

NFPA

409

# AIRCRAFT HANGARS 1979



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**NATIONAL FIRE PROTECTION ASSOCIATION, INC.**

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**Standard on**  
**Aircraft Hangars**

**NFPA 409-1979**

**1979 Edition of NFPA 409**

This 1979 edition of NFPA 409, *Standard on Aircraft Hangars*, was prepared by the Technical Committee on Airport Facilities and was adopted by the National Fire Protection Association, Inc., on May 16, 1979, at its Annual Meeting in St. Louis, MO. It was released by the Standards Council on June 11, 1979.

This edition of the standard is a revision of the 1975 edition. It has been rewritten according to the NFPA Manual of Style and SI units have been added. Changes other than editorial are denoted by a vertical line in the margin of the pages in which they appear.

The 1975 edition of this text was approved as an American National Standard by the American National Standards Institute. This new edition is currently being submitted for ANSI approval.

**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 in 1930 (now the American Insurance Association). Revisions were issued by the NBFU in 1931, 1943, 1945, and 1950. During the period 1943 until 1954, these recommendations were published as NBFU Pamphlet 85.

In 1951, the National Fire Protection Association, Inc. organized a Committee on Aircraft Hangars to which the National Board of Fire Underwriters and other interested groups lent their support. The NFPA's first standard was adopted in 1954, and the NBFU adopted the same text, rescinding their earlier 1950 standard. Revisions were made in 1957 and 1958 by this NFPA Committee. In 1959, a reorganization of the NFPA Aviation activities resulted in assigning this standard to the Sectional Committee on Aircraft Hangars and Airport Facilities and the 1960, 1962, 1965, 1966, 1967, 1969, 1970, 1971, 1972, 1973 and the 1975 editions were prepared by this Sectional Committee.

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# Standard on Aircraft Hangars

NFPA 409-1979

## NOTICE

An asterisk (\*) following the number or letter designating a section indicates explanatory material in Appendix A.

Information on referenced publications can be found in Appendix G.

## PART A

### INTRODUCTION

#### Chapter 1 Scope and Purpose

**1-1 Scope.** This standard contains the minimum requirements for the proper construction and protection of aircraft hangars from fire.

**1-2 Purpose.** The purpose of this standard is to provide a reasonable degree of protection for life and property from fire for aircraft hangars based upon sound engineering principles, test data and field experience.

**1-3\* General.** The adequacy and usefulness of aircraft hangars depends, to a large extent, upon the fire resistance of their construction and the fire protection provided within the buildings. These standards provide guidance on the proper construction and protection of aircraft hangars.

**1-4 Subdivisions of this Standard.** This standard is divided into five parts as follows:

- (a) **Part A Introduction**
- (b) **Part B Construction of Types I and II Aircraft Hangars**
- (c) **Part C Protection of Type I Aircraft Hangars**
- (d) **Part D Protection of Type II Aircraft Hangars**
- (e) **Part E Construction and Protection of Type III Aircraft Hangars**

**1-5 Appendices.** There are seven Appendices which give reference data or supplemental information as follows:

- (a) **Appendix A Recommendations Supplementing the Provisions of Parts A, B, C, D and E**
- (b) **Appendix B Construction and Protection of Wing or Nose Hangars**
- (c) **Appendix C Construction and Protection of Nonportable Aircraft Docks**
- (d) **Appendix D Exterior Fire Protection Facilities for Hangars**
- (e) **Appendix E Diagrams Related to Chapters 8 and 12**
- (f) **Appendix F Tabulation of Wing Areas of Large Aircraft**
- (g) **Appendix G Referenced Publications**

**1-6 Units.** Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). One unit (liter), outside of but recognized by SI, is commonly used in international fire protection.

**1-6-1** If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated is to be regarded as the requirement. A given equivalent value may be approximate.

**1-6-2** The conversion procedure for the SI units has been to multiply the quantity by the conversion factor and then round the result to the appropriate number of significant digits.

*NOTE: For additional conversions and information see ASTM E380, Standard for Metric Practice.*

**PART B****CONSTRUCTION OF TYPES I and II  
AIRCRAFT HANGARS****Chapter 2 Definitions**

**2-1 Aircraft Hangar.** A building or other structure in any part of which aircraft are housed or stored and in which aircraft may be undergoing servicing, repairs or alternations. For the purposes of this standard, aircraft hangars are classified as follows:

**2-1.1 Type I Aircraft Hangar.** A hangar with either a clear door height over 28 ft (8.5 m) or with a fire area in excess of 40,000 sq ft (3 716 m<sup>2</sup>) or housing aircraft with a tail height of over 28 ft (8.5 m).

**2-1.2 Type II Aircraft Hangar.** A hangar with a clear door height 28 ft (8.5 m) or less and with a fire area 40,000 sq ft (3 716 m<sup>2</sup>) or less, but greater than those specified in Table 5-2 (*see Section 5-2*).

**2-1.3 Type III Aircraft Hangar.** A hangar with a clear door height 28 ft (8.5 m) or less and with a fire area up to the maximum permitted for hangars in Table 5-2 not equipped with approved fire protection systems (*see Section 5-2*).

**2-1.4 Other Types of Aircraft Hangars.** Hangars housing strategically important military aircraft shall conform to the requirements applicable to Type I hangars.

**2-2 Fire Area.** For the purposes of this standard, an area within an aircraft hangar subject to loss by a single fire because of lack of internal subdivisions as specified in Section 5-3.

**2-3 Aircraft Storage and Servicing Area.** That part of a hangar normally used for the storage and servicing of one or more aircraft (other than those with drained and purged fuel tanks), not including any adjacent or contiguous areas or structures (e.g., shops, storage areas, offices).

**2-4 Single Hangar Building.** A building with one area for the storage and servicing of aircraft and any attached, adjoining, or contiguous structure (e.g., "lean-to," shop area, or parts storage area) not separated as specified in Sections 5-4 and 5-5. (*See also Section 5-6.*)

**2-5 Hangar Building Group.** A building or group of buildings with more than one area for the storage and servicing of aircraft and all attached, adjoining, or contiguous structures not separated as specified in Section 5-5. (*See also Section 5-6.*)

**2-6 Wing or Nose Hangars.** Buildings which provide shelter for the servicing of aircraft without housing the aircraft aft of the trailing edge of the wings. Wing or nose hangars may have extensive service shops and offices incorporated within the structures.

**2-7 Nonportable Aircraft Docks.** Shelters or covers for the servicing of aircraft engines. Such docks do not house the wings nor contain service shops or offices.

**2-8 Drained and Purged Aircraft Fuel Tanks.** Those from which the flammable or combustible liquid has been drained and the flammable or combustible vapor atmosphere or any residue capable of producing flammable or combustible vapors has been removed so that subsequent airing or ventilation will not result in the reinstatement of a flammable or combustible atmosphere unless or until a flammable or combustible liquid is again introduced.

**2-9 Tail Height.** As defined in the manufacturer's literature.

### Chapter 3 General

**3-1\* Communicating Sections.** Where shop, office, and storage areas communicate with an aircraft storage and servicing area and possess inherent hazards, contain valuable records or store concentrations of critical or highly valued materials, they shall be cut off in the manner specified in Section 5-3.

## Chapter 4 General Construction Types

**4-1\* Fire-resistive Construction.** Hangars of this type shall have structural members of noncombustible materials having fire resistance ratings of not less than three hours for bearing walls or bearing portions of walls (exterior or interior) and wall supporting members and columns, and not less than two hours for floors, roof decks and supports thereof. Exterior and interior bearing walls shall be of approved masonry or reinforced concrete construction. Non-bearing walls or portions of walls shall be noncombustible and fire resistant as required depending upon conditions of occupancy or exposure. Bearing walls and bearing partitions shall have adequate stability under fire conditions in addition to the specified fire resistance rating.

**4-2\* Heavy Timber Construction.** Hangars of this type shall have columns, beams, girders and roofs of heavy timber or of approved glued laminated construction of not less than the following nominal dimensions for individual members:

Columns . . . . .	8 in. (203 mm)
Trusses . . . . .	4 in. by 6 in. (102 mm by 152 mm)
Beams and Girders	6 in. by 10 in. (152 mm by 254 mm)
Roof Decks . . . . .	2 in. (51 mm) (plank), 3 in. (76 mm) (laminated)

Bearing walls or bearing portions of walls of masonry or other noncombustible construction shall have a minimum fire resistance rating of not less than two hours and stability under fire conditions. Nonbearing exterior walls shall be noncombustible and fire resistant as required depending upon conditions of occupancy or exposure. Interior structural members, columns, beams, girders or trusses of materials other than wood may be substituted for heavy timber members (as specified above) provided they have a fire resistance rating of not less than one hour.

**4-3\* Noncombustible Construction.** Hangars of this type shall have walls, partitions and structural members of noncombustible materials which, as assembled, do not qualify as fire resistive (*see Section 4-1*). In hangar construction two types of noncombustible construction are:

**4-3.1 Protected Noncombustible.** Protected noncombustible hangars shall have bearing walls or portions of bearing walls (exterior or interior) of noncombustible materials having a fire resistance

rating of not less than two hours and roof decks and supports of non-combustible materials having a fire resistance rating of not less than one hour. A one-hour fire resistant ceiling beneath the roof construction may be used in lieu of the specified fire resistance of the roof construction. Nonbearing walls or portions of walls should be non-combustible and fire resistant as required depending upon conditions of occupancy or exposure. Bearing walls and bearing partitions shall have adequate stability under fire conditions in addition to the specified fire resistance rating.

**4-3.2 Unprotected Noncombustible.** Unprotected noncombustible hangars shall be constructed of noncombustible materials for walls, columns, girders, trusses, floor, roof and partitions of unspecified fire resistance.

#### **4-4 Ordinary Construction.**

**4-4.1** Hangars of this type shall have exterior bearing walls or bearing portions of exterior walls of noncombustible construction having a minimum fire resistance rating of two hours and stability under fire conditions. Nonbearing exterior walls shall likewise be of noncombustible construction and fire resistant as required depending upon conditions of occupancy or exposure. Roofs, floors (except as specified in Section 6-2), and interior framing are normally wholly or partly of wood (or other combustible material) of smaller dimensions than required for heavy timber construction (*see Section 4-2*).

**4-4.2** Ordinary construction shall be designated protected ordinary construction when the roof and floor construction and their supports have a one-hour fire resistance rating.

#### **4-5 Wood Frame.**

**4-5.1** Hangars in which exterior walls, bearing walls and partitions and roof construction and its supports are of wood or other combustible material not qualifying as heavy timber construction (*see Section 4-2*) or ordinary construction (*see Section 4-4*). Hollow spaces between inner and outer sheathing shall be firestopped at each 8 ft (2.4 m) of height.

**4-5.2** This type of construction shall be designated protected wood frame construction when the roof and floor construction and its supports have a one-hour fire resistance rating.

## Chapter 5 Internal Subdivisions and Separation

**5-1 General.** Precautions shall be taken to insure ready access to hangars from all sides. Adequate separation shall be provided to reduce fire exposure between buildings. The clear spaces specified in Tables 5-4 and 5-5 shall not be used for the storage of aircraft or concentrations of combustible materials nor shall buildings of any type be erected therein.

**5-2\* Maximum Areas for Hangars Not Protected by Approved Fire Protection Systems.** Areas for hangars not protected by approved fire protection systems shall be limited as specified in Table 5-2.

**Table 5-2**  
**Maximum Areas for Hangars Not Protected**  
**by Fire Protection Systems**

Types of Construction	Single Hangar Buildings Maximum Fire Areas		Hangar Building Groups Total Areas	
	(sq ft)	(m <sup>2</sup> )	(sq ft)	(m <sup>2</sup> )
Fire-resistive	30,000	2 787	60,000	5 574
Protected Noncombustible	20,000	1 858	40,000	3 716
Heavy Timber or Protected Ordinary	15,000	1 394	30,000	2 787
Unprotected Noncombustible	12,000	1 115	24,000	2 230
Ordinary	12,000	1 115	24,000	2 230
Protected Wood Frame	8,000	743	16,000	1 486
Wood Frame	5,000	465	10,000	929

**5-3 Internal Subdivisions.** When two or more aircraft storage and servicing areas adjoin or are connected by lean-tos or other intervening construction, they shall be separated by an approved fire wall. Openings in such fire walls communicating directly between two aircraft storage and servicing areas shall be provided with approved Class A doors on both sides of the wall. Single approved Class A fire doors may be used at fire wall openings where the openings are not direct to another aircraft storage and servicing area. Partitions and ceilings separating aircraft storage and servicing areas from all other areas (e.g., shop, office and parts storage areas) shall have at least a one-hour fire resistance rating with openings protected by approved Class C fire doors. Curbs, ramps or drains shall be provided at all openings from aircraft storage and servicing areas to prevent the flow of liquids through the openings.

**5-4 Separation Between Single Hangar Buildings.** Clear space distances specified in Table 5-4 shall be maintained on all sides of single hangar buildings. Where mixed types of construction are involved the predominating type of construction shall be used.

Table 5-4

Type of Construction	Separation Required
Fire-resistive .....	50 ft (15 m)
Protected Noncombustible .....	50 ft (15 m)
Heavy Timber or Protected Ordinary .....	50 ft (15 m)
Unprotected Noncombustible .....	50 ft (15 m)
Ordinary .....	50 ft (15 m)
Protected Wood Frame and Wood Frame .....	75 ft (23 m)

**5-5 Separation Between Hangar Building Groups.** Clear space distances specified in Table 5-5 shall be maintained on all sides of hangar building groups. Where mixed types of construction are involved, the predominating type of construction shall be used.

Table 5-5

Type of Construction	Separation Required
Fire-resistive .....	75 ft (23 m)
Protected Noncombustible .....	75 ft (23 m)
Heavy Timber .....	75 ft (23 m)
Protected Ordinary .....	100 ft (30 m)
Unprotected Noncombustible .....	100 ft (30 m)
Ordinary .....	100 ft (30 m)
Protected Wood Frame and Wood Frame .....	125 ft (38 m)

*Exception No. 1: If both exposing walls of adjacent single hangar buildings are stable under fire conditions and both walls are unpierced and have a fire resistance rating of at least three hours, no distance separation shall be required, in which case the buildings shall be considered a hangar building group.*

*Exception No. 2: If one hangar has as its exposing wall a stable, unpierced wall having a fire resistance rating of two hours or longer, the distance separation may be reduced to not less than 25 ft (7.5 m) for single hangar buildings and 50 ft (15 m) for hangar building groups.*

*Exception No. 3: If the exposing walls of both buildings are stable under fire conditions, have a fire resistance rating of two hours or longer with all windows protected by wired glass in fixed steel sash (approved Class E type) with outside sprinkler protection, and each doorway is protected with one automatically operated approved*

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*Class D fire door, the clear space may be reduced to not less than 25 ft (7.5 m) for single hangar buildings and 50 ft (15 m) for hanger building groups. Glass area in the exposing walls under such conditions shall not be more than 25 percent of the wall area. (See NFPA 80, Fire Doors and Windows.)*

## Chapter 6 Common Structural Requirements

**6-1\* Mezzanines, Tool Rooms, etc.** Mezzanine floors, tool rooms, and other enclosures within aircraft storage and servicing areas shall be of noncombustible construction in all but wood frame hangars (*see Section 4-5*).

### 6-2 Floors.

**6-2.1** The surface of the grade floor of aircraft storage and servicing areas, regardless of type of hangar construction, shall be non-combustible and above the grade of the approach or apron at the entrance to the hangar.

**6-2.2** The floors of adjoining and communicating areas, regardless of type of hangar construction, shall be as specified in 6-2.1 wherever the occupancy conditions present special hazards (as in spray painting or doping areas, flammable liquid storage or mixing rooms, cutting and welding areas, etc.).

**6-3 Floor Openings.** 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 in which the opening is made.

### 6-4 Roofs.

**6-4.1 Roof Coverings.** Roof coverings shall be of an approved type of tile, slate, metal, asbestos, asphalt shingles or of built-up roofing finished with asphalt, slate or gravel or other approved material. Roof coverings which are listed by Underwriters Laboratories Inc. as Class "A" or "B" shall be accepted as meeting the requirements of this paragraph. Underwriters Laboratories approved Class "C" roof coverings may be used on wood frame hangars (*see Section 4-5*).

**6-4.2 Roof Decks.** Except where roof coverings are of a character permitting attachment direct to framework, roof decks shall be solid or close fitting. (*See Sections 4-1, 4-2, 4-3, 4-4 or 4-5 for materials used and desired fire resistance ratings.*)

**6-4.3 Roof Insulation.** Approved types of insulation shall be used on top of the roof deck provided such installation is covered with an approved type of roof covering applied directly thereto.

**6-4.4 Roof Spaces.** When suspended ceilings are provided in aircraft storage and servicing areas, the roof space shall be cut off from the area below so that the roof space cannot be used for storage or other occupancy. The roof space shall be provided with ventilation louvers to assure air circulation therein.

**6-4.5 Ladders to Roofs.** Unless enclosed stairs leading directly to the roof of aircraft storage and servicing areas are available from the exterior of the hangar, adequate permanent exterior ladders to hangar roofs shall be provided on all hangars exceeding 25,000 sq ft (2 323 m<sup>2</sup>) in area, or exceeding 40 ft (12 m) in height, or exceeding 100 ft (30 m) in the smallest dimension to assure access in case of fire emergencies.

## **6-5 Protection of Structural Steel.**

**6-5.1 Columns.** All main structural columns within the aircraft storage and servicing areas shall be made fire resistant using approved materials and methods to give a fire-resistive rating of not less than two hours. Fixed water or foam-water deluge systems may be used in lieu of two-hour fire resistant rating, if such systems are designed specifically to protect the columns.

**6-5.2 Fire Resistant Materials.** All fire resistant materials used to protect structural steel shall be of a type that will resist damage from discharge of the fixed fire protection system.

## **6-6 Doors and Curtains.**

### **6-6.1 Doors to Accommodate Aircraft.**

**6-6.1.1** Hangar doors to accommodate aircraft shall be of noncombustible construction when hangar walls are of fire-resistive or noncombustible construction. (*See Sections 4-1, 4-2, 4-3, and 4-4.*)

**6-6.1.2** The power source for hangar doors shall be on independent circuits and shall not be disengaged when the main disconnect switches for general hangar power are shut off.

**6-6.1.3** Vertical acting doors shall be so counter-balanced, and horizontal slide- or accordion-type doors shall be so arranged that manual or auxiliary operation (as with winches or tractors) is feasible. Preplanning shall assure availability of necessary auxiliary equipment (such as tractors, cables, grappels, etc.) where manual operation is either not possible or too slow to allow prompt aircraft removal.

**6-6.1.4** In areas where freezing temperatures may occur, door tracks or the bottom edges of doors shall be protected (by heating coils or equivalent means) to prevent ice formation which might prevent or delay operation. (See also 7-2.3.)

**6-6.2 Other Exterior Doors.** See Section 5-6 for exposure protection for exterior doors in certain locations and Chapter 11 with regard to exit doors.

**6-6.3 Curtains Enclosing Work Areas.** Where curtains are used to enclose a work area, they shall be of a listed flame resistant type.

### **6-7\* Landing Gear Pits and Tunnels.**

**6-7.1 General.** Landing gear pits and associated access or ventilation tunnels located below floor level shall be designed on the basis that flammable liquids and vapor will be present at all times. Materials and equipment shall be of fire resistant or noncombustible construction.

**6-7.2 Electrical Equipment.** Electrical equipment for all landing gear pits, ducts and tunnels located below hangar floor level shall be suitable for use in Class I, Division 1, Group D hazardous locations in compliance with Article 501 of NFPA 70, *National Electrical Code*®.

### **6-7.3 Mechanical Ventilation.**

**6-7.3.1** All landing gear pits, ducts, and tunnels shall be provided with a positive mechanical exhaust ventilation system capable of providing air changes at the rate of five per hour during normal operations and be designed to discharge externally to the hangar.

**6-7.3.2** In addition, the ventilation system shall be capable of providing a ventilation rate of thirty air changes per hour for the landing gear pit and all associated ducts or tunnels upon the detection of flammable vapors.

**6-7.3.3** The ventilation system shall be connected to a properly designed and installed continuous-reading combustible gas analyzing system that is arranged to operate the ventilation system at the higher rate specified in 6-7.3.2 automatically upon detection of a specified flammable vapor concentration that is below the lower flammable limit. The detection system shall have sensors located throughout all ducts and tunnels.

**6-7.4 Drainage.** As entry of fuel, oil, and water into landing gear pits is inevitable, drainage or pumping facilities shall be provided. Water trapped vapor seals and appropriate separator fuel traps shall be provided. Where automatic pumping facilities are necessary, they shall be suitable for use with aviation fuel and water. If drainage is routed through ventilation or access tunnels to external discharge points, the drainage shall be fully enclosed pipe runs.

**6-7.5\* Explosion Protection.** 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, *Standard on Explosion Prevention Systems*.

**6-7.6\* Fire Protection.** An approved fire protection system shall be installed to protect each pit unless the hangar fire protection specified in Parts C or D are adequate.

## **6-8 Exposed Interior Thermal Insulation.**

**6-8.1** The use of exposed interior thermal insulation attached to walls and roofs in an aircraft storage and servicing area of a hangar not provided with a sprinkler system designed in accordance with Chapter 12 or Chapter 18, as applicable, shall be noncombustible as defined in NFPA 220, *Standard on Types of Building Construction*.

**6-8.2** In an aircraft storage and servicing area of a hanger equipped with an approved sprinkler system designed in accordance with Chapter 12 or Chapter 18, as applicable, exposed interior thermal insulation attached to walls and roofs shall be noncombustible or limited-combustible as defined in NFPA 220, *Standard on Types of Building Construction*.

## Chapter 7 Drainage of Aprons and Hangar Floors

**7-1 Apron Drainage.** The apron or approach at the entrance to the hangar shall slope away from the hangar with a minimum grade of one-half of one percent (1:200) for the first 50 ft (15 m). Ramps used for aircraft fueling adjacent to hangar structures shall comply with NFPA 415, *Standard on Aircraft Fueling Ramp Drainage*. In establishing locations for nearby aircraft parking, consideration shall be given to the drainage pattern of the apron.

### 7-2 Hangar Floor Drainage.

#### 7-2.1\* General.

**7-2.1.1** Floor drainage systems shall be provided to restrict the spread of fuel and provide means to reduce the fire and explosion hazards from fuel spillage.

**7-2.1.2** Drainage systems shall be designed to reduce fire and explosion hazards within the systems to the maximum extent by the use of fire-resistive underground piping and by as direct routing as possible to a safe outside location. Such systems shall be designed with suitable traps or provided with adequate ventilation to prevent vapor mixtures forming within the underground drainage system.

#### 7-2.2 Interior Drainage Systems.

**7-2.2.1\*** Drainage systems in aircraft storage or servicing areas protected by water deluge sprinkler systems shall be so designed and constructed that they have sufficient capacity to prevent buildup of flammable liquids and water (ponding effect) over the drain inlet when the water deluge sprinkler systems and hose streams are discharging at the design rate. In general, this will mean that the design must be adequate to assure that the liquid level at the center of the drain is below the top surface of the drain inlet grating for grated round, rectangular or long trench-type inlets, or the floor surface in the case of a slit trench.

**7-2.2.2** Where the hangar is protected by water deluge systems as specified in Section 12-9, the pitch of the floor shall be a minimum of one percent. Where the hangar is protected by foam-water sprinkler systems as specified in Section 12-10, the pitch of the floor shall be a minimum of one-half of one percent. The floor pitch provided shall take into consideration the towability of the aircraft and the problems of aircraft maintenance, weight and balance checking, etc.

**7-2.2.3\*** Each drainage system shall be calculated separately taking into consideration the maximum rated discharge from the fire protection systems and hose lines.

**7-2.2.4** The size of drainage piping shall be determined by the hydraulic demands placed upon the system throughout its length.

**7-2.3\*** **Openings from Aircraft Storage and Servicing Areas.** Drains, curbs, or ramps shall be provided to prevent flow of liquids from aircraft storage and servicing areas through openings to shops, offices or other communicating areas during fuel spill or fire emergencies.

**7-2.4 Pit Drainage.** Pits for service facilities (e.g., for compressed air, electrical outlets, etc.) shall drain into the floor drainage system.

**7-2.5 Oil Separators.** Oil separators shall be provided for the drainage systems serving all aircraft storage and servicing areas. These separators may be for each hangar drainage system, for a group of hangar drainage systems, or installed as part of a general airport drainage system. In aircraft storage and servicing areas protected by water deluge or foam-water sprinkler 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 product to a safely located tank, cistern, or sump.

**7-2.6 Drain and Separator Maintenance.** Periodic maintenance checks (at least monthly and more frequently if necessary) and flushing shall be conducted on all drains and oil separators to assure that they are clear of obstructions and function in the manner for which they were designed. The hangar drainage system shall not be used for disposal of flammable liquids or waste oil.

**7-2.7 Grates and Drain Covers.** Grates and drain covers shall be of sufficient strength to take the point loading of the heaviest type aircraft or equipment which the hangar serves. Grates and covers shall be removable to facilitate cleaning and flushing.

## Chapter 8 Draft Stops in Sprinklered Hangars

**8-1\* Materials.** Where provided, draft stops shall be constructed of noncombustible materials not subject to disintegration or fusion during the early stages of a fire and shall be tightly fitted to the underside of the roof or ceiling. Any opening in draft stops shall be provided with self-closing doors of materials equivalent in fire resistance to the draft stop itself.

## Chapter 9 Hangar Services and Utilities

### 9-1 Heating. (See Appendix E.)

**Caution:** It should be noted that fire protection equipment in aircraft hangars is frequently of a type which depends on rate-of-temperature-rise at the ceiling and that the sudden input of large quantities of heated air at any point may endanger the correct operation of automatic fire extinguishing and alarm equipment.

**9-1.1\* General.** No heater employing an open flame or glowing element shall be installed in aircraft storage and servicing areas or sections communicating therewith, except as authorized in 9-1.1.2 or 9-1.1.3.

**9-1.1.1** Heating equipment shall be installed, as applicable, in accordance with NFPA 90A, *Standard on Installation of Air Conditioning and Ventilating Systems*; NFPA 31, *Installation of Oil Burning Equipment*; and NFPA 54, *National Fuel Gas Code*, except as hereinafter specifically provided.

**9-1.1.2** Hangar heating plants fired with gas, liquid or solid fuels (not covered under 9-1.2, herein) which 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 one-hour fire resistance rating. 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. Openings in the walls of such rooms communicating with other portions of the hangar shall be restricted to those necessary for ducts or pipes and each such duct shall be protected with a listed automatic fire damper or door. All air for combustion purposes entering such separated rooms shall be drawn from outside of the building.

**9-1.1.3** Fan furnace heating systems employing recirculation of air within aircraft storage and servicing areas shall have return air openings not less than 10 ft (3 m) above the floor. Supply air openings shall not be installed in the floor and shall be at least 6 in. (152 mm) from the floor measured to the bottom of the opening. Fans for such systems shall be arranged to shut down automatically by the operation of the interior automatic fire protection system. One or more manual fan shutoff switches shall also be provided. Shutoff switches shall be accessible and clearly placarded. Personnel shall be fully instructed that in event of a serious gasoline or similar flammable liquid spill on the hangar floor, the fans should be shut off.

**9-1.2 Suspended or Elevated Heaters.** Electric, gas or oil heaters, listed for use in aircraft hangars, may be used if installed as specified in 9-1.2.1, 9-1.2.2 and 9-1.2.3.

**9-1.2.1** In aircraft storage and servicing areas, they shall be installed at least 10 ft (3 m) above the upper surface of wings or of engine enclosures of the highest aircraft which may be housed in the hangar. The measure shall be made from the wing or engine enclosure, whichever is higher from the floor, to the bottom of the heater.

**9-1.2.2** In shops, offices and other sections of aircraft hangars communicating with aircraft storage or servicing areas, they shall be installed not less than 8 ft (2.4 m) above the floor.

**9-1.2.3** Suspended or elevated heaters shall be so located in all spaces of aircraft hangars that they shall not be subject to injury by aircraft, cranes, movable scaffolding or other objects. Provision shall be made to assure accessibility to suspended heaters for recurrent maintenance purposes.

**9-2 Ventilation and Blower and Exhaust Systems.** When a mechanical ventilating system is employed in hangars or shops, the ventilating system shall be installed in accordance with NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems* and in accordance with the provisions of Section 9-1. When blower and exhaust systems are installed for vapor removal, the systems shall be installed in accordance with NFPA 91, *Standard for the Installation of Blower and Exhaust Systems*.

**9-3 Lighting and Electrical Systems.**

**9-3.1** Artificial lighting shall be restricted to electricity.

**9-3.2** Electrical services shall be installed in compliance with the provisions for aircraft hangars contained in Article 513 of NFPA 70, *National Electrical Code*. (See also 6-6.1.2 on power supply to doors accommodating aircraft.)

**9-3.3** Main distribution panels, metering equipment, etc. shall be located in a suitable enclosure provided therefor and for no other hazardous purpose. This room shall be separated from the aircraft storage and servicing area by a solid, unpierced partition having at least a one-hour fire resistance rating.

**9-4\*** **Lightning Protection.** Where provided, lightning protection shall be installed in accordance with NFPA 78, *Lightning Protection Code*.

## Chapter 10 Grounding Facilities for Static Electricity

**10-1\* General.** Grounding facilities shall be provided for removal and control of static electrical accumulations on aircraft while aircraft are stored or undergoing servicing in a hangar, except that aircraft which have never been fueled or are in dead storage with fuel tanks removed or drained and purged need not be grounded.

**10-2 Installation Methods.** An adequate number of floor ground 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 (e.g., cold water or sprinkler piping) or driven electrodes. When driven electrodes are used they shall consist of  $\frac{3}{8}$ -in. (15.9-mm) diameter or larger metal rods driven at least 5 ft (1.5 m) in the ground. Floor grounding receptacles shall be designed so as to minimize the tripping hazard.

**10-3 Grounding Wires.** Grounding wires shall be bare and of a gage which will be satisfactory from the durability standpoint as influenced by mechanical strains and usage (speedometer, preformed steel or equivalent cable will minimize danger of employee hand injury).

## Chapter 11 Exit and Access Requirements

**11-1\* Exits from Aircraft Storage and Servicing Areas.** In general, exits from aircraft storage and servicing areas shall be provided at intervals of not more than 150 ft (45 m) on all exterior walls and be so located as to secure minimum interior travel distance for occupants. There shall be a minimum of two exits serving each aircraft storage and servicing area. Exits along interior fire walls shall be provided at intervals of not more than 100 ft (30 m) positioned so as to secure minimum interior travel distance for occupants. Dwarf or "smash" doors in doors accommodating aircraft may be used to comply with these requirements. All doors designated as exits (except sliding doors) shall swing in the direction of exit travel and shall be kept unlocked in the direction of exit travel while area is occupied. They shall be not less than 36 in. (914 mm) wide.

**11-2 Exits from Mezzanine Floors Located in Aircraft Storage and Servicing Areas.** Exits from mezzanine floors in aircraft storage and servicing areas shall be so arranged that the maximum travel to reach the nearest exit from any point on the mezzanine shall not exceed 75 ft (22.5 m). Such exits shall lead directly to a properly enclosed stairwell discharging directly to the exterior or to a suitably cut-off area or to outside fire escape stairs.

**11-3 Exit Signs.** Exit signs shall be provided over doors and exitways. They shall be so located as to be readily observed. Except where otherwise required by law, exit signs shall have white letters on a red field, or, for internally illuminated types, shall have red letters of translucent material in an opaque field.

**11-4 Access Aisles to Fire Fighting Equipment.** Aisles and clear space shall be maintained to assure access to sprinkler control valves, standpipe hose, fire extinguishers and similar equipment.

**11-5 Marking and Identification of Exit and Access Aisles.** Exit and access aisles shall be conspicuously and permanently marked on floors.

## PART C

## PROTECTION OF TYPE I AIRCRAFT HANGARS

## Chapter 12 Primary Protection Systems

## 12-1 Application and Definitions.

**12-1.1 Application.** This chapter covers fixed primary fire protection systems which are designed to protect Type I aircraft hangars.

**12-1.2 Sprinkler System.** The term "sprinkler system," for the purpose of this chapter, shall include:

**12-1.2.1 Foam Water Sprinkler System.** A system, pipe connected to and including a source of air-foam liquid concentrate and a water supply. Water and air-foam liquid concentrate (protein, fluoro-protein, or aqueous film forming foam [AFFF]) are delivered to open discharge devices for extinguishing agent discharge and for distribution over the area to be protected. The piping is connected to the water supply through an automatic valve which is actuated by the operation of a heat-responsive system installed in the same areas as the discharge devices. When this valve opens, water flows into the piping system, air-foam liquid concentrate is injected into the water, and the resulting discharge of air-foam solution through the foam-water discharge devices generates and distributes foam. Upon exhaustion of the air-foam liquid concentrate supply, water discharge will follow the foam and continue until shut off manually.

**12-1.2.2 Water Deluge Sprinkler System.** A system employing open sprinklers attached to and including a piping system and the connected water supply. Water is delivered to open sprinklers through a valve which is opened by the operation of a detection system installed in the same areas as the sprinklers. When this valve opens, water flows into the piping system and discharges from all sprinklers attached thereto.

**12-1.3 Detection System.** A system consisting of detectors, controls, control panels, automatic and manual actuating mechanisms, all wiring, piping, and tubing, and all associated equipment which is used to actuate the sprinkler system deluge valve.

## 12-2 General.

**12-2.1\*** Type I aircraft hangar storage and servicing areas shall be equipped with an approved sprinkler system and, where applicable, the protection specified in Chapter 13.

12-2.2 Automatic closed-head sprinkler protection shall be provided inside separate shop, office, and storage areas located inside aircraft maintenance and servicing areas, unless they are otherwise provided with automatic fire protection systems.

12-2.3 Each sprinkler system shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*; NFPA 16, *Standard for Foam-Water Sprinkler and Foam-Water Spray Systems*; NFPA 11, *Standard for Foam Extinguishing Systems*; and NFPA 11B, *Standard for Synthetic Foam and Combined Agent Systems*, as applicable and in accordance with the recommendations contained in this standard.

12-2.4 In addition to the provisions of sprinkler systems as required by this chapter, protection as required by Chapter 13 (where applicable), and Chapters 14 and 15 shall be provided.

### 12-3 Pipe and Fittings.

12-3.1\* Piping shall be standard weight, black steel pipe, or of other materials approved for use in fire protection systems.

12-3.2 Fittings shall be of a class and rating to withstand the maximum working pressure expected within the systems. Screwed and flanged fittings shall be cast iron. Grooved joint fittings shall be ductile iron, malleable iron, or steel. Wedged fittings shall be steel.

12-4\* **Plans and Specifications.** Before systems are installed, complete specifications and working plans shall be drawn to scale showing all essential details and be so made that they can be easily reproduced to provide necessary copies. Information supplied shall include:

- (a) The design purpose of the system
- (b) Discharge densities and period of discharge
- (c) Hydraulic calculations
- (d) Details of tests of available water supply
- (e) Details of proposed water supplies
- (f) Detailed layout of the piping and of the detection system
- (g) Make and type of discharge devices, operating equipment and air-foam liquid concentrate to be installed
- (h) Location and spacing of discharge devices
- (i) Pipe hanger and bracing location and installation details
- (j) Location of draft curtains
- (k) An accurate and complete layout of the area to be protected
- (l) Details of any air-foam liquid concentrate, its storage and injection and other pertinent data to provide a clear explanation of the proposed design.

**12-5 Acceptance Tests.** The following tests shall be performed prior to final acceptance of any sprinkler system in an aircraft hangar.

**12-5.1\* Flushing Underground Pipe.** Underground mains and each lead-in connection shall be flushed thoroughly before connection is made to sprinkler piping in order to remove foreign materials which may have entered during the course of installation. The minimum rate of flow for flushing lines shall include measurement of the actual flow rate used. The flow shall be continued to assure thorough cleaning.

**12-5.2 Hydrostatic Tests.** Hydrostatic pressure tests shall be conducted on each sprinkler system as specified in NFPA 13, *Standard for the Installation of Sprinkler Systems*, or NFPA 16, *Standard for Foam-Water Sprinkler Systems and Foam-Water Spray Systems*, as applicable.

**12-5.3 Flow Tests.** Full flowing tests with water only shall be made on each foam-water sprinkler and water-deluge system as a means of checking the sprinkler distribution and to assure against clogging of piping and sprinklers by foreign matter carried by the water. The maximum number of systems that may be expected to operate in case of fire, including supplementary systems, (*see 12-7.1.1, 12-7.1.2 and 12-7.1.3*) shall be in full operation simultaneously to give a check as to adequacy and condition of the water supply. Suitable gage connections and gages shall be provided to verify hydraulic calculations (*see 12-8.4*). In addition, flow tests for foam-water sprinkler installations shall include:

**12-5.3.1** The discharge of a single system using air-foam liquid concentrate.

**12.5.3.2** The simultaneous discharge with foam of the maximum number of systems expected to operate.

The latter tests shall be run with a stabilized discharge.

**12-6 Final Approval.** The installing company shall furnish a written statement that the work has been completed in accordance with Section 12-4 and tested in accordance with the provisions of Section 12-5.

## **12-7 Water Supply.**

**12-7.1\* Sprinkler System Only.** Supply shall be capable of furnishing water for the largest number of systems which may be expected to operate, determined as follows:

**12-7.1.1** In aircraft storage and servicing areas having a maximum roof or ceiling height of 25 ft (7.5 m) or less, the water supply shall be sufficient for the operation of the largest number of systems, obtained by assuming that a fire at any point will operate all the systems in every draft-curtained area that is wholly or partially within 50 ft (15 m) of that point measured horizontally.

**12-7.1.2** In aircraft storage and servicing areas having a maximum roof or ceiling height in excess of 25 ft (7.5 m) but not more than 75 ft (22.5 m) above floor level, the water supply shall be sufficient for the operation of the largest number of systems, obtained by assuming that a fire at any point will operate all the systems in every draft-curtained area that is wholly or partially within 75 ft (22.5 m) of that point measured horizontally.

**12-7.1.3** In aircraft storage and servicing areas having a maximum roof or ceiling height in excess of 75 ft (22.5 m) above the floor level, the water supply shall be sufficient for the operation of the largest number of systems, obtained by assuming that a fire at any point will operate all the systems in every draft-curtained area that is wholly or partially within 100 ft (30 m) of that point measured horizontally.

**12-7.2\* Water Supply Duration.** The water supply duration specified herein is based on the relative effectiveness of the overall fire protection features provided within a hangar.

**12-7.2.1** The supply shall be capable of maintaining water discharge at the design rate and pressure for a minimum of 60 min over the entire area protected by systems expected to operate simultaneously as determined by 12-7.1, unless protection is provided as specified in 12-7.2.2 and 12-7.2.3.

**12-7.2.2** Where foam-water systems are installed in accordance with 12-1.2, where applicable supplemental protection is installed in accordance with 13-8.2 and where adequate drainage is provided as specified in Chapter 7, the water supply duration shall be for a minimum of 45 min.

**12-7.2.3** Where water deluge systems are installed in accordance with 12-1.2, where a high expansion foam system is installed in accordance with 13-8.3, and where adequate drainage is provided as specified in Chapter 7, the water supply duration shall be for a minimum of 45 min.

**12-7.3 Additional Water Requirement for Hose Streams, etc.** When the water supply for sprinklers also serves as a supply for hose streams, the total supply shall be increased by 500 gpm (1 893

L/min) and shall be included in the hydraulic calculations (*see 12-8.3*). In the case of hose streams, the calculated demand shall be at the point where supply piping for the hose station(s) connects to the system piping or fire protection underground. For hydrants, the entire calculated demand shall be applied at a point downstream of the sprinkler system lead-in connections from the fire protection underground. (*See also Section 13-6.*)

**12-7.4\* Suction Reservoirs.** Where a single reservoir is used for the basic water supply, such reservoir shall be divided into approximately equal sections, arranged so at least one half of the water supply will always be maintained in service in order to increase the reliability of the water supply. The suction line from each section shall be sized to deliver the full rated capacity of all fire pumps.

### **12-7.5 Fire Pumps.**

**12-7.5.1** Fire pumps shall be installed in accordance with NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*, and in accordance with the provisions of 12-7.5.2 through 12-7.5.6.

**12-7.5.2** The total pumping capacity shall be such that maximum demand can be met with the largest fire pump out of service.

**12-7.5.3** Pump houses and rooms shall be of fire-resistive or non-combustible construction (*see Sections 4-1 and 4-3*). Where exposed fuel storage tanks for 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, *Standard for the Installation of Sprinkler Systems*.

**12-7.5.4** Fire pumps shall be started automatically by a drop in water pressure. Where two or more electrically driven fire pumps supplied from the same electrical feeder are used, they shall be electrically designed to prevent simultaneous starting.

**12-7.5.5** Frequent operation of fire pumps shall be avoided by the installation of a small auxiliary pressure maintenance pump or other suitable means to maintain normal system pressures.

**12-7.5.6** 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 continuously attended area.

## 12-8 Sprinkler System Design — General.

12-8.1\* In aircraft storage and servicing areas, the maximum projected floor area under an individual sprinkler system shall not exceed 15,000 sq ft (1 394m<sup>2</sup>).

12-8.2 Sprinkler spacing in aircraft storage and servicing areas shall be in accordance with the requirements for extra hazard occupancies, as given in NFPA 13, *Standard for the Installation of Sprinkler Systems*. The protection area for fire-resistive construction shall be considered the floor area. For all other types of construction, the spacing as projected on the floor shall be no wider than required for extra hazard occupancies, but in no case shall the spacing on the roof or ceiling be wider than required for ordinary hazard occupancies. In other portions of hangars protected by sprinklers, the spacing shall be in accordance with the hazard requirements of the areas involved. (See *Appendix E for further information.*)

12-8.3 System piping shall be hydraulically calculated and sized to allow for friction loss in water supply piping. Pipe sizes shall be adjusted according to detailed friction loss calculation. These calculations shall show the relationship between water supply and total demand.

12-8.4 Uniform sprinkler discharge shall be based on a maximum variation of 15 percent above the required discharge rates in gallons per minute per square foot. Variation below the required discharge rate as specified shall not be permitted. When steel pipe is installed the coefficient C in Hazen & Williams formula shall be taken as 120 in the calculations.

12-8.5 Where open hangar doors result in interference with the distribution of water from the hangar sprinkler systems, additional sprinklers shall be provided to assure effective floor coverage.

12-9 **Water Deluge Sprinkler Systems.** The discharge density from water deluge sprinkler systems shall be a minimum of 0.25 gal of water per min per sq ft [(10.2 L/min)/m<sup>2</sup>] of floor area.

## 12-10 Foam-Water Sprinkler Systems.

12-10.1 Discharge devices used in these systems are either air-aspirating or non-air-aspirating and shall have deflectors designed to produce water discharge patterns closely comparable to those of

“standard” sprinklers (nomenclature from NFPA 13, *Standard for the Installation of Sprinkler Systems*), when discharging at the same rates of flow. They shall generate air-foam when supplied with the air-foam solution under pressure and shall distribute the foam in a pattern essentially similar to that of water discharging therefrom. These discharge devices shall have a minimum nominal  $\frac{1}{4}$ -in. (6.4-mm) orifice and shall be listed for use with the particular type of air-foam solution to be used in the system.

**12-10.2** The discharge rate from air-aspirating discharge devices using protein-, fluoroprotein-, or AFFF-type air-foam solutions shall be a minimum of 0.20 gal of air-foam solution per min per sq ft [(8.1 L/min)/m<sup>2</sup>] of floor area. The discharge rate from non-air-aspirating discharge devices using AFFF-type air-foam solutions shall be a minimum of 0.16 gal of air-foam solution per min per sq ft [(6.5 L/min)/m<sup>2</sup>] of floor area.

**12-10.3\*** The quantities of air-foam liquid concentrate (either protein foam, fluoroprotein, or AFFF) shall be sufficient for a foam discharge at the design rate for a minimum of 10 min. Where the systems have been designed to have a discharge rate higher than the specified minimums, a proportionate reduction in the discharge period may be made. There shall be a directly connected equal reserve of air-foam liquid concentrate of compatible type for the system readily available. The main and reserve supply shall be satisfactory for the system installed.

**12-10.4\*** Where air-foam liquid concentrate is introduced into the water stream by pumping, there shall be two pumps, either of which can supply the air-foam liquid concentrate at the design rate. The arrangement of power supplies, controllers, piping and valves shall be consistent with NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*. Piping shall be so arranged that either pump is able to deliver the concentrate to the system from both the primary and reserve supplies (*see also 12-10.3*).

**12-10.5** The air-foam liquid concentrate storage and injection system equipment and control valves shall be located outside aircraft storage and servicing areas. The environmental conditions shall be suitable for the particular agent involved.

## **12-11 Conversion of Existing System.**

**12-11.1** In converting one type of system to another, all provisions of this chapter pertaining to new systems shall be applied. In addition, special attention shall be given to the following factors.

**12-11.1.1** The hydraulic design of the original system and the existing water supply shall be carefully considered when planning conversion.

**12-11.1.2** If water supplies are greater than necessary, the uniform discharge requirement of 12-8.4 may be waived if the required minimum discharge rate in gallons per minute per square foot is available in all areas.

**12-11.1.3** All devices and equipment, existing and new, shall be compatible so as to provide a functionally correct system.

**12-11.1.4** Converted systems shall be tested in accordance with 12-5.3.

## **12-12 Detection System Design.**

**12-12.1** Detection systems for actuating the primary protection systems shall be rate-of-rise or fixed temperature rate-compensation types. (*See Section 9-1 for precautionary considerations.*)

**12-12.2** Detection systems shall be provided with complete supervision.

**12-12.3** Manual tripping stations operable from both inside and outside the aircraft storage and servicing area shall be provided for each deluge valve.

**12-13 Protection of Landing Gear Pits and Tunnels.** (*See Section 6-7 in Part B of this standard.*)

**12-14\* Maintenance of Sprinkler Systems.**

## Chapter 13

### Supplementary Systems for External Aircraft Protection

#### 13-1\* Application and Definitions.

**13-1.1 Application.** The systems outlined in this chapter concern the provision of fixed or semi-fixed supplementary extinguishing means intended to provide protection against fuel spill fires for aircraft having wing areas in excess of 3,000 sq ft (279 m<sup>2</sup>) housed inside a hangar for storage or servicing. (See *Appendix F*.)

**13-1.2 Design Objective.** Each system shall be designed with the intent of reducing heat exposure to the aircraft to acceptable limits (temperatures below those which can cause structural damage to the aircraft) and establishing a secure and effective blanketing of any fuel spills within the protected area.

#### 13-1.3 Definitions.

**13-1.3.1 Fixed Systems.** Fixed systems shall mean equipment that is permanently installed in the hangar, connected to piped supplies of extinguishing media.

**13-1.3.2 Semi-fixed Equipment.** Semi-fixed equipment shall mean auxiliary appliances for agent application which are attached to a fixed piping system after the aircraft is in its parking position.

**13-1.3.3 Supplementary Systems.** For the purpose of this chapter, this term means an approved air-foam system. These types of foam systems are defined and covered in NFPA 11, *Standard for Foam Extinguishing Systems*, NFPA 11A, *Standard for High Expansion Foam Systems*, and NFPA 11B, *Standard for Synthetic Foam and Combined Agent Systems*.

**13-1.3.4 Detection System.** For the purpose of this chapter, this term means detectors, controls, control panels, automatic and manual actuating mechanisms, all wiring, piping and tubing, and all associated equipment which is used to actuate the supplementary system.

#### 13-2 General. (See *Appendix F*.)

**13-2.1\*** Aircraft having wing areas in excess of 3,000 sq ft (279 m<sup>2</sup>) stored or serviced inside a hangar shall be protected with a listed sup-

plementary protection system designed to protect the exterior of the aircraft from exposure to fuel spill fires.

**13-2.2** Each supplemental protection system shall be designed, installed, and maintained in accordance with NFPA 11, *Standard for Foam Extinguishing Systems*, NFPA 11A, *Standard for High Expansion Foam Systems*, and NFPA 11B, *Standard for Synthetic Foam and Combined Agent Systems*, where applicable.

**13-3\* Plans and Specifications.** Before systems are installed, complete specifications and working plans shall be drawn to scale showing all essential details and be so made that they can be easily reproduced to provide necessary copies and shall include:

- (a) An accurate and complete layout of the area to be protected.
- (b) Information on the primary protection systems installed in the hangar.
- (c) Location and spacing of agent distributors, showing the area coverage.
- (d) Installation layout of the detection systems.
- (e) Detailed layout of water supply piping, agent storage, pumping and piping power sources, and location and details of mechanical foam liquid concentrate injection equipment.
- (f) Make and type of discharge devices and air-foam liquid concentrate and hydraulic calculations of the systems.

**13-4 Acceptance Tests.** The following tests shall be performed prior to final acceptance:

**13-4.1 Hydrostatic Tests.** All piping shall be subjected to a 2-hour hydrostatic pressure test at 200 lb/sq in. (1 380 kPa) or 50 lb/sq in. (345 kPa) in excess of the maximum pressure anticipated, whichever is greater, in general conformity with NFPA 13, *Standard for the Installation of Sprinkler Systems*. All normally dry piping shall be checked for leakage, freedom of obstructions, and to determine if proper drainage pitch has been provided.

**13-4.2 Operating Tests.** All devices and equipment installed as part of the system shall be tested.

**13-4.3 Discharge Tests.** Supplementary extinguishing systems shall be subjected to flow tests, with water or foam flowing simultaneously from the maximum number of primary protection systems expected to operate, in order to insure that the hazard is protected in conformance with the design specification and to determine if the flow pressures, agent discharge capacity, foam quality, consumption rate of extinguishing agent, manpower requirements, and other operating characteristics are satisfactory.

**13-4.4 Visual Inspections.** Supplementary extinguishing systems shall be examined visually to determine that they have been properly installed. 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 properly identified and operating instructions prominently posted.

**13-5 Final Approval.** The installing company shall furnish a written statement to the effect that the work has been completed in accordance with Section 13-3 and tested in accordance with Section 13-4.

**13-6\* Water Supply.** Water shall be available in sufficient quantity and pressure to supply the maximum number of agent distributors likely to operate simultaneously in addition to meeting the demands of overhead hangar protection systems as determined in Chapter 12 and the requirements for hose stream and other equipment as determined in Chapters 14 and 15. Water shall be suitable for the production of foam.

**13-7 Foam Concentrate.** The quantities of agent shall be sufficient to provide protection specified by the requirements of this chapter.

**13-7.1** The agent supplied with system shall be that listed for use with the distribution equipment.

**13-7.2\*** There shall be a directly connected equal reserve of agent of a compatible type for the distribution system.

**13-7.3** When the agent requires pumping to the distribution system, there shall be a minimum of two pumps, either of which can supply the agent at the design rate.

**13-7.4** The agent storage facilities, pumps and injection equipment shall be located outside the aircraft storage and servicing area. Environmental conditions shall be suitable for the particular agent involved.

## 13-8 Air-Foam Systems.

**13-8.1\* General.** Low expansion air-foam systems employ AFFF, protein or fluoroprotein foam liquid concentrates. High expansion air-foam systems usually utilize surfactants as the foaming ingredient. For the protection of shielded areas beneath aircraft as covered in this chapter, local application designs shall be used for both types of foam systems.

**13-8.1.1\*** Each system shall be designed to cover a specified floor area beneath the aircraft being protected. The design objective is to achieve control of the fire within the protected area within 30 sec of system actuation and extinguishment of the fire within 60 sec.

**13-8.2 Low Expansion Foam Systems.** These systems shall be designed to cover the specified floor area beneath the aircraft by means of a horizontal foam discharge from nozzles located at or near floor level. The nozzles may be oscillating; such nozzles may be water-powered or powered by electric motors. The discharge of foam from such nozzles shall be designed to control or extinguish a fire as specified in 13-8.1.1. Other design criteria are:

**13-8.2.1** When protein- or fluoroprotein-based concentrates are used, the minimum application rate shall be 0.16 gpm of air-foam solution per sq ft [(6.5 L/min)/m<sup>2</sup>] of floor area beneath the wing and wing-center section of the aircraft protected. When AFFF concentrate is used, the minimum application rate shall be 0.10 gpm of air-foam solution per sq ft [(4.1 L/min)/m<sup>2</sup>] of floor area beneath the wing and wing-center section of the aircraft protected.

**13-8.2.2** The quantity of water and foam concentrate shall be sufficient to operate the system at the required discharge rate for a period of at least 10 min.

**13-8.2.3** If any nozzles are removed to allow moving of aircraft and other aircraft in area are still protected by the system, removal of the nozzles shall not reduce the effectiveness of the remaining system.

**13-8.2.4** Electric power reliability for concentrate pumps and oscillating nozzles shall be consistent with electric fire pump requirements given in NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*.

**13-8.2.5** Where monitor-type nozzles are used, an individual manual control valve shall be provided for each unit.

**13-8.3\* High Expansion Foam Systems.** These systems shall be designed to discharge at a rate sufficient to control or extinguish a fire as specified in 13-8.1.1. Other design criteria are:

**13-8.3.1** The quantity of water and foam concentrate shall be sufficient to operate the system at the required discharge rate for a period of 12 min.

**13-8.3.2** The foam generators shall be located at the ceiling or on exterior walls in such a way that only air from outside the aircraft storage and servicing area can be used for foam generation. Roof vents shall be located to avoid recirculation of combustion products into the air inlets of the foam generators.

**13-8.3.3** Generators shall be powered by reliable water-driven or electric motors. Electric power reliability for both generators and concentrate pumps shall be consistent with electric fire pump requirements given in NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*.

**13-8.3.4** Discharge rates shall take into consideration the sprinkler breakdown factor required in NFPA 11A, *Standard for High Expansion Foam Systems*.

**13-9\* Actuation System.**

**13-9.1** Actuation of any primary fire protection system shall simultaneously operate the supplementary extinguishing system.

**13-9.2** Actuation systems shall be provided with complete circuit supervision and be arranged in accordance with Chapter 16.

**13-9.3** Manual tripping stations shall be provided for each special protection system and shall be operable from 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.

## Chapter 14 Hand Hose Systems

**14-1 Introduction.** The intent of Chapter 14 is to provide 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 (*see 14-3.2*). For special applications, the use of carbon dioxide hand hose systems or dry chemical hand hose systems may be provided. More than one of these types of systems may be installed for the protection of the same area. In areas where building codes or local fire department regulations require independent hose connection systems, designed either for fire department use only or for use by occupants as well as the fire department, these required systems satisfy the intent of this chapter provided they are designed to permit use by the occupants, and, in the aircraft storage and servicing areas, are arranged to supply water and foam for fire extinguishing purposes.

### 14-2 General.

**14-2.1** Hand hose systems shall be installed in every hangar, including sprinklered hangars, to provide for manual fire control.

**14-2.2** The hand hose systems shall be arranged to permit application of water or other extinguishing agents on each side and into the interior of the aircraft located in each aircraft storage and servicing area.

### 14-3 Water-Foam and Water Spray Hand Hose Systems.

#### 14-3.1 Aircraft Storage and Servicing Areas.

**14-3.1.1** Water-foam hand hose systems shall be installed in aircraft storage and servicing areas. The systems shall conform with the applicable portions of NFPA 14, *Standard on Standpipe and Hose Systems*, and NFPA 11, *Standard on Foam Extinguishing Systems*, or NFPA 11B, *Standard on Synthetic Foam and Combined Agent Systems*. These hand hose systems shall be supplied from a connection to the sprinkler system header or from a direct connection to the water source. Each hand hose connection shall be a minimum of 1½ in. in size and fitted with a control valve. The hose shall be of suitable length and diameter to meet the requirements of Section 14-2 and provide a maximum flow of 60 gpm (227 L/min) at an adequate nozzle pressure. The stream range shall be calculated based on

the volume and pressures available under maximum demand conditions. The hose shall be properly racked or reeled. Hoses shall be fitted with an approved foam-maker nozzle or a combination-type nozzle designed to permit foam application or water spray. Nozzles shall be of the shutoff type or shall have a shutoff valve at the nozzle inlet.

**14-3.1.2** Foam-liquid concentrate may be supplied from a central distribution system separate from or a part of a foam-water sprinkler system or from stationary foam-liquid concentrate containers fitted with listed proportioning devices. The minimum supply of foam-liquid concentrate shall be sufficient to provide operation of at least two hand hose stations for a period of 20 min at a foam solution discharge rate of 50 gpm (189 L/min) (nominal).

**14-3.2 Shop, Office and Storage Areas of Hangars.** Except where special hazards exist and require special protection, water standpipe and hand hose systems shall be installed in accordance with the applicable portions of NFPA 14, *Standard on Standpipe and Hose Systems*. Hoses shall be fitted with a listed combination-type nozzle designed to permit solid-stream or water-spray application.

#### **14-4 Carbon Dioxide or Dry Chemical Hand Hose Systems.**

**14-4.1** Carbon dioxide and dry chemical standpipe and hand hose systems are also effective in combatting flammable liquid, electrical and aircraft fires and may be installed in aircraft storage and servicing areas of hangars to supplement the required foam-water hose systems.

**14-4.2** Where provided, carbon dioxide hand hose systems in aircraft storage and servicing areas shall be installed in accordance with Chapter 4 of NFPA 12, *Standard for Carbon Dioxide Extinguishing Systems*, except as outlined herein:

**14-4.2.1** The supply pipe and length of hose shall be designed to provide an effective discharge of carbon dioxide within 30 sec after actuation.

**14-4.2.2** Hose shall be of a type that will permit discharge without complete removal from the reel or rack.

**14-4.2.3** The carbon dioxide supply and distribution system shall be adequate to provide for continuous operation of two hand hose lines for at least 2½ min at a discharge rate of at least 200 lb/min (90 g/min) per hand hose line.

**14-4.3** Where provided, dry chemical hand hose systems in aircraft storage and servicing areas shall be installed in accordance with NFPA 17, *Standard for Dry Chemical Extinguishing Systems*.

*Exception No. 1: The supply pipe and length of hose shall be designed to provide an effective discharge of dry chemical within 30 sec after actuation.*

*Exception No. 2: The dry chemical supply and distribution system shall be adequate to provide for continuous operation of two hand hose lines for at least 2½ min at a discharge rate of at least 200 lb/min (90 kg/min) per hand hose line.*

NOTE: Do not permit hose to stay on reel or rack during use since this will cause restriction in discharge of dry chemical.

## Chapter 15 Wheeled and Portable Extinguishers

15-1 Wheeled and portable extinguishers shall be provided in accordance with NFPA 10, *Standard for the Installation, Maintenance, and Use of Portable Fire Extinguishers*. In aircraft storage and servicing areas, the distribution of such devices shall be in accordance with the extra hazard classification outlined in Chapter 4 of NFPA 10. 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 such room or area following the requirements in NFPA 10.

## Chapter 16 Protection System Alarms and Fire Detection Systems

**16-1 Protection System Alarms.** In addition to local alarm service, alarms shall be transmitted to a constantly attended location. [*See the NFPA Standards for Protective Signaling Systems (NFPA 71, 72A, 72B, 72C, and 72D).*]

## Chapter 17 Employee Organization for Firesafety

**17-1** All personnel engaged in aircraft maintenance operations and all other persons regularly employed and working in or around aircraft hangars shall be instructed in fire prevention practices as part of their regular training. These personnel shall also be trained in the operation of all portable fire extinguishers and hose line systems provided in the hangar, shop or office area where they work.

**17-2** Selected personnel on each operational shift plus all watchmen or security guards shall be trained in the operation of the fixed fire protection systems provided in the hangar, shop or office area where they work. This training shall be accompanied by a comprehensive explanation of all features of such systems and the areas they protect.

**17-3** Responsibility for fire protection equipment inspection and maintenance shall be assigned to key personnel.

## PART D

### PROTECTION OF TYPE II AIRCRAFT HANGARS

#### Chapter 18 Fire Protection Systems

##### 18-1 Application and Definitions.

**18-1.1 Application.** The systems described in this chapter concern the provisions of fire protection means for the protection of Type II aircraft hangars. (See 2-1.2.)

**18-1.2 Sprinkler Systems.** For the purpose of this chapter, the term "sprinkler system" is defined as a hydraulically calculated closed wet-pipe standard sprinkler system or preaction standard sprinkler system as described in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

**18-1.3 Foam Extinguishing Systems.** The term "foam extinguishing system" for the purpose of this chapter shall mean an approved air-foam system. These types of foam systems are defined and covered in NFPA 11, *Standard for Foam Extinguishing Systems*, NFPA 11A, *Standard for High Expansion Foam Systems*, and NFPA 11B, *Standard for Synthetic Foam and Combined Agent Systems*.

**18-1.4 Detection System.** The term "detection system" for the purpose of this chapter shall mean detectors, controls, control panels, automatic and manual actuating mechanisms, all wiring, piping and tubing, and all associated equipment which is used to actuate the foam extinguishing system or preaction valve.

##### 18-2 General.

**18-2.1** The protection of Type II aircraft hangars shall be in accordance with either one of the following two possibilities:

**18-2.1.1** The provisions of Chapter 12.

*Exception: Where foam-water sprinkler systems utilizing air-aspirating discharge devices (as described in 12-10.2.1) are installed for the protection of Type II aircraft hangars, the discharge rate specified in 12-10.2 may be reduced to a minimum of 0.16 gal of air-foam solution per min per sq ft [(6.5 L/min)/m<sup>2</sup>] of floor area.*

**18-2.1.2** A combination of two systems. The first of the two required systems shall be a hydraulically calculated closed-head wet-pipe or preaction sprinkler system located under roofs, ceilings, mezzanines, etc. The second of the two required systems shall be an approved foam extinguishing system as specified later in this chapter.

**18-2.2** Sprinkler and foam extinguishing systems shall be designed and installed in accordance with the applicable sections of NFPA 11, 11A, 11B, or 13, and the provisions of this chapter.

**18-2.3** Automatic closed-head sprinkler protection shall be provided inside separate shop, office, and storage areas located inside aircraft maintenance and servicing areas, unless they are otherwise provided with automatic fire protection systems.

**18-2.4** In addition to the provision of sprinkler and foam extinguishing systems as required by this chapter, protection as required by either Chapters 14 or 15 shall be provided.

**18-3 Pipes and Fittings.** Piping and fittings shall be as specified in 12-3.1 and 12-3.2.

#### **18-4 Plans and Specifications.**

**18-4.1 Sprinkler Systems.** Plans and specifications for sprinkler systems shall provide the information required by Section 12-4.

**18-4.2 Foam Extinguishing Systems.** Plans and specifications for foam extinguishing systems shall include the information required by Section 13-3.

#### **18-5 Acceptance Tests.**

**18-5.1 Sprinkler Systems.** Acceptance tests for sprinkler systems shall be performed in accordance with 12-5.1 and 12-5.2.

**18-5.2 Foam Extinguishing Systems.** Acceptance tests for foam extinguishing systems shall be performed in accordance with 13-4.1, 13-4.2 and 13-4.4. In addition, the systems shall be subjected to flow tests with water or foam flowing from the maximum number of foam distributors expected to operate in order to insure that the hangar is protected in conformance with the design specification and to determine if the flow pressures, agent discharge capacity, foam quality (including drainage time) consumption rate of extinguishing agent, manpower requirements, and other operating characteristics are satisfactory.

**18-6 Final Approval.** The installing company shall furnish a written statement to the effect that the work has been completed in accordance with 18-4.1 and 18-4.2 and tested in accordance with the provisions of 18-5.1 and 18-5.2.

**18-7 Water Supply.** The total water supply shall be sufficient to satisfy the combination of systems used, as individually described below in 18-7.1, 18-7.2 and 18-7.3.

#### **18-7.1 Sprinkler System.**

**18-7.1.1** The water supply shall be capable of furnishing water at the design discharge density over a minimum area of 5,000 sq ft (465 m<sup>2</sup>).

**18-7.1.2** The water supply duration shall be for a minimum of 30 min.

**18-7.2 Foam Extinguishing Systems.** The water supply shall be capable of furnishing water at the required densities for the maximum number of foam distributors expected to operate simultaneously. The duration of discharge of the foam shall be 10 min for low expansion foam and 12 min for high expansion foam. Water shall be suitable for the production of foam.

#### **18-7.3 Hose Stations.**

**18-7.3.1** The water supply shall be capable of satisfying the requirements of Chapter 14 in addition to those specified in 18-7.1 and 18-7.2.

**18-7.3.2** When the water supply for the systems also serves as a supply for exterior hose streams, a hose stream allowance of 500 gpm (1 893 L/min) shall be included in the system hydraulic calculations. Calculations for hose stream shall be in accordance with Chapter 7 of NFPA 13, *Standard for the Installation of Sprinkler Systems*.

**18-7.4 Fire Pumps and Suction Reservoirs.** Where provided, fire pumps and suction reservoirs shall be designed and installed in accordance with 12-7.4 and 12-7.5.

**18-8 Foam Concentrate Supply.** The provisions of Sections 13-7 and 13-8 shall be used in determining foam concentrate supply.

## 18-9 Sprinkler System Design.

### 18-9.1 General.

18-9.1.1 In aircraft storage and servicing areas, the maximum projected floor area under an individual sprinkler system shall not exceed 25,000 sq ft (2 323 m).

18-9.1.2 Sprinkler spacing shall be as specified in 12-8.2.

18-9.1.3 Sprinkler piping shall be hydraulically calculated in accordance with Chapter 7 of NFPA 13, *Standard for the Installation of Sprinkler Systems*.

18-9.1.4 Where open hangar doors result in interference with the distribution of water from the hangar sprinkler systems, additional sprinklers shall be provided to assure effective floor coverage.

18-9.2 **Design Discharge Rate.** The discharge rate from sprinkler systems shall be a minimum of 0.17 gal of water per min per sq ft [(6.9 L/min)/m<sup>2</sup>] of floor area.

### 18-9.3 Sprinklers.

18-9.3.1 Standard sprinklers having a minimum nominal ½-in. (12.7-mm) orifice shall be used.

18-9.3.2 Sprinklers shall be of an extra high temperature classification as defined in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

## 18-10 Air-Foam System Design.

18-10.1 **General.** For the protection of Type II aircraft hangars as covered in this chapter, local application designs shall be used for the foam extinguishing systems. These systems shall be provided to protect the entire aircraft storage and servicing area.

18-10.2 **Low Expansion Foam Systems.** Low expansion foam systems shall be designed to protect an area as specified in 18-10.1. The minimum application rate shall be 0.16 gpm of air-foam solution per sq ft [(6.5 L/min)/m<sup>2</sup>] of floor area when protein or fluoroprotein base concentrates are used. When AFFF concentrate is used, the minimum application rate shall be 0.10 gpm of air-foam solution per sq ft [(4.1 L/min)/m<sup>2</sup>] of floor area. Other design criteria shall be in accordance with 13-8.2.3, 13-8.2.4 and 13-8.2.5.

**18-10.3 High Expansion Foam Systems.** High expansion foam systems shall be designed to protect an area as specified in 18-10. The application rate shall be a minimum of 3 ft/min (0.9 m/min). Other design criteria shall be in conformance with 13-8.3.1, 13-8.3.2, 13-8.3.3 and 13-8.3.4.

### **18-11 Detection System Design.**

**18-11.1** Detection systems for actuating foam extinguishing systems and preaction standard sprinkler systems shall be rate-of-rise or fixed temperature rate-compensation types.

**18-11.2** Detection systems shall be provided with complete supervision.

**18-11.3** Manual tripping stations operable from both inside and outside the aircraft storage and servicing area shall be provided for each system.

## PART E

### CONSTRUCTION AND PROTECTION FOR TYPE III AIRCRAFT HANGARS

#### Chapter 19 Definition

**19-1 Type III Aircraft Hangars.** Type III hangars can be single units for an individual aircraft, single units joined to form a row of hangars, or single units for multiple aircraft. Routine maintenance work, excluding hazardous operations such as transfer of fuel, welding, cutting, soldering, doping or spray painting, may be done in Type III hangars.

#### Chapter 20 Construction of Type III Hangars

**20-1\*** The construction of Type III hangars shall conform to the applicable portions of the recommendations contained in Part B, Construction of Aircraft Hangars, subject to the following exceptions:

**20-1.1** Shop, office or storage areas where attached to storage hangars shall be cut off as described in 20-1.2.

**20-1.2** The provisions of Section 5-3 shall apply except that in lieu of a fire wall, solid fire partitions having a fire resistance equivalent to that of the walls or roof shall be provided between each adjoining hangar. Where Type III hangars are joined, there shall be a fire partition provided between every third hangar. The provisions of Section 5-6 do not apply.

**20-1.3** Type III hangars shall be limited to one story in height and shall not be adjoined by any multistory structure.

**20-1.4** The provisions of Section 6-2 shall not exclude earth flooring for Type III hangars. Roof coverings, specified under Section 6-4 shall be "Class C" or better, as listed by a recognized testing laboratory, except that metal roof decking may also be used. Hangar aprons shall slope away from the level of the hangar floors sufficiently to prevent liquid on apron surfaces from flowing into the hangars. Where multiple Type III hangars are attached, curbing shall be used between each hangar to prevent the flow of liquids from one to the next.

**20-1.5** The provisions of Chapter 11 may be modified for Type III hangars but every hangar shall have at least one exit not requiring the opening of doors accommodating aircraft.

## **Chapter 21 Protection of Type III Hangars**

**21-1\*** The protection required for Types I and II hangars need not be followed for Type III hangars. The provisions of NFPA 10, *Standard for the Installation, Maintenance, and Use of Portable Fire Extinguishers* shall be followed. Where portable extinguishers are locked up to preclude possibility of theft, each tenant and aircraft owner shall be provided with a key for the locks.

**21-2\*** Dry grass and vegetation between Type III hangars shall be cleared so as to act as a fire break.

## Appendix A

The following notes bearing the same number as the text of the Standard on Aircraft Hangars to which they apply contain useful explanatory material and references to standards.

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

### A-1-3 General.

#### (a) Related Fire Protection Publications Dealing with Aircraft Maintenance and Servicing.

- (1) NFPA 407, *Aircraft Fuel Servicing*
- (2) NFPA 410A, *Aircraft Electrical System Maintenance Operations*
- (3) NFPA 410B, *Aircraft Breathing Oxygen System Maintenance Operations*
- (4) NFPA 410C, *Aircraft Fuel System Maintenance*
- (5) NFPA 410D, *Aircraft Cleaning, Painting, and Paint Removal*
- (6) NFPA 410E, *Aircraft Welding Operations in Hangars*
- (7) NFPA 410F, *Aircraft Cabin Cleaning and Refurbishing Operations*

#### (b) Related Fire Protection Publications Dealing with Aircraft Rescue and Fire Fighting.

- (1) NFPA 403, *Recommended Practice for Aircraft Rescue and Fire Fighting Services at Airports and Heliports*
- (2) NFPA 402, *Aircraft Rescue and Fire Fighting Operational Procedures for Airport Fire Departments*
- (3) NFPA 414, *Standard for Aircraft Rescue and Fire Fighting Vehicles*
- (4) NFPA 412, *Standard on Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles*
- (5) NFPA 422M, *Aircraft Fire Investigators Manual*

#### (c) Related Fire Protection Publications Dealing with Other Airport Fixed Properties (Short Titles).

- (1) NFPA 415, *Aircraft Fueling Ramp Drainage*
- (2) NFPA 416, *Airport Terminal Buildings*
- (3) NFPA 417, *Aircraft Loading Walkways*
- (4) NFPA 419, *Airport Water Supply Systems*

(d) **Other Applicable Airport Standards.** Applicable national or international standards should be followed with regard to the clearance distance for hangars in relation to the center line of airport runways.†

(e) **Local Fire Regulations.** It is recommended that every airport develop fire protection and prevention regulations to meet local conditions and to implement these standards on a local basis.

### A-3-1 General.

(a) **Preferential Construction.** Single hangar buildings separated by space are preferable to two or more adjoining hangars separated by fire walls.

(b) **Communicating Sections.** Shop, office and storage areas should be in separate, detached buildings. Workshops, offices and storage areas having their own roof coverings and built within aircraft storage or servicing areas should have watertight roof deck coverings.

(c) **Height Limitations.** The height of aircraft storage or servicing areas should be limited to one story regardless of type of construction. This should not be interpreted to prohibit a roof space (*see 6-4.4*) nor to prohibit multiple story adjoining or communicating structures suitably cut off by fire division walls from aircraft storage and servicing areas.

**A-4-1. Construction of Fire Walls.** Fire wall construction is covered in the National Building Code recommended by the American Insurance Association.

**A-4-2 Options in Heavy Timber Construction.** In this type construction spaced members may be composed of two or more pieces not less than 3 in. (76 mm), nominal, in thickness when blocked solidly throughout their intervening spaces or when such spaces are tightly closed by a continuous wood cover plate of not less than 2 in. (51 mm), nominal, thickness secured to the underside of members. Splice scabs should be not less than 3 in. (76 mm), nominal, thickness. When the building is protected with an approved protection system, the framing members may be reduced to not less than 3 in. (76 mm), nominal, thickness.

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†In the U.S.A., see the Advisory Circulars on airport design features available from the Federal Aviation Administration, Standards Division, Airports Service (AS-57), Washington, D. C. 20553 and Parts 77 and 139 of the Federal Air Regulations (Title 14 of Code of Federal Regulations). Internationally, see also "Annex 14 Aerodromes," issued by the International Civil Aviation Organization. Copies available from ICAO, International Aviation Building, 1080 University St., Montreal, Canada.

**A-4-3 Typical Noncombustible Materials.** Materials considered noncombustible do not ignite and burn when subject to fire; typical noncombustible materials include steel, iron, brick, tile, concrete, slate, asbestos, glass or plasters.

**A-5-2 Maximum Recommended Areas — Hangars Protected by Fire Protection Systems.** Areas recommended for single hangar buildings and hangar building groups protected with approved fire protection systems should be limited in areas as specified in Table A-5-2. Where mixed types of construction are involved, the predominating type of construction should be used. (*For clear space distances required, see Table 5-4.*)

**Table A-5-2**  
**Maximum Recommended Areas for Single Hangar Buildings and**  
**Hangar Building Groups**  
**Protected by Approved Fire Protection Systems**

Type of Construction (See Definitions, Chapter 4)	Max. Fire Area Single Hangar Bldgs.		Max. Total Area Hangar Bldg. Groups	
	(sq ft)	(m <sup>2</sup> )	(sq ft)	(m <sup>2</sup> )
Fire-resistive	200,000	18 580	500,000*	46 450*
Protected Noncombustible	160,000	14 864	400,000	37 160
Heavy Timber, Protected Ordinary or Unprotected Noncombustible	120,000	11 148	300,000	27 870
Ordinary	40,000	3 716	120,000	11 148
Protected Wood Frame	30,000	2 787	90,000	8 361
Wood Frame	20,000	1 858	60,000	5 574

\*Where walls separating fire areas have a fire-resistance rating of not less than three hours, the total area for fire-resistive construction may be unlimited.

**A-6-1 Preference for Noncombustible Construction.** Preference should be given to the use of noncombustible materials in wood frame hangars. Separate shops, offices, and storage areas should comply with the provisions of Section 5-3.

**A-6-7 Landing Gear Pits, Ducts and Tunnels.** Landing gear pits, ducts and tunnels located beneath the hangar floor should be avoided if possible because of the danger of accumulation of flammable liquids or vapors; where their use is essential, the protection measures specified in Section 6-7 shall be followed. (*For floor drainage, see Section 7-2.*)

**A-6-7.5 Venting of Landing Gear Pits.** The venting arrangements will be dependent upon the design of the pits, elevating

platforms, and means of access. It may be necessary for part of the platform surface to be grated or perforated to give adequate explosion venting area. The general principles in NFPA 68, *Explosion Venting Guide*, should be followed.

**A-6-7.6 Protection of Landing Gear Pits.** Consideration should be given to the selection of an extinguishing agent which could also be used as a means of inerting in the pit in the event that flammable vapors were present concurrent with the loss of use of the ventilation system because of power failure, maintenance, or other causes. For this reason carbon dioxide or the lower toxicity halogenated agents (UL Group 5 or 6) may be useful in this respect.

**A-7-2.1 Floor Drainage in Hangars.** Aircraft hangars may also require floor drainage systems to effectively dispose of water used for cleaning aircraft and hangar floor surfaces, possible flooding due to high ground water tables, and to drain away water discharged from the fire protection equipment provided within the structure (*see Part C, Chapters 12 and 13 and Section 14-3*). Reference may be made to NFPA 415, *Standard on Aircraft Fueling Ramp Drainage*, for guidance on drainage systems and to the Appendix of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, for information on drainage equipment and arrangements.

**A-7-2.2.1 Distance Between Drains.** The distance between drainage inlets or grids on the hangar floor should minimize the distance any spilled fuel must flow to such drains. The basic consideration is to reduce potential heat exposure to the critical structural elements of any aircraft in the hangar and any essential building structural components; other considerations are the placement and form of any accessory maintenance equipment, the slope and construction of the floor, the design and type of the fire protection systems installed, and the exposures of adjoining or communicating shop or apron area.

**A-7-2.2.3 Spillovers from Drains.** The drainage system, including high points or ridges in the hangar floor, should be so constructed as to limit spillover of fuel to adjacent areas.

**A-7-2.3 Drains at Main Hangar Doors.** Drains should be provided at main hangar doors to dispose of as much as possible of the fuel and water flow resulting from the operation of interior water sprinklers and any fire hose streams used in the hangar. Such drains should consist of grated trenches at each such door extending approximately the full width of the opening but should not pass fire

walls. In addition to the separation of the trench ends at fire walls, intermediate barriers should be provided within a trench to prevent flow of water and flammable liquids from one protected section to another. Each section of trench between such barriers should have an independent bottom drain outlet. Door trenches may be located inside or outside the door but, if outside, special precautions should be taken in cold climates to keep them clear of ice and snow. Where the door trenches are outside, bottom door seals and tracks should not interfere with efficient drainage. (See 6-6.1.4.)

### **A-8-1 Draft Stops.**

(a) **Depth.** Draft stops should extend down from the roof or ceiling of aircraft storage and servicing areas not less than one-eighth of the height from the floor to roof or ceiling. Under curved or sloping roofs extending to grade level or close to grade level, draft stops need not be continued below 16 ft (4.8 m) from the floor.

(b) **Installation.** Draft stops should be installed, preferably, at right angles to the hangar doors forming roof pockets that are rectangular in shape. Hangars that are long and narrow, however, may best be subdivided by a "grid" system of draft stops that are both at right angles and parallel to the doors. In arch-type hangars, draft stops may be hung on exposed interior roof supports running parallel to the doors. The method of installation selected should be based on securing maximum operational efficiency from the sprinkler protection taking into consideration mean wind conditions, the floor drains, the floor pitch and details of occupancy usage.

(c) **Roof Sections as Draft Stops.** Structural features of a building which accomplish the purpose of draft stops (such as roof monitors, sawtooth roofs, etc.) may be accepted in lieu of specially constructed draft stops.

**A-9-1.1 Heating.** It is recommended that hangar heating plants fired with gas, liquid or solid fuels be located in a fire-resistive or noncombustible detached building wherever possible.

**A-9-4 Lightning Protection.** All aircraft hangars should be surveyed to determine the need for approved lightning protection. When installed, such systems should bear the Master Label of Underwriters Laboratories Inc. (See *NFPA 78, Lightning Protection Code.*)

**A-10-1 Resistance for Static Grounding.** As low a resistance as possible should be secured and maintained. 10,000 ohms is a prac-

tical recommended maximum when determined by standard procedures. For further details on this subject, see NFPA 407, *Standard for Aircraft Fuel Servicing*, and NFPA 77, *Recommended Practice on Static Electricity*.

**A-11-1 Exits.** See NFPA 101<sup>®</sup>, *Life Safety Code*<sup>®</sup>, for further information.

**A-12-2.1 Purposes of Protection Systems.** An approved water deluge sprinkler system installed in the aircraft storage and servicing areas of an aircraft hangar is primarily intended to protect the hangar structure, prevent extension of the fire beyond its area of fire origin, and control, but not necessarily extinguish, any flammable liquid spill fire. When adequate floor drainage is provided, as recommended in Chapter 7, water deluge sprinkler systems may be expected to be effective in restricting the extent of damage resulting from any fire in an aircraft hangar. (See also Chapter 13.) An approved foam-water sprinkler system installed in the aircraft storage and servicing areas of an aircraft hangar provides an increased degree of protection for the hangar structure, prevents extension of fire beyond the area of fire origin, and reduces appreciably the extent of any flammable liquid spill fire. Foam discharge from discharge devices covers the floor area permitting blanketing and smothering fires in flammable liquid spills of the type that may be encountered. In the event of a serious fuel spill not resulting in fire, foam-water sprinkler systems may be operated manually and may be useful in preventing ignition until cleanup measures can be safely carried out. Floor drainage systems, as outlined in Chapter 7, should be provided where foam-water sprinkler systems are installed to aid in the disposal of the water which drains from the foam and to restrict the extent of any fuel spill. (See also Chapter 13.) In many cases the provision of adequate floor drainage (see Chapter 7) in aircraft storage and servicing areas of aircraft hangars may be difficult for technical, operational or economic reasons. Where the provision of such floor drainage is not achieved, foam discharged from foam-water sprinkler systems will provide a blanketing effect on any spilled fuel and, thus, accomplish, to a degree, similar benefits to removing the fuel by drainage. Foam-water sprinkler systems should be installed in hangars where the provision for floor drainage, as specified in Chapter 7, is not achieved. The effectiveness of either system may depend not only upon the proper installation and maintenance of the equipment and the detection system designed to operate the equipment, but also upon the provision and effective use of supplemental or manual operable fire extinguishing equipment in the aircraft storage and servicing areas of the hangar structure.