NFPA

102

ASSEMBLY SEATING, TENTS, AIR-SUPPORTED STRUCTURES 1978

NATIONAL FIRE PROTECTION ASSN.
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Standard for

Assembly Seating, Tents, and Air-Supported Structures

NFPA 102–1978

1978 Edition of NFPA 102

The 1978 edition of NFPA 102 was prepared by the Committee on Tents, Grandstands, and Air-Supported Structures and was adopted by the Association on November 15, 1978, at its Fall Meeting in Montreal, Quebec, Canada. It was released by the Standards Council for publication on December 4, 1978.

This edition is a complete revision of the 1972 edition which has been retitled *Assembly Seating, Tents, and Air-Supported Structures.* The complete revision includes expanded sections on tents, air-supported structures, grandstands, and bleachers, telescopic seating, and means of egress. The means of egress section has been coordinated to the provisions of the *Life safety Code,* NFPA 101.

Origin and Development of NFPA 102

This standard is the result of a committee project inaugurated shortly after the circus fire in Hartford, Conn., 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, 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 makes the standard applicable to foldable grandstands in buildings which 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.

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This list represents the membership at the time the Committee was balloted. Since that time, changes in the membership may have occurred.

Contents

Standard for

Assembly Seating, Tents, and Air-Supported Structures

NFPA 102-1978

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

Chapter 1 General

1-1* Scope. This standard is concerned with the hazards of fire, storm, collapse, and panic and covers:

(a) Folding or telescopic seating for mass seating as differentiated from grandstands and bleachers.

(b) The construction, location, protection, and maintenance of tents and air-supported structures, used for places of assembly.

(c) Temporary, permanent and portable grandstands and bleachers, both exterior and within tents and air-supported structures.

1-2* Purpose. The purpose of this standard is to provide for safety to life from the hazards of fire, storm, collapse and panic in assembly seating, tents and air-supported structures.

1-3 Application. This standard applies to both new facilities and existing facilities where specifically noted.

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 construction standards for safety to life and property. In matters not specifically covered in this standard, conformity with the applicable standards in Appendix B shall be deemed as compliance with approved standards for safety to persons and property.

Chapter 2 Definitions

2-1 General.

2-1.1 The following terms, for the purposes of this Standard, 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-Supported Structure means a structure wherein the shape and structural support are attained by air pressure.

Approved means acceptable to the authority having jurisdiction. 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 testing laboratories, inspection agencies, or other organizations concerned with product evaluations, which are in a position to determine compliance with appropriate standards for the current production of listed items, and the satisfactory performance of such equipment or materials in actual usage.

Authority Having Jurisdiction means the organization, office, or individual responsible for "approving" equipment, an installation or a procedure.

Bleachers means a grandstand where the seats are not provided with backrests.

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

Folding and Telescopic Seating means 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 means 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 means a type of construction as defined in *Standard on Types of Building Construction*, NFPA 220 (*see Appendix B*).

Labeled means 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.

Listed means 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.

Places of Assembly means, 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, amusement, or awaiting transportation.

Tent means a structure, the covering of which is made of pliable material which achieves its sole support by mechanical means such as beams, columns, poles, arches, ropes, and/or cables.

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

Temporary means in place for less than 180 consecutive calendar days.

Chapter 3 Means of Egress

3-1 General.

3-1.1 Where not specifically covered by this standard, means of egress from facilities included within the scope of this standard shall comply with the provisions of the *Life Safety Code*, NFPA 101 (*see Appendix B*).

3-1.2 No aisle, passageway, stair, door or other means of egress shall be obstructed in any manner while the facilities are occupied by the public.

3-1.3 No guy wire or guy rope shall cross any means of egress at a height of less than 7 ft. 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.

3-1.4* Consideration shall be given to exiting facilities for the handicapped.

3-1.5 Occupant Load.

3-1.5.1 The number of persons admitted to any place of assembly within the scope of this standard shall not exceed the capacity as computed in accordance with the provisions of this section, nor shall it exceed the capacity of the exits as defined in Section 3-3.

3-1.5.2 The occupant load in any assembly structure, or portion thereof, shall be based on the following:

(a) An assembly area of concentrated use with movable seats such as an auditorium, church, chapel, dance floor, and lodge room — 7 net sq. ft. per person.

(b) An assembly area of less concentrated use, such as a conference room, dining room, drinking establishment, exhibit room, gymnasium, or lounge — 15 net sq. ft. per person.

(c) Seats without dividing arms or other physical definition — 18 in. per person.

(d) The occupant load of an area having fixed seats shall be determined by the number of fixed seats installed.

Exception: The occupant load permitted may be increased above that specified herein if the necessary aisles and exits are provided, subject to the approval of the authority having jurisdiction. An approved aisle, exit, and/or seating diagram may be required by the authority having jurisdiction to substantiate an increase in occupant load.

3-1.5.3 The walking surfaces of stairways, ramps, aisles, passageways, or spaces used for exit access or circulation shall not be obstructed or used for seats, sitting or standing room.

3-2 Types of Exits.

3-2.1 Exits of the specified number and width shall be of one or more of the following types, in accordance with the provisions of Chapter 5 of the *Life Safety Code,* NFPA 101 (*see Appendix B*).

(a) Door openings, leading directly to the outside of the structure.

(b) Stairs, Class A for all new places of assembly.

(c) Ramps, Class A or Class B for all new places of assembly.

(d) Escalators and moving walks, moving in the direction of exit travel.

3-2.2 Turnstiles. No turnstiles, revolving doors, or other devices to restrict the movement of persons shall be installed in any place of assembly in such a manner as to interfere in any way with required exit facilities.

3-3 Capacity of Exits.

3-3.1 Means of egress shall be measured in units of exit width of 22 in. Fractions of a unit less than 12 in. shall not be counted. Fractions of a unit comprising 12 or more in. added to one or more full units, shall be counted as ½ unit of exit width.

3-3.2 Required stairways and ramps shall be not less than 44 in. clear width. Moving stairways and walkways, when moving in the direction of exit travel, may be considered the equivalent of stairways in computing exit capacity.

3-3.3 The total exit capacity of a place of assembly shall be determined as follows:

(a) Horizontal travel including Class A ramps—100 persons per unit.

(b) Stairs and Class B ramps—60 persons per unit.

Exception: For outdoor grandstands with or without a canopy the exit capacity shall be determined on the basis of 500 persons per unit.

3-3.4 Doorways serving as required exits from stairways, ramps, or passageways shall be not less than 34 in. in clear width, nor less in width than the required width of the exitway served.

3-3.5* The aggregate clear width of doorways serving as exits from the enclosure of a fenced place of assembly shall be determined on a basis of not less than one unit of 22 in. width for each 100 persons to be accommodated.

Exception: If the enclosure has within it an easily accessible and unobstructed area which provides refuge, the aggregate width may be determined on a basis of not less than one unit of 22 in. width for each 500 persons to be accommodated.

3-3.6 The width of exit discharge shall be at least equal to the required width for the occupant load served.

3-3.7 Where several ways serve as exit access, each shall have a width suitable for the traffic but not less than 34 in. clear width.

3-4 Number of Exits.

3-4.1 Every structure and every balcony or tier considered separately used as a place of assembly shall be provided with at least two means of egress remote from each other and leading directly to the outside. If the capacity of such structure, balcony or tier thereof exceeds 1,000 there shall be at least three exits, and if the capacity exceeds 4,000 there shall be at least four exits, provided that in tents and air-supported structures if the capacity exceeds 600 there shall be at least three exits, and if the capacity exceeds 1,000 there shall be at least four exits.

3-4.2 A fenced outdoor place of assembly 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.

3-5 Arrangement of Means of Egress.

3-5.1 Aisles from seating arrangements that do not lead directly to an exit discharge shall discharge into an unobstructed space leading directly to one or more exit discharges, and shall be so arranged as to be conveniently accessible to every occupant; and such space shall have a clear width not less than the required width of the exit to which it leads, but in no case less than 5 ft.

3-5.2 Aisles shall terminate in a cross aisle, foyer, or exit. The width of such cross aisle, foyer, or exit shall be not less than the sum of the required width of the widest aisle plus 50 percent of the total required width of the remaining aisles which it serves.

3-6* Travel Distance. The travel distance to an exit or safe place of refuge shall not be greater than 150 ft.

Exception: As provided in Chapter 9.

3-7 Exit Discharge.

3-7.1 All places of assembly 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.

3-7.2 If required exits from places of assembly do not discharge directly into a street or open space leading to a street, unobstructed lanes not less than 20 ft. in width shall be maintained from such exits to the street at all times while such places of assembly are occupied by the public.

3-8 Illumination of Means of Egress.

3-8.1 Means of egress from structures used as places of assembly shall be kept adequately lighted at all times when such structures are occupied by the public. Artificial light shall be provided whenever natural light is inadequate. Lighting conforming to the requirements of Section 5-8 of the *Life Safety Code,* NFPA 101 (*see Appendix B*), will be considered adequate.

3-8.2 All tents and air-supported structures having an occupant load of 100 or more, if used when natural light is not available, shall have emergency lighting in accordance with Section 5-9 of the *Life Safety Code,* NFPA 101 (*see Appendix B*).

3-9 Marking of Means of Egress.

3-9.1 In structures having a capacity of 100 persons or more there shall be placed over each opening to be used for egress a sign with the word EXIT in plainly legible letters not less than 6 in. high, and with the principal strokes of such letters not less than ¾ in. in width.

3-9.2 Exits from structures used as places of assembly shall be adequately indicated.

3-9.3 Exit signs shall be illuminated in conformity with Section 5-10 of the *Life Safety Code*, NFPA 101 (*see Appendix B*) at all times when the structure is occupied by the public.

3-9.4 Where necessary, suitable directional signs shall be displayed in conspicuous locations to indicate the proper direction of egress.

Chapter 4 Protection

4-1 Flammable Liquids and Gases.

4-1.1 Storage and handling of flammable liquids or gases shall be in accordance with the applicable standards below:

(a) *Flammable and Combustible Liquids Code,* NFPA 30 (*see Appendix B*)

(b) *National Fuel Gas Code,* NFPA 54 (*see Appendix B*)

(c) *Standard for the Storage and Handling of Liquefied Petroleum Gases,* NFPA 58 (*see Appendix B*).

4-1.2 No storage or handling of flammable liquids or gases shall be permitted at any location at which it would jeopardize egress from the structure.

4-1.3 Refueling of equipment with liquids with flash points below 100°F shall not be permitted within the place of assembly.

4-2 Fire Hazard.

4-2.1 The applicable provisions of Chapters 8 and 17 of the *Life Safety Code*, NFPA 101 (*see Appendix B*), which pertain to fire hazards shall govern in places of public assembly in tents or air-supported structures.

4-2.2 The ground enclosed by any structure used in connection with a place of assembly, and for a reasonable distance, but not less than 10 ft. 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.

4-2.3 No hay, straw, shavings, or similar combustible materials shall be permitted within any structure used for public assembly.

Exception: Animal bedding and fodder in quantitites approved by the authority having jurisdiction.

4-2.4 No smoking shall be allowed in any tent or air-supported structure unless authorized by the authority having jurisdiction.

4-2.5 Fireworks or unauthorized open flames shall be prohibited in any tent or air-supported structure.

4-3* Fire Extinguishing Equipment.

4-3.1 Fire extinguishing equipment of approved types shall be furnished and maintained by the person operating, conducting, or promoting any place of assembly in such amount and in such locations as may be directed by the authority having jurisdiction.

4-3.2 Fire extinguishing equipment shall be maintained in good working order in accordance with the *Standard for Portable Fire Extinguishers,* NFPA 10 (*see Appendix B*).

4-3.3 Employees of places of assembly shall be properly trained to operate fire extinguishing equipment and shall be required to exhibit their skill when requested by the authority having jurisdiction.

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

4-5* Fire Detail. Fire details, if deemed necessary in any place of assembly, shall be determined by the authority having jurisdiction.

Chapter 5 Services

5-1 Electrical Installations.

5-1.1 Electrical installations shall conform to the requirements of the *National Electrical Code*, NFPA 70 (*see Appendix B*).

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

5-1.2 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.

5-1.3 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.

5-2 Heating Devices.

5-2.1 Fired Heaters.

5-2.1.1 Only listed and labeled heating devices shall be used.

5-2.1.2 Combustion chambers for heaters shall be located outside, not less than 3 ft. from any tent or air-supported structure.

5-2.1.3 Fired heaters and their installation shall be approved by the authority having jurisdiction.

5-2.1.4 Ducts used to convey heated air shall be of noncombustible materials.

5-2.1.5 Containers for liquefied petroleum gases shall be installed not less than 5 ft. from any tent or air-supported structure and in accordance with the provisions of the *Standard for Storage and Handling of Liquefied Petroleum Gases*, NFPA 58 (*see Appendix B*).

5-2.1.6 Tanks shall be secured in the upright position and protected from vehicular traffic.

5-2.1.7 Heating devices shall comply with the requirements of the following standards:

(a) *Installation of Oil Burning Equipment*, NFPA 31 (*see Appendix B*)

(b) *National Fuel Gas Code*, NFPA 54 (*see Appendix B*)

(c) *Chimneys, Fireplaces and Vents*, NFPA 211 (*see Appendix B*).

5-2.2 Electric Heaters.

5-2.2.1 Only listed and labeled heaters shall be used.

5-2.2.2 Heaters may be used inside a tent or air-supported structure when approved by the authority having jurisdiction.

5-2.2.3 Heaters must be connected to electricity by electric cable suitable for outside use, and of sufficient size to handle electric load.

Chapter 6 Tents

6-1 General. Tents used for theaters, motion picture theaters, and dance halls, exceeding 1000 person capacity, shall only be permitted on a temporary basis.

6-2 Size Limitations. Tents shall be erected to cover not more than 75 percent of the premises, unless otherwise approved by the authority having jurisdiction.

6-3 Structural Requirements.

6-3.1 All supporting members shall be of sufficient size and strength to support the structure.

6-3.2 The poles and their supporting guys, stays, stakes, fastenings, etc., shall be of sufficient strength and attached so as to resist a minimum wind pressure of 20 lbs. per sq. ft. of projected area of the tent.

6-3.3 Tents shall be adequately guyed, supported and braced to withstand a minimum pressure or suction of 10 lbs. per sq. ft.

6-3.4 Pull-down ropes on center poles and side poles on push-pull tents shall be provided.

6-4 Flame Resistance.

6-4.1 All tent fabric shall meet the requirements of the small scale test contained in the *Standard Methods of Fire Tests for Flame-Resistant Textiles and Films*, NFPA 701 (*see Appendix B*).

Exception: The authority having jurisdiction may require the tent fabric to meet the requirements of the large scale test contained in the "Standard Methods of Fire Tests for Flame-Resistant Textiles and Films," NFPA 701 (see Appendix B).

6-4.2 The authority having jurisdiction shall require a certificate or other evidence of approval by a laboratory of recognized standing, or he may accept the report of tests made by other inspection authorities as evidence that the tent fabric materials have the required flame resistance.

6-4.2.1 The authority having jurisdiction may also require confirmatory field tests 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 which has been cut into test strips 1½ in. by 4 in.

6-5 Location and Means of Egress.

6-5.1 Location and Spacing.

6-5.1.1 There shall be a minimum of 10 ft. between stake lines.

6-5.1.2 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. 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 may be erected less than 10 ft. 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 1,200 sq. ft. in ground area, located in fair grounds or similar open spaces, need not be separated from each other, provided safety precautions meet the approval of the authority having jurisdiction.

6-5.1.3 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.

6-5.2 Means of Egress.

6-5.2.1 Seating shall conform to the requirements of Chapter 8 of the *Life Safety Code,* NFPA 101 (*see Appendix B*).

Exception: Grandstand seating shall comply with Chapter 8 of this standard.

6-5.2.2 Aisles serving areas other than seating shall be not less than 5 ft. wide and the number of such aisles shall be at the discretion of the authority having jurisdiction.

Chapter 7 Air-Supported Structures

7-1 General.

7-1.1* The provisions of this chapter shall apply to air-supported structures which are up to 150 ft. in width or diameter.

7-1.2 Air-supported structures used for theaters, motion picture theaters, and dance halls, exceeding 1000 person capacity, shall only be permitted on a temporary basis.

7-1.3 The design, materials, and construction of the structural envelope, anchorage system, and all accessory equipment for an air-supported structure shall be in accordance with the requirements of this chapter, and *Air Structures Design and Standards Manual* of the Air Structures Institute (*see Appendix B*).

7-1.4 Material loading and strength, anchorage design and strength, and sizing of the inflation system shall be certified by the manufacturer and verified by analytical or test data prepared by a professional engineer. The physical properties of fabric material shall be verified and certified by an approved independent testing laboratory.

7-1.5 The owner shall supply certification every two years to the authority having jurisdiction to verify that the structure has been inspected and serviced by a qualified service organization to assure that the requirements of this standard are met.

7-2 Location and Spacing. The distance between an air-supported structure and any other building or air-supported structure shall be not less than 20 ft.

Exception: Air-supported structures may be interconnected to conventional buildings, but this interface shall be properly designed to minimize air leakage and to assure uniform distribution of loads around connecting openings. This arrangement is acceptable only if the authority having jurisdiction approves the design.

7-3 Size Limitation. No ground-to-ground, air-supported structure shall be erected to cover more than 75 percent of the premises unless otherwise approved by the authority having jurisdiction.

7-4 Structural Requirements.

7-4.1 Envelope Design. The design, materials, and construction for the structural envelope shall conform to the requirements of this section.

7-4.2 Material Strength. Calculation of fabric stresses shall include consideration of inflation pressure, design wind load, and the radius of the structure. The minimum design criteria for material strength shall comply with the requirements of Figure 13 of *Air Structures Design and Standards Manual* (*see Appendix B*). Minimum design criteria shall be for 80 mph wind conditions. Local climatic conditions, as determined by local code authorities, may require design criteria for higher wind 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 approved, independent testing laboratory.

7-4.3 Joint Strength. All seams shall develop the full strength of the envelope material as specified in *Air Structures Design and Standards Manual* (*see Appendix B*).

7-4.4 Load Distribution.

7-4.4.1 The envelope shall be properly 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. Openings shall be at or near the base of the structure.

7-4.4.2 There shall be sufficient slack between the envelope and rigid components to permit free movement under load.

7-4.4.3 Reinforced areas, such as around openings, shall provide a flexible but airtight seal.

7-4.4.4 A smoothly contoured envelope, when fully pressurized, provides prima facie evidence of proper patterning and uniform stress distribution.

7-5 Pressurization (Inflation) System.

7-5.1 The operating inflation pressure for the air structure shall be adequate to withstand a wind velocity of 80 mph. Local climatic conditions, as determined by local authorities, may require pressurization for higher wind conditions.

7-5.2 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) Blowers shall be weather protected

(d) Blowers 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 shall be certified by the manufacturer, and the design of the entire system shall be certified by a professional engineer.

7-6 Emergency Power System.

7-6.1 Design.

7-6.1.1 A fully automatic emergency 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 which is sized for 1½ times the normal operating capacity and is powered by an internal combustion engine.

7-6.1.2 The emergency power system shall be fully automatic to assure continuous inflation in the event of any failure of the primary power. This system shall start automatically within 30 sec. of a power failure and shall be capable of operating continuously for a minimum period of 8 hrs.

7-6.2 Certification. The sizing and capacity of the emergency power system shall be certified by a professional engineer.

7-7 Anchorage Design.

7-7.1 Basic Requirements. A positive anchorage system shall be provided to securely anchor the envelope to the ground.

7-7.2* Specific Requirements. Anchor loading varies with the size, height, and anchor spacing for the structure, and this 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 Figure 22 of *Air Structures Design and Standards Manual (see Appendix B).*

7-8 Means of Egress.

7-8.1 The means of egress shall conform to Chapter 3.

7-8.2 Other specific requirements for means of egress shall be as follows:

(a) All door openings shall be properly reinforced and balanced to evenly distribute structural loads around openings.

(b) All door frames or housings shall be structurally anchored at the base.

(c) All doors shall automatically close against normal operating pressures.

(d) Opening force at the door edge shall not exceed 15 lbs. with the structure inflated to its operating inflation pressure.

7-9 Accessory Equipment. The design and use of accessory equipment for heating, air conditioning, lighting, etc., shall conform to the requirements of Chapter 5 and to approved recognized standards.

7-10 Flame Resistance.

7-10.1 All air-supported structure fabric shall meet the requirements of the small scale test contained in *Standard Methods of Fire Tests for Flame-Resistant Textiles and Films,* NFPA 701 *(see Appendix B).*

Exception: The authority having jurisdiction may require the air-supported structure fabric to meet the requirements of the large-scale test contained in the Standard Methods of Fire Tests for Flame-Resistant Textiles and Films, NFPA 701 (see Appendix B).

7-10.2 The authority having jurisdiction shall require a certificate or other evidence of acceptance by a laboratory of recognized standing, or he may accept the report of tests made by other inspection authorities or a recognized testing laboratory as evidence that the air structure fabric materials have the required flame resistance.

7-10.2.1 The authority having jurisdiction may also require confirmatory field tests using test specimens from the original material which shall have been affixed at the time of manufacture to the exterior of the structure. The test specimen shall consist of a full-width of material which has been cut into test strips 1½ in. by 4 in.

7-11 Safety.

7-11.1 Operating Pressure. Operating pressure shall be maintained at the design pressure.

7-11.2 Clearance. There shall be a minimum clearance of 3 ft. between the envelope and contents or equipment and any exterior object.

Exception: Support or accessory equipment.

7-11.3 Inspection Frequency. The owner shall have the entire air structure system inspected at not less than quarterly intervals to assure that the installation is in good operating condition and is so maintained.

Chapter 8 Grandstands and Bleachers

8-1 Location. Grandstands shall be erected or otherwise located only where adequate load-carrying capacities exist to safely support the loads.

8-2 Design.

8-2.1 The design of grandstands shall be in accordance with accepted structural engineering practice.

8-2.2 Load tests in accordance with accepted engineering practice may be made in lieu of the design analysis for a grandstand unit or a part thereof.

8-2.3 Where required by the authority having jurisdiction, the manufacturer shall submit either calculations verifying the design analysis prepared by a professional engineer or a report of load tests conducted by an approved independent testing laboratory and certified by a professional engineer. The authority having jurisdiction may also require the manufacturer to certify that the equipment supplied is in accordance with the design, or is essentially identical to the structure tested.

8-2.4 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 to be overturned either by wind or unequal distribution of live load.

8-2.5 Design Loads.

8-2.5.1 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 lbs. per sq. ft. of gross horizontal projection.

8-2.5.2 All seat and footboard members shall be designed for live loads of not less than 120 lbs. per linear ft.

8-2.5.3 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 lbs. per linear ft. of seats, and in a direction perpendicular to the length of the seats, of 10 lbs. per linear ft. of seats.

8-2.5.4 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 *Minimum Design Loads in Buildings and Other Structures*, ANSI A58.1, Figure 1, and Table 12 (*see Appendix B*).

8-2.5.4.1 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.

8-2.5.4.2 Uplift wind pressures equal in magnitude to those shown in Table 12 of ANSI A58.1 (*see Appendix B*) 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.

8-2.5.4.3 Uplift wind pressure equal to 1¼ times those shown in Table 12 of ANSI A58.1 (*see Appendix B*) shall be assumed to be acting normal to an unenclosed roof situated over a grandstand.

8-2.5.5 Railings or guards of grandstands shall be capable of sustaining a vertical or horizontal load of 50 lbs. per ft. Loads need not be applied simultaneously.

8-2.5.6 Each of the horizontal forces in 8-2.5.3 and 8-2.5.5 need not be applied simultaneously with other lateral forces such as wind or seismic loads.

8-2.6 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.

8-2.7 Stresses permitted in the design standards of the various materials may be increased by 33⅓ 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.

8-2.8 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.

8-3 Aisles.

8-3.1 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 8-3.1.

Table 8-3.1 Number of Seats to Aisle

	Number of Seats to Aisle	
Application	**Outdoors**	**Tents/Air-Supported Structures**
Grandstands	11	6
Bleachers (*see Exception*)	20	9

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 less than 28 in.

(c) Rise per row, including first row, 9 in. or less

(d) Number of rows does not exceed 21 outdoors or 16 in tents or air-supported structures

(e) Seat spaces are not physically defined.

8-3.2 Aisles provided in compliance with 8-3.1 shall be not less than 44 in. clear width.

Exception No. 1: Aisles in portable grandstands or bleachers without canopy, roof, or cover, or in grandstands of aluminum, steel, concrete, or masonry, or combination thereof, which have a closed noncombustible deck under the seating, may be not less than 34 in. clear width.

Exception No. 2: Aisles serving not more than 60 seats may be 22 in. clear width. Where an aisle is divided by a portal, column, handrail, or other obstruction, each part shall be not less than 22 in. clear width.

8-3.3 Where the entrance to an aisle is elevated above ground level, such aisle shall be provided with a stairway or ramp, whose width is not less than the width of the aisle, or shall be served by a cross aisle.

8-3.4 Steps shall not be placed in aisles to overcome difference in level unless the gradient shall exceed 1 ft. in 10 ft. of run. When the rise of seating platform exceeds 11 in. 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., 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. The full length of the nose of each step in the aisle shall be conspicuously marked.

8-4 Travel Distance. The travel distance to the nearest exit shall be not greater than 150 ft.

8-5 Seating.

8-5.1 The horizontal distance back-to-back of seats shall be not less than 30 in. for seats having back rests or not less than 22 in. for bleachers. There shall be a space of not less than 12 in. between the back of each seat and the front of the seat immediately behind it. Where the same level is used for both seats and footrests these levels shall be not less than 24 in. in width. All measurements shall be taken between plumb lines.

8-5.2 The depth of footboards and seatboards in grandstands shall be not less than 9 in. Where the same level is not used for both seat foundations and footrests, footrests independent of seats shall be provided.

8-5.3 Seats and footrests of grandstands shall be securely supported and fastened in such a manner that they cannot be displaced inadvertently.

8-5.4 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.

8-6 Railings or Guards.

8-6.1 Railings or guards not less than 42 in. high above the aisle surface or footrest or 42 in. vertically above the center of the seat board surface, whichever is adjacent, shall be provided along those portions of the backs and ends of all grandstands where the seats are more than 4 ft. 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.

8-6.2 Where the front footrest of any grandstand is more than 2 ft. above the ground, railings or guards not less than 26 in. high above such front footrests shall be provided.

8-6.3 Cross aisles located at the front of the grandstand shall be provided with a rail not less than 36 in. high.

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

8-6.4 Cross aisles other than those located at the front of the grandstand shall be provided with a rail not less than 26 in. high.

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

8-6.5 Openings between the top railing or guard and the walkway surface below shall not permit the passage of a sphere larger than 9 in. in diameter.

8-7 Special Requirements, Wood Grandstands.

8-7.1 No outdoor wood grandstand shall be erected within less than ⅔ of its height but in no case less than 10 ft. of a building, unless the separation from such building be of not less than 1-hr. fire resistance and have any openings therein 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.

8-7.2* No outdoor wood grandstand unit shall exceed 10,000 sq. ft. in ground area or 200 ft. in length. Grandstand units of the maximum size shall be placed not less than 20 ft. apart or shall be separated by walls of 1-hr. fire resistance. Not more than 3 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-resistive construction extending 2 ft. above the seat platforms or by an open space not less than 50 ft.

Exception: When entirely constructed of listed and labeled fire retardant treated wood which has passed the standard rain test, "Method of Test for Durability of Fire Retardant Treatment of Wood," ASTM D2898 (see Appendix

B), or of members conforming to dimensions for heavy timber construction, the allowable ground area or length may be doubled.

8-7.3 The highest level of seat platforms of any wood grandstand shall be not more than 20 ft., and of portable grandstands within tents or air-supported structures not more than 12 ft., above the ground or the surface at the front of the grandstand.

8-8 Special Requirements, Portable Grandstands.

8-8.1 Portable grandstands shall conform to the requirements of Chapter 8, for grandstands, and the following special requirements.

8-8.2 Portable grandstands shall be self-contained, having within themselves all necessary parts to withstand and restrain all forces which 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.

8-8.3 Portable grandstands shall be provided with base plates, sills, floor runners, or sleepers of such area that the total live and dead load exerted under any of these shall not exceed 55 lbs. per sq. in. 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.

8-8.4 A-frames or other supports, and seat stringers for portable grandstands shall be secured to prevent accidental displacement during occupancy.

8-8.5 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 woodscrews are permissable 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 2 bolts, rivets, or lag screws or by approved connectors or other approved devices. All iron or steel fastenings and fastening devices shall be hot-dipped galvanized. (*See Appendix B.*) Adequate provision shall be made to prevent the splitting or shearing of wood at such connections.

8-8.6 Portable grandstands shall not be used for public occupancy unless all parts have been erected, or re-erected, in accordance with the approved design and specifications. Members comprising the seating, walkways, railings, bracing, and supporting members shall be structurally sound.

8-9 Spaces Underneath Grandstands.

8-9.1 Spaces underneath a grandstand or bleacher shall be kept free of flammable or combustible materials.

Exception: Accessory uses, such as ticket booths, toilet facilities, or concession booths may be permitted in such spaces when of noncombustible or fire-resistive construction.

8-9.2 Food serving or processing stands located under grandstands and bleachers shall be protected with an automatic fire suppression system.

Exception: Booths of construction having a 1-hr. fire resistance rating.

8-10 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. The authority having jurisdiction may require certification that such inspection has been performed.

Chapter 9 Folding and Telescopic Seating

9-1 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.

9-2 Design.

9-2.1 The design of folding and telescopic seating shall be in accordance with accepted structural engineering practice.

9-2.2 Load tests in accordance with accepted engineering practice may be made in lieu of the design analysis for a seating unit or part thereof.

9-2.3 Where required by the authority having jurisdiction, the manufacturer shall submit either calculations verifying the design analysis prepared by a professional engineer or a report of load tests conducted by an approved independent testing laboratory and certified by a professional engineer. The authority having jurisdiction may also require the manufacturer to certify that the equipment supplied is in accordance with the design or is essentially identical to the structure tested.

9-2.4 Design Loads.

9-2.4.1 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 lbs. per sq. ft. of gross horizontal projection.

9-2.4.2 Seatboards and footrests shall be designed for a live load of not less than 120 lbs. per linear ft.

9-2.4.3 A sway force applied to seats shall be 24 lbs. per linear ft. parallel to the seats, and 10 lbs. per linear ft. perpendicular to the seats. Sway forces shall not be considered simultaneously applied.

9-2.4.4 Railings or guards shall be capable of sustaining a vertical or horizontal load of 50 lbs. per ft. Loads need not be simultaneously applied.

9-2.4.5 Each of the horizontal forces in 9-2.4.3 and 9-2.4.4 need not be applied simultaneously with other lateral forces such as wind or seismic loads.

9-2.4.6 Stresses permitted in the design standards of the various materials may be increased 33⅓ 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.

9-2.5 Structural design shall consider the stresses in all members due to all of the loadings indicated in 9-2.4, Design Loads, 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.

9-2.6 All design criteria shall be met when the seating is in each configuration intended for occupancy.

9-3 Review and Approvals.

9-3.1 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 of telescopic seating units and details of attachments, if any

(c) Location of guards and details thereof.

9-3.2 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 the *Life Safety Code*, NFPA 101 (*see Appendix B*)

(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.

9-4 Aisles.

9-4.1 Aisles shall be required when any of the following conditions exist:

(a) When backrest-type seating is used

(b) When rise per row exceeds 12 in.

(c) When exits from seating area are partially or fully restricted by front or rear railing

(d) When row spacing exceeds 28 in. unless seat foundation and footboard are at same elevation.

9-4.2 When required, aisles shall be arranged so that the number of seats between any seat and the nearest aisle shall not exceed the number shown in Table 9-4.2.

Table 9-4.2 Number of Seats to Aisle

	Number of Seats to Aisle	
Application	**Outdoors**	**Indoors**
Grandstands	11	6
Bleachers	20	9

9-4.3 Aisles required in conformance with 9-4.1 shall be not less than 34 in. clear width.

Exception: Aisles serving not more than 60 seats may be 22 in. clear width.

9-4.4 Where an aisle is divided by a portal, column or other obstruction, each part shall be not less than 22 in. clear width.

9-4.5 Rise of steps within an aisle shall not exceed 12 in.

9-4.6 At the foot of each aisle a step shall be provided having a height equal to ½ the height of the first seat and a tread not less than 10 in.

9-5 Travel Distance. The travel distance to the nearest exit shall be not greater than 150 ft.

Exception: The travel distance may be increased to 200 ft. in buildings completely protected by automatic sprinklers installed in accordance with the "Standard for the Installation of Sprinklers Systems," NFPA 13 *(see Appendix B).*

9-6 Seating.

9-6.1 The horizontal distance back-to-back of seats shall be not less than 22 in. for seats without backs. There shall be a space of not less than 12 in. 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. 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.

9-6.2 The depth of footboards (footrests) and seatboards in folding and telescopic seating shall be not less than 9 in. Where the same level is not used for both seat foundations and footrests, footrests independent of seats shall be provided.

9-6.3 Individual chair-type seats shall be permitted in folding and telescopic seating only if firmly secured in groups of not less than 3.

9-7 Guards and Rails.

9-7.1 Railings or guards not less than 42 in. high above the aisle surface or footrest or 36 in. 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. above the floor.

Exception: When folding or telescopic seating is used adjacent to a wall or fence within 6 in. of the seating and of sufficient height to afford the intended protection, guards may be omitted.

9-7.2 Where the front footrest of any folding or telescopic seating is more than 2 ft. above the floor, railings or guards not less than 33 in. 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. high.