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NFPA 409 Aircraft Hangars 1990 Edition

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Policy Adopted by NFPA Board of Directors on December 3, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

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

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Errata

NFPA 409

Aircraft Hangars

1990 Edition

Reference: 3-2.3.13

The Committee on Airport Facilities notes the following error in the 1990 edition of NFPA 409, *Aircraft Hangars*. The 1990 Annual Meeting TCR Proposal 409-23 was incorrectly incorporated at the end of sentence one and should have been placed at the end of sentence two. The paragraph should read as follows:

3-2.3.13 The quantities of 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 minutes. 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 but not less than 7 minutes.

Issue Date: June 2, 1992

NFPA 409

Standard on Aircraft Hangars

1990 Edition

This edition of NFPA 409, *Standard on Aircraft Hangars*, was prepared by the Technical Committee on Airport Facilities, released by the Correlating Committee on Aviation, and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 21-24, 1990 in San Antonio, TX. It was issued by the Standards Council on July 20, 1990, with an effective date of August 17, 1990, and supersedes all previous editions.

The 1990 edition of this document has been approved by the American National Standards Institute.

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

Origin and Development of NFPA 409

The original fire protection recommendations for the construction and protection of airplane hangars were published by the National Board of Fire Underwriters (now the American Insurance Association) in 1930. Revisions were issued by the NBFU in 1931, 1943, 1945, and 1950. During the period 1943 through 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 the assignment of this standard to the Sectional Committee on Aircraft Hangars and Airport Facilities. The 1960, 1962, 1965, 1966, 1967, 1969, 1970, 1971, 1972, 1973 and 1975 editions were prepared by this sectional committee. The sectional committee was reorganized as the Technical Committee on Airport Facilities and completed a revision to NFPA 409 in 1978. The document underwent extensive editorial revision and partial technical revision in 1984. This standard was revised in 1990.

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

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Standard on

Aircraft Hangars

1990 Edition

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

Information on referenced publications can be found in Chapter 7 and Appendix B.

Chapter 1 Administration

1-1 Scope.

1-1.1 This standard contains the minimum requirements for the proper construction and protection of aircraft hangars from fire.

1-2 Purpose.

1-2.1* The purpose of this standard is to provide a reasonable degree of protection from fire for life and property in aircraft hangars, based upon sound engineering principles, test data, and field experience.

1-2.2 No part of this standard is intended to restrict new technologies or alternate arrangements, provided the level of safety prescribed by the standard is not lowered.

1-3 Definitions.

1-3.1 Aircraft Access Door. Any opening through which any portion of the aircraft is passed to gain entry to the hangar.

1-3.2 Aircraft Hangar. A building or other structure inside any part of which aircraft are housed or stored, and in which aircraft may be undergoing service, repairs, or alterations. For the purposes of this standard, aircraft hangars are classified as follows:

1-3.2.1 Group I Aircraft Hangar. A hangar having at least one of the following features and operating conditions:

(a) An aircraft access door height over 28 ft (8.5 m)

(b) A single fire area in excess of 40,000 sq ft (3716 m^2)

(c) Provision of housing for an aircraft with a tail height over 28 ft (8.5 m)

(d) Provision of housing for strategically important military aircraft as determined by the Department of Defense.

1-3.2.2 Group II Aircraft Hangar. A hangar having both of the following features:

(a) An aircraft access door height of 28 ft (8.5 m) or less; and

(b) A single fire area for specific types of construction in accordance with Table 1-3.2.2.

Table 1-3.2.2

Type of Construction	Single Fire Area Equal or Greater Than Sq Ft	(M^2)	But Not Larger Than Sq Ft	(M^2)
Type I (443) and (332)	30,001	(2,787)	40,000	(3,716)
Type II (222)	20,001	(1,858)	40,000	(3,716)
Type II (111), Type III (211), and Type IV (2HH)	15,001	(1,394)	40,000	(3,716)
Type II (000)	12,001	(1,115)	40,000	(3,716)
Type III (200)	12,001	(1,115)	40,000	(3,716)
Type V (111)	8,001	(743)	40,000	(3,716)
Type V (000)	5,001	(465)	40,000	(3,716)

1-3.2.3* Group III Aircraft Hangar. A Group III hangar may be a freestanding unit for a single aircraft, a row hangar having a common structural wall and roof system and housing multiple aircraft as well as having door openings for each aircraft, or an open bay hangar capable of housing multiple aircraft, and have both of the following features:

(a) An aircraft access door height of 28 ft (8.5 m) or less; and

(b) A single fire area that measures up to the maximum square footage permitted for specific types of construction in accordance with Table 1-3.2.3.

Table 1-3.2.3 Maximum Fire Areas for Group III Hangars

Type of Construction	Maximum Single Fire Area Sq Ft	(M^2)
Type I (443) and (332)	30,000	(2,787)
Type II (222)	20,000	(1,858)
Type II (111), Type III (211), and Type IV (2HH)	15,000	(1,394)
Type II (000)	12,000	(1,115)
Type III (200)	12,000	(1,115)
Type V (111)	8,000	(743)
Type V (000)	5,000	(465)

1-3.3 Aircraft Storage and Servicing Area. That part of a hangar normally used for the storage and servicing of one or more aircraft, not including any adjacent or contiguous areas or structures, such as shops, storage areas, and offices.

1-3.4 Approved. Acceptable to the "authority having jurisdiction."

NOTE: The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of

installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

1-3.5 Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office, or individual responsible for "approving" equipment, an installation, or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

1-3.6 Detection System. A system consisting of detectors, controls, control panels, automatic and manual actuating mechanisms, all wiring, piping, and tubing, and all associated equipment that is used to actuate an extinguishing system.

1-3.7 Drained and Purged Aircraft Fuel Tanks. Those tanks 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. This procedure is performed so that subsequent airing or ventilation cannot result in the reinstatement of a flammable or combustible atmosphere within the tanks unless or until a flammable or combustible liquid is reintroduced.

1-3.8 Fire Area. An area within an aircraft hangar subject to loss by a single fire because of lack of internal subdivisions as specified in Section 2-2 or Section 5-2 of this standard, as appropriate.

1-3.9 Foam-Water Deluge System. A system having a pipe connected to and including a source of foam liquid concentrate and a water supply. Water and foam liquid concentrate [protein, fluoroprotein, 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 that is actuated by the operation of a detection system installed in the same areas as the discharge devices. When this valve opens, water flows into the piping system, foam liquid concentrate is injected into the water, and the resulting discharge of foam solution through the foam-water discharge devices generates and distributes foam. Upon exhaustion of the foam liquid concentrate supply, water discharge will follow the foam and continue until shut off manually.

1-3.10 Hangar Building Cluster. A group of buildings with more than one area for the storage and servicing of aircraft and all attached or contiguous structures, or structures not separated as specified in 2-3.2 or 5-2.1 of this standard, as appropriate.

1-3.11 Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.

1-3.12 May. This term is used to state a permissive use, or an alternative method to a specified requirement.

1-3.13 Shall. Indicates a mandatory requirement.

1-3.14 Should. Indicates a recommendation or that which is advised but not required.

1-3.15 Single Hangar Building. A building with one area for the storage and servicing of aircraft and any attached, adjoining, or contiguous structure, such as a lean-to, shop area, or parts storage area not separated as specified in 2-3.2 or 5-2.1 of this standard, as appropriate.

1-3.16 Tail Height. The maximum tail height as stated in aircraft manufacturer's specifications.

Chapter 2 Construction of Group I and Group II Aircraft Hangars

2-1 Types of Construction.

2-1.1* Group I and Group II hangars shall be constructed of any of the types of construction specified in NFPA 220, *Standard on Types of Building Construction.*

2-1.2* Mezzanines, tool rooms, and other enclosures within aircraft storage and servicing areas shall be constructed of noncombustible material in all hangars except those of Type V (111) and (000) construction.

2-2 Internal Separations.

2-2.1* Where two or more aircraft storage and servicing areas adjoin, they shall be separated by a fire wall having not less than a 3-hr fire resistance rating. Any openings in

such fire walls communicating directly between two aircraft storage and servicing areas shall be provided with a listed 3-hr fire door or 3-hr shutter actuated from both sides of the wall. Where areas are of different heights, the tallest wall shall have a fire resistance rating of not less than 3 hours.

2-2.2 Where two or more aircraft storage and servicing areas are separated by continuous offices, shops, and parts storage areas, one of the two walls between the aircraft storage and servicing areas and the offices, shops, and parts storage areas shall comply with 2-2.1. The other wall shall comply with 2-2.3.

2-2.3* Partitions and ceilings separating aircraft storage and servicing areas from all other areas, shops, offices, and parts storage areas shall have at least 1-hr fire resistance rating with openings protected by listed fire doors having a minimum fire resistance rating of 45 min.

2-2.4 Where a storage and servicing area has an attached, adjoining, or contiguous structure, such as a lean-to, shop, office, or parts storage area, the wall common to both areas shall have at least a 1-hr fire resistance rating, with openings protected by listed fire doors having a minimum fire resistance rating of 45 minutes.

2-3 Clear Space Distance Requirements Around Hangars.

2-3.1 Precautions shall be taken to ensure ready access to hangars from all sides. Adequate separation shall be provided to reduce fire exposure between buildings. The clear spaces specified in Tables 2-3.2 and 2-3.3 shall not be used for the storage or parking of aircraft or concentrations of combustible materials, nor shall buildings of any type be erected therein.

2-3.2 For single hangar buildings, the clear space distances specified in Table 2-3.2 shall be maintained on all sides of the single hangar. Where mixed types of construction are involved, the less fire resistant type of construction shall be used to determine the separation required. Where the minimum separations specified in Table 2-3.2 cannot be met, the buildings shall be considered a hangar building cluster.

Table 2-3.2

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

2-3.2.1 Where both exposing walls and openings therein of adjacent single hangar buildings have a minimum fire resistance rating of at least 3 hrs, no minimum separation distance shall be required. These buildings shall be considered a hangar building cluster.

2-3.2.2 Where the exposing wall and any openings therein of one hangar have a minimum fire resistance rating of at least 2 hrs, the minimum separation distance may be reduced to not less than 25 ft (7.5 m) for single hangar buildings.

2-3.2.3* Where the exposing walls of both buildings have a minimum fire resistance rating of at least 2 hrs, with all windows protected by listed glass in fixed steel sash having a minimum fire resistance rating of $\frac{3}{4}$ hr, with outside sprinkler protection, and each doorway is protected with one automatically operated listed fire door having a minimum fire resistance rating of $1\frac{1}{2}$ hrs, the clear space distance may be reduced to not less than 25 ft (7.5 m) for single hangar buildings. Under such conditions, the glass area in the exposing walls shall be not more than 25 percent of the wall area.

2-3.3 The clear space distances specified in Table 2-3.3 shall be maintained on all sides of the hangar building clusters. Where mixed types of construction are involved, the less fire resistant type of construction shall be used to determine required clear space differences.

Table 2-3.3

Type of Construction	Minimum Separation Required
Type I (443) and (332)	75 ft (23 m)
Type II (222)	75 ft (23 m)
Type IV (2HH)	75 ft (23 m)
Type II (III) and Type III (211)	100 ft (30 m)
Type II (000)	100 ft (30 m)
Type III (200)	100 ft (30 m)
Type V (III) and (000)	125 ft (38 m)

2-3.3.1 Where the exposing wall and any openings therein of one hangar have a minimum fire resistance rating of at least 2 hrs, the separation distance may be reduced to not less than 50 ft (15 m) for hangar building clusters.

2-3.3.2* Where the exposing walls of both buildings have a minimum fire resistance rating of at least 2 hrs, with all windows protected by listed glass in fixed steel sash having a minimum fire resistance rating of $\frac{3}{4}$ hr, with outside sprinkler protection, and each doorway is protected with one automatically operated listed fire door having a minimum fire resistance rating of $1\frac{1}{2}$ hrs, the clear space may be reduced to not less than 50 ft (15 m) for hangar building groups. Under such conditions, the glass area in the exposing walls shall be not more than 25 percent of the wall area.

2-4 Floors.

2-4.1 The surface of the grade floor of aircraft storage and servicing areas, regardless of type of hangar construction, shall be noncombustible and above the grade of the approach or apron at the entrance to the hangar.

2-4.2* The floors of adjoining areas that pose flammable or combustible liquid spill hazards, and connect with aircraft storage and servicing areas, shall be noncombustible and shall be designed to prevent a spill from entering the aircraft storage and servicing area.

2-4.3 Floor openings in multistoried sections of hangars shall be enclosed with partitions or protected with construction having a fire resistance rating not less than that required for the floor construction in which the opening is made.

2-5 Roofs.

2-5.1 Roof coverings shall be of an approved type of tile, slate, metal, or asphalt shingle, or of built-up roofing finished with asphalt, slate, gravel, or other approved material. Roof coverings shall be listed as Class "A" or "B" when tested in accordance with NFPA 256, *Standard Methods of Fire Tests of Roof Coverings*.

2-5.2 Where insulated metal deck assemblies are used, they shall be equivalent to FM Class 1, or UL Fire Classified ratings.

2-5.3 Spaces under roofs created where suspended ceilings are provided in aircraft storage and servicing areas shall be cut off from the area below so that the space cannot be used for storage or other occupancy. The space shall be provided with ventilation louvers to ensure air circulation therein.

2-5.4 Permanent exterior ladders to hangar roofs shall be provided on all hangars exceeding 25,000 sq ft (2,323 m^2) in area, or exceeding 40 ft (12 m) in height, or exceeding 100 ft (30 m) in their smallest dimension unless enclosed stairs leading directly to the roof of aircraft storage and servicing areas are available from the exterior of the hangar.

2-6 Columns.

2-6.1 All main steel structural columns of the aircraft storage and servicing areas shall be made fire resistant using listed materials and methods to provide a fire-resistive rating of not less than 2 hrs.

2-6.2* Fixed water or foam-water systems may be used in lieu of a 2-hr fire resistant rating, if such systems are designed specifically to protect the columns.

2-6.3 All fire resistant materials used to protect structural steel columns shall be of a type that will resist damage from discharge of the fixed fire protection system.

2-7 Doors.

2-7.1 Hangar doors that accommodate aircraft shall be of noncombustible construction where hangars are of any Type I or Type II construction as specified in 2-1.1 of this chapter.

2-7.2 The power source for hangar doors shall operate on independent circuits and shall not be deenergized when the main disconnect switches for general hangar power are shut off.

2-7.3* Vertical traveling doors shall be so counterbalanced, and horizontal slide or accordion-type doors shall be so arranged, that manual or auxiliary operation by means of winches or tractors, for example, is feasible.

2-7.4 In areas where freezing temperatures can occur, door tracks or the bottom edges of doors shall be protected by heating coils or equivalent means to prevent ice formation that might prevent or delay operation.

2-8 Curtains.

2-8.1 Where curtains are used to enclose a work area, they shall be of a listed flame-retardant type.

2-9 Landing Gear Pits, Ducts, and Tunnels.

2-9.1* Landing gear pits, ducts, and tunnels located below floor level shall be designed on the premise that flammable liquids and vapor will be present at all times. Materials and equipment shall be impervious to liquids and shall be fire resistant or noncombustible.

2-9.2 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®*.

2-9.3 All landing gear pits, ducts, and tunnels shall be provided with a positive mechanical exhaust ventilation system capable of providing a minimum rate of 5 air changes per hour during normal operations and be designed to discharge externally to the hangar.

2-9.4 Upon the detection of flammable vapors, the ventilation system shall be capable of providing a minimum ventilation rate of 30 air changes per hour for the landing gear pit and all associated ducts or tunnels.

2-9.5 The ventilation system shall be controlled by an approved continuous-reading combustible gas analyzing system that is arranged to operate the ventilation system at the rate specified in 2-9.4 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.

2-9.6 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. The drainage shall be fully enclosed pipe runs if drainage is routed through ventilation or access tunnels to external discharge points.

2-9.7* Explosion protection shall be provided in landing gear pits and communicating ducts and tunnel areas in the form of pressure-relief venting or by a listed explosion prevention system installed in accordance with NFPA 69, *Standard on Explosion Prevention Systems*.

2-9.8* An approved fire protection system shall be installed to protect each pit unless the hangar fire protection required by either Chapter 3 or Chapter 4 of this standard is adequate to protect each pit.

2-10 Exposed Interior Insulation.

2-10.1 Exposed interior 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 3 or Chapter 4 of this standard, as applicable, shall be noncombustible as defined in Section 2-6 of NFPA 220, *Standard on Types of Building Construction.*

2-10.2 In an aircraft storage and servicing area of a hangar equipped with an approved sprinkler system designed in accordance with Chapter 3 or Chapter 4 of this standard, as applicable, exposed interior insulation attached to walls and roofs shall be noncombustible or limited-combustible as defined in Chapter 2 of NFPA 220, *Standard on Types of Building Construction.*

2-11 Drainage of Aprons and Hangar Floors.

2-11.1 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.

2-11.2 Hangar Floor Drainage.

2-11.2.1* Floor drainage systems shall be provided to restrict the spread of fuel in order to reduce the fire and explosion hazards from fuel spillage.

2-11.2.2 Drainage systems shall be designed to reduce fire and explosion hazards within the systems to the maximum extent by the use of noncombustible underground piping, and by routing drainage as directly as possible to a safe outside location. Such systems shall be designed with suitable traps or provided with adequate ventilation to prevent vapor mixtures from forming within the underground drainage system.

2-11.2.3* Drainage systems in aircraft storage or servicing areas shall be so designed and constructed that they have sufficient capacity to prevent buildup of flammable liquids and water over the drain inlet when all fire protection systems and hose streams are discharging at the design rate.

2-11.2.4 The pitch of the floor shall be a minimum of one-half of one percent. The floor pitch provided shall be calculated taking into consideration the towing requirements of the aircraft and the factors of aircraft weight, balance checking, and maintenance.

2-11.2.5 Each drainage system shall be calculated separately, taking into consideration the maximum rated discharge from the fire protection systems and hose lines.

2-11.2.6 The size of drainage piping shall be determined by the hydraulic demands placed upon the system throughout its length.

2-11.2.7 Curbs, ramps, or drains shall be provided at all openings from aircraft storage and servicing areas, or the slope of the floor shall be such as to prevent the flow of liquids through openings.

2-11.2.8 Pits for service facilities, such as for compressed air, electrical outlets, etc., shall drain into the floor drainage system.

2-11.2.9 Oil separators shall be provided for the drainage systems serving all aircraft storage and servicing areas. These separators may serve each hangar drainage system, a group of hangar drainage systems, or be installed as part of a general airport drainage system.

2-11.2.10 In aircraft storage and servicing areas protected by water sprinkler systems or foam-water deluge systems, a bypass shall be provided around the separator to allow for emergency direct disposal of water and flammable liquids. Separator systems shall discharge flammable liquid products to a safely located tank, cistern, or sump.

2-11.2.11 Grates and drain covers shall be of sufficient strength to support the point loading of the heaviest type aircraft or equipment that the hangar may serve. Grates and covers shall be removable to facilitate cleaning and flushing.

2-12 Heating and Ventilating.

2-12.1* Heating equipment shall be installed, as applicable, in accordance with NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*; NFPA 31, *Standard for the Installation of Oil Burning Equipment*; or NFPA 54, *National Fuel Gas Code*, except as hereinafter specifically provided.

2-12.2 No heater employing an open flame or glowing element shall be installed in aircraft storage and servicing areas or sections communicating therewith, other than as provided for in 2-12.5 of this section.

2-12.3 Hangar heating plants that are fired with gas, liquid, or solid fuels not covered under 2-12.5 of this section and that are not located in a detached building shall be located in a room separated from other parts of the hangar by construction having at least a 1-hr 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. Penetrations of the 1-hour fire resistance rated enclosure shall be firestopped with an approved material properly installed and capable of maintaining the required fire resistance rating for the enclosure. 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 the building.

2-12.4* 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.

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

2-12.5 Suspended or Elevated Heaters.

2-12.5.1 Listed electric, gas, or oil heaters may be used if installed as specified in 2-12.5.2, 2-12.5.3, and 2-12.5.4 of this subsection.

2-12.5.2 In aircraft storage and servicing areas, heaters shall be installed at least 10 ft (3 m) above the upper surface of wings or of the engine enclosures of the highest aircraft that may be housed in the hangar. The measurement shall be made from the wing or engine enclosure, whichever is higher from the floor, to the bottom of the heater.

2-12.5.3 In shops, offices, and other sections of aircraft hangars communicating with aircraft storage or servicing areas, the bottom of the heaters shall be installed not less than 8 ft (2.4 m) above the floor.

2-12.5.4 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 ensure accessibility to suspended heaters for recurrent maintenance purposes.

2-12.6 Where 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 applicable provisions of Section 2-12 of this chapter.

2-12.7 Where 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 for Dust, Stock, and Vapor Removal or Conveying*.

2-13 Lighting and Electrical Systems.

2-13.1 Artificial lighting shall be restricted to electric lighting.

2-13.2* Electrical services shall be installed in compliance with the provisions for aircraft hangars contained in Article 513 of NFPA 70, *National Electrical Code®*.

2-13.3 Main distribution panels, metering equipment, and similar electrical equipment shall be located in a room separated from the aircraft storage and servicing areas by a partition having at least a 1-hr fire resistance rating. The partition shall not be penetrated except by electrical raceways, which shall be protected by approved sealing methods maintaining the same fire resistance rating as the partition.

2-14 Lightning Protection.

2-14.1* Where provided, lightning protection shall be installed in accordance with NFPA 78, *Lightning Protection Code*.

2-15 Grounding Facilities for Static Electricity.

2-15.1* 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.

2-15.2 An adequate number of floor grounding receptacles shall be provided. The receptacles shall be either grounded through individual driven electrodes or electrically bonded together in a grid system and the entire system grounded to underground metal piping, such as cold water or sprinkler piping, or driven electrodes. Where driven electrodes are used, they shall consist of $^5/_8$-in. (15.9-mm) diameter or larger metal rods driven at least 5 ft (1.5 m) into the ground. Floor grounding receptacles shall be designed so as to minimize the tripping hazard.

2-15.3* Grounding wires shall be bare and of a gage that will be satisfactorily durable to withstand mechanical strains and usage.

2-16 Exit and Access Requirements.

2-16.1* Means of egress from the aircraft hangar shall comply with NFPA *101®*, *Life Safety Code®*.

2-16.2 Aisles and clear space shall be maintained to ensure access to sprinkler control valves, standpipe hose, fire extinguishers, and similar equipment.

2-17 Draft Curtains.

2-17.1* Materials. Where provided, draft curtains 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 constructed of materials equivalent in fire resistance to the draft stop itself.

Chapter 3 Protection of Group I Aircraft Hangars

3-1 General.

3-1.1 Group I aircraft hangar storage and servicing areas shall be equipped with an approved automatic foam-water deluge system as specified in Section 3-2 of this chapter as the primary protection system. In addition, a supplementary protection system as specified in Section 3-3 of this chapter shall also be provided where applicable.

Exception: These requirements do not apply to aircraft storage and servicing areas housing aircraft with drained and purged fuel tanks.

3-1.2 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.

3-1.3 Each sprinkler system shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and NFPA 16, *Standard on Deluge Foam-Water Sprinkler and Foam-Water Spray Systems*, as applicable, and in accordance with the requirements of this chapter.

3-1.4 Additional protection as specified in Sections 3-4 and 3-6 of this chapter, shall be provided in all Group I aircraft hangars in addition to other protection systems required by this chapter.

3-2 Sprinkler System Design and Performance.

3-2.1 Plans and Specifications.

3-2.1.1* Before systems are installed, complete specifications and working plans shall be drawn to scale showing all essential details, and they shall be easily reproducible to provide necessary copies.

3-2.1.2 Information supplied in these plans and specifications shall include:

(a) 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 systems

(g) Make and type of discharge devices, operating equipment, and 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) Accurate and complete layout of the area to be protected

(l) Details of any foam liquid concentrate, its storage and injection, and other pertinent data to provide a clear explanation of the proposed design.

3-2.2 Pipe and Fittings.

3-2.2.1 Piping shall be of materials approved for use in fire protection systems.

3-2.2.2 Fittings shall be of a class and rating sufficient 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. Welded fittings shall be steel.

3-2.2.3 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.

3-2.3 System Design.

3-2.3.1* In aircraft storage and servicing areas, the maximum projected floor area under an individual deluge system shall not exceed 15,000 sq ft (1394 m^2).

3-2.3.2 Sprinkler spacing in aircraft storage and servicing areas shall be in accordance with the requirements for extra hazard occupancies, as specified in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

3-2.3.3 The area to be protected 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.

3-2.3.4 In other portions of hangars protected by sprinklers, the spacing shall be in accordance with the hazard requirements of the areas involved.

3-2.3.5 Uniform sprinkler discharge shall be based on a maximum variation of 15 percent above the required discharge rates in gal per min per sq ft. Variation below the required discharge rate as specified shall not be permitted. Where steel pipe is installed, the coefficient C in the Hazen and Williams formula shall be taken as 120 in the calculations.

3-2.3.6 Where open hangar doors result in interference with the distribution of overhead systems, additional devices shall be provided to ensure effective floor coverage.

3-2.3.7 Foam-water deluge systems discharge devices shall be either air-aspirating or non-air-aspirating and shall have deflectors designed to produce water discharge patterns closely comparable to those of "standard" sprinklers as defined in NFPA 13, *Standard for the Installation of Sprinkler Systems*, when discharging at the same rates of flow.

3-2.3.8 The discharge devices shall generate foam where supplied with the foam solution under pressure and shall distribute the foam in a pattern essentially similar to that of water discharging therefrom.

3-2.3.9 The 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 foam liquid concentrate to be used in the system.

3-2.3.10 Strainers shall be installed in accordance with NFPA 16, *Standard for the Installation of Deluge Foam-Water Sprinkler Systems and Foam-Water Spray Systems*.

3-2.3.11 The discharge rate from air-aspirating discharge devices using protein-type, fluoroprotein-type, or AFFF-type foam solutions shall be a minimum of 0.20 gal of foam solution per min per sq ft (8.1 L/min/m^2) of floor area.

3-2.3.12 The discharge rate from non-air-aspirating discharge devices using AFFF-type foam solutions shall be a minimum of 0.16 gal of foam solution per min per sq ft (6.5 L/min/m^2) of floor area.

3-2.3.13 The quantities of 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 minutes but not less than 7 minutes. 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.

3-2.3.14* A reserve supply of foam liquid concentrate of compatible type for the system shall be directly connected to the system and readily available. The reserve supply shall be in the same quantity as the main supply.

3-2.3.15 Where foam liquid concentrate is introduced into the water stream by pumping, there shall be two pumps, either of which can supply the foam liquid concentrate at the design rate. The arrangement of power supplies, controllers, piping, and valves shall be in accordance with NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*. Piping shall be so arranged that either pump shall be able to deliver the concentrate to the system from both the primary and reserve supplies.

3-2.3.15.1 Where foam concentrate lines to the injection points are run underground or where they are run aboveground for more than 50 ft (15 m), foam concentrate in these lines shall be maintained under pressure to ensure prompt foam application and to provide a means of checking on the tightness of the system. Pressure may be maintained by a small auxiliary pump or other approved means.

3-2.3.16 The control valves, foam liquid concentrate storage, injection system, and foam concentrate pump shall be located outside aircraft storage and servicing areas. The environmental conditions shall be suitable for the particular agent involved.

3-2.4 Water Supply.

3-2.4.1* The water supply shall be capable of furnishing water for the largest number of systems that may be expected to operate.

3-2.4.1.1 Where draft curtains meeting the requirements of Section 2-17 are not provided, water supply requirements shall be calculated on the premise that all systems in the aircraft storage and servicing area not subdivided by fire walls will operate.

3-2.4.1.2 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. Sufficient water supply requirements are determined 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.

3-2.4.1.3 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. Sufficient water supply requirements are determined 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.

3-2.4.1.4 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. Sufficient water supply requirements are determined 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.

3-2.4.2 The water supply shall be capable of maintaining water discharge at the design rate and pressure for a minimum of 60 minutes covering the entire area protected by systems expected to operate simultaneously as determined by 3-2.4.1 of this section, unless protection is provided as specified in 3-2.4.3 of this section.

3-2.4.3 Where foam-water systems are installed, and where applicable additional protection is installed in accordance with Section 3-3 of this standard, the water supply duration shall be for a minimum of 45 minutes.

3-2.4.4 The water supply shall be capable of satisfying the requirements of Section 3-4 of this chapter for interior hose stations. The calculated demand shall be the demand at a point where supply piping for the interior hose station(s) connects to the system piping or fire protection underground.

3-2.4.5 Where the water supply for the system also serves as a supply for exterior hose streams, a hose stream allowance of 500 gpm (1893 L/min) shall be included in the water supply hydraulic calculations. Calculations for hose streams shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

3-2.4.6* 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 maximum water supply requirement.

3-2.5 Fire Pumps.

3-2.5.1 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 3-2.5.2 through 3-2.5.6 of this subsection.

3-2.5.2 The total pumping capacity shall be such that maximum demand can be met with the largest fire pump out of service.

3-2.5.3 Pump houses and rooms shall be of fire-resistive or noncombustible construction. Where internal combustion engines used for driving fire pumps are located inside the fire pump house or room, protection shall be provided by automatic sprinklers installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

3-2.5.4* 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 controlled to prevent simultaneous starting.

3-2.5.5 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.

3-2.5.6 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.

3-2.6 Flushing Underground Pipe.

3-2.6.1* Underground mains and each lead-in connection shall be flushed as specified in NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*.

3-2.7 Acceptance Tests.

3-2.7.1 The following tests shall be performed prior to final acceptance of any fire protection system in an aircraft hangar.

3-2.7.1.1 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 on Deluge Foam-Water Sprinkler and Foam-Water Spray Systems*, as applicable.

3-2.7.1.2 Full-flowing tests with water only shall be made on each foam-water deluge system as a means of checking the sprinkler distribution and to ensure against clogging of piping and sprinklers by foreign matter carried by the water. The maximum number of systems that may be expected to operate in case of fire, including supplementary systems, shall be in full operation simultaneously to provide a check on the adequacy and condition of the water supply. Suitable gage connections and gages shall be provided to verify hydraulic calculations.

3-2.7.1.3 The smallest single foam-water deluge system shall be discharged using foam liquid concentrate. This test shall be run for a length of time sufficient to stabilize discharge before test samples are taken to determine foam concentrate percentage.

3-2.7.1.4 The maximum number of systems expected to operate shall be simultaneously discharged with foam. This test shall be run for a length of time sufficient to stabilize discharge before test samples are taken to determine foam concentrate percentage.

3-2.8 Final Approval.

3-2.8.1 The installing company shall furnish a written statement that the work has been completed in accordance with 3-2.1 of this section, and tested in accordance with the provisions of 3-2.7 of this section.

3-2.9 Conversion of Existing System.

3-2.9.1 In converting one type of system to another, all provisions of this chapter pertaining to new systems shall be applied.

3-2.9.1.1 If water supplies are greater than necessary, the uniform discharge requirement of 3-2.3.5 of this section may be waived if the required minimum discharge rate in gal per min per sq ft is available in all areas.

3-2.9.2 All devices and equipment, existing and new, shall be compatible so as to provide a functionally correct system.

3-2.9.3 Converted systems shall be tested in accordance with 3-2.7.1.2 of this section.

3-2.10 Detection System Design.

3-2.10.1 Detectors for actuating the primary protection systems shall be rate-of-rise, fixed temperature, or rate-compensation types.

3-2.10.2 Detection systems shall be provided with complete supervision.

3-2.10.3* Manual actuation stations shall be located so that each system can be individually operated from both inside and outside the aircraft storage and servicing area. The manual stations shall be installed so that they are unobstructed, readily accessible, and located in the normal paths of exit from the area.

3-3 Supplementary Protection Systems.

3-3.1* Hangars housing aircraft having wing areas in excess of 3,000 sq ft (279 m^2) shall be protected with a listed supplementary protection system.

3-3.2* Each system shall be designed to cover a specified floor area beneath the aircraft being protected. The design objective shall be to achieve control of the fire within the protected area within 30 seconds of system actuation and extinguishment of the fire within 60 seconds.

3-3.3 Each supplemental protection system shall be designed, installed, and maintained in accordance with NFPA 11, *Standard for Low Expansion Foam and Combined Agent Systems*, and NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*.

3-3.4 Plans and Specifications.

3-3.4.1* Before systems are installed, complete specifications and working plans shall be drawn to scale showing all essential details, and they shall be easily reproducible to provide necessary copies.

3-3.4.2* These plans and specifications shall include:

(a) 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 actuation 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 foam liquid concentrate and hydraulic calculations of the systems.

3-3.5 Low Expansion Foam Systems.

3-3.5.1 Low expansion foam systems shall employ AFFF, protein, or fluoroprotein foam-liquid concentrates and shall be designed for local application.

3-3.5.2* Coverage of the specified floor area beneath the aircraft shall be by means of a horizontal foam discharge from nozzles located above floor level.

3-3.5.3* Where oscillating nozzles are used, the discharge pattern limits shall be established for the design. Positive securement of the limits of oscillation shall be provided by such devices as set screws, locking pins, or similar methods. When placed in service, the manual override feature, if any, shall be locked out to provide for automatic operation only.

3-3.5.4 Where protein- or fluoroprotein-based concentrates are used, the minimum application rate shall be 0.16 gpm of foam solution per sq ft (6.5 L/min/m^2) of floor area beneath the wing and wing-center section of the aircraft. Where AFFF concentrate is used, the minimum application rate shall be 0.10 gpm of foam solution per sq ft (4.1 L/min/m^2) of floor area beneath the wing and wing-center section of the aircraft.

3-3.5.5 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 minutes.

3-3.5.6 If any nozzles are removed to allow movement of the aircraft, removal of the nozzles shall not reduce the effectiveness of the remaining system.

3-3.5.7 Electric power reliability for concentrate pumps and oscillating nozzles shall be in accordance with electric fire pump requirements of NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps.*

3-3.5.8 Where monitor-type nozzles are used, an individual manual control valve shall be provided for each unit.

3-3.6 High Expansion Foam Systems.

3-3.6.1 High expansion foam systems shall utilize surfactants as the foaming ingredient and shall be designed for local application.

3-3.6.2* These systems shall be designed to discharge at a rate to cover the protected area to a depth of at least 3 ft within 1 minute.

3-3.6.3 Discharge rates shall take into consideration the sprinkler breakdown factor required in 2-3.5.2(b) of NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems.*

3-3.6.4 The quantity of water and foam concentrate shall be sufficient to operate the system at the required discharge rate for a period of 12 minutes.

3-3.6.5 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.

3-3.6.6 Generators shall be powered by reliable water-driven or electric motors. Electric power reliability for both generators and concentrate pumps shall be in accordance with electric fire pump requirements of NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps.*

3-3.7 Water Supply.

3-3.7.1* 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 this Chapter, and the requirements for hose stream and other equipment as determined in Section 3-4 of this chapter. Water shall be suitable for the production of foam.

3-3.8 Foam Concentrate.

3-3.8.1 The quantities of foam concentrate shall be sufficient to provide protection specified by the requirements of this chapter.

3-3.8.2 The foam concentrate supplied with the system shall be that listed for use with the distribution equipment.

3-3.8.3* A reserve supply of foam liquid concentrate of compatible type for the system shall be directly connected to the system and readily available. The reserve supply shall be in the same quantity as the main supply.

3-3.8.4 Where the agent requires pumping to the distribution system, there shall be a minimum of two pumps, either of which can supply the foam concentrate at the design rate.

3-3.8.5 Control valves, foam concentrate liquid storage tanks, concentrate pumps, controllers, and bypass balancing equipment shall be located outside the aircraft storage and service area.

3-3.9 Acceptance Tests.

3-3.9.1 The following tests shall be performed prior to final acceptance of any supplementary system in an aircraft hangar.

3-3.9.2 All piping shall be subjected to a 2-hr hydrostatic pressure test at 200 lb/sq in. (1380 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 from obstructions, and to determine if proper drainage pitch has been provided.

3-3.9.3 All devices and equipment installed as part of the system shall be tested.

3-3.9.4 Supplementary protection systems shall be subjected to flow tests, with foam flowing simultaneously from the maximum number of primary protection systems expected to operate, in order to ensure that the hazard is protected in conformance with the design specification and to determine whether the flow pressures, agent discharge capacity, foam coverage, percent concentration, and other operating characteristics are satisfactory.

Exception: Where separate proportioning systems are utilized for the primary and supplementary protection systems, water only may be flowed in the primary protection system simultaneously with foam in the supplementary protection system.

3-3.9.5 Supplementary protection 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.

3-3.10 Final Approval.

3-3.10.1 The installing company shall furnish a written statement to the effect that the work has been completed in accordance with approved plans and specifications, and tested in accordance with 3-3.9 of this section.

3-3.11 Actuation System.

3-3.11.1* Actuation of any primary fire protection system shall simultaneously operate the supplementary extinguishing system.

3-3.11.2 Actuation systems shall be provided with complete circuit supervision and be arranged in accordance with Section 3-6 of this chapter.

3-3.11.3 Manual actuation stations shall be provided for each supplemental protection system and shall be located both inside and outside the aircraft maintenance and servicing area. Stations shall be located as close as possible to the aircraft positions to facilitate early system actuation in the event of a fire.

3-4 Hand Hose Systems.

3-4.1* Hand hose systems shall be installed in every hangar, including sprinklered hangars, to provide for manual fire control.

3-4.2 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. At least two hose lines shall be considered to be operated simultaneously.

3-4.3 Foam-Water Hand Hose Systems.

3-4.3.1 Foam-water hand hose systems shall be installed in aircraft storage and servicing areas.

Exception: Where aircraft storage and servicing areas house only aircraft with drained and purged fuel tanks, as defined in 1-3.7, hand hose systems shall be provided in accordance with 3-4.4 of this standard.

3-4.3.2 The systems shall conform with the applicable portions of NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, and NFPA 11, *Standard for Low Expansion Foam and Combined Agent Systems*.

3-4.3.3 These hand hose systems shall be supplied from a connection to the sprinkler system header or from a direct connection to the water source.

3-4.3.4 Each hand hose connection shall be a minimum of 1½ in. (38 mm) in size and fitted with a control valve. The hose shall be of suitable length and diameter to provide a minimum 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.

3-4.3.5 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.

3-4.3.6 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.

3-4.3.7 The minimum supply of foam-liquid concentrate shall be sufficient to provide operation of at least two hand hose lines for a period of 20 minutes at a foam solution discharge rate of 60 gpm (227 L/min) each.

3-4.4 Water Hand Hose Systems.

3-4.4.1 Water hand hose and standpipe systems shall be installed in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, in all shop, office, and nonaircraft storage areas in hangars, except where special hazards that require special protection exist.

3-4.4.2 Hoses shall be fitted with listed adjustable stream pattern nozzles designed to permit straight stream or water spray application.

3-5 Wheeled and Portable Extinguishers.

3-5.1 Wheeled and portable extinguishers shall be provided in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.

3-5.2 In aircraft storage and servicing areas, the distribution of such devices shall be in accordance with the extra hazard classification outlined in NFPA 10, *Standard for Portable Fire Extinguishers*.

3-5.3 The distribution of extinguishers in other areas of aircraft hangars shall be in accordance with light, ordinary, or extra hazard occupancy based on an analysis of each such room or area following the requirements of NFPA 10, *Standard for Portable Fire Extinguishers*.

3-6 Protection System Alarms.

3-6.1* In addition to local alarm service, alarms shall be transmitted to a constantly attended location.

Chapter 4 Protection of Group II Aircraft Hangars

4-1 General.

4-1.1 The protection of aircraft storage and servicing areas of Group II aircraft hangars, other than those housing aircraft with drained and purged fuel tanks, shall be in accordance with any one of the following:

(a) The provisions of Chapter 3 of this standard.

Exception: Where foam-water deluge systems utilizing air-aspirating discharge devices are installed for the protection of Group II aircraft hangars, the discharge rate specified in 3-2.3.11 of this standard may be reduced to a minimum of 0.16 gal of foam solution per min per sq ft (6.5 L/min/m^2) of floor area.

(b) A combination of automatic sprinkler protection in accordance with Section 4-2 of this chapter, AND an automatic, low-level, low expansion foam system in accordance with Section 4-3 of this chapter.

(c) A combination of automatic sprinkler protection in accordance with Section 4-2 of this chapter, AND an automatic high expansion foam system in accordance with Section 4-4 of this chapter.

4-1.2 Automatic closed-head sprinkler protection shall be provided inside separate shop, office, and storage areas located inside aircraft maintenance and servicing areas. The design shall be in accordance with hazard classifications specified in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

4-1.3 In addition to the provision for sprinkler and foam extinguishing systems as required by this chapter, protection as required by Section 3-4, Section 3-5, and Section 3-6 of this standard shall also be provided.

4-2 Sprinkler System.

4-2.1* Sprinkler systems shall be either wet pipe or preaction, designed and installed in accordance with the applicable sections of NFPA 13, *Standard for the Installation of Sprinkler Systems*, and the provisions of this chapter.

4-2.2 Sprinkler piping shall be hydraulically sized in accordance with Chapter 7 of NFPA 13, *Standard for the Installation of Sprinkler Systems*. Calculations shall be based on all sprinklers operating over any 5000-sq ft area, including the most hydraulically remote areas.

4-2.3 Piping shall be of materials approved for use in fire protection systems.

4-2.4 Fittings shall be of a class and rating sufficient 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. Welded fittings shall be steel.

4-2.5 In aircraft storage and servicing areas, the maximum projected floor area under an individual sprinkler system shall not exceed 25,000 sq ft (2323 m^2).

4-2.6 Sprinkler spacing shall be as specified in 3-2.3.2 of this standard.

4-2.7 Where open hangar doors result in interference with the distribution of water from the hangar sprinkler systems, additional sprinklers shall be provided to ensure effective floor coverage.

4-2.8 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^2) over any 5000-sq ft area, including the most hydraulically remote areas.

4-2.9 Standard sprinklers shall have a nominal orifice size of $1/2$ in. (12.7 mm) or $17/32$ in. (13.5 mm).

4-2.10 Sprinklers shall have a temperature rating of 325°F to 375°F (162°C to 190°C).

4-2.11 Plans and specifications for sprinkler systems shall provide the information required by 3-2.1 of this standard.

4-2.12 Sprinkler systems shall be flushed and tested in accordance with 3-2.6 and 3-2.7.1.1 of this standard.

4-2.13 The installing company shall furnish a written statement to the effect that the work has been completed in accordance with approved plans and specifications, and tested in accordance with the provisions of 4-2.12 of this section.

4-3 Low Expansion Foam System.

4-3.1 Foam systems shall be of the fixed type and shall be designed and installed in accordance with the applicable portions of NFPA 11, *Standard for Low Expansion Foam and Combined Agent Systems*.

4-3.2 The foam system shall use low-level monitor type discharge nozzles, with individual manual shutoff valves for each nozzle.

4-3.3* The discharge nozzles shall be arranged to achieve initial foam coverage in the expected aircraft parking area.

4-3.4 The minimum application rate shall be 0.16 gpm of foam solution per sq ft (6.5 L/min/m^2) where protein-based or fluoroprotein-based concentrate is used. Where AFFF concentrate is used, the minimum application rate shall be 0.10 gpm of foam solution per sq ft (4.1 L/min/m^2).

4-3.5 The discharge rate of the system shall be based on the rate of application multiplied by the entire aircraft storage and servicing floor area.

4-3.6 Foam Concentrate.

4-3.6.1 The quantity of foam concentrate shall be sufficient to operate the system at the required discharge rate for a period of at least 10 minutes.

4-3.6.2 The foam concentrate supplied with the system shall be listed for use with the distribution equipment.

4-3.6.3 There shall be a reserve of foam concentrate of a compatible type directly connected to the system. The reserve supply shall be in the same quantity as the main supply.

4-3.6.4 There shall be a minimum of two pumps where the foam concentrate requires pumping to the distribution system. Either pump shall be capable of supplying the foam concentrate at the design rate.

4-3.6.5 The control valves, foam-liquid concentrate storage, injection system, and foam concentrate pump shall be located outside aircraft storage and servicing areas. The environmental conditions shall be suitable for the particular agent involved.

4-3.7 Plans and specifications for foam extinguishing systems shall provide the information required by 3-3.4 of this standard.

4-3.8 Acceptance Tests.

4-3.8.1 Acceptance tests for foam extinguishing systems shall be performed in accordance with 3-3.9.2, 3-3.9.3, and 3-3.9.5 of this standard.

4-3.8.2 The systems shall be subjected to flow tests with foam flowing from the maximum number of foam distributors expected to operate in order to ensure that the hangar is protected in conformance with the design specifications, and to determine if the flow pressures, agent discharge capacity, foam coverage, percentage of concentration, and other operating characteristics are satisfactory.

4-3.8.2.1 A flow test shall be performed with only the foam system operating.

4-3.8.2.2 A flow test shall be performed with the foam system operating at the design pressure with the sprinkler system and hose demand.

4-3.9 The installing company shall furnish a written statement to the effect that the work has been completed in accordance with approved plans and specifications, and tested in accordance with the provisions of 4-3.8 of this section.

4-4 High Expansion Foam System.

4-4.1 High expansion foam systems shall be designed and installed in accordance with the applicable portions of NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*.

4-4.2 The high expansion foam system shall be of the local application type as specified in Sections 3-1, 3-2, and 3-3 of NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*.

4-4.3 The high expansion foam generators shall be arranged to achieve initial foam coverage in the anticipated aircraft parking area.

4-4.4 The effective application rate shall be a minimum of 3 cfm/sq ft. The application rate shall take into consideration the sprinkler breakdown factor specified in 2-3.5.2(b) of NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*.

4-4.5 The discharge rate of the system shall be based on the rate of application multiplied by the entire aircraft storage and servicing floor area.

4-4.6 Foam generators shall be supplied with air from outside the aircraft storage and servicing area. Roof vents shall be located to avoid recirculation of combustion products into the air inlets of the foam generators.

4-4.7 Foam generators shall be powered by reliable water-driven or electric motors. Electric power reliability for both foam generators and foam concentrate pumps shall be consistent with electric fire pump requirements specified in Chapters 6 and 7 of NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*.

4-4.8 Foam Concentrate.

4-4.8.1 The quantity of foam concentrate shall be sufficient to operate the system at the required discharge rate for a period of at least 12 minutes.

4-4.8.2 The foam concentrate supplied with the system shall be listed for use with the distribution equipment.

4-4.8.3 There shall be a reserve of foam concentrate of a compatible type directly connected to the system. The reserve supply shall be in the same quantity as the main supply.

4-4.8.4 There shall be a minimum of two pumps where the foam concentrate requires pumping to the distribution system. Either pump shall be capable of supplying the foam concentrate at the design rate.

4-4.8.5 The control valves, foam-liquid concentrate storage, injection system, and foam concentrate pump shall be located outside aircraft storage and servicing areas. The environmental conditions shall be suitable for the particular agent involved.

4-4.9 Plans and specifications for foam extinguishing systems shall provide the information required by 3-3.4 of this standard.

4-4.10 Acceptance Tests.

4-4.10.1 Acceptance tests for foam extinguishing systems shall be performed in accordance with 3-3.9.2, 3-3.9.3, and 3-3.9.5 of this standard.

4-4.10.2 The systems shall be subjected to flow tests with foam flowing from the maximum number of foam distributors expected to operate in order to ensure that the hangar is protected in conformance with the design specifications, and to determine if the flow pressures, agent discharge capacity, foam coverage, percentage of concentration, and other operating characteristics are satisfactory.

4-4.10.2.1 A flow test shall be performed with only the foam system operating.

4-4.10.2.2 A flow test shall be performed with the foam system operating at the design pressure with the sprinkler system and hose demand.

4-4.11 The installing company shall furnish a written statement to the effect that work has been completed in accordance with approved plans and specifications, and tested in accordance with the provisions of 4-4.10 of this section.

4-5 Detection and Actuation Systems.

4-5.1 Detectors for actuating high or low expansion foam systems and for actuating preaction standard sprinkler systems shall be rate-of-rise, fixed temperature, or rate-compensation type.

4-5.2 These detectors shall be installed in accordance with NFPA 72E, *Standard on Automatic Fire Detectors.*

4-5.3 Detection systems shall be provided with complete supervision.

4-5.4 Manual actuation stations shall be located so that each system can be individually operated from both inside and outside the aircraft storage and servicing area. The manual stations shall be installed so that they are unobstructed, readily accessible, and located in the normal paths of exit from the area.

4-6 Water Supply.

4-6.1 The total water supply shall be sufficient to satisfy the combination of systems and hose stations as described in 4-1.1(b), 4-1.1(c), and 4-1.3 of this chapter for durations as specified in this section.

4-6.2 The water supply for sprinkler systems shall have a minimum duration of 30 minutes at the rate specified in 4-2.8 of this chapter.

4-6.3 The water supply for low expansion foam systems shall be capable of furnishing water at the rate specified in 4-3.4 of this chapter for a minimum period of 10 minutes. Water shall be suitable for the production of foam.

4-6.4 The water supply for high expansion foam systems shall be capable of furnishing water at the rate specified in 4-4.4 of this chapter for a minimum period of 12 minutes. Water shall be suitable for the production of foam.

4-6.5 The water supply for hose stations shall be capable of satisfying the requirements of Section 3-4 of this standard, in addition to those specified in 4-6.2, and either 4-6.3 or 4-6.4 of this section. The demand shall be calculated at the point where supply piping for the hose stations connects to the system piping or fire protection underground.

4-6.6 Where the water supply for the systems also serves as a supply for exterior hose streams, a hose stream allowance of 500 gpm (1893 L/min) shall be included in the water supply hydraulic calculations. Calculations for hose stream shall be in accordance with Chapter 7 of NFPA 13, *Standard for the Installation of Sprinkler Systems.*

4-6.7 Where provided, fire pumps and suction reservoirs shall be designed and installed in accordance with 3-2.4.6 and 3-2.5 of this standard.

Chapter 5 Group III Aircraft Hangars

5-1 Construction.

5-1.1* Group III hangars shall be constructed of any of the types of construction specified in NFPA 220, *Standard on Types of Building Construction.*

5-1.2 Group III hangars shall be limited to one story. Where a Group III Hangar as defined in 1-3.2.3 exceeds one story, the hangar shall be designated as a Group II Hangar.

5-1.3 The surface of the grade floor of aircraft storage and servicing areas, regardless of type of hangar construction, shall be noncombustible and above the grade of the approach or apron at the entrance to the hangar.

5-1.4 Hangar aprons shall slope away from the level of the hangar floors to prevent liquid on the apron surfaces from flowing into the hangars.

5-1.5 In freestanding hangars for a single aircraft and in row hangars, a minimum of 6-in. (15-cm) high curbing shall be provided between each aircraft space to prevent the flow of liquid from one space to adjacent spaces.

5-1.5.1 Open bay hangars capable of housing multiple aircraft shall be provided with floor drainage in accordance with Section 2-11 of this standard.

5-1.6 Roof coverings shall be listed as Class C, or better, where tested in accordance with NFPA 256, *Standard Methods of Fire Tests of Roof Coverings.*

5-1.7 Exposed interior insulation attached to walls and roofs in aircraft storage and servicing areas shall be noncombustible as defined in NFPA 220, *Standard on Types of Building Construction.*

5-1.7.1 In an aircraft storage and servicing area of a hangar equipped with an approved sprinkler system designed in accordance with Chapter 4 of this standard, exposed interior insulation attached to walls and roofs may be limited noncombustible as defined in NFPA 220, *Standard Types of Building Construction.*

5-1.8 Egress doors for personnel that do not require the opening of doors accommodating aircraft shall be provided in each partitioned space. Intervals between doors shall not exceed 150 ft (45 m) on all exterior walls or 100 ft (30 m) along interior walls.

5-1.9 Exit signs shall be provided over exit doors.

5-2 Separation and Internal Subdivisions.

5-2.1 For single hangar buildings, the clear space distances specified in Table 5-2.1 shall be maintained on all sides of the single hangar. Where mixed types of construction are involved, the less fire resistant type of construction shall be used to determine separation required. Where the minimum separations specified in Table 5-2.1 cannot be met, the buildings shall be considered a hangar building cluster.

Table 5-2.1

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

5-2.1.1 Where single hangar buildings adjoin each other and each has fire walls with a minimum rating of at least 2 hours, located so that fire areas shall not exceed the maximum areas specified in Table 1-3.2.3 of this standard, no minimum separation distance shall be required. These buildings shall not be considered a hangar building cluster.

5-2.2 Row hangars shall be divided by solid partitions having a fire resistance equivalent to that of the exterior walls or roof, whichever is greater, so that no more than three aircraft spaces shall be within an enclosed area.

5-2.3 Partitions and ceilings separating aircraft storage and servicing areas from other areas, such as shops, offices, and parts storage areas shall have at least a 1-hr fire resistance rating with openings protected by listed fire doors having a fire resistance rating of at least 3/4 hr.

5-3 Hangar Building Clusters.

5-3.1 In hangar building clusters, Group III hangars within that cluster shall be limited in total area for the specific types of construction in accordance with Table 5-3.1. Where mixed types of construction are involved, the less fire resistant type of construction shall be used to determine the maximum allowable area in accordance with the table.

Table 5-3.1 Maximum Fire Areas for Hangar Building Clusters

Types of Construction	Hangar Building Clusters (Sq Ft)	Hangar Building Clusters (M^2)
Type I (443) and (332)	60,000	(5,574)
Type II (222)	40,000	(3,716)
Type II (111), Type III (211), and Type IV (2HH)	30,000	(2,787)
Type II (000)	24,000	(2,230)
Type III (200)	24,000	(2,230)
Type V (111)	16,000	(1,486)
Type V (000)	10,000	(929)

5-3.2 Where the total area of all Group III hangars in a cluster exceeds that specified in Table 5-3.1, selected buildings in the hangar cluster shall be considered as Group II hangars and protected in accordance with Chapter 4 of this standard. These buildings shall be selected such that the total area of the unprotected Group III hangar buildings in the hangar cluster is below the maximum area allowed by Table 5-3.1 for the less fire resistant type of construction.

5-3.3 For hangar building clusters, the clear space distances specified in Table 5-3.3 shall be maintained on all sides of the hangar building clusters. Where mixed types of construction are involved, less fire resistant type of construction shall be used.

Table 5-3.3

Type of Construction	Minimum Separation Required
Type I (433) and (332)	75 ft (23 m)
Type II (222)	75 ft (23 m)
Type IV (2HH)	75 ft (23 m)
Type II (111) and Type III (211)	100 ft (30 m)
Type II (000)	100 ft (30 m)
Type III (200)	100 ft (30 m)
Type V (111) and (000)	125 ft (38 m)

5-4 Heating and Ventilating.

5-4.1 Heating equipment shall be installed, as applicable, in accordance with NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*; NFPA 31, *Standard for the Installation of Oil Burning Equipment*; and NFPA 54, *National Fuel Gas Code*, except as hereinafter specifically provided.

5-4.2 No heater employing an open flame or glowing element shall be installed in aircraft storage and servicing areas or sections communicating therewith, except as provided for in 5-4.3 of this section.

5-4.3 Hangar heating plants that are fired with gas, liquid, or solid fuels not covered under 5-4.2 of this section, and that are not located in a detached building, shall be located in a room separated from other parts of the hangar by construction having at least a 1-hr 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. Penetrations of the 1-hour fire resistance rated enclosure shall be firestopped with an approved material properly installed and capable of maintaining the required fire resistance rating for the enclosure. 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 the building.

5-4.4* 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.

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

5-4.5 Suspended or Elevated Heaters.

5-4.5.1 Listed electric, gas, or oil heaters, may be used if installed as specified in 5-4.5.2, 5-4.5.3, and 5-4.5.4 of this subsection.

5-4.5.2 In aircraft storage and servicing areas, heaters shall be installed at least 10 ft (3 m) above the upper surface of wings or of the engine enclosures of the highest aircraft that may be housed in the hangar. The measurement shall be made from the wing or engine enclosure, whichever is higher from the floor, to the bottom of the heater.

5-4.5.3 In shops, offices, and other sections of aircraft hangars communicating with aircraft storage or servicing areas, the bottom of the heaters shall be installed not less than 8 ft (2.4 m) above the floor.

5-4.5.4 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 ensure accessibility to suspended heaters for recurrent maintenance purposes.

5-4.6 Where 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 applicable provisions of Section 5-4 of this chapter.

5-4.7 Where 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 for Dust, Stock, and Vapor Removal or Conveying*.

5-5 Lighting and Electrical Systems.

5-5.1 Artificial lighting shall be restricted to electric lighting.

5-5.2* Electrical services shall be installed in compliance with the provisions for aircraft hangars contained in Article 513 of NFPA 70, *National Electrical Code*.

5-6 Lightning Protection.

5-6.1 Where provided, lightning protection shall be installed in accordance with NFPA 78, *Lightning Protection Code*.

5-7 Grounding Facilities for Static Electricity.

5-7.1* 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.

5-7.2 An adequate number of floor grounding receptacles shall be provided. The receptacles shall be either grounded through individual driven electrodes or electrically bonded together in a grid system and the entire system grounded to underground metal piping or driven electrodes. Where driven electrodes are used, they shall consist of $^5/_8$-in. (15.9-mm) diameter or larger metal rods driven at least 5 ft (1.5 m) into the ground. Floor grounding receptacles shall be designed so as to minimize the tripping hazard.

5-7.3* Grounding wires shall be bare and of a gage that will be satisfactorily durable to withstand mechanical strains and usage.

5-8 Exit and Access Requirements.

5-8.1 Means of egress from the aircraft hangar shall comply with NFPA *101, Life Safety Code.*

5-8.2 Aisles and clear space shall be maintained to ensure access to sprinkler control valves, where provided, standpipe hose, fire extinguishers, and similar equipment.

5-9 Fire Protection for Group III Hangars.

5-9.1 Fixed fire protection systems shall not be required.

5-9.1.1 Where hazardous operations including fuel transfer, welding, torch cutting, torch soldering, doping, and spray painting are performed in any Group III hangar, the Group III hangar shall be protected with the fire protection specified in Chapter 4 of this standard, and shall also meet the requirements specified in 2-4.2 of this standard.

5-9.2 Portable fire extinguishers shall be provided in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*. Where portable extinguishers are locked up to preclude the possibility of theft, each tenant and aircraft owner shall be provided with a key for the locks.

5-9.2.1 In aircraft storage and servicing areas, the distribution of portable fire extinguishers shall be in accordance with extra hazard classification outlined in NFPA 10, *Standard for Portable Fire Extinguishers*.

5-9.2.2 The distribution of extinguishers in other areas of aircraft hangars shall be in accordance with light, ordinary, or extra hazard occupancy based on an analysis of each room or area following the requirements of NFPA 10, *Standard for Portable Fire Extinguishers*.

Chapter 6 Periodic Inspection and Testing

6-1 Fire Protection Systems.

6-1.1 Inspection and testing of fire protection systems in aircraft hangars shall be performed in accordance with Table 6-1.1.

6-1.2 Records of inspections, tests, and test results shall be maintained.

Table 6-1.1

System Components	Type and Frequency of Inspection and Tests					
	Weekly	Monthly	Semi-Ann.	Ann.	Qtrly.	5 Yrs.
Sprinkler Heads				V		
Piping				V		D
Pipe Hangers				V		
Sprinkler Alarm Valve		V			01	
Deluge Valve		V		O		D
Shutoff Valves		V		F		
Fire Pumps	F4			D		
Water Reservoirs		V				
Hose Stations		V				D
Strainers				V		
Foam Concentrate				F2		
Conc. Storage Tanks		V				
Conc. Pump	F4			O		D
Conc. Control Valve (Auto)		V		O		D
Conc. Shutoff Valve		V		F		
Foam Prop. Device		V				D
H_2O Powered Mon. Noz.		V		D		
Elec. Powered Man. Noz.		V		F		D
H_2O Powered HEF Gen.		V		O		D
Elec. Powered HEF Gen.		V		F		D
Pneumatic Detector			F	O3		
Electric Detector			F	O3		
Optical Detector	V		F	O3		
Control Panels		V	F	O		
Alarm Transmission (Local & Remote)		F				
Tamper Switch					F	
Flow Indication Switch				O		
Supervisory Alarms			F			
Manual Actuation Stations			F			
Hangar Floor Drain Sys. & Separators		V				D
Fire Doors		V		F		
Gas Detectors		V	F			
Ventilation System in Pits, Tunnels, & Ducts			F			
Grounding Equipment						F

V = Visual
F = Functional (No flow)
O = Operational (W/Flow - No Discharge)
D = Operational with actual discharge

1 = For the purposes of this test, the inspector's flow valve is acceptable.
2 = A sample should be sent to the manufacturer for analysis.
3 = At this time it is necessary to check that the set points are the same as the original.
4 = Churn test.

Chapter 7 Referenced Publications

7-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

7-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

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

NFPA 11-1988, *Standard for Low Expansion Foam and Combined Agent Systems*

NFPA 11A-1988, *Standard for Medium- and High-Expansion Foam Systems*

NFPA 13-1989, *Standard for the Installation of Sprinkler Systems*

NFPA 14-1990, *Standard for the Installation of Standpipe and Hose Systems*

NFPA 15-1990, *Standard for Water Spray Fixed Systems for Fire Protection*

NFPA 16-1986, *Standard on Deluge Foam-Water Sprinkler Foam-Water Spray Systems*

NFPA 20-1990, *Standard for the Installation of Centrifugal Fire Pumps*

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

NFPA 54-1988, *National Fuel Gas Code*

NFPA 69-1986, *Standard on Explosion Prevention Systems*

NFPA 70-1990, *National Electrical Code*

NFPA 72E-1990, *Standard on Automatic Fire Detectors*

NFPA 78-1989, *Lightning Protection Code*

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

NFPA 91-1990, *Standard for for the Installation Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying*

NFPA *101*-1988, *Life Safety Code*

NFPA 220-1985, *Standard on Types of Building Construction*

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

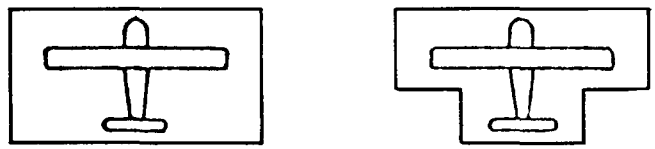
NFPA 415-1987, *Standard on Aircraft Fueling Ramp Drainage*

Appendix A

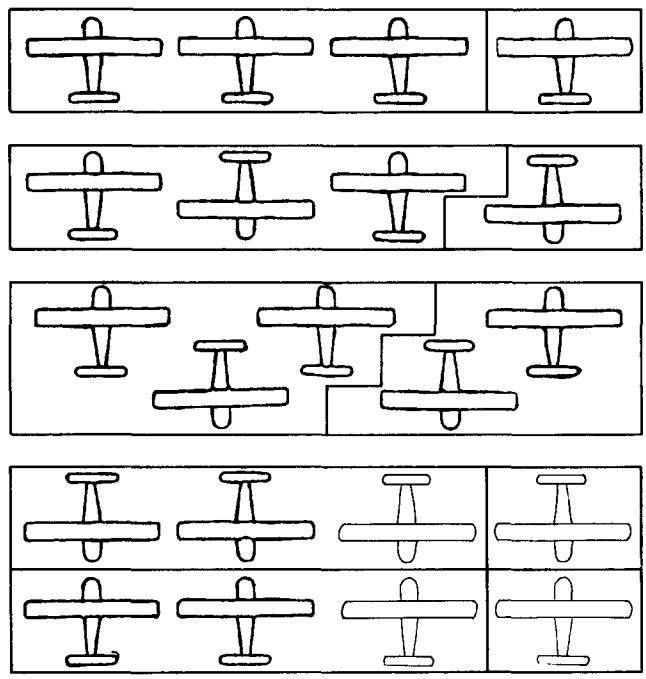
This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

A-1-2.1 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.

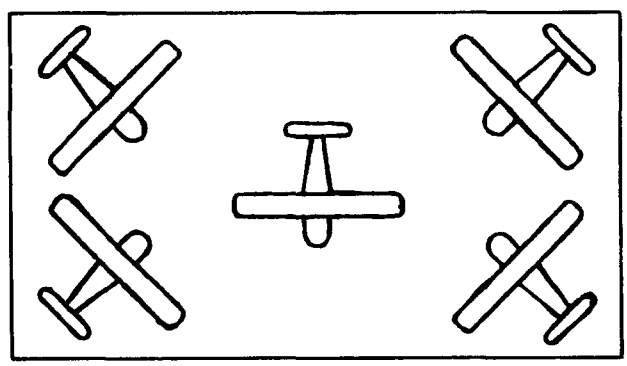
A-1-3.2.3 Typical Group III Hangars.



Freestanding Unit for a Single Aircraft



Typical Configurations of Row Hangars



Hangar Capable of Housing Multiple Aircraft

A-2.1.1 Building construction types are defined in NFPA 220, *Standard on Types of Building Construction*. The following material is extracted verbatim from NFPA 220, the

	Type I		Type II			Type III		Type IV	Type V	
	443	332	222	111	000	211	200	2HH	111	000
EXTERIOR BEARING WALLS —										
Supporting more than one floor, columns or other bearing walls	4	3	2	1	0[1]	2	2	2	1	0[1]
Supporting one floor only	4	3	2	1	0[1]	2	2	2	1	0[1]
Supporting a roof only	4	3	1	1	0[1]	2	2	2	1	0[1]
INTERIOR BEARING WALLS —										
Supporting more than one floor, columns or other bearing walls	4	3	2	1	0	1	0	2	1	0
Supporting one floor only	3	2	2	1	0	1	0	1	1	0
Supporting a roof only	3	2	1	1	0	1	0	1	1	0
COLUMNS —										
Supporting more than one floor, bearing walls or other columns	4	3	2	1	0	1	0	H[2]	1	0
Supporting one floor only	3	2	2	1	0	1	0	H[2]	1	0
Supporting a roof only	3	2	1	1	0	1	0	H[2]	1	0
BEAMS, GIRDERS, TRUSSES & ARCHES —										
Supporting more than one floor, bearing walls or columns	4	3	2	1	0	1	0	H[2]	1	0
Supporting one floor only	3	2	2	1	0	1	0	H[2]	1	0
Supporting a roof only	3	2	1	1	0	1	0	H[2]	1	0
FLOOR CONSTRUCTION	3	2	2	1	0	1	0	H[2]	1	0
ROOF CONSTRUCTION	2	1½	1	1	0	1	0	H[2]	1	0
EXTERIOR NONBEARING WALLS	0[1]	0[1]	0[1]	0[1]	0[1]	0[1]	0[1]	0[1]	0[1]	0[1]

Those members listed that are permitted to be of approved combustible material.

[1] Requirements for fire resistance of exterior walls, the provision of spandrel wall sections, and the limitation or protection of wall openings are not related to construction type. They need to be specified in other standards and codes, where appropriate, and may be required in addition to the requirements of this Standard for the construction type.

[2] "H" indicates heavy timber members; see text for requirements.

1985 edition, and is included here as a convenience for users of this standard. Any requests for Formal Interpretations (FI) or Tentative Interim Amendments (TIA) on the following material must be directed to the Technical Committee on Building Construction:

3-1 Type I (443-332).

3-1.1 Type I Construction is that type in which the structural members, including walls, columns, beams, floors, and roofs, are of approved noncombustible or limited-combustible materials and have fire resistance ratings not less than those set forth in Table 3.

3-2 Type II (222-111-000).

3-2.1 Type II Construction is that type not qualifying as Type I Construction in which the structural members including walls, columns, beams, floors, and roofs are of approved noncombustible or limited-combustible materials and have fire resistance ratings not less than those set forth in Table 3.

3-3 Type III (211-200).

3-3.1 Type III Construction is that type in which exterior walls and structural members which are portions of exterior walls are of approved noncombustible or limited-combustible materials, and interior structural members, including walls, columns, beams, floors, and roofs, are wholly or partly of wood of smaller dimensions than required for Type IV Construction or of approved noncombustible, limited-combustible, or other approved combustible materials. In addition, structural members have fire resistance ratings not less than those set forth in Table 3.

3-4 Type IV[1] (2HH).

3-4.1 Type IV Construction is that type in which exterior and interior walls and structural members which are portions of such walls are of approved noncombustible or limited-combustible materials. Other interior structural members including columns, beams, arches, floors and roofs are of solid or laminated wood without concealed spaces and comply with the provisions of 3-4.2 through 3-4.6. In addition, structural members have fire resistance ratings not less than those set forth in Table 3.

Exception No. 1: Interior columns, arches, beams, girders, and trusses of approved materials other than wood are permitted provided they are protected to provide a fire resistance rating of not less than 1 hour.

Exception No. 2: Certain concealed spaces are permitted by the Exception to 3-4.4.

3-4.2 Wood columns supporting floor loads shall be not less than 8 in. (203 mm) in any dimension; wood columns supporting roof loads only shall be not less than 6 in. (152 mm) in least dimension and not less than 8 in. (203 mm) in depth.

[1] The dimensions used for sawn and glued laminated lumber in this Section 3-4 are nominal dimensions.

3-4.3 Wood beams and girders supporting floor loads shall be not less than 6 in. (152 mm) in width and not less than 10 in. (254 mm) in depth; wood beams and girders and other roof framing, supporting roof loads only, shall be not less than 4 in. (102 mm) in width and not less than 6 in. (152 mm) in depth.

3-4.4 Framed or glued laminated arches which spring from grade or the floor line and timber trusses which support floor loads shall be not less than 8 in. (203 mm) in width or depth. Framed or glued laminated arches for roof construction which spring from grade or the floor line and do not support floor loads shall have members not less than 6 in. (152 mm) in width and not less than 8 in. (203 mm) in depth for the lower half of the height and not less than 6 in. (152 mm) in depth for the upper half. Framed or glued laminated arches for roof construction which spring from the top of walls or wall abutments and timber trusses which do not support floor loads shall have members not less than 4 in. (102 mm) in width and not less than 6 in. (152 mm) in depth.

Exception: Spaced members may be composed of two or more pieces not less than 3 in. (76 mm) in thickness when blocked solidly throughout their intervening spaces or when such spaces are tightly closed by a continuous wood cover plate not less than 2 in. (51 mm) in thickness, secured to the underside of the members.

Splice plates shall be not less than 3 in. (76 mm) in thickness.

3-4.5 Floors shall be constructed of splined or tongued and grooved plank not less than 3 in. (76 mm) in thickness covered with 1-in. (25-mm) tongue and groove flooring, laid crosswise or diagonally to the plank, or with 1/2-in. (12.7-mm) plywood, or of laminated planks not less than 4 in. (102 mm) in width, set on edge close together, spiked at intervals of 18 in. (457 mm) and covered with 1-in. (25-mm) tongue and groove flooring laid crosswise or diagonally to the plank or with 1/2-in. (12.7-mm) plywood.

3-4.6 Roof decks shall be of splined or tongued and grooved plank not less than 2 in. (51 mm) in thickness; or of laminated planks not less than 3 in. (76 mm) in width, set on edge close together, and laid as required for floors; or of 1 1/8-in. (28.6-mm) thick interior plywood (exterior glue); or of approved noncombustible or limited-combustible materials of equal fire durability.

3-5 Type V (111-000).

3-5.1 Type V Construction is that type in which exterior walls, bearing walls, and floors and roofs and their supports are wholly or partly of wood or other approved combustible material smaller than required for Type IV Construction. In addition, structural members have fire resistance ratings not less than those set forth in Table 3.

A-2-1.2 Preference should be given to the use of noncombustible materials in Type V (111) and (000) hangars. Separate shops, offices, and storage areas should comply with the provisions of 2-2.1.

A-2-2.1 Fire wall construction should be in accordance with a listed construction assembly or the local building code. The construction should be resistant to or protected from mechanical damage and potential damage from discharge of the fixed fire protection system.

A-2-2.3 Shops, 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.

A-2-3.2.3 Also see NFPA 80, *Standard for Fire Doors and Windows.*

A-2-3.3.2 Also see NFPA 80, *Standard for Fire Doors and Windows.*

A-2-4.2 These special hazards include, but are not limited to, spray painting or doping areas, flammable liquid storage or mixing rooms, cutting and welding areas, etc.

A-2-6.2 Additional guidance pertaining to fixed water systems may be found in NFPA 15. This information may also be used in the design of foam-water systems. The design of such protection should take into account such factors as the shape of the column, wetting of lower sprinklers, etc.

A-2-7.3 Preplanning should ensure availability of necessary auxiliary equipment such as tractors, cables, grapnels, etc., where manual operation is either impossible or too slow to allow prompt aircraft removal.

A-2-9.1 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 2-9 must be followed. For floor drainage, see 2-11.2.

A-2-9.7 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 provide adequate explosion venting area. The general principles in NFPA 68, *Guide for Venting of Deflagrations*, should be followed.

A-2-9.8 Consideration should be given to the selection of an extinguishing agent that could also be used as a means of inerting the pit in the event that flammable vapors are present concurrent with the loss of use of the ventilation system due to power failure, maintenance, or other causes. For this reason, carbon dioxide or the lower toxicity halogenated agents can be useful in this respect.

A-2-11.2.1 Aircraft hangars may also require floor drainage systems to effectively dispose of water used for cleaning aircraft and hangar floor surfaces and water accumulation from possible flooding due to high groundwater tables, and to drain away water discharged from the fire protection equipment provided within the structure. Reference can be made to NFPA 415, *Standard on Aircraft Fueling Ramp Drainage*, for information on drainage systems and

the appendix of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, for information on drainage equipment and arrangements.

A-2-11.2.3 In general, this will mean that the design must be adequate to ensure that the liquid level at the center of the drain is below the top surface of the drain inlet grating for grated round, rectangular, and long trench-type inlets, or the floor surface in the case of a slit trench.

A-2-12.1 It is recommended that hangar heating plants fired with gas, liquid, or solid fuel be located in a fire-resistive or noncombustible detached building wherever possible.

A-2-12.4 Personnel should 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.

A-2-13.2 See also 2-7.2 on power supply to doors accommodating aircraft.

A-2-14.1 All aircraft hangars should be surveyed to determine the need for approved lightning protection. Where installed, such systems should be listed. See NFPA 78, *Lightning Protection Code*.

A-2-15.1 As low a resistance as possible should be secured and maintained. Ten thousand ohms is a practical recommended maximum where 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-2-15.3 Speedometer, preformed steel, or equivalent cable will minimize danger of employee hand injury.

A-2-16.1 See NFPA *101*, *Life Safety Code*, for further information.

A-2-17.1 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, might 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 can be hung on exposed interior roof supports running parallel to the doors. The method of installation selected should be based on obtaining maximum operational efficiency from the sprinkler protection, taking into consideration mean wind conditions, floor drains, floor pitch, and details of occupancy usage.

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

A-3-2.1.1 It is highly important and expedient that all applicable areas of responsibility, such as those that cover adequacy of water supplies, design, testing, flushing, approvals, etc., be clearly defined in the contract documents. This is important where there is shared responsibility for various portions of the fire protection systems.

A-3-2.3.1 The manual control valve for each individual sprinkler system should be located outside aircraft storage and servicing areas.

A-3-2.3.14 To prevent accidental depletion of this reserve supply, it should be available to the system only by intentional manual operation.

A-3-2.4.1 Aircraft storage and servicing areas with large doors on both ends can present special draft problems affecting the efficient operation of the sprinkler systems. In such cases, additional systems should be included in the calculation of water supply needed. Draft stops should effectively surround each individual sprinkler system. See Section 2-17.

A-3-2.4.6 The development of satisfactory water supplies is a matter requiring engineering judgment and careful analysis of local conditions. See NFPA 419, *Guide for Master Planning Airport Water Supply Systems for Fire Protection*; NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*; and NFPA 22, *Standard for Water Tanks for Private Fire Protection*. Acceptable types of water supplies can consist of one or more of the following:

(a) connections to reliable waterworks systems, including automatic booster pumps where required;

(b) automatic fire pumps taking suction under a head from storage reservoirs or other suitable supply;

(c) gravity tanks.

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

A-3-2.5.4 Supplemental means for automatically starting the fire pumps should also be provided.

A-3-2.6.1 In connection with the flushing operation, preplanning should be made for means of disposing of the large quantities of water discharged.

A-3-2.10.3 In locating manual actuation stations inside, multiple stations should be considered to provide occupants with a selection of paths of exit from which they can actuate the system.

The location of exterior actuation stations should ensure accessibility once the occupant has exited the hangar through any of the emergency exits. Security fences, adjacent buildings, or other obstructions should be considered when locating exterior actuation stations.

A-3-3.1 Supplementary protection systems for hangars containing several aircraft, each having wing areas less than 3,000 sq ft (279 m^2), can be warranted. Such systems are recommended where:

(1) Rapid control of a fuel fire exposing a single aircraft is considered essential.

(2) Strategically important military aircraft or multiple high valued aircraft are accommodated.

(3) Arrangement of aircraft within hangar results in congestion and limited access to individual aircraft.

Table A-3-3.1

Following is a listing of the wing areas of various transport-type aircraft:

Wing Areas of Various Aircraft

	Aircraft	Wing Area Sq Ft	(M^2)
1*	L-500-Galaxy	6,200	(576.0)
2*	Boeing 747	5,500	(511.0)
3*	Concorde	3,856	(358.2)
4*	DC-10-20, 30	3,550	(329.8)
5*	L-1011	3,456	(321.1)
6*	Boeing 767	3,050	(283.4)
7*	Ilyushun IL-62	3,030	(281.5)
8	Boeing 707-320 B/C	2,950	(274.1)
9	DC-10	2,932	(272.4)
10	DC-8-63	2,927	(271.9)
11	DC-8-62	2,926	(271.8)
12	DC-8-61	2,883	(267.8)
13	A-300 Airbus	2,799	(260.0)
14	BAC-3-11	2,450	(227.6)
15	A310 Airbus	2,357	(218.9)
16	Tupolev TU-154	2,169	(201.5)
17	Boeing 757	1,951	(181.2)
18	L-100-20 Hercules	1,745	(162.1)
19	Caravelle	1,579	(146.7)
20	Boeing 727-100	1,560	(144.9)
21	Trident 3B	1,493	(138.7)
22	Trident 1E	1,466	(136.2)
23	Tupolev TU-34	1,370	(127.3)
24	Trident 1C	1,358	(126.2)
25	BAC 1-11-500	1,031	(95.8)
26	NAMC YS-11	1,020	(94.8)
27	BAC 1-11-300,400	1,003	(93.2)
28	DC 9-30	1,001	(93.0)
29	Boeing 737-200, 300	980	(91.0)
30	DC 9-20	934	(86.8)

Table A-3-3.1, Continued

31	Convair 640	920	(84.5)
32	Herald	886	(82.3)
33	Fokker Fellowship	822	(76.4)
34	Fokker Fellowship	754	(70.0)
35	Nord	592	(55.0)
36	Twin Otter	420	(39.0)
37	Beechcraft Model 99	298	(27.7)

*Aircraft with wing areas in excess of 3,000 sq ft (279 m^2)

A-3-3.2 In general, the specified floor area would be the area under the wing and wing-center sections of the aircraft. Configuration of aircraft and positioning of aircraft and ground equipment within an aircraft storage and servicing area can compromise the effectiveness of any supplemental protection systems. Original design and testing of such systems should anticipate obstructions on the floor (such as those created by working platforms) in providing protection over the specified floor areas. The discharge from overhead hangar protection systems may not protect the aircraft from a fire in the shielded areas beneath the wing and wing-center section. The supplementary system is intended to provide protection in these shielded areas by controlling such fires quickly and preventing extensive damage to the aircraft. The area to be protected will depend on the configuration and the number of aircraft and their positioning arrangements, as well as the location of permanent service structures within the aircraft maintenance and servicing area. Protection of the entire aircraft maintenance and servicing area could be required because of the variety of possible aircraft positioning arrangements.

The total area to be protected by a single system will depend upon the number and configuration of aircraft and their proximity to one another and the drainage arrangements. If more than one aircraft is located within any drainage system, the supplementary foam system should preferably be capable of covering the floor area beneath all such aircraft.

A-3-3.4.1 It is highly important and expedient that all applicable areas of responsibility such as those that cover suitability of agent, application rates used, area covered, approvals, testing, etc., be clearly defined in the contract documents. This is especially important when there may be shared responsibility for the various portions of the fire protection system.

A-3-3.4.2 The total area to be protected by a single system will depend upon the number and configuration of aircraft and their proximity to one another and the drainage arrangements. If more than one aircraft is located within any drainage system, the supplementary foam system should preferably be capable of covering the floor area beneath all such aircraft.

A-3-3.5.2 The total area to be protected by a single system will depend upon the number and configuration of aircraft and their proximity to one another and the drainage arrangements. If more than one aircraft is located within any drainage system, the supplementary foam system should preferably be capable of covering the floor area beneath all such aircraft.