Certification Program. The truss certification program shall include, as a minimum, procedures for quality of materials, workmanship and manufacturing tolerances, description and calibration of test equipment, truss retesting criteria, and procedures in case of noncomplying results.

7.3 Requirements for Windows, Sliding Glass Doors, and Skylights Used in Manufactured Homes.

7.3.1 Scope. Section 7.3 shall set the requirements for prime windows and sliding glass doors.

Exception: Windows used in entry doors are components of the door and thus are excluded from these requirements.

7.3.2* Performance.

7.3.2.1 All primary windows and sliding glass doors shall comply with AAMA 1701.2, *Primary Window and Sliding Glass Door: Voluntary Standard for Utilization in Manufactured Housing.*

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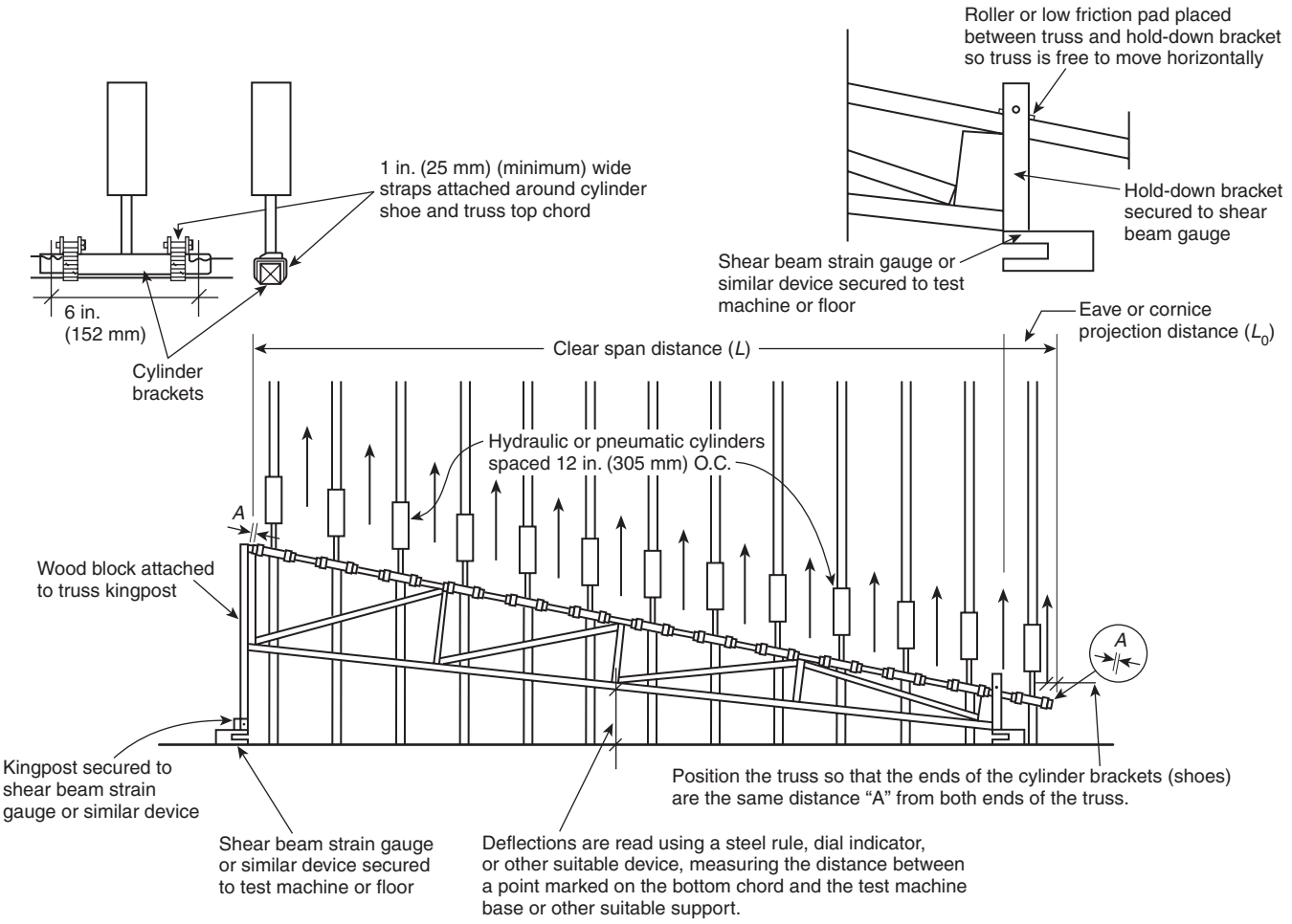


FIGURE 7.2.5.1 Uplift Load Test Fixture.

Exception: The exterior and interior standard wind pressure tests shall be conducted at the design wind loads required for components and cladding specified in 6.5.3.1.

7.3.2.2 All skylights shall comply with AAMA/WDMA 1600/I.S. 7, *Voluntary Specifications for Skylights.* Skylights shall comply with exterior roof coverings, sheathing, and fastenings wind pressures specified in 6.5.3.1.

7.3.3 Installation. All primary windows, sliding glass doors, and skylights shall be installed in a manner that allows proper operation and provides protection against the elements. *(See Section 6.7.)*

7.3.4 Glass.

7.3.4.1 Safety glazing materials, where used, shall meet the requirements of ANSI Z 97.1, *Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings.*

7.3.4.2 Sealed insulating glass, where used, shall meet all performance requirements for Class C in accordance with ASTM E 774, *Standard Specification for the Classification of the Durability of Sealed Insulating Glass Units.* The sealing system shall be qualified in accordance with ASTM E 773, *Standard Test Method for Accelerated Weathering of Sealed Insulating Glass Units.* Each glass unit shall be permanently identified with the name of the insulating glass manufacturer.

7.3.5 Certification.

7.3.5.1 All primary windows and sliding glass doors to be installed in manufactured homes shall be certified as complying with AAMA 1701.2, *Primary Window and Sliding Glass Door: Voluntary Standard for Utilization in Manufactured Housing.* This certification shall be based on tests conducted at the design wind loads specified in 6.5.3.1.

7.3.5.2 All skylights to be installed in manufactured homes shall be certified as complying with AAMA/WDMA 1600/I.S. 7, *Voluntary Specifications for Skylights.* This certification shall be based on applicable design wind loads specified in 6.5.3.1.

7.3.5.3 All such windows, doors, and skylights shall show evidence of certification by having a quality certification label affixed to the product in accordance with ANSI Z 34.1, *For Certification — Third-Party Certification Program.*

7.3.5.4 In determining certifiability of window and sliding glass door products, an independent quality assurance agency shall conduct preproduction specimen tests in accordance with AAMA 1701.2. Further, such agency shall inspect the product manufacturer's facility at least twice per year.

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7.3.6* Protection of Primary Window and Sliding Glass Door Openings in High Wind Areas. For homes designed to be located in Wind Zones II, III, and IV, manufacturers shall design exterior walls surrounding the primary window and sliding glass door openings to allow for the installation of shutters or other protective covers, such as plywood, to cover these openings. The manufacturer shall provide to the homeowner instructions for at least one method of protecting primary window and sliding glass door openings if shutters or other protective covers are not provided. This method shall be capable of resisting the design wind pressures specified in Section 6.5 without taking the home out of conformance with the requirements in Section 7.3. These instructions shall be included in the printed instructions that accompany each manufactured home. The instructions also shall indicate whether receiving devices, sleeves, or anchors, for fasteners to be used to secure the shutters or protective covers to the exterior walls, have been installed or provided by the manufacturer.

7.4 Requirements for Egress Windows and Devices for Use in Manufactured Homes.

7.4.1 Purpose. The purpose of Section 7.4 shall be to establish the requirements for the design, construction, and installation of windows and approved devices intended to be used as emergency exits during conditions encountered in a fire or similar disaster.

7.4.2* Performance. Egress windows, including auxiliary frame and seals, if any, shall meet all requirements of AAMA 1701.2, *Primary Window and Sliding Glass Door: Voluntary Standard for Utilization in Manufactured Housing,* and AAMA 1704, *Voluntary Standard: Egress Window Systems for Utilization in Manufactured Housing.*

Exception: The exterior and interior pressure tests for components and cladding shall be conducted at the design wind loads required by 6.5.3.1.

7.4.3 Installation.

7.4.3.1 Egress windows or devices shall be installed in a manner that allows for proper operation and provides protection against the elements. *(See Section 6.7.)*

7.4.3.2 An operational check of each installed egress window or device shall be made at the manufactured home factory. All egress windows and devices shall be capable of being opened to the minimum required dimension by normal operation of the window without binding or requiring the use of tools. Windows that require the removal of the sash to meet egress size requirements shall be prohibited. Any window or device failing this check shall be repaired or replaced. A repaired window shall conform to its certification. Any repaired or replaced window or device shall pass the operational check.

7.4.4 Operating Instructions. Operating instructions shall be affixed to each egress window and device and shall carry the legend "Do Not Remove."

7.4.5 Certification of Egress Windows and Devices. Egress windows and devices shall be listed in accordance with the procedures and requirements of AAMA 1704, *Voluntary Standard: Egress Window Systems for Utilization in Manufactured Housing.* This certification shall be based on tests conducted at the design wind loads specified in 6.5.3.1.

7.4.6* Protection of Egress Window Openings in High Wind Areas. For homes designed to be located in Wind Zones II, III, and IV, manufacturers shall design exterior walls surrounding the egress window openings to allow for the installation of shutters or other protective covers, such as plywood, to cover these openings. The manufacturer shall provide to the homeowner instructions for at least one method of protecting egress window openings if shutters or other protective covers are not provided. This method shall be capable of resisting the design wind pressures specified in Section 6.5 without taking the home out of conformance with the requirements in Section 7.4. These instructions shall be included in the printed instructions that accompany each manufactured home. The instructions also shall indicate whether receiving devices, sleeves, or anchors for fasteners to be used to secure the shutters or protective covers to the exterior walls have been installed or provided by the manufacturer.

7.5 Requirements for Swinging Exterior Passage Doors for Use in Manufactured Homes.

7.5.1 Scope. These requirements shall apply to all exterior passage door units. These requirements shall apply only to the door frame, consisting of jambs, head, and sill, and the attached door or doors.

Exception: Sliding doors and doors used for access to utilities and compartments shall be excluded from these requirements.

7.5.2 Performance Requirements. The design and construction of exterior door units shall meet all requirements of AAMA 1702.2, *Swinging Exterior Passage Doors: Voluntary Standard for Utilization in Manufactured Housing.*

7.5.3 Materials and Methods. Any material or method of construction shall conform to the performance requirements as outlined in 7.5.2. Wood materials or wood-based materials also shall conform to 7.5.3.1 and 7.5.3.2.

7.5.3.1 Wood. Doors shall conform to the Type 1 requirements of NWWDA I.S.1, *Architectural and Wood Flush Doors.*

7.5.3.2 Plywood. Plywood shall be exterior type and preservative treated in accordance with NWWDA I.S.4, *Water-Repellent Preservative Non-Pressure Treatment for Millwork.*

7.5.4 Exterior Doors. All swinging exterior doors shall be installed in a manner that allows proper operation and provides protection against the elements. *(See Section 6.7.)*

7.5.5 Certification. All swinging exterior doors to be installed in manufactured homes shall be certified as complying with AAMA 1702.2, *Swinging Exterior Passage Doors: Voluntary Standard for Utilization in Manufactured Housing.*

7.5.5.1 All such doors shall show evidence of certification by having a quality certification label affixed to the product in accordance with ANSI Z 34.1, *For Certification — Third-Party Certification Program.*

7.5.5.2 In determining certifiability of the products, an independent quality assurance agency shall conduct preproduction specimen tests in accordance with AAMA 1701.2. Further, such agency shall inspect the product manufacturer's facility at least twice per year.

7.5.6* Protection of Exterior Doors in High Wind Areas. For homes designed to be located in Wind Zones II, III, and IV, manufacturers shall design exterior walls surrounding the exterior door openings to allow for the installation of shutters or other protective covers, such as plywood, to cover these openings. The manufacturer shall provide to the homeowner instructions for at least one method of protecting exterior door openings if shutters or other protective covers are not provided. This method shall be capable of resisting the design wind pressures

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specified in Section 6.5 without taking the home out of conformance with the requirements in Section 7.5. These instructions shall be included in the printed instructions that accompany each manufactured home. The instructions also shall indicate whether receiving devices, sleeves, or anchors for fasteners to be used to secure the shutters or protective covers to the exterior walls have been installed or provided by the manufacturer.

7.6 Air Chamber Test Method for Certification and Qualification of Formaldehyde Emission Levels.

7.6.1 Preconditioning. Preconditioning of plywood or particleboard panels for air chamber tests shall be initiated as soon as practicable but not in excess of 30 days after the plywood or particleboard is produced or surface-finished, whichever is later, using randomly selected panels.

7.6.1.1 If preconditioning is to be initiated more than two days after the plywood or particleboard is produced or surface-finished, whichever is later, the panels shall be dead-stacked or air-tight wrapped until preconditioning is initiated.

7.6.1.2 Panels selected for testing in the air chamber shall not be taken from the top or bottom of the stack.

7.6.2 Testing. Testing shall be conducted in accordance with ASTM E 1333, *Standard Test Method for Determining Formaldehyde Levels from Wood Products Under Defined Test Conditions Using a Large Chamber,* with the following exceptions:

(1) The chamber shall be operated indoors.
(2) Plywood and particleboard panels shall be individually tested in accordance with the following loading ratios:
   (a) Plywood — 0.29 ft^2/ft^3 (0.95 m^2/m^3)
   (b) Particleboard — 0.13 ft^2/ft^3 (0.43 m^2/m^3)
(3) Temperature to be maintained inside the chamber shall be 77°F (25°C) plus or minus 2°F (1°C).
(4) The test concentration (C) shall be standardized to a level (C_0) at a temperature (t_0) of 77°F (25°C) and 50 percent relative humidity (H_0) by the following formula:

$$C = C_0\left[1 + A\left(H - H_0\right)\right]e^{-R\left(1/t - 1/t_0\right)}$$

where:
C = test formaldehyde concentration
C_0 = standardized formaldehyde concentration
A = coefficient of humidity (0.0175)
H = actual relative humidity (percent)
H_0 = standardized relative humidity (percent)
e = natural log base
R = coefficient of temperature (9799)
t = actual test condition temperature (K)
t_0 = standardized temperature (K)

The standardized level (C_0) shall be the concentration used to determine compliance with 6.8.1.

(5) The air chamber shall be inspected and recalibrated at least annually to ensure its proper operation under test conditions.

Chapter 8 Thermal Protection

8.1 Scope. This chapter shall set forth the requirements for condensation control, air infiltration, thermal insulation, and certification for heating and comfort cooling.

8.2 Definitions. The following definitions shall be applicable to Chapter 8 only.

8.2.1 Pressure Envelope. That primary air barrier surrounding the living space that serves to limit air leakage. In construction using ventilated cavities, the pressure envelope is the interior skin.

8.2.2 The thermal envelope shall be determined from the sum of the surface area of outside walls, ceiling, and floor, including all openings.

8.2.2.1 The wall area of a single-story dwelling unit shall be measured by multiplying outside wall lengths by the inside wall height from floor to ceiling.

8.2.2.2 The wall area of multi-story dwelling units shall be measured by multiplying outside wall lengths by the inside wall height from the floor of the lowest story to the ceiling of the highest story within each dwelling unit.

8.2.2.3 The floor and ceiling areas shall be considered as horizontal surfaces using exterior width and length.

8.3 Materials. Materials used for insulation and the thermal and pressure envelopes shall be of proven effectiveness and adequate durability to ensure that required design conditions concerning thermal transmission and energy conservation are attained. *(See 8.8.3.)*

8.4 Condensation Control and Installation of Vapor Retarders.

8.4.1 Ceiling Vapor Retarders.

8.4.1.1 In U_0 value Zone 2 and value Zone 3, ceilings shall have a vapor retarder with a permeance of no greater than 1 perm (as measured by ASTM E 96, *Standard Test Methods for Water Vapor Transmission of Materials*) installed on the living space side of the roof cavity.

8.4.1.2 For manufactured homes designed for U_0 value Zone 1, the vapor retarder shall be permitted to be omitted.

8.4.1.3 In multi-story dwelling units, the ceiling vapor retarder shall be permitted to be omitted when the story directly above is part of the same dwelling unit.

8.4.2 Exterior Walls.

8.4.2.1 Vapor Retarders. Exterior walls shall be provided with a system or method to manage moisture and vapor accumulation with one of the following.

8.4.2.1.1 Exterior walls shall have a vapor retarder no greater than 1 perm (dry cup method) installed on the living space side of the wall.

8.4.2.1.2 For purposes of this requirement, the mating wall of each single-family attached dwelling unit shall be considered to be an exterior wall.

8.4.2.1.3 Unventilated wall cavities shall have an external covering and/or sheathing that forms the pressure envelope. The covering and/or sheathing shall have a combined permeance of not less than 5.0 perms. In the absence of test data, combined permeance shall be permitted to be computed using the following formula:

$$P_{total} = \frac{1}{\left(\frac{1}{P_1}\right) + \left(\frac{1}{P_2}\right)}$$

where:
P_1 and P_2 = the permeance values of the exterior covering and sheathing in perms

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8.4.2.1.3.1 Formed exterior siding applied in sections with joints not caulked or sealed shall not be considered to restrict water vapor transmission.

8.4.2.1.4 Wall cavities shall be constructed so that ventilation is provided to dissipate any condensation occurring in these cavities.

8.4.2.1.5 Except as shown in 8.4.2.1.6, homes manufactured to be sited in "humid climates" or "fringe climates," as shown in Figure 8.4.2.1.5, and identified in the counties listed in Table 8.4.2.1.5, shall be permitted to have a vapor retarder specified in 8.4.2.1 installed on the exterior side of the wall insulation when the interior wall covering is not less than 5 perms.

Table 8.4.2.1.5 Humid Climate by State and Counties

State	Counties			
Alabama	Autauga	Conecuh	Houston	Russell
	Baldwin	Coosa	Jefferson	Shelby
	Barbour	Covington	Lee	St. Clair
	Bibb	Crenshaw	Lowndes	Sumter
	Bullock	Dale	Macon	Talladega
	Butler	Dallas	Marengo	Tallapoosa
	Calhoun	Elmore	Mobile	Tuscaloosa
	Chambers	Escambia	Monroe	Walker
	Chilton	Geneva	Montgomery	Washington
	Choctaw	Greene	Perry	Wilcox
	Clarke	Hale	Pickens	
	Coffee	Henry	Pike	
Arkansas	Arkansas	Desha	Lincoln	Prairie
	Ashley	Drew	Little River	Pulaski
	Bradley	Faulkner	Logan	Saline
	Calhoun	Garland	Lonoke	Scott
	Chicot	Grant	Miller	Sevier
	Clark	Hempstead	Monroe	St. Francis
	Cleveland	Hot Spring	Nevada	Union
	Columbia	Howard	Ouachita	White
	Conway	Jefferson	Perry	Woodruff
	Crittenden	Lafayette	Phillips	Yell
	Cross	Lee	Pike	
	Dallas			
Florida	Alachua	Flagler	Lake	Pinellas
	Baker	Franklin	Lee	Polk
	Bay	Gadsden	Leon	Putnam
	Bradford	Gilchrist	Levy	Santa Rosa
	Brevard	Glades	Liberty	Sarasota
	Broward	Gulf	Madison	Seminole
	Calhoun	Hamilton	Manatee	St. Johns
	Charlotte	Hardee	Marion	St. Lucie
	Citrus	Hendry	Martin	Sumter
	Clay	Hernando	Monroe	Suwannee
	Collier	Highlands	Nassau	Taylor
	Columbia	Hillsborough	Okaloosa	Union
	Dade	Holmes	Okeechobee	Volusia
	De Soto	Indian River	Orange	Wakulla
	Dixie	Jackson	Osceola	Walton
	Duval	Jefferson	Palm Beach	Washington
	Escambia	Lafayette	Pasco	

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Table 8.4.2.1.5 *Continued*

State	Counties			
Georgia	Appling	Decatur	Lee	Stewart
	Atkinson	Dodge	Liberty	Sumter
	Bacon	Dooly	Lincoln	Talbot
	Baker	Dougherty	Long	Taliaferro
	Baldwin	Early	Lowndes	Tattnall
	Ben Hill	Echols	Macon	Taylor
	Berrien	Effingham	Marion	Telfair
	Bibb	Emanuel	McDuffie	Terrell
	Bleckley	Evans	McIntosh	Thomas
	Brantley	Glascock	Meriwether	Tift
	Brooks	Glynn	Miller	Toombs
	Bryan	Grady	Mitchell	Treutlen
	Bulloch	Greene	Monroe	Troup
	Burke	Hancock	Montgomery	Turner
	Calhoun	Harris	Morgan	Twiggs
	Camden	Heard	Muscogee	Upson
	Charlton	Houston	Peach	Ware
	Chatham	Irwin	Pierce	Warren
	Chattahoochee	Jasper	Pike	Washington
	Clay	Jeff Davis	Pulaski	Wayne
	Clinch	Jefferson	Putnam	Webster
	Coffee	Jenkins	Quitman	Wheeler
	Colquitt	Johnson	Randolph	Wilcox
	Columbia	Jones	Richmond	Wilkinson
	Cook	Lamar	Schley	Worth
	Crawford	Lanier	Screven	
	Crisp	Laurens	Seminole	
Louisiana	Acadia	East Baton Rouge	Madison	St. Landry
	Allen	East Carroll	Morehouse	St. Martin
	Ascension	East Feliciana	Natchitoches	St. Mary
	Assumption	Evangeline	Orleans	St. Tammany
	Avoyelles	Franklin	Ouachita	Tangipahoa
	Beauregard	Grant	Plaquemines	Tensas
	Bienville	Iberia	Pointe Coupee	Terrebonne
	Bossier	Iberville	Rapides	Union
	Caddo	Jackson	Red River	Vermilion
	Calcasieu	Jefferson	Richland	Vernon
	Caldwell	Jefferson Davis	Sabine	Washington
	Cameron	La Salle	St. Bernard	Webster
	Catahoula	Lafayette	St. Charles	West Baton Rouge
	Claiborne	Lafourche	St. Helena	West Carroll
	Concordia	Lincoln	St. James	West Feliciana
	De Soto	Livingston	St. John the Baptist	Winn
Mississippi	Adams	Greene	Lawrence	Rankin
	Amite	Grenada	Leake	Scott
	Attala	Hancock	Leflore	Sharkey
	Bolivar	Harrison	Lincoln	Simpson
	Calhoun	Hinds	Lowndes	Smith
	Carroll	Holmes	Madison	Stone
	Chickasaw	Humphreys	Marion	Sunflower
	Choctaw	Issaquena	Monroe	Walthall
	Claiborne	Jackson	Montgomery	Warren
	Clarke	Jasper	Neshoba	Washington
	Clay	Jefferson	Newton	Wayne
	Copiah	Jefferson Davis	Noxubee	Webster
	Covington	Jones	Oktibbeha	Wilkinson
	Forrest	Kemper	Pearl River	Winston
	Franklin	Lamar	Perry	Yazoo
	George	Lauderdale	Pike	

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Table 8.4.2.1.5 *Continued*

State	Counties			
North Carolina	Beaufort	Columbus	Hyde	Pamlico
	Bladen	Craven	Jones	Pender
	Brunswick	Dare	New Hanover	Sampson
	Carteret	Duplin	Onslow	Tyrrell
Oklahoma	Carter	Jefferson	Love	Pushmataha
	Choctaw	Johnston	Marshall	
South Carolina	Aiken	Clarendon	Hampton	Newberry
	Allendale	Colleton	Horry	Orangeburg
	Bamberg	Darlington	Jasper	Richland
	Barnwell	Dillon	Lee	Saluda
	Beaufort	Dorchester	Lexington	Sumter
	Berkeley	Edgefield	Marion	Williamsburg
	Calhoun	Florence	Marlboro	
	Charleston	Georgetown	McCormick	
Tennessee	Fayette			
	Shelby			
Texas	Anderson	Duval	Kinney	Robertson
	Angelina	Edwards	Kleberg	Runnels
	Aransas	Ellis	La Salle	Rusk
	Atascosa	Falls	Lampasas	Sabine
	Austin	Fayette	Lavaca	San Augustine
	Bandera	Fort Bend	Lee	San Jacinto
	Bastrop	Freestone	Leon	San Patricio
	Bee	Frio	Liberty	San Saba
	Bell	Galveston	Limestone	Schleicher
	Bexar	Gillespie	Live Oak	Shelby
	Blanco	Goliad	Llano	Smith
	Bosque	Gonzales	Madison	Somervell
	Brazoria	Grimes	Mason	Starr
	Brazos	Guadalupe	Matagorda	Sutton
	Brewster	Hamilton	Maverick	Tarrant
	Brooks	Hardin	McCulloch	Terrell
	Brown	Harris	McLennan	Tom Green
	Burleson	Hays	McMullen	Travis
	Burnet	Henderson	Medina	Trinity
	Caldwell	Hidalgo	Menard	Tyler
	Calhoun	Hill	Milam	Upton
	Cameron	Hood	Mills	Uvalde
	Chambers	Houston	Montgomery	Val Verde
	Cherokee	Irion	Nacogdoches	Victoria
	Coleman	Jackson	Navarro	Walker
	Colorado	Jasper	Newton	Waller
	Comal	Jefferson	Nueces	Washington
	Comanche	Jim Hogg	Orange	Webb
	Concho	Jim Wells	Panola	Wharton
	Coryell	Johnson	Pecos	Willacy
	Crane	Karnes	Polk	Williamson
	Crockett	Kendall	Presidio	Wilson
	Dalla	Kenedy	Reagan	Zapata
	De Witt	Kerr	Real	Zavala
	Dimmit	Kimble	Refugio	

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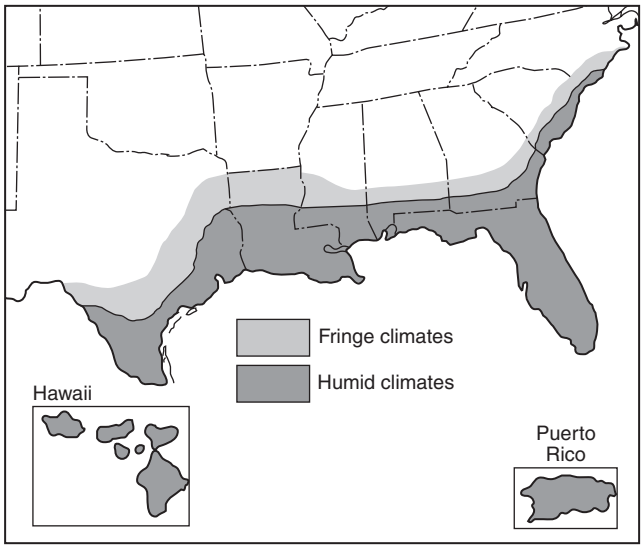


FIGURE 8.4.2.1.5 Fringe and Humid Climates.

8.4.2.1.6 The following areas shall not be required to meet the provisions of 8.4.2.1.5:

(1) Kitchen backsplash materials
(2) Bathroom tub and shower compartment cabinetry
(3) Built-in furniture
(4) Chair rails
(5) Trim
(6) Interior surface areas that have a cumulative total of 50 ft^2 (4.6 m^2) or less

8.4.3 Liquid Applied Vapor Retarders. Liquid applied vapor retarders shall be tested by a nationally recognized testing agency for use on the specific substrate to which it is applied. The test report shall include the perm rating(s) (as measured by ASTM E 96, *Standard Test Methods for Water Vapor Transmission of Materials*) and associated application rate(s) for the specific substrate(s).

8.4.4 Attic or Roof Ventilation.

8.4.4.1 A clear air passage space having a minimum height of 1 in. (25 mm) shall be provided between the top of the insulation and the roof sheathing or roof covering. Baffles or other means shall be provided where needed to ensure the 1 in. (25 mm) height of the clear air passage space is maintained. Attic and roof cavities shall be vented in accordance with one of the following:

(1) A minimum free-ventilation area of not less than 1/300 of the attic or roof cavity floor area. At least 50 percent of the required free-ventilation area shall be provided by ventilators located in the upper portion of the space to be ventilated. At least 40 percent shall be provided by eave, soffit, or low gable vents. The location and spacing of the vent openings and ventilators shall provide cross ventilation to the entire attic or roof cavity space.
(2) A mechanical attic or roof ventilation system shall be permitted to be installed instead of providing the free-ventilation area when the mechanical system provides a minimum air change rate of 0.02 cfm (0.54 L/min) per square foot of attic floor area. Intake and exhaust vents shall be located so as to provide air movement throughout the space.

Exception: Homes manufactured to be sited in "humid climates" or "fringe climates" as shown in Figure 8.4.2.1.5 shall be permitted not to have attic or roof ventilation.

8.4.4.2 Single-section manufactured homes constructed with metal roofs and having no sheathing or underlayment installed shall not be required to be provided with attic or roof cavity ventilation, provided that the air leakage paths from the living space to the roof cavity created by electrical outlets, electrical junctions, electrical cable penetrations, plumbing penetrations, flue pipe penetrations, and exhaust vent penetrations are sealed.

8.4.4.3 Parallel membrane roof sections of a closed-cell-type construction shall not be required to be ventilated.

8.4.4.4 The vents provided for ventilating attics and roof cavities shall be designed to resist entry of rain and insects.

8.5 Air Infiltration.

8.5.1 Envelope Air Infiltration. The opaque envelope shall be designed and constructed to limit air infiltration to the living area of the home. Any design, material, method, or combination thereof that accomplishes this goal shall be permitted to be used. The goal of the infiltration control criteria is to reduce heat loss/heat gain due to infiltration, limit moisture transfer that causes condensation, and reduce draft that causes comfort problems.

8.5.1.1* Envelope Penetrations. Plumbing, mechanical, and electrical penetrations of the pressure envelope not exempted by this requirement, and installations of window and door frames, shall be constructed or treated to limit air infiltration. Penetrations of the pressure envelope made by electrical equipment, other than distribution panel boards and cable and conduit penetrations, shall be exempt from this requirement. Cable penetrations through outlet boxes shall be considered exempt.

8.5.1.2 Joints between Major Envelope Elements. Joints not designed to limit air infiltration between wall-to-wall, wall-to-ceiling, and wall-to-floor connections shall be caulked or otherwise sealed. When walls are constructed to form a pressure envelope on the outside of the wall cavity, they shall be deemed to meet this requirement.

8.6 Heat Loss/Heat Gain. The manufactured home heat loss/heat gain shall be determined by methods outlined in Sections 8.8 and 8.9. The U_0 (coefficient of heat transmission) value zone for which the manufactured home is acceptable and the lowest outdoor temperature to which the installed heating equipment will maintain a temperature of 70°F (21°C) shall be certified as specified in Section 8.10. The U_0 value zone shall be determined in accordance with Figure 8.6.

8.6.1 Coefficient of Heat Transmission.

8.6.1.1 The overall coefficient of heat transmission (U_0) of the manufactured home for the respective zones and an indoor design temperature of 70°F (21°C), including internal and external ducts, and excluding infiltration, ventilation, and condensation control, shall not exceed the Btu/hr·ft^2·°F (W/m^2·K) of the manufactured home envelope area as tabulated in Table 8.6.1.1.

8.6.1.2 To ensure uniform heat transmission in manufactured homes, cavities in exterior walls, floors, and ceilings shall be provided with thermal insulation.

8.6.1.2.1 For insulation purposes, the mating wall of each single family attached dwelling unit shall be considered an exterior wall.

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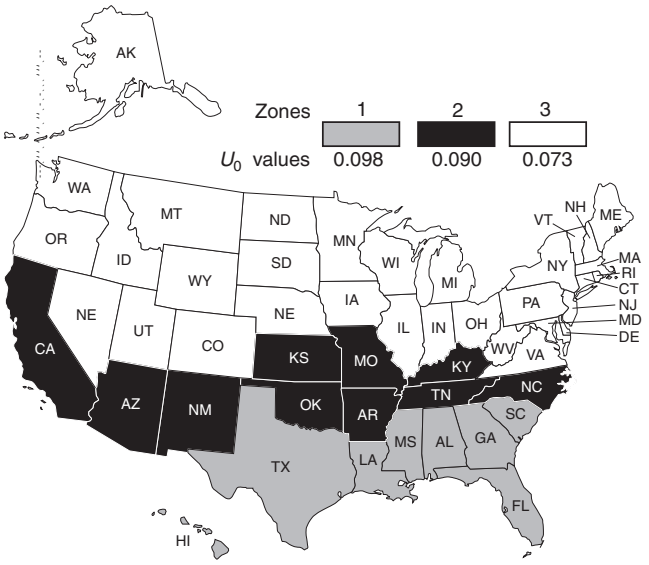


FIGURE 8.6 U_0 Value Zone Map.

Table 8.6.1.1 Coefficient of Heat Transmission (U_0)

U_0 Value Zone	Maximum Coefficient of Heat Transmission
1	0.098 Btu/hr·ft^2·°F (0.557 W/m^2·K)
2	0.090 Btu/hr·ft^2·°F (0.511 W/m^2·K)
3	0.073 Btu/hr·ft^2·°F (0.415 W/m^2·K)

8.6.1.2.2 Floor/ceiling assemblies between stories of the dwelling unit shall not be required to be insulated.

8.6.1.3 Manufactured homes designed for U_0 value Zone 3 shall be factory-equipped with storm windows or insulating glass. Interior mounted storm window frames shall be sealed.

8.7 Comfort Heat Gain. Information necessary to calculate the home cooling load shall be provided as specified in this chapter.

8.7.1* Transmission Heat Gains. Homes complying with Section 8.7 shall meet the minimum heat loss transmission coefficients specified in 8.6.1.

8.8 Heat Loss, Heat Gain, and Cooling Load Calculations.

8.8.1 Information, values, and data necessary for heat loss and heat gain determinations shall be taken from the 1997 *ASHRAE Handbook of Fundamentals*, Chapters 22 through 27. The portions of those chapters listed in Table 8.8.1 shall not apply.

8.8.2 The calculation of the manufactured home's transmission heat loss coefficient (U_0) shall be in accordance with the fundamental principles of the 1997 *ASHRAE Handbook of Fundamentals* and, at a minimum, shall address all the heat loss or heat gain considerations in a manner consistent with the calculation procedures provided in the document "Overall *U*-values and Heating/Cooling Loads — Manufactured Homes," February 1992, PNL 8006, HUD User No. 0005945.

Table 8.8.1 Sections Not Applicable

Sections	Topics
23.1	Heavy steel frame construction
23.2	Masonry construction
23.3	Foundation and floor systems
23.15	Pipes
23.17	Tanks, vessels, and equipment
23.18	Refrigerated rooms and buildings
24.15	Mechanical and industrial systems
25.19	Commercial building envelope leakage
27.9	Calculating heat loss from crawl spaces

8.8.3* Areas where the insulation does not fully cover a surface or is compressed shall be accounted for in the *U*-calculation *(see Section 8.6)*. The effect of framing on the *U*-value shall be included in the U_0 calculation. Other low-*R*-value heat-flow paths ("thermal shorts") shall be explicitly accounted for in the calculation of the transmission heat loss coefficient if, in the aggregate, all types of low-*R*-value paths amount to more than 1 percent of the total exterior surface area or 40 ft^2 (3.7 m^2), whichever is less.

8.8.3.1 Areas shall be considered low-*R*-value heat-flow paths if the following apply:

(1) They separate conditioned and unconditioned space.
(2) They are not insulated to a level that is at least one-half the nominal insulation level of the surrounding building components.

8.8.4* High-Efficiency Heating and Cooling Equipment Credit. The calculated transmission heat loss coefficient (U_0) used for meeting the requirement in 8.6.1 shall be permitted to be adjusted for heating and cooling equipment above that required by the *National Appliance Energy Conservation Act of 1987* (NAECA) by applying the following formula:

$$U_0 \text{ adjusted} = (U_0 \text{ standard}) \times \left[1 + (0.60)(\text{heating efficiency increase factor}) + (\text{cooling multiplier})(\text{cooling efficiency increase factor})\right]$$

where:

U_0 adjusted = maximum U_0 standard adjusted for high-efficiency HVAC equipment
U_0 standard = maximum U_0 for U_0 zone required by 8.6.1
Heating efficiency increase factor = increase factor in heating equipment efficiency measured by the Annual Fuel Utilization Efficiency (AFUE) or by the Heating Seasonal Performance Factor (HSPF) for heat pumps, above that required by NAECA (indicated as "NAECA" in formula). The formula is heating efficiency increase factor = AFUE (HSPF) home – AFUE (or HSPF) NAECA ÷ AFUE (HSPF) NAECA.
Cooling efficiency increase factor = increase factor in the cooling equipment efficiency measured by the Seasonal Energy Efficiency Ratio (SEER) above that required by NAECA. The formula is cooling equipment = SEER home – SEER NAECA ÷ SEER NAECA.

8.8.4.1 The cooling multiplier for the U_0 zone is taken from Table 8.8.4.1.

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Table 8.8.4.1 Cooling Multipliers

U_0 Zone	Cooling Multiplier (CM)
1	0.60 (Florida only)
1	0.20 (all other locations)
2	0.07
3	0.03

8.8.5* *U*-values for any glazing (e.g., windows, skylights, and the glazed portions of any door) shall be based on tests using AAMA 1503.1, *Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections,* or the NFRC 100, *Procedure for Determining Fenestration Product Thermal Properties.* In the absence of tests, manufacturers shall use the residential window *U*-values contained in Chapter 29, Table 5, of the 1997 *ASHRAE Handbook of Fundamentals.* In the event that the classification of the window type is indeterminate, the manufacturer shall use the classification that gives the higher *U*-value. Where a composite of materials from two different product types is used, the product shall be assigned the higher *U*-value. For the purpose of calculating U_0-values, storm windows shall be treated as an additional pane.

8.8.6 Annual Energy Use–Based Compliance. As an alternative, homes shall be permitted to demonstrate compliance with the annual energy used implicit in the coefficient of heat transmission (U_0) requirement. The annual energy use determination must be based on generally accepted engineering practices. The home seeking compliance approval shall demonstrate a projected annual energy use, including both heating and cooling, less than or equal to a similar "base case" home that meets the standard. The calculations of the energy use for both homes must be based on the same assumptions, including assuming the same dimensions for all boundaries between conditioned and unconditioned spaces, site characteristics, usage patterns, and climate.

8.9 Criteria in Absence of Specific Data. In the absence of specific data for heat loss/heat gain calculations, the criteria in 8.9.1 through 8.9.3 shall be used.

8.9.1 Infiltration Heat Loss. In the absence of measured infiltration heat loss data, the following formula shall be used to calculate heat loss due to infiltration and intermittently operated fans exhausting to the outdoors. The perimeter calculation shall be based on the dimensions of the pressure envelope.

$$\text{Infiltration heat loss} = 0.7(T)(\text{ft of perimeter}) \text{ in Btu/hr } (\text{mJ/s})$$

where:
T = 70 minus the heating system capacity certification temperature stipulated in the heating certificate, in °F

8.9.2 Framing Areas. For walls, calculations shall be based on 15 percent of wall area less windows and doors. For floors and ceilings, calculations shall be based on 10 percent of the area.

8.9.3 Insulation Compression. Insulation compressed to less than nominal thickness shall have its nominal *R*-values reduced for the area that is compressed in accordance with Table 8.9.3.

8.9.3.1 When insulation is installed over the framing members, the thermal performance of the insulation shall be reduced due to compression at the framing members. The resistance value of the insulation between the framing members shall be reduced by 12.5 percent for framing members 16 in. (406 mm) on center, 8.5 percent for framing members 24 in. (610 mm) on center, and 4 percent for framing members 48 in. (1220 mm) on center. The *R*-value for loose-fill insulation in sloping cavities shall be adjusted in accordance with Table 8.9.3.

8.9.4 Air Supply Ducts within Floor Cavity. Air supply ducts located within a floor cavity shall be assumed to be heating or cooling the floor cavity to living space temperatures unless the duct is structurally isolated by the framing system or thermally insulated from the rest of the floor cavity with a thermal insulation at least equal to *R*-4.

8.9.5 Air Supply Ducts within Ceiling Cavity. Where supply ducts are located in ceiling cavities, the influence of the duct on cavity temperatures shall be considered in calculating envelope heat loss or heat gain.

8.9.6 Air Supply Duct Heat Loss or Gain. The supply duct heat loss, and/or heat gain where applicable *(see Section 8.11)*, shall be calculated using the actual duct surface area and the actual thickness of insulation between the duct and outside of the manufactured home. If there is an air space of at least ½ in. (13 mm) between the duct and the insulation, heat loss/heat gain need not be calculated if the cavity where the duct is located is assumed to be at living space temperature. The average temperature inside the supply duct, including ducts installed outside the manufactured home, shall be assumed to be 130°F (54°C) for purposes of calculation of heat loss and 60°F (16°C) for calculation of heat gain.

8.9.7 Return Air Cavities. Cavities used as return air plenums shall be considered to be at living space temperature.

8.10 Heat Loss Certificate.

8.10.1 Heating Certificate. The manufactured home manufacturer shall permanently affix the certificate shown in Figure 8.10.1 to an interior surface of the home that is readily visible to the homeowner. (*See 8.11.1.*) The heating certificate shall include a reproduction of Figure 8.6. The U_0 value zone map shall be not less than 3½ in. × 2¼ in. (89 mm × 57 mm). The manufacturer shall provide the following statement on the heating certificate when the home is built, with a vapor retarder of not greater than 1 perm (dry cup method) on the exterior side of the insulation, as shown in the accompanying Figure 8.4.2.1.5, which shall be shown on the certificate not less than 3½ × 2¼ in. (89 mm × 57 mm). This home is designed to be sited in humid or fringe climate regions. It shall be permitted to combine Figure 8.4.2.1.5 and Figure 8.6, provided all information is clearly indicated.

8.10.2 Heating Zone Certification. The heating certificate shall indicate the design zone at which the manufactured home heat loss complies with 8.6.1.1.

8.10.3 Outdoor Certification Temperature. The heating certificate shall indicate the lowest outdoor temperature at which the installed heating equipment will maintain a 70°F (21°C) temperature inside the home.

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Table 8.9.3 Effect of Insulation Compression and Restriction on *R*-value

Original Thickness	Nonuniform Restriction*		Uniform Compression†	Original Thickness	Nonuniform Restriction*		Uniform Compression†
	Batt	Blown	Batt		Batt	Blown	Batt
0%	20%	15%	0%				
1%	26%	21%	1%	51%	81%	73%	62%
2%	32%	25%	2%	52%	81%	73%	63%
3%	36%	28%	4%	53%	82%	74%	64%
4%	38%	30%	5%	54%	82%	75%	65%
5%	41%	32%	7%	55%	83%	75%	65%
6%	43%	33%	8%	56%	83%	76%	66%
7%	45%	35%	10%	57%	84%	76%	67%
8%	46%	36%	11%	58%	84%	77%	68%
9%	48%	38%	13%	59%	84%	78%	69%
10%	49%	39%	14%	60%	85%	78%	70%
11%	51%	40%	15%	61%	85%	79%	71%
12%	52%	42%	17%	62%	86%	79%	72%
13%	53%	43%	18%	63%	86%	80%	73%
14%	54%	44%	20%	64%	87%	81%	74%
15%	55%	45%	21%	65%	87%	81%	74%
16%	57%	46%	22%	66%	88%	82%	75%
17%	58%	47%	24%	67%	88%	82%	76%
18%	59%	48%	25%	68%	88%	83%	77%
19%	59%	49%	26%	69%	89%	84%	78%
20%	60%	50%	28%	70%	89%	84%	78%
21%	61%	51%	29%	71%	90%	85%	79%
22%	62%	52%	30%	72%	90%	85%	80%
23%	63%	52%	31%	73%	90%	86%	81%
24%	64%	53%	33%	74%	91%	86%	82%
25%	65%	54%	34%	75%	91%	87%	82%
26%	65%	55%	35%	76%	92%	87%	83%
27%	66%	56%	36%	77%	92%	88%	84%
28%	67%	57%	37%	78%	92%	89%	85%
29%	68%	57%	39%	79%	93%	89%	85%
30%	68%	58%	40%	80%	93%	90%	86%
31%	69%	59%	41%	81%	93%	90%	87%
32%	70%	60%	42%	82%	94%	91%	88%
33%	70%	60%	43%	83%	94%	91%	88%
34%	71%	61%	44%	84%	95%	92%	89%
35%	72%	62%	45%	85%	95%	92%	90%
36%	72%	63%	47%	86%	95%	93%	91%
37%	73%	63%	48%	87%	96%	93%	91%
38%	74%	64%	49%	88%	96%	94%	92%
39%	74%	65%	50%	89%	96%	94%	93%
40%	75%	65%	51%	90%	97%	95%	93%
41%	75%	66%	52%	91%	97%	95%	94%
42%	76%	67%	53%	92%	97%	96%	95%
43%	76%	68%	54%	93%	98%	96%	95%
44%	77%	68%	55%	94%	98%	97%	96%
45%	78%	69%	56%	95%	98%	97%	97%
46%	78%	70%	57%	96%	99%	98%	97%
47%	79%	70%	58%	97%	99%	98%	98%
48%	79%	71%	59%	98%	99%	99%	99%
49%	80%	71%	60%	99%	100%	99%	99%
50%	80%	72%	61%	100%	100%	100%	100%

Note: To use this table, first compute the restricted insulation thickness as a fraction of the uncompressed (full) insulation thickness. Then, look up the *R*-value remaining from the appropriate column (Non-Uniform Restriction, Batt; Non-Uniform Restriction, Blown; or Uniform Compression, Batt). Example: Assume a section of loose-fill ceiling insulation went from *R*-25 insulation at a height of 10 in. to a minimum height of 2 in. at the edge of the ceiling. The ratio of minimum to full thickness is 0.20 (2 divided by 10). Look up 0.20 (20 percent), read across to column 3 (Non-Uniform Restriction, Blown), and read 50 percent. Therefore, the *R*-value of the loose-fill insulation over the restricted area would be *R*-12.5 (50 percent of 25).

*Nonuniform restriction is that which occurs between non-parallel planes, such as in the ceiling near the eaves.

†Uniform compression is compression between parallel planes, such as that which occurs in a wall.

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Heating Certificate

Home Manufacturer: _____
Plant Location: _____
Model Home: _____

This manufactured home has been thermally insulated to conform with the requirements of NFPA 501, 2005, for all locations within U_0 Value Zone _____ (see U_0 Value Zone map in NFPA 501, *Standard on Manufactured Housing,* for zone numbers).

Heating Equipment Manufacturer: _____
Heating Equipment Model: _____

The above heating equipment has the capacity to maintain an average 70°F temperature in this home at outdoor temperatures of _____ °F/°C (see 8.10.3 in NFPA 501, *Standard on Manufactured Housing*).

This home is designed to be sited in the humid or fringe climate regions, as shown.

FIGURE 8.10.1 Heating Certificate.

8.11 Comfort Cooling Certificate and Information.

8.11.1 The manufactured home manufacturer shall permanently affix the comfort cooling certificate shown in Figure 8.11.1 to an interior surface of the home that is readily visible to the homeowner. This certificate shall be permitted to be combined with the heating certificate required in Section 8.10. *(See 8.10.1.)* The manufacturer shall be permitted to comply with this requirement using one of the alternatives in 8.11.1.1, 8.11.1.2, or 8.11.1.3.

Comfort Cooling Certificate

Air Conditioner Manufacturer: _____
Air Conditioner Model: _____

Certified capacity _____Btu/hr in accordance with the appropriate Air Conditioning and Refrigeration Institute Standards.

The central air-conditioning system provided with this home has been sized assuming an orientation of the front (hitch) end of the home facing _____ , and it is designed on the basis of a 75°F (24°C) indoor temperature and an outdoor temperature of _____ °F/°C dry bulb and _____ °F/°C wet bulb.

FIGURE 8.11.1 Comfort Cooling Certificate.

8.11.1.1 Alternative 1. If a central air-conditioning system is provided by the home manufacturer, the heat gain calculation necessary to properly size the air-conditioning equipment shall be in accordance with procedures outlined in Chapter 27 of the 1997 *ASHRAE Handbook of Fundamentals,* with an assumed location and orientation, as shown in Figure 8.11.1.1.

8.11.1.2 Alternative 2. For each home suitable for a central air cooling system, the manufacturer shall provide the following statement: "The air distribution system of this home is suitable for the installation of a central air-conditioning system." The statement shall be as shown in Figure 8.11.1.2.

Comfort Cooling Certificate

Manufactured Home Manufacturer: _____
Plant Location: _____
Manufactured Home Model: _____
Air Conditioner Manufacturer: _____

Certified capacity _____ Btu/hr in accordance with the appropriate Air Conditioning and Refrigeration Institute Standards.

The central air-conditioning system provided with this home has been sized assuming an orientation of the front (hitch end) of the home facing _____ . On this basis, the system is designed to maintain an indoor temperature of 75°F (24°C) when outdoor temperatures are _____ °F/°C dry bulb and _____°F/°C wet bulb.

The temperature to which this home can be cooled will change depending upon the amount of exposure of the windows of this home to the sun's radiant heat. Therefore, the home's heat gains will vary dependent upon its orientation to the sun and any permanent shading provided. Information concerning the calculation of cooling loads at various locations, window exposures, and shadings are provided in Chapter 24 of the 1997 ASHRAE *Handbook of Fundamentals*.

FIGURE 8.11.1.1 Sample Comfort Cooling Certificate for Alternative 1.

Comfort Cooling Certificate

Manufactured Home Manufacturer: _____
Plant Location: _____
Manufactured Home Model: _____

The air distribution system of this home is suitable for the installation of a central air-conditioning system.

The supply air distribution system installed in this home is sized for manufactured home central air-conditioning systems of up to _____Btu/hr. This is based on air circulators of such air conditioners rated at 3.0 in. water column static pressure (75 Pa) or greater for the cooling air delivered to the manufactured home supply air duct system.

Information necessary to calculate cooling loads at various locations and orientations is included in the special comfort cooling information provided with this manufactured home.

FIGURE 8.11.1.2 Sample Comfort Cooling Certificate for Alternative 2.

8.11.1.3 Alternative 3. If the manufactured home is not equipped with an air supply duct system, or if the manufacturer elects not to designate the home as being suitable for the installation of a central air-conditioning system, the manufacturer shall provide the following statement: "The air distribution system of this home has not been designed in anticipation of its use with a central air-conditioning system." The statement shall be as shown in Figure 8.11.1.3.

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Comfort Cooling Certificate

Manufactured Home Manufacturer: _____

_____

Plant Location: _____

Manufactured Home Model: _____

The air distribution system of this home has not been designed in anticipation of its use with a central air-conditioning system.

FIGURE 8.11.1.3 Sample Comfort Cooling Certificate for Alternative 3.

8.11.2 Maximum Central Manufactured Home Air-Conditioning Capacity. For each home designated as suitable for central air-conditioning, the manufacturer shall provide the maximum central manufactured home air-conditioning capacity certified in accordance with ARI 210/240, *Unitary Air-Conditioning and Air-Source Heat Pump Equipment,* and in accordance with 10.14.3.1 of this standard. If the capacity information provided is based on entrances to the air supply duct at other than the furnace plenum, the manufacturer shall indicate the correct supply air entrance and return air exit locations.

8.11.3* Comfort Cooling Information. For each manufactured home designated either "suitable for" or "provided with" a central-air conditioning system, the manufacturer shall provide comfort cooling information specific to the manufactured home necessary to complete the cooling load calculations. The comfort cooling information shall include a statement to read as shown in Figure 8.11.3.

Information Provided by the Manufacturer Necessary to Calculate Sensible Heat Gain

Walls (without windows and doors)	_____ U
Ceilings and roofs of light color	_____ U
Ceilings and roofs of dark color	_____ U
Floors	_____ U
Air ducts in floor	_____ U
Air ducts in ceiling	_____ U
Air ducts installed outside the home	_____ U

FIGURE 8.11.3 Manufacturer's Information for Calculation of Sensible Heat Gain.

Chapter 9 Plumbing Systems

9.1 Scope. This chapter shall cover the plumbing materials, fixtures, and equipment installed within or on manufactured homes. It is the intent of this chapter to ensure the use of water supply, drain, waste, and vent systems that permit satisfactory functioning and provide for health and safety under all conditions of normal use.

9.2 Definitions. The following definitions shall apply to Chapter 9 only.

9.2.1 Accessible. Able to approach, access a fixture, connection, appliance, or equipment. Access shall be permitted to require removal of an access panel or the opening of a door.

9.2.2 Air Gap (Water Distribution System). The unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or faucet supplying water to a tank, plumbing fixture, water-supplied appliance, or other device, and the flood level rim of the receptor.

9.2.3 Backflow. The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any source(s) other than its intended source(s).

9.2.4 Backflow Connection. Any arrangement whereby backflow can occur.

9.2.5 Backflow Preventer. A device or means to prevent backflow.

9.2.6 Branch. Any part of the piping system other than a riser, main, or stack.

9.2.7 Continuous Waste. A drain from two or more fixtures connected to a single trap.

9.2.8 Critical Level. A point established by the testing laboratory (usually stamped on the device by the manufacturer) that determines the minimum elevation above the flood level rim of the fixture or receptor served where the device can be installed. When a backflow prevention device does not bear a critical level marking, the bottom of the vacuum breaker, combination valve, or any such approved or listed device shall constitute the critical level.

9.2.9 Cross Connection. Any physical connection or arrangement between two otherwise separate systems or sources, one of which contains potable water and the other either water, steam, gas, or chemical of unknown or questionable safety, whereby there can be a flow from one system or source to the other, the direction of flow depending on the pressure differential between the two systems.

9.2.10 Developed Length. That length of pipe measured along the center line of the pipe and fittings.

9.2.11 Diameter. Unless otherwise specifically stated, the nominal (inside) diameter designated commercially.

9.2.12 Drain. A pipe that carries waste, water, or water-borne waste in a drainage system.

9.2.12.1 Fixture Drain. The drain from the trap of a fixture to the junction of that drain with any other drain pipe.

9.2.12.2 Main Drain. The lowest pipe of a drainage system that receives sewage from all the fixtures within a manufactured home and conducts these wastes to the drain outlet.

9.2.13 Drain Connector. The removable extension, consisting of all pipes, fittings, and appurtenances, from the drain outlet to the drain inlet serving the manufactured home.

9.2.14 Drain Outlet. The lowest end of the main or secondary drain to which a sewer connection is made.

9.2.15 Drainage System. All piping, within or attached to the structure, that conveys sewage or other liquid waste to the drain outlet, not including the drain connector.

9.2.16 Fixture Supply. The water supply pipe connecting a fixture to a branch water supply pipe or directly to a main water supply pipe.

9.2.17 Flood Level. The edge of the receptor or fixture over which water overflows.

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9.2.18 Flooded. The condition that results when the liquid in a fixture, container, or receptor rises to the flood level.

9.2.19 Grade. The fall (slope) of a pipe in reference to a horizontal plane, expressed in inches per foot length (millimeters per meter).

9.2.20 Horizontal Branch. Any pipe extending laterally that receives the discharge from one or more fixture drains and connects to the main drain.

9.2.21 Horizontal Pipe. Any pipe or fitting that makes an angle of not more than 45 degrees with the horizontal.

9.2.22 Inlet Coupling. The terminal end of the water system to which the water service connection is attached. It can be a swivel fitting or threaded pipe end.

9.2.23 Main. The principal artery of the system to which branches can be connected.

9.2.24 Mechanical Vent Device. A device that automatically opens to admit air to a fixture drain above the connection of the trap arm, so as to prevent siphonage, and closes tightly when the pressure within the drainage system is equal to or greater than atmospheric pressure, so as to prevent the escape of gases from the drainage system into the manufactured home.

9.2.25 Offset. A combination of pipe and/or fittings that brings one section of the pipe out of line but into a line parallel with the other section.

9.2.26 Pitch. See 9.2.19, Grade.

9.2.27 Plumbing Appliance. Any one of a special class of plumbing fixtures that is intended to perform a special plumbing function. Its operation and/or control can be dependent upon one or more energized components, such as motors, control, heating elements, or pressure- or temperature-sensing elements. Such fixtures can operate automatically through one or more of the following actions: a time cycle, a temperature range, a pressure range, a measured volume, or weight. Alternatively, the fixture can be manually adjusted or controlled by the user or operator.

9.2.28 Plumbing Appurtenance. A manufactured device, a prefabricated assembly, or an on-the-job assembly of component parts that is an adjunct to the basic piping system, plumbing system, and plumbing fixtures. An appurtenance demands no additional water supply, nor does it add any discharge load to a fixture or to the drainage system.

9.2.29 Plumbing Fixtures. Receptors, devices, or appliances that are supplied with water or receive liquid or liquid-borne wastes for discharge into the drainage system.

9.2.30 Plumbing System. The water supply and distribution pipes; plumbing fixtures, faucets, and traps; soil, waste, and vent pipes; and water-treating or water-using equipment.

9.2.31 Sewage. Any liquid waste containing animal or vegetable matter in suspension or a solution permitted to include liquids containing chemicals in solution.

9.2.32 Siphonage. The loss of water seal from fixture traps resulting from partial vacuum in the drainage system can be induced-siphonage, or self-siphonage, or a combination of the two.

9.2.32.1 Induced-Siphonage. Loss of water seal from fixture traps resulting from vacuum in the drainage system generated by the discharge of one or more fixtures other than the one under observation.

9.2.32.2 Self-Siphonage. Loss of water seal from fixture traps resulting from vacuum in a fixture drain generated solely by the discharge of the fixture served by that drain.

9.2.33 Tank.

9.2.33.1 Flush Tank. That portion of a water closet that is designed to contain sufficient water to adequately flush the fixture.

9.2.33.2 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.

9.2.34 Trap. A fitting or device designed and constructed to provide a liquid seal that will prevent the back-passage of air without materially affecting the flow of liquid waste through it.

9.2.35 Trap Arm. The portion of a fixture drain between a trap and its vent.

9.2.36 Trap Seal. The vertical depth of liquid that a trap will retain.

9.2.37 Vacuum Breaker. See 9.2.5, Backflow Preventer.

9.2.38 Valve.

9.2.38.1 Flush Valve. A device located at the bottom of a flush tank for flushing a water closet.

9.2.38.2 Flushometer Valve. A device that discharges a predetermined quantity of water to a fixture for flushing purposes and is closed by direct water pressure.

9.2.39 Vent.

9.2.39.1 Common Vent. A vent connecting at the junction of fixture drains and serving as a vent for more than one fixture.

9.2.39.2 Continuous Vent. A vertical vent that is a continuation of the drain to which it connects.

9.2.39.3 Individual Vent. A pipe installed to vent a fixture drain.

9.2.39.4 Main Vent. The principal artery of the venting system to which vent branches can be connected.

9.2.39.5 Primary Vent. See 9.2.39.4, Main Vent.

9.2.39.6 Relief Vent. An auxiliary vent that permits additional circulation of air in or between drainage and vent systems.

9.2.39.7 Secondary Vent. Any vent other than the main vent or those vents serving each water closet.

9.2.39.8 Wet Vent. A vent that also serves as a drain for one or more fixtures.

9.2.40 Vent Cap. The device or fitting that protects the vent pipe from foreign substances with an opening to the atmosphere equal to the area of the vent it serves.

9.2.41 Vent System. That part of a piping installation that provides circulation of air within a drainage system.

9.2.42 Vertical Pipe. Any pipe or fitting that makes an angle of not more than 45 degrees with the vertical.

9.2.43 Water Closet Drain. That part of the drainage piping that receives the discharge from each individual water closet.

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9.2.44 Water Connection. The fitting or point of connection for the manufactured home water distribution system designed for connection to a water supply.

9.2.45 Water Connector. The removable extension connecting the manufactured home water distribution system to the water supply.

9.2.46 Water Distribution System. Potable water piping within, or permanently attached to, the manufactured home.

9.2.47 Wet-Vented Drainage System. The specially designed system of drain piping that also vents one or more plumbing fixtures by means of a common waste and vent pipe.

9.2.48 Whirlpool Bathtub. A plumbing appliance consisting of a bathtub fixture that is equipped and fitted with a circulation piping system, pump, and other appurtenances and is so designed to accept, circulate, and discharge bathtub water upon each use.

9.3 General Requirements.

9.3.1 Minimum Requirements. Any plumbing system installed in a manufactured home shall conform with the minimum provisions of Chapter 9.

9.3.1.1 General. The plumbing system shall be of durable material, free from defective workmanship, and so designed and constructed as to give satisfactory service for a reasonable life expectancy.

9.3.1.2 Conservation. Water closets shall not use more than 1.6 gal (6 L) of water.

9.3.1.3 Connection to Drainage System. All plumbing, fixtures, drains, appurtenances, and appliances designed or used to receive or discharge liquid waste or sewage shall be connected to the manufactured home drainage system in a manner provided by this standard.

9.3.1.4 Workmanship. All design, construction, and workmanship shall be in conformance with accepted engineering practices and shall be of such character as to secure the results sought to be obtained by this standard.

9.3.1.5 Components. Plumbing materials, devices, fixtures, fittings, equipment, appliances, appurtenances, and accessories intended for use in, or for being attached to, a manufactured home shall conform to one of the applicable standards referenced in Table 9.4.1. Where an applicable standard is not referenced, or an alternative recognized standard is utilized, the plumbing component shall be listed by a nationally recognized testing laboratory, inspection agency, or other qualified organization as suitable for the intended use.

9.3.1.6 Prohibited Fittings and Practices.

9.3.1.6.1 Drainage or vent piping shall not be drilled and tapped for the purpose of making connections.

9.3.1.6.2 Vent pipes shall not be used as waste or drain pipes.

Exception: As specifically provided elsewhere in this standard.

9.3.1.6.3 Fittings, connections, devices, or methods of installation that obstruct or retard the flow of sewage or the flow of air in the drainage or venting systems in an amount greater than the normal frictional resistance to flow shall not be used unless their use is acceptable in this standard, or their use is accepted as having a desirable and acceptable function of ultimate benefit to the proper and continued functioning of the plumbing system.

9.3.1.6.4 Cracks, holes, or other imperfections in materials shall not be concealed by welding, brazing, or soldering, or by paint, wax, tar, or other leak-sealing or repairing agents.

9.3.1.6.5 Piping, fixtures, or equipment shall be located so as not to interfere with the normal use or with the normal operation and use of windows, doors, or other required facilities.

9.3.1.6.6 Galvanized pipe shall not be bent or welded.

9.3.1.7 Alignment of Fittings. All valves, pipes, and fittings shall be installed in correct relationship to the direction of flow.

9.3.1.8 Installation Practices. Plumbing systems shall be installed in a manner conforming to this standard, other applicable standards, and the manufacturer's installation instructions.

9.3.2 Protective Requirements.

9.3.2.1 Cutting Structural Members. Structural members shall not be unnecessarily or carelessly weakened by cutting or notching.

9.3.2.2 Exposed Piping. All piping, pipe threads, hangers, and supports exposed to the weather, water, mud, and road hazard, and subject to damage therefrom, shall be painted, coated, wrapped, or otherwise protected from deterioration.

9.3.2.3 Road Damage. Pipes, supports, drains, outlets, or drain hoses shall not extend or protrude in a manner where they could be unduly subjected to damage during transit.

9.3.2.4 Freezing. All piping and fixtures subject to freezing temperatures shall be insulated or protected to prevent freezing under normal occupancy. The manufacturer shall provide the following:

(1) Written installation instructions for the method(s) required for compliance to this section
(2) A statement in the installation instructions stating that if heat tape or pipe heating cable is used, it shall be listed for use with manufactured homes

9.3.2.5 Drainage. All piping shall be designed to allow drainage.

Exception: Fixture trap.

9.3.2.6 Rodent Resistance. All exterior openings around piping and equipment shall be sealed to resist the entrance of rodents.

9.3.2.7 Heat Exposure. Piping and electrical wiring shall not pass through the same holes in walls, floors, or roofs. Plastic piping shall not be exposed to heat in excess of manufacturer's recommendation, or to radiation from heat-producing appliances.

9.4 Materials.

9.4.1 Minimum Standards. Materials, devices, fixtures, fittings, equipment, appliances, appurtenances, and accessories shall conform to one of the standards in Table 9.4.1 and shall be free from defects. Where an appropriate standard is not indicated in Table 9.4.1 or a standard not indicated in the table is preferred, the item shall be permitted to be used if it is listed. A listing also shall be required when so specified in other sections of this chapter.

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Table 9.4.1 Minimum Standards for Plumbing Systems

Materials	Reference Standards
Ferrous Pipe and Fittings	
Gray Iron Threaded Fittings	ASME B 16.4-1998
Malleable Iron Threaded Fittings	ASME B 16.3-1998
Welding and Seamless Wrought Steel Pipe	ASME B 36.10M-1995
Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless	ASTM A 53-2001
Pipe Threads, General Purpose (Inch)	ASME B 1.20.1-1992
Standard Specification for Cast Iron Soil Pipe and Fittings	ASTM A 74-1998
Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications	CISPI 301-2001
Nonferrous Pipe and Fittings	
Standard Specification for Seamless Copper Pipe, Standard Sizes	ASTM B 42-2002
Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube	ASTM B 251-1997
Standard Specification for Seamless Copper Water Tube	ASTM B 88-1999
Standard Specification for Copper Drainage Tube (DWV)	ASTM B 306-1999
Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings	ASME B 16.22-1995
Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings-DWV	ASME B 16.29-2002
Cast Copper Alloy Solder-Joint Pressure Fittings	ASME B 16.18-2002
Cast Copper Alloy Solder-Joint Drainage Fittings-DWV	ASME B 16.23-1992
Cast Copper Alloy Fittings for Flared Copper Tubes	ASME B 16.26-1988
Standard Specification for Seamless Red Brass Pipe, Standard Sizes	ASTM B 43-1998
Cast Bronze Threaded Fittings, Classes 125 and 250	ASME B 16.15-1994
Plastic Pipe and Fittings	
Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings	ASTM D 2661-2002
Standard Specification for Solvent Cement for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings	ASTM D 2665-2002
Standard Specification for Drain, Waste and Vent (DWV) Plastic Fittings	ASTM D 3311-1994
Standard Specification for Solvent Cement for Acrylonitrile-Butadiene- Styrene (ABS) Schedule 40, Plastic Drain, Waste, and Vent Pipe with a Cellular Core	ASTM F 628-2001
Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems	ASTM D 2846M-1999
Standard Specification for Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems	ASTM D 3309-1996
Standard Specification for Crosslinked Polyethylene (PEX) Tubing	ASTM F 876-2001
Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems	ASTM F 877-2002
Plastic Piping Components and Related Materials	ANSI/NSF 14-2002
Polyethylene (PE) Plastic Pipe, (SDR-PR) Based on Controlled Inside Diameter	ASTM D 2239-2001
Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe	ASTM D 2609-2002
Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems	ASTM D 2846-1999
Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Sch. 40	ASTM F 438-2002
Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Sch. 80	ASTM F 439-2002
Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Sch. 40 and 80	ASTM F 441-2002
Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings	ASTM F 493-1997
Crosslinked Polyethylene (PEX) Tubing	ASTM F 986-2002

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Table 9.4.1 *Continued*

Materials	Reference Standards
Plastic and Pipe Fittings (continued)	
Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe	ASTM F 1281-2002
Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe	ASTM F 1282-2002
Metal Insert Fittings with Copper Crimp Ring for SDR 9 Crosslinked Polyethylene (PEX) Tubing	ASTM F 1807-2002a
Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Linked Polyethylene (PEX) Tubing	ASTM F 1960-2003
Metal Cold Flare Compression Fittings with Disc Springs for Crosslinked Polyethylene (PEX) Tubing	ASTM F 1961-1999
Metal Insert Fittings for Polyethylene/Aluminum/Polyethylene and Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene Composite Pressure Pipe	ASTM F 1974-2002
Cold-Expansion Fittings With Metal Compression Sleeves for Cross-Linked Polyethylene (PEX) Pipe	ASTM F 2080-2001
Miscellaneous	
Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings	ASTM C 564-1997
Backwater Valves	ASME A 112.14.1-1975 (R1998)
Plumbing Fixture Setting Compound	TT-P-1536A-1975
Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems	ANSI Z 21.22-1999, with Addendum Z
Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings	ASTM D 2235-2001
Standard Specification for Solvent Cement for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems	ASTM D 2564-2002
Specification for Neoprene Rubber Gaskets for HUB and Spigot Cast Iron Soil Pipe and Fittings	CISPI-HSN-1985
Plumbing System Components for Manufactured Homes and Recreational Vehicles	NSF 24-1998
Drinking Water System Components — Health Effects	NSF 61-2002
Material and Property Standard for Diversion Tees and Twin Waste Elbow	IAPMO PS 9-1984
Material and Property Standard for Flexible Metallic Field Fabricated Water Connectors	IAPMO PS 14-2002
Material and Property Standard for Dishwasher Drain Airgaps	IAPMO PS 23-1989
Material and Property Standard for Backflow Prevention Devices	IAPMO PS 31-1995
Plumbing Fixtures	
Plumbing Fixtures (General Specifications)	FS WW P- 541E/GEN-1990
Vitreous China Plumbing Fixtures	ASME A 112.19.2M-1998
Enameled Cast Iron Plumbing Fixtures	ASME A 112.19.1M-1999
Porcelain Enameled Formed Steel Plumbing Fixtures	ASME A 112.19.4M-1999
Plastic Bathtub Units	ANSI Z 124.1-1995, with Addenda Z124.1a-1990 and Z124.16-1991
Standard for Porcelain Enameled Formed Steel Plumbing Fixtures	IAPMO TS 22-1997
Plastic Shower Receptors and Shower Stalls	ANSI Z 124.2-1995, with Addendum Z124.2a-1990
Stainless Steel Plumbing Fixtures (Designed for Residential Use)	ASME A 112.19.3M-1996
Material and Property Standard for Drains for Prefabricated and Precast Showers	IAPMO PS 4-2003a
Plastic Lavatories	ANSI Z 124.3-1995, with Addendum Z124.3a-1990

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Table 9.4.1 *Continued*

Materials	Reference Standards
Plumbing Fixtures (continued)	
Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings	ANSI Z 97.1-1984 (R1994)
Plumbing Fixture Fittings	ANSI A 112.18.1M-1996
Plumbing Fixture Waste Fittings	ASME A 112.18.2-2002
Hydraulic Requirements for Water Closets and Urinals	ANSI A 112.19.6-1995
Trim for Water-Closet Bowls, Tanks, and Urinals	ASME A 112.19.5-1979 (R1999)
Plastic Water-Closet Bowls and Tanks	ANSI Z 124.4-1996, with Addendum Z124.4a-1990
Whirlpool Bathtub Appliances	ASME A 112.19.7M-1995
Performance Requirements for Individual Thermostatic Pressure Balancing and Combination Control Valves for Bathing Facilities	ASSE 1016-1996
Performance Requirements for Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures	ASSE 1037-1990
Performance Requirements for Gravity Operated Mechanical Vents (Air Admittance Valves)	ASSE 1051-2002
Performance Requirements for Water Closet Flush Tank Fill Valves (Ballcocks)	ASSE 1002-1999
Performance Requirements for Handheld Showers	ASSE 1014-1989
Hydrants for Utility and Maintenance Use	ASME A 112.21.3M-1995
Performance Requirements for Home Laundry Equipment	ASSE 1007-1992
Plumbing Requirements for Hot Water Dispensers, Household Storage Type Electrical	ASSE 1023-1979
Plumbing Requirements for Residential Use (Household) Dishwashers	ASSE 1006-1986
Performance Requirements for Household Food Waste Disposer Units	ASSE 1008-1986
Performance Requirements for Temperature-Activated Mixing Valves for Primary Domestic Use	ASSE 1017-1998
Performance Requirements for Water Hammer Arresters	ASSE 1010-1996
Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, Hot Tubs, and Whirlpool Bathtub Appliances	ASME A 112.19.8M-1996
Air Gaps in Plumbing Systems	ASME A 112.1.2-1998
Performance Requirements for Diverters for Plumbing Faucets with Hose Spray, Anti-Siphon Type, Residential Applications	ASSE 1025-1978
Performance Requirements for Pipe Applied Atmospheric Type Vacuum Breakers	ASSE 1001-2002
Performance Requirements for Hose Connection Vacuum Breakers	ASSE 1011-1995
Performance Requirements for Wall Hydrants, Frost Proof Automatic Draining, Anti-Backflow Types	ASSE 1019-1997
Plastic Toilet (Water Closet) Seats	ANSI Z 124.5-1997
Prefabricated Plastic Spa Shells	ANSI Z 124.7-1997
Plastic Bathtub Liners	ANSI Z 124.8-1990
Plastic Urinal Fixtures	ANSI Z 124.9-1994
Water Heater Relief Valve Drain Tubes	ASME A 112.4.1-1998
Flexible Water Connectors	ASME A 112.18.6-1999
Performance Requirements for Backflow Protection Devices and Systems in Plumbing Fixture Fittings	ASME A 112.18.3-1996
Non-Vitreous Ceramic Plumbing Fixtures	ASME A 112.19.9M-1998
Dual Flush Devices for Water Closets	ASME A 112.19.10
Deck Mounted Bath/Shower Transfer Valves with Integral Backflow Protection	ASME A 112.18.7-1999
Plastic Fittings for Connecting Water Closets to the Sanitary Drainage System	ASME A 112.4.3-1999

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9.4.2 Where more than one standard is referenced for a particular material or component, compliance with only one of those standards shall be required.

Exception No. 1: When one of the reference standards requires evaluation of chemical, toxicity, or odor properties that are not included in the other standard, then conformance to the applicable requirements of each standard shall be required.

Exception No. 2: When a plastic material or component is not covered by the standards in Table 9.4.1, it shall be certified as nontoxic in accordance with NSF 14, Plastic Piping Components and Related Materials.

9.5 Joints and Connections.

9.5.1 Tightness. Joints and connections in the plumbing system shall be gastight and watertight for the pressures required under testing procedures.

9.5.2 Assembling of Pipe. All joints and connections shall be correctly assembled for tightness. Pipe threads shall be fully engaged with the threads of the fitting. Plastic pipe and copper tubing shall be inserted to the full depth of the solder cup or welding sockets of each fitting. Pipe threads and slip joints shall not be wrapped with string, paper, putty, or similar fillers.

9.5.3 Threaded Joints. Threads for screw pipe and fittings shall conform to the approved or listed standard. Pipe ends shall be reamed out to size of bore. All burrs, chips, cutting oil, and foreign matter shall be removed. Pipe joint cement or thread lubricant shall be of approved type and applied to male threads only.

9.5.4 Solder Joints. Solder joints for tubing shall be made with approved or listed solder-type fittings. Surfaces to be soldered shall be cleaned bright. The joints shall be properly fluxed with noncorrosive paste-type flux and, for manufactured homes that are to be connected to a public water system, made with solder having not more than 0.2 percent lead.

9.5.5 Plastic Pipe, Fittings, and Joints. Plastic pipe and fittings shall be joined by installation methods recommended by the manufacturer or in accordance with the provisions of a recognized, approved, or listed standard.

9.5.6 Union Joints. Metal unions in water piping shall have metal-to-metal ground seats.

9.5.7 Flared Joints. Flared joints for soft-copper water tubing shall be made with approved or listed fittings. The tubing shall be expanded with a proper flaring tool.

9.5.8 Cast-Iron Soil Pipe Joints. Approved or listed cast-iron pipe shall be permitted to be joined as follows:

(1) Approved or listed hubless pipe and fittings shall be permitted to be joined with listed couplings or adapters, per the manufacturer's recommendations.
(2) Hub and plain-end soil pipe shall be permitted to be joined by compression fittings, per the manufacturer's recommendation.

9.6 Traps and Cleanouts.

9.6.1 Traps.

9.6.1.1 Traps Required. Each plumbing fixture shall be separately trapped by approved water seal "P" traps. All traps shall be effectively vented.

Exception: Listed toilets.

9.6.1.2 Combination Fixtures. A two- or three-compartment sink, up to three single sinks, or up to three lavatories, with waste outlets not more than 30 in. (760 mm) apart, in the same room, and flood level rims at the same level shall be permitted to be connected to one "P" trap and considered as a single fixture for the purposes of drainage and vent requirements.

9.6.1.3 Prohibited Traps. A trap that depends for its seal on concealed interior partitions shall not be used. Full "S" traps, bell traps, drum traps, crown-vented traps, and running traps shall not be permitted. Fixtures shall not be double-trapped.

9.6.1.4 Material and Design. Each trap shall be self-cleaning, with a smooth and uniform interior waterway. Traps shall be manufactured of cast iron, cast brass, or drawn brass tubing of not less than No. 20 Brown and Sharpe gauge, or of approved or listed plastic, or other approved or listed material. Union joints for a trap shall be beaded to provide a shoulder for the union nut. Each trap shall have the manufacturer's name stamped or cast in the body of the trap, and each tubing trap shall show the gauge of the tubing.

9.6.1.5 Trap Seal. Each "P" trap shall have a water seal of not less than 2 in. (50 mm) and not more than 4 in. (100 mm) and shall be set true to its seal.

9.6.1.6 Size. Traps shall be not less than 1¼ in. (32 mm) in diameter. A trap shall not be larger than the waste pipe to which it is connected.

9.6.1.7 Location. Each trap shall be located as close to its vent and fixture outlet as structural conditions will allow.

9.6.1.8 Length of Tailpiece. The vertical distance from a trap to the fixture outlet shall not exceed 24 in. (610 mm).

9.6.1.9 Installation.

9.6.1.9.1 Grade of Trap Arm. The piping between a "P" trap and the fixture tee or the vented waste line shall be graded ¼ in./ft (20 mm/m) toward the vent and in no case shall have a slope greater than its diameter. The vent opening at fixture tees shall not be below the weir of the "P" trap outlet.

9.6.1.9.2 Trap Arm Offset. The piping between the "P" trap and vent shall be permitted to change direction or be offset horizontally with the equivalent of no more than 180 degrees total change in direction, with a maximum of 90 degrees by any one fitting.

9.6.1.9.3 Concealed Traps. Traps with mechanical joints shall be accessible for repair and inspection.

9.6.1.9.4 Removability of Traps. Traps shall be designed and installed so the "U" bend is removable without removing the strainers from the fixture. Continuous waste and tailpieces that are permanently attached to the "U" bend also shall be removable without removing the strainer from the fixture.

9.6.2 Cleanout Openings.

9.6.2.1 Location of Cleanout Fittings.

9.6.2.1.1 Cleanouts shall be installed if the drainage system cannot be cleaned through fixtures, drains, or vents. Cleanouts also shall be provided when fittings of more than 45 degrees are used to effect an offset.

Exception: Where long-turn ells provide sufficient "sweep" for cleaning.

9.6.2.1.2 A full-size cleanout shall be installed at the upper end of any section of drain piping that does not have the required minimum slope of ¼ in./ft (20 mm/m) grade.

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9.6.2.1.3 A cleaning tool shall not be required to pass through more than 360 degrees of fittings, excluding removable "P" traps, to reach any part of the drainage system. Water closets shall be permitted to be removed for drainage system access.

9.6.2.2 Access to Cleanouts. Cleanouts shall be accessible through an unobstructed minimum clearance of 12 in. (305 mm) directly in front of the opening. Each cleanout fitting shall open in a direction opposite to the flow or at right angles to the pipe. Concealed cleanouts that are not provided with access covers shall be extended to a point above the floor or outside of the manufactured home with pipe and fittings installed, as required, for drainage piping without sags and pockets.

9.6.2.3 Material. Plugs and caps shall be brass, or approved or listed plastic, with screw pipe threads.

9.6.2.4 Design. Cleanout plugs shall have raised heads. Plugs at floor level shall have countersunk slots.

9.7 Plumbing Fixtures.

9.7.1 General Requirements.

9.7.1.1 Quality of Fixtures. Plumbing fixtures shall have smooth, impervious surfaces, be free from defects and concealed fouling surfaces, be capable of resisting road shock and vibration, and conform in quality and design to listed standards. Fixtures shall be permanently marked with the manufacturer's name or trademark.

9.7.1.2 Strainers. The waste outlet of all plumbing fixtures shall be equipped with a drain fitting that will provide an adequate unobstructed waterway.

Exception: Toilets.

9.7.1.3 Fixture Connections. Fixture tailpieces and continuous wastes in exposed or accessible locations shall be not less than No. 20 Brown and Sharpe gauge seamless drawn-brass tubing or other approved pipe or tubing materials. Inaccessible fixture connections shall be constructed according to the requirements for drainage piping. Each fixture tailpiece, continuous waste, or waste and overflow shall be not less than 1½ in. (40 mm) for sinks of two or more compartments, dishwashers, clothes washing machines, laundry tubs, bathtubs, and showers; and not less than 1¼ in. (32 mm) for lavatories and single-compartment sinks that have a 2 in. (50 mm) maximum drain opening.

9.7.1.4 Concealed Connections. Concealed slip joint connections shall be provided with adequately sized, unobstructed access panels and shall be accessible for inspection and repair.

9.7.1.5 Directional Fitting. An approved or listed "Y" or other directional-type branch fitting shall be installed in every tailpiece or continuous waste that receives the discharge from food waste disposal units, dishwashing, or other forced-discharge fixture or appliance. *(See also 9.7.2.4.2.)*

9.7.1.6 Water Conservation. All lavatory faucets, shower heads, and sink faucets shall not exceed a flow of 2.5 gpm (9.5 L/min).

9.7.2 Fixtures.

9.7.2.1 Spacing. All plumbing fixtures shall be located and installed so as to be reasonably accessible for their intended use.

9.7.2.2 Water Closets.

9.7.2.2.1 Water closets shall be designed and manufactured according to approved or listed standards and shall be equipped with a water-flushing device capable of adequately flushing and cleaning the bowl at each operation of the flushing mechanism.

9.7.2.2.2 Water closet flushing devices shall be designed to replace the water seal in the bowl after each operation. Flush valves, flushometer valves, flushometer tanks, and ball cocks shall automatically shut off at the end of each flush or when the tank is filled to operating capacity.

9.7.2.2.3 All water closets shall be low consumption [1.6 gpf (6 L)] closets.

9.7.2.2.4 Flush tanks shall be fitted with an overflow pipe large enough to prevent flooding at the maximum flow rate of the ball cock. Overflow pipes shall discharge into the toilet through the tank.

9.7.2.2.5 Water closets that have fouling surfaces that are not thoroughly washed at each discharge shall not be permitted. Any water closet that allows the contents of the bowl to be siphoned back into the water system shall not be permitted.

9.7.2.2.6 Floor Connection. Water closets shall be securely bolted to an approved flange or other approved fitting that is secured to the floor by means of corrosion-resistant screws. The bolts shall be of solid brass or other corrosion-resistant material and shall be not less than ¼ in. (6 mm) in diameter. A watertight seal shall be made between the water closet and flange or other approved fitting by use of a gasket, sealing compound, or listed connector device.

9.7.2.3 Shower Compartment.

9.7.2.3.1 Each shower compartment shall be provided with an approved watertight receptor with sides and back extending at least 1 in. (25 mm) above the finished dam or threshold. In no case shall the depth of a shower receptor be less than 2 in. (50 mm) or more than 9 in. (230 mm) measured from the top of the finished dam or threshold to the top of the drain. The wall area shall be constructed of smooth, noncorrosive, and nonabsorbent waterproof materials to a height not less than 6 ft (2 m) above the bathroom floor level. Such walls shall form a watertight joint with each other and with the bathtub, receptor, or shower floor. The floor of the compartment shall slope uniformly to the drain at not less than ¼ in./ft (20 mm/m) or more than ½ in./ft (43 mm/m).

9.7.2.3.2 The joint around the drain connection shall be made watertight by a flange, clamping ring, or other approved, listed means.

9.7.2.3.3 Shower doors and tub and shower enclosures shall be constructed so as to be waterproof, and, if they are glazed, glazing shall comply with ANSI Z 97.1, *Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings.*

9.7.2.3.4 Prefabricated plumbing fixtures shall be approved or listed.

9.7.2.3.5 Showers, bathtub, and bath-shower combinations shall be protected with individual control valves of the pressure-balancing, thermostatic, or combination pressure-balancing mixing valve type. The handle position or limit stops on such valves shall be set to deliver a maximum hot water setting of 120°F (49°C). The water heater thermostat shall not be considered a suitable control for adjusting the maximum hot water setting.

9.7.2.4 Dishwashing Machines.

9.7.2.4.1 A dishwashing machine shall discharge its waste through a fixed air gap installed above the machine; through a

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high loop as specified by the dishwashing machine manufacturer; or into an open standpipe-receptor with a height greater than the washing compartment of the machine. When a standpipe is used, it shall be at least 18 in. (457 mm), but not more than 30 in. (762 mm), above the trap weir. The drain connections from the air gap or high loop shall be permitted to connect to an individual trap; to a directional fitting installed in the sink tailpiece; or to an opening provided on the inlet side of a food waste disposal unit.

9.7.2.4.2 The drain from a dishwashing machine shall not be connected to a sink tailpiece, continuous waste line, or trap on the discharge side of a food waste disposal unit.

9.7.2.5 Clothes Washing Machines.

9.7.2.5.1 Clothes washing machines shall drain either into a properly vented trap, into a laundry tub tailpiece with watertight connections, into an open standpipe receptor, or over the rim of a laundry tub.

9.7.2.5.2 Standpipes shall be either 1½ in. (40 mm) minimum nominal iron pipe size, 1½ in. (40 mm) diameter nominal brass tubing not less than No. 20 Brown and Sharpe gauge, or 1½ in. (40 mm) approved plastic materials. Receptors shall discharge into a vented trap or shall be connected to a laundry tub tailpiece by means of an approved or listed directional fitting. Each standpipe shall extend not less than 18 in. (457 mm) or more than 48 in. (1219 mm) above its trap and shall terminate in an accessible location no lower than the top of the clothes washing machine. A removable, tight-fitting cap or plug shall be installed on the standpipe when a clothes washing machine is not provided.

9.7.2.5.3 The clothes washing machine drain shall not be connected to the tailpiece, continuous waste, or trap of any sink or dishwashing machine.

9.7.2.6 Shower Valves. Shower and tub-shower combination valves shall be balanced pressure, thermostatic, or combination mixing valves that conform to the requirements of ASSE 1016, *Performance Requirements for Individual Thermostatic Pressure Balancing and Combination Control Valves for Bathing Facilities*. Such valves shall be equipped with handle position stops that are adjustable in accordance with the valve manufacturer's instructions to a maximum hot water setting of 120°F (49°C).

9.7.3 Installation.

9.7.3.1 Access. Each plumbing fixture and standpipe receptor shall be located and installed so as to be accessible for usage, cleaning, repair, and replacement. Access to diverter valves and other connections from the fixture hardware shall not be required.

9.7.3.2 Alignment. Fixtures shall be set level and in true alignment with adjacent walls. Where practical, piping from fixtures shall extend to the nearest wall.

9.7.3.3 Brackets. Wall-hung fixtures shall be rigidly attached to walls by metal brackets or supports without any strain being transmitted to the piping connections. Flush tanks shall be securely fastened to water closets or to the wall with corrosive-resistant materials.

9.7.3.4 Tub Supports. Bathtub rims at the wall shall be supported on metal hangers or on end-grain wood blocking attached to the wall unless otherwise recommended by the manufacturer of the tub.

9.7.3.5 Fixture Fittings. Faucets and diverters shall be installed so that the flow of hot water from the fittings corresponds to the left-hand side of the fitting.

9.7.3.6 Hydromassage Bathtub.

9.7.3.6.1 Access Panel. A door or panel of sufficient size shall be installed to provide access to the pump for repair and/or replacement.

9.7.3.6.2 Piping Drainage. The circulation pump shall be accessibly located above the crown weir of the trap. The pump drain line shall be properly sloped to drain the volute after fixture use.

9.7.3.6.3 Piping. Hydromassage bathtub circulation piping shall be installed so as to be self-draining.

9.7.3.6.4 Electrical. Electrical installations shall be in accordance with Article 680, Part VII, of NFPA 70, *National Electrical Code*.

9.8 Hangers and Supports.

9.8.1 Strains and Stresses. Piping in a plumbing system shall be installed without undue strains and stresses, and provisions shall be made for expansion, contraction, and structural settlement.

9.8.2 Piping Supports. Piping shall be secured at sufficiently close intervals to keep the pipe in alignment and carry the weight of the pipe and contents. Unless otherwise stated in the referenced standards in Table 9.4.1, or unless specified by the pipe manufacturer, horizontal plastic drainage piping shall be supported at intervals not to exceed 4 ft (1220 mm), and horizontal plastic water piping shall be supported at intervals not to exceed 3 ft (915 mm). Vertical drainage and water piping shall be supported at each story height.

9.8.3 Hangers and Anchors.

9.8.3.1 Hangers and anchors shall be of sufficient strength to support their proportional share of the pipe alignments and prevent rattling.

9.8.3.2 Piping shall be securely attached to the structure by hangers, clamps, or brackets that provide protection against motion, vibration, road shock, or torque in the chassis.

9.8.3.3 Hangers and straps supporting plastic pipe shall not compress, distort, cut, or abrade the piping and shall allow free movement of the pipe.

9.9 Water Distribution Systems.

9.9.1 Water Supply.

9.9.1.1 Supply Piping. Piping systems shall be sized to provide an adequate quantity of water to each plumbing fixture at a flow rate sufficient to keep the fixture in a clean and sanitary condition without any danger of backflow or siphonage *(see Table 9.9.6.1)*. The manufacturer shall include in the written installation instructions that the manufactured home has been designed for an inlet water pressure of 80 psi (552 kPa), and a statement that when the manufactured home is to be installed in areas where the water pressure exceeds 80 psi (552 kPa), a pressure-reducing valve shall be installed.

9.9.1.2 Hot Water Supply. Each manufactured home equipped with a kitchen sink, bathtub, and/or shower shall be provided with a hot water supply system, including a listed water heater.

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9.9.2 Water Outlets and Supply Connections.

9.9.2.1 Water Connection. Each manufactured home with a water distribution system shall be equipped with a ¾ in. (20 mm) threaded inlet connection. This connection shall be tagged or marked "Fresh Water Connection" (or "Fresh Water Fill"). A matching cap or plug shall be provided to seal the water inlet when it is not in use and shall be permanently attached to the manufactured home or water supply piping. When a master cold water shutoff full-flow valve is not installed on the main feeder line in an accessible location, the manufacturer's installation instructions shall indicate that such a valve is to be installed in the water supply line adjacent to the home. When a manufactured home includes expandable rooms or is composed of two or more units, fittings or connectors designed for such purpose shall be provided to connect any water piping. When not connected, the water piping shall be protected by means of matching threaded caps or plugs.

9.9.2.2 Prohibited Connections.

9.9.2.2.1 The installation of potable water supply piping, or fixture or appliance connections, shall be made in a manner that prevents the possibility of backflow.

9.9.2.2.2 No part of the water system shall be connected to any drainage or vent piping.

9.9.2.3 Rim Outlets. The outlets of faucets, spouts, and similar devices shall be spaced at least 1 in. (25 mm) above the flood level of the fixture.

9.9.2.4 Appliance Connections. Water supplies connected to clothes washing or dishwashing machines shall be protected by an approved or listed fixed air gap provided within the appliance by the manufacturer.

9.9.2.5 Flushometer Valves or Manually Operated Flush Valves. An approved or listed vacuum breaker shall be installed and maintained in the water supply line on the discharge side of a water closet flushometer valve or manually operated flush valve. Vacuum breakers shall have a minimum clearance of 6 in. (152 mm) above the flood level of the fixture to the critical level mark unless otherwise permitted in their approval.

9.9.2.6 Flush Tanks. Water closet flush tanks shall be equipped with an approved or listed anti-siphon ball cock that shall be installed and maintained with its outlet or critical level mark not less than 1 in. (25 mm) above the full opening of the overflow pipe.

9.9.2.7 Hose Bibbs. When provided, all exterior hose bibbs and laundry sink hose connections shall be protected by a listed nonremovable backflow prevention device. This provision shall not be applicable to hose connections provided for automatic washing machines with built-in backflow prevention or water heater drain valves.

9.9.2.8 Flushometer Tanks. Flushometer tanks shall be equipped with an approved air gap or vacuum breaker assembly that is located above the flood level rim above the fixture.

9.9.3 Water Heater Safety Devices.

9.9.3.1 Relief Valves. All water heaters shall be installed with approved and listed fully automatic valve(s) designed to provide temperature and pressure relief.

9.9.3.1.1 Any temperature relief valve or combined pressure and temperature relief valve installed for this purpose shall have the temperature-sensing element immersed in the hot-test water within the upper 6 in. (152 mm) of the tank. It shall be set to start relieving at a pressure of 150 psi (1034 kPa) or the rated working pressure of the tank, whichever is lower, and at or below a water temperature of 210°F (99°C).

9.9.3.1.2 Relief valves shall be provided with full-sized drains, with cross-section areas equivalent to that of the relief valve outlet. The outlet of a pressure relief valve, temperature relief valve, or combination thereof, shall not be directly connected to the drainage system. The discharge for the relief valve shall be piped full size separately to the outside of the dwelling unit or to an approved location inside the dwelling unit. Drain lines shall be of a material listed for hot water distribution and shall drain fully by gravity, shall not be trapped, and shall not have their outlets threaded. The end of the drain shall be visible for inspection.

9.9.4 Materials.

9.9.4.1 Water distribution pipe and fittings shall be of brass copper, copper, cast iron, CPVC, galvanized malleable iron, galvanized wrought iron, galvanized steel, PEX, PEX-AL-PEX, or other listed or approved materials. PE-AL-PE water pipe and fittings shall be used only for cold-water distribution systems. All materials used in the water supply system, except valves and similar devices, shall be of a like material, except where listed or approved.

9.9.4.2 Copper tube for water piping shall have a weight of not less than Type L.

9.9.4.3 All hard-drawn copper tubing, in addition to the required incised marking, shall be marked in accordance with 19.3.1 and 19.3.2 of ASTM B 88, *Standard Specification for Seamless Copper Water Tube*. The colors shall be Type K, green; Type L, blue; Type M, red; and Type DWV, yellow.

9.9.4.4 Listed flexible copper water connectors shall be installed in readily accessible locations, unless otherwise listed.

9.9.4.5 Cast iron fittings up to and including 2 in. (51 mm) in size, when used in connection with potable water piping, shall be galvanized.

9.9.4.6 All malleable iron water fittings shall be galvanized.

9.9.4.7 Piping and tubing that has been used previously for any purpose other than for potable water systems shall not be used.

9.9.4.8 Solder shall conform to the requirements of 9.5.4.

9.9.4.9 Water pipe and fittings with a lead content that exceeds 8 percent shall be prohibited in piping systems used to convey potable water.

9.9.4.10 PEX. Cross-linked polyethylene (PEX) tubing shall be marked with the appropriate standard designation(s) listed in Table 9.4.1 for which the tubing has been approved.

9.9.4.10.1 PEX Fittings. Metal insert fittings, metal compression fittings, and cold expansion fittings used with PEX tubing shall be manufactured to and marked in accordance with the standards for the fittings in Table 9.4.1.

9.9.4.10.2 Water Heater Connections. PEX, PEX-AL-PEX, or PE-ALPE tubing shall not be installed within the first 18 in. (457 mm) of piping connected to a water heater.

9.9.4.11 Flexible Corrugated Connectors. Flexible corrugated connectors of copper or stainless steel shall be limited to the following connector lengths:

(1) Water heater connectors — 24 in. (609 mm)
(2) Fixture connectors — 30 in. (762 mm)

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(3) Washing machine connectors — 72 in. (1827 mm)
(4) Dishwasher and icemaker connectors — 120 in. (3048 mm).

9.9.4.12 PEX-AL-PEX and PE-AL-PE. Crosslinked polyethylene-aluminum-crosslinked polyethylene (PEX-AL-PEX) and polyethylene-aluminum-polyethylene (PE-AL-PE) composite pipe shall be marked with the appropriate standard designations listed in Table 9.4.1 for which the piping has been listed or approved. PEX-AL-PEX and PE-AL-PE piping shall be installed in compliance with the provisions of this section.

9.9.4.12.1 PEX-AL-PEX and PE-AL-PE. Fittings used with PEX-AL-PEX and PE-AL-PE piping shall be manufactured to and marked in accordance with the standard for the fittings in Table 9.4.1.

9.9.5 Installation of Piping.

9.9.5.1 Minimum Requirement. All piping equipment, appurtenances, and devices shall be installed in a workmanlike manner and shall conform with the provisions and intent of this standard.

9.9.5.2 Screw Pipe. Iron pipe-size brass or galvanized iron or steel pipe fittings shall be joined with approved or listed standard pipe threads fully engaged in the fittings. Pipe ends shall be reamed to the full bore of the pipe. Pipe-joint compound shall be insoluble in water, nontoxic, and applied to male threads only.

9.9.5.3 Solder Fittings. Joints in copper water tubes shall be made by the appropriate use of approved cast brass or wrought copper fittings and shall be properly soldered together. The surface to be soldered shall be thoroughly cleaned bright by mechanical means. The joints shall be properly fluxed and made with a solder that contains no more than 0.2 percent lead.

9.9.5.4 Flared Fittings. A flaring tool shall be used to shape the ends of flared tubing to match the flare of fittings.

9.9.5.5 Plastic Pipe and Fittings. Plastic pipe and fittings shall be joined by installation methods recommended by the manufacturer or in accordance with provisions of a listed standard.

9.9.5.5.1 CPVC Solvent Cement Plastic Pipe Joints. CPVC pipe and fittings shall be cleaned and then joined with listed primer(s) and solvent cement(s).

9.9.5.5.2 Listed solvent cements that do not require the use of primer shall be permitted for use with CPVC pipe and fittings, manufactured in accordance with ASTM D 2846M, *Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems*, ½ in. through 2 in. in diameters. [UPC, 316.1.6]

9.9.6 Size of Water Supply Piping.

9.9.6.1 Minimum Size. The size of water supply piping and branch lines shall not be less than the sizes shown in Table 9.9.6.1.

9.9.6.2 Sizing Procedure. Both hot and cold water piping systems shall be computed by the following method:

(1) *Size of Branch.* Start at the most remote outlet on any branch of the hot or cold water piping and progressively count toward the water service connection, computing the total number of fixtures supplied along each section of piping. Where branches are joined together, the number of fixtures on each branch shall be totaled so that no fixture is counted twice. Following down the left-hand column of the preceding table, a corresponding number of fixtures will be found. The required pipe or tubing size is indicated in the other columns on the same line.
(2) *Non-Water-Using Fixtures.* A water heater, food waste disposal unit, evaporative cooler, or ice maker shall not be counted as a water-using fixture when computing pipe sizes.

9.9.7 Line Valves. Valves, when installed in the water supply distribution system and fully opened, shall have a cross-sectional area of the smallest orifice or opening through which the water flows at least equal to the cross-sectional area of the nominal size of the pipe in which the valve is installed.

Exception: Those valves immediately controlling a one-fixture supply.

9.10 Drainage Systems.

9.10.1 General.

9.10.1.1 Each fixture directly connected to the drainage system shall be installed with a water seal trap. *(See 9.6.1.)*

9.10.1.2 The drainage system shall be designed to provide an adequate circulation of air in all piping, with no danger of siphonage, aspiration, or forcing of trap seals under conditions of ordinary use.

9.10.2 Materials.

9.10.2.1 Pipe. Drainage piping shall be standard weight galvanized steel, brass, copper tube DWV, listed Schedule 40 ABS plastic, listed Schedule 40 PVC plastic, cast iron, or other listed or approved materials.

Table 9.9.6.1 Minimum Size Tubing and Pipe for Water Distribution Systems

Number of Fixtures	Tubing (nominal)				Pipe Iron Pipe Size	
	Diameter		Outer Diameter			
	in.	mm	in.	mm	in.	mm
1	¼*	8	⅜	10	½	15
2	⅜	10	½	15	½	15
3	½	15	⅝	18	½	15
4	½	15	⅝	18	½	15
5 or more	¾	20	⅞	22	¾	20

*6 ft (1830 mm) maximum length.

Exceptions: ⅜ in. (10 mm) nominal diameter or ½ in. (15 mm) OD minimum size for clothes washing or dishwashing machines, unless larger size is recommended by the fixture manufacturer. ½ in. (15 mm) nominal diameter or ⅝ in. (16 mm) OD minimum size for flushometer or metering-type valves unless otherwise specified in their listing. No galvanized screw piping shall be less than ½ in. (15 mm) iron pipe size.

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9.10.2.2 Fittings. Drainage fittings shall be of a recessed drainage pattern with smooth interior waterways of the same diameter as the piping and of a material conforming to the type of piping used. Drainage fittings shall be designed to provide for a ¼ in./ft (20 mm/m) grade in horizontal piping.

9.10.2.2.1 Fittings for screw pipe shall be cast iron, malleable iron, brass, or listed plastic and shall have standard pipe threads.

9.10.2.2.2 Fittings for copper tubing shall be cast brass or wrought copper.

9.10.2.2.3 Socket-type fittings for plastic piping shall comply with those standards listed in Table 9.4.1.

9.10.2.2.4 Brass or bronze adapter or wrought copper fittings shall be used to join copper tubing to threaded pipe.

9.10.3 Drain Outlets.

9.10.3.1 General. Each manufactured home shall have only one drain outlet.

9.10.3.2 Clearance from Drain Outlet. The drain outlet shall be provided with a minimum clearance of 3 in. (76 mm) in any direction from all parts of the structure or appurtenances, and with not less than 18 in. (457 mm) unrestricted clearance directly in front of the drain outlet.

9.10.3.3 Drain Connector. The drain connector shall not be smaller than the piping to which it is connected and shall be equipped with a watertight cap or plug matching the drain outlet. The cap or plug shall be permanently attached to the manufactured home or drain outlet.

9.10.3.4 Pipe Size. The drain outlet and drain connector shall not be less than 3 in. (75 mm) inside diameter.

9.10.3.5 Preassembly of Drain Lines. Section(s) of the drain system that are designed to be located underneath the manufactured home or between stories of a manufactured home shall not be required to be factory installed when the manufacturer designs the system for site assembly and also provides all materials and components, including piping, fittings, cement, supports, and instructions necessary for proper site installation.

9.10.4 Fixture Connections. Drainage piping shall be provided with approved or listed inlet fittings for fixture connections that are correctly located according to the size and type of fixture to be connected.

9.10.4.1 Water Closet Connection. The drain connection for each water closet shall be 3 in. (76 mm) minimum inside diameter and shall be fitted with an iron, brass, or listed plastic floor flange adapter ring securely screwed, soldered, or otherwise permanently attached to the drain piping in an approved manner and shall be securely fastened to the floor.

9.10.5 Size of Drainage Piping — Fixture Load. Drain pipe sizes shall be determined by the type of fixture and the total number of fixtures connected to each drain.

Exception: As provided by 9.11.4.

9.10.5.1 Fixture drains shall be sized as follows:

(1) Fixture drains serving a single lavatory shall be 1¼ in. (32 mm) minimum.
(2) Fixture drains serving other fixtures or multiple fixtures up to three shall be 1½ in. (40 mm) minimum.
(3) Fixture drains shall not be smaller than the sizes specified in 9.7.2.

9.10.5.2 Piping that has a 2 in. (50 mm) minimum diameter shall be required for four or more individually vented fixtures.

9.10.5.3 Piping that has a 3 in. (75 mm) minimum diameter shall be required for water closets.

9.10.6 Wet-Vented Drainage System. Plumbing fixture traps shall be permitted to connect into a wet-vented drainage system designed and installed to accommodate the passage of air and waste in the same pipe.

9.10.6.1 Horizontal Piping. All parts of a wet-vented drainage system, including the connected fixture drains, shall be horizontal. Where required by structural design, wet-vented drain piping shall be permitted to be offset vertically when other vented fixture drains or relief vents are connected to the drain piping at or below the vertical offsets.

Exception: Wet-vented vertical risers shall terminate with a 1½ in. (40 mm) minimum diameter continuous vent.

9.10.6.2 Size. A wet-vented drain pipe shall be 2 in. (50 mm) minimum diameter and at least one pipe size larger than the largest connected trap or fixture drain. No more than three fixtures shall be permitted to connect to a 2 in. (50 mm) diameter wet-vented drain system.

9.10.6.3 Length of Trap Arm. Fixture traps shall be located within the distance given in 9.11.3.5. No more than one trap shall connect to a trap arm.

9.10.7 Offsets and Branch Fittings.

9.10.7.1 Changes in Direction. Changes in the direction of drainage piping shall be made by the appropriate use of approved or listed fittings and shall be of the following angles: 11¼ degrees, 22½ degrees, 45 degrees, 60 degrees, or 90 degrees, or other approved or listed fittings or combinations of fittings with equivalent radius or sweep.

9.10.7.2 Horizontal to Vertical. Horizontal drainage lines connecting with a vertical pipe shall enter through 45-degree "Y" branches, 60-degree "Y" branches, long-turn "TY" branches, sanitary "T" branches, or other approved or listed fittings or combination of fittings having equivalent sweep. Fittings having more than one branch at the same level shall not be used unless the fitting is constructed so that the discharge from any one branch cannot readily enter any other branch. However, a double sanitary "T" shall be permitted to be used when the drain line is increased not less than two pipe sizes.

9.10.7.3 Horizontal-to-Horizontal and Vertical-to-Horizontal. Horizontal drainage lines connecting with other horizontal drainage lines, or vertical drainage lines connecting with horizontal drainage lines, shall enter through 45-degree "Y" branches, long-turn "TY" branches, or other approved or listed fittings or combination of fittings having equivalent sweep.

9.10.8 Grade of Horizontal Drainage Piping. Horizontal drainage piping shall be run in practical alignment and shall have a uniform grade of not less than ¼ in./ft (20 mm/m) toward the manufactured home drain outlet. Where it is impractical, due to the structural features or arrangement of any manufactured home, to obtain a grade of ¼ in./ft (20 mm/m), the pipe or piping shall be permitted to have a grade of not less than ⅛ in./ft (10 mm/m) when a full-size cleanout is installed at the upper end.

Exception: Fixture connections on the inlet side of the trap.

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9.11 Vents and Venting.

9.11.1 General. Each plumbing fixture trap shall be protected against siphonage and back pressure. Air circulation shall be ensured throughout all parts of the drainage system by means of vents installed in accordance with the requirements of Section 9.11 and as otherwise required by this standard.

9.11.2 Materials.

9.11.2.1 Pipe. Vent piping shall be standard weight galvanized steel, brass, copper tube DWV, listed Schedule 40 ABS plastic, listed Schedule 40 PVC plastic, cast iron, or other listed or approved materials.

9.11.2.2 Fittings. Appropriate fittings shall be used for all changes in direction or size and at the location where pipes are joined. The material and design of vent fittings shall conform to the type of piping used.

9.11.2.2.1 Fittings for screw pipe shall be cast iron, malleable iron, plastic, or brass and shall have standard pipe threads.

9.11.2.2.2 Fittings for copper tubing shall be cast brass or wrought copper.

9.11.2.2.3 Fittings for plastic piping shall be made in accordance with approved applicable standards.

9.11.2.2.4 Brass adapter fittings or wrought copper shall be used to join copper tubing to threaded pipe.

9.11.2.2.5 Listed rectangular tubing shall be permitted to be used for vent piping only, provided it has an open cross section at least equal to the circular vent pipe required. Listed transition fittings shall be used.

9.11.3 Size of Vent Piping.

9.11.3.1 Main Vent. The drain piping for each water closet shall be vented by a 1½ in. (40 mm) minimum diameter vent or by a rectangular vent of venting cross section equivalent to or greater than the venting cross section of a 1½ in. (40 mm) diameter vent. The vent shall be connected to the water closet drain by one of the following methods:

(1) A 1½ in. (40 mm) minimum diameter individual vent pipe or equivalent that is directly connected to the water closet drain piping within the distance allowed in Table 9.11.3.5 for 3 in. (75 mm) trap arms undiminished in size through the roof.
(2) A 1½ in. (40 mm) minimum diameter continuous vent or equivalent that is indirectly connected to the water closet drain piping within the distance allowed in Table 9.11.3.5 for 3 in. (75 mm) trap arms through a 2 in. (50 mm) wet-vented drain that carries the waste of not more than one fixture. Sections of the wet vented drain that is 3 in. (75 mm) diameter shall be permitted to carry the waste of an unlimited number of fixtures.
(3) Two or more vented drains, when at least one is wet-vented or 2 in. (50 mm) minimum diameter and each drain is separately connected to the water closet drain. At least one of the drains shall connect within the distance allowed in Table 9.11.3.5 for 3 in. (75 mm) trap arms.

9.11.3.2 Vent Pipe Areas. Each individually vented fixture with a 1½ in. (40 mm), or smaller, trap shall be provided with a vent pipe equivalent in area to a 1¼ in. (32 mm) nominal pipe size. The main vent, water closet vent, relief vent, and the continuous vent of wet-vented systems shall have an area equivalent to 1½ in. (40 mm) nominal pipe size.

9.11.3.3 Common Vent. Where two fixture traps located within the distance allowed from their vent have their trap arms connected separately at the same level into an approved double fitting, an individual vent pipe shall be permitted to serve as a common vent without any increase in size.

9.11.3.4 Intersecting Vents. Where two or more vent pipes are joined together, no increase in size shall be required; however, the largest vent pipe shall extend full-size through the roof.

9.11.3.5 The distance of the fixture trap from the vent shall not exceed the values given in Table 9.11.3.5.

Table 9.11.3.5 Maximum Distance of Fixture Traps from Vent

Size of Fixture Drain		Distance of Trap from Vent	
in.	mm	ft	mm
1½	32	4½	1372
1½	40	4½	1372
2	50	5	1525
3	75	6	1830

9.11.4 Mechanical Vents. Where mechanical vents are used as a secondary vent system for plumbing fixtures that are protected by traps, they shall comply with 9.11.4.1 or 9.11.4.2.

9.11.4.1 Spring-operated mechanical (anti-siphon) vents shall comply with the following.

9.11.4.1.1 No more than two fixtures individually protected by the spring-operated mechanical vent shall be drained by a common 1½ in. (40 mm) drain.

9.11.4.1.2 Minimum drain size for three or more fixtures individually protected by the spring-operated mechanical vent shall be 2 in. (50 mm).

9.11.4.1.3 Spring-operated mechanical vents shall be restricted to venting fixtures with 1½ in. (40 mm) traps.

9.11.4.1.4 A spring-operated mechanical vent shall be installed in a location that allows a free flow of air and shall be accessible for inspection, maintenance, and replacement. The sealing function shall be at least 6 in. (152 mm) above the top of the trap arm.

9.11.4.1.5 Materials for the spring-operated mechanical vents shall be as follows:

(1) Cap and housing shall be listed acrylonitrile-butadiene-styrene, DWV grade.
(2) Stem shall be DWV grade nylon or acetal.
(3) Spring shall be stainless steel wire, Type 302.
(4) Sealing disc shall be either of the following:
   (a) Neoprene, conforming to CISPI HSN-85, *Specification for Neoprene Rubber Gaskets for HUB and Spigot Cast Iron Soil Pipe and Fittings*, and ASTM C 564, *Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings*
   (b) ASTM C 920, *Standard Specification for Elastomeric Joint Sealants*, and ASTM D 4635, *Specification for Low-Density Polyethylene Films for General Use and Packaging Applications*

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9.11.4.2 Gravity-operated mechanical (air admittance valves) vents shall comply with the following:

9.11.4.2.1 Where installed to vent any fixture, the drain system shall have a minimum 1½ in. (40 mm) diameter vent that terminates outside the manufactured home.

9.11.4.2.2 Where gravity-operated mechanical vent devices terminate in the attic cavity, the following shall apply:

(1) The attic cavity is accessible as described in 9.11.4.1.4.
(2) The sealing device is installed a minimum of 6 in. (152 mm) above building insulation materials.
(3) The attic is vented in accordance with 8.4.4.1.

9.11.4.3 Mechanical vents shall be installed in accordance with the manufacturer's installation instructions.

9.11.5 Grade and Connections — Horizontal Vents. Each vent shall extend vertically from its fixture "T" or point of connection with the waste piping to a point not less than 6 in. (152 mm) above the extreme flood level of the fixture it is venting before offsetting horizontally or being connected with any other vent pipe. Vents for horizontal drains shall connect above the centerline of the drain piping ahead (downstream) of the trap. Where required by structural conditions, vent piping shall be permitted to offset below the rim of the fixture at the maximum angle or height possible.

9.11.6 Vent Terminal. Vents shall terminate through the roof, wall, or to a mechanical vent device, in accordance with 9.11.4.

9.11.6.1 Roof Extension. Each vent pipe shall extend through its flashing and terminate vertically. Vents that extend through the roof shall extend undiminished in size, not less than 2 in. (50 mm) above the roof. Vent openings shall not be less than 3 ft (914 mm) away from any motor-driven air intake that opens into habitable areas.

9.11.6.2 Wall Vent Extensions. Extensions through exterior walls shall terminate downward, shall have a screen to prevent entrance of birds and rodents, and shall be located as follows:

(1) Extensions shall not be located beneath a door.
(2) Extensions shall be a minimum of 10 ft (3 m) above the finished floor.
(3) Extensions shall not be located beneath a window or other opening.
(4) Extensions shall be located a minimum of 2 ft (0.6 m) above any building opening within 5 ft (1.5 m) horizontally.

9.11.6.3 Flashing. The opening around each roof vent pipe shall be made watertight by flashing or flashing material. Wall vent pipe penetrations shall be made watertight.

9.11.7 Vent Caps. Vent caps, if provided, shall be of the removable type (without removing the flashing from the roof). When vent caps are used for roof space ventilation and the caps are identical to vent caps used for the plumbing system, plumbing system caps shall be identified with permanent markings.

9.12 Tests and Inspection.

9.12.1 Water System. All water piping in the water distribution system shall be subjected to a pressure test. The test shall be made by subjecting the system to air or water at 80 psi + 5 psi (552 kPa + 35 kPa) for 15 minutes without loss of pressure. The water used for the test shall be obtained from a potable source of supply.

9.12.2 Drainage and Vent System and Plumbing Fixtures. The waste and vent system shall be tested by one of the following three methods for evidence or indication of leakage:

(1) *Water Test.* Before plumbing fixtures are connected, all of the openings into the piping shall be plugged and the entire piping system subjected to a static water test for 15 minutes by filling it with water to the top of the highest vent opening. There shall be no evidence of leakage.
(2) *Air Test.* After all fixtures have been installed, the traps filled with water, and the remaining openings securely plugged, the entire system shall be subjected to a 2 in. (50 mm) (manometer) water column air pressure test. If the system loses pressure, smoke shall be permitted to be pumped into the system to locate the leaks, or soap suds shall be permitted to be spread on the exterior of the piping (bubble test).
(3) *Flood Level Test.* The manufactured home shall be in a level position, all fixtures shall be connected, and the entire system shall be filled with water to the rim of the water closet bowl. (Tub and shower drains shall be plugged.) After all trapped air has been released, the test shall be sustained for not less than 15 minutes without evidence of leaks. Then the system shall be unplugged and emptied. The waste piping above the level of the water closet bowl shall then be tested. There shall be no indication of leakage when the high fixtures are filled with water and emptied simultaneously to obtain the maximum possible flow in the drain piping.

9.12.3 Fixture Test. The plumbing fixtures and connections shall be subjected to a flow test by filling them with water and checking for leaks and retarded flow while they are being emptied.

9.12.4 Shower Compartments. Shower compartments and receptors shall be tested for leaks prior to being covered by finish material. Each pan shall be filled with water to the top of the dam for not less than 15 minutes without evidence of leakage.

Chapter 10 Heating, Cooling, and Fuel-Burning Systems

10.1 Scope. This chapter shall cover the heating, cooling, and fuel-burning equipment installed within, on, or external to a manufactured home.

10.2 Definitions. The following definitions shall apply to Chapter 10 only. *(See Section 5.2.)*

10.2.1 Accessible. Able to approach, access a fixture, connection, appliance, or equipment. Access shall be permitted to require the removal of an access panel, door, or similar obstruction.

10.2.2 Air Conditioner Blower Coil System. A comfort cooling appliance where the condenser section is placed external to the manufactured home and the evaporator section with circulating blower is attached to the manufactured home air supply duct system. Provision must be made for a return air system to the evaporator/blower section. Refrigerant connection between the two parts of the system is accomplished by tubing.

10.2.3 Air Conditioner Split System. A comfort cooling appliance where the condenser section is placed external to the manufactured home and the evaporator section is incorporated into the heating appliance or with a separate blower/coil section

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within the manufactured home. Refrigerant connection between the two parts of the system is accomplished by tubing.

10.2.4 Air-Conditioning Condenser Section. That portion of a refrigerated air cooling or, in the case of a heat pump, heating system that includes the refrigerant pump (compressor) and the external heat exchanger.

10.2.5 Air-Conditioning Evaporator Section. A heat exchanger used to cool or, in the case of a heat pump, heat air for use in comfort cooling, or heating, the living space.

10.2.6 Air-Conditioning Self-Contained System. A comfort cooling appliance that combines the condenser section, evaporator, and air circulating blower into one unit with connecting ducts for the supply and return air systems.

10.2.7 Air Duct. Conduit or passageway for conveying air to or from heating, cooling, air conditioning, or ventilation equipment, but not including the plenum.

10.2.8 Automatic Pump (Oil Lifter). A pump that is not an integral part of the oil-burning appliance and that automatically pumps oil from the supply tank and delivers the oil under a constant head to an oil-burning appliance.

10.2.9 Btu (British Thermal Unit). The quantity of heat required to raise the temperature of 1 lb of water 1°F.

10.2.10 Btu/hr. British thermal units per hour.

10.2.11 Burner. A device used for the final conveyance of fuel or a mixture of fuel and air to the combustion zone.

10.2.12 Central Air-Conditioning System. Either an air-conditioning split system or an external combination heating/cooling system.

10.2.13 Class 0 Air Ducts and Air Connectors. Air ducts and air connectors having a fire hazard classification of zero when tested in accordance with UL 181, *Standard for Safety Factory-Made Air Ducts and Air Connectors*.

10.2.14 Class 1 Air Ducts and Air Connectors. Air ducts and air connectors having a flame spread index of not over 25 without evidence of continued progressive combustion and a smoke-developed index of not over 50 when tested in accordance with UL 181, *Standard for Safety Factory-Made Air Ducts and Air Connectors*.

10.2.15 Clearance. The distance between the appliance, chimney vent, chimney, or vent connector or plenum and the nearest surface.

10.2.16 Combination Space Heating and Water Heating Appliance. A listed unit that is designed to provide space heating and water heating from a single primary energy source.

10.2.17 Connector-Gas Appliance. A flexible or semi-rigid connector used to convey fuel gas between a gas outlet and a gas appliance.

10.2.18 Direct-Vent System. A system or method of construction where all air for combustion is derived directly from the outside atmosphere and all flue gases are discharged to the outside atmosphere.

10.2.19 Direct-Vent System Appliance. An appliance that is installed with a direct-vent system.

10.2.20 External Combination Heating/Cooling System. A comfort conditioning system placed external to the manufactured home with connecting ducts to the manufactured home for the supply and return air systems.

10.2.21 Factory-Built Fireplace. A hearth, fire chamber, and chimney assembly composed of listed factory-built components assembled in accordance with the terms of listing to form a complete fireplace.

10.2.22 Fireplace Stove. A chimney-connected solid fuel-burning stove having part of its fire chamber open to the room.

10.2.23 Fuel Gas Piping System. The arrangement of piping, tubing, fittings, connectors, valves, and devices designed and intended to supply or control the flow of fuel gas to the appliance(s).

10.2.24 Fuel Oil Piping System. The arrangement of piping, tubing, fittings, connectors, valves, and devices designed and intended to supply or control the flow of fuel oil to the appliance(s).

10.2.25 Gas Clothes Dryer. A device used to dry wet laundry by means of heat derived from the combustion of fuel gases.

10.2.26 Gas Refrigerator. A gas-burning appliance designed to extract heat from a suitable chamber.

10.2.27 Gas Supply Connection. The terminal end or connection to which a gas supply connector is attached.

10.2.28 Gas Supply Connector, Manufactured Home. A listed, flexible connector designed to connect the manufactured home to the gas supply source.

10.2.29 Gas Vents. Factory-built vent piping and vent fittings, listed by an approved testing agency, that are assembled and used in accordance with the terms of their listings for conveying flue gases to the outside atmosphere.

10.2.29.1 Gas Vent, Type B. A gas vent for venting gas appliances with draft hoods and other gas appliances listed for use with Type B gas vents.

10.2.29.2 Gas Vent, Type BW. A gas vent for venting listed gas-fired vented wall furnaces.

10.2.30 Heating Appliance. An appliance for comfort heating, domestic water heating, or a combination of comfort heating and domestic water heating.

10.2.31 Heat-Producing Appliance. All heating and cooking appliances and fuel-burning appliances.

10.2.32 Liquefied Petroleum Gases. The terms *liquefied petroleum gases*, *LPG*, and *LP-Gas*, as used in this standard, shall mean and include any material that is composed predominantly of any of the following hydrocarbons, or mixtures of hydrocarbons: propane, propylene butanes (normal butane or isobutane), and butylenes.

10.2.33 Plenum. An air compartment that is part of an air-distributing system, to which one or more ducts or outlets are connected.

10.2.33.1 Furnace Return Plenum. A plenum that is attached directly to, or is an integral part of, the return inlet of the furnace.

10.2.33.2 Furnace Supply Plenum. A plenum that is attached directly to, or is an integral part of, the air supply outlet of the furnace.

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10.2.34 Quick-Disconnect Device. A hand-operated device that provides a means for connecting and disconnecting a gas supply or for connecting gas systems, and which is equipped with an automatic means to shut off the gas supply when the device is disconnected.

10.2.35 Readily Accessible. Direct access without the necessity of removing any panel, door, or similar obstruction.

10.2.36 Roof Jack. That portion of a manufactured home heater flue or vent assembly, including the cap, insulating means, flashing, and ceiling plate, located in and above the roof of a manufactured home.

10.2.37 Sealed Combustion System Appliance. An appliance that by its inherent design is constructed so that all air supplied for combustion, the appliance's combustion system, and all products of combustion are completely isolated from the atmosphere of the space where it is installed.

10.2.38 Water Heater. An appliance for heating water for domestic purposes.

10.3 Minimum Standards. Heating, cooling, and fuel-burning appliances and systems in manufactured homes shall be free of defects and conform to applicable standards in Table 10.3 unless otherwise specified in this standard *(see Section 1.4)*. When more than one standard is referenced, compliance with any one such standard shall meet the requirements of this standard.

Table 10.3 Minimum Standards for Heating, Cooling, and Fuel-Burning Systems

Materials	Reference Standards
Appliances	
Standard for Safety Liquid Fuel-Burning Heating Appliances for Manufactured Homes and Recreational Vehicles	UL 307A, seventh edition, 1995
Electric Baseboard Heating Equipment	UL 1042, fourth edition, 1994
Gas-Burning Heating Appliances for Manufactured Homes and Recreational Vehicles	UL 307B, fourth edition, 1995
Gas Clothes Dryers, Vol. 1, Type 1 Clothes Dryers	ANSI Z 21.5.1-1999, with Addendum Z21.5.1a 1999
Gas-Fired Absorption Summer Air Conditioning Appliances	ANSI Z 21.40.1-1996, with Addendum Z 21.40.1a-1997
Gas-Fired Central Furnaces	ANSI Z 21.47-1998, with Addendum Z 21.47a-1999
Vented Gas-Fired Space Heating Appliances	ANSI Z 21.86-1998, with Addendum Z 21.86a-1999
Decorative Gas Appliances for Installation in Solid-Fuel Burning Fireplaces	ANSI Z 21.60-1996
Vented Gas Fireplaces	ANSI Z 21.88-1998, with Addenda Z 21.88a-1998 and Z 21.88b-1999
Household Cooking-Gas Appliances	ANSI Z 21.1-1996
Refrigerators Using Gas Fuel	ANSI Z 21.19-1990, with Addenda Z 21.19a-1992 and Z 21.19b-1995
Gas Water Heaters, Vol. 1, Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less	ANSI Z 21.10.1-1998, with Addendum Z21.10.1-2000
Household Electric Storage Tank Water Heaters	UL 174, ninth edition, 1996
Standard for Fixed and Location-Dedicated Electric Room Heaters	UL 2021-2002
Heating and Cooling Equipment	UL 1995, second edition, with revisions through July 31, 1998
Ferrous Pipe and Fittings	
Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless	ASTM A 53-2001
Standard Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines	ASTM A 539-90a-1999
Pipe Threads, General Purpose (Inch)	ASME B 1.20.1-1992
Welded and Seamless Wrought Steel Pipe	ASME B 36.10M-1995
Gas Piping Systems Using Corrugated Stainless Steel Tubing	LC 1-1997, with Addenda LC-1a-1999

(Sheet 1 of 2)

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Table 10.3 *Continued*

Materials	Reference Standards
Nonferrous Pipe, Tubing, and Fittings	
Standard Specification for Seamless Copper Water Tube	ASTM B 88-1999
Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service	ASTM B 280-1999
Metal Connectors for Gas Appliances	ANSI Z 21.24-1997, with Addendum Z21.24a-2000
Manually Operated Gas Valves for Appliances, Appliance Connector Valves, and Hose End Valves	ANSI Z 21.15-1997
Standard for Gas Supply Connectors for Manufactured Homes	IAPMO TS 9-1997
Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube	ASTM B 251-1997
Standard Specification for Seamless Copper Pipe, Standard Sizes	ASTM B 42-2002
Miscellaneous	
Standard for Factory-Made Air Ducts and Connectors	UL 181, ninth edition, 1996
Tube Fittings for Flammable and Combustible Fluids, Refrigeration Service, and Marine Use	UL 109, sixth edition, 1997
Standard for Pigtails and Flexible Hose Connectors for LP-Gas	UL 569, eighth edition, 1996
Roof Jacks for Manufactured Homes and Recreational Vehicles	UL 311, eighth edition, 1994
Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems	ANSI Z 21.22-1999, with Addendum Z
Automatic Gas Ignition Systems and Components	ANSI Z 21.20-2000, with Addendum Z 21.20a
Automatic Valves for Gas Appliances	ANSI Z 21.21-1995, with Addenda Z 21.21a-1998 and Z.21.21b-1999
Gas Appliance Thermostats	ANSI Z 21.23-2000
Gas Vents	UL 441, ninth edition, 1996
Standard for the Installation of Oil-Burning Equipment	NFPA 31, 2001
National Fuel Gas Code	ANSI Z 223.1/NFPA 54, 1999
Standard for the Installation of Warm Air Heating and Air-Conditioning Systems	NFPA 90B, 2002
Liquefied Petroleum Gas Code	NFPA 58, 2001
Flares for Tubing	SAE J 533b, 1992
Chimneys, Factory-Built Residential Type and Building Heating Appliance	UL 103, tenth edition, 2001
Factory-Built Fireplaces	UL 127-1996
Room Heaters, Solid-Fuel Type	UL 1482, fifth edition, 1996
Fireplace Stoves	UL 737, eighth edition, 1996

10.4 Gas Piping Systems.

10.4.1 General. The requirements of Section 10.4 shall govern the installation of all fuel-gas piping attached to any manufactured home. The gas piping supply system shall be designed for a pressure no more than 14 in. (3.4 kPa) water column (½ psi) and no less than 7 in. (1.7 kPa) water column (¼ psi). The manufacturer shall indicate in its written installation instructions the design pressure limitations for safe and effective operation of the gas piping system. None of the requirements listed in Section 10.4 shall apply to the piping supplied as a part of an appliance. All exterior openings around piping, ducts, plenums, or vents shall be sealed to resist the entrance of rodents.

10.4.2 Materials. All materials used for the installation, extension, alteration, or repair of any gas piping system shall be new and free from defects or internal obstructions. It shall not be permitted to repair defects in gas piping or fittings. Inferior or defective materials shall be removed and replaced with acceptable material. The system shall be made of materials having a melting point of not less than 1450°F (788°C), except as provided in 10.4.5. The gas piping system shall consist of one or more of the materials described in 10.4.2.1 through 10.4.2.4.

10.4.2.1 Steel or wrought-iron pipe shall comply with ANSI B 36.10M, *Welded and Seamless Wrought Steel Pipe*. Threaded brass pipe in iron pipe sizes shall be permitted to be used. Threaded brass pipe shall comply with ASTM B 43, *Standard Specification for Seamless Red Brass Pipe, Standard Sizes*.

10.4.2.2 Fittings for gas piping shall be wrought iron, malleable iron, steel, or brass (containing not more than 75 percent copper).

10.4.2.3 Copper tubing shall be annealed type, Grade K or Grade L, conforming to ASTM B 88, *Standard Specification for Seamless Copper Water Tube,* or shall comply with ASTM B 280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*. Copper tubing shall be internally tinned.

10.4.2.4 Steel tubing shall have a minimum wall thickness of 0.032 in. (0.8 mm) for tubing of ½ in. (15 mm) diameter and

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smaller and 0.049 in. (1.2 mm) for diameters ½ in. (15 mm) and larger. Steel tubing shall be constructed in accordance with ASTM A 539, *Standard Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines,* and shall be externally corrosion-protected.

10.4.2.5 Corrugated stainless steel tubing (CSST) systems shall be listed and installed in accordance with ANSI/IAS LC-1, *Gas Piping Systems Using Corrugated Stainless Steel Tubing,* and the requirements of this section.

10.4.3 Piping Design. Each manufactured home requiring fuel gas for any purpose shall be equipped with a natural gas piping system acceptable for LP-Gas. Where fuel-gas piping is to be installed in more than one section of an expandable or multiple-unit home, the design and construction of the crossover(s) shall be in accordance with 10.4.3.1 through 10.4.3.7.

10.4.3.1 All points of crossover beneath the transportable sections shall be readily accessible from the exterior of the home. In multi-story dwelling units, the connections between stories shall be accessible through a panel on the exterior or interior of the dwelling unit.

10.4.3.2 The connection(s) between units shall be made with a connector(s) listed for exterior use or direct plumbing sized in accordance with 10.4.4. A shutoff valve of the nondisplaceable rotor type, conforming to ANSI Z 21.15, *Manually Operated Gas Valves for Appliances, Appliance Connector Valves, and Hose End Valves,* suitable for outdoor use, shall be installed at each crossover point upstream of the connection when listed connectors are used.

10.4.3.3 The connection(s) shall be permitted to be made by a listed quick-disconnect device that is designed to provide a positive seal of the supply side of the gas system when such device is separated.

10.4.3.4 The flexible connector, direct plumbing pipe, or "quick-disconnect" device shall be provided with protection from mechanical and impact damage and shall be located to minimize the possibility of tampering.

10.4.3.5 For gas line crossover connections made with either hard pipe or flexible connectors, the crossover point(s) shall be capped on the supply side to provide a positive seal and covered on the other side with a suitable protective covering.

10.4.3.6 Suitable protective coverings for the connection device(s), when separated, shall be permanently attached to the device or flexible connector.

10.4.3.7 When a quick-disconnect device is installed, a tag with a minimum size of 3 in. × 1¾ in. (75 mm × 44 mm) made of etched, metal-stamped, or embossed brass; stainless steel; anodized or alclad aluminum not less than 0.020 in. (0.5 mm) thick; or other approved material [e.g., 0.005 in. (0.1 mm) plastic laminate] shall be permanently attached on the exterior wall adjacent to the access to the quick-disconnect device. Each tag shall be legibly inscribed, in letters no smaller than ¼ in. (6 mm) high, with the following statement:

WARNING: DO NOT USE TOOLS TO SEPARATE THE QUICK-DISCONNECT DEVICE.

10.4.4 Gas Pipe Sizing. Gas piping systems shall be sized so that the pressure drop to any appliance inlet connection from any gas supply connection, when all appliances are in operation at maximum capacity, is not more than 0.5 in. (0.12 kPa) water column, as determined on the basis of a test or in accordance with Table 10.4.4. When determining gas pipe sizing in Table 10.4.4, gas shall be assumed to have a specific gravity of 0.65 and be rated at 1000 Btu/ft^3 (37 mJ/m^3). The natural gas supply connection(s) shall be no less than the size of the gas piping, but shall be no smaller than ¾ in. (19 mm) nominal pipe size.

10.4.5 Joints for Gas Pipe. All pipe joints in the piping system, unless welded or brazed, shall be threaded joints that comply with ANSI/ASME B 1.20.1, *Pipe Threads, General Purpose (Inch).* Right and left nipples or couplings shall not be used. Unions, if used, shall be of ground-joint type. The material used for welding or brazing pipe connections shall have a melting temperature in excess of 1000°F (538°C).

10.4.6 Joints for Tubing.

10.4.6.1 Tubing joints shall be made with either a single or a double flare of 45 degrees in accordance with SAE-J 533b, *Flares for Tubing,* or with other listed vibration-resistant fittings, or joints shall be permitted to be brazed with material having a melting point exceeding 1000°F (538°C). Metallic ball-sleeve compression-type tubing fittings shall not be used.

10.4.6.2 Steel tubing joints shall be made with a double flare in accordance with SAE-J 533b, *Flares for Tubing.*

10.4.7 Pipe Joint Compound. Screw joints shall be made tight with listed pipe joint compound that is insoluble in liquefied petroleum gas. Pipe joint compound shall be applied to the male threads only.

10.4.8 Concealed Tubing. Copper tubing shall not be run inside walls, floors, partitions, or roofs. Corrugated stainless steel tubing (CSST) shall be permitted to be run inside walls, floors, partitions, and roofs under the following conditions:

(1) Where they are protected from accidental puncture by a steel striker barrier not less than 0.0508 in. (1.3 mm) thick, or equivalent, installed between the tubing and the finished wall and that extends at least 4 in. (100 mm) beyond concealed penetrations of plates, fire stops, wall studs, and so forth
(2) Where the tubing is installed in single runs and not rigidly secured

10.4.8.1 Where tubing passes through exterior walls, floors, partitions, roofs, or similar construction, such tubing shall be protected by the use of weather-resistant grommets that shall fit snugly both the tubing and the hole through which the tubing passes or as specified by the tubing manufacturer's installation instructions.

10.4.9 Concealed Joints. Piping or tubing joints shall not be located in any floor, wall partition, or similar concealed construction space.

10.4.10 Gas Supply Connections. When gas appliances are installed, at least one gas supply connection shall be provided on each home dwelling unit.

10.4.11 Identification of Gas Supply Connections. Each manufactured home dwelling unit shall have permanently affixed to the exterior skin, at or near each gas supply connection or the end of the pipe, a tag with a minimum size of 3 in. × 1¾ in. (75 mm × 44 mm) made of etched, metal-stamped, or embossed brass; stainless steel; anodized or alclad aluminum not less than 0.020 in. (0.5 mm) thick, or other approved material [e.g., 0.005 in. (0.1 mm) plastic laminate], with the information shown in Figure 10.4.11. The connector capacity indicated on this tag shall be equal to or greater than the total Btu/hr rating of all intended gas appliances.

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Table 10.4.4 Maximum Capacity of Different Sizes of Pipe and Tubing in Thousands of Btu/hr of Natural Gas for Gas Pressures of 0.5 psig or Less, and a Maximum Pressure Drop of ½ in. Water Column

Iron Pipe Sizes — Length										
ID		**10 ft**	**20 ft**	**30 ft**	**40 ft**	**50 ft**	**60 ft**	**70 ft**	**80 ft**	**90 ft**	**100 ft**
¼ in.		43	29	24	20	18	16	15	14	13	12
⅜ in.		95	65	52	45	40	36	33	31	29	27
½ in.		175	120	97	82	73	66	61	57	53	50
¾ in.		360	250	200	170	151	138	125	118	110	103
1 in.		680	465	375	320	285	260	240	220	215	195
Corrugated Stainless Steel Tubing — Length*										
EHD†	**ID**	**10 ft**	**20 ft**	**30 ft**	**40 ft**	**50 ft**	**60 ft**	**70 ft**	**80 ft**	**90 ft**	**100 ft**
13	⅜ in.	31	21	17	14	13	12	11	10	10	9
15	⅜ in.	42	30	24	20	18	16	15	14	13	12
18	½ in.	79	56	45	39	36	33	30	28	27	25
19	½ in.	91	64	52	45	40	36	35	32	31	29
23	¾ in.	155	111	92	80	72	65	60	58	55	52
25	¾ in.	184	132	108	93	84	77	71	66	62	60
30	1 in.	317	222	180	156	138	126	116	108	103	97
31	1 in.	368	258	209	180	161	147	135	127	120	113
37	1¼ in.	598	426	350	304	273	250	231	217	205	195
Copper Tubing — Length										
OD		**10 ft**	**20 ft**	**30 ft**	**40 ft**	**50 ft**	**60 ft**	**70 ft**	**80 ft**	**90 ft**	**100 ft**
¼ in.		27	18	15	13	11	10	9	9	8	8
⅜ in.		56	38	31	26	23	21	19	18	17	16
½ in.		113	78	62	53	47	43	39	37	34	33
¾ in.		197	136	109	93	83	75	69	64	60	57
1 in.		280	193	155	132	117	106	98	91	85	81

For SI units, 1000 Btu = 0.293 kW; 1 ft = 0.305 m; 1 psi = 6.894 kPa; 1 in. water column = 0.249 kPa.

*Includes losses for four 90-degree bends and two end fittings. Tubing runs with larger numbers of bend and/or fittings shall be increased by an equivalent length of tubing according to the following equation: $L = 1.3n$, where L is actual length (ft) of tubing and n is the number of additional fittings and/or bends.

†EHD (equivalent hydraulic diameter) is a measure of the hydraulic efficiency between different tubing sizes.

Combination LP-Gas and Natural Gas Systems

This gas piping system is designed for use with either liquefied petroleum gas or natural gas.

NOTICE: BEFORE TURNING ON GAS, BE CERTAIN APPLIANCES ARE DESIGNED FOR THE GAS CONNECTED AND ARE EQUIPPED WITH CORRECT ORIFICES. SECURELY CAP THIS INLET WHEN NOT CONNECTED FOR USE.

When connecting to lot outlet, use a listed gas supply connector for mobile homes rated at ❑ 100,000 Btu/hr or more; ❑ 250,000 Btu/hr or more.

Before turning on gas, make certain that all gas connections have been made tight, all appliance valves are turned off, and any unconnected outlets are capped.

After turning on gas, test gas piping and connections to appliances for leakage with soapy water or bubble solution, and light all pilots.

FIGURE 10.4.11 Gas Supply Connection Identification Tag Information.

10.4.12 LP-Gas Supply Connectors.

10.4.12.1 A listed LP-Gas flexible connector conforming to UL 569, *Standard for Pigtails and Flexible Hose Connectors for LP-Gas,* or equivalent, shall be supplied when LP-Gas cylinder(s) and regulator(s) are supplied.

10.4.12.2 Appliance Connections. All gas-burning appliances shall be connected to the fuel piping. Materials such as those provided in 10.4.2 or listed appliance connectors shall be used. Listed appliance connectors, when used, shall not run through walls, floors, ceilings, or partitions, except for cabinetry, and shall be 3 ft (914 mm) or less in length, or in the case of cooking appliances, 6 ft (1830 mm) or less. Aluminum connectors shall not be used outdoors. A manufactured home containing a combination LP-Gas and natural gas system shall be permitted to be provided with a gas outlet to supply exterior appliances, when installed in accordance with 10.4.12.2.1 through 10.4.12.2.4.

10.4.12.2.1 No portion of the completed installation shall project beyond the wall of the manufactured home.

10.4.12.2.2 The outlet shall be provided with an approved quick-disconnect device designed to provide a positive seal on the supply side of the gas system when the appliance is discon-

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nected. A shutoff valve of the nondisplaceable rotor type, conforming to ANSI Z 21.15, *Manually Operated Gas Valves for Appliances, Appliance Connector Valves, and Hose End Valves,* shall be installed immediately upstream of the quick-disconnect device. The complete device shall be provided as part of the original installation.

10.4.12.2.3 Protective caps or plugs for the quick-disconnect device, when disconnected, shall be permanently attached to the manufactured home adjacent to the device.

10.4.12.2.4 A tag shall be permanently attached to the outside of the exterior wall of the manufactured home, as close as possible to the gas supply connection. The tag shall indicate the type of gas and the Btu/hr capacity of the outlet and shall be legibly inscribed with the following statement:

WARNING: THIS OUTLET IS DESIGNED FOR USE WITH PORTABLE GAS APPLIANCES WHOSE TOTAL INPUT DOES NOT EXCEED _____ BTU/HR. REPLACE PROTECTIVE COVERING OVER CONNECTOR WHEN NOT IN USE.

10.4.12.3 Valves. A shutoff valve shall be installed in the fuel piping at each appliance inside the manufactured home structure, upstream of the union or connector, in addition to any valve on the appliance, and shall be arranged so as to be accessible for the servicing of the appliance and removal of its components. The shutoff valve shall be located within 6 ft (1830 mm) of a cooking appliance and within 3 ft (914 mm) of any other appliance. A shutoff valve shall be permitted to serve more than one appliance if located in accordance with these requirements. Shutoff valves shall be of the nondisplaceable rotor type and conform to ANSI Z 21.15, *Manually Operated Gas Valves for Appliances, Appliance Connector Valves, and Hose End Valves.*

10.4.12.4 Gas Piping System Openings. All openings in the gas piping system shall be made gastight with threaded pipe plugs or pipe caps.

10.4.12.5 Electrical Ground. Gas piping shall not be used for an electrical ground.

10.4.12.6 Couplings. Pipe couplings and unions shall be used to join sections of threaded piping. Right and left nipples or couplings shall not be used.

10.4.12.7 Hangers and Supports. All horizontal gas piping shall be adequately supported by galvanized or equivalently protected metal straps or hangers at intervals of not more than 4 ft (1220 mm), except where adequate support and protection is provided by structural members. Vertical gas piping in multi-story dwelling units shall be supported at intervals of not more than 6 ft (1.8 m). Solid iron pipe connection(s) shall be rigidly anchored to a structural member within 6 in. (152 mm) of the supply connection(s).

Exception: Where adequate support and protection is provided by structural members.

10.4.12.8 Testing for Leakage.

10.4.12.8.1 Before appliances are connected, piping systems shall stand a pressure of 3 psi ± 0.2 psi gauge (21 kPa ± 1.5 kPa gauge) for a period of not less than 10 minutes without showing any drop in pressure. Pressure shall be measured with a mercury manometer or slope gauge calibrated so as to be read in increments of not greater than one-tenth pound, or be measured with an equivalent device. The source of normal operating pressure shall be isolated before the pressure tests are performed. Before a test is begun, the temperature of the ambient air and of the piping shall be approximately the same, and constant air temperature shall be maintained throughout the test.

10.4.12.8.2 After appliances are connected, the piping system shall be pressurized to no less than a 10 in. water column (2.5 kPa), nor more than a 14 in. water column (3.5 kPa), and the appliance connections shall be tested for leakage with soapy water or bubble solution.

10.4.12.8.3 Where gas piping between transportable sections must be made by means of hard pipe installed on site, the installation instructions shall contain provisions for on-site testing for leakage.

10.5 Oil Piping Systems.

10.5.1 General. The requirements of Section 10.5 shall govern the installation of all liquid fuel piping attached to any manufactured home. None of the requirements listed in Section 10.5 shall apply to the piping in the appliance(s).

10.5.2 Materials. All materials used for the installation, extension, alteration, or repair of any oil piping systems shall be new and free from defects or internal obstructions. The system shall be made of materials having a melting point of not less than 1450°F (788°C), except as provided in 10.5.4 and 10.5.5. Oil piping systems shall consist of one or more of the materials described in 10.5.2.1 through 10.5.2.4.

10.5.2.1 Steel or wrought-iron pipe shall comply with ANSI B 36.10M, *Welded and Seamless Wrought Steel Pipe.* Threaded copper or brass pipe in iron pipe sizes shall be permitted to be used.

10.5.2.2 Fittings for oil piping shall be wrought iron, malleable iron, steel, or brass (containing not more than 75 percent copper).

10.5.2.3 Copper tubing shall be annealed type, Grade K or Grade L, conforming to ASTM B 88, *Standard Specification for Seamless Copper Water Tube,* or shall comply with ASTM B 280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.*

10.5.2.4 Steel tubing shall have a minimum wall thickness of 0.032 in. (0.8 mm) for diameters up to ½ in. (15 mm) and 0.049 in. (1.2 mm) for diameters ½ in. (15 mm) and larger. Steel tubing shall be constructed in accordance with ASTM A 539, *Standard Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines,* and shall be externally corrosion-protected.

10.5.3 Size of Oil Piping. The minimum size of all fuel-oil tank piping connecting outside tanks to the appliance shall be no smaller than ⅜ in. (9 mm) OD copper tubing or ¼ in. (6 mm) IPS. If No. 1 fuel oil is used with a listed automatic pump (fuel lifter), copper tubing shall be sized as specified by the pump manufacturer.

10.5.4 Joints for Oil Piping. All pipe joints in the piping system, unless welded or brazed, shall be threaded joints that comply with ASME B 1.20.1, *Pipe Threads, General Purpose (Inch).* The material used for brazing pipe connections shall have a melting temperature in excess of 1000°F (538°C).

10.5.5 Joints for Tubing. Joints in tubing shall be made with either a single or double flare of the degree recommended by the tubing manufacturer by means of listed tubing fittings, or

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shall be brazed with materials having a melting point in excess of 1000°F (538°C).

10.5.6 Pipe Joint Compound. Threaded joints shall be made tight with listed pipe joint compound applied to the male threads only.

10.5.7 Couplings. Pipe couplings and unions shall be used to join sections of threaded pipe. Right and left nipples or couplings shall not be used.

10.5.8 Grade of Piping. Fuel-oil piping installed in conjunction with gravity feed systems to oil heating equipment shall slope in a gradual rise upward from a central location to both the oil tank and the appliance in order to eliminate air locks.

10.5.9 Strap Hangers. All oil piping shall be adequately supported by galvanized or equivalently protected metal straps or hangers at intervals of not more than 4 ft (1220 mm). Solid iron pipe oil supply connection(s) shall be rigidly anchored to a structural member within 6 in. (152 mm) of the supply connection(s).

Exception: Where adequate support and protection is provided by structural members.

10.5.10 Testing Tag. A tag shall be affixed to the oil-fired appliance(s) stating the following: Before setting the system in operation, tank installations and piping shall be checked for oil leaks with fuel oil of the same grade that will be burned in the appliance. No other material shall be used for testing fuel oil tanks and piping. Tanks shall be filled to maximum capacity for the final check for oil leakage.

10.6 Heat-Producing Appliances.

10.6.1 Heat-producing appliances and vents, and the roof jacks and chimneys necessary for their installation in manufactured homes, shall be listed or certified by a nationally recognized testing agency for use in manufactured homes.

10.6.1.1 A manufactured home shall be provided with a comfort heating system.

10.6.1.1.1 When a manufactured home is designed to contain a heating appliance, the heating appliance shall be installed by the manufacturer of the manufactured home in compliance with applicable sections of this chapter.

10.6.1.1.2 When a manufactured home is designed for field application of an external heating or combination heating/cooling appliance, preparation of the manufactured home for this external application shall comply with the applicable sections of this chapter.

10.6.1.2 Gas- and oil-burning comfort heating appliances shall have an Annual Fuel Utilization Efficiency of not less than as specified in the *National Appliance Energy Conservation Act.*

10.6.2 Fuel-burning, heat-producing appliances and refrigeration appliances shall be of the vented type and shall vent to the outside. *(See Section 10.9.)*

Exception: Ranges and ovens.

10.6.3 Fuel-burning appliances shall not be converted from one fuel to another fuel unless converted in accordance with the terms of their listing and the appliance manufacturer's instructions.

10.6.4 Performance Efficiency. All automatic storage water heaters shall comply with the efficiency requirements of the *National Appliance Energy Conservation Act.*

10.6.5 Each space heating, cooling, or combination heating and cooling system shall be provided with at least one readily adjustable automatic control for regulation of living space temperature. The control shall be placed a minimum of 3 ft (914 mm) from the vertical edge of the appliance compartment door. It shall not be located on an exterior wall or on a wall separating the appliance compartment from a habitable room.

10.6.6 Oil-Fired Heating Equipment. All oil-fired heating equipment shall conform to the requirements for liquid fuel-burning heating appliances in UL 307A, *Standard for Safety Liquid Fuel-Burning Heating Appliances for Manufactured Homes and Recreational Vehicles,* and shall be installed in accordance with NFPA 31, *Standard for the Installation of Oil-Burning Equipment.*

Exception: Regardless of the requirements of the above-referenced standards, or any other referenced standards, the following shall not be required:

(1) External switches or remote controls that shut off the burner or the flow of oil to the burner
(2) An emergency disconnect switch to interrupt electric power to the equipment under conditions of excessive temperature

10.7 Exhaust Duct System and Provisions for the Future Installation of a Clothes Dryer.

10.7.1 Clothes Dryers.

10.7.1.1 All gas and electric clothes dryers shall be exhausted to the outside by a moisture/lint exhaust duct and termination fitting. When the manufacturer supplies the clothes dryer, the exhaust duct and termination fittings shall be completely installed by the manufacturer. If the exhaust duct system is subject to damage during transportation, or a field connection between transportable sections is required, factory installation shall not be required when the following apply:

(1) The exhaust duct system is connected to the clothes dryer.
(2) A moisture/lint exhaust duct system is roughed in, and installation instructions are provided in accordance with 10.7.2(3) or 10.7.3.

10.7.1.2 A clothes dryer moisture/lint exhaust duct shall not be connected to any other duct, vent, or chimney.

10.7.1.3 The exhaust duct shall not terminate beneath the manufactured home.

10.7.1.4 Moisture/lint exhaust ducts shall not be connected with sheet metal screws or other fastening devices that extend into the interior of the duct.

10.7.1.5 Moisture/lint exhaust duct and termination fittings shall be installed in accordance with the appliance manufacturer's printed instructions.

10.7.2 Provisions for Future Installation of a Gas Clothes Dryer. A manufactured home shall be permitted to be provided with "stubbed-in" equipment at the factory to accommodate future installation of a gas clothes dryer by the owner, provided it complies with the following provisions:

(1) The "stubbed-in" gas outlet shall be provided with a shut-off valve, the outlet of which is closed by a threaded pipe plug or cap.
(2) The "stubbed-in" gas outlet shall be permanently labeled to identify it for use only as the supply connection for a gas clothes dryer.

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(3) A moisture/lint duct system consisting of a complete access space (hole) through the wall or floor cavity shall be provided, and a cap or cover on the interior and exterior of the cavity that is secured in such a manner that it can be removed by a common household tool shall be provided. The cap or cover in place shall limit air infiltration and shall be designed to resist the entry of water or rodents. The manufacturer shall not be required to provide the moisture/lint exhaust duct or the termination fitting. The manufacturer shall provide written instructions to the owner on how to complete the exhaust duct installation in accordance with the provisions of 10.7.1.1 through 10.7.1.5.

10.7.3 Provisions for Future Installation of Electric Clothes Dryers. When wiring is installed to accommodate future installation of an electric clothes dryer by the owner, the manufacturer shall comply with the following provisions:

(1) The manufacturer shall provide a roughed-in, moisture/lint exhaust duct system consisting of a complete access space (hole) through the wall or floor cavity, and a cap or cover on the interior and exterior of the cavity that is secured in such a manner that it can be removed by the use of common household tools. The cap or cover in place shall limit air filtration and shall be designed to resist the entry of water or rodents into the home. The manufacturer shall not be required to provide the moisture/lint exhaust duct or the termination fitting.
(2) The manufacturer shall install a receptacle for future connection of the dryer.
(3) The manufacturer shall provide written instructions on how to complete the exhaust duct installation in accordance with the provisions of 10.7.1.1 through 10.7.1.5.

10.8 Installation of Appliances.

10.8.1 The installation of each appliance shall conform to the terms of its listing and the manufacturer's instructions. The installer shall leave the manufacturer's instructions attached to the appliance. Every appliance shall be secured in place to avoid displacement. For the purpose of servicing and replacement, each appliance shall be both accessible and removable.

10.8.1.1 A direct vent space heating appliance shall be permitted to be shipped loose for on-site installation in a basement provided the following:

(1) The heating appliance is listed for the installation.
(2) Approved installation instructions are provided that include requirements for completion of all gas and electrical connections and provide for inspection and/or testing of all connections.
(3) Approved instructions are provided to assure connection of the vent and combustion air systems in accordance with 10.9.2, and to provide for inspection of the systems for compliance.
(4) Approved installation and inspection procedures are provided for the connection of the site-installed heating appliance to the factory-installed circulation air system and return air systems.

10.8.1.2 The procedures shall include revisions to assure compliance of the installed systems with Section 10.14.

10.8.1.3 The approved installation instructions shall require that the installation be performed by a qualified and, where required, licensed HVAC contractor.

10.8.1.4 All water heater appliances installed in manufactured homes designed or constructed for sale in seismic design categories D_0, D_1, D_2 and E, as defined in NFPA 225, *Model Manufactured Home Installation Standard*, shall be braced, anchored, or strapped to resist not less than 200 lb (0.9 kN) equivalent static lateral loads to prevent falling or horizontal displacement due to earthquake motion. The water heater bracing, anchors, or strapping shall include mechanical connections to a structural member, and/or wall studs, adjacent to the appliance, in order to prevent tipping or rotation of the appliance along the center axis of the appliance.

10.8.2 Heat-producing appliances shall be so located that no doors, drapes, or other such material can be placed or swung closer to the front of the appliance than the clearances specified on the labeled appliances.

10.8.3 Clearances surrounding heat-producing appliances shall not be less than the clearances specified in the terms of their listings.

10.8.3.1 Prevention of Storage. The area surrounding heat-producing appliances installed in areas with interior or exterior access shall be framed in or guarded with noncombustible material such that the distance from the appliance to the framing or guarding material is not greater than 3 in. (75 mm), or the appliance shall be installed in compliance with 10.8.3.2. When clearance required by the listing is greater than 3 in. (75 mm), the guard or frame shall not be closer to the appliance than the distance provided in the listing.

10.8.3.2 Clearances. Clearance spaces surrounding heat-producing appliances shall not be required to be framed in or guarded with noncombustible material when in compliance with the following:

(1) A space is designed specifically for a clothes washer or dryer.
(2) Dimensions surrounding the appliance do not exceed 3 in. (75 mm).
(3) The manufacturer affixes a 3 in. × 5 in. (75 mm × 127 mm) adhesive-backed, plastic-laminated label or the equivalent to a clearly visible location on the side of the alcove or compartment containing the appliance, or to the appliance itself, that reads as follows:

WARNING: THIS COMPARTMENT IS NOT TO BE USED AS A STORAGE AREA. STORAGE OF COMBUSTIBLE MATERIALS OR CONTAINERS ON OR NEAR ANY APPLIANCE IN THIS COMPARTMENT MAY CREATE A FIRE HAZARD. DO NOT STORE SUCH MATERIALS OR CONTAINERS IN THIS COMPARTMENT.

10.8.4 All fuel-burning appliances shall be installed to provide for the complete separation of the combustion system from the interior atmosphere of the manufactured home. Combustion air inlets and flue gas outlets shall be listed or certified as components of the appliance. The required separation shall be permitted to be obtained by one of the following:

(1) The installation of direct-vent system (sealed combustion system) appliances.
(2) The installation of appliances within enclosures so as to separate the appliance combustion system and venting system from the interior atmosphere of the manufactured home. There shall not be any door, removable access panel, or other opening into the enclosure from the inside of the manufactured home. Any opening for ducts, piping, wiring, and so on, shall be sealed.

Exception: Ranges, ovens, illuminating appliances, clothes dryers, solid fuel-burning fireplaces, and solid fuel-burning fireplace stoves.

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10.8.5 A forced-air appliance and its return-air system shall be designed and installed so that negative pressure created by the air-circulating fan cannot affect its own combustion air supply, or that of another appliance, or act to mix products of combustion with circulating air.

10.8.5.1 The air-circulating fan of a furnace installed in an enclosure with another fuel-burning appliance shall be operable only when any door or panel covering an opening in the furnace fan compartment, or in a return air plenum or duct, is in the closed position.

Exception: This requirement shall not apply if both appliances are direct-vent system (sealed combustion system) appliances.

10.8.5.2 If a warm-air appliance is installed within an enclosure to conform to 10.8.4(2), each warm-air outlet and each return-air inlet shall extend to the exterior of the enclosure. Ducts, if used for that purpose, shall not have any opening within the enclosure and shall terminate at a location exterior to the enclosure.

10.8.5.3 Cooling coils installed as a portion of, or in connection with, any forced-air furnace shall be installed on the downstream side, unless the furnace is specifically otherwise listed.

10.8.5.4 An air conditioner evaporator section shall not be located in the air discharge duct or plenum of any forced-air furnace unless the manufactured home manufacturer has complied with certification required in Section 8.11.

10.8.5.5 If a cooling coil is installed with a forced-air furnace, the coil shall be installed in accordance with its listing. When a furnace coil unit has a limited listing, the installation shall be in accordance with that listing.

10.8.5.6 When an external heating appliance or a combination cooling/heating appliance is to be field-installed, the home manufacturer shall make provisions for the proper location of the connections to the supply and return air systems. The manufacturer shall not be required to provide the cooling/heating appliances. Provisions for connection to the home's supply and return air system made by the manufacturer shall include all fittings and connection ducts to the main duct and return air system such that the installer is only required to provide the following:

(1) The appliance
(2) Any appliance connections to the home
(3) The connecting duct between the external appliance and the fitting installed on the home by the manufacturer

Exception: The requirement for manufacturer preparations for connections to the supply and return air systems shall not apply to supply or return air systems designed only to accept external cooling (i.e., self-contained air-conditioning systems, etc.).

10.8.5.7 The installation of a self-contained air conditioner comfort cooling appliance shall meet the following requirements:

(1) Installation on a duct common with an installed heating appliance shall require the installation of an automatic damper or other means to prevent the cooled air from passing through the heating appliance.

Exception: The heating appliance is certified or listed for such application and the supply system is intended for such an application.

(2) The installation shall prevent the flow of heated air into the external cooling appliance and its connecting ducts to the manufactured home supply and return air system during the operation of the heating appliance installed in the manufactured home.

(3) The installation shall prevent simultaneous operation of the heating and cooling appliances.

10.8.6 Vertical Clearance above Cooking Top. Ranges shall have a vertical clearance above the cooking top of not less than 24 in. (610 mm). *(See Section 5.4.)*

10.8.7 Solid fuel–burning, factory-built fireplaces and fireplace stoves listed for use in manufactured homes shall be installed in manufactured homes in accordance with 10.8.7.1. A fireplace or fireplace stove shall not be considered as a heating facility for determining compliance with Chapter 8.

10.8.7.1 A solid fuel–burning fireplace or fireplace stove shall be equipped with integral door(s) or shutter(s) designed to close the fireplace or fireplace stove fire chamber opening and shall include complete means for venting through the roof, a combustion air inlet, a hearth extension, and means to securely attach the fireplace or the fireplace stove to the manufactured home structure. The installation shall conform to 10.8.7.1.1 through 10.8.7.1.7.

10.8.7.1.1 A listed, factory-built chimney, designed to be attached directly to the fireplace or fireplace stove, shall be used. The listed, factory-built chimney shall be equipped with, and contain as part of its listing, a termination device(s) and a spark arrester(s).

10.8.7.1.2 A fireplace or fireplace stove, air intake assembly, hearth extension, and chimney shall be installed in accordance with the terms of their listings and their manufacturers' instructions.

10.8.7.1.3 The combustion air inlet shall conduct the air directly into the fire chamber and shall be designed to prevent material from the hearth dropping onto the area beneath the manufactured home.

10.8.7.1.4 The fireplace or fireplace stove shall not be installed in a sleeping room.

10.8.7.1.5 The hearth extension shall be of noncombustible material not less than ⅜ in. (10 mm) thick. The hearth shall extend at least 16 in. (406 mm) in front of and 8 in. (203 mm) beyond each side of the fireplace or fireplace stove opening. Furthermore, the hearth shall extend over the entire surface beneath a fireplace stove, or beneath an elevated or overhanging fireplace.

10.8.7.1.6 The label on each solid fuel–burning fireplace and solid fuel–burning fireplace stove shall include the following wording:

FOR USE WITH SOLID FUEL ONLY

10.8.7.1.7 The chimney shall extend at least 3 ft (914 mm) above the part of the roof through which it passes and at least 2 ft (610 mm) above the highest elevation of any part of the manufactured home within 10 ft (3050 mm) of the chimney. Portions of the chimney and termination that exceed an elevation of 13½ ft (4115 mm) above ground level shall be permitted to be designed to be removed for transporting the manufactured home.

10.8.8 A corrosion-resistant water drip collection and drain pan shall be installed under each water heater that will allow water leaking from the water heater to drain to either the underside or the exterior of the manufactured home, or a drain.

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10.8.9 Site Installed Water Heater. A water heater shall be permitted to be shipped loose for on-site installation provided that 10.8.9.1 through 10.8.9.6 are met.

10.8.9.1 The water heater shall be listed for the installation.

10.8.9.2 Approved installation instructions shall be provided which include requirements for completion of all gas, water, and electrical connections, and provide for inspection and/or test of all connections.

10.8.9.3 Approved instructions shall be provided to assure connection of the vent and combustion air systems in accordance with 10.9.2, and for the inspection of the completed installation.

10.8.9.4 Approved instructions shall be provided for installation and inspection of the relief valve for compliance with 9.9.3.

10.8.9.5 When a water heater with an ignition source is to be installed in a garage, the installation instructions shall require that the water heater be elevated such that the source of ignition is not less than 18 in. (457 mm) above the garage floor except if it is listed as being resistant to the ignition of flammable vapors.

10.8.9.6 The approved installation instructions shall require that the installation be performed by a qualified and, where required, licensed installer.

10.9 Venting, Ventilation, and Combustion Air.

10.9.1 The venting required by 10.6.2 shall be accomplished by one or more of the following methods:

(1) An integral vent system listed or certified as part of the appliance
(2) A venting system consisting entirely of listed components, including roof jack, installed in accordance with the terms of the appliance listing and the appliance manufacturer's instructions

10.9.2 Venting and combustion air systems shall be installed in accordance with 10.9.2.1 through 10.9.2.3.

10.9.2.1 Components shall be securely assembled and properly aligned at the factory in accordance with the appliance manufacturer's instructions. Vertical or horizontal sections of a fuel-fired heating appliance venting system that extend beyond the roof line or outside the wall line shall be permitted to be installed at the site. Sectional venting systems shall be listed for such applications and installed in accordance with the terms of their listings and manufacturers' instructions. In cases where sections of the venting system are removed for transportation, a label shall be permanently attached to the appliance that includes the following statement:

WARNING: SECTIONS OF THE VENTING SYSTEM HAVE NOT BEEN INSTALLED. WARNING — DO NOT OPERATE THE APPLIANCE UNTIL ALL SECTIONS HAVE BEEN ASSEMBLED AND INSTALLED IN ACCORDANCE WITH MANUFACTURERS' INSTRUCTIONS.

10.9.2.2 Draft hood connectors shall be firmly attached to draft hood outlets or flue collars by sheet metal screws or by equivalent effective mechanical fasteners.

10.9.2.3 Every joint of a vent, vent connector, exhaust duct, and combustion air intake shall be secure and in alignment.

10.9.3 Venting systems shall not terminate underneath a manufactured home.

10.9.4 Venting system terminations shall be not less than 3 ft (914 mm) from any motor-driven air intake discharging into habitable areas.

10.9.5 The area where cooking appliances are located shall be ventilated by a metal duct, or by listed mechanical ventilating equipment discharging outside the home that is installed in accordance with the terms of listing and the manufacturer's instructions. The metal duct shall be permitted to be single-wall; not less than 12.5 in.^{2} (8064 mm^2) in cross-sectional area, with a minimum dimension of 2 in. (51 mm); located above the appliance(s) and terminating outside the manufactured home. Gravity or mechanical ventilation shall be installed within a horizontal distance of not more than 10 ft (3050 mm) from the vertical front of the appliance(s).

10.9.6 Mechanical ventilation that exhausts directly to the outside atmosphere from the living space of a home shall be equipped with an automatic or manual damper. Operating controls shall be provided such that mechanical ventilation can be separately operated without directly energizing other energy-consuming devices.

10.10 Instructions. Operating instructions shall be provided with each appliance. All operating and installation instructions shall be provided with the homeowner's manual.

10.11 Marking.

10.11.1 Information on clearances, input rating, lighting, and shutdown shall be attached to the appliances with the same permanence as the nameplate, and shall be so located that it is easily readable when the appliance is properly installed or shut down for transporting of the manufactured home.

10.11.2 Each fuel-burning appliance shall bear permanent markings designating the type(s) of fuel for which it is listed.

10.12 Accessibility. Every appliance shall be accessible for inspection, service, repair, and replacement without removing permanent construction. For these purposes, inlet piping supplying the appliance shall not be considered permanent construction. Sufficient space shall be available to enable the operator to observe the burner, control, and ignition means while starting the appliance.

10.13 Appliances, Cooling.

10.13.1 Every air-conditioning unit or combination air-conditioning and heating unit shall be listed or certified by a nationally recognized testing agency for the application for which the unit is intended, and shall be installed in accordance with the terms of its listing.

10.13.1.1 Mechanical air conditioners shall be rated in accordance with ARI 210/240, *Unitary Air-Conditioning and Air-Source Heat Pump Equipment,* and certified by ARI or another nationally recognized testing agency capable of providing follow-up service.

10.13.1.1.1 Electric motor–driven unitary air-cooled air conditioners and heat pumps in the cooling mode with rated capacity less than 65,000 Btu/hr (19,045 W), when rated at the ARI standard rating conditions in ARI 210/240, *Unitary Air-Conditioning and Air-Source Heat Pump Equipment,* shall have seasonal energy efficiency (SEER) values not less than as specified in the *National Appliance Energy Conservation Act.*

10.13.1.1.2 Heat pumps shall be certified to comply with all the requirements of ARI 210/240, *Unitary Air-Conditioning and Air-Source Heat Pump Equipment.* Electric motor–driven vapor compression heat pumps with supplemental electrical resistance heat

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shall be sized to provide by compression at least 60 percent of the calculated annual heating requirements for the manufactured home being served. A control shall be provided and set to prevent operation of supplemental electrical resistance heat at outdoor temperatures above 40°F (4°C), except for defrost conditions. Electric motor–driven vapor compression heat pumps with supplemental electric resistance heat conforming to ARI 210/240, *Unitary Air-Conditioning and Air-Source Heat Pump Equipment,* shall have HSPF efficiencies not less than as specified in the *National Appliance Energy Conservation Act.*

10.13.1.1.3 Electric motor–driven vapor compression heat pumps with supplemental electric-resistance heat of cooling capacity less than 65,000 Btu/hr (19,045 W), conforming to ARI 210/240, *Unitary Air-Conditioning and Air-Source Heat Pump Equipment,* shall have a cooling mode SEER of at least 10 for split systems and 9.7 for single package systems.

10.13.1.2 Gas-fired absorption air conditioners shall be listed or certified in accordance with ANSI Z 21.40, *Gas-Fired Absorption Summer Air Conditioning Appliances,* with Addendum 1a.

10.13.1.3 Direct refrigerating systems serving any air-conditioning or comfort cooling system installed in a manufactured home shall employ a type of refrigerant that ranks no lower than Group 5 in *UL Classification of Comparative Life Hazard of Various Chemicals.*

10.13.1.4 When a cooling or heat pump coil and air conditioner blower are installed with a furnace or heating appliance, they shall be tested and listed in combination for heating and safety performance by a nationally recognized testing agency.

10.13.1.5 Cooling or heat pump indoor coils and outdoor sections shall be certified, listed, and rated in combination for capacity and efficiency by a nationally recognized testing agency(ies). Rating procedures shall be based on U.S. Department of Energy test procedures.

10.13.2 Installation and Instructions.

10.13.2.1 The installation of each appliance shall conform to the terms of its listing as specified on the appliance and in the manufacturer's instructions. The installer shall include the manufacturer's installation instructions in the manufactured home. Appliances shall be secured in place to avoid displacement and movement from vibration and road shock.

10.13.2.2 Operating instructions shall be provided with the appliance.

10.13.3 Fuel-burning air conditioners also shall comply with Section 10.6.

10.13.4 The appliance rating plate shall be located so that it is easily readable when the appliance is properly installed.

10.13.5 Every installed appliance shall be accessible for inspection, service, repair, and replacement without removing permanent construction.

10.14 Circulating Air System.

10.14.1 Supply air ducts, fittings, and any dampers contained therein shall be made from galvanized steel, tin-plated steel, or aluminum, or shall be listed in accordance with UL 181, *Standard for Safety Factory-Made Air Ducts and Air Connectors.* Class 1 air ducts and air connectors shall be located at least 3 ft (914 mm) from the furnace bonnet or plenum. Air connectors shall not be used for exterior manufactured home duct connection. A duct system integral with the structure shall be of durable construction that can be demonstrated to be equally resistant to fire and deterioration. Ducts constructed from sheet metal shall be in accordance with Table 10.14.1.

Table 10.14.1 Minimum Metal Thickness for Ducts

	Diameter 14 in. (356 mm) or Less		Width over 14 in. (356 mm)	
Duct Type	**in.**	**mm**	**in.**	**mm**
Round	0.013	0.33	0.016	0.41
Enclosed rectangular	0.013	0.33	0.016	0.41
Exposed rectangular	0.016	0.41	0.019	0.48

Note: When nominal thicknesses are specified, 0.003 in. (0.08 mm) shall be added to these minimum metal thicknesses.

10.14.2 Furnace supply plenums shall be constructed of metal that extends a minimum of 3 ft (914 mm) from the heat exchanger measured along the centerline of airflow.

10.14.3 Duct Static Pressure Test. The duct static pressure test shall be performed after the system has demonstrated compliance with 10.14.5.

10.14.3.1 Ducts shall be so designed that when a labeled, forced-air furnace is installed and operated continuously at its normal heating air circulating rate in the manufactured home, with all registers in the full open position, the static pressure measured in the casing shall not exceed 90 percent of that shown on the label of the appliance. For upflow furnaces, the static pressure shall be taken in the duct plenum. For external heating or combination heating/cooling appliances, the static pressure shall be taken at the point used by the agency listing or certifying the appliance.

10.14.3.2 When an evaporator coil specifically designed for the particular furnace is installed between the furnace and the duct plenum, the total static pressure shall be measured downstream of the coil in accordance with the appliance label, and shall not exceed 90 percent of that shown on the label of the appliance.

10.14.3.3 When any other listed air cooler coil is installed between the furnace and the duct plenum, the total static pressure shall be measured between the furnace and the coil and shall not exceed 90 percent of that shown on the label of the furnace.

10.14.3.4 The minimum dimension of any branch duct shall be at least 1½ in. (40 mm), and the minimum dimension of any main duct shall be at least 2½ in. (64 mm).

10.14.4 Sizing of Ducts.

10.14.4.1 The manufactured home manufacturer shall certify the capacity of the air cooling supply duct system for the maximum allowable output of ARI-certified central air-conditioning systems. The certification shall be at operating static pressure of 0.3 in. (75 Pa) of water or greater. *(See Section 8.11.)*

10.14.4.2 The refrigerated air cooling supply duct system, including registers, shall be capable of handling at least 300 cfm ($0.14\ m^3/s$) per 10,000 Btu/hr (2930 W) with a static pressure no greater than 0.3 in. (75 Pa) of water when measured at room temperature. In the case of the application of external self-contained comfort cooling appliances or the cooling mode of combination heating/cooling appliances, either the external ducts between the appliance and the manufactured home supply system shall be considered part of, and shall comply with the

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requirements for, the refrigerated air cooling supply duct system, or the connecting duct between the external appliance and the mobile supply duct system shall be a part of the listed appliance. The minimum dimension of any branch duct shall be at least 1½ in. (40 mm), and the minimum dimension of any main duct shall be at least 2½ in. (64 mm).

10.14.5 Airtightness of Supply Duct Systems. Supply ducts shall demonstrate duct leakage of less than 60 cfm (1.7 m^3/min) per floor when tested at a differential pressure of 1/10 in. water (25 Pa). Supply duct testing shall occur at a frequency determined by the quality assurance plan.

10.14.6 Expandable or Multiple Manufactured Home Connections.

10.14.6.1 An expandable or multiple manufactured home shall be permitted to have ducts of the heating system installed in the various units. The points of connection shall be designed and constructed such that when the manufactured home is fully expanded or coupled, the resulting duct joint will conform to the requirements of 10.14.6.

10.14.6.2 Installation instructions for supporting, mechanically fastening, sealing, and insulating the crossover duct and crossover duct extension from the manufactured home shall be provided for on-site installation. Instructions shall caution the installer from allowing the crossover duct from being in contact with the ground and describe means to support the duct without compressing the insulation and restricting airflow.

10.14.7* Air supply ducts installed outside the thermal envelope shall be insulated with material having an effective thermal resistance (*R*) of not less than 4, unless they are within manufactured home insulation having a minimum effective value of *R*-4 for floors, or *R*-6 for ceilings.

10.14.8 Supply and return ducts, fittings, and crossover duct plenums exposed directly to outside air, such as those under chassis crossover ducts or ducts connecting external heating, cooling, or combination heating/cooling appliances, shall be insulated with material having a minimum thermal resistance of *R*-8 in thermal zones 1, 2, and 3. All such insulating materials shall have a continuous vapor barrier having a perm rating of not more than 1 perm. Where ducts are exposed underneath the manufactured home, they shall comply with 10.14.6.2 and shall be listed for exterior use.

10.14.9 Return Air Systems.

10.14.9.1 Return Air Openings. Provisions shall be made to permit the return of circulating air from all rooms and living spaces, except toilet room(s), to the circulating air supply inlet of the furnace.

10.14.9.2 Duct Material. Return ducts and any diverting dampers contained therein shall be in accordance with 10.14.9.2.1 through 10.14.9.2.5.

10.14.9.2.1 Portions of return ducts directly above the heating surfaces, or closer than 2 ft (610 mm) from the outer jacket or casing of the furnace, shall be constructed of metal in accordance with 10.14.1, or shall be listed Class 0 or Class 1 air ducts.

10.14.9.2.2 Return ducts shall be constructed of 1 in. (25 mm) (nominal) wood boards (flame-spread index of not more than 200), other suitable material no more flammable than 1 in. (25 mm) board, or in accordance with 10.14.1.

10.14.9.2.3 The interior of combustible ducts shall be lined with noncombustible material at points where there is a danger from incandescent particles dropped through the register or furnace, such as directly under floor registers and the bottom return of a furnace.

10.14.9.2.4 Factory-made air ducts and air connectors used for connecting external heating, cooling, or combination heating/cooling appliances to the supply system and return air system of a manufactured home shall be listed by a nationally recognized testing agency. Ducts applied to external heating appliances or combination heating/cooling appliances supply system outlets shall be constructed of metal in accordance with 10.14.1, or shall be listed Class 0 or Class 1 air ducts for those portions of the duct closer than 2 ft (610 mm) from the outer casing of the appliance. Air connectors shall not be used in exterior locations.

10.14.9.2.5 Ducts applied to external appliances shall be resistant to deteriorating environmental effects, including, but not limited to, ultraviolet rays, cold weather, or moisture and shall be resistant to insects and rodents.

10.14.9.3 Sizing. The cross-sectional areas of the return air duct shall not be less than 2 $in.^2$ (1290 mm^2) for each 1000 Btu/hr (293 W) input rating of the appliance. Dampers shall not be placed in a combination fresh air intake and return air duct arranged so that the required cross-sectional area will not be reduced at all possible positions of the damper.

10.14.9.4 Permanent, Unclosable Openings. Living areas not served by return air ducts, or that are closed off from the return opening of the furnace by doors, sliding partitions, or other means, shall be provided with permanent, unclosable openings in the doors or separating partitions to allow circulated air to return to the furnace. Such openings shall be permitted to be grilled or louvered. The net free area of each opening shall be not less than 1 $in.^2$ (645 mm^2) for every 5 ft^2 (0.4645 m^2) of total living area closed off from the furnace by the door or partition serviced by that opening. Undercutting doors connecting the closed-off space shall be permitted to be used as a means of providing return air area. However, in the event that doors are undercut, they shall be undercut a minimum of 2 in. (50 mm), and no more than 2½ in. (64 mm), as measured from the top surface of the floor decking to the bottom of the door; and no more than one-half of the free air area so provided shall be counted as return air area.

10.14.10 Joints and Seams. Joints and seams of sheet metal and factory-made flexible ducts, including trunks, branches, risers, crossover ducts, and crossover duct plenums, shall be mechanically secured and made substantially airtight. Slip joints in sheet metal ducts shall have a lap of at least 1 in. (25 mm) and shall be mechanically fastened. Tapes or caulking compounds listed for the use intended shall be permitted to be used for sealing mechanically secure joints. Tapes used on the inside of metal duct joints shall be approved and listed for that application. Sealants and tapes shall be applied only to surfaces that are dry and dust-, dirt-, oil-, and grease-free.

10.14.10.1 Tapes and mastic closure systems for use with factory-made rigid fiberglass air ducts and air connectors shall be listed in accordance with UL 181A, *Closure Systems for Use with Rigid Air Ducts and Air Connectors.*

10.14.11 Supports.

10.14.11.1 Ducts shall be securely supported. Nails shall not be driven through duct walls, and unnecessary holes shall not be cut therein.

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10.14.11.2 Where vertical ducts are installed within closets or rooms, they shall be enclosed with materials equivalent to those used in the closet or room construction.

10.14.12 Registers or Grilles. Fittings connecting the registers or grilles to the duct system shall be constructed of metal or material that complies with the requirements of Class 0 or Class 1 air ducts or air connectors in accordance with UL 181, *Standard for Safety Factory-Made Air Ducts and Air Connectors*. Air supply terminal devices (registers) when installed in kitchens, bedrooms, and bathrooms shall be equipped with adjustable dampers. Registers or grilles shall be constructed of metal or conform with the following:

(1) Registers or grilles shall be made of a material classified 94V-0 or 94V-1 when tested as described in UL 94, *Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*.
(2) Registers or grilles shall resist, without structural failure, a 200 lb (90.7 kg) concentrated load on a 2 in. (50 mm) diameter disc applied to the most critical area of the exposed face of the register or grille. For this test, the register or grille shall be at a temperature of not less than 165°F (74°C), and shall be supported in accordance with the manufacturer's instructions.

Chapter 11 Electrical Systems

11.1 Scope.

11.1.1 This chapter and Part I of Article 550 of NFPA 70, *National Electrical Code (NEC)*, shall apply to the electrical conductors and equipment installed within or on manufactured homes, and the conductors that connect manufactured homes to a supply of electricity.

11.1.2 In addition to the requirements of this standard and Article 550 of NFPA 70, *National Electrical Code (NEC)*, the applicable portions of other articles of the *NEC* that cover electrical installations in manufactured homes shall be followed. Wherever the requirements of this standard differ from the requirements of the *NEC,* this standard shall apply.

11.1.3 The provisions of this standard shall apply to manufactured homes intended for connection to a wiring system nominally rated 120/240 volts, 3-wire ac, with grounded neutral.

11.1.4 All electrical materials, devices, appliances, fittings, and other equipment shall be listed or labeled by an approved testing agency and shall be connected in an approved manner when in service.

11.2 Definitions. The following definitions shall apply to Chapter 11 only. *(See Section 5.2.)*

11.2.1 Accessible (as Applied to Equipment). Admitting close approach; not guarded by locked doors, elevation, or other effective means. *(See definition 11.2.37, Readily Accessible.)*

11.2.2 Accessible Wiring Methods. Capable of being removed or exposed without damaging the manufactured home structure or finish, or not permanently closed in by the structure or finish of the manufactured home. *(See definition 11.2.10, Concealed, and definition 11.2.17, Exposed Live Parts.)*

11.2.3 Air Conditioning or Comfort Cooling Equipment. All equipment intended or installed for the purpose of processing the treatment of air so as to control simultaneously its temperature, humidity, cleanliness, and distribution to meet the requirements of the conditioned space.

11.2.4 Appliance. Utilization equipment, generally other than industrial, 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, and so on.

11.2.4.1 Fixed Appliance. An appliance that is fastened or otherwise secured at a specific location.

11.2.4.2 Portable Appliance. An appliance that is actually moved or can easily be moved from one place to another in normal use. For the purpose of this standard, the following major appliances are considered portable if cord-connected: refrigerators, clothes washers, dishwashers without booster heaters, or other similar appliances.

11.2.4.3 Stationary Appliance. An appliance that is not easily moved from one place to another in normal use.

11.2.5 Attachment Plug, Plug Cap, Cap. A device that, by insertion in a receptacle, establishes connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle.

11.2.6 Bonding. The permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed.

11.2.7 Branch Circuit. The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s). A device not approved for branch-circuit protection, such as a thermal cutout or motor overload-protective device, is not considered as the overcurrent device protecting the circuit.

11.2.7.1 Appliance Branch Circuit. A branch circuit supplying energy to one or more outlets to which appliances are to be connected; such circuits are to have no permanently connected lighting fixtures not a part of an appliance.

11.2.7.2 General Purpose Branch Circuit. A branch circuit that supplies a number of outlets for lighting and appliances.

11.2.7.3 Individual Branch Circuit. A branch circuit that supplies only one utilization equipment.

11.2.8 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 can be hung.

11.2.9 Circuit Breaker. A device designed to open and close a circuit by nonautomatic means, and to open the circuit automatically on a predetermined overload of current without injury to itself when properly applied within its rating.

11.2.10 Concealed. Rendered inaccessible by the structure or finish of the manufactured home. Wires in concealed raceways are considered concealed, even though they may become accessible by withdrawing them. *(See definition 11.2.2, Accessible Wiring Methods.)*

11.2.11 Dead Front (as Applied to Switches, Circuit-Breakers, Switchboards, and Distribution Panelboard). Designed, constructed, and installed so that no current-carrying parts are normally exposed on the front.

11.2.12 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.

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11.2.13 Device. A unit of an electrical system that is intended to carry, but not utilize, electrical energy.

11.2.14 Disconnecting Means. A device, group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply.

11.2.15 Enclosed. Surrounded by a case that will prevent a person from accidentally contacting live parts.

11.2.16 Equipment. A general term, including material, fittings, devices, appliances, fixtures, apparatus, and the like, used as a part of, or in connection with, an electrical installation.

11.2.17 Exposed Live Parts. Capable of being inadvertently touched or approached nearer than a safe distance by a person. The term is applied to parts not suitably guarded, isolated, or insulated. *[See definition 11.2.1, Accessible (as Applied to Equipment), and definition 11.2.10, Concealed.]*

11.2.18 Exposed Wiring Method. On or attached to the surface or behind panels designed to allow access. *(See definition 11.2.2, Accessible Wiring Methods.)*

11.2.19 Externally Operable. Capable of being operated without exposing the operator to contact with live parts.

11.2.20 Feeder Assembly. The overhead or under-chassis feeder conductors, including the grounding conductor, together with the necessary fittings and equipment, or a power supply cord approved for manufactured home use, that are designed for the purpose of delivering energy from the source of electrical supply to the distribution panelboard within the manufactured home.

11.2.21 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.

11.2.22 Ground. A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and earth, or to some conducting body that serves in place of the earth.

11.2.23 Grounded. Connected to earth or to some conducting body that serves in place of the earth.

11.2.24 Grounded Conductor. A system or circuit conductor that is intentionally grounded.

11.2.25 Grounding Conductor. A conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes.

11.2.26 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.

11.2.27 Isolated. Not readily accessible to persons unless special means for access are used.

11.2.28 Laundry Area. An area containing, or designed to contain, either a laundry tray, clothes washer, and/or clothes dryer.

11.2.29 Lighting Outlet. An outlet intended for the direct connection of a lampholder, a lighting fixture, or a pendant cord terminating in a lampholder.

11.2.30 Manufactured Home Accessory Building or Structure. Any awning, cabana, ramada, storage cabinet, carport, fence, windbreak, or porch established for the use of the occupant of the manufactured home upon a manufactured home lot.

11.2.31 Manufactured Home Service Equipment. The equipment containing the disconnecting means, overcurrent protective devices, receptacles, or other means for connecting a manufactured home feeder assembly.

11.2.32 Outlet. A point on the wiring system at which current is taken to supply utilization equipment.

11.2.33 Panelboard. A single panel or group of panel units designed for assembly in the form of a single panel; including buses, automatic overcurrent protective 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 or partition and accessible only from the front.

11.2.34 Pressure (Solderless) Connector. 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.

11.2.35 Raceway. An enclosed channel of metal or nonmetallic materials designed expressly for holding wires, cables, or busbars, with additional functions as permitted in NFPA 70, *National Electrical Code.* Raceways include, but are not limited to, rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, liquidtight flexible conduit, flexible metallic tubing, flexible metal conduit, electrical nonmetallic tubing, electrical metallic tubing, underfloor raceways, cellular concrete floor raceways, cellular metal floor raceways, surface raceways, wireways, and busways.

11.2.36 Raintight. Constructed or protected so that exposure to a beating rain will not result in the entrance of water under specified field test conditions.

11.2.37 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, chairs, and so on. *[See definition 11.2.1, Accessible (as Applied to Equipment).]*

11.2.38 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.

11.2.39 Receptacle Outlet. An outlet where one or more receptacles are installed.

11.2.40 Utilization Equipment. Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes.

11.2.41* Voltage (of a Circuit). The greatest root-mean-square (effective) difference of potential between any two conductors of the circuit concerned.

11.2.42* Weatherproof. Constructed or protected so that exposure to the weather will not interfere with successful operation.

11.3 Power Supply.

11.3.1 The power supply to the manufactured home shall be a feeder assembly consisting of not more than one listed 50-ampere manufactured home power-supply cord or permanently installed circuit. A manufactured home that is factory-equipped with gas or oil-fired central heating equipment and cooking appliances shall be permitted to be provided with a listed manufactured home power-supply cord rated 40 amperes.

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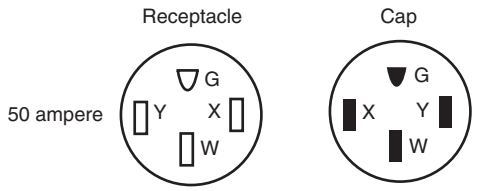
11.3.2 If the manufactured home has a power-supply cord, it shall be permanently attached to the distribution panelboard or to a junction box permanently connected to the distribution panelboard, with the free end terminating in an attachment plug cap.

11.3.3 Cords with adapters and pigtail ends, extension cords, and similar items shall not be attached to, or shipped with, a manufactured home.

11.3.4 A suitable clamp or the equivalent shall be provided at the distribution panelboard knockout to afford strain relief for the cord to prevent strain from being transmitted to the terminals when the power-supply cord is handled in its intended manner.

11.3.5 The cord shall be of a listed type with four conductors, one of which shall be identified by a continuous green color or a continuous green color with one or more yellow stripes for use as the grounding conductor.

11.3.6 The attachment plug cap shall be a 3-pole, 4-wire, grounding type, rated 50 amperes, 125/250 volts with a configuration as shown in Figure 11.3.6 and intended for use with the 50-ampere, 125/250-volt receptacle configuration shown in Figure 11.3.6. It shall be listed, by itself or as part of a power-supply cord assembly for the purpose, and shall be molded to or installed on the flexible cord so that it is secured tightly to the cord at the point where the cord enters the attachment plug or cap. If a right-angle cap is used, the configuration shall be so oriented that the grounding member is farthest from the cord.



Note: 50-ampere 125/250-volt receptacle and attachment plug cap configurations, 3-pole, 4-wire, grounding types used for manufactured home supply cords and manufactured home parks. Complete details of the 50-ampere cap and receptacle can be found in *Wiring Devices Dimensional Requirements* (ANSI/NEMA WD6-1997).

FIGURE 11.3.6 Receptacle and Attachment Plug Cap Configurations.

11.3.7 The overall length of a power-supply cord, measured from the end of the cord, including bared leads, to the face of the attachment plug cap, shall not be less than 21 ft (6.4 m) and shall not exceed 36½ ft (11.1 m). The length of cord from the face of the attachment plug cap to the point where the cord enters the manufactured home shall not be less than 20 ft (6.1 m).

11.3.8 The power-supply cord shall bear one of the following markings: "For use with manufactured homes — 40 amperes" or "For use with manufactured homes — 50 amperes."

11.3.9 Where the cord passes through walls or floors, it shall be protected by means of conduits and bushings or the equivalent. The cord shall be permitted to be installed within the manufactured home walls, provided a continuous raceway having a maximum size of 1¼ in. (31.8 mm) is installed from the branch-circuit panelboard to the underside of the manufactured home floor.

11.3.10 Permanent provisions shall be made for the protection of the attachment plug cap of the power-supply cord and any connector cord assembly or receptacle against corrosion and mechanical damage if such devices are in an exterior location while the manufactured home is in transit.

11.3.11 Where the calculated load exceeds 50 amperes, or where a permanent feeder is used, the supply shall be by means of one of the following:

(1) One mast weatherhead installation, installed in accordance with Article 230 of NFPA 70, *National Electrical Code*, containing four continuous, insulated, color-coded feeder conductors, one of which shall be an equipment grounding conductor.
(2) A metal raceway or rigid nonmetallic conduit from the disconnecting means in the manufactured home to the underside of the manufactured home, with provisions for the attachment of a suitable junction box of fitting to the raceway on the underside of the manufactured home [with or without conductors as in 11.3.11(1)]. The manufacturer shall provide written installation instructions stating the proper feeder conductor sizes for the raceway and the size of the junction box to be used.
(3) Service equipment installed in or on the manufactured home, provided that all of the following conditions are met:
   (a) The manufacturer shall include in its written installation instructions information indicating that the home shall be secured in place by an anchoring system or installed on and secured to a permanent foundation.
   (b) The installation of the service equipment shall comply with Article 230 of NFPA 70, *National Electrical Code*.
   (c) Means shall be provided for the connection of a grounding electrode conductor to the service equipment and routing it outside the structure.
   (d) Bonding and grounding of the service shall be in accordance with Article 250, NFPA 70, *National Electrical Code*.
   (e) The manufacturer shall include in its written installation instructions one method of grounding the service equipment at the installation site. The instructions shall clearly state that other methods of grounding are found in Article 250 of NFPA 70, *National Electrical Code*.
   (f) The minimum size grounding electrode conductor shall be specified in the instructions.
   (g) A red warning label shall be mounted on or shall be placed adjacent to the service equipment. The label shall state the following:

WARNING: DO NOT PROVIDE
ELECTRICAL POWER UNTIL
THE GROUNDING ELECTRODE(S)
IS INSTALLED AND CONNECTED
(SEE INSTALLATION INSTRUCTIONS).

11.4 Disconnecting Means and Branch-Circuit Protective Equipment.

11.4.1 The branch-circuit equipment shall be permitted to be combined with the disconnecting means as a single assembly. Such a combination shall be permitted to be designated as a distribution panelboard. If a fused distribution panelboard is used, the maximum fuse size for the mains shall be plainly marked with lettering at least ¼ in. (6 mm) high and visible when fuses are changed. *(See Section 110.22 of NFPA 70, National Electrical Code, concerning identification of each disconnecting means and each service, feeder, or branch circuit at the point where it originated, and the type marking needed.)*

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11.4.2 Plug fuses and fuseholders shall be tamper-resistant, Type S, enclosed in dead-front fuse panelboards. Electrical distribution panelboards containing circuit breakers shall also be dead-front type.

11.4.3 Disconnecting Means. A single disconnecting means shall be provided in each manufactured home consisting of a circuit breaker, or a switch and fuses and its accessories installed in a readily accessible location near the point of entrance of the supply cord or conductors into the manufactured home. The main circuit breakers or fuses shall be plainly marked "Main." This equipment shall contain a solderless type of grounding connector or bar for the purposes of grounding, with sufficient terminals for all grounding conductors. The neutral bar termination of the grounded circuit conductors shall be insulated in accordance with 11.9.2.

11.4.4 The disconnecting equipment shall have a rating suitable for the connected load. The distribution equipment, either circuit breaker or fused type, shall be located a minimum of 24 in. (610 mm) from the bottom of such equipment to the floor level of the manufactured home.

11.4.5 A distribution panelboard employing a main circuit breaker shall be rated not less than 50 amperes and employ a 2-pole circuit breaker rated 40 amperes for a 40-ampere supply cord, or 50 amperes for a 50-ampere supply cord. A distribution panelboard employing a disconnect switch and fuses shall be rated not less than 60 amperes and shall employ a single, 2-pole fuseholder rated not less than 60 amperes with 40- or 50-ampere main fuses for 40- or 50-ampere supply cords, respectively. The outside of the distribution panelboard shall be plainly marked with the fuse size.

11.4.6 Distribution panelboards shall be located in an accessible location. Distribution panelboards shall not be located in a bathroom or a clothes closet. A clear working space at least 30 in. (762 mm) wide and 30 in. (762 mm) in front of the distribution panelboard shall be provided. This space shall extend from the floor to the top of the distribution panelboard. Where used as switches, circuit breakers shall be so installed that the center of the grip of the operating handle of the circuit breaker, when in its highest position, will not be more than 6 ft 7 in. (2.0 m) above the floor.

11.4.7 Branch-circuit distribution equipment shall be installed in each manufactured home and shall include overcurrent protection for each branch circuit consisting of either circuit breakers or fuses.

11.4.7.1 The branch-circuit overcurrent devices shall be rated in accordance with the following:

(1) Not more than the circuit conductors
(2) Not more than 150 percent of the rating of a single appliance rated 13.3 amperes or more that is supplied by an individual branch circuit
(3) Not more than the overcurrent protection size marked on the air conditioner or other motor-operated appliance

11.4.8 A 15-ampere multiple receptacle shall be permitted where connected to a 20-ampere laundry circuit.

11.4.9 Where circuit breakers are provided for branch-circuit protection, 240-volt circuits shall be protected by 2-pole common or companion trip or handle-tied, paired circuit breakers.

11.4.10 The manufacturer shall provide in its written installation instructions or on the data plate the minimum ampere rating of the feeder assembly or, where provided, the service entrance conductors intended for connection to the manufactured home. The rating provided shall not be less than the minimum load as calculated in accordance with Section 11.11.

11.4.11 When a home is provided with installed service equipment, a single disconnecting means for disconnecting the branch-circuit conductors from the service entrance conductors shall be provided in accordance with Part VI of Article 230 of NFPA 70, *National Electrical Code*. The disconnecting means shall be listed for use as service equipment. The disconnecting means shall be permitted to be combined with the disconnect required by 11.4.3. The disconnecting means shall be rated not more than the ampere supply or service capacity indicated in the written installation instructions required by 11.4.10.

11.5 Branch Circuits Required. The number of branch circuits required shall be determined in accordance with Section 11.5(1) through 11.5(3).

(1) *Lighting.* Based on 3 volt-amperes per square foot × outside dimensions of the manufactured home (coupler excluded) ÷ 120 volts × 15 or 20 amperes to determine number of 15- or 20-ampere lighting area circuits.
Example:

$$\frac{3 \times \text{length} \times \text{width}}{120 \times 15(\text{or } 20)} = \text{Number of 15- (or 20-) ampere circuits}$$

(2) *Small Appliances.* For the small appliance load in kitchens, pantries, dining rooms, and breakfast rooms of manufactured homes, two or more 20-ampere appliance branch circuits, in addition to the branch circuit specified in Section 11.5(1), shall be provided for all receptacle outlets in these rooms, and such circuits shall have no other outlets. Countertop receptacle outlets installed in the kitchen 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 kitchen and other rooms specified above.

Exception No. 1: For a receptacle installed solely for the electrical supply to and support of an electric clock in any of the rooms specified in Section 11.5(2).

Exception No. 2: For receptacles installed to provide power for supplemental equipment and lighting on gas-fired ranges, ovens, or counter-mounted cooking units.

(3) *General Appliances (Including Furnace, Water Heater, Range, and Central or Room Air Conditioner, etc.).* There shall be one or more circuits of adequate rating in accordance with the following:
   (a) The ampere rating of fixed appliances shall not exceed 50 percent of circuit rating if lighting outlets (receptacles, other than kitchen, dining area, and laundry, considered as lighting outlets) are on the same circuit.
   (b) For fixed appliances on a circuit without lighting outlets, the sum of rated amperes shall not exceed the branch-circuit rating. Motor loads or other continuous duty loads shall not exceed 80 percent of the branch-circuit rating.
   (c) The rating of a single cord- and plug-connected appliance on a circuit having no other outlets shall not exceed 80 percent of the circuit rating.
   (d) The rating of a range branch circuit shall be based on the range demand as specified for ranges in 11.11.1(2)(e). *(For central air-conditioning, see Article 440 of NFPA 70, National Electrical Code.)*

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(e) Where a laundry area is provided, a 20-ampere branch circuit shall be provided to supply laundry receptacle outlets. This circuit shall have no other outlets. *[See 11.6.4(7).]*
(f) Bathroom receptacle outlets shall be supplied by at least one 20-ampere branch circuit. Such circuits shall have no other outlets. *(See 11.6.2.)*

11.6 Receptacle Outlets.

11.6.1 All receptacle outlets shall be in accordance with the following:

(1) Be of grounding type
(2) Be installed according to Section 406.3 of NFPA 70, *National Electrical Code*
(3) Be parallel-blade, 15- or 20-ampere, 125-volt, either single or duplex, except when supplying specific appliances

11.6.2 All 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed outdoors or in compartments accessible from outside the manufactured home, and in bathrooms, including receptacles in light fixtures, shall have ground-fault circuit-interrupter protection for personnel. Ground-fault circuit-interrupter protection for personnel shall be provided for receptacles serving countertops in kitchens and receptacle outlets located within 6 ft (1.83 m) of a wet bar sink. Feeders supplying branch circuits shall be permitted to be protected by a ground-fault circuit-interrupter in lieu of the provision for such interrupters specified above.

Exception: Receptacles installed for appliances in dedicated spaces, such as for dishwashers, disposals, refrigerators, freezers, and laundry equipment.

11.6.3 There shall be an outlet of the grounding type for each cord-connected fixed appliance installed.

11.6.4 Receptacle Outlets Required. Except in the bath, closet, and hall areas, receptacle outlets shall be installed at wall spaces 2 ft (610 mm) wide or more, so that no point along the floor line is more than 6 ft (1.83 m), measured horizontally, from an outlet in that space. Receptacle outlets in floors shall not be counted as part of the required number of receptacle outlets unless located within 18 in. (457 mm) of the wall. In addition, a receptacle outlet shall be installed in the following locations:

(1) Over or adjacent to countertops in the kitchen [at least one on each side of the sink if countertops are on each side and are 12 in. (305 mm) or more in width].
(2) Adjacent to the refrigerator and freestanding gas-range space. (A duplex receptacle shall be permitted to serve as the outlet for a countertop and a refrigerator.)
(3) At countertop spaces for built-in vanities.
(4) At countertop spaces under wall-mounted cabinets.
(5) In the wall at the nearest point to where a bar-type counter attaches to the wall.
(6) In the wall at the nearest point where a fixed room divider attaches to the wall.
(7) In laundry areas within 6 ft (1.83 m) of the intended location of the laundry appliance(s).
(8) At least one receptacle outlet outdoors.
(9) At least one receptacle outlet shall be installed in bathrooms within 36 in. (914 mm) of the outside edge of each basin. The receptacle outlet shall be located above or adjacent to the basin location. This receptacle shall be in addition to any receptacle that is part of a lighting fixture or appliance. The receptacle shall not be enclosed within a bathroom cabinet or vanity.
(10) On the underside of the unit for the connection of pipe heating cable(s), as follows:
(a) Located within 2 ft (610 mm) of the cold water inlet.
(b) Connected to an interior branch circuit, other than a small appliance branch circuit. It shall be permitted to utilize a bathroom receptacle circuit for this purpose.
(c) Located on a circuit where all of the outlets are on the load side of the ground-fault circuit-interrupter protection for personnel.
(d) This outlet shall not be considered as the receptacle required by 11.6.4(8).

11.6.5 Receptacle outlets shall not be required in the following locations:

(1) In the wall space occupied by built-in kitchen or wardrobe cabinets
(2) In the wall space behind doors that can be opened fully against a wall surface
(3) In room dividers of the lattice type that are less than 8 ft (2.44 m) long, not solid, and within 6 in. (152 mm) of the floor
(4) In the wall space afforded by bar-type counters

11.6.6 Receptacle outlets shall not be installed above electric baseboard heaters, unless provided for in the listing or manufacturer's instructions.

11.6.7 Receptacles shall not be in a face-up position in any countertop.

11.7 Fixtures and Appliances.

11.7.1 Electrical materials, devices, appliances, fittings, and other equipment installed, intended for use in, or attached to the manufactured home shall be approved for the application and shall be connected in an approved manner when in service. Means shall be provided to securely fasten appliances when the manufactured home is in transit. *(See Section 11.9.)*

11.7.2 Listed pendant-type fixtures or pendant cords shall be permitted in manufactured homes.

11.7.3 Where a lighting fixture is installed over a bathtub or in a shower stall, it shall be listed for wet locations. *[See also Section 410.4(D) of NFPA 70, National Electrical Code.]*

11.7.4 Any combustible wall or ceiling finish exposed between the edge of a fixture canopy, or pan, and an outlet box shall be covered with noncombustible or limited-combustible material.

11.7.5 Every appliance shall be accessible for inspection, service, repair, or replacement without removal of permanent construction.

11.8 Wiring Methods and Materials. Except as specifically limited in this section, the wiring methods and materials specified in NFPA 70, *National Electrical Code*, shall be used in manufactured homes.

11.8.1 Aluminum conductors, aluminum alloy conductors, and aluminum core conductors such as copper-clad aluminum shall not be acceptable for use in branch-circuit wiring in manufactured homes.

11.8.2 Nonmetallic outlet boxes shall be permitted only with nonmetallic cable or nonmetallic raceways.

11.8.3 Nonmetallic cable located 15 in. (381 mm) or less above the floor, if exposed, shall be protected from physical damage by

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covering boards, guard strips, or raceways. Cable likely to be damaged by stowage shall be so protected in all cases.

11.8.4 Nonmetallic sheathed cable shall be secured by staples, straps, or similar fittings designed and installed so as not to injure any cable. Cable shall be secured in place at intervals not exceeding 4½ ft (1.37 m) and shall be within 12 in. (305 mm) from every cabinet, box, or fitting.

11.8.5 Metal-covered and nonmetallic cables shall be permitted to pass through the centers of the wide side of 2 in. × 4 in. (50 mm × 100 mm) studs. However, they shall be protected where they pass through 2 in. × 2 in. (50 mm × 50 mm) studs or at other studs or frames where the cable or armor would be less than 1¼ in. (32 mm) from the inside or outside surface of the studs where the wall covering materials are in contact with the studs. Steel plates on each side of the cable, or a tube, with not less than No. 16 MSG wall thickness shall be required to protect the cable. These plates or tubes shall be securely held in place.

11.8.6 Where metal faceplates are used, they shall be effectively grounded.

11.8.7 If the range, clothes dryer, or similar appliance is connected by metal-covered cable or flexible metal conduit, a length of not less than 3 ft (914 mm) of free cable or conduit shall be provided to permit moving the appliance. Type NM or Type SE cable shall not be used to connect a range or a dryer. This shall not prohibit the use of Type NM or Type SE cable between the branch-circuit overcurrent-protective device and a junction box or range or dryer receptacle.

11.8.8 Where rigid metal conduit or intermediate metal conduit is terminated at an enclosure with a locknut and bushing connection, two locknuts shall be provided, one inside and one outside of the enclosure. Rigid nonmetallic conduit or electrical nonmetallic tubing shall be permitted. All cut ends of conduit and tubing shall be reamed or otherwise finished to remove rough edges.

11.8.9 Switches shall be rated as follows:

(1) For lighting circuits, switches shall be rated not less than 10 amperes, 120 volts to 125 volts, and in no case less than the connected load.
(2) For motors or other loads, switches shall have ampere or horsepower ratings, or both, adequate for loads controlled. (An "ac general-use" snap switch shall be permitted to control a motor 2 horsepower or less, with full-load current not over 80 percent of the switch ampere rating.)

11.8.10 At least 6 in. (152 mm) of free conductor shall be left at each outlet box.

Exception: Where conductors are intended to loop without joints.

11.8.11 When outdoor or under-chassis line-voltage (120 volts, nominal or higher) wiring is exposed to moisture or physical damage, it shall be protected by rigid metal conduit or intermediate metal conduit. The conductors shall be suitable for wet locations. Electrical metallic tubing or rigid nonmetallic conduit shall be permitted to be used when closely routed against frames and equipment enclosures.

11.8.12 Outlet boxes of dimensions less than those required in Table 314.16(A) of NFPA 70, *National Electrical Code*, shall be permitted, provided the box has been tested and approved for the purpose.

11.8.13 Boxes, fittings, and cabinets shall be securely fastened in place and shall be supported from a structural member of the manufactured home, either directly or by using a substantial brace. Snap-in-type boxes provided with special wall or ceiling brackets that securely fasten boxes in walls or ceilings shall be permitted.

11.8.14 Outlet boxes shall fit closely to openings in combustible walls and ceilings and shall be flush with the finish surface or project therefrom. In walls and ceilings of noncombustible material, outlet boxes and fittings shall be installed so that the front edge of the box or fitting will not be set back from the finished surface more than ¼ in. (6 mm). Plaster, drywall, or plasterboard surfaces that are broken or incomplete shall be repaired so that there will be no gaps or open spaces greater than ⅛ in. (3 mm) at the edge of the box or fitting.

11.8.15 Appliances having branch-circuit terminal connections that operate at temperatures higher than 140°F (60°C) shall have circuit conductors as described in 11.8.15.1 and 11.8.15.2.

11.8.15.1 Branch-circuit conductors having an insulation suitable for the temperature encountered shall be permitted to be run directly to the appliance.

11.8.15.2 Conductors having an insulation suitable for the temperature encountered shall be run from the appliance terminal connections to a readily accessible outlet box placed at least 1 ft (305 mm) from the appliance. These conductors shall be in a suitable raceway or Type AC or MC cable of at least 18 in. (450 mm) but not more than 6 ft (1.83 m) in length.

11.8.16 A substantial brace for securing a box, fitting, or cabinet shall be as described in NFPA 70, *National Electrical Code*, Section 314.23(B); or the brace, including the fastening mechanism to attach the brace to the home structure, shall withstand a force of 50 lb (22.7 kg) applied to the brace at the intended point(s) of attachment for the box in a direction perpendicular to the surface where the box is installed.

11.8.17 Where the sheathing of NM cable has been cut or damaged and visual inspection reveals that the conductor and its insulation have not been damaged, repair of the cable sheath with electrical tape that provides equivalent protection to the sheath shall be permitted.

11.9 Grounding.

11.9.1 General. Grounding of both electrical and nonelectrical metal parts in a manufactured home shall be through connection to a grounding bus in the manufactured home distribution panelboard. The grounding bus shall be grounded through the green-colored conductor in the supply cord or the feeder wiring to the service ground in the service-entrance equipment located adjacent to the manufactured home location. Neither the frame of the manufactured home nor the frame of any appliance shall be connected to the grounded circuit conductor (neutral) in the manufactured home.

11.9.2 Insulated Neutral.

11.9.2.1 The grounded circuit conductor (neutral) shall be insulated from the grounding conductors and from equipment enclosures and other grounded parts. The grounded circuit terminals (neutral) in the distribution panelboard and in ranges, clothes dryers, counter-mounted cooking units, and wall-mounted ovens shall be insulated from the equipment enclosure. Bonding screws, straps, or buses in the distribution panelboard or in appliances shall be removed and discarded. However, where service equipment is installed in the manufactured home, the neutral conductors and the ground bus shall be permitted to be connected in the distribution panel.

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11.9.2.2 Connections of ranges and clothes dryers with 120/240-volt, 3-wire ratings shall be made with 4-conductor cord and 3-pole, 4-wire, grounding-type plugs, or by Type AC cable, Type MC cable, or conductors enclosed in flexible metal conduit. For 120-volt-rated devices, a 3-conductor cord and a 2-pole, 3-wire, grounding-type plug shall be permitted.

11.9.3 Equipment Grounding Means.

11.9.3.1 The green-colored insulated grounding wire in the supply cord or permanent feeder wiring shall be connected to the grounding bus in the distribution panelboard or disconnecting means.

11.9.3.2 In the electrical system, all exposed metal parts, enclosures, frames, lamp fixture canopies, and so forth, shall be effectively bonded to the grounding terminal or enclosure of the distribution panelboard.

11.9.3.3 Cord-connected appliances, such as washing machines, clothes dryers, refrigerators, and the electrical system of gas ranges, shall be grounded by means of an approved cord with grounding conductor and grounding-type attachment plug.

11.9.4 Bonding of Noncurrent-Carrying Metal Parts.

11.9.4.1 All exposed noncurrent-carrying metal parts that are able to become energized shall be effectively bonded to the grounding terminal or enclosure of the distribution panelboard. A bonding conductor shall be connected between each distribution panelboard and an accessible terminal on the chassis.

11.9.4.2* Grounding terminals shall be of the solderless type and listed as pressure-terminal connectors recognized for the wire size used. Star washers or other approved paint-penetrating fittings shall be used to bond terminals to the chassis or other coated areas. The bonding conductor shall be solid or stranded, insulated or bare, and shall be No. 8 copper minimum, or equal. The bonding conductor shall be routed so as not to be exposed to physical damage.

11.9.4.3 Metallic gas, water, and waste pipes and metallic air-circulating ducts shall be considered bonded if they are connected to the terminal on the chassis *(see 11.9.4.1)* by clamps, by solderless connectors, or by suitable grounding-type straps.

11.9.4.4 Any metallic roof and exterior covering shall be considered bonded if in accordance with the following.

(1) The metal panels overlap one another and are securely attached to the wood or metal frame parts by metallic fasteners.
(2) The lower panel of the metallic exterior covering is secured by metallic fasteners at a cross member of the chassis by two metal straps per manufactured home unit or section at opposite ends. The bonding strap material shall be a minimum of 4 in. (102 mm) in width of material equivalent to the skin or a material of equal or better electrical conductivity. The straps shall be fastened with paint-penetrating fittings, such as screws and star washers or equivalent.

11.10 Electrical Testing.

11.10.1 Dielectric Strength Test. The wiring of each manufactured home shall be subjected to a 1-minute, 900-volt to 1079-volt, dielectric strength test (with all switches closed) between live parts and the manufactured home ground and neutral and the manufactured home ground. Alternatively, the test shall be permitted to be performed at 1080 volts to 1250 volts for 1 second. This test shall be performed after branch circuits are complete and after fixtures or appliances are installed.

Exception: Fixtures or appliances that are listed shall not be required to withstand the dielectric strength test.

11.10.2 Each manufactured home shall be subjected to the following tests:

(1) An electrical continuity test to ensure that metallic parts are effectively bonded.
(2) An operational test of all devices, and utilization equipment except water heaters, electric ranges, electric furnaces, dishwashers, clothes washers/dryers, and portable appliances to demonstrate that they are connected and in working order.
(3) Electrical polarity checks to determine that connections have been made in accordance with applicable provisions of Manufactured Home Construction and Safety Standards (MHCSS) and NFPA 70, *National Electrical Code*. Visual verification shall be an acceptable electrical polarity check.

11.11 Calculations.

11.11.1 The following method shall be employed in computing the supply cord and distribution-panelboard load for each feeder assembly for each manufactured home and shall be based on a 3-wire, 120/240-volt supply with 120-volt loads balanced between the two legs of the 3-wire system. Lighting circuits shall be permitted to serve built-in gas ovens with electric service only for lights, clocks, or timers, or listed cord-connected garbage disposal units.

(1) *Lighting and Small Appliance Load.*
  (a) *Lighting Volt-Amperes:* Length × width of manufactured home (outside dimensions exclusive of coupler) × 3 volt-amperes per square foot.

$$\text{Length} \times \text{width} \times 3 = \text{Lighting volt-amperes}$$

  (b) *Small Appliance Volt-Amperes:* Number of circuits × 1500 volt-amperes for each 20-ampere appliance receptacle circuit *(see definition 11.2.4.2, Portable Appliance).*

$$\text{Number of circuits} \times 1500 = \text{Small appliance volt-amperes}$$

  (c) *Laundry Area Circuit Volt-Amperes:* 1500 volt-amperes.
  (d) *Total Volt-Amperes:* Lighting volt-amperes plus small appliance plus laundry = total volt-amperes. First 3000 total volt-amperes at 100 percent plus remainder at 35 percent = volt-amperes to be divided by 240 volts to obtain current (amperes) per leg.
(2) *Total Load for Determining Power Supply.* The total load for determining power supply shall be the sum of the following:
  (a) Lighting and small appliance load as calculated in 11.11.1(1).
  (b) Nameplate amperes for motors and heater loads (exhaust fans, air conditioners, and electric, gas, or oil heating). Omit smaller of air-conditioning and heating, except include blower motor if used as air-conditioner evaporator motor. Where an air conditioner is not installed and a 40-ampere power-supply cord is provided, allow 15 amperes per leg for air conditioning.
  (c) 25 percent of current of largest motor in 11.11.1(2)(b).
  (d) Total of nameplate amperes for disposal, dishwasher, water heater, clothes dryer, wall-mounted oven, and cooking units. (Where the number of these appliances exceeds three, use 75 percent of total.)
  (e) Derive amperes for freestanding range (as distinguished from separate ovens and cooking units) by dividing the values in Table 11.11.1(a) by 240 volts.
  (f) If outlets or circuits are provided for other than factory-installed appliances, include the anticipated load.

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(3) The following example illustrates the application of this method of calculation:
Example: A manufactured home is 70 ft × 10 ft and has two portable appliance circuits; a laundry area, a 1000-volt-ampere, 240-volt heater; a 200-volt-ampere, 120-volt exhaust fan; a 400-volt-ampere, 120-volt dishwasher; and a 7000-volt-ampere electric range. *[See Table 11.11.1(b).]*

Table 11.11.1(a) Amperes

Nameplate Rating	Use
10,000 watts or less	80 percent of rating in volt-amperes
10,001 to 12,500 watts	8000 volt-amperes
12,501 to 13,500 watts	8400 volt-amperes
13,501 to 14,500 watts	8800 volt-amperes
14,501 to 15,500 watts	9200 volt-amperes
15,501 to 16,500 watts	9600 volt-amperes
16,501 to 17,500 watts	10,000 volt-amperes

11.11.2 The following shall be permitted as an optional method of calculation for lighting and appliance loads for manufactured homes served by a single, 3-wire, 120/240-volt set of feeder conductors with an ampacity of 100 or greater. The total load for determining the feeder ampacity shall be permitted to be computed in accordance with Table 11.11.2 instead of the method previously specified. Feeder conductors whose demand load is determined by this optional calculation shall be permitted to have the neutral load determined by Section 220.22 of NFPA 70, *National Electrical Code*. The loads identified in Table 11.11.2 as "other load" and as "remainder of other load" shall include the following:

(1) 1500 volt-amperes for each 2-wire, 20-ampere small appliance branch circuit and each laundry branch circuit specified
(2) 3 volt-amperes per square foot for general lighting and general-use receptacles
(3) Nameplate rating of all fixed appliances, ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers, and water heaters

Table 11.11.1(b) Calculation of Anticipated Load

Lighting and Small Appliance Load	Volt-Amperes
Lighting and small appliance load	2100
Small appliance, 1500 × 2	3000
Laundry, 1500 × 1	1500
Total	6600
First 3000 volt-amperes at 100%	3000
Remainder (6600 – 3000) at 35%	1260
Total	4260

$$\frac{4260 \text{ volt-amperes}}{240 \text{ volts}} = 17.75 \text{ amperes per leg}$$

	Amperes per Leg A	Amperes per Leg B
Lighting and small appliances	17.75	17.75
Heater (240 volts): $\frac{1000 \text{ volt-amperes}}{240 \text{ volts}}$	4.2	4.2
Fan (120 volts): $\frac{200 \text{ volt-amperes} \times 125\%}{120 \text{ volts}}$	2.08	
Dishwasher (120 volts): $\frac{400 \text{ volt-amperes}}{120 \text{ volts}}$		3.3
Range: $\frac{7000 \text{ volt-amperes} \times 0.8}{240 \text{ volts}}$	23.3	23.3
Totals	47.33	48.55

Note: Based on the higher current calculated for either leg, use one 50 ampere supply cord.

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(4) Nameplate ampere or kVA rating of all motors and of all low-power-factor loads
(5) The largest of the following loads:
  (a) Air-conditioning load
  (b) 65 percent of nameplate rating of the central electric space-heating load
  (c) 65 percent of nameplate rating of the load of fewer than four separately controlled electric space-heating units
  (d) Connected load of four or more separately controlled electric space-heating units

Table 11.11.2 Optional Calculation for Manufactured Homes with 110-Ampere or Larger Service

Load (kW or kVA)	Demand Factor (percent)
Air-conditioning and cooling, including heat-pump compressors	100
Central electric space heating	65
Fewer than four separately controlled electric space-heating units	65
First 10 kW of all other loads	100
Remainder of other loads	40

11.12 Wiring of Expandable Units and Multi-Wide Units.

11.12.1 Expandable or multi-wide manufactured homes shall use approved and listed fixed-type wiring methods and materials for connecting such units to each other.

11.12.2 Expandable or multiple-unit manufactured homes not having permanently installed feeders that are to be moved from one location to another shall be permitted to have disconnecting means with branch-circuit protective equipment in each unit where so located that after assembly or joining together of units, the requirements of Section 11.3 are met.

11.13 Outdoor Outlets, Fixtures, Air-Conditioning Equipment, and Other Equipment.

11.13.1 Outdoor fixtures and equipment shall be listed for outdoor use. If located on the underside of the home or located under roof extensions or similarly protected locations, outdoor fixtures and equipment shall be listed for use in damp locations.

11.13.2 A manufactured home provided with a branch circuit designed to energize outside heating equipment or air-conditioning equipment, or both, located outside the manufactured home, other than room air conditioners, shall have such branch-circuit conductors terminate in a listed outlet box, or disconnecting means, located on the outside of the manufactured home. A label shall be permanently affixed adjacent to the outlet box and shall contain the following information.

WARNING: THIS CONNECTION IS FOR HEATING AND/OR AIR-CONDITIONING EQUIPMENT. THE BRANCH CIRCUIT IS RATED AT NOT MORE THAN _____ AMPERES, AT _____ VOLTS, 60 HERTZ, _____ CONDUCTOR AMPACITY. A DISCONNECTING MEANS SHALL BE LOCATED WITHIN SIGHT OF THE EQUIPMENT.

11.13.2.1 The correct voltage and ampere rating shall be given. The tag shall be not less than 0.020 in. (0.508 mm) thick etched brass, stainless steel, anodized or alclad aluminum, or equivalent. The tag shall not be less than 3 in. × 1¾ in. (75 mm × 44 mm) minimum size.

11.14 Painting. Metal raceways and sheath of nonmetallic cable shall be permitted to be painted during the painting or staining of the manufactured home. Provisions shall be made to ensure that no paint is applied to the individual wires so the color coding is not obliterated by the paint.

Exception: Metal raceways shall not be permitted to be painted where grounding continuity would be reduced.

11.15 Polarization.

11.15.1 The white conductor shall be employed for the grounded (neutral) circuit conductors only and shall be connected to the white terminal or lead on receptacle outlets and fixtures. The grounded conductor shall be the unswitched wire in switched circuits.

Exception: A cable containing an insulated conductor with a white or natural gray outer finish or a marking of three continuous white stripes shall be permitted for single-pole, 3-way, or 4-way switch loops where this conductor is used for the supply to the switch, but not as a return conductor from the switch to the switched outlet. In these applications, the conductor with white or natural gray insulation or with three continuous white stripes shall be permanently re-identified to indicate its use by painting or other effective means at its terminations and at each location where the conductor is visible and accessible.

11.15.2 If the identified (white) conductor of a cable is used for other than grounded conductors or for other than switch loops, as explained in 11.15.1 (for a 240-volt circuit, for example), the conductor shall be finished in a color other than white at each outlet where the conductors are visible and accessible.

11.15.3 Green-colored wires or those that are green with yellow stripes shall be used for grounding conductors only.

11.16 Examination of Equipment for Safety. The examination or inspection of equipment for safety in accordance with this standard shall be conducted under uniform conditions and by organizations properly equipped and qualified for experimental testing, inspections of the run of goods at factories, and service-value determinations through field examinations.

Chapter 12 Transportation

12.1 Scope. This chapter shall cover the general requirements for designing the structure of the manufactured home for transportation.

12.2 Definitions. The following definitions shall apply to Chapter 12 only.

12.2.1 Chassis. The entire transportation system comprising the following subsystems: drawbar and coupling mechanism, frame, running gear assembly, and lights.

12.2.2 Drawbar and Coupling Mechanism. The rigid assembly (usually an A frame) where the coupling mechanism is mounted that connects the manufactured home's substructure to the towing vehicle.

12.2.3 Frame. The fabricated, rigid substructure that provides support to the affixed manufactured home structure, both during transport and on-site, and provides a platform for securement of the running gear assembly and the drawbar and coupling mechanism.

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12.2.4 Running Gear Assembly. An assembly consisting of suspension springs, axles, bearings, wheels, hubs, tires, and brakes, with their related connecting hardware.

12.2.5 Transportation System. See 12.2.1, Chassis.

12.3 General Requirements. The manufactured home and its transportation system (as defined in Section 12.2) shall withstand the effects of highway movement such that the home is capable of being transported safely and installed as a habitable structure. Structural, plumbing, mechanical, and electrical systems shall be designed to function after set-up. The home shall remain weather protected during the transportation sequence to prevent internal damage. Suitability of the transportation system and home structure to withstand the effects of transportation shall be permitted to be determined by testing, or engineering analysis, or a combination of the two as required in 12.3.1 and 12.3.2.

12.3.1 Road Tests. Tests shall be witnessed by an independent registered professional engineer or architect, or by a recognized testing organization. Such testing procedures shall be become part of the manufacturer's approved design. *(Suggested guidelines for a transportation road test protocol are provided in Annex C.)*

12.3.2* Engineering Analysis. Engineering analysis methods, based on the rational application of principles of mechanics and on data that shall be permitted to be taken from successfully transported homes, shall be permitted to be developed to support adequacy of the transportation system.

12.4* System Requirements. The transportation system shall be designed and constructed as an integrated unit that is safe and suitable for its specific use. In operation, the transportation system shall effectively respond to the control of the towing vehicle tracking and braking, while traveling at applicable highway speeds and in normal highway traffic conditions.

12.5 System Component Requirements.

12.5.1 Drawbar. The drawbar shall be constructed of sufficient strength, rigidity, and durability to safely withstand those dynamic forces experienced during highway transportation. It shall be securely fastened to the manufactured home substructure.

12.5.2 Coupling Mechanism. The coupling mechanism, usually of the socket type, shall be securely fastened to the drawbar in such a manner as to ensure safe and effective transfer of the maximum loads, including dynamic loads, between the manufactured home structure and the hitch-assembly of the towing vehicle. The coupling shall be equipped with a manually operated mechanism so adapted as to prevent disengagement of the unit while in operation. The coupling shall be designed so that it can be disconnected, regardless of the angle of the manufactured home to the towing vehicle.

12.5.3 Chassis. The chassis, in conjunction with the manufactured home structure, shall be constructed to effectively sustain the designed loads. The integrated structure shall be capable of ensuring the integrity of the complete manufactured home and ensuring against excessive deformation of structural or finish members.

12.5.4 Running Gear Assembly.

12.5.4.1 Design Criteria. The design load used to size running gear components shall be the gross dead weight minus the static tongue weight supported by the drawbar. Running gear shall be designed to accept shock and vibration from the highway and the towing vehicle and to effectively dampen these forces so as to protect the manufactured home structure from damage and fatigue. The components of the running gear assembly shall be designed to facilitate routine maintenance, inspection, and replacement.

12.5.4.2 Location. Location of the running gear assembly shall be determined by documented engineering analysis, taking into account the gross weight (including all contents), total length of the manufactured home, the necessary coupling hitch weight, span distance, and turning radius. The coupling weight shall not be less than 12 percent nor more than 25 percent of the gross weight.

12.5.5 Spring Assemblies. Spring assemblies (springs, hangers, shackles, bushings, and mounting bolts) shall be capable of supporting the running gear design loads without exceeding maximum allowable stresses for design spring assembly life as recommended by the spring assembly manufacturer. The capacity of the spring system shall ensure that under maximum operating load conditions sufficient clearance shall be maintained between the tire and manufactured home's substructure to permit unimpeded wheel movement and the changing of tires.

12.5.6 Axles. Axles and their connecting hardware shall be capable of supporting the running gear design loads without exceeding the maximum allowable design axle loads as recommended by the axle manufacturer. The number and load capacity of axles necessary to provide a safe tow shall not be less than those required to support the design load.

12.5.6.1 Recycled Axles. Before reuse, all axles, including all component parts, shall be reconditioned as required pursuant to a program accepted by a nationally recognized testing agency. The recycling program shall be approved and the axles shall be labeled by a nationally recognized testing agency. Recycled axles and their components shall utilize compatible components and be of the same size and rating as the original equipment.

12.5.7 Hubs and Bearings. Hubs and bearings shall meet the requirements of 12.5.4.1 and good engineering practice. Both of these components shall be accessible for inspection, routine maintenance, and replacement of parts.

12.5.8 Tires, Wheels, and Rims. Tires and rims shall be selected, sized, and fitted to axles so that static dead load supported by the running gear does not exceed the load capacity of the tires. Tires shall not be loaded beyond the load rating marked on the sidewall of the tire or, in the absence of such a marking, the load rating specified in any of the publications of any of the organizations listed in FMVSS No. 119 [49 CFR 571.119, §5.1(b)]. Wheels and rims shall be sized in accordance with the tire manufacturer's recommendations as suitable for use with the tires selected.

12.5.8.1 Valve Stems. Valve stems shall be sized according to the Tire and Rim Association, Incorporated Yearbook, 2001.

12.5.8.2 Inflation Pressure. The load and cold inflation pressure imposed on the rim or wheel shall not exceed the rim and wheel manufacturer's instructions even if the tire has been approved for a higher load or inflation. Tire cold inflation pressure limitations and the inflation pressure measurement correction for heat shall be as specified in 49 CFR 393.75(h).

12.5.8.3 Used Tires. Used tires shall be permitted to be sized in accordance with 12.5.8 whenever the tread depth is at least 1⁄16 in. (1.6 mm) as determined by a tread wear indicator. The

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determination as to whether a particular used tire is acceptable shall also include a visual inspection for thermal and structural defects (e.g., dry rotting, excessive tire sidewall splitting, etc.).

12.5.9 Brake Assemblies.

12.5.9.1 Braking Axles. The number, type, size, and design of braking assemblies required to assist the towing vehicle in providing effective control and stopping of the manufactured home shall be determined and documented by engineering analysis. Those alternatives listed in 12.5.9.2 shall be permitted in place of such analysis. Unless substantiated in the design to the satisfaction of the approval agency by either engineering analysis in accordance with 12.3.2 or tests in accordance with 12.5.9.2, there shall be a minimum of two axles equipped with brake assemblies on each manufactured home transportable section.

12.5.9.2 Stopping Distance. Brakes on the towing vehicle and the manufactured home (a drive-away/tow-away operation) shall be capable of ensuring that the maximum stopping distance from an initial speed of 20 mph (32 km/h) does not exceed 35 ft (10.7 m) (U.S. Department of Transportation Regulations).

12.5.9.3 Electrical Brake Wiring. Brake wiring shall be installed to provide sufficient operating voltage for each brake. The voltage available at the brakes shall not be less than the value specified in the brake manufacturer's instructions. Aluminum wire, when used, shall be provided with suitable termination that is protected against corrosion.

12.5.10 Lamps and Associated Wiring. Stop lamps, turn signal/lamps, and associated wiring shall meet the appropriate sections of the Federal Motor Vehicle Safety Standard (FMVSS) No. 108, which specify the performance and location of these lamps and their wiring. The manufacturer shall have the option of meeting these requirements by utilizing a temporary light/wiring harness, which has components that meet the FMVSS No. 108. The temporary harness shall be permitted to be provided by the manufactured home transportation carrier.

Chapter 13 Special Construction Consideration

13.1 Scope. This chapter shall set forth the requirements for single-family attached dwellings and other related construction associated with manufactured homes not addressed within this document.

13.2 Definitions. The following definitions shall be applicable to Chapter 13 only.

13.2.1 Common Wall. A wall of a single-family attached dwelling unit that is structurally independent of a wall of another single-family attached dwelling unit with a fire separation distance of less than 3 ft (0.91 m).

13.2.2 Fire Separation Distance. The distance measured from the building face to the closest interior lot line, to the centerline of a street, alley, or public way, or to an imaginary line between two buildings on the property. The distance shall be measured at right angles from the lot line.

13.2.3 Single-Family Attached Dwelling. A single-family dwelling unit constructed in a group of two or more attached units in which each unit is structurally independent from foundation to roof and with open space on at least two sides. Adjacent units are structurally independent but with the appearance of a physical connection (i.e., zero lot line).

13.3 Dwelling Unit Separation.

13.3.1 Single-family attached dwelling units shall be separated from each other by a common wall of not less than 1-hour fire-resistive rating when tested in accordance with ASTM E 119, *Standard Test Method for Fire Tests of Building Construction and Materials*. Fire resistance rated common wall assemblies shall extend to the underside of the roof sheathing.

13.3.2 Fire Separation Penetrations.

13.3.2.1 Fire rated common walls shall not contain through penetrations or openings.

13.3.2.2 Membrane penetrations for electrical boxes shall be permitted provided the following.

(1) Steel electrical boxes not exceeding 16 in.^{2} (0.01 m^2) may be installed provided that the total area of such boxes does not exceed 100 in.^{2} (0.06 m^2). Steel electrical boxes in adjacent common walls shall be separated by a horizontal distance of not less than 24 in. (610 mm).
(2) Listed 2-hour fire-resistant nonmetallic electrical boxes are installed in accordance with the listings.
(3) No other membrane penetrations are allowed.

13.3.3 The common walls for single-family attached dwelling units shall be continuous from the foundation to the underside of the roof sheathing, deck, or slab and shall extend the full length of the common walls.

13.3.4 Parapets.

13.3.4.1 Parapets constructed in accordance with 13.3.4.2 shall be provided for single-family attached dwelling units as an extension of common walls in accordance with the following.

13.3.4.1.1 Where roof surfaces adjacent to the common walls are at the same elevation, the parapet shall extend not less than 30 in. (762 mm) above the roof surfaces.

13.3.4.1.2 Where roof surfaces adjacent to the wall or walls are at a different elevations and the higher roof is not more than 30 in. (762 mm) above the lower roof surface, the parapet shall extend not less than 30 in. (762 mm) above the lower roof surface.

13.3.4.1.2.1 Parapets shall be provided except as noted by the following: (1) Roofs covered with a Class C roof covering under one of the following conditions: (a) when the roof is covered with a minimum Class C roof covering, and the roof decking or sheathing is of noncombustible materials or approved fire-retardant-treated wood for a distance of 4 ft (1.2 m) on each side of the common walls; (b) one layer of 5⁄8 in. (16 mm) Type X gypsum board is installed directly beneath the roof decking or sheathing for a distance of 4 ft (1.2 m) on each side of the common walls.

13.3.4.1.2.2 A parapet shall not be required where roof surfaces adjacent to the common walls are at different elevations and the higher roof is more than 30 in. (762 mm) above the lower roof. The common wall construction from the lower roof to the underside of the higher roof deck shall not have less than a 1-hour fire-resistive rating. The wall shall be rated for exposure from both sides.

13.3.4.2 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 in. (457 mm), to include counter flashing and coping materials.

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Where the roof slopes toward a parapet at slopes greater than two 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 ft (0.91 m), but in no case shall the height be less than 30 in. (762 mm).

13.4 Exterior Walls.

13.4.1* The requirements of 8.4.2 for condensation control and 8.4.3 for vapor retarder installation shall apply to the common wall on each single-family attached dwelling unit.

13.4.2* The requirements of Section 8.6 for heat loss/gain shall apply to the common wall on each single-family attached dwelling unit.

13.5 Electrical Service.

13.5.1 A dwelling unit shall be supplied by only one service.

13.5.2 Service conductors supplying one dwelling unit shall not pass through the interior of another dwelling unit.

13.6 Water Service.

13.6.1 Each dwelling unit shall have an individual water supply that will service only that unit.

13.6.2 Each dwelling unit shall have a hot water supply system that will service only that unit.

Chapter 14 Referenced Publications

14.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

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NFPA 72®, *National Fire Alarm Code®*, 2002 edition.
NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*, 2002 edition.
NFPA 220, *Standard on Types of Building Construction*, 1999 edition.
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NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 2003 edition.
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ANSI/AHA A 135.5, *Prefinished Hardboard Paneling*, 1995.
ANSI/AHA A 135.6, *Hardboard Siding*, 1998.

14.3.4 AISC Publication. American Institute of Steel Construction, One East Wacker Drive, Suite 3100, Chicago, IL 60601.

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AISI-SG 971, *Specification for the Design of Cold-Formed Steel Structural Members*, 1996 edition.

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ANSI A 112.19.7M, *Whirlpool Bathtub Appliances*, 1995.
ANSI A 112.19.6, *Hydraulic Requirements for Water Closets and Urinals*, 1995.
ANSI A 112.21.3M, *Hydrants for Utility and Maintenance Use*, 2001.
ANSI A 208.1, *Mat-formed Wood Particleboard*, 1999.
ANSI A 208.2, *Medium Density Fiberboard for Interior Use (MDF)*, 1994.
ANSI B 36.10M, *Welded and Seamless Wrought Steel Pipe*, 1995.
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UL 181, *Standard for Safety Factory-Made Air Ducts and Air Connectors,* 1996.
UL 181A, *Closure Systems for Use with Rigid Air Ducts and Air Connectors,* 1994.
UL 181B, *Closure Systems for Use with Flexible Air Ducts and Air Connectors,* 1995.
UL 217, *Single and Multiple Station Smoke Alarms,* 1997.
UL 268, *Smoke Detectors for Fire Protective Signaling Systems,* 1996.
UL 307A, *Standard for Safety Liquid Fuel-Burning Heating Appliances for Manufactured Homes and Recreational Vehicles,* 1995.
UL 307B, *Gas-Burning Heating Appliances for Manufactured Homes and Recreational Vehicles,* 1995.
UL 311, *Roof Jacks for Manufactured Homes and Recreational Vehicles,* 1994.
UL 441, *Gas Vents,* 1996.
UL 569, *Standard for Pigtails and Flexible Hose Connectors for LP-Gas*, 1995.
UL 737, *Fireplace Stoves,* 1996.
UL 923, *Microwave Cooking Appliances*, 2002.
UL 1042, *Electric Baseboard Heating Equipment,* 1994, with Revision 9/98.
UL 1482, *Room Heaters, Solid-Fuel Type*, 1996 with Revision 9/98.
UL 1971, *Signaling Devices for Hearing Impaired,* 1995.
UL 1995, *Heating and Cooling Equipment,* 1995 with Revision 7/98.
UL 2021, *Standard for Fixed and Location-Dedicated Electric Room Heaters*, 1997, with Revisions 7/98, 12/2002.

14.3.32 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 16, Code of Federal Regulations, Part 1201, Safety Glazing Test Standard.
Title 16, Code of Federal Regulations, Parts 1209 and 1404, Cellulose Insulation.
Title 24, Code of Federal Regulations, Part 3282.12, Excluded Structures — Modular Homes.
Title 24, Code of Federal Regulations, Part 3282.207, Manufactured Home Procedural and Enforcement Regulations.

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Title 24, Code of Federal Regulations, Part 3283, Manufactured Home Consumer Manual Requirements.
Title 49, Code of Federal Regulations, Parts 393.75(h) and 571.119, Transportation, Federal Motor Vehicle Safety Standards.
National Appliance Energy Conservation Act of 1987.
Safe Drinking Water Act, Section 109(c)(2), Amendments, 1986.
National Manufactured Housing Construction and Safety Standards Act of 1974 (PL 93-383, as amended).
USDOC PS-1-95, *Construction and Industrial Plywood*, 1995.
USDOC PS-2-92, *Performance Standard for Wood-Based Structural-Use Panels*, 1992.
USDOC PS-20-99, *American Softwood Lumber Standard*, 1999.

14.3.33 WDMA Publications. Window and Door Manufacturers Association, 1400 East Touhy Avenue, Suite 470, Des Plaines, IL 60018.

ANSI/WDMA I.S.1-A-97, *Architectural and Wood Flush Doors*, 1997.
ANSI/AAMA/WDMA 101/I.S.2-97, *Voluntary Specifications for Aluminum, Vinyl, PVC, and Wood Windows and Glass Doors*, 1997.
WDMA I.S.4-00, *Water-Repellent Preservative Non-Pressure Treatment for Millwork*, 2000.

14.3.34 Other Publications.

Federal Motor Vehicle Safety Standard (FMVSS) No. 108.
Tire and Rim Association, Incorporated Yearbook, 2001.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.2.2 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.1.2.3 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.1.2.12 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.1.11.4 The road side is the right side of the manufactured home when one views the manufactured home from the tow bar of the manufactured home.

A.4.5.2.2 When a manufactured home is being designed for accessibility, one of the exterior swinging doors should provide a minimum 33 in. × 73 in. (838 mm × 1854 mm) clear opening.

A.4.8.1 For those units which may be requested by the consumer to be handicap accessible, the interior swinging doors should have a minimum clear opening width of 32 in. (810 mm).

A.4.11 For those units which may be requested by the consumer to be handicap accessible, the bathroom passage doors should have a minimum clear opening width of 32 in. (810 mm).

A.4.12 It is recognized that it is an option of the homeowner of a single-section home that a 36 in. (910 mm) wide hallway can be requested and the measurements should be established as defined in Section 4.12.

A.5.3.2.4 Adjacent surfaces are the exposed vertical surfaces between the rangetop height and the overhead cabinets and/or ceiling and within 6 horizontal in. (152 mm) of the cooking range.

A.5.6.1 A concealed space does not lose its character as a concealed draft opening if it is blocked by materials or filled with insulation or other material that does not comply with 5.6.2.

A.5.8.2.2 See Figure A.5.8.2.2 for further information on smoke alarms or smoke detectors spacing layout for sloped ceiling (peaked type).

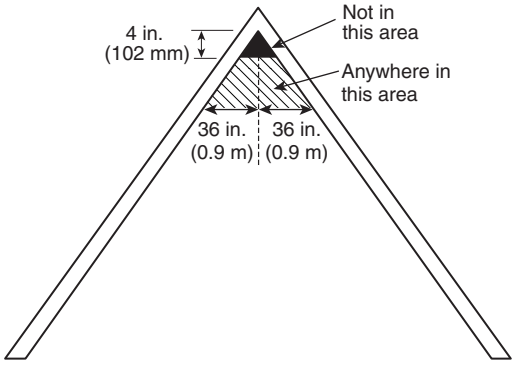


FIGURE A.5.8.2.2 Sloped Ceilings (Peaked Type).

A.5.8.2.3 See Figure A.5.8.2.3 for further information on placement of smoke alarms or smoke detectors on sloped ceilings.

A.5.8.2.4 See Figure A.5.8.2.4 for an example of proper mounting for smoke alarms or smoke detectors.

A.5.8.3.1(1) A sleeping area is considered to be those rooms that are used for sleeping and other auxiliary rooms adjacent to the sleeping room, such as sitting areas or other suite arrangements.

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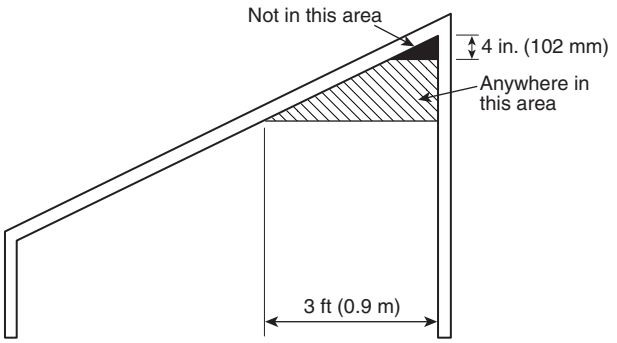


FIGURE A.5.8.2.3 Sloped Ceilings (Shed Type).

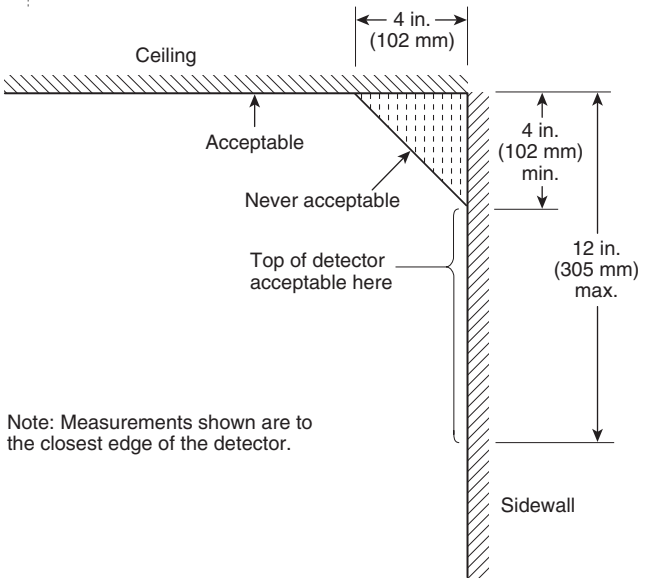


FIGURE A.5.8.2.4 Example of Proper Mounting for Smoke Alarms and Smoke Detectors.

A.5.8.3.2(2) The measurement of the horizontal path is determined by measuring the normal available path of travel the products of combustion can follow in a particular layout. It is not the intent to take this measurement as a radius of 20 ft (6 m) from the detector, not considering any building walls of configuration.

A.5.8.3.2(4) The measurement of the horizontal path is determined by measuring the normal available path of travel the products of combustion can follow in a particular layout. It is not the intent to take this measurement as a radius of 3 ft (0.9 m) from the detector, not considering any building walls of configuration.

A.6.5.3.3.1.1 The county map in Figure A.6.5.3.3.1.1 represents some of the counties listed in 6.5.3.3.1.1 and is provided to assist the document user.

A.6.5.3.3.1.2 The county map in Figure A.6.5.3.3.1.2 represents some of the counties listed in 6.5.3.3.1.2 and is provided to assist the document user.

A.7.1.1 The following are examples of when design live load deflection criteria do not apply: Exterior cladding tests where the cladding and its fastening are evaluated but the framing system, necessary to test the cladding, is not being evaluated.

A.7.1.2 The following are examples of when design live load deflection criteria do not apply: Exterior cladding tests where the cladding and its fastening are evaluated but the framing system, necessary to test the cladding, is not being evaluated.

A.7.3.2 As of January 17, 1995, the exterior and interior pressure tests where required are to be those specified in 6.5.3.1.

A.7.3.6 Manufacturers are encouraged to provide the shutters or protective covers and to install receiving devices, sleeves, or anchors for fasteners to be used to secure the shutters or protective covers to the exterior walls.

A.7.4.2 As of January 17, 1995, the exterior and interior pressure tests where required are to be those specified in 6.5.3.1.

A.7.4.6 Manufacturers are encouraged to provide the shutters or protective covers and to install receiving devices, sleeves, or anchors for fasteners to be used to secure the shutters or protective covers to the exterior walls.

A.7.5.6 Manufacturers are encouraged to provide the shutters or protective covers and to install receiving devices, sleeves, or anchors for fasteners to be used to secure the shutters or protective covers to the exterior walls.

A.8.5.1.1 The home manufacturer should address each of the following considerations for each type of penetration encountered in the home design and construction:

(1) Location(s) in envelope and the expected size of the penetration to be sealed
(2) Type of material to seal the penetration
(3) Material application technique and steps required to ensure the seal is not damaged
(4) Whether the material will be applied during construction or setup
(5) Quality control inspections to ensure proper workmanship

A.8.7.1 To minimize the cooling load of homes located in Zone 1 of Figure 8.6, consideration should be given to overhangs, awnings or other permanent shading devices or the use of glazing with 0.40 solar heat gain coefficient (SHGC) for double pane windows, and 0.60 SHGC for single pane windows with or without storm windows. SHGC should be based on tests using NFRC 200, *Procedures for Determining Fenestration Product Thermal Properties.*

A.8.8.3 All areas where insulation compression exists should be addressed by plant quality control processes. This includes compression as a result of electrical wiring and receptacles, plumbing, medicine cabinets and utility panels, and metal frames. To address this, batt-type wall insulation should be cut around electrical and plumbing fixtures and electrical wire and plumbing runs. Batt-type or blanket-type insulation should be cut to fit, to limit compression and comply with the insulation manufacturer stated *R*-value. Exceptions should be limited to "thermal shorts" associated with penetrations from plumbing and ducts.

A.8.8.4 No credit is given for electric resistance comfort heating systems.

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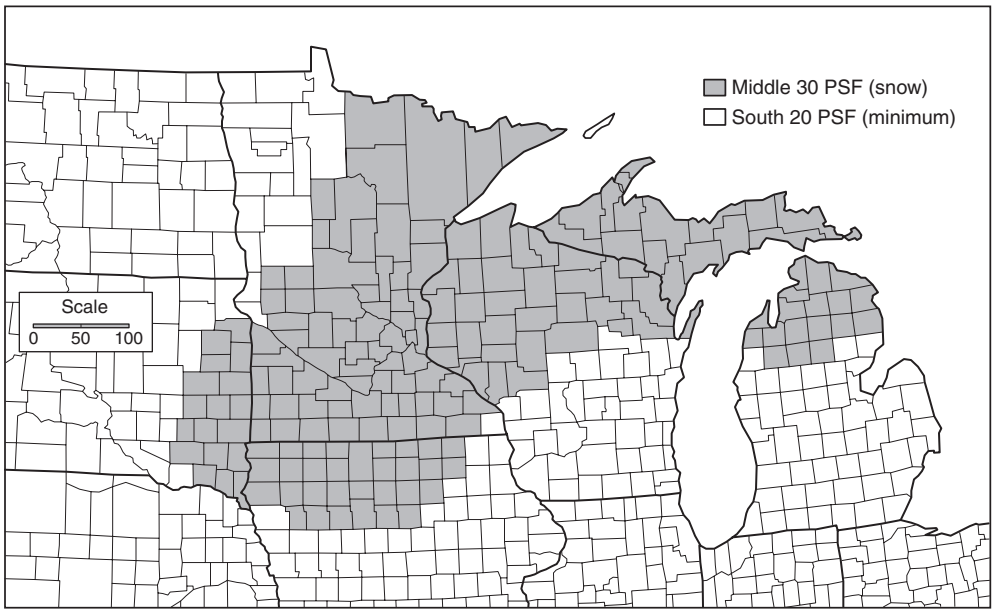


FIGURE A.6.5.3.3.1.1 Middle Roof Load Zones.

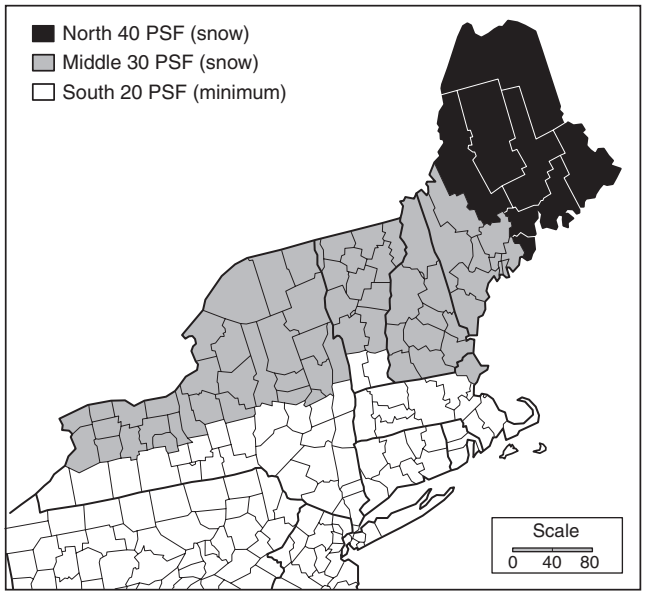


FIGURE A.6.5.3.3.1.2 North Roof Load Zones.

A.8.8.5 To minimize the cooling load in hot climates [>1500 Cooling Degree Days at Base 65°F (18.3°C)] consideration should be given to using roof covering with a solar reflectance tested by ASTM E 903 of no less than 0.25.

A.8.11.3 A cooling load (heat gain) calculation is required to determine the required capacity of equipment to cool a home efficiently and economically. The cooling load is dependent on the orientation, location, and structure of the home. Central air conditioners operate most efficiently and provide the greatest comfort when their capacity closely approximates the calculated cooling load. Each home's air conditioner should be sized in accordance with Chapter 27 of the 1997 *ASHRAE Handbook of Fundamentals*, once the location and orientation are known.

A.10.14.7 This provision intends to separate the duct from the outside air by the stated *R*-value.

A.11.2.41 Voltage (of a Circuit). Some systems, such as 3-phase 4-wire, single-phase 3-wire, and 3-wire direct-current, may have various circuits of various voltages.

A.11.2.42 Weatherproof. Rainproof, raintight, or watertight equipment can fulfill the requirements for weatherproof where varying weather conditions other than wetness, such as snow, ice, dust, or temperature extremes, are not a factor.

A.11.9.4.2 Protection can be afforded by the configuration of the chassis.

A.12.3.2 Additional information for engineering analysis can be found in Annex B, Structural Calculation Guidelines for In-Transit Conditions for Manufactured Homes.

A.12.4 While the majority of manufactured homes utilize a fabricated steel substructure, upon which the manufactured home structure is considered, it is not the intent of this standard to limit innovation. Therefore, other components, such as integrating the substructure function into the manufactured home structure, are acceptable, provided that such design meets the intent and requirements of Section 12.4.

A.13.4.1 The common wall for the attached dwelling unit configuration is treated in the same manner as an exterior wall for these purposes.

A.13.4.2 The common wall for the attached dwelling unit configuration is treated in the same manner as an exterior wall for these purposes.

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Annex B Structural Calculation Guidelines for In-Transit Conditions for Manufactured Homes

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 General. The following engineering guidelines are descriptive of methods and design assumptions that shall be permitted to be used for analytical evaluation of in-transit loading conditions. These guidelines have been developed with emphasis on the design of the longitudinal structural components of the manufactured home (e.g., main chassis girder beam, the sidewall, rim joist), as transportation loadings are ordinarily critical in the longitudinal direction. However, all elements necessary to the structural integrity of the manufactured home during in-transit loading are to be evaluated (e.g., transverse chassis and floor framing members, drawbar). HUD recognizes the complexity and variety of design assumptions and techniques that shall be permitted to be used in evaluating in-transit loading conditions and provides these guidelines as initial methods for determining compliance with this section. Due to this variation and complexity of assumptions, HUD has undertaken, as part of its transportation research study, the development of analytical methods for predicting the dynamic response of the manufactured home to in-transit load.

B.2 Design Methods and Assumptions — Design Loading. The summation of loadings in B.2.1 through B.2.3 shall be permitted to be used to determine the adequacy of the chassis in conjunction with the manufactured home structure to resist in-transit loading.

B.2.1 Dead load is the vertical load due to the weight of all structural and nonstructural components of the manufactured home at the time of shipment.

B.2.2 Floor load is a minimum of 3 lb/ft^2 (143 N/m^2).

B.2.3 Dynamic loading effect equals (0.25)[(B.2.1) + (B.2.2)].

However, the in-transit design loading need not exceed twice the dead load of the manufactured home.

B.3 Design Considerations. To determine the adequacy of individual longitudinal structural components to resist the in-transit design loading, a load distribution based on the relative flexural rigidity and shear stiffness of each component shall be permitted to be utilized. For the purpose of loading distribution, the sidewall shall be permitted to be considered to be acting as a "deep beam" in conjunction with other load-carrying elements in determining the relative stiffness of the integrated structure. Further, by proper precambering of the chassis assembly, additional loading shall be permitted to be distributed to the chassis, and the remaining loading shall be permitted to be distributed to each of the load-carrying components by the relative stiffness principle.

B.3.1 In addition, the analysis shall be permitted to include consideration for the following:

(1) Location of openings in the sidewall during transport and, when appropriate, provisions for reinforcement of the structure and/or chassis at the opening
(2) Sidewall component member sizing and joist-splice analysis (i.e., top plate, and so forth) and connections between load-carrying elements

Annex C Transportation Road Test Protocol Guidelines

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 Purpose. The road testing procedures outlined below may be used pursuant to 12.3.1 to qualify new manufactured home models or construction variations to new or existing models.

C.2 New/Revised Models. The following considerations can be used by the approval agency as a guideline for determining when a transportation test may be required:

(1) Variations in length, width, height and weight of the home
(2) Chassis construction including hitch and axles
(3) Floor construction
(4) Sidewall construction including the type of siding used
(5) Window and door sizes and/or locations
(6) Roof construction and configuration including roofing material, dormers, and overhangs
(7) Mating wall construction and configuration
(8) Porches, carports, recessed entries, expandable rooms, and so forth

C.3 Procedure. The approval agency shall identify new or revised models that require transportation testing using the following guidelines.

(1) The test model should be selected to represent the most critical condition in the manufacturer's model line with consideration given to weight; size; spacing and size of structural supports; number and location of axles; and location of openings. Should the manufacturer not be in a position to test the most critical conditions, additional tests may be necessary to qualify additional design modifications.
(2) The approval agency should provide a detailed set of approved drawings and specifications to the test observer for comparing the test model to the drawings and a copy of the Manufactured Home Test Report for use in reporting the test results.
(3) The test home should be produced to the approval agency's approved drawings. The federally appointed inspection agency should inspect the home and red tag it for purposes of the test.
(4) The test observer should inspect the home prior to the transportation test using the Manufactured Home Transportation Test Report form *(see Figure C.3)*. The home should be transported not less than 200 miles as covered in the Report and re-inspected. The test observer should complete the Report and forward it to the approval agency for final review and design approval, if the test is successful.

C.4 Unit(s) Passing Criteria. The home successfully passes the transportation test when no visible structural damage or degradation occurs after transportation.

C.5 Unit(s) Failure Criteria. The home fails the transportation test when any of the following defects are found:

(1) Structural cracks
(2) Structural damage
(3) Buckled or bowed panels
(4) Failure of components, assemblies, or connections

C.6 Federally Appointed Inspection Agency Approval. The inspection agency should release the home only with the approval of the approval agency.

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MANUFACTURED HOME TRANSPORTATION TEST REPORT

Test date: _____

Manufacturer: _____

Address: _____

_____

_____

Model number: _____ Serial number: _____

Box size: Length: _____ Width: _____ Height: _____

Chassis: (standard, perimeter, other) _____

Floor: (long, transverse, other) _____

Wall construction: (2 in. × 4 in., 2 in. × 6 in., other) _____

Siding type: _____ Roofing type: _____

Number of axles: _____ Gross weight: _____

Axle weight: _____ Hitch height: _____

Verify that the test unit(s) has been compared to and complies with the prints and specifications provided by the approval agency: ❑ Yes ❑ No

If NO, contact the approval agency for instructions before proceeding. This will permit all elements of the structure to be approved prior to the construction except for transportation. Final approval by the approval agency will be conditional upon the successful completion of the road test. The material submitted for design approval must include transportation weather protection and temporary bracing to be used.

Determine the gross weight, axle weight, and hitch weight for each unit(s), after the unit(s) is loaded with normal contents and ship loose items for transportation.

Inspect each unit prior to the road test using the Manufactured Home Transportation Test Report. Any defects found are to be corrected prior to testing.

Road test each unit for a minimum of 200 miles. Approximately half of the miles are to be at 55 miles per hour (mph) on interstate-type roads, and the other half are to be the posted speed limit on secondary roads. Record all data on the test report and trip log using additional sheets as needed.

After the road test, a complete re-inspection of the unit(s) is to be made using the inspection checklist.

A completed copy of the test report must be submitted to the approval agency for approval. The approval agency will then review the test report and issue an approval of the design based on the successful completion of the road test.

All damage and defects are to be described in detail on the back of these pages and/or on attached separate sheets.

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FIGURE C.3 Sample Transportation Test Report.

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MANUFACTURED HOME TRANSPORTATION TEST REPORT (Cont.)

Test date: _____

Component	Before-Transport Observations		After-Transport Observations	
	Yes	No	Yes	No
A. Chassis				
(1) Main beams — buckled, bent, or twists	_____	_____	_____	_____
(2) Outriggers — buckled, bent, or twists	_____	_____	_____	_____
(3) Cross members — buckled, bent, or twists	_____	_____	_____	_____
(4) Hitch/coupler damage	_____	_____	_____	_____
(5) Axle, spring, spring hanger, wheel damage	_____	_____	_____	_____
(6) Welds/connections — cracks, breaks, or damage	_____	_____	_____	_____
(7) Damage due to exposed gas lines, waterlines, drainlines, or supports	_____	_____	_____	_____
B. Floor System				
(1) Damage, separation, loosening of lags from chassis to floor	_____	_____	_____	_____
(2) Buckled floor, damaged decking/floor coverings, opening of joints, loose or popped fasteners	_____	_____	_____	_____
(3) Damage to bottom board, patches, loose fasteners	_____	_____	_____	_____
C. Exterior/Interior/Marriage Walls				
(1) Interior wall panels — buckled, cracked, bowed, separations, fasteners popped or loose	_____	_____	_____	_____
(2) Separations of walls at floor, ceiling, column supports, window and door openings	_____	_____	_____	_____
(3) Exterior siding and trim — buckled, cracked, bowed, separations, fasteners popped or loose	_____	_____	_____	_____
(4) Windows and doors — damaged, buckled, bowed, or parts missing	_____	_____	_____	_____
(5) Windows and doors — operate properly	_____	_____	_____	_____
(6) Damage to caulking and sealants	_____	_____	_____	_____
D. Roof/Ceiling				
(1) Roofing — buckled, cracked, bowed, splits, openings, loose or popped fasteners	_____	_____	_____	_____
(2) Damage to roof penetrations — vents, roof jacks, skylights, caulking and sealants	_____	_____	_____	_____
(3) Damage to eaves, overhangs, transitions	_____	_____	_____	_____
(4) Ceilings — buckled, cracked, bowed, sagging, separations, loose or popped fasteners	_____	_____	_____	_____

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FIGURE C.3 *Continued*

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MANUFACTURED HOME TRANSPORTATION TEST REPORT (Cont.)

Test date: _____

Component	Before-Transport Observations		After-Transport Observations	
	Yes	No	Yes	No
E. Plumbing				
(1) Damage to fixtures, piping, fittings, connections, and supports	_____	_____	_____	_____
F. Mechanical				
(1) Damage to appliances, fuel piping, fittings, connections, vent systems, and supports	_____	_____	_____	_____
G. Electrical				
(1) Damage to fixtures, appliances, materials, and connections	_____	_____	_____	_____
H. Any Other Visible Damage				
(1) If YES, explain:	_____	_____	_____	_____

_____

_____

_____

Transport each unit of the home a minimum of 200 miles including approximately 100 miles of interstate-type roads (55 mph) and 100 miles on secondary roads (where local laws permit) at posted speed limits.

Actual miles driven: _____

Miles on interstate-type roads: _____ Average speed: _____

Miles on secondary roads: _____ Average speed: _____

I have witnessed the test as described above, have inspected the home before and after the test, and have completed all necessary notations for evaluation.

Authorized Representative: _____

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FIGURE C.3 *Continued*

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MANUFACTURED HOME TRANSPORTATION TEST REPORT (Cont.)

Test date: _____

TRIP LOG

Date: _____ Manufacturer: _____

From: _____ Plant: _____

To: _____ Model number: _____

Beginning/Ending Odometer Reading	Mileage	Elapsed Time	Road Type*	Average Speed	Remarks
/					
/					
/					
/					
/					
/					
/					
/					
/					
/					
/					
/					
/					

* City/Town/Village Street
County/Township Road
County Highway
State Highway – 2 Lane
State Highway – 4 Lane
Interstate

Manufacturer's Representative: _____

Authorized Representative: _____

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FIGURE C.3 ***Continued***

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C.7 Qualifications of the Test Observer. The transportation test should be witnessed by qualified persons employed or authorized by the approval agency. The approval agency's technical staff, the federally appointed inspection agency staff, a registered professional engineer, and a registered architect are considered qualified for this purpose.

Annex D Informational References

D.1 Referenced Publications. The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not part of the requirements of this document unless also listed in Chapter 14.

D.1.1 NFPA Publications. (Reserved)

D.1.2 Other Publications.

D.1.2.1 ASHRAE Publication. American Society of Heating, Refrigeration and Air Conditioning Engineers, 1791 Tullie Circle, N.E., Atlanta, GA 30329.

ASHRAE Handbook of Fundamentals, 1997.

D.1.2.2 ASTM Publication. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 903, *Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres*, 1996.

D.1.2.3 NFRC Publication. National Fenestration Rating Council, 1300 Spring Street, Suite 500, Silver Spring, MD 20910.

NFRC 200, *Procedures for Determining Fenestration Product Thermal Properties*, 2004.

D.2 Informational References. (Reserved)

D.3 References for Extracts. The following documents are listed here to provide reference information, including title and edition, for extracts given throughout the nonmandatory sections of this standard as indicated by a reference in brackets [ ] following a section or paragraph. These documents are not a part of the requirements of this document unless also listed in Chapter 14 for other reasons.

NFPA 5000®, *Building Construction and Safety Code®*, 2003 edition.

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▼

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▼

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▼

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▼

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