409

AIRCRAFT HANGARS 1965

Seventy-five Cents

NATIONAL FIRE PROTECTION ASSOCIATION
International
60 Batterymarch Street, Boston, Mass. 02110

5M-6-65-FP
Printed in U.S.A.

National Fire Protection Association

International

Official NFPA Definitions

Adopted Jan. 23, 1964. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

SHALL is intended to indicate requirements.

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

APPROVED means acceptable to the authority having jurisdiction. The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of nationally recognized testing laboratories,* i.e., laboratories qualified and equipped to conduct the necessary tests, in a position to determine compliance with appropriate standards for the current production of listed items, and the satisfactory performance of such equipment or materials in actual usage.

*Among the laboratories nationally recognized by the authorities having jurisdiction in the United States and Canada are the Underwriters' Laboratories, Inc., the Factory Mutual Engineering Division, the American Gas Association Laboratories, the Underwriters' Laboratories of Canada, the Canadian Standards Association Testing Laboratories, and the Canadian Gas Association Approvals Division.

LISTED: Equipment or materials included in a list published by a nationally recognized testing laboratory that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner.

LABELED: Equipment or materials to which has been attached a label of a nationally recognized testing laboratory that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling is indicated compliance with nationally recognized standards or the conduct of tests to determine suitable usage in a specified manner.

AUTHORITY HAVING JURISDICTION: The organization, office or individual responsible for "approving" equipment, an installation, or a procedure.

Units of Measurements

Units of measurements used here are U. S. standard. 1 U. S. gallon = 0.83 Imperial gallons = 3.785 liters. One foot = 0.3048 meters. One inch = 25.40 millimeters. One pound per square inch = 0.06805 atmospheres = 2.307 feet of water. One pound = 453.6 grams.

Standard on

Aircraft Hangars

NFPA No. 409 – 1965

1965 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 1965 Annual Meeting held in Washington, D. C., May 17-21, and supersedes all previous editions. The principal parts affected deal with floor drainage (Chapter 9), old Chapters 15 and 16 (which have in this edition been combined into Chapter 15) dealing with water-deluge and foam-water sprinkler systems, plus relatively minor revisions in old Chapters 18 and 20 (now Chapters 17 and 19) and Part F. Other necessary editorial and reference changes have been made in this 1965 Edition.

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, and this 1965 edition were prepared by this Committee which reports to the Association through the NFPA Committee on Aviation.

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. Reference should be made to the NFPA List of Publications and to Volume 10 of the National Fire Codes for texts on these subjects.

Committee on Aviation

Jerome Lederer,† *Chairman,*
Flight Safety Foundation, 468 Park Avenue South, New York, N. Y. 10016

Harvey L. Hansberry (SFPE), *Vice-Chairman,*
Federal Aviation Agency, Aircraft Branch RD-740, Systems Research & Development Service, Federal Aviation Agency, Atlantic City, N. J. 08405

George H. Tryon (SFPE), *Secretary,*
National Fire Protection Association, 60 Batterymarch St., Boston, Mass. 02110

J. C. Abbott, British Overseas Airways Corp. (Personal)

H. F. Blumel, Jr., American Airlines. Chairman of Sectional Committee.

Henry G. Bone, Jr., The Boeing Co. (Personal)

E. Thomas Burnard, Airport Operators Council.

H. L. Butler, Eastern Air Lines. (Personal)

R. C. Byrus, University of Maryland. Chairman of Sectional Committee.

John J. Carroll, Civil Aeronautics Board.

J. M. Chase, Flight Safety Foundation. Chairman of Sectional Committee.

N. L. Christoffel, United Air Lines. (Personal)

C. W. Conaway, Factory Insurance Association.

G. T. Cook, Department of the Air Force.

Robert F. Farrell, United States Aviation Underwriters.

B. V. Hewes, Airline Pilots Assn.

H. Prater Hogue, The Boeing Company. (Personal)

Charles H. Kaman, Vertical Lift Council, Aerospace Industries Assn. of America, Inc.

G. C. Koth, Factory Mutual Engineering Division.

R. Dan Mahaney,† Federal Aviation Agency.

James S. Mathews, Associated Aviation Underwriters.

C. M. Middlesworth,† Federal Aviation Agency.

J. A. O'Donnell, American Airlines. Chairman of Sectional Committee.

F. E. Parker, Australian Dept. of Civil Aviation.

R. C. Petersen, Port of New York Authority. (Personal)

H. B. Peterson, U. S. Naval Research Laboratory.

W/C B. C. Quinn, Canadian Department of National Defence.

E. E. Reed, American Petroleum Institute.

George Schrank, Fire Equipment Manufacturers Association.

S. W. Sheat, United Kingdom, Ministry of Aviation.

John T. Stephan, American Association of Airport Executives.

E. F. Tabisz, Underwriters' Laboratories of Canada.

Douglas C. Wolfe, American Association of Airport Executives.

Alternates.

Alternate to Mr. Burnard
ROSS A. KNIGHT (Airport Operators Council)

Alternate to Mr. Hewes
WILLIAM L. COLLIER (Air Line Pilots Association)

Alternate to Mr. Conaway
F. J. MCCLAIN (Factory Insurance Association)

Alternate to Mr. Cook
ROSCOE L. BELL (Dept. of the Air Force)

Alternate: American Ins. Assn.
CHARLES S. RUST (Appointment of principal pending)

Alternate to Mr. Tabisz
G. L. TOPPIN (Underwriters' Laboratories of Canada)

Alternate to Mr. Reed
W. V. PAULUS (American Petroleum Institute)

Liaison Representatives.†

Allen W. Dallas, Air Transport Association
S. Krzyczkowski, International Air Transport Association
W. A. McGowan, National Aeronautics and Space Administration
J. A. Pope, National Business Aircraft Association
Dr. A. F. Robertson, National Bureau of Standards
E. J. C. Williams, Air Ministry, United Kingdom
Chief, Aerodromes, Air Routes and Ground Aids Section, International Civil Aviation Organisation

†Non-voting member.

Sectional Committee on Aircraft Hangars and Airport Facilities

H. F. Blumel, Jr., *Chairman,*
American Airlines, 633 3rd Ave., New York, N. Y. 10017

J. C. Abbott, British Overseas Airways Corp.

J. J. Brenneman, United Air Lines.

C. W. Conaway, Factory Insurance Association.

Donald L. Drumm, American Insurance Association.

Stuart C. Hand (SFPE), J. S. Frelinghuysen Corp.

Harvey L. Hansberry (SFPE), (ex-officio), Federal Aviation Agency.

R. E. Hitchcock, Mohawk Airlines, Inc.

E. B. Hoge, Eastern Air Lines.

G. C. Koth (SFPE), Factory Mutual Engineering Division.

Jerome Lederer† (ex-officio), Flight Safety Foundation.

R. C. Petersen (SFPE), Airport Operators Council.

E. E. Reed, American Petroleum Institute.

E. B. Rumble (SFPE), National Automatic Sprinkler & Fire Control Association.

George Schrank, Fire Equipment Manufacturers Association.

J. H. Sellers, Insurance Company of North America.

F. R. Senior, Royal Canadian Air Force, Dept. of National Defence.

Alternates.

T. S. Duke (SFPE), National Automatic Sprinkler & Fire Control Association. (Alternate to E. B. Rumble.)

W/C G. S. Galley, Royal Canadian Air Force. (Alternate to F. R. Senior.)

F. J. McClain (SFPE), Factory Insurance Association. (Alternate to C. W. Conaway.)

W. V. Paulus, American Petroleum Institute. (Alternate to E. E. Reed.)

Liaison Representatives.†

Frank J. Hanrahan, American Institute of Timber Construction.

T. R. Higgins, American Institute of Steel Construction.

Harold L. Moulton, National Lumber Manufacturers Association.

Ralph M. Weaver, Portland Cement Association.

† Nonvoting member.

Contents

Standard on

Aircraft Hangars

NFPA No. 409 – 1965

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 are defined not only to include the so-called community hangars accommodating more than one aircraft of all types, but also 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.

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

103. FIRE RECORD OF HANGARS. The fire record of aircraft hangars indicates that unusual precautions must be taken to assure continuity of use. Aircraft maintenance activities and the special hazards associated with aircraft storage and shop work account for approximately 64% of the known fire causes. The average losses for hangars over a period of 20 years reveals that the average per-square-foot loss to the building is $2.72 while the average per-square-foot loss to the contents is approximately $7.00. An average of six aircraft are destroyed in each hangar fire according to the fire record studies conducted by the National Fire Protection Association.* In approximately 71% of all the hangars which sustained fires during the period studied, roof collapse resulted. One of the principal reasons for heavy fire losses in aircraft hangars is revealed in the statistics which show that in 60% of the cases, airports at which these fires occurred were located "outside city or town limits, beyond established fire protection zones." In an additional 10% of the cases, the airports were located in communities having less than 10,000 population, in which communities fully staffed public fire protection services are not ordinarily found.

104. 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.

*See "An Analysis of Aircraft Hangar Fire Experience" (NFPA AH-4) available from the Association for $5.00 per copy.

105. 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 such operations.* The recommendations contained herein do, however, contemplate the hazards existing in aircraft maintenance and storage operations 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 "Suggestions for Aircraft Rescue and Fire Fighting Services at Airports and Heliports" (NFPA No. 403) 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 2003).

106. 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.†

107. 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.

108. USE OF TERMS. The following definitions apply throughout the standard:

SHALL is intended to indicate requirements.

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

APPROVED refers to approval by the authority having jurisdiction.

---

*See NFPA Publications for texts on aircraft maintenance.

†See pamphlet "Airport Design" available from the Federal Aviation Agency, Standards Division, Airports Service (AS-57), Washington D. C. 20553 and Part 77 of the Federal Air Regulations.

See "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 2101, 2401 and 2701 for special types.)

202. A SINGLE HANGAR BUILDING is a building which contains one aircraft storage or servicing area and any adjoining structure (e.g., "lean-to") not separated as specified in Par. 503.

203. A HANGAR BUILDING GROUP is a building or group of buildings containing more than one aircraft storage or servicing area and all structures attached thereto not separated as specified in Paragraph 504.

Chapter 3.
General Recommendations on Hangar Design.

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. Separate shops, 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 by Construction Types.

401. FIRE RESISTIVE CONSTRUCTION. Hangars of this type shall have structural members of noncombustible materials having fire resistance ratings of not less than three hours for bearing walls or bearing portions of walls (exterior or interior) and wall supporting members and columns, and not less than two hours for floors, 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 automatic sprinkler or foam-water sprinkler 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.

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

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.

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

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.

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.*

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

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.

Chapter 7. Area Limitations.

701. Maximum Areas for Single Hangar Buildings. 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.)

Table III
Maximum Recommended Areas
Single Hangar Buildings

Type of Construction	Maximum Area Nonsprinklered Square Feet	Maximum Area Sprinklered Square Feet
Fire Resistive	30,000	100,000
Protected Noncombustible	20,000	80,000
Heavy Timber or Protected Ordinary	15,000	65,000
Unprotected Noncombustible	12,000	65,000
Ordinary	12,000	40,000
Protected Wood Frame	8,000	30,000
Wood Frame	5,000	20,000

702. Maximum Areas for Hangar Building Groups. Areas permitted for hangar building groups should be limited in length to 1,200 feet and in area as specified in Table IV, including all lean-tos and enclosed spaces attached or adjoining. No single aircraft storage or servicing area should exceed the limits of a single hangar building as 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 AREAS
HANGAR BUILDING GROUPS

TYPE OF CONSTRUCTION	MAXIMUM AREA NONSPRINKLERED SQUARE FEET	MAXIMUM AREA SPRINKLERED SQUARE FEET
Fire Resistive	60,000	300,000
Protected Noncombustible	40,000	240,000
Heavy Timber or Protected Ordinary	30,000	195,000
Unprotected Noncombustible	24,000	195,000
Ordinary	24,000	120,000
Protected Wood Frame	16,000	90,000
Wood Frame	10,000	60,000

Chapter 8. Structural Requirements Common To All Types of Hangars.

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. The floor shall be laid on ground without air space underneath and without basement. Tunnels beneath the floor should be avoided but where used in no case shall openings be made in the floor of the aircraft storage or servicing areas to such tunnels. (For floor drainage, see Paragraph 902; for static protection, see Paragraph 1302; for floor openings, see Paragraph 803.)

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 (see also Paragraph 1602.b.).

805. 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). Adequate door operating provisions should be made to permit removal of aircraft from a hangar in case a

fire occurs when doors are closed. The primary power supply to power-operated doors shall be reliable and shall have an independent circuit supplying power to the doors, with wiring run in rigid conduit directly from the main electrical distribution panel of the hangar to the door controls. If a secondary source of power is not available in case of primary power failure, an auxiliary power source should be provided to operate the doors.

(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 1507.e.)

(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.

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 AIRCRAFT STORAGE OR SERVICING AREAS FLOOR DRAINAGE.

a. GENERAL.

(1). Floor drains are needed in aircraft storage or servicing areas to dispose of water used for cleaning of aircraft, washing of floors, and similar "utility" purposes, and, to carry away any spilled flammable liquids and water discharged from operating sprinkler systems or fire hose streams during

a fire emergency. In addition, adequate drainage to dispose of surface liquids on the hangar floor is desired to restrict the spread of fire or area of hazard within a hangar resulting from the spillage of flammable liquids and to prevent extension of the fire or hazard zone to aprons on which aircraft may be parked.

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

(3). 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.

* "Each protected section" means each individual system surrounded by draft stops (see Paragraph 1511) or the entire aircraft storage and servicing area if no draft stops are provided.

(4). 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*.

NOTE 1: The floor pitch provided should take into consideration the towability of the aircraft and the problems of aircraft maintenance, weight and balance checking, etc.

NOTE 2: To provide adequate pitch for efficient drainage, the pitch should be at least ⅛ inch per foot (one percent).

NOTE 3: Surface roughness of the floor finish will affect the flow of liquids to drains and pitch should consider that factor.

(5). In no case shall drain pipes be less than 6 inches in diameter.

(6). The maximum flow distance on the floor from any point to the nearest drain inlet shall not be greater than 40 feet.

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.

(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 should 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 also Paragraph 805.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.

---

* "Each protected section" means each individual system surrounded by draft stops (see Paragraph 1511) or the entire aircraft storage and servicing area if no draft stops are provided.

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 1511 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.

b. GENERAL.

1. Heating equipment shall be installed to conform with Article XI of the National Building Code issued by the American Insurance Association (NBFU), the Standard on "Installation of Air Conditioning and Ventilating Systems of Other than Residence Type" (No. 90A), the "Installation of Oil Burning Equipment" (No. 31) and the "Installation of Gas Piping and Gas Appliances in Buildings" (No. 54), 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 below) which are not located in a detached building, shall be located in a

*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.

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 below.

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 of Other than Residence Type" (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" (No. 91).

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 (No. 70). (See also Paragraph 805.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 National Fire Protection Association Lightning Protection Code, NFPA No. 78, ASA 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 Manual "Static Electricity in Aircraft Operations and Maintenance" (NFPA No. 404M) and "Aircraft Fueling on the Ground" (NFPA No. 407).

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 dis

*See NFPA Building Exits Code (NFPA No. 101), including Section 28, for further information.

tance 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.

PART C

PROTECTION OF AIRCRAFT HANGARS.

Chapter 15. Sprinkler Systems.

1501. Definitions.

a. 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 heat-responsive 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 foam-liquid concentrate and a water supply. Water and 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 heat-responsive system installed in the same areas as the sprinklers. When this valve opens, water flows into the piping system, 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.

(3). Heat-Responsive System: the control system consisting of the heat 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 Para-

graph 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. 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.

c. 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.d.).

d. 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, it is of particular importance that foam-water sprinkler systems 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.

e. The effectiveness of either system may depend not only upon the proper installation and maintenance of the equipment and the heat-responsive systems designed to oper-

ate 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 16 and 17). 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.

f. 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. PLANS AND SPECIFICATIONS. The design and installation of a sprinkler system in an aircraft hangar should be entrusted only to fully qualified and responsible persons. Before such a system is 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 heat-responsive 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 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.

1504. 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 1506.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 1507.c.). In addition, flow tests for each foam-water sprinkler system 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).]

1505. 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 1504.

1506. 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 less than 25 feet and where draft stops are installed to conform with Paragraph 1511, 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 above floor level and where draft stops are installed to conform with Paragraph 1511, 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). 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. 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 1507.c.). 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.

c. WATER SUPPLY DURATION. The supply shall be capable of maintaining water discharge at the design rate and pressure for a period of at least 45 minutes over the entire area protected by systems expected to operate simultaneously.

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 outline general suggestions of an advisory nature. The authority having jurisdiction shall be consulted for recommendations applicable to specific situations. (See 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.

(1). Pump houses and rooms should be of fire-resistive or noncombustible construction (see Paragraphs 401 and 403). Where pump rooms adjoin hangars, they shall be cut off from aircraft storage or servicing areas by approved fire walls. Pump rooms which are located inside hangars shall be of fire-resistive construction. Pump rooms shall have no direct access from the aircraft storage or servicing areas and pumping equipment shall be safeguarded against interruption of service through damage by fire, windstorm or flood.

(2). 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).]

(3). 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.

(4). 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.

1507. SPRINKLER SYSTEM DESIGN—GENERAL.

a. In aircraft storage or servicing areas, the maximum number of sprinklers supplied through one riser and controlled by one deluge valve shall not exceed 150.

b. 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-1507 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.

c. 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.

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

e. Where 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.

1508. WATER DELUGE SPRINKLER SYSTEMS.

a. The discharge rate from water deluge sprinkler systems shall be a minimum of 0.17 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.

1509. FOAM-WATER SPRINKLER SYSTEMS.

a. The discharge rate from foam-water sprinkler systems shall be a minimum of 0.17 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. Where nominal ⅜-inch or larger orifice foam-water sprinklers are used throughout the system, pipe and fittings need not be galvanized.

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 foam discharge for a minimum period of 10 minutes. Where the system has been designed to have a discharge rate higher than the specified minimum of 0.17 gallons per minute per square foot, a proportionate reduction in the discharge period may be made except that the discharge period shall not be less than 7 minutes. In addition, there should be an equal reserve supply of foam-liquid concentrate of compatible type for the system* readily available. This supply may be directly connected to the foam-liquid concentrate system or may be in the form of a tank truck "pool" supply on the airport. When planning this reserve supply, the authorities having jurisdiction shall be consulted.

1510. OPERATING-MEANS DESIGN.

a. Automatic operation of sprinkler systems shall be

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

provided for by rate-of-rise heat-responsive systems approved for use with the particular sprinkler systems installed.

b. Heat-responsive systems shall be provided with complete supervision so arranged that loss of supervising air pressure, loss of electrical energy, or loss of continuity of wiring will result in positive notification of the abnormal conditions.

c. The spacing of heat-responsive devices for systems installed for protection of hangars shall be in accordance with the Standard for the Installation of Sprinkler Systems (NFPA No. 13). Where corrosive conditions exist that affect normal heat-responsive devices or systems, types of materials or protective coatings designed to resist corrosion shall be used.

d. Manually operated mechanical tripping devices shall be provided for each deluge valve and shall be operable outside the protected area.

1511. 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.

1512. 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 1507.d. 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 compatability 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.

1513. 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.)

Chapter 16. Fixed Standpipe and Hose Systems (All Types).

1601. GENERAL.

a. Facilities shall be provided within every hangar to supply water hand hose lines (see Paragraph 1605.b.). Foam, carbon dioxide and dry chemical types of standpipe and hose systems are recommended for combating flammable liquid fires. Carbon dioxide and dry chemical types are also suitable for electrical fires.

NOTE: Dry chemical, other than approved foam compatible types, used in conjunction with foam poses some problems of compatibility which vary with the quantities involved and the techniques used.

b. At least one station of each type of fixed standpipe system installed in the aircraft storage or servicing area shall be located near the hangar door equipped with at least 150 feet of hose to provide protection on hangar apron areas.

1602. WATER STANDPIPE AND HOSE SYSTEMS.

a. INTERIOR.

(1). (See Paragraph 1601.) Interior water standpipes for hose systems installed in aircraft storage or servicing areas shall be not less than 2 inches in diameter and should be so located that with not more than 100 feet of hose connected to each, any part of the hangar or an aircraft therein may be

effectively reached. (In very large hangars, additional hose may be required at each standpipe to accomplish the range specified.) The installation of such systems shall be in compliance with the "Standard for the Installation of Standpipe and Hose Systems" (No. 14) and "Standard for Water Spray Systems" (No. 15).

(2). The water supply for hose streams preferably should be from an independent connection to the underground water supply system. Small hose may be supplied from sealed head wet pipe sprinkler systems if connected to not less than 2½-inch pipes.

(3). The 1½-inch fire hose supplied for use inside hangars shall be equipped with suitable nozzles of the adjustable straight stream and spray type with the solid stream orifice not to exceed ½-inch nominal.

b. ROOF CONNECTIONS.

(1). Hose connections and hose should be installed on roofs of hangars having combustible roof coverings, regardless of roof deck construction, when such roofs exceed 25,000 square feet in area, or 50 feet in height, or 100 feet in smallest dimension.

(2). Roof hose connections should be spaced to cover all points of the roof not readily covered from the ground. They may be supplied from 2½-inch or larger wet pipe sprinkler mains. 1½-inch hose connections should be spaced not over 200 feet apart and not over 75 feet of 1½-inch hose with ½-inch nozzle should be supplied from each hose connection.

(3). Roof hose connections for hangars having deluge or dry pipe systems should be supplied from the standpipe riser for hose systems but may be supplied through a connection to the sprinkler system located below the sprinkler riser control valve with a cold weather valve located in the heated sprinkler valve house.

(4). In unheated, unsprinklered hangars, roof hose connections should be supplied through a cold weather valve in a heated valve house. In cold weather, the lines to roof hose connections should be kept shut off and should be properly drained They should be maintained wet during warm weather months.

(5). Usual consideration should be given to the design of supply mains to roof hose connections in regard to length of piping and water supplies available. Mains should be capable of supplying at least 2 lines of hose being discharged simultaneously.

(6). Hose connection houses should be properly heated and constructed to serve the purpose.

(7). For ladders to roofs, see Paragraph 804.e.

1603. CARBON DIOXIDE STANDPIPE AND HOSE SYSTEMS (WHEN INSTALLED).

a. (See Paragraph 1601 and the Standard on "Carbon Dioxide Extinguishing Systems", No. 12.) Carbon dioxide hose stations shall be located so that all the floor area in the aircraft storage or servicing area (or other areas requiring this special protection) can be effectively reached with at least two lines.

b. Controls shall be arranged so that each hose line can be put into operation by one man at the hose reel station. A manual discharge control valve shall be provided at the nozzle.

c. The supply pipe and length of hose shall be designed to provide an effective discharge of carbon dioxide in not more than 30 seconds. In addition, the supply piping shall be adequate to permit the effective use of at least any two hose lines at the same time.

d. Hose lines suitable for this use can be secured to provide a discharge rate of from 200 pounds-per-minute to 600 pounds-per-minute and the selection of equipment will depend on the nature of the protection requirements. Lower discharge rates may be used for protection of localized special hazards. Hose used shall be of a type that will permit discharge without complete removal from reel or rack.

e. The carbon dioxide supply shall be at least sufficient for any hose line or group of hose lines which may be used at one time to provide continuous operation for 2½ minutes.

1604. DRY CHEMICAL STANDPIPE AND HOSE SYSTEMS (WHEN INSTALLED).

a. (See Paragraph 1601 and the Standard on "Dry Chemical Extinguishing Systems", No. 17.) Dry chemical hose stations shall be so located that all floor area in the aircraft storage or servicing area (or other area requiring this special protection) can be effectively reached with at least two lines.

b. Controls shall be arranged so that each hose line can be put into operation by one man at the hose reel station. A manual discharge control valve shall be provided at the nozzle.

c. The supply pipe and length of hose shall be designed to provide an effective discharge of dry chemical in not more

than 30 seconds. In addition, the supply piping shall be adequate to permit the effective use of at least any two hose lines at the same time.

d. Hose lines suitable for this use can be secured to provide a discharge rate of from 200 pounds-per-minute to 500 pounds-per-minute and the selection of equipment will depend on the nature of the protection requirements. Lower discharge rates may be used for protection of localized special hazards. Hose used shall be of type that will permit discharge without complete removal from reel or rack.

e. The dry chemical supply shall be at least sufficient for any hose line or group of hose lines which may be used at one time to provide continuous operation for 2½ minutes.

1605. FOAM STANDPIPE AND HOSE SYSTEMS (WHEN INSTALLED).

a. (See Paragraph 1601 and the Standards for "Foam Extinguishing Systems", No. 11.) Air (mechanical) foam should be used in these systems because of its stability should water be subsequently discharged in the same area.

b. Where aircraft storage or servicing areas are protected by foam-water sprinkler systems, as discussed in Chapter 15, fixed foam standpipe and hose systems supplied by such foam-water sprinkler systems may be used in lieu of water standpipe and hose systems (see Paragraph 1601.a.).

c. Where aircraft storage or servicing areas are protected by water deluge sprinkler systems, as discussed in Chapter 15, foam from fixed standpipe systems may also be used, if backed up with water. Foam nozzles in such cases should be of such design as to permit discharging a satisfactory stream of water alone, after foam discharge ceases. Foam-water hand hose lines should be installed in accordance with the provisions of Paragraph 1602.a.

d. When used in unheated hangars, air foam mixing equipment shall be located in enclosures heated (where required) to 50-75 degress F. so as to prevent freezing and to obtain the optimum chemical mixture of stabilizer and water.

e. Foam standpipe extinguishing systems shall be designed to provide for the simultaneous use of two streams of 50 gallons-per-minute of water (including foam liquid) each for a period of 10 minutes in sprinklered hangars and 20 minutes in

nonsprinklered hangars. A full recharge for an equivalent amount (two standpipes) of foam producing material shall be maintained in reserve.

Chapter 17. Wheeled and Portable Extinguishers

1701. 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). 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.

Chapter 18. Sprinkler Alarms and Fire Detection Systems.

1801. SPRINKLER ALARMS. In addition to local alarm service, waterflow alarms should be transmitted to the airport fire department headquarters (if any), to the airport control tower (if any), and to the public fire alarm headquarters or central station. If the control tower or airport fire department is manned 24 hours a day and is provided with a direct fire alarm box connection to the public fire alarm headquarters or central station, the direct waterflow connection to public fire alarm headquarters or central station may be omitted.

1802. FIRE DETECTION SYSTEMS.* **Nonsprinklered hangars** should be equipped with an approved automatic fire detection system. Alarms from it should be transmitted to the airport fire department headquarters (if any), to the airport control tower (if any), and to the public fire alarm headquarters or central station. If the control tower or airport fire department is manned 24 hours a day and is provided with a direct fire alarm box connection to the public fire alarm headquarters or central station, the direct connection from the automatic fire detection system to the public fire alarm headquarters or central station may be omitted. (See NFPA Standards for Protective Signalling Systems, Nos. 71, 72A, 72B, 72C and 72D).

---

*See footnote to Paragraph 1101.

Chapter 19. Employee Organization for Fire Safety.

1901. All personnel engaged in aircraft maintenance operations and all other persons regularly employed and working in or around aircraft hangars should be instructed in fire *prevention* practices as part of their regular training. [See, for instance, NFPA Recommended Practices on Aircraft Electrical System Maintenance Operations (No. 410A), Aircraft Breathing Oxygen System Maintenance Operations (No. 410B), Aircraft Fuel System Maintenance (No. 410C), Aircraft Welding Operations in Hangars (No. 410E), and Aircraft Cabin Cleaning and Refurbishing Operations (No. 410F).] These personnel should also be trained in the operation of all portable fire extinguishers and hose line systems provided in the hangar, shop or office area where they work.

1902. Selected personnel on each operational shift plus all watchmen or security guards should be trained in the operation of the fixed fire protection systems provided in the hangar, shop or office area where they work. This training should be accompanied with a comprehensive explanation of all features of such systems and the areas they protect.

1903. Responsibility for fire protection equipment inspection and maintenance shall be assigned to key personnel.

Chapter 20. Exterior Fire Protection Facilities for Hangars.

NOTE: This Chapter is not intended to cover specifications for general exterior fire protection services for airports but is restricted to good practice recommendations for the protection of hangar structures and their contents.

2001. WATER SUPPLY—GENERAL. The airport should be provided with an adequate water supply for fire department use. This supply may be from suitable connections to a municipal underground source, from nearby surface supplies or from

reservoirs or similar static sources. (See Standard for "Outside Protection", No. 24, for guidance on this subject.) Because elevated water tanks may constitute a hazard to air navigation (see Paragraph 106), ground reservoirs are normally used at airports if adequate water supplies are not available from municipal water supply systems or other sources.

2002. WATER SUPPLY—HANGAR PROTECTION.

a. For aircraft hangar protection purposes, the supply for hydrants (exclusive of sprinkler, inclusive of standpipe requirements) should be adequate to produce at least 500 to 1,000 gallons-per-minute for 45 minutes where the hangars are provided with automatic protection (see Chapter 15 and Paragraph 1506.b. and c.) and at least 1,500 to 2,000 gallons-per-minute for 45 minutes where the hangars are not so protected. The quantities specified should be delivered at the hydrant with at least 20 pounds-per-square-inch pressure where fire department pumpers are available and at least 75 pounds-per-square-inch pressure where direct hydrant hose streams are to be used.

b. Where pumps are required to provide the fire flows specified in Paragraph 2002.a., the NFPA Standard for the "Installation and Operation of Centrifugal Fire Pumps" (No. 20) shall be used as a guide.

c. Underground water supply piping serving hangar areas should be no smaller than 8 inches and should be part of the airport grid system to assure reliability and minimize friction loss.

d. Hydrants should be spaced according to the hazard requirements of each hangar. Where flush type hydrants are used their location shall be clearly marked and access to them shall be maintained by prohibiting aircraft or vehicle parking within a minimum of 10 feet radius (measured from any portion of aircraft) and by keeping such hydrant locations clear of snow or ice accumulations during winter months.

2003. USE OF MOBILE FIRE EQUIPMENT.

a. AIRPORT FIRE DEPARTMENTS. Aircraft rescue and fire fighting equipment (see Paragraph 105.b.) and other mobile fire fighting equipment available at the airport should be very valuable in handling aircraft fires on hangar aprons and in the aircraft storage or servicing areas of hangars. Personnel manning such equipment should be trained in their application for this pur-