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AIRCRAFT HANGARS 1975

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Standard on
Aircraft Hangars

NFPA No. 409 — 1975

1975 Edition of No. 409

This Standard is the work of the NFPA Sectional Committee on Aircraft Hangars and Airport Facilities. This Sectional Committee reports to the Association through the NFPA Correlating Committee on Aviation. This edition was adopted by the National Fire Protection Association at its 1975 Fall Meeting, held in Pittsburgh, PA on Nov. 18, 1975, and supersedes all previous editions.

This 1975 edition is a revision of the last previous edition (1973). Changes in this 1975 text revise Paragraphs 401, 402, 403.a., 404.a., 404.b., 405.a., 405.b., 607.e., 702.c. (editorial), 702.e., 901.a.(2), 901.b., 902 (editorial), 1201.c. (editorial), 1202.d. (editorial), 1207.e.(3), 1208.a., 1304.d., 1403.a.(2), 1403.b., 1809.a.(1), 1809.c.(2), 1901 (editorial), C1309 (editorial), and J1208.b. (editorial). New material appears in Paragraphs 608 a. and b., 1207.e.(1), (old paragraph renumbered), and 1802.a. Exception. Old Paragraphs 1209.(b) and B702.b.(2) were deleted. References to other Standards have been updated as appropriate. Vertical lines in margins indicate revisions.

The 1973 edition of this text was approved as an American National Standard by the American National Standards Institute and was identified as ANSI No. Z214.1–1974. This new edition is currently being submitted for ANSI approval. When and if approved by ANSI, the cover of the pamphlet editions of this Standard will reflect this action.

Origin and Development of No. 409

The original fire protection recommendations for the construction and protection of airplane hangars were published by the National Board of Fire Underwriters in 1930 (now the American Insurance Association). Revisions were issued by the NBFU in 1931, 1943, 1945, and 1950. During the period 1943 until 1954, these recommendations were published as NBFU Pamphlet No. 85.

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

The NFPA Sectional Committee on Aircraft Maintenance and Servicing has under its jurisdiction development of fire safety recommendations to cover aircraft maintenance operations, many of which are carried out in hangar structures. (See Paragraph A101.a. of Appendix A.)

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, this Committee has been disbanded and a Correlating Committee on Aviation established, composed of the officers of the Sectional Committee operating under its aegis.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

Interpretation Procedure of the Sectional Committee on Aircraft Hangars and Airport Facilities

Those desiring an interpretation shall supply the Chairman with five identical copies of a statement in which shall appear specific reference to a single problem, paragraph, or section. Such a statement shall be on the business stationery of the inquirer and shall be duly signed.

When applications involve actual field situations they shall so state and all parties involved shall be named.

The Interpretations Committee will reserve the prerogative to refuse consideration of any application that refers specifically to proprietary items of equipment or devices. Generally inquiries should be confined to interpretation of the literal text or the intent thereof.

Requests for interpretations should be addressed to the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.

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Standard on

Aircraft Hangars

NFPA No. 409 — 1975

PART A
INTRODUCTION

Chapter 1. Scope and Purpose*

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

102. Subdivisions of this Standard. This standard is divided into five parts as follows:

a. Part A. Introduction.

b. Part B. Construction of Types I and II Aircraft Hangars.

c. Part C. Protection of Type I Aircraft Hangars.

d. Part D. Protection of Type II Aircraft Hangars.

e. Part E. Construction and Protection of Type III Aircraft Hangars.

103. Appendices. There are nine Appendices which give reference data or supplemental information as follows:

a. Appendix A. References to Related Fire Protection Recommendations Applicable to Aircraft Hangars.

b. Appendix B. Recommendations Supplementing the Provisions of Part B.

c. Appendix C. Recommendations Supplementing the Provisions of Part C.

d. Appendix E. Recommendations Supplementing the Provisions of Part E.**

e. Appendix F. Construction and Protection of Wing or Nose Hangars.

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*Asterisk before paragraph number indicates additional information in Appendix A.

**There is no Appendix D.

g. Appendix G. Construction and Protection of Nonportable Aircraft Docks.

h. Appendix H. Exterior Fire Protection Facilities for Hangars.

i. Appendix J. ** **Diagrams Related to Chapters 8 and 12.**

j. Appendix K. Tabulation of Wing Areas of Large Aircraft.

**There is no Appendix I.

PART B

CONSTRUCTION OF TYPES I and II AIRCRAFT HANGARS*

Chapter 2. Definitions.

201. Aircraft Hangar is defined as a building or other structure in any part of which aircraft are housed or stored and in which aircraft may be undergoing servicing, repairs or alterations. For the purposes of this Standard, aircraft hangars are classified as follows:

a. Type I Aircraft Hangar: a hangar with either a clear door height over 28 feet or with a fire area in excess of 40,000 sq. ft.

b. Type II Aircraft Hangar: a hangar with a clear door height 28 feet or less and with a fire area 40,000 sq. ft. or less, but greater than those specified in Table I (*see paragraph 502*).

c. Type III Aircraft Hangar: a hangar with a clear door height 28 feet or less and with a fire area up to the maximum permitted for hangars in Table I not equipped with approved fire protection systems (*see paragraph 502*).

d. Other Types of Aircraft Hangars: hangars housing strategically important military aircraft shall conform to the requirements applicable to Type I hangars.

202. Fire Area. For the purposes of this Standard, an area within an aircraft hangar subject to loss by a single fire because of lack of internal subdivisions as specified in paragraph 503.

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

204. Single Hangar Building is a building with one area for the storage and servicing of aircraft and any attached, adjoining, or contiguous structure (e.g., "lean-to," shop area, or parts storage area) not separated as specified in paragraphs 504 and 505. (*See also paragraph 506.*)

205. Hangar Building Group is a building or group of buildings with more than one area for the storage and servicing of aircraft and all attached, adjoining, or contiguous structures not separated as specified in paragraph 505. (*See also paragraph 506.*)

*Asterisk before paragraph numbers indicates additional information in Appendix B.

206. Wing or Nose Hangars are buildings which provide shelter for the servicing of aircraft without housing the aircraft aft of the trailing edge of the wings. Wing or nose hangars may have extensive service shops and offices incorporated within the structures.

207. Nonportable Aircraft Docks are shelters or covers for the servicing of aircraft engines. Such docks do not house the wings nor contain service shops or offices.

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

Chapter 3. General.

***301. Communicating Sections.** Where shop, office, and storage areas communicate with an aircraft storage and servicing area and possess inherent hazards, contain valuable records or store concentrations of critical or highly valued materials, they shall be cut off in the manner specified in paragraph 503.

Chapter 4. General Construction Types.

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

***402. Heavy Timber Construction.** Hangars of this type shall have columns, beams, girders and roofs of heavy timber or of ap-

proved glued laminated construction of not less than the following nominal dimensions for individual members:

Columns	8 inches
Trusses	4 inches by 6 inches
Beams and Girders	6 inches by 10 inches
Roof Decks	2 inches (plank), 3 inches (laminated)

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

*403. **Noncombustible Construction.** Hangars of this type shall have walls, partitions and structural members of noncombustible materials which, as assembled, do not qualify as Fire Resistive (*see paragraph 401*). In hangar construction two types of noncombustible construction are:

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

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

404. Ordinary Construction.

a. Hangars of this type shall have exterior bearing walls or bearing portions of exterior walls of noncombustible construction having a minimum fire resistance rating of two hours and stability

under fire conditions. Nonbearing exterior walls shall likewise be of noncombustible construction and fire resistant as required depending upon conditions of occupancy or exposure. Roofs, floors (except as specified in paragraph 602), and interior framing are normally wholly or partly of wood (or other combustible material) of smaller dimensions than required for Heavy Timber Construction (*see paragraph 402*).

b. Ordinary construction shall be designated Protected Ordinary Construction when the roof and floor construction and their supports have a one hour fire resistance rating.

405. Wood Frame.

a. Hangars in which exterior walls, bearing walls and partitions and roof construction and its supports are of wood or other combustible material not qualifying as Heavy Timber Construction (*paragraph 402*) or Ordinary Construction (*paragraph 404*). Hollow spaces between inner and outer sheathing shall be firestopped at each eight feet of height.

b. This type of construction shall be designated Protected Wood Frame Construction when the roof and floor construction and its supports have a one-hour fire resistance rating.

Chapter 5. Internal Subdivisions and Separation.

501. General. Precautions shall be taken to insure ready access to hangars from all sides. Adequate separation shall be provided to reduce fire exposure between buildings. The clear spaces specified in Tables II and III of paragraphs 504 and 505 shall not be used for the storage of aircraft or concentrations of combustible materials nor shall buildings of any type be erected therein.

***502. Maximum Areas for Hangars Not Protected By Approved Fire Protection Systems.**

Areas for hangars not protected by approved fire protection systems shall be limited as specified in Table I.

Table I

Maximum Areas for Hangars Not Protected by Fire Protection Systems

Types of Construction	Single Hangar Buildings Maximum Fire Areas (sq. ft.)	Hangar Building Groups Total Areas (sq. ft.)
Fire-Resistive	30,000	60,000
Protected Noncombustible	20,000	40,000
Heavy Timber or Protected Ordinary	15,000	30,000
Unprotected Noncombustible	12,000	24,000
Ordinary	12,000	24,000
Protected Wood Frame	8,000	16,000
Wood Frame	5,000	10,000

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

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

Table II

Type of Construction	Separation Required
Fire Resistive	50 ft.
Protected Noncombustible	50 ft.
Heavy Timber or Protected Ordinary	50 ft.
Unprotected Noncombustible	50 ft.
Ordinary	50 ft.
Protected Wood Frame and Wood Frame	75 ft.

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

Table III

Type of Construction	Separation Required
Fire Resistive	75 ft.
Protected Noncombustible	75 ft.
Heavy Timber	75 ft.
Protected Ordinary	100 ft.
Unprotected Noncombustible	100 ft.
Ordinary	100 ft.
Protected Wood Frame and Wood Frame	125 ft.

506. Exceptions To Separation Requirements.

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

b. If one hangar has as its exposing wall a stable, unpierced wall having a fire resistance rating of two hours or longer, the distance separation may be reduced to not less than 25 feet for single hangar buildings and 50 feet for hangar building groups.

c. If the exposing walls of both buildings are stable under fire conditions, have a fire resistance rating of two hours or longer with all windows protected by wired glass in fixed steel sash (approved Class E type) with outside sprinkler protection, and each doorway is protected with one automatically operated approved Class D fire door, the clear space may be reduced to not less than 25 feet for single hangar buildings and 50 feet for hangar building groups. Glass area in the exposing walls under such conditions shall not be more than 25 percent of the wall area. (*See NFPA No. 80, Fire Doors and Windows.*)

Chapter 6. Common Structural Requirements.

*601. **Mezzanines, Tool Rooms, etc.** Mezzanine floors, tool rooms, and other enclosures within aircraft storage and servicing areas shall be of noncombustible construction in all but wood frame hangars (*see paragraph 405*).

602. **Floors.**

a. 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.

b. The floors of adjoining and communicating areas, regardless of type of hangar construction, shall be as specified in paragraph 602a. wherever the occupancy conditions present special hazards (as in spray painting or doping areas, flammable liquid storage or mixing rooms, cutting and welding areas, etc.).

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

604. **Roofs.**

a. **Roof Coverings.** Roof coverings shall be of an approved type of tile, slate, metal, asbestos, asphalt shingles or of builtup roofing finished with asphalt, slate or gravel or other approved material. Roof coverings which are listed by Underwriters' Laboratories, Inc., as Class "A" or "B" shall be accepted as meeting the requirements of this paragraph. Underwriters' Laboratories approved Class "C" roof coverings may be used on Wood Frame Hangars (*see paragraph 405*).

b. **Roof Decks.** Except where roof coverings are of a character permitting attachment direct to framework, roof decks shall be solid or close fitting. (*See paragraphs 401, 402, 403, 404 or 405 for materials used and desired fire resistance ratings.*)

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

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

e. Ladders to Roofs. Unless enclosed stairs leading directly to the roof of aircraft storage and servicing areas are available from the exterior of the hangar, adequate permanent exterior ladders to hangar roofs shall be provided on all hangars exceeding 25,000 square feet in area, or exceeding 40 feet in height, or exceeding 100 feet in the smallest dimension to assure access in case of fire emergencies.

605. Protection of Structural Steel.

a. Columns. All main structural columns within the aircraft storage and servicing areas shall be made fire resistant using approved materials and methods to give a fire-resistive rating of not less than two (2) hours. Fixed water or foam-water deluge systems may be used in lieu of two (2) hour fire resistant rating, if such systems are designed specifically to protect the columns.

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

606. Doors and Curtains.

a. Doors to Accommodate Aircraft.

(1) Hangar doors to accommodate aircraft shall be of noncombustible construction when hangar walls are of fire resistive or noncombustible construction. (*See paragraphs 401, 402, 403 and 404.*)

(2) The power source for hangar doors shall be on independent circuits and shall not be disengaged when the main disconnect switches for general hangar power are shut off.

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

(4) In areas where freezing temperatures may occur, door tracks or the bottom edges of doors shall be protected (by heating coils or equivalent means) to prevent ice formation which might prevent or delay operation. (*See also paragraph B702.c.*)

b. Other Exterior Doors. See paragraph 506 for exposure protection for exterior doors in certain locations and Chapter 11 with regard to exit doors.

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

***607. Landing Gear Pits and Tunnels.**

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

b. Electrical Equipment: Electrical equipment for all landing gear pits, ducts and tunnels located below hangar floor level shall be suitable for use in Class I, Division 1, Group D hazardous locations in compliance with Article 501 of the National Electrical Code (NFPA No. 70–1975; ANSI C1–1975).

c. Mechanical Ventilation:

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

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

(3) The ventilation system shall be connected to a properly designed and installed continuous-reading combustible gas analyzing system that is arranged to operate the ventilation system at the higher rate specified in paragraph 607c. (2) automatically upon detection of a specified flammable vapor concentration that is below the lower flammable limit. The detection system shall have sensors located throughout all ducts and tunnels.

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

e. Explosion Protection. Explosion protection shall be provided in landing gear pits and communicating ducts and tunnel areas in the form of pressure-relief venting or by a listed explosion prevention system installed in accordance with the *NFPA Standard for Explosion Prevention Systems* (*NFPA No. 69–1973*).

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

608. Exposed Interior Thermal Insulation.

a. The use of exposed interior thermal insulation attached to walls and roofs in an aircraft storage and servicing area of a hangar not provided with a sprinkler system designed in accordance with Chapter 12 or Chapter 18, as applicable, shall be noncombustible as defined in the *NFPA Standard on Types of Building Construction (NFPA No. 220–1975)*.

b. In an aircraft storage and servicing area of a hangar equipped with an approved sprinkler system designed in accordance with Chapter 12 or Chapter 18, as applicable, exposed interior thermal insulation attached to walls and roofs shall be noncombustible or limited-combustible as defined in the *NFPA Standard on Types of Building Construction (NFPA No. 220–1975)*.

Chapter 7. Drainage of Aprons and Hangar Floors.

701. Apron Drainage. The apron or approach at the entrance to the hangar shall slope away from the hangar with a minimum grade of one-half of one percent (1:200) for the first 50 feet. Ramps used for aircraft fueling adjacent to hangar structures shall comply with the Standard on Aircraft Fueling Ramp Drainage (NFPA No. 415–1973). In establishing locations for nearby aircraft parking, consideration shall be given to the drainage pattern of the apron.

702. Hangar Floor Drainage.

***a. General.**

(1) Floor drainage systems shall be provided to restrict the spread of fuel and provide means to reduce the fire and explosion hazards from fuel spillage.

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

b. Interior Drainage Systems.

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

(2) Where the hangar is protected by water deluge systems as specified in paragraph 1209, the pitch of the floor shall be a minimum of one percent. Where the hangar is protected by foam-water sprinkler systems as specified in paragraph 1210, the pitch of the floor shall be a minimum of one-half of one percent. The floor pitch provided shall take into consideration the towability of the aircraft and the problems of aircraft maintenance, weight and balance checking, etc.

*(3) Each drainage system shall be calculated separately taking into consideration the maximum rated discharge from the fire protection systems and hose lines.

(4) The size of drainage piping shall be determined by the hydraulic demands placed upon the system throughout its length.

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

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

e. Oil Separators. Oil separators shall be provided for the drainage systems serving all aircraft storage and servicing areas. These separators may be for each hangar drainage system, for a group of hangar drainage systems, or installed as part of a general airport drainage system. In aircraft storage and servicing areas protected by water deluge or foam-water sprinkler systems, a bypass shall be provided around the separator to allow for emergency direct disposal of water and flammable liquids. Separator systems shall discharge flammable liquid product to a safely located tank, cistern, or sump.

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

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

Chapter 8. Draft Stops in Sprinklered Hangars.

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

Chapter 9. Hangar Services and Utilities.

901. Heating.†

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

***a. General.** No heater employing an open flame or glowing element shall be installed in aircraft storage and servicing areas or sections communicating therewith, except as authorized in subparagraphs (2) or (3) below:

(1) Heating equipment shall be installed, as applicable, in accordance with the *Standard on Installation of Air Conditioning and Ventilating Systems* (*NFPA No. 90A–1975*, the *Installation of Oil Burning Equipment* (*NFPA No. 31–1974*; *ANSI Z95.1–1974* and the *National Fuel Gas Code* (*NFPA No. 54–1974*; *ANSI Z223.1–1974*) (*NFPA No. 54–1969*), except as hereinafter specifically provided.

(2) Hangar heating plants fired with gas, liquid or solid fuels (not covered under subparagraph b, herein) which are not located in a detached building, shall be located in a room separated from other parts of the hangar by construction having at least a one-hour fire resistance rating. This separated room shall not be used for any other hazardous purpose or combustible storage and shall have no direct access from the aircraft storage or servicing area. Openings in the walls of such rooms communicating with other portions of the hangar shall be restricted to those necessary for ducts or pipes and each such duct shall be protected with a listed automatic fire damper or door. All air for combustion purposes entering such separated rooms shall be drawn from outside of the building.

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

†See Appendix J.

b. Suspended or Elevated Heaters. Electric, gas or oil heaters, listed for use in aircraft hangars, may be used if installed as specified in subparagraphs 1, 2 and 3 herein.

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

(2) In shops, offices and other sections of aircraft hangars, communicating with aircraft storage or servicing areas, they shall be installed not less than eight feet above the floor.

(3) Suspended or elevated heaters shall be so located in all spaces of aircraft hangars that they shall not be subject to injury by aircraft, cranes, movable scaffolding or other objects.

Warning: Provision shall be made to assure accessibility to suspended heaters for recurrent maintenance purposes.

902. Ventilation and Blower and Exhaust Systems. When a mechanical ventilating system is employed in hangars or shops, the ventilating system shall be installed in accordance with the *Standard for the Installation of Air Conditioning and Ventilating Systems* (*NFPA No. 90A–1975*) and in accordance with the provisions of paragraph 901. When blower and exhaust systems are installed for vapor removal, the systems shall be installed in accordance with the *Standards for the Installation of Blower and Exhaust Systems* (*NFPA No. 91–1973*; *ANSI Z23.1*).

903. Lighting and Electrical Systems.

a. Artificial lighting shall be restricted to electricity.

b. Electrical services shall be installed in compliance with the provisions for aircraft hangars contained in Article 513 of the National Electrical Code (NFPA No. 70–1975; ANSI C1–1975). (*See also Paragraph 606.a.(2) on power supply to doors accommodating aircraft.*)

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

***904. Lightning Protection.** Where provided, lightning protection shall be installed in accordance with the *Lightning Protection Code* (*NFPA No. 78–1975*; *ANSI C5.1–1975*).

Chapter 10. Grounding Facilities For Static Electricity.

*1001. **General.** Grounding facilities shall be provided for removal and control of static electrical accumulations on aircraft while aircraft are stored or undergoing servicing in a hangar, except that aircraft which have never been fueled or are in dead storage with fuel tanks removed or drained and purged need not be grounded.

1002. **Installation Methods.** An adequate number of floor ground receptacles shall be provided. The receptacles shall be either grounded through individual driven electrodes or electrically bonded together in a grid system and the entire system grounded to underground metal piping (e.g. cold water or sprinkler piping) or driven electrodes. When driven electrodes are used they shall consist of $\frac{5}{8}$ inch diameter or larger metal rods driven at least five feet in the ground. Floor grounding receptacles shall be designed so as to minimize the tripping hazard.

1003. **Grounding Wires.** Grounding wires shall be bare and of a gage which will be satisfactory from the durability standpoint as influenced by mechanical strains and usage (speedometer, preformed steel or equivalent cable will minimize danger of employee hand injury).

Chapter 11. Exit and Access Requirements.

*1101. **Exits From Aircraft Storage and Servicing Areas.** In general, exits from aircraft storage and servicing areas shall be provided at intervals of not more than 150 feet on all exterior walls and be so located as to secure minimum interior travel distance for occupants. There shall be a minimum of two exits serving each aircraft storage and servicing area. Exits along interior fire walls shall be provided at intervals of not more than 100 feet positioned so as to secure minimum interior travel distance for occupants. Dwarf or "smash" doors in doors accommodating aircraft may be used to comply with these requirements. All doors designated as exits (except sliding doors) shall swing in the direction of exit travel and shall be kept unlocked in the direction of exit travel while area is occupied. They shall be not less than 36 inches wide.

1102. Exits from Mezzanine Floors Located in Aircraft Storage and Servicing Areas. Exits from mezzanine floors in aircraft storage and servicing areas shall be so arranged that the maximum travel to reach the nearest exit from any point on the mezzanine shall not exceed 75 feet. Such exits shall lead directly to a properly enclosed stairwell discharging directly to the exterior or to a suitably cut-off area or to outside fire escape stairs.

1103. Exit Signs. Exit signs shall be provided over doors and exitways. They shall be so located as to be readily observed. Except where otherwise required by law, exit signs shall have white letters on a red field, or, for internally illuminated types, shall have red letters of translucent material in an opaque field.

1104. Access Aisles to Fire Fighting Equipment. Aisles and clear space shall be maintained to assure access to sprinkler control valves, standpipe hose, fire extinguishers and similar equipment.

1105. Marking and Identification of Exit and Access Aisles. Exit and access aisles shall be conspicuously and permanently marked on floors.

PART C

PROTECTION OF TYPE I AIRCRAFT HANGARS.

Chapter 12. Primary Protection Systems.

1201. Scope and Definitions.

a. Scope: This chapter covers fixed primary fire protection systems which are designed to protect Type I aircraft hangars.

b. Sprinkler System: The term "sprinkler system," for the purpose of this chapter, shall include:

(1) *Foam Water Sprinkler System:* a system, pipe connected to and including a source of air-foam liquid concentrate and a water supply. Water and air-foam liquid concentrate (protein, 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 which is actuated by the operation of a heat-responsive system installed in the same areas as the discharge devices. When this valve opens, water flows into the piping system, air-foam liquid concentrate is injected into the water, and the resulting discharge of air-foam solution through the foam-water discharge devices generates and distributes foam. Upon exhaustion of the air-foam liquid concentrate supply, water discharge will follow the foam and continue until shut off manually.

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

c. Detection System: a system consisting of detectors, controls, control panels, automatic and manual actuating mechanisms, all wiring, piping, and tubing, and all associated equipment which is used to actuate the sprinkler system deluge valve.

1202. General.

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

*Asterisk before paragraph numbers indicates additional information in Appendix C.

b. 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.

c. Each sprinkler system shall be installed in accordance with the *Standard for the Installation of Sprinkler Systems* (*NFPA No. 13–1975*) the *Standard for Foam-Water Sprinkler and Foam-Water Spray Systems* (*NFPA No. 16–1974*), the *Standard for Foam Extinguishing Systems* (*NFPA No. 11–1975*), the *Standard for Synthetic Foam and Combined Agent Systems* (*NFPA No. 11B–1974*), as applicable and in accordance with the recommendations contained in this Standard.

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

1203. Pipe and Fittings.

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

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

***1204. Plans and Specifications.** Before systems are installed, complete specifications and working plans shall be drawn to scale showing all essential details and be so made that they can be easily reproduced to provide necessary copies. Information supplied shall include:

a. the design purpose of the system,

b. discharge densities and period of discharge,

c. hydraulic calculations,

d. details of tests of available water supply,

e. details of proposed water supplies,

f. detailed layout of the piping and of the detection system,

g. make and type of discharge devices, operating equipment and air-foam liquid concentrate to be installed.

h. location and spacing of discharge devices,

i. pipe hanger and bracing location and installation details,

j. location of draft curtains,

k. an accurate and complete layout of the area to be protected,

l. details of any air-foam liquid concentrate, its storage and injection and other pertinent data to provide a clear explanation of the proposed design.

1205. Acceptance Tests. The following tests shall be performed prior to final acceptance of any sprinkler system in an aircraft hangar.

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

b. Hydrostatic Tests. Hydrostatic pressure tests shall be conducted on each sprinkler system as specified in the *Standard for the Installation of Sprinkler Systems (NFPA No. 13–1975)*, or the *Standard for Foam-Water Sprinkler Systems and Foam-Water Spray Systems (NFPA No. 16–1974)*, as applicable.

c. Flow Tests. Full flowing tests with water only shall be made on each foam-water sprinkler and water-deluge system as a means of checking the sprinkler distribution and to assure against clogging of piping and sprinklers by foreign matter carried by the water. The maximum number of systems that may be expected to operate in case of fire, including supplementary systems, (*see paragraphs 1207, a. (1), (2) and (3)*) shall be in full operation simultaneously to give a check as to adequacy and condition of the water supply. Suitable gage connections and gages shall be provided to verify hydraulic calculations (*see paragraph 1208.d*). In addition, flow tests for foam-water sprinkler installations shall include:

(1) The discharge of a single system using air-foam liquid concentrate.

(2) The simultaneous discharge with foam of the maximum number of systems expected to operate.

The latter tests shall be run with a stabilized discharge.

1206. Final Approval. The installing company shall furnish a written statement that the work has been completed in accordance with paragraph 1204 and tested in accordance with the provisions of paragraph 1205.

1207. Water Supply.

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

(1) In aircraft storage and servicing areas having a maximum roof or ceiling height of 25 feet or less, the water supply shall be sufficient for the operation of the largest number of systems, obtained by assuming that a fire at any point will operate all the systems

in every draft-curtained area that is wholly or partially within 50 feet of that point measured horizontally.

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

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

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

(1) The supply shall be capable of maintaining water discharge at the design rate and pressure for a minimum of 60 minutes over the entire area protected by systems expected to operate simultaneously as determined by paragraph 1207 a., unless protection is provided as indicated below in (2) and (3).

(2) Where foam-water systems are installed in accordance with paragraph 1201,b. (1), where applicable supplemental protection is installed in accordance with paragraph 1308.b. and where adequate drainage is provided as specified in Chapter 7, the water supply duration shall be for a minimum of 45 minutes.

(3) Where water deluge systems are installed in accordance with paragraph 1201.b. (2), where a high expansion foam system is installed in accordance with paragraph 1308.c., and where adequate drainage is provided as specified in Chapter 7, the water supply duration shall be for a minimum of 45 minutes.

c. Additional Water Requirement for Hose Streams, etc. When the water supply for sprinklers also serves as a supply for hose streams, the total supply shall be increased by 500 gpm and shall be included in the hydraulic calculations (*see 1208.c.*). In the case of hose streams, the calculated demand shall be at the point where supply piping for the hose station(s) connects to the system piping or fire protection underground. For hydrants, the entire calculated demand shall be applied at a point downstream of the sprinkler system lead-in connections from the fire protection underground. (*See also paragraph 1306.*)

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

e. Fire Pumps

(1) Fire pumps shall be installed in accordance with the *Standard for the Installation of Centrifugal Fire Pumps (NFPA No. 20–1974)* and in accordance with the provisions of the following subparagraphs (2) through (6).

(2) The total pumping capacity shall be such that maximum demand can be met with the largest fire pump out of service.

(3) Pump houses and rooms shall be of fire resistive or noncombustible construction (*see paragraphs 401 and 403*). Where exposed fuel storage tanks for internal combustion engines used for driving fire pumps are located inside the fire pump house or room, protection shall be provided by automatic sprinklers installed in accordance with the *Standard for the Installation of Sprinkler Systems (NFPA No. 13–1975)*.

(4) Fire pumps shall be started automatically by a drop in water pressure. Where two or more electrically driven fire pumps supplied from the same electrical feeder are used, they shall be electrically designed to prevent simultaneously starting.

(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.

(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.

1208. Sprinkler System Design — General.

*a. In aircraft storage and servicing areas, the maximum projected floor area under an individual sprinkler system shall not exceed 15,000 square feet.

b. Sprinkler spacing in aircraft storage and servicing areas shall be in accordance with the requirements for extra hazard occupancies, as given in the *Standard for the Installation of Sprinkler Systems (NFPA No. 13–1975)*. The protection area for fire-resistive construction shall be considered the floor area. For all other types of construction, the spacing as projected on the floor shall be no wider than required for extra-hazard occupancies, but in no case shall the spacing on the roof or ceiling be wider than required for ordinary-hazard occupancies. In other portions of hangars pro-

tected by sprinklers, the spacing shall be in accordance with the hazard requirements of the areas involved. (*See Appendix J for further information.*)

c. 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.

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

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

1209. Water Deluge Sprinkler Systems.

a. The discharge density from water deluge sprinkler systems shall be a minimum of 0.25 gallons of water per-minute-per-square-foot of floor area.

1210. Foam-Water Sprinkler Systems.

a. Discharge devices used in these systems are either air-aspirating or nonair-aspirating and shall have deflectors designed to produce water discharge patterns closely comparable to those of "standard" sprinklers [nomenclature from the *Standard for the Installation of Sprinkler Systems* (*NFPA No. 13–1975*) when discharging at the same rates of flow. They shall generate air-foam when supplied with the air-foam solution under pressure and shall distribute the foam in a pattern essentially similar to that of water discharging therefrom. These discharge devices shall have a minimum nominal ¼-inch orifice and shall be listed for use with the particular type of air foam solution to be used in the system.

b. The discharge rate from air-aspirating discharge devices using protein-, fluoroprotein-, or AFFF-type air foam solutions shall be a minimum of 0.20 gallons of air-foam solution per-minute-per-square-foot of floor area. The discharge rate from nonair-aspirating discharge devices using AFFF type air-foam solutions shall be a minimum of 0.16 gallons of air-foam solution per-minute-per-square-foot of floor area.

*__c.__ The quantities of air-foam liquid concentrate (either protein foam, fluoroprotein, or AFFF) shall be sufficient for a foam discharge at the design rate for a minimum of 10 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. There shall be a directly connected equal reserve of air-foam liquid concentrate of compatible type for the system readily available. The main and reserve supply shall be satisfactory for the system installed.

***d.** Where air-foam liquid concentrate is introduced into the water stream by pumping, there shall be two (2) pumps, either of which can supply the air-foam liquid concentrate at the design rate. The arrangement of power supplies, controllers, piping and valves shall be consistent with the *Standard for the Installation of Centrifugal Fire Pumps (NFPA No. 20–1974)*. Piping shall be so arranged that either pump is able to deliver the concentrate to the system from both the primary and reserve supplies (*see also paragraph 1210c.*).

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

1211. Conversion of Existing System.

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

(1) The hydraulic design of the original system and the existing water supply shall be carefully considered when planning conversion.

(2) If water supplies are greater than necessary, the uniform discharge requirement of paragraph 1208.d. may be waived if the required minimum discharge rate in gallons per-minute-per-square-foot is available in all areas.

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

(4) Converted systems shall be tested in accordance with paragraph 1205.c.

1212. Detection System Design.

a. Detection systems for actuating the primary protection systems shall be rate-of-rise or fixed temperature rate-compensation types. (*See paragraph 901 for precautionary considerations.*)

b. Detection systems shall be provided with complete supervision.

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

1213. Protection of Landing Gear Pits and Tunnels. *See paragraph 607 in Part B of this Standard.*

***1214. Maintenance of Sprinkler Systems.** *See Appendix C, paragraph C1214.*

Chapter 13.

Supplementary Systems For External Aircraft Protection.

*1301. Scope and Definitions.

a. Scope. The systems outlined in this chapter concern the provision of fixed or semi-fixed supplementary extinguishing means intended to provide protection against fuel spill fires for aircraft having wing areas in excess of 3,000 square feet housed inside a hangar for storage or servicing. (*See Appendix K.*)

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

c. Definitions.

(1) *Fixed Systems.* Fixed systems shall mean equipment that is permanently installed in the hangar, connected to piped supplies of extinguishing media.

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

(3) *Supplementary Systems.* For the purpose of this chapter, this term means an approved air-foam system. These types of foam systems are defined and covered in the *Standard for Foam Extinguishing Systems* (*NFPA No. 11–1975*), the *Standard for High Expansion Foam Systems* (*NFPA No. 11A–1970*), and the *Standard for Synthetic Foam and Combined Agent Systems* (*NFPA No. 11B–1974*).

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

1302. General.

*a. Aircraft having wing areas in excess of 3,000 square feet† stored or serviced inside a hangar shall be protected with a listed supplementary protection system designed to protect the exterior of the aircraft from exposure to fuel spill fires.

b. Each supplemental protection system shall be designed, installed, and maintained in accordance with the *Standard for Foam Extinguishing Systems* (*NFPA No. 11–1975*), the *Standard for High Expansion Foam Systems* (*NFPA No. 11A–1970*), and the *Standard for Synthetic Foam and Combined Agent Systems* (*NFPA No. 11B–1974*), where applicable.

***1303. Plans and Specifications.** Before systems are installed, complete specifications and working plans shall be drawn to scale showing all essential details and be so made that they can be easily reproduced to provide necessary copies and shall include:

a. An accurate and complete layout of the area to be protected.

b. Information on the primary protection systems installed in the hangar.

c. Location and spacing of agent distributors, showing the area coverage.

d. Installation layout of the detection systems.

e. Detailed layout of water supply piping, agent storage, pumping and piping power sources, and location and details of mechanical foam liquid concentrate injection equipment.

f. Make and type of discharge devices and air-foam liquid concentrate, and hydraulic calculations of the systems.

1304. Acceptance Tests. The following tests shall be performed prior to final acceptance:

a. Hydrostatic Tests. All piping shall be subjected to a 2-hour hydrostatic pressure test at 200 lb. per square inch or 50 lb. in excess of the maximum pressure anticipated, whichever is greater, in general conformity with the *Standard for the Installation of Sprinkler Systems* (*NFPA No. 13–1975*). Al normally dry piping shall be checked for leakage, freedom of obstructions, and to determine if proper drainage pitch has been provided.

b. Operating Tests. All devices and equipment installed as part of the system shall be tested.

c. Discharge Tests. Supplementary extinguishing systems

†See Appendix K.

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

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

1305. Final Approval. The installing company shall furnish a written statement to the effect that the work has been completed in accordance with paragraph 1303 and tested in accordance with paragraph 1304.

***1306. Water Supply.** Water shall be available in sufficient quantity and pressure to supply the maximum number of agent distributors likely to operate simultaneously in addition to meeting the demands of overhead hangar protection systems as determined in Chapter 12 and the requirements for hose stream and other equipment as determined in Chapters 14 and 15. Water shall be suitable for the production of foam.

1307. Foam Concentrate. The quantities of agent shall be sufficient to provide protection specified by the requirements of this chapter.

a. The agent supplied with system shall be that listed for use with the distribution equipment.

***b.** There shall be a directly connected equal reserve of agent of a compatible type for the distribution system.

c. When the agent requires pumping to the distribution system, there shall be a minimum of two (2) pumps, either of which can supply the agent at the design rate.

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

1308. Air Foam Systems.

***a. General.** Low expansion air foam systems employ AFFF,

protein or fluoroprotein foam liquid concentrates. High expansion air foam systems usually utilize surfactants as the foaming ingredient. For the protection of shielded areas beneath aircraft as covered in this Chapter, local application designs shall be used for both types of foam systems.

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

(2) Provisions shall be made to automatically shut down the foam distributors to prevent disruption of the foam blanket when the foam concentrate supply is exhausted.

b. Low Expansion Foam Systems. These systems shall be designed to cover the specified floor area beneath an aircraft by means of a horizontal foam discharge from nozzles located at or near floor level. The nozzles may be oscillating; such nozzles may be water-powered or powered by electric motors. The discharge of foam from such nozzles shall be designed to control or extinguish a fire as specified in paragraph 1308.a.(1). Other design criteria are:

(1) When protein- or fluoroprotein-based concentrates are used, the minimum application rate shall be 0.16 gpm of air-foam solution per square foot of floor area beneath the wing and wing-center section of the aircraft protected. When AFFF concentrate is used, the minimum application rate shall be 0.10 gpm of air-foam solution per square foot of floor area beneath the wing and wing-center section of the aircraft protected.

(2) The quantity of water and foam concentrate shall be sufficient to operate the system at the required discharge rate for a period of at least 10 minutes.

(3) If any nozzles are removed to allow moving of aircraft and other aircraft in area are still protected by the system, removal of the nozzles shall not reduce the effectiveness of the remaining system.

(4) Electric power reliability for concentrate pumps and oscillating nozzles shall be consistent with electric fire pump requirements given in the *Standard for the Installation of Centrifugal Fire Pumps* (*NFPA No. 20–1974*).

***c. High Expansion Foam Systems.** These systems shall be designed to discharge at a rate sufficient to control or extinguish a fire as specified in paragraph 1308.a.(1). Other design criteria are:

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

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

(3) Generators shall be powered by reliable water-driven or electric motors. Electric power reliability for both generators and concentrate pumps shall be consistent with electric fire pump requirements given in the *Standard for the Installation of Centrifugal Fire Pumps* (*NFPA No. 20–1974*).

(4) Discharge rates shall take into consideration the sprinkler breakdown factor required in the *Standard for High Expansion Foam Systems* (*NFPA No. 11A–1970*).

***1309. Actuation System.**

a. Actuation of any primary fire protection system shall simultaneously operate the supplementary extinguishing system.

b. Actuation systems shall be provided with complete circuit supervision and be arranged in accordance with Chapter 16.

c. Manual tripping stations shall be provided for each special protection system and shall be operable from both inside and outside the aircraft maintenance and servicing area. Stations shall be located as close as possible to the aircraft positions to facilitate early system actuation in the event of a fire.

Chapter 14. Hand Hose Systems.

1401. Introduction. The intent of Chapter 14 is to provide a means for fire fighting by occupants of the hangar through the use of hand hose supplied from the hangar's fixed fire protection system or from an independent source. The hand hose system in aircraft storage and servicing areas is usually arranged for foam application with water spray or straight water streams used in other areas (*see paragraph 1403.b.*). For special applications, the use of carbon dioxide hand hose systems or dry chemical hand hose systems may be provided. More than one of these types of systems may be installed for the protection of the same area. In areas where building codes or local fire department regulations require independent hose connection systems, designed either for fire department use only or for use by occupants as well as the fire department, these required systems satisfy the intent of this chapter provided they are designed to permit use by the occupants, and,

in the aircraft storage and servicing areas, are arranged to supply water and foam for fire extinguishing purposes.

1402. General.

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

b. 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.

1403. Water-Foam and Water Spray Hand Hose Systems.

a. Aircraft Storage and Servicing Areas.

(1) Water-foam hand hose systems shall be installed in aircraft storage and servicing areas. The systems shall conform with the applicable portions of the *Standard on Standpipe and Hose Systems* (*NFPA No. 14–1974*) and the *Standard on Foam Extinguishing Systems* (*NFPA No. 11–1975*) or *Standard on Synthetic Foam and Combined Agent Systems* (*NFPA No. 11B–1974*). These hand hose systems shall be supplied from a connection to the sprinkler system header or from a direct connection to the water source. Each hand hose connection shall be a minimum of 1½ inches in size and fitted with a control valve. The hose shall be of suitable length and diameter to meet the requirements of paragraph 1402 and provide a maximum flow of 60 gpm at an adequate nozzle pressure. The stream range shall be calculated based on the volume and pressures available under maximum demand conditions. The hose shall be properly racked or reeled. Hoses shall be fitted with an approved foam-maker nozzle or a combination-type nozzle designed to permit foam application or water spray. Nozzles shall be of the shutoff type or shall have a shutoff valve at the nozzle inlet.

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

b. Shop, Office and Storage Areas of Hangars. Except where special hazards exist and require special protection, water standpipe and hand hose systems shall be installed in accordance with the applicable portions of the *Standard on Standpipe and Hose Systems* (*NFPA No. 14–1974*). Hoses shall be fitted with a listed combination-type nozzle designed to permit solid-stream or water-spray application.

1404. Carbon Dioxide or Dry Chemical Hand Hose Systems.

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

b. Where provided, carbon dioxide hand hose systems in aircraft storage and servicing areas shall be installed in accordance with Chapter 4 of the *Standard for Carbon Dioxide Extinguishing Systems* (*NFPA No. 12–1973; ANSI A54.1*) except as outlined herein:

(1) The supply pipe and length of hose shall be designed to provide an effective discharge of carbon dioxide within 30 seconds after actuation.

(2) Hose shall be of a type that will permit discharge without complete removal from the reel or rack.

(3) The carbon dioxide supply and distribution system shall be adequate to provide for continuous operation of two hand hose lines for at least 2½ minutes at a discharge rate of at least 200 pounds per minute per hand hose line.

c. Where provided, dry chemical hand hose systems in aircraft storage and servicing areas shall be installed in accordance with the *Standard for Dry Chemical Extinguishing Systems* (*NFPA No. 17–1975*), except as outlined herein:

(1) The supply pipe and length of hose shall be designed to provide an effective discharge of dry chemical within 30 seconds after actuation.

(2) The dry chemical supply and distribution system shall be adequate to provide for continuous operation of two hand hose lines for at least 2½ minutes at a discharge rate of at least 200 pounds per minute per hand hose line.

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

Chapter 15. Wheeled and Portable Extinguishers.

1501. Wheeled and portable extinguishers shall be provided in accordance with *Standard for the Installation, Maintenance, and Use of Portable Fire Extinguishers (NFPA No. 10–1975; ANSI Z112.1)*. In aircraft storage and servicing areas, the distribution of such devices shall be in accordance with the extra-hazard classification outlined in Chapter 4 of NFPA No. 10. The distribution of extinguishers in other areas of aircraft hangars shall be in accordance with light, ordinary or extra-hazard occupancy based on an analysis of each such room or area following the guidance in No. 10.

Chapter 16. Protection System Alarms and Fire Detection Systems.

1601. Protection System Alarms. In addition to local alarm service, alarms shall be transmitted to a constantly attended location. [*See the NFPA Standards for Protective Signaling Systems (NFPA Nos. 71, 72A, 72B, 72C, and 73D.)*]

Chapter 17. Employee Organization for Fire Safety.

1701. All personnel engaged in aircraft maintenance operations and all other persons regularly employed and working in or around aircraft hangars shall be instructed in fire prevention practices as part of their regular training. These personnel shall also be trained in the operation of all portable fire extinguishers and hose line systems provided in the hangar, shop or office area where they work.

1702. Selected personnel on each operational shift plus all watchmen or security guards shall be trained in the operation of the fixed fire protection systems provided in the hangar, shop or office area where they work. This training shall be accompanied by a comprehensive explanation of all features of such systems and the areas they protect.

1703. Responsibility for fire protection equipment inspection and maintenance shall be assigned to key personnel.

PART D
PROTECTION OF TYPE II AIRCRAFT HANGARS.

Chapter 18. Fire Protection Systems.

1801. Scope and Definitions.

a. Scope: The systems described in this chapter concern the provisions of fire protection means for the protection of Type II aircraft hangars. (*See paragraph 201.b.*)

b. Sprinkler Systems: For the purpose of this chapter the term "sprinkler system" is defined as a hydraulically calculated closed wet-pipe standard sprinkler system or preaction standard sprinkler system as described in the *Standard for the Installation of Sprinkler Systems* (*NFPA No. 13–1975*).

c. Foam Extinguishing Systems: The term "Foam Extinguishing System" for the purpose of this chapter shall mean an approved air foam system. These types of foam systems are defined and covered in the *Standard for Foam Extinguishing Systems* (*NFPA No. 11–1975*), the *Standard for High Expansion Foam Systems* (*NFPA No. 11A–1970*) and the *Standard for Synthetic Foam and Combined Agent Systems* (*NFPA No. 11B–1974*).

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

1802. General.

a. Type II aircraft hangars shall be protected in accordance with the provisions of either Chapter 12 or by means of a hydraulically calculated closed wet-pipe standard sprinkler system or preaction standard sprinkler system located under roofs, ceilings, mezzanines, etc., in conjunction with an approved foam extinguishing system as specified in this chapter.

Exception: Where foam-water sprinkler systems utilizing air-aspirating discharge devices (as described in Paragraph 1201.a.) are installed for the protection of Type II aircraft hangars, the discharge rate specified in Paragraph 1210.b. may be reduced to a minimum of 0.16 gallons of air-foam solution per-minute-per-square-foot of floor area.

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

c. 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.

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

1803. Pipes and Fittings: Piping and fittings shall be as specified in paragraphs 1203.a. and b.

1804. Plans and Specifications.

a. Sprinkler Systems: Plans and specifications for sprinkler systems shall provide the information required by paragraph 1204.

b. Foam Extinguishing Systems: Plans and specifications for foam extinguishing systems shall include the information required by paragraph 1303.

1805. Acceptance Tests.

a. Sprinkler Systems: Acceptance tests for sprinkler systems shall be performed in accordance with paragraphs 1205.a. and b.

b. Foam Extinguishing Systems: Acceptance tests for foam extinguishing systems shall be performed in accordance with paragraphs 1304.a.b. and d. In addition, the systems shall be subjected to flow tests with water or foam flowing from the maximum number of foam distributors expected to operate in order to insure that the hangar is protected in conformance with the design specification and to determine if the flow pressures, agent discharge capacity, foam quality, consumption rate of extinguishing agent, manpower requirements, and other operating characteristics are satisfactory.

1806. Final Approval. The installing company shall furnish a written statement to the effect that the work has been completed in accordance with paragraphs 1804.a. and b. and tested in accordance with the provisions of paragraphs 1805.a. and b.

1807. Water Supply.

a. Sprinkler System Only:

(1) The water supply shall be capable of furnishing water at the design discharge density over a minimum area of 5,000 sq. ft.

(2) The water supply duration shall be for a minimum of 30 minutes.

b. Foam Extinguishing Systems: Water shall be available in sufficient quantity to supply the maximum number of foam distributors expected to operate simultaneously in addition to meeting the demands of the sprinkler system as specified in para-

graph 1807.a. and the requirements for hose streams and other equipment as specified in paragraph 1807.c. and Chapter 14, where applicable. Water shall be suitable for the production of foam.

c. Additional Water Requirements For Exterior Hose Streams. When the water supply for sprinklers also serves as a supply for exterior hose streams, the total supply shall be increased by 500 gpm and shall be included in the hydraulic calculations. Calculations for hose stream demand shall be in accordance with Chapter 7 of the *Standard for the Installation of Sprinkler Systems, (NFPA No. 13–1975).*

d. Fire Pump and Suction Reservoirs: Where provided, fire pumps and suction reservoirs shall be designed and installed in accordance with 1207.d. and 1207.e.

1808. Foam Concentrate Supply. The provisions of paragraph 1307 shall be used in determining foam concentrate supply.

1809. Sprinkler System Design.

a. General.

(1) In aircraft storage and servicing areas, the maximum projected floor area under an individual sprinkler system shall not exceed 25,000 square feet.

(2) Sprinkler spacing shall be as specified in paragraph 1208.b.

(3) Sprinkler piping shall be hydraulically calculated in accordance with Chapter 7 of NFPA No. 13.

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

b. Design Discharge Rate.

(1) The discharge rate from sprinkler systems shall be a minimum of 0.17 gallons of water per minute per square foot of floor area.

c. Sprinklers.

(1) Standard spray sprinklers having a minimum nominal ½-in. orifice shall be used.

(2) Sprinklers shall be of an extra-high temperature classification as defined in the *Standard for the Installation of Sprinkler Systems (NFPA No. 13–1975).*

1810. Air Foam Systems.

a. General. For the protection of Type II aircraft hangars as covered in this chapter, local application designs shall be used

for the foam extinguishing systems. These systems shall be provided to protect the entire aircraft storage and servicing area. Provisions shall be made to automatically shut down the foam distributors to prevent disruption of the foam blanket when the foam concentrate supply is exhausted.

b. Low Expansion Foam Systems. Low expansion foam systems shall be designed to protect an area as specified in paragraph 1810a. The minimum application rate shall be 0.16 gpm of air foam solution per square foot of floor area when protein or fluoroprotein base concentrates are used. When AFFF concentrate is used, the minimum application rate shall be 0.10 gpm of air foam solution per square foot of floor area. Other design criteria shall be in accordance with paragraph 1308.b.(2), (3), and (4).

c. High Expansion Foam Systems. High expansion foam systems shall be designed to protect an area as specified in paragraph 1810.a. The application rate shall be a minimum of 3 feet per minute. Other design criteria shall be in conformance with 1308.c.(1), (2), (3), (and 4).

1811. Detection System Design.

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

b. Detection systems shall be provided with complete supervision.

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

PART E
CONSTRUCTION AND PROTECTION FOR TYPE III AIRCRAFT HANGARS

Chapter 19. Definition

1901. Type III Aircraft Hangars. Type III hangars can be single units for an individual aircraft, or joined to form a row of hangars, or single units for multiple aircraft. Routine maintenance work, excluding hazardous operations such as transfer of fuel, welding, cutting, or soldering, doping or spray painting, may be done in Type III hangars.

Chapter 20. Construction of Type III Hangars.

***2001.** The construction of Type III hangars shall conform to the applicable portions of the recommendations contained in Part B, Construction of Aircraft Hangars, subject to the following exceptions:

a. Shop, office or storage areas where attached to storage hangars shall be cut off as described in paragraph 2001.b.

b. The provisions of paragraph 503 shall apply except that in lieu of a fire wall, solid fire partitions having a fire resistance equivalent to that of the walls or roof shall be provided between each adjoining hangar. Where Type III hangars are joined, there shall be a fire partition provided between every third hangar. The provisions of paragraph 506 do not apply.

c. Type III hangars shall be limited to one story in height and shall not be adjoined by any multistory structure.

d. The provisions of paragraph 602 shall not exclude earth flooring for Type III hangars. Roof coverings, specified under paragraph 604 shall be "Class C" or better, as listed by a recognized testing laboratory, except that metal roof decking may also be used. Hangar aprons shall slope away from the level of the hangar floors sufficiently to prevent liquid on apron surfaces from flowing into the hangars. Where multiple Type III hangars are attached, curbing shall be used between each hangar to prevent the flow of liquids from one to the next.

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

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*Asterisk before paragraph numbers indicates additional information in Appendix E.

Chapter 21. Protection of Type III Hangars.

*2101. The protection required for Types I and II hangars need not be followed for Type III hangars. The provisions of the *Standard for the Installation, Maintenance, and Use of Portable Fire Extinguishers* (*NFPA No. 10–1975; ANSI Z112.1*) shall be followed. Where portable extinguishers are locked up to preclude possibility of theft, each tenant and aircraft owner shall be provided with a key for the locks.

2102. Dry grass and vegetation between Type III hangars shall be cleared so as to act as a fire break.

Appendix A

References to Related Fire Protection Recommendations Applicable to Aircraft Hangars

A101.a. Related Fire Protection Publications Dealing with Aircraft Maintenance and Servicing.

(1) Aircraft Fuel Servicing (NFPA No. 407; ANSI Z119.1).

(2) Aircraft Electrical System Maintenance Operations (No. 410A).

(3) Aircraft Breathing Oxygen System Maintenance Operations (NFPA No. 410B; ANSI Z227.1).

(4) Aircraft Fuel System Maintenance (No. 410C).

(5) Aircraft Cleaning, Painting, and Paint Removal (No. 410D).

(6) Aircraft Welding Operations in Hangars (No. 410E).

(7) Aircraft Cabin Cleaning and Refurbishing Operations (No. 410F).

A101.b. Related Fire Protection Publications Dealing with Aircraft Rescue and Fire Fighting.

(1) Recommended Practice for Aircraft Rescue and Fire Fighting Services at Airports and Heliports (NFPA No. 403; ANSI Z213.1).

(2) Standard Operating Procedures, Aircraft Rescue and Fire Fighting (NFPA No. 402).

(3) Standard for Aircraft Rescue and Fire Fighting Vehicles (NFPA No. 414; ANSI B128.1).

(4) Standard on Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles (NFPA No. 412).

(5) Aircraft Fire Investigators' Manual (NFPA No. 422M).

A101.c. Related Fire Protection Publications Dealing with Other Airport Fixed Properties (Short Titles).

(1) Aircraft Fueling Ramp Drainage (NFPA No. 415).

(2) Airport Terminal Buildings (NFPA No. 416; ANSI Z246.1).

(3) Aircraft Loading Walkways (NFPA No. 417).

(4) Airport Water Supply Systems (NFPA No. 419).

A101.d. Other Applicable Airport Standards. Applicable national or international standards should be followed with regard

to the clearance distance for hangars in relation to the center line of airport runways.†

A101.e. Local Fire Regulations. It is recommended that every airport develop fire protection and prevention regulations to meet local conditions and to implement these standards on a local basis.

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

Appendix B

Recommendations Supplementing Provisions of Part B

B301. General.

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

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

c. Height Limitations. The height of aircraft storage or servicing areas should be limited to one story regardless of type of construction. This should not be interpreted to prohibit a roof space (*see paragraph 604.d.*) nor to prohibit multiple story adjoining or communicating structures suitably cut off by fire division walls from aircraft storage and servicing areas.

B401. Construction of Fire Walls. Fire wall construction is covered in the National Building Code recommended by the American Insurance Association.

B402. Options in Heavy Timber Construction. In this type construction spaced members may be composed of two or more pieces not less than 3 inches, nominal, in thickness when blocked solidly throughout their intervening spaces or when such spaces are tightly closed by a continuous wood cover plate of not less than two inches, nominal, thickness secured to the underside of members. Splice scabs should be not less than three inches, nominal thickness. When the building is protected with an approved protection system, the framing members may be reduced to not less than three inches, nominal, thickness.

B403. Typical Noncombustible Materials. Materials considered noncombustible do not ignite and burn when subject to fire; typical noncombustible materials include steel, iron, brick, tile, concrete, slate, asbestos, glass or plasters.

B502. Maximum Recommended Areas — Hangars Protected by Fire Protection Systems. Areas recommended for single hangar buildings and hangar building groups protected with approved fire protection systems should be limited in area as specified in Table B502. Where mixed types of construction are involved, the predominating type of construction should be used. (*For clear space distances required, see Table II, paragraph 504.*)

Table B502

Maximum Recommended Areas for Single Hangar Buildings and Hangar Building Groups Protected by Approved Fire Protection Systems

Type of Construction (See Definitions, Chapter 4)	Max. Fire Area Single Hangar Bldgs. Square Feet	Max. Total Area Hangar Bldg. Groups Square Feet
Fire Resistive	200,000	500,000*
Protected Noncombustible	160,000	400,000
Heavy Timber, Protected Ordinary or Unprotected Noncombustible	120,000	300,000
Ordinary	40,000	120,000
Protected Wood Frame	30,000	90,000
Wood Frame	20,000	60,000

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

B601. Preference for Noncombustible Construction. Preference should be given to the use of noncombustible materials in wood frame hangars. Separate shops, offices and storage areas should comply with the provisions of paragraph 503.

B607. Landing Gear Pits, Ducts and Tunnels. Landing gear pits, ducts and tunnels located beneath the hangar floor should be avoided if possible because of the danger of accumulation of flammable liquids or vapors; where their use is essential, the protection measures specified in paragraph 607 shall be followed. (*For floor drainage, see paragraph 702.*)

B607.e. Venting of Landing Gear Pits. The venting arrangements will be dependent upon the design of the pits, elevating platforms, and means of access. It may be necessary for part of the platform surface to be grated or perforated to give adequate explosion venting area. The general principles in the *Explosion Venting Guide* (*NFPA No. 68*) should be followed.

B607.f. Protection of Landing Gear Pits. Consideration should be given to the selection of an extinguishing agent which could also be used as a means of inerting in the pit in the event that flammable vapors were present concurrent with the loss of use of the ventilation system because of power failure, maintenance, or other causes. For this reason carbon dioxide or the lower toxicity halogenated agents (UL Group 5 or 6) may be useful in this respect.

B702.a. Floor Drainage in Hangars. Aircraft hangars may also require floor drainage systems to effectively dispose of water used

for cleaning aircraft and hangar floor surfaces, possible flooding due to high ground water tables, and to drain away water discharged from the fire protection equipment provided within the structure (see Part C, Chapters 12 and 13 and Section 1403). Reference may be made to the *Standard on Aircraft Fueling Ramp Drainage* (*NFPA No. 415*) for guidance on drainage systems and to the Appendix of the *Standard for Water Spray Fixed Systems for Fire Protection* (*NFPA No. 15*) for information on drainage equipment and arrangements.

B702.b.(1) Distance Between Drains. The distance between drainage inlets or grids on the hangar floor should minimize the distance any spilled fuel must flow to such drains. The basic consideration is to reduce potential heat exposure to the critical structural elements of any aircraft in the hangar and any essential building structural components; other considerations are the placement and form of any accessory maintenance equipment, the slope and construction of the floor, the design and type of the fire protection systems installed, and the exposures of adjoining or communicating shop or apron area.

B702.b.(3) Spillovers from Drains. The drainage system, including high points or ridges in the hangar floor, should be so constructed as to limit spillover of fuel to adjacent areas.

B702.c. Drains at Main Hangar Doors. Drains should be provided at main hangar doors to dispose of as much as possible of the fuel and water flow resulting from the operation of interior water sprinklers and any fire hose streams used in the hangar. Such drains should consist of grated trenches at each such door extending approximately the full width of the opening but should not pass fire walls. In addition to the separation of the trench ends at fire walls, intermediate barriers should be provided within a trench to prevent flow of water and flammable liquids from one protected section to another. Each section of trench between such barriers should have an independent bottom drain outlet. Door trenches may be located inside or outside the door but, if outside, special precautions should be taken in cold climates to keep them clear of ice and snow. Where the door trenches are outside, bottom door seals and tracks should not interfere with efficient drainage. (*See paragraph 606.a.(4).*)

B801. 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 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. from the floor.

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

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

B901.a. Heating. It is recommended that hangar heating plants fired with gas, liquid or solid fuels be located in a fire-resistive or noncombustible detached building wherever possible.

B904. Lightning Protection. All aircraft hangars should be surveyed to determine the need for approved lightning protection. When installed, such system should bear the Master Label of Underwriters' Laboratories, Inc. (*See Lightning Protection Code, NFPA No. 78, ANSI C5.1.*)

B1001. Resistance for Static Grounding. As low a resistance as possible should be secured and maintained. 10,000 ohms is a practical recommended maximum when determined by standard procedures. For further details on this subject, see *Standard for Aircraft Fuel Servicing* (*NFPA No. 407; ANSI Z119.1*) and the *Recommended Practice on Static Electricity* (*NFPA No. 77*).

B1101. Exits. See *Life Safety Code* (*NFPA No. 101; ANSI A9.1*), including Section 15–3, for further information.