NFPA®409

Standard on

Aircraft Hangars

2016 Edition

This edition of NFPA 409, *Standard on Aircraft Hangars*, was prepared by the Technical Committee on Airport Facilities. It was issued by the Standards Council on May 26, 2015, with an effective date of June 15, 2015, and supersedes all previous editions.

This edition of NFPA 409 was approved as an American National Standard on June 15, 2015.

Origin and Development of NFPA 409

The original fire protection recommendations for the construction and protection of airplane hangars were published by the National Board of Fire Underwriters (NBFU), now the American Insurance Association, in 1930. Revisions were issued by the NBFU in 1931, 1943, 1945, and 1950. The 1943, 1945, and 1950 editions were published as NBFU Pamphlet 85. In 1951, the National Fire Protection Association organized a Committee on Aircraft Hangars, to which the NBFU and other interested groups lent their support. The NFPA's first standard on aircraft hangars was adopted in 1954, and the NBFU adopted the same text, rescinding its 1950 standard. Revisions were made in 1957 and 1958 by the NFPA committee. In 1959, a reorganization of the NFPA aviation activities resulted in the assignment of NFPA 409 to the Sectional Committee on Aircraft Hangars and Airport Facilities, which prepared the 1960, 1962, 1965, 1966, 1967, 1969, 1970, 1971, 1972, 1973, and 1975 editions. In 1978, the sectional committee was reorganized as the Technical Committee on Airport Facilities and completed a revision to NFPA 409. The document underwent extensive editorial revision and partial technical revision in 1984 and was again revised in 1990 and 1995.

For the 2001 edition, the fire protection requirements for Group I hangars were extensively revised, and new criteria were added for membrane-covered rigid-steel-frame-structure hangars.

The 2004 edition of this standard was a partial revision.

The 2011 edition of this standard was also a partial revision. Criteria were added to clarify where sprinklers are required for smaller hangars such as those used by general aviation entities. Unenforceable terms were removed to comply with the *Manual of Style for NFPA Technical Committee Documents.*

For the 2016 edition, the committee re-examined many of the long-standing requirements with respect to current technologies, modern design practices, and known fire loss history. That fresh look resulted in the relaxation of the requirements for divided water reservoirs, redundant fire pumps, and reserve supplies of foam concentrate, among others. In addition, zoning of low-level foam systems is now permitted in Group I and Group II hangars, and Chapter 8 has been simplified for Group III hangars.

Contents

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2013 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems,* 2015 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection,* 2016 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 2016 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2014 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2015 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment,* 2011 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials,* 2015 edition.

NFPA 54, *National Fuel Gas Code,* 2015 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2014 edition.

NFPA 69, *Standard on Explosion Prevention Systems,* 2014 edition.

NFPA 70®, National Electrical Code®, 2014 edition.

NFPA 72®, National Fire Alarm and Signaling Code, 2016 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2016 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems,* 2015 edition.

NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems,* 2015 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids,* 2015 edition.

NFPA *101®, Life Safety Code®,* 2015 edition.

NFPA 220, *Standard on Types of Building Construction,* 2015 edition.

NFPA 410, *Standard on Aircraft Maintenance,* 2015 edition.

NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways,* 2016 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films,* 2015 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2014 edition.

2.3 Other Publications.

2.3.1 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM G155, *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials,* 2013.

2.3.2 *Merriam-Webster's Collegiate Dictionary,* 11th edition, Merriam-Webster Ave., Springfield, MA. 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2016 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* 2012 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems,* 2015 edition.

*NFPA 70®, National Electrical Code®,*2014 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* 2015 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

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

3.2.3* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.4 Shall. Indicates a mandatory requirement.

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

3.2.6 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Aircraft Access Door. Any opening through which any portion of the aircraft is passed to gain entry to the hangar.

3.3.2 Aircraft Hangar. A building or other structure inside any part of which aircraft are housed.

3.3.3* Aircraft Storage and Servicing Area. That part of a hangar normally used for the storage and servicing of one or more aircraft, not including any adjacent or contiguous areas or structures, such as shops, storage areas, and offices.

3.3.4 Calculation Method.

3.3.4.1 ***Demand Calculation Method.*** Hydraulic calculation procedure for determining the minimum theoretical flow and pressure required to produce a minimum specified total discharge from a specific configuration of piping and discharge devices.

4.1.4 Group IV Aircraft Hangar. A Group IV aircraft hangar shall be any structure constructed of a membrane-covered rigid-steel frame.

Chapter 5 Construction of Group I and Group II Aircraft Hangars

5.1 Types of Construction.

5.1.1* Group I hangars shall be either Type I or Type II construction in accordance with NFPA 220. Group II hangars shall be constructed of any of the types of construction specified in NFPA 220 or any combination thereof.

5.1.2* Mezzanines, tool rooms, and other enclosures within aircraft storage and servicing areas shall be constructed of noncombustible material or limited-combustible material as defined in NFPA 220 in all hangars except those of Type V (111) and (000) construction.

5.2 Internal Separations.

5.2.1* Where aircraft storage and servicing areas are subdivided into separate fire areas, the separation shall be by a fire barrier wall having not less than a 2-hour fire resistance rating. Any openings in such fire barrier walls communicating directly between two aircraft storage and servicing areas shall be provided with a listed 2-hour fire door or 2-hour shutter actuated from both sides of the wall. Where areas are of different heights, the tallest wall shall have a fire resistance rating of not less than 2 hours.

5.2.2 Where two or more aircraft storage and servicing areas constituting separate fire areas are separated by continuous offices, shops, and parts storage areas, one of the two walls between the aircraft storage and servicing areas and the offices, shops, and parts storage areas shall comply with 5.2.1. The other wall shall comply with 5.2.3.

5.2.3* Partitions and ceilings separating aircraft storage and servicing areas from all other areas, shops, offices, and parts storage areas shall have at least a 1-hour fire resistance rating with openings protected by listed fire doors or shutters having a minimum fire resistance rating of 45 minutes.

5.2.4 Where a storage and servicing area has an attached, adjoining, or contiguous structure, such as a lean-to, shop, office, or parts storage area, the wall common to both areas shall have at least a 1-hour fire resistance rating, with openings protected by listed fire doors having a minimum fire resistance rating of 45 minutes and actuated from both sides of the wall.

5.3 Clear Space Distance Requirements Around Hangars.

5.3.1 Precautions shall be taken to ensure ready access to hangars from all sides. Separation shall be provided to reduce fire exposure between buildings. The clear spaces specified in Table 5.3.1 shall not be used for the storage or parking of aircraft or concentrations of combustible materials, nor shall buildings of any type be erected therein.

5.3.2 For single hangar buildings, the clear space distances specified in Table 5.3.1 shall be maintained on all sides of the single hangar. Where mixed types of construction are involved, the less fire-resistant type of construction shall be used to determine the clear space required.

Table 5.3.1 Clear Space Distances for Single Hangar Buildings

Type of Construction	Minimum Separation Required	
	m	ft
Type I (443) and (332)	15	50
Type II (222)	15	50
Type II (111), Type III (211), and Type IV (2HH)	15	50
Type II (000)	15	50
Type III (200)	15	50
Type V (111) and (000)	23	75

5.3.2.1 Where both exposing walls and openings therein of adjacent single hangar buildings have a minimum fire resistance rating of at least 3 hours, no minimum separation distance shall be required.

5.3.2.2 Where the exposing wall and any openings therein of one hangar have a minimum fire resistance rating of at least 2 hours, the minimum separation distance shall be permitted to be reduced to not less than 7.5 m (25 ft) for single hangar buildings.

5.3.2.3* Where the exposing walls of both buildings have a minimum fire resistance rating of at least 2 hours, with all windows protected by listed glass in fixed steel sash having a minimum fire resistance rating of 45 minutes, with outside sprinkler protection and each doorway protected with one automatically operated listed fire door having a minimum fire resistance rating of 1½ hours, the clear space distance shall be permitted to be reduced to not less than 7.5 m (25 ft) between single hangar buildings. Under such conditions, the glass area in the exposing walls shall be not more than 25 percent of the wall area.

5.4 Floors.

5.4.1 The surface of the grade floor of aircraft storage and servicing areas, regardless of type of hangar construction, shall be noncombustible and above the grade of the approach or apron at the entrance to the hangar.

5.4.2* The floors of adjoining areas that pose flammable or combustible liquid spill hazards and that connect with aircraft storage and servicing areas shall be noncombustible and shall be designed to prevent a spill from entering the aircraft storage and servicing area.

5.4.3 Floor openings in multistoried sections of hangars shall be enclosed with partitions or protected with construction having a fire resistance rating not less than that required for the floor construction where the opening is made.

5.5 Roofs.

5.5.1* Roof coverings shall be of an approved type of tile, slate, metal, or asphalt shingle or of built-up roofing finished with asphalt, slate, gravel, or other approved material. Roof coverings shall be listed as Class A or Class B.

5.5.2 Where insulated metal deck assemblies are used, they shall meet or exceed FM Class 1 or UL Fire Classified ratings.

5.5.3* Spaces under roofs, created where suspended ceilings are provided in aircraft storage and servicing areas, shall be cut

5.11.1.3 In establishing locations for nearby aircraft parking, consideration shall be given to the drainage pattern of the apron.

5.11.2 Hangar Floor Trench Drainage.

5.11.2.1 In aircraft storage and servicing areas of hangars, floor trench drainage in accordance with 5.11.2.2 through 5.11.2.12 shall be provided.

5.11.2.2* Floor trench drainage systems shall be provided to restrict the spread of fuel in order to reduce the fire and explosion hazards from fuel spillage.

5.11.2.3 Trench drainage systems shall be designed to reduce fire and explosion hazards within the systems to the maximum extent by the use of noncombustible underground piping and by routing trench drainage as directly as possible to a safe outside location. Such systems shall be designed with traps or be provided with ventilation to prevent vapor mixtures from forming within the underground trench drainage system.

5.11.2.4 Trench drainage systems in aircraft storage or servicing areas shall be designed and constructed so that they have a capacity large enough to prevent buildup of flammable liquids and water over the drain inlet when all fire protection systems and hose streams are discharging at the design rate.

5.11.2.5 The pitch of the floor shall be a minimum of 0.5 percent. The floor pitch provided shall be calculated, taking into consideration the towing requirements of the aircraft and the factors of aircraft weight, balance checking, and maintenance.

5.11.2.6 Each trench drainage system shall be calculated separately, taking into consideration the maximum rated discharge based on the supply calculation method for the fire protection systems and hose lines.

5.11.2.7 The size of trench drainage piping shall be determined by the hydraulic demands placed on the system throughout its length.

5.11.2.8 Curbs, ramps, or drains shall be provided at all openings from aircraft storage and servicing areas, or the slope of the floor shall be such so as to prevent the flow of liquids through openings.

5.11.2.9 Pits for service facilities, such as for compressed air, electrical outlets, and so forth, shall drain into the floor trench drainage system.

5.11.2.10 Oil separators shall be provided for the trench drainage systems serving all aircraft storage and servicing areas. These separators shall be permitted to serve each hangar trench drainage system or a group of hangar trench drainage systems or be installed as part of a general airport trench drainage system.

5.11.2.11 In aircraft storage and servicing areas protected by water sprinkler systems or foam-water systems, a bypass shall be provided around the separator to allow for emergency direct disposal of water and flammable liquids. Separator systems shall discharge flammable liquid products to a tank, cistern, or sump located away from any exposures.

5.11.2.12 Grates and drain covers shall support the point loading of the heaviest type aircraft or equipment to be housed in the hangar. Grates and covers shall be removable to facilitate cleaning and flushing.

5.12 Heating and Ventilating.

5.12.1* Heating, ventilating, and air-conditioning equipment shall be installed, as applicable, in accordance with NFPA 90A, NFPA 31, NFPA 54, NFPA 90B, and NFPA 58.

5.12.2 In aircraft storage and servicing areas, no heating, ventilating, and air-conditioning equipment employing an open flame or glowing element shall be installed, other than as provided for in 5.12.5.

5.12.3 In aircraft storage and servicing areas, hangar heating plants that are fired with gas, liquid, or solid fuels not covered under 5.12.5 and that are not located in a detached building shall be located in a room separated from other parts of the hangar by construction having at least a 1-hour fire resistance rating.

5.12.3.1 This separated room shall not be used for any other hazardous purpose or combustible storage and shall have no direct access from the aircraft storage or servicing area.

5.12.3.2 Openings in the walls of such rooms communicating with other portions of the hangar shall be restricted to those necessary for ducts or pipes.

5.12.3.3 Penetrations of the 1-hour fire resistance–rated enclosure shall be firestopped with an approved material installed and capable of maintaining the required fire resistance rating for the enclosure.

5.12.3.4 Each such duct shall be protected with a listed automatic fire damper or door.

5.12.3.5 All air for combustion purposes entering such separated rooms shall be drawn from outside the building.

5.12.4* In aircraft storage and servicing areas, heating, ventilating, and air-conditioning systems employing recirculation of air within aircraft storage and servicing areas shall have return air openings not less than 3 m (10 ft) above the floor. Supply air openings shall not be installed in the floor and shall be at least 152 mm (6 in.) from the floor measured to the bottom of the opening.

5.12.4.1 Where automatic fire protection systems are installed in aircraft storage and servicing areas, fans for furnace heating systems shall be arranged to shut down automatically by means of the operation of the interior automatic fire protection system.

5.12.4.1.1 One or more manual fan shutoff switches shall be provided.

5.12.4.1.2 Shutoff switches shall be accessible and clearly placarded.

5.12.5 Suspended or Elevated Heaters.

5.12.5.1 In aircraft storage and servicing areas, listed electric, gas, or oil heaters shall be permitted to be used if installed as specified in 5.12.5.2 through 5.12.5.4.

5.12.5.2 In aircraft storage and servicing areas, heaters shall be installed at least 3 m (10 ft) above the upper surface of wings or of the engine enclosures of the highest aircraft that are capable of being housed in the hangar. The measurement shall be made from the wing or engine enclosure, whichever is higher from the floor, to the bottom of the heater.

6.1.6 Additional protection, as specified in 6.2.9 and Sections 6.3 and 6.4, shall be provided in all Group I aircraft hangars in addition to other protection systems required by this chapter.

6.1.7 Each foam protection system shall be designed, installed, and maintained in accordance with NFPA 11.

6.1.8 Foam solution piping shall be permitted to be any ferrous material meeting the requirements of NFPA 13.

6.2 Fire Protection Systems.

6.2.1 Plans and Specifications.

6.2.1.1* Before systems are installed, complete specifications and working plans shall be drawn to scale showing all essential details, and plans shall be easily reproducible to provide necessary copies.

6.2.1.2 Information supplied in these plans and specifications shall be in accordance with NFPA 13 and shall include the following:

(1) Design purpose of the systems
(2) Discharge densities and the period of discharge
(3) Hydraulic calculations
(4) Details of tests of the available water supply
(5) Details of proposed water supplies
(6) Detailed layout of the piping and of the detection systems
(7) Make and type of discharge devices, operating equipment, and foam concentrate to be installed
(8) Location and spacing of discharge devices
(9) Pipe hanger and bracing location and installation details
(10) Location of draft curtains
(11) Accurate and complete layout of the area to be protected, including drainage layout
(12) Details of any foam concentrate, its storage and injection, and other pertinent data to provide a clear explanation of the proposed design
(13) Location and spacing of supplementary or low-level agent distributors, showing the area of coverage
(14) Installation layout of the actuation systems
(15) Detailed layout of water supply piping, agent storage, pumping and piping, power sources, and location and details of mechanical foam–liquid concentrate injection equipment

6.2.2 Deluge Foam-Water Sprinkler System Design and Performance.

6.2.2.1 In aircraft storage and servicing areas, each sprinkler system shall be designed in accordance with NFPA 13 and NFPA 16, as applicable, and in accordance with this chapter.

6.2.2.2* In aircraft storage and servicing areas, the maximum projected floor area under an individual deluge system shall not exceed 1394 m^2 (15,000 ft^2).

6.2.2.3 In aircraft storage and servicing areas, the protection area as projected on the floor shall be limited to 12 m^2 (130 ft^2). The maximum distance between sprinklers either on branch lines or between branch lines shall be 3.7 m (12 ft). In buildings with storage bays 7.6 m (25 ft) wide, a distance of 3.8 m (12 ft 6 in.) shall be permitted.

6.2.2.4 System piping shall be hydraulically designed using two separate calculation methods.

6.2.2.4.1 The demand calculation method shall be performed to determine the adequacy of the water supply.

6.2.2.4.2 The supply calculation method shall be performed to determine the amount of foam concentrate required.

6.2.2.4.3 Where steel pipe is installed, the coefficient C in the Hazen–Williams formula shall be taken as 120 in the calculations.

6.2.2.5 In other portions of hangars protected by sprinklers, the spacing shall be in accordance with the hazard requirements of the areas involved.

6.2.2.6 Uniform sprinkler discharge shall be based on a maximum variation of 15 percent between the sprinkler providing the lowest density and the sprinkler providing the greatest density within an individual deluge system as specified in 6.2.2.12 or 6.2.2.13.

6.2.2.6.1 Local application protection for columns shall not be required to comply with the maximum variation of 15 percent.

6.2.2.6.2 Variation below the required density shall not be permitted.

6.2.2.6.3 Orifice plates, sprinklers of different orifice sizes, piping of less than 25.4 mm (1 in.) diameter, or multiple fittings installed between a branch line fitting and an individual sprinkler for the sole purpose of increasing pressure loss shall not be permitted as a means to limit discharge.

6.2.2.7* Where open hangar doors result in interference with the distribution of overhead systems, additional devices shall be provided to ensure required floor coverage.

6.2.2.8 Foam-water deluge systems discharge devices shall be either air-aspirating or non-air-aspirating and shall have deflectors designed to produce water discharge patterns closely comparable to those of spray sprinklers as defined in NFPA 13 when discharging at the same rates of flow.

6.2.2.9 The discharge devices shall generate foam where supplied with the foam solution under pressure and shall distribute the foam in a pattern essentially equal to that of water discharging therefrom.

6.2.2.10 The discharge devices shall have a minimum nominal 6.4 mm (¼ in.) orifice and shall be listed for use with the particular type of foam concentrate to be used in the system.

6.2.2.11 Strainers shall be installed in accordance with NFPA 16.

6.2.2.12 The discharge density from air-aspirating discharge devices using protein foam, fluoroprotein foam, or aqueous film-forming foam (AFFF) solutions shall be a minimum of 8.1 L/min/m^2 (0.20 gpm/ft^2) of floor area.

6.2.2.13 The discharge density from non-air-aspirating discharge devices using AFFF solution shall be a minimum of 6.5 L/min/m^2 (0.16 gpm/ft^2) of floor area.

6.2.3 Supplementary Protection Systems.

6.2.3.1* Hangars protected in accordance with 6.1.1(1) and housing aircraft having wing areas in excess of 279 m^2 (3000 ft^2) shall be protected with a listed supplementary protection system.

6.2.5.3.2* The discharge rate of the system shall be based on the rate of application multiplied by the entire aircraft storage and servicing floor area.

6.2.5.3.3 The foam system shall use low-level discharge nozzles. Where monitor nozzles are used, they shall be provided with individual manual shutoff valves for each nozzle. The discharge nozzles shall be arranged to achieve initial foam coverage in the expected aircraft parking area.

6.2.5.3.4* Nozzles shall be located and installed so that aircraft positioning and workstand placement will not necessitate removal or repositioning of nozzles. All nozzle settings shall be marked and permanently secured in position after installation and acceptance testing.

6.2.5.3.5 Electric power reliability for oscillating nozzles shall be in accordance with electric fire pump requirements of NFPA 20.

6.2.5.4 Low-Level High-Expansion Foam Systems.

6.2.5.4.1 Low-level high-expansion foam systems shall be designed and installed in accordance with requirements for local application systems of NFPA 11.

6.2.5.4.2 The application rate shall be a minimum of 0.9 $m^3/min/m^2$ (3 $ft^3/min/ft^2$).

6.2.5.4.3 The discharge rate of the system shall be based on the application rate multiplied by the entire aircraft storage and servicing floor area. The application total discharge rate shall include the sprinkler breakdown factor in accordance with NFPA 11.

6.2.5.4.4 The high-expansion foam generators shall be arranged to achieve initial foam coverage in the expected aircraft parking area.

6.2.5.4.5 Foam generators shall be supplied with air from outside the aircraft storage and servicing area. Roof vents shall be located to avoid recirculation of combustion products into the air inlets of the foam generators.

6.2.5.4.6* Foam generators shall be powered by reliable water-driven or electric motors. Electric power reliability for foam generators shall be consistent with electric fire pump requirements specified in Chapters 6 and 7 of NFPA 20.

6.2.6* Foam Concentrate Supply. The friction losses in piping carrying foam concentrate shall be calculated using the Darcy formula, also known as the Fanning formula.

6.2.6.1* The quantities of low-expansion foam concentrate, either protein foam, fluoroprotein, or AFFF, shall be large enough for a 10-minute foam discharge based on the supply calculation in 6.2.2.4.

6.2.6.2* The quantity of high-expansion foam concentrate shall be large enough for a 12-minute discharge at the water flow rate based on the supply calculation method required in 6.2.2.4.

6.2.6.3 A reserve supply of foam concentrate shall be provided in accordance with 4.3.2.5.2 of NFPA 11.

6.2.6.4 Control valves, foam concentrate liquid storage tanks, concentrate pumps, controllers, and bypass balancing equipment shall be located outside the aircraft storage and service area.

6.2.7 Foam Concentrate Pumps.

6.2.7.1 Foam concentrate pump installations shall comply with the applicable provisions of NFPA 20, except as modified by this standard.

6.2.7.2* Where foam concentrate is introduced into the water stream by pumping, the total foam concentrate pumping capacity shall be such that the maximum flows and pressures are met with the largest foam concentrate pump out of service. The reserve pump(s) shall be arranged to operate only upon failure of the primary pump(s).

6.2.7.3 Where a connected foam concentrate reserve is provided, piping shall be arranged so that maximum foam concentrate demand shall be supplied by any foam concentrate pump from either primary or reserve foam concentrate tanks.

6.2.7.4 Foam concentrate pumps shall be provided with means of pressure relief from the pump discharge to prevent excessive pressure and temperature. Discharge from the relief valve shall be piped back to the foam concentrate storage tank. Connection to the suction piping shall not be permitted.

6.2.7.5 The pressure regulating valve shall not be used as the pressure relief valve.

6.2.7.6 Foam concentrate pumps shall be started automatically by either a pressure drop in the foam concentrate piping system or a signal from the detection system control panel.

6.2.7.7 A pressure maintenance pump shall be provided to maintain pressure in the foam concentrate piping system where foam concentrate lines to the protective system injection points are run underground or where they run aboveground for more than 15 m (50 ft).

6.2.7.8 Once started, foam concentrate pumps shall be arranged to run continuously until stopped manually. There shall be an audible "pump running" alarm in a constantly attended location.

6.2.7.9 Power supply for the drivers of foam concentrate pumps shall be installed in accordance with NFPA 20 and *NFPA 70*. Power supplies shall be arranged such that disconnecting power to the protected facility during a fire shall not disconnect the power supply to the foam concentrate pump feeder circuit.

6.2.7.10 Controllers for foam concentrate pumps shall be as follows:

(1) For electric-drive foam concentrate pumps, a listed full-service electric foam pump controller shall be used.
(2) For diesel engine–driven foam concentrate pumps, a listed fire pump controller shall be used.

6.2.8 Detection and Actuation System Design.

6.2.8.1 General.

6.2.8.1.1 Actuation systems shall be provided with complete circuit supervision and shall be arranged in accordance with Section 6.4.

6.2.8.1.2 These detectors shall be installed in accordance with *NFPA 72*.

6.2.8.1.3 Detection systems shall be provided with supervision as required by *NFPA 72*.

protection systems shall have a minimum duration of 45 minutes.

6.2.10.5 Hand Hose Systems. The water supply for hand hose systems shall be capable of satisfying the requirements of 6.2.9 of this standard. The demand shall be calculated at the point where supply piping for the hand hose systems connects to the system piping or fire protection underground.

6.2.10.6 Exterior Hose Streams. Where the water supply for the systems also serves as a supply for exterior hose streams, a hose stream allowance of 1893 L/min (500 gpm) shall be included in the water supply hydraulic calculations. Calculations for hose stream shall be in accordance with NFPA 13.

6.2.10.7 Fire Pumps.

6.2.10.7.1 Fire pumps shall be installed in accordance with NFPA 20 and in accordance with the provisions of 6.2.10.7.2 through 6.2.10.7.7.

6.2.10.7.2 The total pumping capacity shall be provided using fire pumps of equal capacity.

6.2.10.7.3 No fewer than two fire pumps shall be provided.

6.2.10.7.4 Pump houses and rooms shall be of fire-resistive or noncombustible construction. Where internal combustion engines used for driving fire pumps are located inside the fire pump house or room, protection shall be provided by automatic sprinklers installed in accordance with NFPA 13.

6.2.10.7.5* Fire pumps shall be started automatically by either a drop in water pressure or a signal from the detection control panel. Where two or more fire pumps are used, they shall be provided with automatic sequential starting.

6.2.10.7.6 Where pressure is used as the starting sequence for fire pumps, a small auxiliary pressure maintenance pump or other suitable means to maintain normal system pressures shall be provided.

6.2.10.7.7 Once started, fire pumps shall be arranged to run continuously until they are stopped manually. There shall be an audible "pump running" alarm in a constantly attended area.

6.2.10.8* Flushing Underground Pipe. Underground mains and each lead-in connection shall be flushed as specified in NFPA 24.

6.2.11 Acceptance Tests. The following tests shall be performed prior to final acceptance of any fire protection system in an aircraft hangar.

6.2.11.1 Hydrostatic pressure tests shall be conducted on each system as specified in NFPA 11, NFPA 13, NFPA 14, or NFPA 16, as applicable.

6.2.11.2 All devices and equipment installed as part of the system shall be tested.

6.2.11.3 Full-flowing tests with water only shall be made on each foam-water deluge system as a means of checking the sprinkler distribution and to ensure against clogging of piping and sprinklers by foreign matter carried by the water. The maximum number of systems that are designed to operate in case of fire, including supplementary systems, shall be in full operation simultaneously to provide a check on the adequacy and condition of the water supply. Suitable gauge connections and gauges shall be provided to verify hydraulic calculations.

6.2.11.4 The smallest single foam-water deluge system shall be discharged using foam concentrate or a listed or approved alternative test method (*see NFPA 11*). This test shall be run for a length of time to stabilize discharge before test samples are taken to determine the proportioning rate.

6.2.11.5 The maximum number of systems expected to operate shall be simultaneously discharged with foam or a listed or approved alternative test method (*see NFPA 11*). This test shall be run for a length of time to stabilize discharge before test samples are taken to determine the proportioning rate.

6.2.11.6 Any proportioner not tested under the requirements of 6.2.11.4 or 6.2.11.5 shall be individually tested with foam concentrate or a listed or approved alternative test method (*see NFPA 11*) to determine the proportioning rate.

6.2.11.7 Supplementary and low-level protection systems shall be subjected to foam flow tests with foam, or a listed or approved alternative test method (*see NFPA 11*), flowing simultaneously from the maximum number of sprinkler systems expected to operate, to ensure that the hazard is protected in conformance with the design specification and to determine whether the flow pressures, agent discharge capacity, foam coverage, proportioning rate, and other operating characteristics are satisfactory.

6.2.11.7.1 Where separate proportioning systems are utilized for the foam-water deluge sprinklers and the supplementary protection systems, water only shall be permitted to be flowed in the foam-water deluge sprinkler systems simultaneously with foam or a listed or approved alternative test method (*see NFPA 11*) in the supplementary protection system.

6.2.11.8 Supplementary and low-level protection systems shall be examined visually to determine that they have been installed correctly. Checks shall be made for such items in conformity with installation plans, continuity of piping, tightness of fittings, removal of temporary blank flanges, and accessibility of valves and controls. Devices shall be identified and operating instructions prominently posted.

6.2.11.9* The timing of the foam system discharge shall be measured beginning at the time of system actuation.

6.2.12 Final Approval. The installing company shall furnish a written statement that the work has been completed in accordance with 6.2.1 and tested in accordance with the provisions of 6.2.11.

6.2.13 Conversion of Existing Systems. In converting one type of system to another, all provisions of this chapter pertaining to new systems shall apply.

6.2.13.1 If water supplies are greater than necessary, the uniform discharge requirement of 6.2.2.6 shall be permitted to be waived if the required minimum discharge rate is available in all areas.

6.2.13.2 Where existing systems are designed with a discharge density higher than the minimum required discharge density [6.5 L/min/m^2 (0.16 gpm/ft^2)], a proportionate reduction in the time of discharge shall be permitted but shall not be less than 7 minutes.

6.2.13.3 Converted systems shall be tested in accordance with 6.2.11.

7.3.3.5 The pressure-regulating valve shall not be used as the pressure relief valve. Foam concentrate pumps shall be started automatically by either a pressure drop in the foam concentrate piping system or a signal from the detection system control panel.

7.3.3.6 A pressure maintenance pump shall be provided to maintain pressure in the foam concentrate piping system where foam concentrate lines to the protective system injection points are run underground or where they run aboveground for more than 15 m (50 ft).

7.3.3.7 Once started, foam concentrate pumps shall be arranged to run continuously until stopped manually. There shall be an audible "pump running" alarm in a constantly attended location.

7.3.3.8 Power supply for the drivers of foam concentrate pumps shall be installed in accordance with NFPA 20 and *NFPA 70*. Power supplies shall be arranged such that disconnecting power to the protected facility during a fire shall not disconnect the power supply to the foam concentrate pump feeder circuit.

7.3.3.9 Controllers for foam concentrate pumps shall be as follows:

(1) For electric-drive foam concentrate pumps, a listed full-service fire pump controller shall be used.
(2) For diesel engine–drive foam concentrate pumps, a listed fire pump controller shall be used.

7.3.4 The control valves, foam–liquid concentrate storage, injection system, and foam concentrate pump shall be located outside aircraft storage and servicing areas.

7.3.5 Plans and specifications for closed-head foam-water sprinkler systems shall provide the information required by 6.2.1 of this standard and NFPA 16. Plans and specifications for other foam extinguishing systems shall provide the information required by 6.2.1.

7.3.6 Acceptance Tests.

7.3.6.1 Acceptance tests for closed-head foam-water sprinkler systems shall be performed in accordance with NFPA 16.

7.3.6.2 Acceptance tests for foam extinguishing systems shall be performed in accordance with 6.2.11.1, 6.2.11.2, 6.2.11.6, and 6.2.11.8.

7.3.6.2.1 The maximum number of discharge devices expected to operate shall be subjected to flow tests using foam concentrate, or a listed or approved alternative test method (see *NFPA 11*), to ensure that the hangar is protected in conformance with the design specifications and to determine if the flow pressures, agent discharge capacity, foam coverage, and proportioning rate are satisfactory.

7.3.6.2.1.1 A flow test shall be performed with only the foam system operating.

7.3.6.2.1.2 A flow test shall be performed with the foam system operating at the design pressure with the sprinkler system and hose demand.

7.3.6.3* The timing of foam system discharge shall be measured beginning at the time of system actuation.

7.3.7 The installing company shall furnish a written statement to the effect that the work has been completed in accordance with approved plans and specifications and tested in accordance with the provisions of 7.3.6.

7.4* Low-Expansion Foam System.

7.4.1 The minimum application rate of foam solution shall be 6.5 $L/min/m^2$ (0.16 gpm/ft^2) where protein-based or fluoroprotein-based concentrate is used. Where AFFF concentrate is used, the minimum application rate of foam solution shall be 4.1 $L/min/m^2$ (0.10 gpm/ft^2).

7.4.2* The discharge rate of the system shall be based on the rate of application multiplied by the entire aircraft storage and servicing floor area.

7.4.3 The foam system shall use low-level discharge nozzles. Where monitor nozzles are used, they shall be provided with individual manual shutoff valves for each nozzle. The discharge nozzles shall be arranged to achieve initial foam coverage in the expected aircraft parking area.

7.4.4* The quantity of foam concentrate shall be calculated for a 10-minute discharge at the water flow rate based on the supply calculation method.

7.4.5 The low-level foam system shall be designed to achieve distribution of foam over the entire aircraft storage and service area. The design objective shall be to achieve coverage of the entire aircraft storage and servicing area to within 1.5 m (5 ft) of the perimeter walls and doors within 3 minutes of system actuation.

7.5 High-Expansion Foam System.

7.5.1 The high-expansion foam generators shall be arranged to achieve initial foam coverage in the anticipated aircraft parking area.

7.5.2 The application rate shall be a minimum of 0.9 $m^3/min/m^2$ (3 $ft^3/min / ft^2$).

7.5.3 The discharge rate of the system shall be based on the application rate multiplied by the entire aircraft storage and servicing floor area. The application total discharge rate shall include the sprinkler breakdown factor specified in 6.12.8.2.3.2 of NFPA 11.

7.5.4 Foam generators shall be supplied with air from outside the aircraft storage and servicing area. Roof vents shall be located to avoid recirculation of combustion products into the air inlets of the foam generators.

7.5.5 Foam generators shall be powered by reliable water-driven or electric motors. Electric power reliability for both foam generators and foam concentrate pumps shall be consistent with electric fire pump requirements specified in Chapters 6 and 7 of NFPA 20.

7.5.6 The quantity of foam concentrate shall be calculated to operate the system at the required discharge rate as determined in 7.5.3 for a period of at least 12 minutes.

7.5.7 The low-level foam system shall be designed to achieve distribution of foam over the entire aircraft storage and service area. The design objective shall be to achieve coverage of the entire aircraft storage and servicing area to within 1.5 m (5 ft) of the perimeter walls and doors within 3 minutes of system actuation.

8.1.7* Roof coverings shall be listed as Class C or better.

8.1.8 Exposed interior insulation attached to walls and roofs in an aircraft storage or servicing area of a hangar shall comply with the special provisions for aircraft storage hangars, interior wall and ceiling finish criteria of NFPA *101*.

8.2 Separation and Internal Subdivisions.

8.2.1 For single hangar buildings, the clear-space distances specified in Table 8.2.1 shall be maintained on all sides of the single hangar. Where mixed types of construction are involved, the least fire-resistant type of construction shall be used to determine the clear space required.

8.2.1.1 Where single hangar buildings adjoin, each one has fire barrier walls with a minimum rating of at least 2 hours, and each one is located so that fire areas shall not exceed the maximum areas specified in Table 4.1.3, no minimum separation distance shall be required.

8.2.2 Partitions and ceilings separating aircraft storage and servicing areas from other areas, such as shops, offices, and parts storage areas, shall have at least a 1-hour fire resistance rating with openings protected by listed fire doors having a fire resistance rating of at least 45 minutes.

8.3 Heating and Ventilating.

8.3.1 Heating, ventilation, and air-conditioning equipment shall be installed, as applicable, in accordance with NFPA 90A, NFPA 31, and NFPA 54, except as hereinafter specifically provided.

8.3.2 No heating, ventilation, and air-conditioning equipment employing an open flame or glowing element shall be installed in aircraft storage and servicing areas or sections communicating therewith, except as provided for in 8.3.5.

8.3.3 Hangar heating plants that are fired with gas, liquid, or solid fuels not covered under 8.3.5, and that are not located in a detached building shall be located in a room separated from other parts of the hangar by construction having at least a 1-hour fire resistance rating.

8.3.3.1 This separated room shall not be used for any other hazardous purpose or combustible storage and shall have no direct access from the aircraft storage or servicing area.

8.3.3.2 Openings in the walls of such rooms communicating with other portions of the hangar shall be restricted to those necessary for ducts or pipes.

Table 8.2.1 Clear-Space Distances for Single Hangar Buildings

Type of Construction	Minimum Separation Required	
	m	ft
Type I (443) and (332)	15	50
Type II (222)	15	50
Type II (111), Type III (211), and Type IV (2HH)	15	50
Type II (000)	15	50
Type III (200)	15	50
Type V (111) and (000)	23	75

8.3.3.3 Penetrations of the 1-hour fire resistance–rated enclosure shall be firestopped with an approved material installed and capable of maintaining the required fire resistance rating for the enclosure.

8.3.3.4 Each such duct shall be protected with a listed automatic fire damper or door.

8.3.3.5 All air for combustion purposes entering such separated rooms shall be drawn from outside the building.

8.3.4* Heating, ventilating, and air-conditioning plants employing recirculation of air within aircraft storage and servicing areas shall have return air openings not less than 3 m (10 ft) above the floor. Supply air openings shall not be installed in the floor and shall be at least 152 mm (6 in.) from the floor measured to the bottom of the opening.

8.3.4.1 Where automatic fire protection systems are installed in aircraft storage and servicing areas, fans for furnace heating systems shall be arranged to shut down automatically by operation of the interior automatic fire protection system. One or more manual fan shutoff switches shall be provided. Shutoff switches shall be accessible and clearly placarded.

8.3.5 Suspended or Elevated Heaters.

8.3.5.1 Listed electric, gas, or oil heaters shall be permitted to be used if installed as specified in 8.3.5.2 through 8.3.5.4.

8.3.5.2 In aircraft storage and servicing areas, heaters shall be installed at least 3 m (10 ft) above the upper surface of wings or the upper surface of the engine enclosures of the highest aircraft that can be housed in the hangar. The measurement shall be made from the wing or engine enclosure, whichever is higher from the floor, to the bottom of the heater.

8.3.5.3 In shops, offices, and other sections of aircraft hangars communicating with aircraft storage or servicing areas, the bottom of the heaters shall be installed not less than 2.4 m (8 ft) above the floor.

8.3.5.4 Suspended or elevated heaters shall be located in all spaces of aircraft hangars so that they shall not be subject to injury by aircraft, cranes, movable scaffolding, or other objects. Provision shall be made to ensure accessibility to suspended heaters for recurrent maintenance purposes.

8.3.6 Where a mechanical ventilating system is employed in hangars or shops, the ventilating system shall be installed in accordance with NFPA 90A and in accordance with the applicable provisions of Section 8.3.

8.3.7 Where blower and exhaust systems are installed for vapor removal, the systems shall be installed in accordance with NFPA 91.

8.4 Lighting and Electrical Systems.

8.4.1 Artificial lighting shall be restricted to electric lighting.

8.4.2* Electrical services shall be installed in compliance with the provisions for aircraft hangars contained in Article 513 of *NFPA 70*.

8.5 Lightning Protection. Where provided, lightning protection shall be installed in accordance with NFPA 780.

9.3 Clear Space Distance Around Hangars. Precautions shall be taken to ensure ready access to membrane-covered rigid-steel-frame-structure hangars from all sides. Separation shall be provided to reduce fire exposure between buildings. The minimum separation shall be 23 m (75 ft).

9.4 Aprons and Floors.

9.4.1 The surface of the grade floor of aircraft storage and servicing areas shall be noncombustible and above the grade of the approach or apron at the entrance to the hangar.

9.4.2 Hangar aprons shall slope away from the level of the hangar floors to prevent liquid on the apron surfaces from flowing into the hangars.

9.5 Doors.

9.5.1 In membrane-covered rigid-steel-frame-structure hangars with a hangar fire area greater than 1115 m^2 (12,000 ft^2), hangar doors that accommodate aircraft shall be of noncombustible or limited-combustible construction.

9.5.2 The power source for hangar doors shall operate on independent circuits and shall not be de-energized when the main disconnect switches for general hangar power are shut off.

9.5.3 Vertical traveling doors shall be counterbalanced, and horizontal slide or accordion-type doors shall be arranged so that manual or auxiliary operation by means of winches or tractors, for example, is feasible.

9.5.4* In an area where freezing temperatures can occur, door tracks of the bottom edges of doors shall be protected by heating coils or equivalent means to prevent ice formation that might prevent or delay operation.

9.6 Curtains. Where curtains are used to enclose a work area, they shall be of a listed flame-retardant type.

9.7 Landing Gear Pits, Ducts, and Tunnels.

9.7.1 Landing gear pits, ducts, and tunnels that are located below floor level in membrane-covered rigid-steel-frame-structure hangars shall be designed on the premise that flammable liquids and vapors will be present at all times. Materials and equipment shall be impervious to liquids and shall be fire resistant or noncombustible.

9.7.2 Electrical equipment for all landing gear pits, ducts, and tunnels that are located below hangar floor level shall be approved for use in Class I, Division 1, Group D hazardous locations in compliance with Article 501 of *NFPA 70.*

9.7.3 All landing gear pits, ducts, and tunnels that are located below hangar floor level shall be provided with a positive mechanical exhaust ventilation system capable of providing a minimum rate of five air changes per hour during regular operations and be designed to discharge externally to the hangar.

9.7.4 Upon the detection of flammable vapors, the ventilation system shall be capable of providing a minimum ventilation rate of 30 air changes per hour for the landing gear pit and all associated ducts or tunnels.

9.7.5 The ventilation system shall be controlled by an approved continuous-reading combustible gas–analyzing system that is arranged to operate the ventilation system at the rate specified in 9.7.4 automatically upon detection of a specified flammable vapor concentration that is below the lower flammable limit (LFL). The detection system shall have sensors located throughout all ducts and tunnels.

9.7.6 Because entry of fuel, oil, and water into landing gear pits is inevitable, drainage or pumping facilities shall be provided. Water-trapped vapor seals and separator fuel traps shall be provided. Where automatic pumping facilities are necessary, they shall be approved for use with aviation fuel and water. The drainage shall be fully enclosed pipe runs if drainage is routed through ventilation or access tunnels to external discharge points.

9.7.7 Explosion protection shall be provided in landing gear pits and communicating ducts and tunnel areas in the form of pressure relief venting or by a listed explosion prevention system installed in accordance with NFPA 69.

9.7.8 An approved fire protection system shall be installed to protect each pit unless the hangar fire protection required by Section 9.14 is designed to protect each pit.

9.8 Exposed Interior Insulation. Exposed interior insulation attached to walls and roofs in the aircraft storage and servicing area of a hangar shall comply with the requirements of the special provisions for aircraft storage hangars, interior wall and ceiling finish criteria of NFPA *101.*

9.9 Drainage of Aprons and Hangar Floors. The drainage of aprons and hangar floors of hangars with a hangar fire area greater than 1115 m^2 (12,000 ft^2) shall be as specified in Section 5.11.

9.10 Heating and Ventilating. Heating, ventilating, and air-conditioning equipment of membrane-covered rigid-steel-frame-structure hangars shall be installed, as applicable, in accordance with Section 5.12.

9.11 Lighting and Electrical Systems.

9.11.1 Artificial lighting shall be restricted to electric lighting.

9.11.2 Electrical services shall be installed in compliance with the provisions for aircraft hangars contained in Article 513 of *NFPA 70.*

9.11.3 In hangars with aircraft storage and servicing areas greater than 1115 m^2 (12,000 ft^2), housing other than unfueled aircraft, main distribution panels, metering equipment, and other electrical equipment shall be located in a room separated from the aircraft storage and servicing area by a partition having at least a 1-hour fire resistance rating. The partition shall not be penetrated except by electrical raceways, which shall be protected by approved sealing methods maintaining the same fire resistance rating as the partition.

9.12 Grounding Facilities for Static Electricity.

9.12.1 Membrane-covered rigid-steel-frame-structure hangars housing other than unfilled aircraft shall be provided with grounding facilities for the removal and control of static electrical accumulations on aircraft while aircraft are stored or undergoing servicing in a hangar.

9.12.2 Floor-grounding receptacles shall be provided. The receptacles shall be either grounded through individual driven electrodes or electrically bonded together in a grid system and the entire system grounded to underground metal piping, such as cold water piping, or driven electrodes. Where driven electrodes are used, they shall consist of 15.9 mm (⅝ in.) diameter

9.14.7 Low-Level Foam Protection Systems.

9.14.7.1 Hangars protected in accordance with 6.1.1(1) or 6.1.1(2) shall be protected with a listed low-level foam protection system.

9.14.7.2 Each low-level foam protection system shall be designed, installed, and maintained in accordance with NFPA 11.

9.14.7.3 The low-level foam system shall be designed to achieve distribution of foam over the entire aircraft storage and servicing area. The design objective shall be to achieve coverage of the entire aircraft storage and servicing area within 3 minutes of system actuation.

9.14.7.4 Low-Level Low-Expansion Foam Systems. Foam systems shall be of the fixed type and shall be designed and installed in accordance with the requirements for fixed-type systems in NFPA 11.

9.14.7.4.1 Where AFFF concentrate is used, the minimum application rate of foam solution shall be 4.1 L/min/m^2 (0.10 gpm/ft^2). The minimum application rate of foam solution shall be 6.5 L/min/m^2 (0.16 gpm/ft^2) where protein-based or fluoroprotein-based concentrate is used.

9.14.7.4.2* The discharge rate of the system shall be based on the rate of application multiplied by the entire aircraft storage and servicing floor area.

9.14.7.4.3 The foam system shall use low-level discharge nozzles. Where monitor nozzles are used, they shall be provided with individual manual shutoff valves for each nozzle. The discharge nozzles shall be arranged to achieve initial foam coverage in the expected aircraft parking area.

9.14.7.4.4 Nozzles shall be located and installed so that aircraft positioning and workstand placement will not necessitate removal or repositioning of nozzles. All nozzle settings shall be marked and permanently secured in position after installation and acceptance testing.

9.14.7.4.5 Electric power reliability for oscillating nozzles shall be in accordance with electric fire pump requirements of NFPA 20.

9.14.7.5 Low-Level High-Expansion Foam Systems.

9.14.7.5.1 Low-level high-expansion foam systems shall be designed and installed in accordance with the requirements for local application systems of NFPA 11.

9.14.7.5.2 The application rate shall be a minimum of 0.9 m^3/min/m^2 (3 ft^3/min/ft^2).

9.14.7.5.3 The discharge rate of the system shall be based on the application rate multiplied by the entire aircraft storage and servicing floor area. The application total discharge rate shall include the sprinkler breakdown factor specified in 6.12.8.2.2 of NFPA 11.

9.14.7.5.4 The high-expansion foam generators shall be arranged to achieve initial foam coverage in the expected aircraft parking area.

9.14.7.5.5 Foam generators shall be supplied with air from outside the aircraft storage and servicing area. Roof vents shall be located to avoid recirculation of combustion products into the air inlets of the foam generators.

9.14.7.5.6 Foam generators shall be powered by reliable water-driven or electric motors. Electric power reliability for foam generators shall be consistent with electric fire pump requirements specified in Chapters 9 and 10 of NFPA 20.

9.14.8 Foam Concentrate Supply.

9.14.8.1 The quantities of low-expansion foam concentrate — protein foam, fluoroprotein foam, or AFFF — shall be calculated for a 10-minute foam discharge based on the supply calculation method.

9.14.8.2 The quantity of high-expansion foam concentrate shall be calculated for a 12-minute discharge at the water flow rate as determined in 9.14.7.5.3.

9.14.8.3 A reserve supply of foam concentrate shall be provided in accordance with 4.3.2.5.2 of NFPA 11.

9.14.8.4 Control valves, foam concentrate liquid storage tanks, concentrate pumps, controllers, and bypass balancing equipment shall be located outside the aircraft storage and servicing area.

9.14.9 Foam Concentrate Pumps.

9.14.9.1 Where foam concentrate is introduced into the water stream by pumping, the total foam concentrate pumping capacity shall be such that the maximum flows and pressures shall be capable of being met with the largest foam concentrate pump out of service. The reserve pump(s) shall be arranged to operate only upon failure of the primary pump(s).

9.14.9.2 Power supply for the drivers of foam concentrate pumps shall be installed in accordance with NFPA 20 and *NFPA 70*. Power supplies shall be arranged such that disconnecting power to the protected facility during a fire shall not disconnect the power supply to the foam concentrate pump feeder circuit.

9.14.9.3 Controllers for foam concentrate pumps shall be as follows:

(1) For electric-drive foam concentrate pumps, a listed full-service fire pump controller shall be used.
(2) For diesel engine–drive foam concentrate pumps, a listed fire pump controller shall be used.

9.14.9.4 Piping shall be arranged so that maximum foam concentrate demand can be supplied from either primary or reserve foam concentrate tanks.

9.14.10 Detection and Actuation System Design.

9.14.10.1 General. Actuation systems shall be provided with complete circuit supervision and shall be arranged in accordance with 9.14.15.

9.14.10.2 Foam Fire Protection Systems.

9.14.10.2.1* An automatic detection system shall be provided for actuation of these systems. Detection systems shall be installed in accordance with *NFPA 72*.

9.14.10.2.2 Manual actuation stations shall be provided for each low-level protection system and shall be located both inside and outside the aircraft maintenance and servicing area. Stations shall be located as close as possible to the aircraft positions to facilitate early system actuation in the event of a fire.

9.14.13.9.5 Any proportioner not tested under the requirements of 9.14.13.9.4 shall be individually tested with foam concentrate to determine concentrate percentage.

9.14.13.9.6 Low-expansion and high-expansion foam protection systems shall be subjected to foam flow tests, with foam flowing simultaneously from the maximum number of foam nozzles or generators expected to operate, in order to ensure that the hazard is protected in conformance with the design specification and to determine whether the flow pressures, agent discharge capacity, foam coverage, and percent concentration, are satisfactory.

9.14.13.9.7 Low-expansion and high-expansion foam protection systems shall be examined visually to determine that they have been installed correctly. Checks shall be made for such items in conformity with installation plans, continuity of piping, tightness of fittings, removal of temporary blank flanges, and accessibility of valves and controls. Devices shall be identified, and operating instructions shall be prominently posted.

9.14.13.9.8* The timing of foam system discharge shall be measured beginning at the time of system actuation.

9.14.13.10 Final Approval. The installing company shall furnish a written statement that the work has been completed in accordance with 9.14.6 and tested in accordance with the provisions of 9.14.13.9.

9.14.14 Wheeled and Portable Extinguishers.

9.14.14.1 Wheeled and portable extinguishers shall be provided in accordance with NFPA 10.

9.14.14.2 In aircraft storage and servicing areas, the distribution of such devices shall be in accordance with the extra hazard classification outlined in NFPA 10.

9.14.14.3 The distribution of extinguishers in other areas of aircraft hangars shall be in accordance with light, ordinary, or extra hazard occupancy based on an analysis of each room or area following the requirements of NFPA 10.

9.14.15* Protection System Alarms. In addition to local alarm service, alarms shall be transmitted to a constantly attended location.

Chapter 10 Paint Hangars

10.1 Construction.

10.1.1 Paint hangars shall be constructed in accordance with Chapter 5 of this standard.

10.1.2 All flammable or combustible liquid storage, mixing, and application apparatus cleaning operations shall be separated from the paint hangar by a minimum 2-hour rated fire separation, with the openings protected by 1½-hour rated fire doors.

10.2 Fire Protection.

10.2.1 The protection of aircraft paint hangars shall be in accordance with either Chapter 6 or Chapter 7 of this standard, whichever is applicable.

10.2.1.1 The design area of the closed-head water sprinkler system shall not be required to be increased for ceiling slope.

10.2.1.2 The design area of the closed-head water sprinkler system shall not be required to be increased for preaction systems.

10.2.2 The protection of an aircraft paint hangar housing unfueled aircraft shall be in accordance with the provisions of NFPA 13 for an extra hazard Group 2 occupancy.

10.3 Ventilation.

10.3.1 The ventilation system in a paint hangar shall be in accordance with the ventilation provisions of NFPA 33 and 10.3.2 through 10.3.4 of this standard.

10.3.2 Ventilation shall be provided to prevent the accumulation of flammable vapors to not more than 25 percent of the LFL in the exhaust stream exiting the paint area.

10.3.3 Recirculation of a portion of the exhaust stream back into the hangar shall be permitted, provided the recirculation provisions of NFPA 33 for booths and rooms and the requirements of 10.3.3.1 and 10.3.3.2 are met.

10.3.3.1* Supply air flow shall be unidirectional and shall provide a uniform airflow across the cross-sectional area of the filters.

10.3.3.2* If the concentration of vapors in the exhaust air stream exceeds 25 percent of the LFL, the recirculation equipment shall be arranged to automatically shut down until the hazardous condition is corrected.

10.3.4 Paint or other flammable or combustible liquid application equipment shall be interlocked with the ventilation system such that the loss of supply, makeup air, or exhaust fans that reduce the supply airflow to below 75 percent of design airflow will interrupt the operation of this application equipment.

10.4 Electrical Equipment.

10.4.1 Electrical equipment in a paint hangar shall be in accordance with Article 513 and Article 516 of *NFPA 70* and 10.4.2 through 10.4.4 of this standard.

10.4.2 The area within 3 m (10 ft) horizontally from aircraft surfaces from the floor to 3 m (10 ft) above the aircraft shall be classified as Class I, Division 1 or Class I, Zone 1. The area horizontally from aircraft surfaces between 3.0 m (10 ft) and 9.0 m (30 ft) from the floor to 9.0 m (30 ft) above the aircraft surface shall be classified as Class I, Division 2 or Class I, Zone 2. [**70**:513.3(C)(2), 2014]

10.4.3 All lighting fixtures within a paint hangar shall be totally enclosed or constructed so as to prevent the escape of sparks or hot particles.

10.4.4* In addition to the grounding requirements in Chapter 5, grounding facilities shall be provided for the paint or other flammable or combustible liquid application system and the application system operator.

10.5 Operations. Flammable or combustible liquid operations inside a paint hangar shall be in accordance with the provisions of NFPA 30 and NFPA 410.

Chapter 12 Unfueled Aircraft Hangars

12.1 General. This chapter shall apply to those hangars housing aircraft that have never been fueled or have had the fuel removed to comply with the definition for unfueled aircraft in Chapter 3.

12.2 Construction. Unfueled aircraft hangars shall be constructed in accordance with Chapter 5 of this standard, and as modified herein.

12.2.1 Internal Separations.

12.2.1.1 Shops, offices, and parts storage areas shall be permitted to be located in the aircraft storage and servicing area without a fire-rated separation.

12.2.1.2 Attached, adjoining, or contiguous structures, such as a lean-to, shop, office, or parts storage area shall be permitted without a fire-rated separation.

12.2.1.3 Internal separations between the aircraft storage and servicing area and shops, offices, and parts storage areas shall be of noncombustible or limited combustible construction.

12.2.2 Columns. Unprotected columns in aircraft storage and servicing areas shall be permitted.

12.2.3 Floors. Hangar floors in aircraft storage and servicing areas without trench drainage systems shall be permitted.

12.2.4 Heating and Ventilating.

12.2.4.1 Heating, ventilating, and air-conditioning equipment shall be permitted to employ the use of open flames or glowing elements.

12.2.4.2 Heating plants that are fired with gas, liquid, or solid fuels shall not be required to be separated from the aircraft storage and servicing area by fire resistance-rated partitions.

12.2.4.3 Heating, ventilating, and air-conditioning systems employing recirculation of air within aircraft storage and servicing areas shall be allowed to have supply and return air openings at or near floor level.

12.3 Lighting and Electrical Systems.

12.3.1 Lighting and electrical systems shall comply with the provisions of *NFPA 70*.

12.3.2 Main electrical distribution panels, metering equipment, and similar electrical equipment shall not be required to be separated from aircraft storage and servicing areas by fire-rated partitions.

12.4 Grounding Facilities for Static Electricity. Aircraft storage and servicing areas shall be provided with grounding facilities in accordance with this standard.

12.5 Protection of Unfueled Aircraft Hangars.

12.5.1 This section shall apply to all Group I and Group II hangars, and Group IV hangars with fire areas greater than 1115 m^2 (12,000 ft^2).

12.5.2* Sprinkler systems shall be either wet pipe or single-interlock preaction, designed and installed in accordance with the applicable sections of NFPA 13 and the provisions of this chapter.

12.5.3 Sprinkler piping shall be hydraulically sized in accordance with NFPA 13. The maximum area covered by a single sprinkler system shall not exceed 3716 m^2 (40,000 ft^2).

12.5.4 Sprinklers shall be spaced in accordance with NFPA 13 or in accordance with their listings.

12.5.5 Where open hangar doors result in an obstruction to the distribution of water from the hangar sprinkler systems, additional sprinklers shall be provided beneath the doors to ensure required floor coverage.

12.5.6 The design density from sprinkler systems shall be a minimum of 6.9 L/min/m^2 (0.17 gpm/ft^2) over any 464.5 m^2 (5000 ft^2) area, including the hydraulically most demanding area as defined in NFPA 13.

12.5.6.1 An outside hose stream demand of 1893 L/min (500 gpm) shall be included in all hydraulic calculations.

12.5.6.2 The design area of the closed-head water sprinkler system shall not be required to be increased for ceiling slope.

12.5.6.3 The design area of the closed-head water sprinkler system shall not be required to be increased for preaction systems.

12.5.7 Sprinklers shall be control mode and have a minimum nominal K-factor of K-80 (K-5.6). Suppression mode sprinklers shall be allowed when the hangar occupancy is covered by other applicable NFPA standards (e.g., the storage protection provisions in NFPA 13). Sprinklers shall be listed for their application, and designed and installed in accordance with NFPA 13 or their listings.

12.5.8 Sprinklers having a temperature rating of 79.4°C (175°F) shall be used. Sprinklers having a temperature rating of 93.3°C (200°F) shall be permitted in areas subject to high ambient temperatures.

12.5.9 Acceptance tests for sprinkler systems shall be in accordance with NFPA 13.

12.5.10 Water hand hose systems shall not be required in aircraft storage and servicing areas, shops, offices or non-aircraft storage areas, except where required by other NFPA standards.

12.5.11 The total water supply shall be available in sufficient quantity and pressure to satisfy the demand created by the combination of the sprinkler system and the requirements for hose streams. This supply shall be available for a minimum duration of 60 minutes.

12.6 Spray Application of Flammable and Combustible Liquids.

12.6.1 Paint spray application booths, installed and protected in accordance with NFPA 33, shall be allowed in the hangar storage and servicing area.

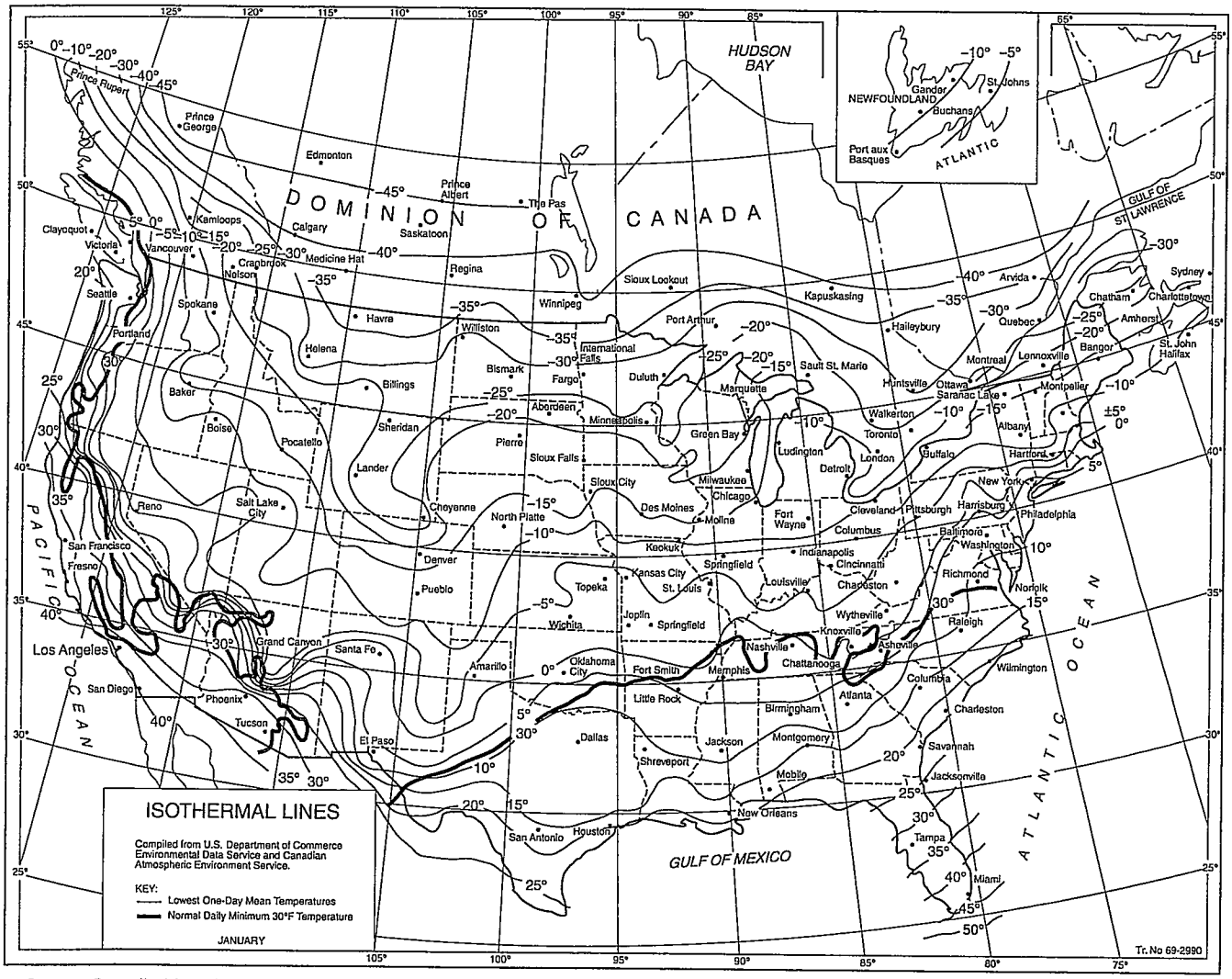
12.6.2 Protection for aircraft hangars used for the spray application of flammable and combustible liquids shall be in accordance with this standard and NFPA 410.

12.6.3 All flammable or combustible liquid storage, mixing, and application apparatus cleaning operations shall be separated from the hangar storage and servicing area by a minimum 2-hour rated fire separation, with the openings protected by 1½-hour rated fire doors.

Table A.3.3.14 Gross Wing Area and Overall Height for Selected Aircraft

Aircraft	Gross Wing Area		Overall Height	
	m^2	ft^2	m	ft–in.
Airbus A-380*	830.0	8920	24.1†	79–0
Antonov An-124*	628.0†	6760	21.0†	69–2
Lockheed L-500-Galaxy*	576.0†	6200	19.8†	65–1
Boeing 747*	541.1†	5825	19.4†	63–8
Airbus A-340-500, -600*	437.0†	4703	16.7†	54–11
Boeing 777*	427.8†	4605	18.5†	60–9
Ilyushin II-96*	391.6†	4215		
DC-10-20, 30*	367.7†	3958	17.7†	58–1
Airbus A-340-200, -300, A-330-200, -300*	361.6†	3892	16.7†	54–11
DC-10-10*	358.7†	3861	17.7†	58–1
Concorde*	358.2†	3856	12.2†	40–0
Boeing MD-11*	339.9†	3648	17.6†	57–9
Boeing MD-17*	353.0†	3800	16.8†	55–1
L-1011*	321.1†	3456	16.9†	55–4
Ilyushin II-76*	300.0†	3229	14.8†	48–5
Boeing 767*	283.4†	3050	15.8†	52–0
Ilyushun IL-62*	281.5†	3030	12.3†	40–6
DC-10 MD-10	272.4	2932		
DC-8-63, -73	271.9	2927		
DC-8-62, -72	271.8	2926		
DC-8-61, 71	267.8	2883		
Airbus A-300	260.0†	2799	16.5†	54–3
Airbus A-310	218.9†	2357	15.8†	51–10
Tupolev TU-154	201.5†	2169	11.4†	37–4
Boeing 757	185.2†	1994	13.5†	44–6
Tupolev TU-204	182.4†	1963	13.9†	45–7
Boeing 727-200	157.9†	1700	10.4†	34–0
Lockheed L-100J Hercules	162.1†	1745	11.6†	38–3
Yakovlev Yak-42	150.0†	1614	9.3†	32–3
Boeing 737-600, -700, -800, -900	125.0†	1345	12.5†	43–3
Airbus A-318, A-319, A-320, A-321	122.6†	1319	11.8†	38–8
Boeing MD 80	112.3†	1209	9.0†	29–7
MD 90			9.3†	30–7
Gulfstream V	105.6†	1137	7.9†	25–10
Boeing 737-300, -400, -500	105.4†	1135	11.1†	36–6
Tupolev TU-334, TU-354	100.0†	1076	9.4†	30–9
BAC 1-11-500	95.8†	1031	7.5†	24–6
NAMC YS-11	94.8†	1020	8.9†	29–5
Fokker 100, 70	93.5†	1006	8.5†	27–10
BAC 1-11-300, -400	93.2	1003	7.5†	24–6
Boeing 717	93.0†	1001	8.8†	29–1
DC-9-30	93.0†	1001	8.4†	27–6
Boeing 737-200	91.0†	980	11.3†	37–0
Gulfstream IV	88.3†	950	7.4†	24–5
DC 9-10	86.8†	934	8.4†	27–6
BAe 146, RJX-70, -85, -100	77.3†	832	8.6†	28–3
Fokker 50, 60	70.0†	753	2.7†	27–3
Canadair RJ-700	68.6†	738	7.6†	24–10
Dash 8 Q400	63.0†	679	7.5†	24–7
ATR 72	61.0†	656	7.6†	25–1

(continues)



Source: Compiled from United States Weather Bureau records.
For SI units, °C = 5⁄9 (°F±32); 1 mi = 1.609 km.

FIGURE A.5.7.4 Lowest Mean Temperature Map.

system of draft curtains that are both at right angles and parallel to the doors. In arch-type hangars, draft curtains can be hung on exposed interior roof supports running parallel to the doors. The method of installation should be based on obtaining maximum operational efficiency from the sprinkler protection, taking into consideration mean wind conditions, floor drains, floor pitch, and details of occupancy usage.

Roof Sections as Draft Curtains. Structural features of a building that serve the purpose of draft curtains (roof monitors, sawtooth roofs, etc.) can be permitted in lieu of specially constructed draft curtains.

A.5.17.3 The reason for limiting a draft curtain area to 697 m^2 (7500 ft^2) is to improve detection and sprinkler response times, not to limit the fire suppression system size.

A.6.2.1.1 It is highly important and expedient that all applicable areas of responsibility, such as those that cover adequacy of water supplies, design, suitability of agent, application rates used, area covered, testing, flushing, approvals, and so forth, be clearly defined in the contract documents. This is important where there is shared responsibility for various portions of the fire protection systems.

A.6.2.2.2 The manual control valve for each individual sprinkler system should be located outside aircraft storage and servicing areas.

A.6.2.2.7 This provision is for the purpose of addressing obstructions that can be caused by hangar door positions. It is not intended to address interference due to wind.

A.6.2.3.1 Supplementary protection systems for hangars containing several aircraft, each having a wing area less than 279 m^2 (3000 ft^2), can be warranted. Such systems are recommended under the following conditions:

(1) Rapid control of a fuel fire exposing a single aircraft is considered essential.
(2) Strategically important military aircraft or multiple high valued aircraft are accommodated.

A.6.2.8.5.1 See A.6.2.8.3.1.

A.6.2.8.5.2 This is a minimum requirement. It does not preclude the system design from operating all low-level foam discharge devices in the aircraft maintenance and servicing area upon operation of one automatic sprinkler or detection device. Note that the design objective to achieve coverage of the entire aircraft storage and servicing area, as required by 6.2.5.2, applies, regardless of zoning of the detection system.

A.6.2.9 Subsection 6.2.9 provides a means for fire fighting by occupants of the hangar through the use of hand hose supplied from the hangar's fixed fire protection system or from an independent source. The hand hose system in aircraft storage and servicing areas is usually arranged for foam application with water spray or straight water streams used in other areas.

A.6.2.10 Where a single reservoir is used as a basic water supply, the reservoir should be divided into approximately equal sections, arranged so that at least one-half of the water supply will always be maintained in service to increase the reliability of the water supply. The suction line from each section should be sized to deliver the maximum water supply.

The development of satisfactory water supplies is a matter requiring engineering judgment and careful analysis of local conditions. *(See NFPA 20 and NFPA 22.)* Acceptable types of water supplies can consist of one or more of the following:

(1) Connections to reliable waterworks systems, including automatic booster pumps where required
(2) Automatic fire pumps taking suction under a head from storage reservoirs or other suitable supply
(3) Gravity tanks

Combinations of these supplies can be used to advantage. It is desirable to have two independent water supplies. Where reliance is placed on automatic fire pumps, special consideration should be given to the use of multiple pumps rather than single pumps and the use of multiple sources of power to increase the reliability of pump drivers. Water supplies should be guarded against entry of foreign material that would clog sprinklers or piping. Waterworks connections, where used as an independent supply, should be capable of delivering water at the specified rate and pressure as determined by flow tests, with due consideration given to any conditions that could affect the design supply and pressure. Investigation should be made to determine the normal and emergency operations of the waterworks system, including domestic consumption and operation of the waterworks pumps at time of test, pressure-reducing valves, or other factors affecting adequacy of a public water supply. Automatic booster fire pumps should be used to provide effective pressure from waterworks connections.

A.6.2.10.1 The presence of corrosion inhibitors, antifreeze agents, marine growth, oil, or other contaminants can result in the reduction of foam volume or stability. If the quality of the water used is questionable, the manufacturer of foam equipment should be consulted. In general, the performance of a foam-water extinguishing system depends on the agent composition, the proportioning concentration, and the application technique. Different brands or types of agents should not be mixed without the advice of the equipment manufacturer regarding their interchangeability and compatibility.

A.6.2.10.2.1 Actual flow rates are often higher than calculated. This will often result in a reduction in foam supply duration.

Aircraft storage and servicing areas with large doors on both ends can present special draft problems that affect the efficient operation of the sprinkler systems. In such cases, additional systems should be included in the calculation of water supply needed. Draft stops should effectively surround each individual sprinkler system. *(See Section 5.17.)*

A.6.2.10.7.5 Supplemental means for automatically starting the fire pumps should also be provided.

A.6.2.10.8 In connection with the flushing operation, preplanning should be made for means of disposing of the large quantities of water discharged.

A.6.2.11.9 System actuation is defined as actuation of the water control valve.

A.6.4 For further information, see *NFPA 72*.

A.7.2.1 A preaction standard sprinkler system should be used only if there is a possibility of freezing in an unheated hangar.

A.7.3 Experience has shown that different brands of foam might not be compatible and can have varying levels of fire-fighting effectiveness. Care should be utilized in the selection of foam concentrates. For further information, see NFPA 16.

A.7.3.6.3 System actuation is defined as actuation of the automatic water control valve.

A.7.4 Experience has shown that different brands of foam might not be compatible and can have varying levels of fire-fighting effectiveness. Care should be utilized in the selection of foam concentrates. For further information, see NFPA 16.

A.7.4.2 This design criterion can be achieved by means of multiple nozzles of the same or different capacities aimed to discharge toward the aircraft parking area. The fluidity of the foam will achieve coverage of the entire floor area.

A.7.4.4 Actual flow rates are often higher than calculated, which will often result in a reduction in foam supply duration.

A.7.6.7 This should be accomplished by providing manifolded drains.

A.7.8 See A.6.2.10 and A.6.2.10.1.

A.8.1.1 Group III hangars for small aircraft either are prefabricated assemblies or are locally constructed of unprotected steel or aluminum, light wood framing, or cement or cinder blocks. The majority of the prefabricated types are unprotected steel structures with sheet steel or aluminum roof coverings and sidings. Other prefabricated hangars have wood or cement sidings and wood or plywood doors. Except in unusual circumstances, construction types other than Type II (000) and Type V (000) are unlikely because of cost factors. Earth floors are common. Floor drainage is not required unless the hangar is protected in accordance with Chapter 7, although utility drains are useful and should be provided. The airport operator should have a master key for the Group III hangars on the airport premises so as to provide emergency access in case of fire. *(See A.5.1.1.)*

A.8.1.7 Such classifications of roof coverings are determined when tested in accordance with ASTM E 108 or UL 790.

A.8.3.4 Personnel should be fully instructed that in the event of a serious gasoline or similar flammable liquid spill on the hangar floor, the fans should be shut off.

Table B.2 Fire Resistance Ratings for Type I through Type V Construction (hr)

	Type I		Type II			Type III		Type IV	Type V	
	442	332	222	111	000	211	200	2HH	111	000
Exterior Bearing Walls[a]										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0[b]	2	2	2	1	0[b]
Supporting one floor only	4	3	2	1	0[b]	2	2	2	1	0[b]
Supporting a roof only	4	3	1	1	0[b]	2	2	2	1	0[b]
Interior Bearing Walls										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	2	1	0
Supporting one floor only	3	2	2	1	0	1	0	1	1	0
Supporting roofs only	3	2	1	1	0	1	0	1	1	0
Columns										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	H	1	0
Supporting one floor only	3	2	2	1	0	1	0	H	1	0
Supporting roofs only	3	2	1	1	0	1	0	H	1	0
Beams, Girders, Trusses, and Arches										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	H	1	0
Supporting one floor only	2	2	2	1	0	1	0	H	1	0
Supporting roofs only	2	2	1	1	0	1	0	H	1	0
Floor-Ceiling Assemblies	2	2	2	1	0	1	0	H	1	0
Roof-Ceiling Assemblies	2	1½	1	1	0	1	0	H	1	0
Interior Nonbearing Walls	0	0	0	0	0	0	0	0	0	0
Exterior Nonbearing Walls[c]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]

H: Heavy timber members *(see text for requirements).*
[a]See 7.3.2.1 [of *NFPA 5000*].
[b]See Section 7.3 [of *NFPA 5000*].
[c]See 7.2.3.2.12, 7.2.4.2.3, and 7.2.5.6.8 [of *NFPA 5000*].
[**5000:** Table 7.2.2.1]

noncombustible, limited-combustible, or other approved combustible materials. [**5000:**7.2.4.1]

B.5 Type IV Construction. Type IV (2HH) construction shall be that type in which fire walls, exterior walls, and interior bearing walls and structural elements that are portions of such walls are of approved noncombustible or limited-combustible materials, except as allowed for exterior walls in 7.2.5.6.7 [of *NFPA 5000*]. Other interior structural elements, arches, floors, and roofs shall be of solid or laminated wood or cross-laminated timber without concealed spaces and shall comply with the allowable dimensions of 7.2.5.5 [of *NFPA 5000*]. [**5000:**7.2.5.1]

B.6 Type V (111 or 000) Construction. Type V (111 or 000) construction shall be that type in which structural elements, walls, arches, floors, and roofs are entirely or partially of wood or other approved material. [**5000:**7.2.6]

Annex C Informational References

C.1 Referenced Publications. *The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.*

C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2012 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2015 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2013 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2013 edition.

NFPA 72®, National Fire Alarm and Signaling Code, 2016 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 2014 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2016 edition.

NFPA 220, *Standard on Types of Building Construction*, 2015 edition.

Index