

NFPA 102

Assembly Seating, Tents, and Membrane Structures

1992 Edition



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There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NFPA 102
Standard for
Assembly Seating, Tents, and Membrane Structures
1992 Edition

This edition of NFPA 102, *Standard for Assembly Seating, Tents, and Membrane Structures*, was prepared by the Technical Committee on Safety to Life and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 18-20, 1991 in Montréal, Québec, Canada. It was issued by the Standards Council on January 17, 1992, with an effective date of February 10, 1992, and supersedes all previous editions.

The 1992 edition of this document has been approved by the American National Standards Institute.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

Origin and Development of NFPA 102

This standard is the result of a committee project inaugurated shortly after the circus fire in Hartford, CT, on July 6, 1944, in which 168 lives were lost.

A committee was organized under the joint sponsorship of the Building Officials Conference of America and the National Fire Protection Association under the procedure of the American Standards Association. As a result of extensive deliberation during the winter of 1944-1945, this committee prepared a draft of a proposed standard, which was submitted at the annual meeting of the National Fire Protection Association in June, 1945. This was then printed and sent to all of the members of the Association, to a representative group of leaders in the outdoor amusement industry, and to all others who filed requests for copies. As a result, numerous constructive suggestions were received, all duly considered by the committee in several meetings, and the 1946 standard was completed by the committee. It was then adopted by the sponsoring organizations, the National Fire Protection Association, and the Building Officials Conference of America, and approved by the American Standards Association as an American Standard on May 22, 1946.

As a result of circulation and use of the 1946 standard, various proposals were made for revision in the interest of clarification. These were considered by the committee and revisions recommended by the committee and circulated to all concerned for comment, further amended, and adopted by the National Fire Protection Association and the Building Officials Conference of America in 1948; the American Standards Association approved the 1948 edition as an American Standard on January 5, 1949.

In 1949 the committee recommended further changes to include the essential features of an earlier standard on grandstands, Z20.1, which covered certain types of grandstands not covered in the 1946-1948 standard, Z20.2, thus making the continuance of the earlier separate standard unnecessary. The 1949 revision, Z20.3, also made the standard applicable to foldable grandstands in buildings that had not been previously covered.

After the usual circulation for comment the revisions were adopted in 1949 by the sponsors, and the revised text was approved by the American Standards Association as an American Standard, April 5, 1950.

Revised editions of the standard have been prepared by the committee and adopted by the sponsors in 1957, 1966, and 1967. The 1972 edition was a reconfirmation of the 1967 edition.

The 1978 edition was prepared by the Committee on Tents, Grandstands, and Air-Supported Structures and represented a complete revision of the 1972 edition, complete with a new title, *Standard for Assembly Seating, Tents, and Air-Supported Structures*. The means of egress section was coordinated with the provisions of NFPA 101,[®] *Life Safety Code*.[®]

The 1986 edition further coordinated with the *Life Safety Code*. It was prepared by the Technical Committee on Safety to Life through its Subcommittee on Tents and Membrane Structures. Its scope was extended beyond assembly occupancies to include tents and membrane structures used for any occupancy.

This 1992 edition deletes all means of egress provisions that are adequately covered by NFPA 101, *Life Safety Code*, so as to avoid redundancy and inconsistencies between the two documents.

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NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.

Information on referenced publications can be found in Chapter 11 and Appendix B.

Chapter 1 General

1-1* Scope. This standard covers the following:

(a) The construction, location, protection, and maintenance of folding or telescopic seating, grandstands, bleachers, tents, and membrane structures.

(b) Means of egress for assembly seating facilities, such as grandstands and bleachers, that are permanent, temporary, or portable, that are fixed, folding, or telescoping, and that are not within the scope of NFPA 101,[®] *Life Safety Code*.[®] Such seating facilities may be located in the open air or within enclosed or semienclosed structures such as tents, membrane structures, and stadium complexes.

1-2 Purpose. The purpose of this standard is to provide for life safety in relation to fire, storm, collapse, and crowd behavior in tents, membrane structures, and assembly seating as covered in Section 1-1.

1-3 Application. This standard applies to new facilities. Where specifically noted, it also applies to existing facilities.

1-4 Referenced Design Standards. The materials, design, fabrication, and construction of structures or devices included within the scope of this standard shall comply with approved standards for safety to life and property as contained herein and in the applicable building code.

1-5 Equivalency Concepts.

1-5.1 Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety to those prescribed by this standard, provided technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency and provided the system, method, or device is approved for the intended purpose.

1-5.2 The specific requirements of this standard may be modified by the authority having jurisdiction to allow alternative arrangements that will secure as nearly equivalent safety to life from fire as practical, but in no case shall the

modification afford less safety to life than, in the judgment of the authority having jurisdiction, that which would be provided by compliance with the corresponding provisions contained in this standard.

1-5.3 Buildings with alternative fire protection features accepted by the authority having jurisdiction shall be considered to conform with this standard.

Chapter 2 Definitions

2-1 General.

2-1.1 For the purposes of this standard, the following terms shall have the meanings given in this chapter.

2-1.2 Words used in the present tense include the future; words used in the masculine gender include the feminine and neuter; the singular number includes the plural and the plural the singular.

2-1.3 Where terms are not defined in this chapter, they shall have their ordinarily accepted meanings or such as the context may imply.

2-2 Definitions.

Air-Inflated Structure. A structure whose shape is maintained by air pressure in cells or tubes forming all or part of the enclosure of the usable area. Occupants of such a structure do not occupy the pressurized area used to support the structure.

Air-Supported Structure.* A structure where shape is maintained by air pressure and occupants of the structure are within the elevated pressure area.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: 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 or 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 concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Assembly Occupancy. Includes, but is not limited to, all structures or portions of structures used for gathering together 50 or more persons for such purposes as deliberation, worship, entertainment, eating and drinking, amusement, or awaiting transportation.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: The phrase "authority having jurisdiction" 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, 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 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."

Bleachers. A grandstand where the seats are not provided with backrests.

Exit.* That portion of a means of egress that is separated from all other spaces of the building or structure by construction or equipment as required to provide a protected way of travel to the exit discharge.

Exit Access. That portion of a means of egress that leads to an exit.

Exit Discharge. That portion of a means of egress between the termination of an exit and a public way.

Fire Resistance Rating. The time in minutes or hours that materials or assemblies have withstood a fire exposure as established in accordance with the test procedures of NFPA 251, *Standard Methods of Fire Tests of Building Construction and Materials*.

Folding and Telescopic Seating. A structure that is used for tiered seating of persons and whose overall shape and size may be reduced, without being dismantled, for purposes of moving or storing.

Grandstand. A structure providing tiered or stepped seating. Where the term grandstand is preceded by an adjective denoting a material, it shall mean a grandstand the essential members of which, exclusive of seating, are of the material designated.

Heavy Timber Construction. Type IV (2HH) construction as defined in NFPA 220, *Standard on Types of Building Construction*.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Limited-Combustible. As applied to a building construction material, means a 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 per pound (8141 kJ/kg) per NFPA 259,

Standard Test Method for Potential Heat of Building Materials, and complies with one of the following paragraphs (a) or (b). Materials subject to increase in combustibility or flame spread rating beyond the limits herein established through the effects of age, moisture, or other atmospheric condition shall be considered combustible.

(a) Materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of $\frac{1}{8}$ in. (3.2 mm) that has a flame spread rating not greater than 50.

(b) Materials, in the form and thickness used, other than as described in (a), having neither a flame spread rating 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 rating greater than 25 nor evidence of continued progressive combustion.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which 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.

Means of Egress. A continuous and unobstructed way of exit travel from any point in a building or structure to a public way, consisting of three separate and distinct parts: (a) the exit access, (b) the exit, and (c) the discharge. A means of egress comprises the vertical and horizontal travel and shall include intervening room spaces, doorways, hallways, corridors, passageways, balconies, ramps, stairs, enclosures, lobbies, escalators, horizontal exits, courts, and yards.

Membrane. A thin, flexible, water-impervious material capable of being supported by an air pressure of 1.5 in. (38.1 mm) of water column.

Membrane Structure. A building or portion of a building incorporating an air-inflated, air-supported, tensioned-membrane structure, a membrane roof, or membrane-covered rigid frame to protect habitable or usable space.

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, *Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, shall be considered noncombustible materials.

Permanent. A building or structure that is intended to remain in place for a period of 180 days or more.

Private Party Tent. A tent erected in the yard of a private residence for entertainment, recreation, dining, reception, or similar function.

Professional Engineer. An engineer who is registered or licensed to practice engineering.

Shall. Indicates a mandatory requirement.

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

Temporary. In place for less than 180 consecutive calendar days.

Tensioned-Membrane Structure.* A membrane structure incorporating a membrane and a structural support system such as arches, columns and cables, or beams wherein the stresses developed in the tensioned membrane interact with those in the structural support so that the entire assembly acts together to resist the applied loads.

Tent. A temporary structure, the covering of which is made of pliable material that achieves its support by mechanical means such as beams, columns, poles, arches, rope, and/or cables. Tent may also include a temporary tensioned-membrane structure.

Weathered Membrane Material. Membrane material that has been subjected to a minimum of 3,000 hours in a weatherometer in accordance with ASTM G 26, *Practice for Operating Light/Exposure Apparatus (Zenon-Arc Type) With and Without Water for Exposure of Non-Metallic Materials*, or approved equal.

Chapter 3 Means of Egress

3-1 General.

3-1.1 Means of egress from facilities included within the scope of this standard shall comply with the provisions of NFPA 101, *Life Safety Code*, unless specifically noted.

3-1.2 No guy wire or guy rope shall cross any means of egress at a height of less than 7 ft (2.1 m). Tent stakes adjacent to any means of egress from any tent open to the public shall be railed off, capped, or covered in such manner as not to present a hazard to the public.

3-2 Number of Exits. A fenced outdoor assembly occupancy shall have at least two widely separated exits from the enclosure. If more than 6,000 persons are to be served by such exits, there shall be at least three, and if more than 9,000 there shall be at least four exits. Exits shall be distributed as uniformly as practicable for exit purposes.

3-3* Travel Distance.

3-3.1 The travel distance along the normal path of travel from any seat to an egress vomitory portal or the egress concourse shall not exceed 150 ft (45.7 m).

Exception: The travel distance may be increased to 200 ft (61 m) in buildings completely protected by automatic sprinklers installed in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems.

3-3.2 The travel distance from the vomitory portal, or entrance to the concourse, to the exterior of the building or entrance to the stairway or ramp shall not exceed 150 ft (45.7 m) (see A-2-2, *Exit*).

3-4 Exit Discharge.

3-4.1 All structures regulated by this standard shall have at all times ample and unrestricted exit discharge to public ways at no less than two points remote from each other. An available park, field, or open space may be approved as a public way.

3-4.2 If required exits from structures regulated by this standard do not discharge directly into a street or open space leading to a street, unobstructed lanes suitable to accommodate the occupant load shall be maintained from such exits to the street at all times while such structures are occupied by the public.

3-5 Illumination of Means of Egress. Private party tents not larger than 1200 sq ft (111.5 sq m) shall be exempt from the illumination of means of egress and emergency lighting requirements of NFPA 101, *Life Safety Code*.

Chapter 4 Grandstands and Bleachers

4-1 Location. Grandstands shall be erected or otherwise located only where adequate load-carrying capacities exist to safely support the loads.

4-2 Design.

4-2.1 The design of grandstands shall be in accordance with accepted structural engineering practice.

4-2.2 Load tests in accordance with accepted engineering practice shall be permitted in lieu of the design analysis for a grandstand unit or a part thereof.

4-2.3 Where required by the authority having jurisdiction, the manufacturer shall submit either calculations verifying the design analysis prepared by a professional engineer or registered architect or a report of load tests conducted by an approved independent testing laboratory and certified by a professional engineer. When required by the authority having jurisdiction, the manufacturer shall certify that the equipment supplied is in accordance with the design or is essentially identical to the structure tested.

4-2.4 A grandstand shall be so designed and assembled that the maximum expansion, contraction, settlement, or misalignment likely to occur will not cause stresses in excess of those permissible nor jeopardize the structure or its occupants. It shall be of such design as to remain stable, so as not be overturned either by wind or unequal distribution of live load.

4-2.5 Design Loads.

4-2.5.1 Grandstands shall be designed to support, in addition to their own weight and the weight of added accessories, a uniformly distributed live load of not less than 100 lb per sq ft (488 kg per sq m) of gross horizontal projection.

4-2.5.2 All seat and footboard members shall be designed for live loads of not less than 120 lb per linear ft (179 kg per linear m).

4-2.5.3 Grandstands shall be designed to resist a horizontal swaying force applied to the seats, in a direction parallel to the length of the seats, of 24 lb per linear ft (36 kg per linear m) of seats and, in a direction perpendicular to the length of the seats, of 10 lb per linear ft (15 kg per linear m) of seats.

4-2.5.4 Wind Loads.

4-2.5.4.1 Grandstands shall be designed to withstand, with or without live loads, the horizontal and uplift pressures due to wind. Wind pressures shall be derived from ASCE 7, *Minimum Design Loads in Buildings and Other Structures*.

4-2.5.4.2 Horizontal pressures shall be assumed to be acting on the gross vertical projection of the grandstand measured above the average level of the adjoining ground.

4-2.5.4.3 Uplift wind pressures equal in magnitude to those shown in ASCE 7, *Minimum Design Loads in Buildings and Other Structures*, shall be assumed to be acting vertically on the gross horizontal projection of "closed deck" grandstands, the understructure of which is unenclosed. Uplift wind pressures equal to 60 percent of these values shall be assumed to be acting vertically on the gross horizontal projection of "closed deck" grandstands, the understructure of which is enclosed at the perimeter with solid walls.

4-2.5.4.4 Uplift wind pressures equal to $1\frac{1}{4}$ times those shown in ASCE 7, *Minimum Design Loads in Buildings and Other Structures*, shall be assumed to be acting normal to an unenclosed roof situated over a grandstand.

4-2.5.5 Handrails or grandstands shall be designed and constructed for:

- (a) A concentrated load of 200 lb (91 kg) applied at any point and in any direction, and
- (b) A uniform load of 50 lb per ft (74 kg/m) applied in any direction.

The concentrated and uniform loading conditions shall not be required to be applied simultaneously.

4-2.5.6 Guards of grandstands shall be designed and constructed for:

- (a) A concentrated load of 200 lb (91 kg) applied at any point and in any direction along the top railing member, and
- (b) A uniform load of 50 lb per ft (74 kg/m) applied horizontally at the required guardrail height and a simultaneous uniform load of 100 lb per ft (149 kg/m) applied vertically downward at the top of the guardrail.

The concentrated and uniform loading conditions shall not be required to be applied simultaneously.

4-2.5.7 Each of the horizontal forces in 4-2.5.3, 4-2.5.5, and 4-2.5.6 need not be applied simultaneously with other lateral forces such as wind or seismic loads.

4-2.6 Members in which the stresses are greater under a partial loading of the grandstand than under full load shall be designed to meet the conditions causing the largest stress.

4-2.7 Stresses permitted in the design standards of the various materials shall be permitted to be increased by $33\frac{1}{3}$ percent due to sway or wind loads or by a combination of sway or wind loads and vertical loads, provided that no such increases shall be allowed for stresses due to vertical loads acting alone.

4-2.8 Foundations for permanent grandstands shall be designed to sustain a total load equal to the dead load plus 60 percent of the total of the live load and the transmitted wind or sway load.

4-3 Aisles. Aisles shall comply with the requirements of NFPA 101, *Life Safety Code*, or as otherwise modified by this section.

Exception No. 1: Aisles in folding and telescoping seating shall be permitted to be by stepped aisles.

Exception No. 2: The riser height of stepped aisles in folding and telescoping seating shall be permitted to be a minimum of $3\frac{1}{2}$ in. (8.9 cm) and a maximum of 11 in. (27.9 cm).

4-3.1 Aisles shall be provided so that the number of seats between any seat and the nearest aisle shall not exceed the number shown in Table 4-3.1.

Exception: Aisles are not required if all the following are met:

- (a) Egress from front row not obstructed by rail, guard, or other obstruction.
- (b) Row spacing is 28 in. (71.1 cm) or less.
- (c) Rise per row, including first row, 6 in. (15.2 cm) or less.
- (d) Number of rows does not exceed 16.
- (e) Seat spaces are not physically defined.

(f) Seat boards that are also used as stepping surfaces for descent shall have a minimum width of 12 in. (30.5 cm), and, where there is a depressed footboard, the gap between seat boards of adjacent rows shall not exceed 12 in. (30.5 cm) measured horizontally. Leading edges of such surfaces shall be provided with a contrasting marking stripe such that the location of such leading edge is readily apparent, particularly when viewed in descent. Such stripe shall be at least 1 in. (2.5 cm) wide and not exceed 2 in. (5.1 cm) width. The marking stripe is not required where bleacher surfaces and environmental conditions in all conditions of use are such that the location of each leading edge is readily apparent, particularly when viewed in descent.

Table 4-3.1 Number of Seats to Aisle

Application	Outdoors	Indoors
Grandstands	11	6
Bleachers (see 4-3.1 Exception)	20	9

4-3.2 Existing Aisle Stairs. Steps shall not be placed in aisles to overcome difference in level unless the gradient exceeds 1 ft (0.3 m) in 10 ft (3 m) of run. When the rise of seating platform exceeds 11 in. (27.9 cm) an intermediate step shall be provided the full width of the aisles and so proportioned as to provide two steps of equal rise per platform. When the rise of the seating platform exceeds 18 in. (45.7 cm), two intermediate steps the full width of the aisles shall be provided and so proportioned as to provide three steps of equal rise per platform. The resulting treads shall be uniform and in no case less than 9 in. (22.9 cm). The full length of the nose of each step in the aisle shall be conspicuously marked.

4-3.3 In grandstand seating, dead ends in vertical aisles shall not exceed a depth of 16 rows.

Exception: A longer dead-end aisle is permitted where seats served by the dead-end aisle are not more than 24 seats from another aisle measured along a row of seats having a minimum clear width of 12 in. (30.5 cm) plus 0.6 in. (1.5 cm) for each additional seat over a total of 7 in the row.

4-4 Travel Distance.

4-4.1 The travel distance along the normal path of travel from any seat to an egress vomitory portal or the egress concourse shall not exceed 150 ft (45.7 m).

Exception: The travel distance may be increased to 200 ft (61 m) in buildings completely protected by automatic sprinklers installed in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems.

4-4.2 The travel distance from the vomitory portal, or entrance to the concourse, to the exterior of the building or entrance to the stairway or ramp shall not exceed 150 ft (45.7 m) (see A-2-2, Exit).

4-5 Seating.

4-5.1 The depth of footboards and seatboards in grandstands shall be not less than 9 in. (22.9 cm). Where the same level is not used for both seat foundations and footrests, footrests independent of seats shall be provided.

4-5.2 Seats and footrests of grandstands shall be securely supported and fastened in such a manner that they cannot be inadvertently displaced.

4-5.3 Individual seats or chairs shall be permitted only if firmly secured in rows in an approved manner.

Exception: Seats, if not more than 16 in number, on level floors, and within railed-in enclosures, such as boxes, need not be fastened.

4-5.4 Any opening between the seatboard and footboard and located more than 30 in. above grade shall be provided with intermediate construction such that a 4 in. (10.2 cm) diameter sphere cannot pass.

4-6 Railings or Guards.

4-6.1 Railings or guards not less than 42 in. (107 cm) high above the aisle surface or footrest or 42 in. (107 cm) vertically above the center of the seat board surface, which-

ever is adjacent, shall be provided along those portions of the backs and ends of all grandstands where the seats are more than 4 ft (1.2 m) above the ground.

Exception: When grandstands are used adjacent to a wall or fence, railings or guards may be omitted from those portions where such wall or fence affords equivalent safeguard.

4-6.2 Where the front footrest of any grandstand is more than 2 ft (0.6 m) above the ground, railings or guards not less than 26 in. (66 cm) high above such front footrests shall be provided.

4-6.3 Cross aisles located at the front of the grandstand shall be provided with a rail not less than 36 in. (91 cm) high.

Exception: Railings at the foot of aisles where steps occur shall not be less than 42 in. (107 cm) high for the width of the aisle.

4-6.4 Cross aisles other than those located at the front of the grandstand shall be provided with a rail not less than 26 in. (66 cm) high.

Exception: Where the backs of the seats in front of the cross aisle project 24 in. (61 cm) or more above the surface of the cross aisle, the rail may be omitted.

4-6.5 Vertical openings between guardrails and footboards or seatboards shall be such as to prevent the passage of a 4 in. (10.2 cm) diameter sphere.

4-7 Special Requirements — Wood Grandstands.

4-7.1 No outdoor wood grandstand shall be erected within less than two-thirds of its height but in no case less than 10 ft (3 m) of a building, unless the separation from such building is of not less than 1-hr fire resistance and any openings in the separation are protected against the fire exposure hazard created by the grandstand, or unless a protection of not less than 1-hr fire resistance is interposed between such grandstand and building.

4-7.2* No outdoor wood grandstand unit shall exceed 10,000 sq ft (929 sq m) in ground area or 200 ft (61 m) in length. Grandstand units of the maximum size shall be placed not less than 20 ft (6.1 m) apart or shall be separated by walls of 1-hr fire resistance. Not more than three such units shall be erected in any one group. Each such group shall be separated from any other group by a wall of 2-hr fire resistance rated construction extending 2 ft (0.6 m) above the seat platforms or by an open space not less than 50 ft (15.2 m).

Exception: When entirely constructed of labeled fire retardant treated wood that has passed the standard rain test, ASTM D 2898, Test Method for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing, or of members conforming to dimensions for heavy timber construction [Type IV (2HH)], the allowable ground area or length may be doubled.

4-7.3 The highest level of seat platforms of any wood grandstand shall be not more than 20 ft (6.1 m), and of portable grandstands within tents or membrane structures

not more than 12 ft (3.7 m), above the ground or the surface at the front of the grandstand.

Exception: When entirely constructed of labeled fire retardant treated wood that has passed the standard rain test, ASTM D 2898, *Test Method of Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing*, or of members conforming to dimensions for heavy timber construction [Type IV (2HH)], the allowable height may be doubled.

4-8 Special Requirements — Portable Grandstands.

4-8.1 Portable grandstands shall conform to the requirements of Chapter 4 for grandstands and the following special requirements.

4-8.2 Portable grandstands shall be self-contained, having within all necessary parts to withstand and restrain all forces that might be developed during human occupancy. They shall be so designed and manufactured that if any structural members essential to the strength and stability of the structure have been omitted during erection, the presence of unused connection fittings shall make the omissions self-evident. The workmanship shall be of such quality as to produce in construction the strength required by the design.

4-8.3 Portable grandstands shall be provided with base plates, sills, floor runners, or sleepers of such area that the allowable bearing capacity of the supporting material is not exceeded. When portable grandstands rest directly on a base of such character as to be incapable of supporting the load without appreciable settlement, mud sills of suitable material, having sufficient area to prevent undue or dangerous settlement, shall be installed under base plates, runners, or sleepers. All bearing surfaces shall be in contact.

4-8.4 A-frames or other supports and seat stringers for portable grandstands shall be secured to prevent accidental displacement during occupancy.

4-8.5 Field connections to wood members shall be by means of rivets, bolts, approved connectors, friction or other devices, or lag screws. The use of nails, lag screws, and wood screws is permissible for holding wood parts together, except that these shall not be used for demountable joinings, nor shall these be used where their loosening or splitting of surrounding wood would jeopardize the structure or its occupants. Members in tension shall be connected at each end by means of not less than two bolts, rivets, or lag screws or by approved connectors or other approved devices. All ferrous fastenings and fastening devices shall be stainless steel or hot-dipped galvanized. (See ASTM A 153 reference in Chapter 11.) Adequate provision shall be made to prevent the splitting or shearing of wood at such connections.

4-8.6 Portable grandstands shall not be used for public occupancy unless all parts have been erected, or reerected, in accordance with the approved design and specifications. Members comprising the seating, walkways, railings, bracing, and supporting members shall be structurally sound.

4-9 Spaces Underneath Grandstands. Spaces underneath a grandstand or bleacher shall be kept free of flammable or combustible materials.

Exception No. 1: Accessory uses such as ticket booths, toilet facilities, or concession booths shall be permitted in such spaces when of noncombustible or fire-resistive construction.

Exception No. 2: Small food serving or processing stands, such as a concession booth, that are protected by an automatic fire suppression system or are of 1-hr fire resistance-rated construction.

Exception No. 3: Assembly occupancies that are protected throughout by an approved automatic sprinkler system and that are of 1-hr fire resistance-rated construction.

4-10 Maintenance. The owner shall provide for not less than annual inspection and required maintenance of each grandstand to assure safe conditions. At least biennially the inspection shall be performed by a professional engineer or registered architect. Where required by the authority having jurisdiction, the owner shall provide certification that such inspection has been performed.

Chapter 5 Folding and Telescopic Seating

5-1 Application. Folding and telescopic seating shall be permitted only if the supporting structure is of adequate strength and there are adequate exit facilities to accommodate the occupants of the seating as well as all other occupants.

5-2 Design.

5-2.1 The design of folding and telescopic seating shall be in accordance with accepted structural engineering practice.

5-2.2 Load tests in accordance with accepted engineering practice shall be permitted in lieu of the design analysis for a seating unit or part thereof.

5-2.3 Where required by the authority having jurisdiction, the manufacturer shall submit either calculations verifying the design analysis prepared by a professional engineer or registered architect or a report of load tests conducted by an approved independent testing laboratory and certified by a professional engineer. Where required by the authority having jurisdiction, the manufacturer shall certify that the equipment supplied is in accordance with the design or is essentially identical to the structure tested.

5-2.4 Design Loads.

5-2.4.1 Folding and telescopic seating shall be designed to support, in addition to its own weight and the weight of added accessories, a uniformly distributed live load of not less than 100 lb per sq ft (488 kg per sq m) of gross horizontal projection.

5-2.4.2 Seatboards and footrests shall be designed for a live load of not less than 120 lb per linear ft (179 kg per linear m).

5-2.4.3 A sway force applied to seats shall be 24 lb per linear ft (36 kg per linear m) parallel to the seats and 10 lb per linear ft (15 kg per linear m) perpendicular to the seats. Sway forces shall not be considered simultaneously applied.

5-2.4.4 Handrails shall be designed and constructed for:

- (a) A concentrated load of 200 lb (91 kg) applied at any point and in any direction, and
- (b) A uniform load of 50 lb per ft (74 kg/m) applied in any direction.

The concentrated and uniform loading conditions shall not be required to be applied simultaneously.

5-2.4.5 Guards shall be designed and constructed for:

- (a) A concentrated load of 200 lb (91 kg) applied at any point and in any direction along the top railing member, and
- (b) A uniform load of 50 lb per ft (74 kg/m) applied horizontally at the required guardrail height and a simultaneous uniform load of 100 lb per ft (149 kg/m) applied vertically downward at the top of the guardrail.

The concentrated and uniform loading conditions shall not be required to be applied simultaneously.

5-2.4.6 Each of the horizontal forces in 5-2.4.3, 5-2.4.4, and 5-2.4.5 need not be applied simultaneously with other lateral forces such as wind or seismic loads.**5-2.4.7** Stresses permitted in the design standards of the various materials shall be permitted to be increased 33 1/3 percent due to sway or wind loads or by a combination of sway or wind loads and vertical loads, provided that no such increases shall be allowed for stresses due to vertical loads acting alone.**5-2.5** Structural design shall consider the stresses in all members due to all of the loadings indicated in 5-2.4, with particular attention to the following:

- (a) Vertical dead load and live load,
- (b) Wind loads,
- (c) Sway load parallel with the seats,
- (d) Sway load to the front and sway load to the rear,
- (e) Wall attachments,
- (f) Partial loading conditions,
- (g) For movable, reverse-fold, and forward-fold folding and telescopic seating, stability against overturning forward or backward during normal operation, or in any condition of intended use, when operated in accordance with manufacturer's operating instructions.

5-2.6 All design criteria shall be met when the seating is in each configuration intended for occupancy.**5-3 Review and Approval.****5-3.1** Design and installation drawings shall be approved prior to installation, and seating shall be installed in conformance therewith. This data shall include the following:

- (a) Conformance with approved designs; this may be by reference to approved standard drawings with any variables applicable to the job noted;

- (b) Location of the folding or telescopic seating units and details of attachments, if any;

- (c) Location of guards and details thereof.

5-3.2 The owner, or his duly authorized representative, shall file with the authority having jurisdiction evidence of the following:

- (a) The adequacy of the exits to accommodate the occupants of the seating as well as all other occupants, based on NFPA 101, *Life Safety Code*;
- (b) Structural ability of the site to support the folding and telescopic seating dead loads when closed and also to support the dead loads and live loads when open.

5-4 Aisles. Aisles shall comply with the requirements of NFPA 101, *Life Safety Code*, as modified by Section 4-3 of this standard.**5-5 Travel Distance.** The travel distance to the nearest exit shall be not greater than 150 ft (45.7 m).

Exception: The travel distance shall be permitted to be increased to 200 ft (61 m) in buildings completely protected by automatic sprinklers installed in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems.

5-6 Seating.**5-6.1** The horizontal distance back-to-back of seats shall be not less than 22 in. (55.9 cm) for seats without backs. There shall be a space of not less than 12 in. (30.5 cm) between the back of each seat and the front of each seat immediately behind it. If seats are of the chair type, the 12-in. (30.5-cm) dimension shall be measured to the front edge of the rear seat in its normal unoccupied position. All measurements shall be taken between plumb lines.**5-6.2** The depth of footboards (footrests) and seatboards in folding and telescopic seating shall be not less than 9 in. (22.9 cm). Where the same level is not used for both seat foundations and footrests, footrests independent of seats shall be provided.**5-6.3** Individual chair-type seats shall be permitted in folding and telescopic seating only if firmly secured in groups of not less than three.**5-6.4** Any opening between the seatboard and footboard and located more than 30 in. above grade shall be provided with intermediate construction such that a 4 in. (10.2 cm) diameter sphere cannot pass.**5-7 Guards and Rails.****5-7.1** Railings or guards not less than 42 in. (107 cm) high above the aisle surface or footrest or 36 in. (91 cm) vertically above the center of the seat or seatboard surface, whichever is adjacent, shall be provided along those portions of the backs and ends of all folding and telescopic seating where the seats are more than 4 ft (1.2 m) above the floor.

Exception: When all openings between the folding or telescopic seating and an adjacent wall, of at least the required guard height, are such as to prevent the passage of a 4-in. (100-mm) sphere, a guard is not required.

5-7.2 Where the front footrest of any folding or telescopic seating is more than 2 ft (0.6 m) above the floor, railings or guards not less than 33 in. (84 cm) high above such footrests shall be provided.

Exception: Where the front row of seats includes backrests, the rails shall be not less than 26 in. (66 cm) high.

5-7.3 Rails 42 in. (107 cm) high shall be located at the foot of each aisle that extends to the front of such folding or telescopic seating and along the front of any cross aisle located at the front of the seating where the foot of the aisle or the cross aisle is more than 30 in. (76 cm) above grade.

5-7.4 Cross aisles located within the seating area shall be provided with rails not less than 26 in. (66 cm) high along the front edge of the aisle.

Exception: Where the backs of the seats in front of the cross aisle project 24 in. (61 cm) or more above the surface of the cross aisle, this rail is not required.

5-7.5 Vertical openings between guardrails and footboards or seatboards shall be such as to prevent the passage of a 4 in. (10.2 cm) diameter sphere.

5-8 Maintenance and Operation.

5-8.1 Instructions in both maintenance and operation shall be transmitted to the owner by the manufacturer of the seating or his representative.

5-8.2 Maintenance and operation of folding and telescopic seating shall be the responsibility of the owner or his duly authorized representative and shall include the following:

(a) During operation of the folding and telescopic seats, the opening and closing shall be supervised by responsible personnel who will assure that the operation is in accordance with the manufacturer's instructions.

(b) Only attachments specifically approved by the manufacturer for the specific installation shall be attached to the seating.

(c) An annual inspection and required maintenance of each grandstand shall be performed to assure safe conditions. At least biennially the inspection shall be performed by a professional engineer or qualified service personnel.

Chapter 6 Permanent Membrane Structures

6-1 General.

6-1.1 Membrane structures designed to meet the applicable requirements of NFPA 101, *Life Safety Code*, this chapter, and the building codes shall be considered as permanent buildings or parts thereof.

6-1.2 Membrane structures shall be permitted for any occupancy in accordance with the applicable building code.

6-1.3 Heights and areas shall be limited by the requirements of applicable building codes based on the type of construction and occupancy classification.

6-1.4 Testing of membrane materials for compliance with this section's use of the categories of noncombustible and limited-combustible materials shall be performed on weathered membrane material as defined in Section 2-2.

6-1.5 Membrane materials shall not be used where fire resistance ratings are required for walls or roofs.

Exception No. 1: Where every part of the roof, including the roof membrane, is not less than 20 ft (6.1 m) above any floor, balcony, or gallery, a noncombustible or limited-combustible membrane shall be permitted to be used as the roof in any type of construction.

Exception No. 2:* With approval of the authority having jurisdiction, membrane materials may be used where every part of the roof membrane is sufficiently above every significant fire potential that the imposed temperature will not exceed the capability of the membrane, including seams, to maintain its structural integrity.

6-1.6 Flame spread of all membrane materials exposed within the structure shall be Class A as defined in Section 6-5 of NFPA 101, *Life Safety Code*.

6-1.7 Roof membranes shall have a roof covering classification as required by the applicable building codes, when tested in accordance with NFPA 256, *Standard Methods of Fire Tests of Roof Coverings*.

6-1.8 Flame Resistance. All membrane structure fabric shall meet the requirements of both the small-scale and large-scale tests contained in NFPA 701, *Standard Methods of Fire Tests for Flame-Resistant Textiles and Films*.

The authority having jurisdiction shall require a certificate or other evidence of acceptance by an organization acceptable to the authority having jurisdiction or the report of tests made by other inspection authorities or organizations acceptable to the authority having jurisdiction as evidence that the fabric materials have the required flame resistance.

Where required by the authority having jurisdiction, confirmatory field tests shall be conducted using test specimens from the original material, which shall have been affixed at the time of manufacture to the exterior of the structure.

6-2 Tensioned-Membrane Structures.

6-2.1 Design. The design, materials, and construction of the building shall be based on plans and specifications prepared by a licensed architect or engineer knowledgeable in this type of construction.

6-2.2 Material loading and strength shall be based on physical properties of the materials verified and certified by an approved testing laboratory.

6-2.3 The membrane roof for structures in climates subject to freezing temperatures and ice buildup shall be composed of two layers with an air space between them through which heated air can be moved to guard against ice accumulation. In lieu of the above, any other approved methods that will protect against ice accumulation shall be permitted.

6-2.4 Roof drains shall be equipped with electrical elements to protect against ice buildup, which would prevent the drains from functioning. Such heating elements shall be served by on-site standby electrical power in addition to the normal public service. In lieu of the above, any other approved methods that will protect against ice accumulation shall be permitted.

6-3 Air-Supported, Air-Inflated Structures.

6-3.1 General. In addition to the foregoing, the requirements of this section shall apply to air-supported structures.

6-3.2 Structural Requirements.

6-3.2.1 Envelope Design. The design, materials, and construction for the structural envelope shall conform to the requirements of this section. Membrane structures shall be designed by a licensed architect or engineer knowledgeable in this type of construction.

6-3.2.2 Material Strength. Calculation of fabric stresses shall include consideration of inflation pressure, the radius of the structure, and wind, ice, snow, and earthquake loads. The minimum design criteria for material strength shall comply with the requirements of ASI 77, *Air Structures Design and Standards Manual*. Minimum design criteria shall be for 80 mph (129 km per hr) wind conditions. More severe design loads, as specified in local building codes, shall be required as a result of local climatic conditions. All material characteristics shall be verified by an approved test method. Material strengths shall be certified by the manufacturer and verified by test data from an organization acceptable to the authority having jurisdiction.

6-3.2.3 Joint Strength. All seams shall develop the full strength of the envelope material as specified in ASI 77, *Air Structures Design and Standards Manual*.

6-3.3 Load Distribution.

6-3.3.1 The envelope shall be patterned and constructed to minimize stress concentrations in crown areas, around openings, and where rigid components such as door frames, vent pipes, and structural members are attached to the envelope.

6-3.3.2 There shall be sufficient clearance between the envelope and rigid components to permit free movement under load.

6-3.3.3 Reinforced areas, such as around openings, shall provide a flexible but airtight seal.

6-3.4 Pressurization (Inflation) System.

6-3.4.1 The operating inflation pressure for the structure shall be adequate to withstand a wind velocity of 80 mph (129 km per hr). Pressurization for higher wind conditions shall be provided where required by the local climatic conditions, as determined by local authorities.

6-3.4.2 The pressurization system shall consist of one or more operating blower units. The system shall include automatic control of auxiliary blower unit(s) to reliably

maintain the required operating pressure. This equipment shall meet the following requirements:

(a) Blowers shall be powered by continuous-rated motors at the maximum power required.

(b) Blowers shall have adequate personnel protection, such as inlet screens and belt guards.

(c) Blower systems shall be weather protected.

(d) Blower systems shall be equipped with back-draft check dampers.

(e) There shall be not fewer than two blower units, each of which has adequate capacity to maintain full inflation pressure with normal leakage.

(f) The blowers shall be designed to be incapable of overpressurization.

(g) The auxiliary blower unit(s) shall operate automatically if there is any loss of internal pressure or if an operating blower unit becomes inoperative.

(h) The design inflation pressure and the capacity of each blower system shall be certified by a professional engineer.

6-3.5 Standby Power System.

6-3.5.1 Design.

6-3.5.1.1 A fully automatic standby power system shall be provided. This shall be either an auxiliary engine generator set capable of running the blower system or a supplementary blower unit that is sized for 1 times the normal operating capacity and is powered by an internal combustion engine.

6-3.5.1.2 The standby power system shall be fully automatic to assure continuous inflation in the event of any failure of the primary power. This system shall be capable of operating continuously for a minimum of 4 hr.

6-3.5.2 Certification. The sizing and capacity of the standby power system shall be certified by a professional engineer.

6-3.6 Anchorage Design.

6-3.6.1 Basic Requirements. A positive anchorage system shall be provided to securely anchor the envelope to the ground or to the structure.

6-3.6.2* Specific Requirements. Anchor loading shall be determined and verified by analytical data prepared by a professional engineer. The minimum requirements for anchorage designs shall be in accordance with the requirements of ASI 77, *Air Structures Design and Standards Manual*.

6-3.7 Accessory Equipment. The design and use of accessory equipment for heating, air conditioning, lighting, and similar functions shall conform to the requirements of Chapter 10 and to approved recognized standards.

6-4 Maintenance and Operation.

6-4.1 Instructions in both operation and maintenance shall be transmitted to the owner by the manufacturer of the tensioned-membrane, air-supported, or air-inflated structure.

6-4.2 An annual inspection and required maintenance of each structure shall be performed to assure safety conditions. At least biennially the inspection shall be performed by a professional engineer or qualified service representative.

Chapter 7 Temporary Membrane Structures

7-1 General.

7-1.1 Membrane structures designed to meet all the requirements of this chapter shall be permitted to be used as temporary buildings subject to the approval of the authority having jurisdiction.

7-1.2 Temporary membrane structures shall comply with all the requirements for:

(a) Chapter 6, "Permanent Membrane Structures," except 6-1.1, 6-1.4, 6-1.5, and 6-1.6.

(b) Chapter 9, "Protection."

7-1.3 Temporary tensioned-membrane structures shall be permitted to comply with Chapter 8, "Tents," instead of this chapter.

7-2 Safety.

7-2.1 Operating Pressure. Operating pressure shall be maintained at the design pressure.

7-2.2 Clearance. There shall be a minimum clearance of 3 ft (0.9 m) between the membrane and the contents or equipment within the building and between the membrane and any exterior object.

Chapter 8 Tents

8-1 General. Tents shall be permitted only on a temporary basis.

8-2 Size Limitations. Tents shall be erected to cover not more than 75 percent of the premises, unless otherwise approved by the authority having jurisdiction.

8-3 Structural Requirements.

8-3.1 All supporting members shall be of sufficient size and strength to support the structure.

8-3.2 The poles and their supporting guys, stays, stakes, and fastenings shall be of sufficient strength and attached so as to resist a minimum wind pressure of 20 lbf per sq ft (0.96 kPa) of projected area of the tent.

8-3.3 Tents shall be adequately guyed, supported, and braced to withstand a minimum pressure or suction of 10 lbf per sq ft (0.48 kPa).

8-3.4 Pull-down ropes (jump ropes) shall be provided on all poles.

8-4 Flame Resistance.

8-4.1 All tent fabric shall meet the requirements of the small-scale test contained in NFPA 701, *Standard Methods of Fire Tests for Flame-Resistant Textiles and Films*. Where required by the authority having jurisdiction the tent fabric shall meet the requirements of the large-scale test contained in NFPA 701, *Standard Methods of Fire Tests for Flame-Resistant Textiles and Films*.

8-4.2 The authority having jurisdiction shall require a certificate or other evidence of approval by a laboratory of recognized standing or the report of tests made by other inspection authorities as evidence that the tent fabric materials have the required flame resistance.

8-4.3 Where required by the authority having jurisdiction, confirmatory field tests shall be conducted using test specimens from the original material affixed at the time of manufacture to the exterior of the tent. The test specimen shall consist of a full width of material that has been cut into test strips 1 in. by 4 in. (3.8 cm by 10.2 cm).

8-5 Location and Means of Egress.

8-5.1 Location and Spacing.

8-5.1.1 There shall be a minimum of 10 ft (3 m) between stake lines.

8-5.1.2 Adjacent tents shall be sufficiently distant from each other to provide an area to be used as a means of emergency egress. Where 10 ft (3 m) between stake lines is not sufficient for means of egress, the distance necessary for means of egress shall govern.

Exception No. 1: Tents not occupied by the public and not used for the storage of combustible material shall be permitted to be erected less than 10 ft (3 m) from other structures only if the authority having jurisdiction deems such close spacing safe from hazard to the public.

Exception No. 2: Tents, each not exceeding 1200 sq ft (111.5 sq m) in ground area, located in fairgrounds or similar open spaces need not be separated from each other, provided safety precautions meet the approval of the authority having jurisdiction.

8-5.1.3 The placement of tents relative to other structures shall be at the discretion of the authority having jurisdiction with consideration being given to occupancy, use, opening, exposure, and other similar factors.

8-5.2 Means of Egress. Curtains shall be permitted across means of egress openings in tent walls if:

(a) Distinctly marked in contrast to the tent wall so as to be recognizable as means of egress, and

(b) Installed across an opening that is a minimum of 6 ft (1.8 m) in width, and

(c) Hung from slide rings or equivalent hardware so as to be readily moved to the side to create an unobstructed opening in the tent wall of the minimum width required of door openings in accordance with NFPA 101, *Life Safety Code*.

Chapter 9 Protection

9-1 Flammable Liquids and Gases.

9-1.1 Storage and handling of flammable liquids or gases shall be in accordance with the applicable standards below:

- (a) NFPA 30, *Flammable and Combustible Liquids Code*;
- (b) NFPA 54, *National Fuel Gas Code*;
- (c) NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*.

9-1.2 No storage or handling of flammable liquids or gases shall be permitted at any location at which it would jeopardize egress from the structure.

9-1.3 Refueling of equipment with liquids having flash points below 100°F (38°C) shall not be permitted within the structure.

9-2 Fire Hazard.

9-2.1 The applicable provisions of NFPA 101, *Life Safety Code*, that pertain to fire hazards shall govern in tents and membrane structures.

9-2.2 The ground enclosed by any tent or temporary membrane structure and for a reasonable distance, but not less than 10 ft (3 m) outside of such structure or structures, shall be cleared of all flammable or combustible material or vegetation. This work shall be accomplished to the satisfaction of the authority having jurisdiction prior to the erection of such structure or structures. The premises shall be kept free from such flammable or combustible materials during the period for which the premises are used by the public.

Exception: Necessary support equipment.

9-2.3 No hay, straw, shavings, or similar combustible materials that have not been treated to make them flame retardant to a degree acceptable to the authority having jurisdiction shall be permitted within any structure used as an assembly occupancy.

Exception: Animal bedding and fodders in quantities approved by the authority having jurisdiction.

9-2.4 Where prohibited by the authority having jurisdiction, smoking shall not be allowed in any tent or temporary membrane structure.

9-2.5 Fireworks or unauthorized open flames shall be prohibited in any tent or temporary membrane structure.

9-3* Fire Extinguishing Equipment.

9-3.1 Structures using the provisions of 3-1.2 shall be protected throughout by an approved supervised automatic sprinkler system in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

Exception No. 1: Where the ceiling or roof, whichever is lower, of the playing (activity) area is more than 55 ft (17 m) above the floor, the authority having jurisdiction shall be permitted to allow the omission of sprinklers above the playing (activity) area.

Exception No. 2: Sprinklers shall not be required above seating areas that view the playing (activity) area.

9-3.2 Facilities such as press boxes, restaurants, club houses, and enclosed boxes and the like within stadia, arenas, and similar structures shall be protected throughout by an approved automatic sprinkler system.

Exception: Press boxes and storage facilities less than 1,000 sq ft in area.

9-3.3 In permanent stadia, arenas, and similar structures, all enclosed areas shall be protected by an approved automatic sprinkler system.

9-3.4 Portable fire extinguishing equipment of approved types shall be furnished and maintained in tents and temporary membrane structures by the person operating any assembly occupancy in such amount and in such locations as directed by the authority having jurisdiction.

Exception: Where a functioning garden hose that can reach all portions of the private party tent is provided.

9-3.5 Fire extinguishing equipment shall be maintained in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.

9-3.6 Employees shall be trained to operate fire extinguishing equipment and shall be required to exhibit their skill when requested by the authority having jurisdiction.

9-4 Emergency Communications. One or more methods of fire alarm and emergency communications shall be provided to the satisfaction of the authority having jurisdiction.

9-5* Fire Detail. Fire details, if deemed necessary in any assembly occupancy, shall be determined by the authority having jurisdiction.

Chapter 10 Services

10-1 Electrical Installations.

10-1.1 Electrical installations shall conform to the requirements of NFPA 70, *National Electrical Code*.®

Exception: As otherwise provided by law, ordinance, or regulation.

10-1.2 The electrical system shall be installed, maintained, and operated in a safe and workmanlike manner. If portable, it shall be inspected daily when in use by a qualified person representing the owner, and any defects found shall be corrected before the public is admitted.

10-1.3 The electrical system and equipment shall be isolated from the public by proper elevation or guarding, and all electrical fuses and switches shall be enclosed in approved enclosures. Cables on the ground in areas traversed by the public shall be placed in trenches or protected by approved covers.

10-2 Heating Devices.**10-2.1 Fired Heaters.**

10-2.1.1 Only labeled heating devices shall be used.

10-2.1.2 Fuel-fired heaters and their installation shall be approved by the authority having jurisdiction.

10-2.1.3 Ducts used to convey heated air shall comply with NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*.

10-2.1.4 Containers for liquefied petroleum gases shall be installed not less than 5 ft (1.5 m) from any tent or temporary membrane structure and in accordance with the provisions of NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*.

10-2.1.5 Tanks shall be secured in the upright position and protected from vehicular traffic.

10-2.1.6 Heating devices shall comply with the requirements of the following standards:

(a) NFPA 31, *Standard for the Installation of Oil Burning Equipment*;

(b) NFPA 54, *National Fuel Gas Code* (see Chapter 11);

(c) NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances*.

10-2.2 Electric Heaters.

10-2.2.1 Only labeled heaters shall be permitted.

10-2.2.2 Heaters used inside a tent or temporary membrane structure shall be approved.

10-2.2.3 Heaters shall be connected to electricity by electric cable suitable for outside use and of sufficient size to handle electrical load.

Chapter 11 Referenced Publications

11-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

11-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10, *Standard for Portable Fire Extinguishers*, 1990 edition

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1991 edition

NFPA 30, *Flammable and Combustible Liquids Code*, 1990 edition

NFPA 31, *Standard for the Installation of Oil Burning Equipment*, 1987 edition

NFPA 54, *National Fuel Gas Code*, 1988 edition

NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*, 1992 edition

NFPA 70, *National Electrical Code*,[®] 1990 edition

NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*, 1989 edition

NFPA 101,[®] *Life Safety Code*,[®] 1991 edition

NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances*, 1988 edition

NFPA 220, *Standard on Types of Building Construction*, 1992 edition

NFPA 251, *Standard Methods of Fire Tests of Building Construction and Materials*, 1990 edition

NFPA 256, *Standard Methods of Fire Tests of Roof Coverings*, 1987 edition

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 1987 edition

NFPA 701, *Standard Methods of Fire Tests for Flame-Resistant Textiles and Films*, 1989 edition

11-1.2 ASTM Publications. American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM A 153-1982, *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*

ASTM D 2898-1981, *Test Method for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing*

ASTM E 136-1982, *Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*

ASTM G 26-1988, *Practice for Operating Light/Exposure Apparatus (Zenon-Arc Type) With and Without Water for Exposure of Non-Metallic Materials*.

11-1.3 Other Publications.

ASI 77-1977, *Air Structures Design and Standards Manual*, Industrial Fabrics Association International, 345 Cedar St., St. Paul, MN 55101

ASCE 7-88, *Minimum Design Loads in Buildings and Other Structures*, American Society of Civil Engineers, 345 East 47th St., New York, NY 10017.

Appendix A

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

A-1-1 The provisions of this standard are intended to be applicable to facilities and structures where a number of persons may stand or sit for the viewing of a contest, exhibition, performance, or for entertainment, and other facilities and structures used for other occupancies as permitted by the applicable building code.

The management of crowds outside of bleachers, grandstands, tents, or membrane structures while approaching or departing from events is beyond the scope of this standard, but the following principles should be considered in the overall planning.

Routes of departure should lead to a street or public way of sufficient capacity to allow continued movement of persons leaving the facility. Parking areas can absorb much of this crowd, but structures and garages should not be considered refuge areas unless designed for this purpose. At least one street should be kept clear at all times to permit access of emergency equipment. In addition, adjacent automobile parking lots, open fields, public parks, etc., may also be used as places of refuge. Where such space is needed for this purpose, the continued use of the facility should be contingent on free access to the space during the periods when crowds may assemble.

A-2-2 Air-Supported Structure. A cable-restrained air-supported structure is one in which the uplift is resisted by cables or webbing that are anchored by various methods to the membrane or that may be an integral part of the membrane. This is not a tensioned-membrane structure.

A-2-2 Exit. In structures where all parts of the means of egress are essentially open to the exterior and, therefore, are not likely to be significantly affected by combustion products from a fire in the structure, an exit in functional terms is that portion of the egress system where flows from the largest number of egress routes are combined. Such an exit would include such items as an opening in the ticket control barrier, a major means of vertical circulation to the level of exit discharge, or similar feature where the maximum number of egress flows converge.

A-2-2 Tensioned-Membrane Structure. The publications *Architectural Fabric Structures, the Use of Tensioned-Fabric Structures by Federal Agencies* and *AFSI Recommended Code Provisions for Architectural Structures* provide details such as materials in general use, coating materials, characteristics of composite materials, and firesafety for membrane structures.

A-3-3 Travel Distance to Exit. In this section as well as in Sections 4-4 and 5-5, the distance to an exit or to an entrance to an exitway is limited to ensure reasonably prompt evacuation of any area that may be in danger from one cause or another. The structures to which the standard applies vary in design and size due to differences in their capacities and to the topography of the sites. Since the requirements of the two sections mentioned are necessarily expressed in general terms, some indication of the committee's intent may be helpful to the authority having jurisdiction.

Sections 4-4 and 5-5 recognize this variation in size, which may range from a simple playground structure with a capacity of perhaps 50 persons to a grandstand accommodating many thousands. Obviously, no hard-and-fast rules can be laid down in the requirements that will fit this range exactly. For the small playground structure the exit from the seating area will be directly to the ground and the same may be true of grandstands accommodating up to perhaps 100,000 persons. From the upper decks of multi-decked grandstands, the exit from the seating area may be to a balcony or passage at the rear of the stands that connects with ramps leading to the ground, a travel distance of several hundred feet.

It is not necessary that persons get to the ground or street in a travel distance of 150 ft (45.7 m). What is intended in Sections 4-4 and 5-5 is that persons will be able to get out of any threatened area by traveling not more than 150 ft (45.7 m). The limiting distance therefore may be to the ground, or to openings on a passage from the seating area, leading to a place of refuge, or to openings through the seating deck structure, such as the portals or vomitories.

A-4-7.2 Fire Retardant Treated Lumber. The increases permitted in the sizes of wood grandstands, if of fire retardant treated lumber, are predicated on the use of lumber impregnated by pressure processes with fire retardant preservatives in accordance with NFPA 703, *Standard for Fire Retardant Impregnated Wood and Fire Retardant Coatings for Building Materials*, or the American Wood Preservers Association standards C-20, *Structural Lumber Fire Retardant Treatment by Pressure Processes*, and C-27, *Plywood-Fire Retardant Treatment by Pressure Processes*.

A-6-1.5 Exception No. 2. A method of appraising fire impact factors on ceilings of large dimension spaces such as covered stadia follows:

Determine the maximum burning rates of potential fires.

The method presented in this appendix depends on the ability to predict reasonably the maximum rate of energy release from fire. The fires of concern include those that might occur within the open space or intrude upon it from adjacent rooms or spaces.

Where the necessary burning rate data exists, it may be used in the appraisal. Where it does not so exist, it should be obtained by test prior to use of this method. The appraisal should cover each critical fire potential. A critical fire potential is one that releases greater energy into the open room than any other source located nearer to the roof (or ceiling) membrane than it.

In a typical covered stadium critical fire potentials are selected starting with the top reaches of the stands. The fire potential at this level might consist of either the seats or a concession stand. Descending towards the playing fields it is necessary to determine any greater fire potentials. Typically, the fuel load on the playing field level would be a critical potential if the space is used for exhibitions. If the playing field will not be used for exhibitions or other special fuel concentrations, it is likely that the maximum potential exposure will occur from a fire in a store-room or similar space abutting the public space.

Table A-6-1.5, from the work of Alpert and Heskestad¹, lists examples of rates of energy release from a number of fuel arrangements. The data for this table were developed by Factory Mutual Research Corporation. Additional burning rate data have been reported by NBS². In some instances the existing data will suffice. Often, however, special tests will be required. Such tests should be large scale and produce rates of heat release. The specific techniques for testing may be any method that reliably produces the rate of heat release of the assemblies involved.

As an alternate, the rate of energy release may be conservatively determined using the semi-universal rate of heat release curve developed by Cooper³. Figure A-6-1.5.1 presents that curve. The semi-universal fire curve gives a maximum rate of heat release likely to be produced by a collection of solid fuels in a readily consumable form. To use the curve, determine the weight of the fuel. In determining the fuel weight consider plastic materials (other than PVC or other highly halogenated plastics) as twice their actual weight. Enter the curve from the fuel consumed entries on the left. Use the weight of fuel as the fuel consumed. Read the time of burning from the bottom scale. Transfer to the rate of heat release curve. Read the rate of heat release from the right scale. For simple formulas, as presented in this appendix, use that value.

Determining Flame Height.

Use Figure A-6-1.5.2 to determine the maximum flame height. Figure A-6-1.5.2 was developed by Alpert¹. Enter Figure A-6-1.5.2 from the base. Use the rate of energy release developed from the preceding determination of burning rate. Use the curve indicated for the location of the fire (i.e., in corner, adjacent to a wall, or away from walls). Read the flame height from the left scale. The temperature of the flame at the indicated flame height is approximately 600°F.

Use Figure A-6-1.5.3 in the same manner as Figure A-6-1.5.2 to determine the height of the solid (continuous) portion of the flame. The temperature of the flame at the flame height indicated by Figure A-6-1.5.3 is approximately 1850°F. Figure A-6-1.5.3 is derived from a formula developed by Hasmi and Tokunaga⁴.

¹ Alpert, R. L. and Ward, E. J., *Evaluating Unsprinklered Fire Hazards*, SFPE Technology Report 83-2, Society of Fire Protection Engineers, Boston, MA, 1983.

² Lawson, J. R., Walton, W.D., and Twilley, W. H., *Fire Performance of Furnishings as Measured in the NBS Furniture Calorimeter*. Part 1, NBSIR 84-2787, National Bureau of Standards, Washington, DC, 1983.

³ Cooper, L. Y. and Stroup, D. W., *Calculating Available Safe Egress Time (ASET) — A Computer Program and User's Guide*, NBSIR 82-2478, National Bureau of Standards, Washington, DC, 1982.

⁴ Hasemi, Y. and Tokunaga, T., *Modeling of Turbulent Diffusion Flames and Fire Plumes for the Analysis of Fire Growth*, Fire Dynamics and Heat Transfer, The American Society of Mechanical Engineers, 21st National Heat Transfer Conference, HTD-Vol. 25, 1983.

Table A-6.1.5(a) Unit Heat Release Rates for Fuels Burning in the Open

Commodity	Heat Release Rate (Btu/sec) +
Flammable Liquid Pool	290/ft ² of surface
Flammable Liquid Spray	2000/gpm of flow
Wood Pallets (Single Stack)	1500/ft of height
Wood or PMMA* (vertical)	
-2 ft height burning	30/ft of width
-4 ft height burning	70/ft of width
-8 ft height burning	180/ft of width
-12 ft height burning	300/ft of width
Wood or PMMA	
-Top of horizontal surface	65/ft ² of surface
Solid Polystyrene (vertical)	
-2 ft height burning	65/ft of width
-4 ft height burning	
-8 ft height burning	400/ft of width
-12 ft height burning	680/ft of width
Solid Polystyrene (horizontal)	120/ft ² of surface
Solid Polypropylene (vertical)	
-2 ft height burning	45/ft of width
-4 ft height burning	100/ft of width
-8 ft height burning	280/ft of width
-12 ft height burning	470/ft of width
Solid Polypropylene (horizontal)	70/ft ² of surface

+ to convert from (Btu/sec) to [W], multiply by 1,055.1

* PMMA—Polymethylmethacrylate (Plexiglas, lucite, acrylic)

For points in the flame between the continuous flaming zone and the maximum height the temperature decreases from the 1850°F level to 600°F at approximately a uniform rate.

Determining Ceiling Plume Jet Temperatures.

For points located over a potential fire but above the maximum flame height, the temperature of the plume is as shown in Figure A-6-1.5.4. This figure is derived from a formula developed by Alpert.¹

A-6-3.6.2 Anchor loading varies with the size, height, and anchor spacing for the structure. These loadings are the same as envelope fabric loadings, but must be converted from lb/sq in. (kg/sq cm) to the equivalent load for the anchor spacing used [generally in terms of lb/sq ft (kg/sq m)]. Anchor loadings are based upon 80 mph (129 km per hr) wind, and a design safety factor of 2 should be used to assure secure anchorage under steady load conditions.

A-9-3 Fire Extinguishing Equipment. Recommendations on the distribution, use, and maintenance of portable fire extinguishing equipment are given in NFPA 10, *Standard for Portable Fire Extinguishers*.

Table A-6.1.5(b) Unit Heat Release Rates for Commodities
(Compiled by G. Heskastad)

Heat-release rate per unit floor area of fully involved combustibles, based on negligible radiative feedback from the surroundings and 100% combustion efficiency.

Commodity	Btu/sec per ft ² of Floor Area
1. Wood pallets, stack 1½ ft high (6-12% moisture)	125
2. Wood pallets, stack 5 ft high (6-12% moisture)	460
3. Wood pallets, stack 10 ft high (6-12% moisture)	940
4. Wood pallets, stack 16 ft high (6-12% moisture)	1500
5. Mail bags, filled, stored 5 ft high	35
6. Cartons, compartmented, stacked 15 ft high	150
7. PE letter trays, filled, stacked 5 ft high on cart	750
8. PE trash barrels in cartons, stacked 15 ft high	175
9. PE-fiberglass shower stalls in cartons, stacked 15 ft high	125
10. PE bottles packed in Item 6	550
11. PE bottles in cartons, stacked 15 ft high	175
12. PU insulation board, rigid foam, stacked 15 ft high	170
13. PS jars packed in Item 6	1250
14. PS tubs nested in cartons, stacked 14 ft high	475
15. PS toy parts in cartons, stacked 15 ft high	180
16. PS insulation board, rigid foam, stacked 14 ft high	290
17. PVC bottles packed in Item 6	300
18. PP tubs packed in Item 6	390
19. PP & PE film in rolls, stacked 14 ft high	550
20. Methyl alcohol	65
21. Gasoline	290
22. Kerosene	290
23. Diesel oil	175

Note: PE—Polyethylene
PS—Polystyrene
PVC—Polyvinylchloride
PP—Polypropylene
PU—Polyurethane

The general information in NFPA 10, *Standard for Portable Fire Extinguishers*, defines Class A, B, C, and D fires and contains specific recommendations for the minimum area of distribution for each extinguisher for "light," "ordinary," and "extra hazard" occupancies. An appendix to the standard gives the appropriate ratings of each type and size of extinguisher based upon a standard method of test.

The requirements cited in the standard are, in general, minimum requirements and do not preclude the installation of additional fire extinguishing equipment where desired.

A-9-5 Patrols or Fire Details. Because of the variety of types of places of assembly covered in this standard, no general requirement for patrols or fire watchers has been included. The committee fully recognizes the importance of this feature of fire protection, however, and believes that a system of well-trained patrols or fire watchers should be maintained in every place of assembly where fire hazards may develop. Such locations would include, among others, the spaces underneath grandstands and the areas inside and outside tents and air-supported structures. The fire watchers serve to detect incipient fires and to prevent an accumulation of materials that will carry fire. The number of such watchers required will, of course, vary for the different types of assembly occupancies, depending upon the combustibility of the construction and the number of persons accommodated. Provided with an adequate supply of portable fire extinguishing equipment located at readily accessible points, such a fire watch or detail should be able to prevent small fires from reaching serious proportions.

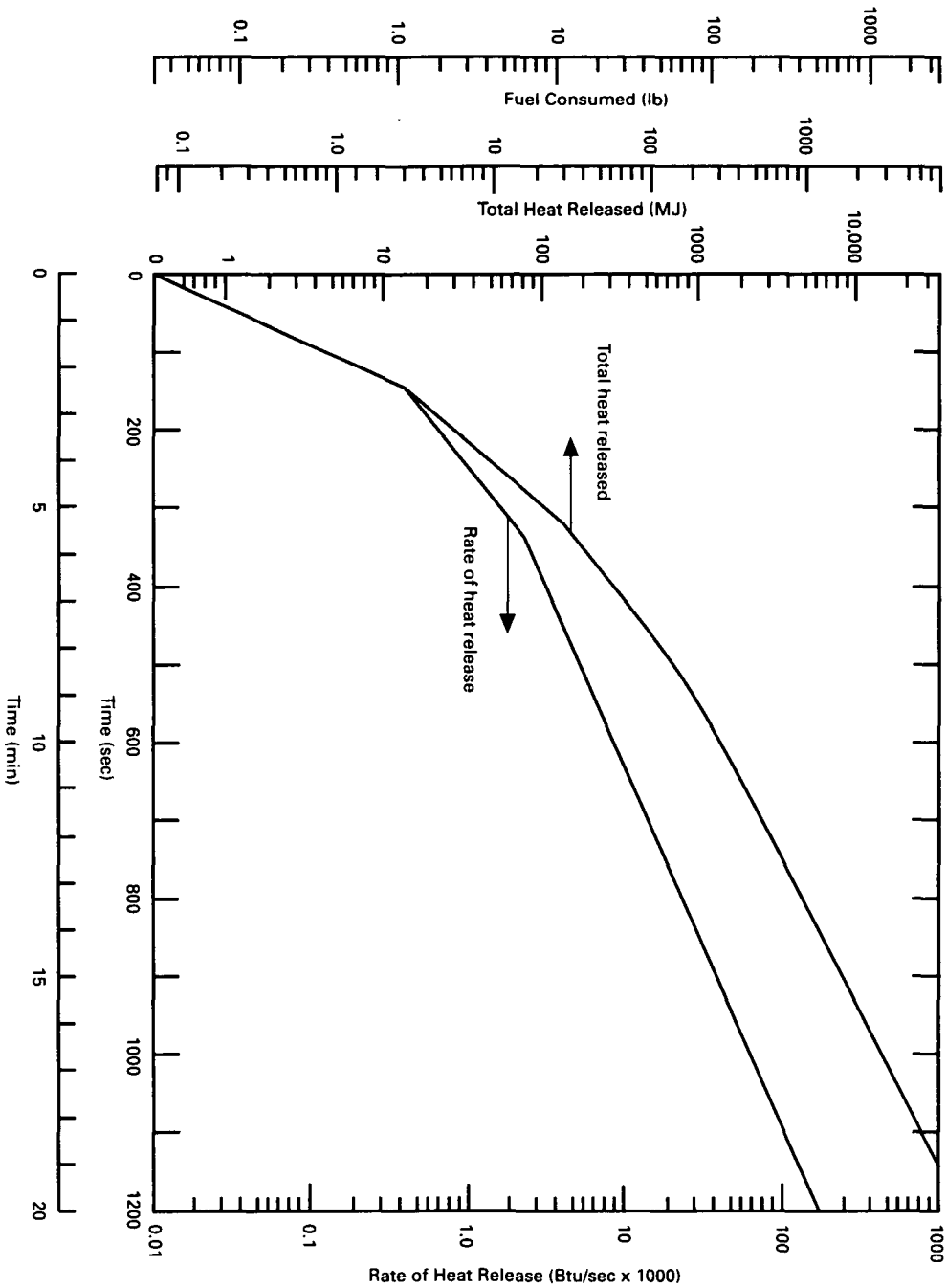


Figure A-6-1.5.1 Semi-universal fire curve.

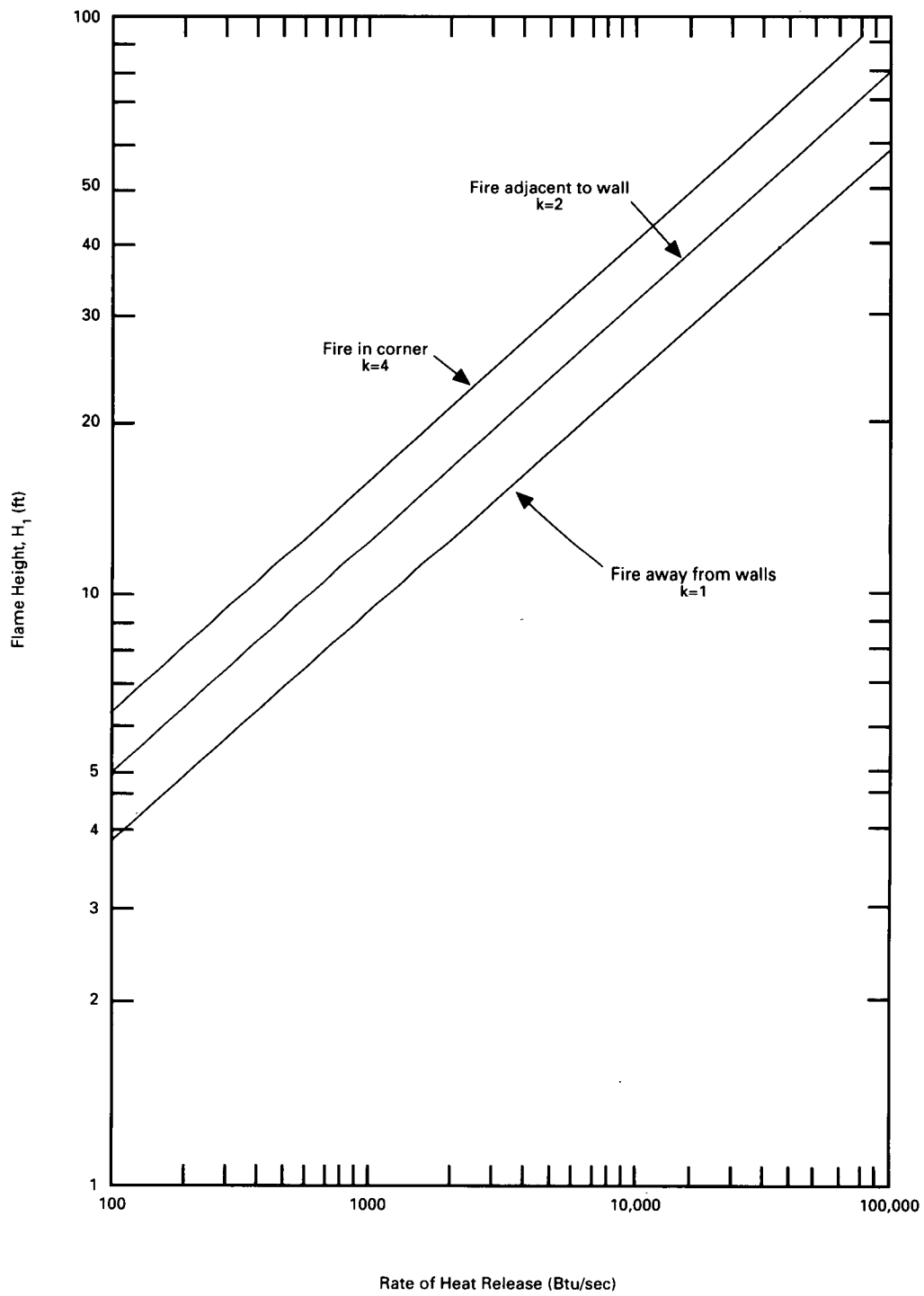


Figure A-6-1.5.2 Maximum flame height.

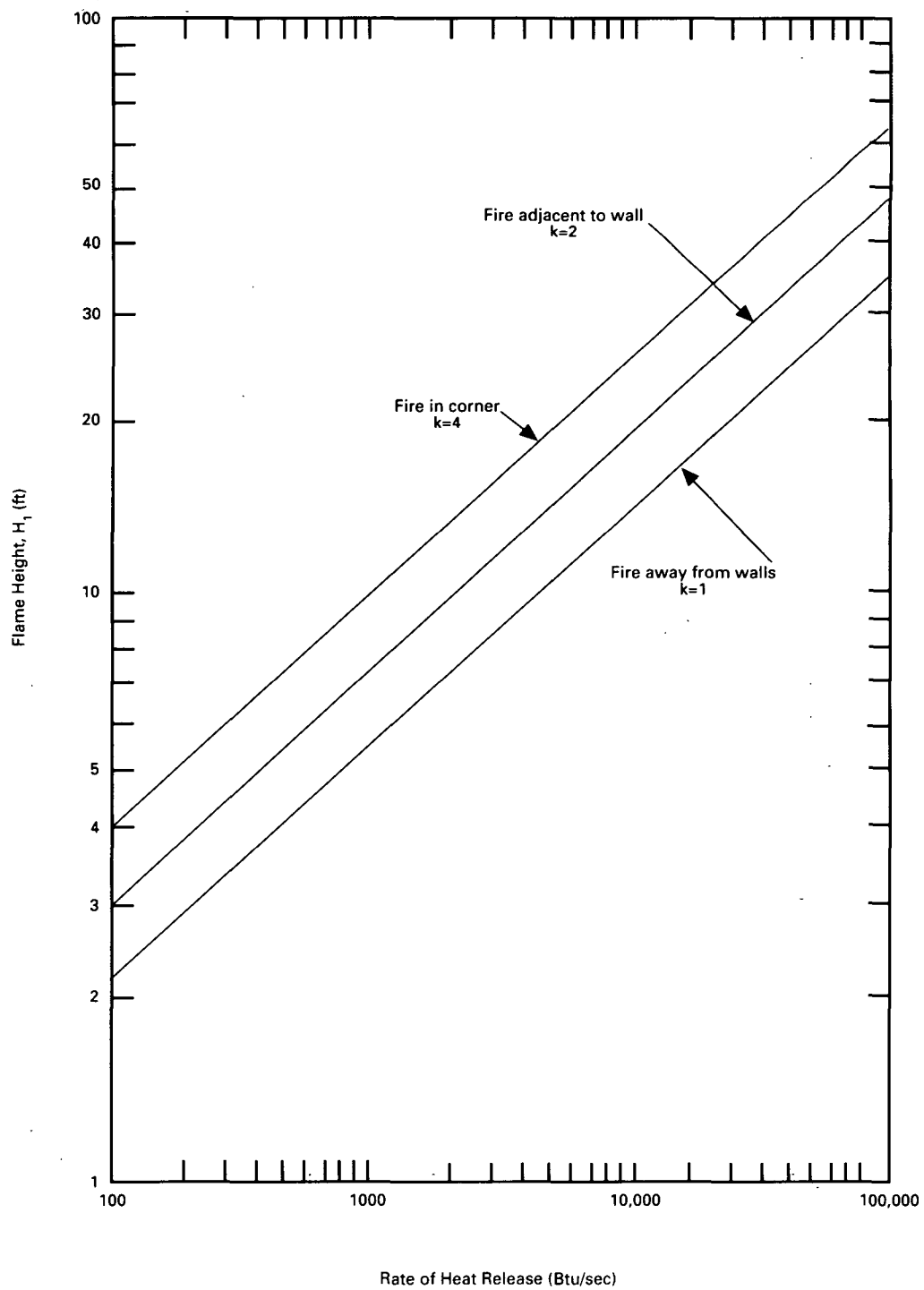


Figure A-6-1.5.3 · Continuous flame height.