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AIRCRAFT HANGARS 1972

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Official NFPA Definitions

Adopted Jan. 23, 1964: Revised Dec. 9, 1969. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

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SHOULD is intended to indicate recommendations or that which is advised but not required.

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Statement on NFPA Procedures

This material has been developed in the interest of safety to life and property under the published procedures of the National Fire Protection Association. These procedures are designed to assure the appointment of technically competent Committees having balanced representation from those vitally interested and active in the areas with which the Committees are concerned. These procedures provide that all Committee recommendations shall be published prior to action on them by the Association itself and that following this publication these recommendations shall be presented for adoption to the Annual Meeting of the Association where anyone in attendance, member or not, may present his views. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

Standard on
Aircraft Hangars

NFPA No. 409 — 1972

1972 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 Committee on Aviation. This edition was adopted by the National Fire Protection Association at their 76th Annual Meeting held in Philadelphia, Pa. on May 16, 1972, and supersedes all previous editions. The substantive changes in this edition as compared with the 1971 text appear in Paragraphs 204; 205; 1503 (new); 1504.f. (old 1503.f.); 1510.b. (old 1509.b.); 1510.d. (old 1509.d.); 1511.a. (old 1510.a.); 1601.c.(4) (new); 1608.b.(1); 1608.c.(1); 1609.a,b,c. and d.; 1702.f. (new); 1703.a.(1); and 1703.b.(1). Editorial changes have also been accomplished to keep the text up to date including some redesignating of Paragraphs, heading changes, and changes in wording and references for consistency.

The 1971 edition of this text was approved as an American National Standard by the American National Standards Institute under date of January 28, 1972 and was identified as ANSI No. Z214.1 — 1972. This new edition has been submitted for ANSI approval. The ANSI designation and date of approval will be printed on the front cover of copies of this edition printed after approval has been received.

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 and this 1972 edition were prepared by this 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 footnote to Paragraph 104 herein and Volume 10 of the National Fire Codes.)

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Scope: To promote fire safety during the operation, maintenance, servicing and storage of aircraft and in the operation of airports and associated functions. The Committee is a policy-making Steering Committee of the NFPA Sectional Committees organized to handle specific technical problems in the aviation field. Reports prepared by the Sectional Committees are circulated for letter ballot to the members of this Committee and the results reported to the Annual Meeting of the Association.

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SCOPE: To develop fire safety recommendations for the construction and protection of aircraft hangars and other types of airport facilities involving construction engineering (whether above or below ground). This Sectional Committee reports to the Association through the Aviation Committee.

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Standard on

Aircraft Hangars

NFPA No. 409 — 1972

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 have been drafted to provide guidance as to the proper construction and protection of aircraft hangars and are intended to provide good practice recommendations for the guidance of airport authorities, aircraft owners and operators, building and fire officials and insurance underwriters.

102. SUBDIVISIONS OF THIS STANDARD. This standard is divided into seven subdivisions as follows:

a. PART A. INTRODUCTION.

b. PART B. CONSTRUCTION OF AIRCRAFT HANGARS. This Part and Part C give recommendations for the conventional aircraft hangar used for the storage and servicing of aircraft of the types commonly used by airline operators, large corporations, the military and a large number of fixed based operators at private, municipal and state owned airports. The recommendations are predicated on the assumption that these hangars will be used for both the storage and servicing of aircraft and include the so-called community hangars accommodating more than one aircraft of all types, the hangar intended to accommodate a single large aircraft (see "Note"), or a single turbine-powered aircraft of any size. For hangars intended for the storage of single small reciprocating-engine-powered aircraft, see Part F.

NOTE: A large aircraft is one of more than 12,500 lbs. maximum certificated take-off weight.

c. PART C. PROTECTION OF AIRCRAFT HANGARS. See remarks under Paragraph 102. b.

d. PART D. WING OR NOSE HANGARS. 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.

e. PART E. NONPORTABLE AIRCRAFT DOCKS. 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.

f. PART F. UNIT TYPE STORAGE HANGARS FOR SMALL AIRCRAFT. These hangars are used for the storage of personal, executive or other small aircraft. Such unit type hangars may be single units for an individual aircraft or joined to form a row of hangars.

NOTE: A "small" aircraft is defined as an aircraft with a maximum certificated take-off weight of 12,500 lbs. or less.

g. PART G. APPENDIX. Diagrams and text designed to assist in implementing this Standard.

103. APPLICATION OF STANDARDS. It is urged that airport operators follow these recommended standards in the construction and protection of aircraft hangars in the absence of adequate local building laws and fire prevention ordinances. It should be clearly understood, however, that these recommendations are not proposed for legal adoption nor are they intended to apply on a retroactive basis to existing hangars except as such recommendations may be found useful in furthering the fire safety of any structure and its contents.

104. SUBJECTS NOT COVERED.

a. AIRCRAFT MAINTENANCE AND STORAGE. This standard does not deal with aircraft storage and maintenance procedures and hazards. The NFPA has detailed recommendations on safeguarding certain aircraft maintenance operations.* The recommendations contained herein do, however, contemplate the hazards existing in aircraft maintenance and storage opera-

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*See the following NFPA publications dealing with aircraft maintenance operations (short titles given):

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

Aircraft Electrical System Maintenance Operations (No. 410A)

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

Aircraft Fuel System Maintenance (No. 410C)

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

Aircraft Welding Operations in Hangars (No. 410E)

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

tions as well as the hazards occasioned by the construction of the building and the utilities supplied for the comfort and convenience of the occupants.

b. AIRCRAFT RESCUE AND FIRE FIGHTING. This standard does not deal with aircraft rescue and fire fighting equipment or manpower. Reference is made to the recommendations of the National Fire Protection Association entitled "Recommended Practice for Aircraft Rescue and Fire Fighting Services at Airports and Heliports" (NFPA No. 403; ANSI Z213.1) and "Standard Operating Procedures, Aircraft Rescue and Fire Fighting" (NFPA No. 402) for data and correlation with the hangar fire protection specified herein. Particular reference is made to Paragraph 111 of NFPA No. 403. Preplanning is recommended for maximum efficiency in the use of this equipment in combating hangar and apron fires (see Paragraph 2103).

105. 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.*

106. LOCAL FIRE REGULATIONS. It is recommended that every airport develop fire protection and prevention regulations in addition to those provided herein as a guide to meet local conditions and to implement these standards on a local basis.

*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 Part 77 of the Federal Air Regulations. (Title 14 of Code of Federal Regulations).

See also "Annex 14 Aerodromes", issued by the International Civil Aviation Organization. Copies available from ICAO, International Aviation Building, 1080 University St., Montreal, Canada.

PART B
CONSTRUCTION OF AIRCRAFT HANGARS.

Chapter 2. Definitions.

201. A HANGAR is defined as a building or other structure in any part of which aircraft are housed or stored, or in which aircraft may be undergoing servicing, repairs or alterations. (See Paragraphs 2201, 2501 and 2801 for special types.)

202. A SINGLE HANGAR BUILDING is a building with one area for the storage or 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 502 and 503. (See also Paragraph 505.)

203. A HANGAR BUILDING GROUP is a building or group of buildings with more than one area for the storage or servicing of aircraft and all attached, adjoining, or contiguous structures not separated as specified in Paragraphs 504 or 505.

204. AIRCRAFT STORAGE AND SERVICING AREA. That part of a hangar normally used for the maintenance, servicing, or storage of one or more aircraft not including any adjacent or contiguous areas or structures (e.g., shops, storage areas, offices, etc.).

205. FIRE AREA. For the purpose of Part B of this Standard, an area within a hangar subject to loss by a single fire because of lack of internal subdivisions as specified in Paragraph 502.

Chapter 3. General Recommendations.

301. PREFERENTIAL CONSTRUCTION. Single hangar buildings, separated by space are preferable to two or more adjoining hangars separated by fire walls.

302. COMMUNICATING SECTIONS. Shop, office and storage areas should be in separate detached buildings wherever possible. Where such areas communicate (as in lean-tos) with an aircraft storage or 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 502. Workshops, offices and storage areas having their own roof coverings and built within aircraft storage or servicing areas, shall have water-tight roof deck coverings.

Chapter 4. Classification of Hangars.

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, roofs 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 resistance may be 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. (See NFPA Standard No. 220 for further details on Fire Resistive Construction.)

NOTE: Construction of fire walls is covered in the National Building Code recommended by the American Insurance Association.

402. HEAVY TIMBER CONSTRUCTION. Hangars of this type shall have columns, beams, girders and roofs of heavy timber or of approved glued laminated construction of not less than the following nominal dimensions for individual members:

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

*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 2 inches, nominal, thickness secured to the underside of members. Splice scabs shall be not less than 3 inches, nominal, thickness. When the building is protected with an approved primary protection system (see Chapter 15) the framing members may be reduced to not less than 3 inches, nominal, thickness.

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 resistance may be 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. (See NFPA Standard No. 220 for further details.)

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). Materials considered noncombustible do not ignite and burn when subject to fire and include such materials as steel, iron, brick, tile, concrete, slate, asbestos, glass or plasters. In hangar construction there are commonly two types of noncombustible buildings which may be described as follows:

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 resistance may be 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. (See NFPA Standard No. 220 for further details.)

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 resistance may be required depending upon conditions of occupancy or exposure. Roofs, floors (except as specified in Paragraph 802), 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). (See NFPA Standard No. 220 for further details.)

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. (See NFPA Standard No. 220 for further details.)

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. (See NFPA Standard No. 220 for further details.)

b. This type construction shall be designated Protected Wood Frame Construction when the roof and floor construction and its supports have a one hour fire resistance rating. (See NFPA Standard No. 220 for further details.)

Chapter 5.
Internal Subdivisions and Separation.

501. GENERAL. The nature of fires in aircraft hangars indicates that more than ordinary precautions should be taken to insure ready access to such buildings from all sides and adequate separation should be provided to reduce fire exposure between buildings. The clear spaces specified in Tables I and II of Paragraphs 503 and 504 should not be used for the storage of aircraft or concentrations of combustible materials nor should buildings of any type be erected therein.

502. INTERNAL SUBDIVISIONS. When two or more aircraft storage or 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 or servicing areas shall be provided with approved Class A fire 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 or servicing area, except where, in the judgment of the authority having jurisdiction, double doors are required. Partitions and ceilings separating aircraft storage and servicing areas from other areas (e.g. shop, office and parts storage areas) should have at least a one-hour fire resistance rating with openings protected by approved Class C fire doors (see Paragraph 302). Curbs, ramps or drains shall be provided at all openings from aircraft storage or servicing areas to prevent the flow of liquids through the openings (see Paragraph 902.c. and d.).

503. SEPARATION BETWEEN SINGLE HANGAR BUILDINGS. Clear space distances specified in Table I shall be maintained

on all sides of single hangar buildings (areas not in excess of provisions of Table III, Paragraph 701). Where mixed types of construction are involved the predominating type of construction shall be used as a guide, subject to the approval of the authority having jurisdiction.

TABLE I

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.

504. SEPARATION BETWEEN HANGAR BUILDING GROUPS. The clear space distances specified in Table II shall be maintained on all sides of hangar building groups (areas not in excess of provisions of Table IV, Paragraph 702). Where mixed types of construction are involved, the predominating type of construction shall be used as a guide, subject to the approval of the authority having jurisdiction.

TABLE II

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.

505. 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 and subject to the area provisions of Paragraph 702.

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.

*See Paragraph 501 for Limitations in Use of Space and Paragraph 505 for Exceptions.

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% of the wall area. The requirement for approved Class E windows and outside sprinkler protection for lean-to portions of hangars may be modified subject to the approval of the authority having jurisdiction.*

Chapter 6. Height Limitations.

601. 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 804.d.) nor to prohibit multiple story adjoining or communicating structures suitably cut off by fire division walls from aircraft storage or servicing areas.

(See Paragraph 802.a. regarding basements and tunnels.)

Chapter 7. Maximum Recommended Fire Areas

701. MAXIMUM RECOMMENDED FIRE AREAS—SINGLE HANGAR BUILDINGS. Fire areas permitted for single hangar buildings without fire wall subdivisions all openings in which are protected by approved double Class A fire doors, should be limited as specified in Table III. Where mixed types of construction are involved, the predominating type of construction shall be used as a guide, subject to the approval of the authority having jurisdiction. (For clear space distances required see Table I, Paragraph 503.)

702. MAXIMUM RECOMMENDED TOTAL AREAS—HANGAR BUILDING GROUPS. Total areas permitted for hangar building groups should be limited as specified in Table IV, including all

*See NFPA Standard on Fire Doors and Windows, No. 80.

TABLE III

MAXIMUM RECOMMENDED FIRE AREAS — SINGLE HANGAR BUILDINGS

TYPE OF CONSTRUCTION	MAX. FIRE AREA NONSPRINKLERED SQUARE FEET	MAX. FIRE AREA SPRINKLERED SQUARE FEET
Fire Resistive	30,000	200,000
Protected Noncombustible	20,000	160,000
Heavy Timber or Protected Ordinary	15,000	120,000
Unprotected Noncombustible	12,000	120,000
Ordinary	12,000	40,000
Protected Wood Frame	8,000	30,000
Wood Frame	5,000	20,000

workshops and other enclosed spaces attached or adjoining. No single fire area should exceed the limits specified in Table III, Paragraph 701. Where mixed types of construction are involved, the predominating type of construction shall be used as a guide, subject to the approval of the authority having jurisdiction. (For clear space distances required see Table II, Paragraph 504.)

TABLE IV

MAXIMUM RECOMMENDED TOTAL AREAS — HANGAR BUILDING GROUPS

TYPE OF CONSTRUCTION	MAX. TOTAL AREA NONSPRINKLERED SQUARE FEET	MAX. TOTAL AREA SPRINKLERED SQUARE FEET
Fire Resistive	60,000	500,000*
Protected Noncombustible	40,000	400,000
Heavy Timber or Protected Ordinary	30,000	300,000
Unprotected Noncombustible	24,000	300,000
Ordinary	24,000	120,000
Protected Wood Frame	16,000	90,000
Wood Frame	10,000	60,000

*Where walls separating fire areas have a fire resistance rating of not less than 3 hours, the total area for fire resistive construction may be unlimited.

Chapter 8. Common Structural Requirements.

801. 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). Preference should be given to the use of noncombustible materials in wood frame hangars. Separate shops, offices and storage areas shall comply with the provisions of Paragraphs 302 and 502.

802. Floors.

a. The surface of the grade floor of aircraft storage or 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. 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 807 shall be followed. (For floor drainage, see Paragraph 902; for static protection, see Paragraph 1302; for floor openings, see Paragraph 803.)

Note: If the floor on grade is built as a structural floor, subsequent subsidence of the earth or fill can create a space below the floor in which flammable vapors could collect. Where such conditions develop or are created by construction methods, it may be necessary to provide positive ventilation or correct the condition by other means.

b. The floors of adjoining and communicating areas, regardless of type of hangar construction, should be as specified in Paragraph 802.a. 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.). In other sections, floors may be combustible or earth, subject to the approval of the authority having jurisdiction.

803. Floor Openings. Floor openings in multi-storied sections of hangars (see Paragraph 601) should 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.

804. Roofs.

a. **Roof Coverings.** Roof coverings shall be of an approved type of tile, slate, metal, asbestos, asphalt shingles or of built-up roofing finished with asphalt, slag 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 may be used on top of the roof deck provided such insulation is covered with an approved type of roof covering applied directly thereto.

d. ROOF SPACES. When suspended ceilings are provided in aircraft storage or 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 louvres to assure air circulation therein.

e. LADDERS TO ROOFS. Unless enclosed stairs leading directly to the roof of aircraft storage or servicing areas are available from the exterior of the hangar, adequate permanent exterior ladders to hangar roofs should 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.

805. PROTECTION OF STRUCTURAL STEEL.

a. COLUMNS. All main structural columns within the aircraft storage or 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.

NOTE: The authority having jurisdiction may accept fixed water or foam-water deluge systems 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.

806. 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. Pre-planning should 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. (See also Paragraph 1508.f.)

(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 902.c.(3).]

b. OTHER EXTERIOR DOORS. See Paragraph 505 for exposure protection for exterior doors in certain locations and Chapter 14 with regard to exit doors.

c. CURTAINS ENCLOSING WORK AREAS. Where curtains are used to enclose a work area they shall be of an approved flame resistant type.

807. 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 times. Materials and equipment shall be of fire resistant or noncombustible construction. The general design features and fire protection measures shall be subject to the approval of the authority having jurisdiction.

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; ANSI C1).

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 807. c. (2) automatically upon detection of a specified flammable vapor concentration that is below the lower flammable limit. The detection system should 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 suitable for use with aviation fuel and water. If drainage is routed through ventilation or access tunnels to external discharge points, the drainage shall be by fully enclosed pipe runs.

e. EXPLOSION VENTING: Explosion relief venting shall be provided in the pit areas. 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 NFPA Guide for Explosion Venting (No. 68) should be followed.

f. FIRE PROTECTION: An approved fire protection system shall be installed to protect each pit unless the overall hangar fire protection system outlined in Part C is adequate. 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.

Chapter 9. Drainage of Aprons and Hangar Floors.

901. 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 per cent (1:200) for the first 50 feet. Ramps used for aircraft fueling adjacent to hangar structures shall comply with the NFPA Standard on Aircraft Fueling

Ramp Drainage (No. 415). In establishing locations for nearby aircraft parking, consideration should be given to the drainage pattern of the apron.

902. HANGAR FLOOR DRAINAGE.

a. GENERAL.

(1). To limit fire spread and achieve rapid fire control in the event of fuel spillage on the hangar floor, floor drainage systems shall be designed to restrict the spread of fuel and provide means to reduce the fire and explosion hazards incident thereto.

NOTE: 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 protective equipment provided within the structure (see Part C, Chapters 15 and 16 and Section 1703).

(2). Drainage systems should 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 should be designed with suitable traps or provided with adequate ventilation to prevent flammable vapor mixtures forming within the underground drainage system.

NOTE: Reference may be made to the NFPA Standard on Aircraft Fueling Ramp Drainage (No. 415) for guidance on drainage systems and to the Appendix of the NFPA Standard for Water Spray Fixed Systems for Fire Protection (No. 15) for information on drainage equipment and arrangements.

b. INTERIOR DRAINAGE SYSTEMS.

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

(2). Where the hangar is protected by water deluge systems as specified in Paragraph 1509, 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 1510, the pitch of

the floor should be a minimum of ½ of one percent. (See Paragraph 1502.d. and e.)

NOTE: The floor pitch provided should take into consideration the towability of the aircraft and the problems of aircraft maintenance, weight and balance checking, etc.

(3). Each protected section* of the aircraft storage and servicing area should be calculated separately taking into consideration the maximum rated discharge from the fire protection systems and hose lines.

(4). Drains in each protected section* of an aircraft hangar storage and servicing area protected by foam-water sprinkler systems should be so constructed that they have sufficient capacity to handle water at a rate equal to 25 percent of the maximum foam-water solution discharge rate.

NOTE: Design of the drainage system inlets and pipes leading from same should be based on the discharge density in gallons per square foot per minute from a single sprinkler system when supplied at the maximum volume and pressure available.

(5). The drainage system, including high points or ridges in the hangar floor, shall be so constructed as to prevent spillover onto floor areas in an adjacent protected section*.

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

(7). The distance between drainage inlets or grids on the hangar floor shall minimize the distance any spilled fuel must flow to such drains.

NOTE: 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.

c. DRAINS AT MAIN HANGAR DOORS.

(1). When drains at these doors are provided as part of the drainage systems, the drains should dispose of as much as possible of the water flow resulting from the operation of interior water sprinklers and any fire hose streams used in the hangar.

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* "Each protected section" means each individual system surrounded by draft stops (see Paragraph 1512) or the entire aircraft storage and servicing area if no draft stops are provided.

(2). 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 past draft curtains. Each section of trench between such barriers shall have an independent bottom drain outlet.

(3). Door trenches may be located inside or outside the door but, if outside, special precautions will be necessary in cold climates to keep them clear of ice and snow. Where the door trenches are outside, bottom door seals and tracks shall not interfere with efficient drainage. [See Par. 806.a.(4).]

d. DRAINS AT OTHER OPENINGS FROM AIRCRAFT STORAGE OR SERVICING AREAS. If drains are provided to prevent flow of liquids from aircraft storage or servicing areas through openings to shops, offices or other communicating areas, the drains shall be so constructed as to prevent the flow of liquids through the door during fuel spill or fire emergencies.

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

f. OIL SEPARATORS. Oil separators should be provided for the drainage systems serving all aircraft storage or servicing areas unless the entire drainage system discharges to a remote location where pollution is not a factor and drain openings located downstream in the system do not constitute any hazard to life and property. In aircraft storage or servicing areas protected by water deluge or foam-water sprinkler systems, a bypass may 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.

g. 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.

h. 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 10. Draft Stops In Sprinklered Hangars.

1001. MATERIALS. Draft stops installed in accordance with the provisions of Paragraph 1512 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.

1002. DEPTH. Draft stops should extend down from the roof or ceiling of aircraft storage or 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 feet from the floor.

(NOTE: See Part G, Par. A-1002, for Sketches.)

1003. 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 shall 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.

1004. 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.

Chapter 11. Hangar Services and Utilities.

1101. HEATING.*

a. No heater employing an open flame or glowing element shall be installed in aircraft storage or servicing areas or sections communicating therewith, except as authorized in subparagraphs b or c below.

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*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.

b. GENERAL.

1. Heating equipment shall be installed to conform with Code for Heat Producing Appliances issued by the American Insurance Association, the Standard on "Installation of Air Conditioning and Ventilating Systems" (NFPA No. 90A), the "Installation of Oil Burning Equipment" (NFPA No. 31; ANSI Z95.1) and the "Installation of Gas Piping and Gas Appliances in Buildings" (NFPA No. 54; ANSI Z21.30), except as hereinafter specifically provided.

2. 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.

3. Hangar heating plants fired with gas, liquid or solid fuels (not covered under subparagraph c 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 should 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 such ducts shall be protected with approved type automatic fire dampers or doors. All air for combustion purposes entering such separated rooms shall be drawn from outside of the building.

4. Fan furnace heating systems employing recirculation of air within aircraft storage or 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 6 inches from the floor, measured to the bottom of the opening. It is recommended that the fans for such systems be arranged to shut down automatically by the operation of the interior automatic fire protection system. One or more manual fan shut-off switches should also be provided. Shut-off switches shall be accessible and clearly placarded. Personnel should be fully instructed that in event of a serious gasoline or similar flammable liquid spill on the hangar floor, the fans should be shut off.

c. SUSPENDED OR ELEVATED HEATERS.

1. Electric, gas or oil heaters, approved as suitable for use in aircraft hangars, may be used if installed as specified in subparagraphs 2, 3 and 4 herein.

2. In aircraft storage or servicing areas, they shall be installed at least 10 feet above the upper surface of wings or

of engine enclosures of the highest aircraft which may be housed in the hangar. (The measure should be made from the wing or engine enclosure, whichever is higher from the floor, to the bottom of the heater.)

3. In shops, offices and other sections of aircraft hangars, communicating with aircraft storage or servicing areas, they shall be installed not less than 8 feet above the floor.

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

1102. VENTILATION AND BLOWER AND EXHAUST SYSTEMS.

a. 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" (No. 90A) and in accordance with the provisions of Paragraph 1101. 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; ANSI Z33.1).

1103. 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; ANSI C1). (See also Paragraph 806. a. (2) on power supply to doors accommodating aircraft.)

c. It is recommended that main distribution panels, metering equipment, etc. be located in a suitable enclosure provided therefor and for no other hazardous purpose. This room should be vented to the outside atmosphere and shall be separated from the aircraft storage or servicing area by a solid, unpierced partition having at least a one-hour fire resistance rating.

Chapter 12. Lightning Protection.

1201. 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).

Chapter 13. Grounding Facilities for Static Electricity.

1301. 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.

NOTE: For the purposes of this standard, a "drained and purged tank" is one from which the flammable liquid has been drained and the flammable vapor atmosphere or any residue capable of producing flammable vapors has been removed so that subsequent airing or ventilation will not result in the reinstatement of a flammable atmosphere unless or until a flammable liquid is again introduced. (See Recommendations on Safeguarding Aircraft Fuel System Maintenance, NFPA No. 410C.)

1302. INSTALLATION METHODS. An adequate number of floor ground receptacles shall be provided. The receptacles should be grounded through individual driven electrodes or may be 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. Where driven electrodes are used they shall consist of ⅝ inch diameter or larger metal rods driven at least 5 feet into the ground. Floor grounding receptacles should be designed so as to minimize the tripping hazard.

1303. RESISTANCE MAXIMUM. As low a resistance as possible should be secured and maintained. 10,000 ohms is a practical recommended maximum when determined by standard procedures. Static grounding facilities should be tested periodically for electrical resistance.

1304. GROUNDING WIRES. Grounding wires shall be bare and of a gauge 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).

1305. REFERENCES. For further details on this subject, see NFPA Standard for Aircraft Fuel Servicing (NFPA No. 407; ANSI Z119.1) and the NFPA Recommended Practice on Static Electricity (No. 77).

Chapter 14. Exit* and Access Requirements.

1401. EXITS FROM AIRCRAFT STORAGE OR SERVICING AREAS. In general, exits from aircraft storage or 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 or 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.

1402. EXITS FROM MEZZANINE FLOORS LOCATED IN AIRCRAFT STORAGE OR SERVICING AREAS. Exits from mezzanine floors in aircraft storage or 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.

1403. 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.

1404. 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.

1405. MARKING AND IDENTIFICATION OF EXIT AND ACCESS AISLES. Exit and access aisles shall be conspicuously and permanently marked on floors where required by the authority having jurisdiction.

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

PART C
PROTECTION OF AIRCRAFT HANGARS.

Chapter 15. Primary Protection Systems.

1501. Definitions and Scope.

a. Scope: This Chapter covers only fixed primary protection systems, located under roofs, ceilings, mezzanines, etc., which are designed to protect an aircraft hangar, to confine a fire to the area of origin and to control or extinguish that fire.

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

(1). 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.

(2). 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 are delivered to open foam-water sprinklers for extinguishing agent discharge and for distribution over the area to be protected. The piping system is connected to the water supply through an automatic valve which is actuated 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, air-foam liquid concentrate is injected into the water, and the resulting discharge of air-foam solution through the foam-water sprinklers 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.

Note: Wherever the term "sprinkler system" is used herein, it shall mean both types of systems described in this Paragraph. Where it is desired to distinguish between the two types of systems, the particular type is specified.

c. Detection System: the system consisting of the 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.

1502. General.

a. It is recommended that the aircraft storage and servicing areas of each hangar of the types described in Paragraph 102.b., d., and e. of this Standard, regardless of size or construction, be equipped with an approved water deluge sprinkler system or an approved foam-water sprinkler system.

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. An approved water deluge sprinkler system installed in the aircraft storage and servicing areas of an aircraft hangar according to these recommendations is primarily intended to protect the hangar structure, prevent extension of the fire beyond its area of fire origin, and control, but not necessarily extinguish, any flammable liquid spill fire. When adequate floor drainage is provided as recommended in Chapter 9, water deluge sprinkler systems may be expected to be particularly effective in restricting the extent of damage resulting from any fire in an aircraft hangar. (See also Chapter 16.)

d. An approved foam-water sprinkler system installed in the aircraft storage and servicing areas of an aircraft hangar according to these recommendations provides an increased degree of protection for the hangar structure, prevents extension of fire beyond the area of fire origin, and reduces appreciably the extent of any flammable liquid spill fire. Foam discharge from foam-water sprinklers covers the floor area regardless of intervening obstructions (such as aircraft wings and fuselages) permitting blanketing and smothering fires in flammable liquid spills of the type that may be encountered. In the event of a serious fuel spillage not resulting in an immediate fire, foam-water sprinkler systems may be operated manually and be useful in affording protection until clean-up measures can be safely carried out. Floor drainage systems, as outlined in Chapter 9, are also desirable where foam-water sprinkler systems are installed to aid in the disposal of the water which separates after discharge of the foam-water sprinkler system and to restrict the extent of any fuel spill (see Paragraph 1502. e.). (See also Chapter 16.)

e. In many cases the provision of adequate floor drainage (see Chapter 9) in existing or new aircraft storage and servicing areas of aircraft hangars may be difficult for technical, operational or economic reasons. Where the provision of such floor drainage is not achieved, foam-water sprinkler systems should be installed to provide the blanketing effect of foam on any spilled fuel and thus accomplish, to a degree, similar benefits to removing the fuel by drainage.

f. The effectiveness of either system may depend not only upon the proper installation and maintenance of the equipment and the detection systems designed to operate the equipment, but also upon the provision and effective use of supplemental, manually operable fire extinguishing equipment in the aircraft storage and servicing areas of the hangar structure, such as hose lines and portable and wheeled extinguishers (see Chapters 17 and 18). Under the protection of either type of sprinkler system it will normally be feasible and practical to use such manual fire extinguishing equipment to extinguish three-dimensional fires (such as fire extending from a ruptured fuel tank to the floor) and to reach the fires inside aircraft compartments which will normally be out of range of sprinkler discharge.

g. Each sprinkler system shall be installed in accordance with the Standard for the Installation of Sprinkler Systems (NFPA No. 13) or the Standard for Foam-Water Sprinkler and Foam-Water Spray Systems (NFPA No. 16) as applicable and in accordance with the recommendations contained in this Standard.

NOTE: It is the intent of this Chapter to detail specific features of particular significance and to detail special requirements for the protection of aircraft hangars to guide those concerned with the installation of sprinkler systems in this type structure.

1503. 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. Welded fittings shall be steel.

1504. PLANS AND SPECIFICATIONS. The design and installation of the primary protection systems in aircraft hangars should

be entrusted only to fully qualified and responsible persons. Before such systems are installed, complete working plans shall be submitted for approval to the authority having jurisdiction. 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 the data detailed in the Standard for the Installation of Sprinkler Systems (NFPA No. 13) or the Standard for Foam-Water Sprinkler and Foam-Water Spray Systems (NFPA No. 16), as applicable, and 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. type of discharge devices and operating equipment to be installed,

h. location and spacing of sprinklers,

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.

NOTE: It is highly important and expedient that all applicable areas of responsibility, such as adequacy of water supplies, design, testing, flushing, approvals, etc., be clearly defined in the contract documents. This is especially important where there may be divided over-all responsibility for various portions of the fire protection systems.

1505. 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 system 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 be the calculated water demand rate of the system(s) expected to operate, determined by the system design. Procedures shall include measurement of the actual flow rate used. The flow shall be continued for a sufficient time to assure thorough cleaning. In connection with the flushing operation, consideration shall be given to means for disposal of the water discharged.

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) or the Standard for Foam-Water Sprinkler Systems and Foam-Water Spray Systems (NFPA No. 16), as applicable.

c. FLOW TESTS. Full flowing tests with water only shall be made on each sprinkler 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 [see Paragraphs 1507.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 1508.d.). In addition, flow tests for each foam-water sprinkler installation 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 should be run for a sufficient time to obtain stabilized discharge; a three-minute minimum operation of the system is recommended. [See also Section 5040 of Standard for Foam-Water Sprinkler Systems and Foam-Water Spray Systems (NFPA No. 16).]

1506. FINAL APPROVAL. Before requesting final approval for any installation of the sprinkler systems covered in this Chapter by the authority having jurisdiction, the installing company shall furnish a written statement to that authority to the effect that the work has been completed in accordance

with the approved plans and specifications and tested in accordance with the provisions of Paragraph 1505.

1507. WATER SUPPLY.

a. SPRINKLER SYSTEMS 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 or servicing areas having a maximum roof or ceiling height of 25 feet or less and where draft stops are installed to conform with Paragraph 1512, 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 or servicing areas having a maximum roof or ceiling height in excess of 25 feet but not more than 75 feet above floor level and where draft stops are installed to conform with Paragraph 1512, 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 or servicing areas having a maximum roof or ceiling height in excess of 75 feet above the floor level and where draft stops are installed to conform with Paragraph 1512, 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.

(4). Aircraft storage or servicing areas with large doors on both ends may present special draft problems affecting the efficient operation of the installed sprinklers. The authority having jurisdiction may require additional systems to be included in the calculation of water supply needed in such cases.

b. ADDITIONAL WATER REQUIREMENT FOR HOSE STREAMS, ETC. Where the water supply for sprinklers also serves as a supply for hose streams, the total supply shall be increased in accordance with the largest number of hose streams likely to be

used in case of fire in the hangars. In most cases at least 500 to 1,000 gallons per minute to supply hose streams shall be added to the sprinkler flow requirements. The authority having jurisdiction shall be consulted to determine the exact hose stream flow requirements. Water supply for hose streams shall be included in the hydraulic calculations (see Paragraph 1508.d.). In the case of hose systems, 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 Paragaph 1606.)

c. WATER SUPPLY DURATION. The minimum water supply durations given below are based on the relative effectiveness of the overall fire protection features provided within a hangar:

NOTE: In hangars protected by foam-water sprinkler systems [as specified in Paragraph 1501.b.(2)] and adequate drainage (as specified in Chapter 9), it is expected that the hazards arising from any fuel spill can be minimized. Provision of supplementary systems, as outlined in Chapter 16, can result in effectively limiting fire spread and reduce fire duration. In improving the fire protection of existing hangars, the provision of such supplementary systems may be considered an acceptable alternative to increasing water supply duration by the authority having jurisdiction.

(1). The supply shall be capable of maintaining water discharge at the design rate and pressure for a period of at least 60 minutes over the entire area protected by systems expected to operate simultaneously as determined by Paragraph 1507.a., unless protection is provided as indicated below in (2) and (3).

(2). Where foam-water sprinkler systems are installed in accordance with Paragraph 1501.b.(2), where applicable supplemental protection is installed in accordance with Paragraph 1608.b., and where adequate drainage is provided as specified in Chapter 9, the water supply duration may be reduced to 45 minutes.

(3). Where water deluge systems are installed in accordance with Paragraph 1501.b.(1), where a high expansion foam system is installed in accordance with Paragraph 1608.c., and where adequate drainage is provided as specified in Chapter 9, the water supply duration may be reduced to 45 minutes.

d. SOURCES OF SUPPLY. The development of satisfactory water supplies is a matter requiring engineering judgment and careful analysis of local conditions. The notes below out-

line general suggestions of an advisory nature. The authority having jurisdiction shall be consulted for recommendations applicable to specific situations. (See Recommended Practice for Master Planning Airport Water Supply Systems for Fire Protection, NFPA No. 419; Standard for the Installation of Centrifugal Fire Pumps, NFPA No. 20; and Standard for Water Tanks for Private Fire Protection, NFPA No. 22.)

NOTES: Acceptable types of water supplies may consist of one or more of the following: (a) connections to reliable water works systems, including automatic booster pumps where required; (b) automatic fire pumps taking suction under a head from storage reservoirs or other suitable supply; (c) gravity tanks. Combination of these supplies may be used to advantage. It is desirable to have two independent water supplies.

Where reliance is placed upon automatic fire pumps, special consideration should be given to the use of multiple pumps in preference to single pumps, the use of multiple sources of power in order to increase the reliability of pump drivers, and the use of a divided reservoir of approximately equal sections, arranged so that at least one section can always be maintained in service in order to increase the reliability of the water supply. The suction line from each reservoir section should be sized to deliver full flow capacity to all fire pumps taking suction from each reservoir section independently.

Water supplies should be guarded against entry of foreign material which would clog sprinklers or piping.

Water works connections, when used as an independent supply, should be capable of delivering water at the specified rate and pressure, as determined by flow tests, due consideration being given to any conditions which may have an effect on the design supply and pressure. Investigation should be conducted as to the normal and emergency operation of the water works system (including domestic consumption and operation of the water works pumps at time of test), pressure reducing valves or other factors affecting adequacy of a public water supply. Automatic booster fire pumps may be used to provide effective pressure from water works connections.

e. FIRE PUMPS AND SUCTION RESERVOIRS.

(1). Where reliance is placed upon automatic fire pumps, special consideration should be given to the use of multiple pumps in preference to single pumps and the use of multiple sources of power in order to increase the reliability of pump drivers. Where a reservoir is used for the basic water supply, such reservoir should be divided into approximately equal sections, arranged so at least one section can always be maintained in service in order to increase the reliability of the water supply. The suction line from each reservoir should be sized to deliver the full rated capacity of all fire pumps taking suction from each such reservoir section independently.

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

(3). Pump houses and rooms should 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 should be provided by automatic sprinklers installed in accordance with the Standard for the Installation of Sprinkler Systems (NFPA No. 13).

(4). Fire pumps shall be started automatically by a drop in water pressure. In addition they should be started automatically by operation of any sprinkler system. Where two or more electrically driven fire pumps are used, the automatic operation should be arranged so that pumps start successively. [See Standard for Installation of Centrifugal Fire Pumps (NFPA No. 20).]

(5). Frequent operation of fire pumps such as might result from leakage from underground pipes 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.

1508. SPRINKLER SYSTEM DESIGN—GENERAL.

a. In aircraft storage or servicing areas, the maximum projected floor area under a sprinkler system supplied through one riser and controlled by one deluge valve shall not exceed 15,000 square feet.

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

c. Sprinkler spacing in aircraft storage or 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). The protection area for fire-resistive construction shall be considered the floor area. For all other types of construction, the spacing as projected on the floor shall be no wider than required for

extra-hazard occupancies, but in no case shall the spacing on the roof or ceiling be wider than required for ordinary-hazard occupancies. In other portions of hangars protected by sprinklers, the spacing shall be in accordance with the hazard requirements of the areas involved.

NOTE: Sketches showing sprinkler spacing are included in Paragraph A-1508 in Part G., Appendix. Consideration should be also given to design and arrangement of the systems to assure adequate water distribution to protect all critical structural members of the building, especially bottom chords of trusses and exposed vertical steel columns.

d. System piping shall be hydraulically calculated and sized to obtain uniform distribution and to allow for friction loss in water supply piping. Pipe sizes shall be adjusted according to detailed friction loss calculations. These calculations shall show the relationship between water supply and total demand.

e. 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.

f. Where operation of hangar doors results in interference with the distribution of water from the hangar sprinkler systems, supplementary sprinklers may be necessary to assure effective floor coverage. Where the design of hangar doors prevents installation of sprinklers to provide desired coverage, special protection means may be required.

1509. WATER DELUGE SPRINKLER SYSTEMS.

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

b. Sprinklers shall have a minimum nominal ½ inch orifice and shall be of approved make and type.

1510. FOAM-WATER SPRINKLER SYSTEMS.

a. The discharge rate from foam-water sprinkler systems shall be a minimum of 0.20 gallons of air-foam solution per minute per square foot of floor area.

b. Foam-water sprinklers shall have a minimum nominal ¼-inch orifice and shall be of approved make and type.

c. Foam-water sprinklers 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)] 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. Minor contraction of the pattern may occur when discharging foam in comparison with the pattern when discharging water.

d. The quantities of air-foam liquid concentrate provided shall be sufficient for a foam discharge for a minimum period of ten minutes. Where the system has been designed to have a discharge rate higher than the specified minimum of 0.20 gallons per minute per square foot, a proportionate reduction in the discharge period may be made. In addition, there shall be a directly connected equal reserve of air-foam liquid concentrate of compatible type for the system* readily available. To prevent accidental use and depletion of this reserve supply, it shall be available to the system only by intentional manual operation. When planning this reserve supply, the authorities having jurisdiction shall be consulted.

e. Where air-foam liquid concentrate is introduced into the water stream by pumping, there should be two (2) pumps, either of which can supply the air-foam liquid concentrate. The prime movers for these pumps should be of different types. The arrangement of power supplies, controllers, piping and valves should follow the NFPA Standard for the Installation of Centrifugal Fire Pumps (NFPA No. 20).

NOTE: The recommendation for two pumps is to provide for maximum reliability of the foam-water sprinkler system. Piping should 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 1510.d.).

f. The air-foam liquid concentrate storage and injection system equipment and control valves shall be located outside aircraft storage and servicing areas.

1511. DETECTION SYSTEM DESIGN.

a. Detection systems for actuating the primary protection

* Normally, foam-water sprinkler systems are tested and listed by the national testing laboratories with a specific manufacturers air-foam liquid concentrate. Care should be exercised to assure that the reserve supply is satisfactory for the system installed.

systems shall be rate-of-rise or fixed temperature rate-compensation types.

NOTE: See Paragraphs 1101 and 1102 for precautionary considerations.

b. Detection systems shall be provided with complete supervision.

c. Where the height to underside of roof deck is 50 feet or more, special attention should be given to the spacing of the detection elements. To increase the sensitivity of the system, the maximum spacing shall be not more than 75 per cent of that given by the approval agencies, measured in a horizontal plane.

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

1512. DRAFT STOPS.

a. Draft stops should effectively surround each individual sprinkler system. (See Chapter 10 for construction details.) In any individual case, the number of draft stops may be reduced by the authority having jurisdiction where the water supply is adequate to meet the requirements. Where draft stops are not provided, water supply requirements shall be calculated on the assumption that all systems in the aircraft storage or servicing area, not subdivided by fire walls, will operate.

1513. 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 1508.e. may be waived if the required minimum discharge rate in gallons per minute per square foot is available in all areas.

(3). Careful consideration must be given to com-

patibility of all devices and equipment, existing and new, so as to provide a functionally correct system.

(4). Before installation of foam-water sprinklers, individual water deluge systems shall be flowed at maximum pressures available. Should any plugging occur during flow, affected section shall be cleaned before installation of sprinklers.

1514. MAINTENANCE OF SPRINKLER SYSTEMS.

a. Sprinkler systems require competent and continuous care and maintenance to effectively perform their purpose at time of fire. Sprinkler systems shall be maintained, serviced, tested and operated periodically by men experienced in this work. A maintenance inspection contract with an installer of sprinkler systems of the types covered in this chapter is recommended. Reports, giving details of such inspection service, should be required by the owner and the authority having jurisdiction. (See Care and Maintenance of Sprinkler Systems, NFPA No. 13A.)

1515. PROTECTION OF LANDING GEAR PITS AND TUNNELS. See Paragraph 807 in Part B of this Standard.

Chapter 16.

Supplementary Systems for External Aircraft Protection.

1601. 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. Actuation of any overhead fire extinguishing system shall be capable of simultaneously operating the supplementary extinguishing system.

NOTE 1 : Configurations of aircraft and positioning of aircraft and ground equipment within an aircraft storage and servicing area can compromise the effectiveness of any supplemental protection systems. Original design and testing of such systems shall contemplate obstructions on the floor (such as those created by work platforms, mobile and semi-mobile equipment, etc.) in providing protection under wing and fuselage areas of the aircraft.

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. By fixed systems is meant equipment that is permanently installed in the hangar, connected to piped supplies of extinguishing media.

(2). SEMI-FIXED EQUIPMENT. By semi-fixed equipment is meant auxiliary appliances for agent application which are attached to a fixed piping system after the aircraft is in its parking position.

(3). SUPPLEMENTARY SYSTEMS. The term "Supplementary Systems" for the purpose of this Chapter means an approved mechanical (air) foam system. These types of foam systems are defined and covered in the NFPA Standard on Foam Extinguishing Systems (No. 11) and the NFPA Standard on High Expansion Foam Systems (No. 11A).

(4). DETECTION SYSTEM. The term "detection system," for the purpose of this Chapter, includes 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.

*See Appendix G, Paragraph A-1601.a.

1602. GENERAL.

a. Aircraft having total wing areas in excess of 3,000 square feet stored and serviced inside a hangar protected in accordance with Chapter 15 of this Standard should be protected with an approved or listed supplementary protection system designed to protect the exterior of the aircraft from exposure to fuel spill fires. The discharge from overhead hangar protection systems may not protect the aircraft from a fire in the shielded areas beneath the wings and fuselage. The supplementary system is intended to provide protection in these shielded areas by controlling such fires quickly, before extensive damage to the aircraft(s) occur(s).

b. The area to be protected will depend on the configuration and the number of aircraft and their positioning arrangements, as well as the location of permanent service structures within the aircraft maintenance and servicing area. Protection of the entire aircraft maintenance and servicing area may be required because of the many varieties of possible aircraft positioning arrangements.

c. Flow rates of the extinguishing agent shall be increased to compensate for dilution or breakdown from overhead sprinkler discharge and to compensate for drainage run-off.

d. Although the provision of a fixed automatic supplementary protection system greatly increases the overall fire protection inside a hangar, supplemental manually operable fire extinguishing equipment such as hose lines and portable and wheeled extinguishers shall also be provided. (See Chapters 17 and 18.)

e. Each special protection system shall be installed in accordance with the current applicable standards. For example, the NFPA Standard for Foam Extinguishing Systems (No. 11) and the NFPA Standard for High Expansion Foam Systems (No. 11A) should be used where applicable. In addition, the system should be designed and installed in accordance with the requirements contained in this Standard.

1603. PLANS AND SPECIFICATIONS. The design and installation of a special protection system in an aircraft hangar should be entrusted only to fully qualified and responsible persons. Where available, approved or listed equipment, devices, and agents shall be used. Before installing such systems the plans and installation procedures shall be submitted to the authority having

jurisdiction for approval. Information submitted shall include the data specified in the applicable Standard and:

a. The design purpose of the system,

b. An accurate and complete layout of the area to be protected, including details of all fire protection facilities and other pertinent data to provide a clear explanation of the proposed design,

c. Installation techniques of the extinguishing equipment to insure maximum reliability of operation,

d. Installation layout of the detection systems.

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

f. Type of discharge devices, operating equipment, power source (electrical or mechanical), and hydraulic calculations of the systems,

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

NOTE: It is highly important and expedient that all applicable areas of responsibility such as suitability of agent, the application rates used, the area coverage, approvals, testing, etc., be clearly defined in the contract documents. This is especially important when there may be divided overall responsibility for the various portions of the fire protection systems.

1604. ACCEPTANCE TESTS. The following tests shall be performed prior to the final acceptance of any supplementary protection system in an aircraft hangar:

a. The completed system shall be tested by qualified personnel to meet approval of the authority having jurisdiction. These tests shall be adequate to determine that the system has been properly installed and will function as intended.

b. PRESSURE 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 NFPA Standard for the Installation of Sprinkler Systems (No. 13). All normally dry piping shall be checked for leakage, freedom from obstructions, and to determine if proper drainage pitch has been provided.

c. OPERATING TESTS. Before acceptance, these systems shall be subjected to such tests as may be required by the authority

having jurisdiction. These tests shall include operation of all devices and equipment installed as part of the system.

d. DISCHARGE TESTS. Approval and acceptance of supplementary extinguishing systems shall be subjected to flow tests in order to insure that the hazard is fully protected in conformance with the design specification and to determine if the flow pressures, actual discharge capacity, quality and consumption rate of extinguishing agent, manpower requirements, and other operating characteristics are satisfactory. If mechanical (air) foam systems are used, the quality of foam shall be as required by the NFPA Standard for Foam Extinguishing Systems (No. 11) and in the NFPA Standard for High Expansion Foam Systems (No. 11A).

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

1605. FINAL APPROVAL. Before requesting final approval of the installation of a supplementary extinguishing system (as covered in this Chapter) by the authority having jurisdiction, the installing company shall furnish a written statement to that authority to the effect that the work has been completed in accordance with the approved plans and specifications and tested in accordance with the provisions of Paragraph 1604.

1606. 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 15 and the requirements for hose stream and other equipment as determined in Chapters 17 and 18. Water shall be suitable for the production of foam. The presence of corrosion inhibitors, anti-freeze agents, marine growth, oil, or other contaminants may result in the reduction of foam volume or stability. If the quality of the water is questionable, the manufacturer of foam equipment shall be consulted.

1607. AGENT SUPPLY. The quantities of agent shall be sufficient to provide the protection specified by the requirements of this Chapter. The duration of discharge will depend upon the

area to be protected, the type of system and type of overhead protection provided.

a. The agent supplied with the system shall be that approved or listed for use with the distribution equipment. In general, the performance of a supplementary extinguishing system will be dependent on the agent composition, the proportioning concentration and the application technique. Different brands or types of agents should not be mixed without the advice of the equipment manufacturer as to their interchangeability and compatibility.

b. There shall be a directly connected equal reserve of agent of a compatible type for the distribution system readily available. To prevent accidental use and depletion of this reserve supply, it shall be available to the system only by intentional manual operation. When planning this reserve supply, the authority having jurisdiction shall be consulted.

c. When the agent requires pumping to the distribution system, there should be two (2) pumps, either of which can supply the agent. The prime movers of the pumps should be of different types. The arrangement of power supplies, controllers, piping, and valves should follow NFPA No. 20, Centrifugal Fire Pumps.

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

1608. MECHANICAL (AIR) FOAM SYSTEMS.

a. GENERAL. Mechanical (air) foam systems employ protein or fluoroprotein foam liquid concentrates. High expansion 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 are recommended for both types of foam systems. These foam systems will require special engineering in order to insure reliable operation, but certain requirements will be common to both.

(1). All components and agent used in a mechanical (air) foam system shall be approved or listed by a recognized testing laboratory. Systems shall be installed inside the hangar in such a way that the production of good quality foam is assured.

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

(3). Following exhaustion of the foam concentrate supply the foam distributor will continue to discharge water. Provisions should be made to permit shutdown of each and any distributor in such cases to conserve water.

b. CONVENTIONAL (PROTEIN) FOAM SYSTEMS. These systems utilize either a protein or fluoroprotein base concentrate. When applied through nozzles located at or near floor level, these foams will satisfactorily protect an aircraft from an external fuel spill fire, provided foam is discharged at a satisfactory rate through nozzles located in such a way that coverage can be obtained beneath the aircraft wings and fuselage. The nozzles may be either oscillating or nonoscillating and shall be firmly supported. Oscillating nozzles should be water-powered or powered by reliable electric motors. The discharge of foam from such nozzles ordinarily should not handicap visibility for manual fire fighting. Nevertheless, it is recommended that the aircraft interior be protected by an approved automatic extinguishing system to minimize damage to the aircraft in the event the fire spreads to the interior. Other design criteria are:

(1). Each extinguishing system shall be designed to attempt to control or extinguish a fire as specified in Paragraph 1608.a.(2). This will require a minimum delivery of 0.16 gpm of air foam solution per square foot of area beneath the aircraft. The foam nozzles shall be arranged to apply foam to areas directly beneath the entire fuselage and wings. A quantity of water and of foam concentrate shall be sufficient to operate all nozzles at the required discharge rate for a period of at least 10 minutes. Where the system has been designed to have a discharge rate higher than the specified 0.16 gpm of air-foam solution per square foot of area beneath the aircraft, a proportionate reduction in the discharge period may be made.

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

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

(4). Electric power reliability for concentrate pumps and oscillating nozzles shall be consistent with electric fire pump

requirements given in the NFPA Standard for the Installation of Centrifugal Fire Pumps (No. 20).

(5). Conventional foam systems shall be designed, installed, and maintained in accordance with NFPA No. 11. Foam systems should be tested on a semiannual basis. The authority having jurisdiction may require special acceptability tests to assure proper operation and to assure suitable coverage of the critical areas.

c. HIGH EXPANSION FOAM SYSTEMS. High expansion foam systems will protect an aircraft satisfactorily from an external fuel spill fire inside a hangar provided the discharge rates are sufficient. High expansion foam shall be delivered at a sufficient rate to provide a depth of 3 feet or more over the entire hangar floor, including that area beneath the aircraft, within 30 seconds. Discharge rates shall take into consideration the breakdown factors set forth in the NFPA Standard for High Expansion Foam Systems (No. 11A). The discharge of high expansion foam may handicap visibility for manual fire fighting. If the fire spreads to the aircraft interior, it could seriously damage or destroy the aircraft unless an automatic fire extinguishing system is provided inside the aircraft cabin. Other general design criteria are:

(1). High expansion foam systems shall be designed to attempt to control or extinguish a fire as specified in Paragraph 1608.a.(2). This would ordinarily require a rate of foam rise of about 3 ft/min beneath the aircraft. With the large shielded areas created by aircraft, considerably higher rates of foam rise will probably be required to achieve the control specified in Paragraph 1608.a.(2). 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. In addition, the foam generators should be installed and positioned in such a way that the flow of foam on the floor is directed to areas beneath the aircraft.

(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 maintenance and service 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 NFPA Standard for the Installation of Centrifugal Fire Pumps (No. 20).

(4). High expansion foam systems shall be designed, installed, and maintained in accordance with the NFPA Standard

on High Expansion Foam Systems (No. 11A). In addition, foam generators should be tested on a semiannual basis to assure the maximum reliability operation. The authority having jurisdiction may require special acceptability tests to assure both proper automatic and manual operation.

1609. Detection-System Design

a. Detection systems for actuating supplementary systems shall be either a radiation (infra-red or ultra-violet) or a heat-responsive (continuous strip or thermistor type) system.

Note 1: If there is any doubt as to the stability of these actuating devices when initially installed because of environmental factors, it is recommended that the devices be utilized to actuate only an alarm rather than trigger the extinguishing systems. As soon as operational experience indicates that the devices are stable, they should be arranged to automatically actuate the extinguishing equipment.

Note 2: See Note under Paragraph 1601.a.

b. Detection systems shall be provided with complete supervision and shall include audible alarm devices as required by the authorities having jurisdiction.

c. Spacing of detection devices shall be no greater than the maximum recommended by the manufacturer.

d. 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 should be located as close as possible to the aircraft positions to facilitate early system actuation in the event of a fire.

Chapter 17. Hand Hose Systems.

1701. Introduction.

a. The intent of Chapter 17 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 should preferably be arranged for foam application in aircraft storage and servicing areas and water spray or straight water streams in other areas (see Paragraph 1703. 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.

Note: It is recognized that in some areas building codes or local fire department regulations may require independent hose connection systems, designed either for fire department use only or for use by occupants as well as the fire department. Where these required systems are installed, they will 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.

1702. General.

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

b. Hand hose systems shall be provided in each aircraft storage and servicing area. The systems should be arranged to permit application of water or other extinguishing agent on each side and into the interior of the aircraft located in each area.

1703. 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 NFPA Standard on Standpipe and Hose Systems (No. 14) and the NFPA Standard on Foam Extinguishing Systems (No. 11). 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. A quick-acting, quarter-turn control valve is pre-

ferred. The hose shall be of suitable length and diameter to meet the requirements of Paragraph 1702 and provide a maximum flow of 60 gpm at an adequate nozzle pressure (the stream range should 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 approved 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.

(1). 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 NFPA Standard on Standpipe and Hose Systems (No. 14). Hoses shall be fitted with an approved combination-type nozzle designed to permit solid-stream or water-spray application.

Note: Any special protection system shall be installed in accordance with the applicable NFPA Standard.

1704. 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. 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; 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. 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) 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 18. Wheeled and Portable Extinguishers.

1801. Wheeled and portable extinguishers shall be provided in accordance with the recommendations contained in the NFPA Standard for the Installation of Portable Fire Extinguishers (NFPA No. 10; 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 the recommendations for light, ordinary or extra-hazard occupancy based on an analysis of each such room or area following the guidance in No. 10.