AIRCRAFT HANGARS

DESCRIPTION

Aircraft hangars are typically provided with highly sophisticated levels of fire protection, simply because of the significant value of today's aircraft. What some people might not realize is that the practices described in this pamphlet are designed to protect the building, rather than the aircraft. However, the design of the fire protection systems in accordance with this standard are such, that if by nothing other than default, the aircraft will be protected. Servicing, maintenance and painting can be hazardous and as a result, the fire protection system must give a high degree of control and extinguishment of any Class A or B fire in the facility.

Most fire protection systems for aircraft handling facilities are designed in accordance with NFPA 409 Standard on Aircraft Hangars, Unified Facilities Criteria – (UFC), Aircraft Maintenance Hangars or the U. S. Air Force ETL (Engineering Technical Letter) Fire Protection Engineering Criteria for Aircraft Maintenance, Servicing and Storage Facilities. Most commercial aircraft hangars throughout the world are designed in accordance with NFPA 409. A review of this standard shows that there are four basic aircraft hangar designs, which can be classified as follows:

GROUP I AIRCRAFT HANGAR: A hangar having at least one of the following features and operating conditions:

- An aircraft access door height over 28 ft. (8.5 m).
- A single fire area in excess of 40,000 sq. ft. (3,716 sq. m).
- Provision for housing an aircraft with a tail height over 28 ft. (8.5 m).
- Provision for housing strategically important military aircraft as determined by the Department of Defense.

GROUP II AIRCRAFT HANGAR: A hangar having **both** of the following features:

- An aircraft access door height of 28 ft. (8.5 m) or less.
- A single fire area not larger than 40,000 sq. ft. (3,716 sq. m) per hangar construction type as defined by NFPA 409. (See table below).

Single Fire Area

Type of Construction	Equal or Greater Than Sq. Ft.	(M2)	But Not Larger Than Sq. Ft.	(M2)
Type I (443) and (332)	30001	(2787)	40000	(3716)
Type II (222)	20001	(1858)	40000	(3716)
Type II (111), Type III (211), and Type IV (2HH)	15001	(1394)	40000	(3716)
Type II (000)	12001	(1115)	40000	(3716)
Type III (200)	12001	(1115)	40000	(3716)
Type V (111)	8001	(743)	40000	(3716)
Type V (000)	5001	(465)	40000	(3716)

GROUP III AIRCRAFT HANGAR: A Group III hangar shall have both of the following features:

- An aircraft access door height of 28 ft. (8.5 m) or less.
- A single fire area that measures up to the maximum square footage permitted for specific types of construction in accordance with NFPA 409. (See table below).

Type of Construction	Maximum Single Fire Area Sq. Ft.	(M2)
Type I (443) and (332)	30000	(2787)
Type II (222)	20000	(1858)
Type II (111), Type III (211) and Type IV (2HH)	15000	(1394)
Type II (000)	12000	(1115)
Type III (200)	12000	(1115)
Type V (111)	8000	(743)
Type V (000)	5000	(465)

Building construction types are defined in NFPA 220, Standard on Types of Building Construction.

GROUP IV AIRCRAFT HANGAR: A hangar constructed of a membrane covered, rigid steel frame.

FIRE PROTECTION OPTIONS

Once the aircraft hangar classification has been determined, a suitable fire protection system can be established. There are four types of foam fire protection systems suitable for the protection of an aircraft hangar. These systems may be used separately or they may be combined.

- **Overhead Foam/Water Sprinkler System.**
- Deluge system. (Group I & II)
- Closed head pre-action system. (Group II)
- Standard wet pipe.

If used with either Protein or Fluoroprotein type foam concentrate, the foam water sprinkler heads shall be the air aspirating type. When used with A.F.F.F., the sprinkler heads can be the standard non air aspirating type.

- **Foam Monitor System.**

  Monitor Systems may be of the oscillating or fixed nozzle type.

  Oscillating Monitor Systems consist of monitors that automatically oscillate from side to side when discharging foam onto the hangar floor. They are normally preset to oscillate over a given arc to provide the correct application rate over a specific area. The unit is typically driven by a water turbine, which requires no external power source, other than a pressurized flowing water supply. For special applications, electric powered oscillating monitors are also available.

  Fixed Monitor Systems have nozzles that are typically mounted on a manifold or as single units approximately 3 feet (0.9 metre) above the hangar floor. They are preset for angle of elevation and discharge pattern to achieve the best possible stream pattern and range while keeping the stream low enough to flow under the wing of any aircraft. This type of monitor system is often used where aircraft or maintenance equipment in the hangar could interfere in the normal operation of an oscillating monitor.

  The following formula can be used as a guide to find the maximum arc of oscillation to give the necessary foam solution application rate when the nozzle inlet pressure and discharge range is known.

$$Y = \frac{A\,(360^\circ)}{(R)\,(\pi)\,(B)}$$

Where Y = Maximum arc of oscillation in degrees.
R = Nozzle range in feet.
π = 3.14159
A = Nozzle flow rate in gpm.
B = Application rate in gpm per sq. ft.

The following formula is used to find the sq. ft. area of coverage required for any monitor.

$$\text{Area of coverage} = \frac{(\pi\, r^2)\ \ (\text{arc of oscillation})}{360o}$$

Note:

This formula should be used as a guide only. The limitation is that the formula cannot calculate for the area below and close to the monitor nozzle where the floor would not normally be covered, except for unintentional "drop-out" due to the effects of gravity and foam flow back toward the nozzle, as a result of the slope of the floor. Consult the Buckeye Engineering Department for additional assistance.

- **Foam Hand Hose Line System.**

These systems are required as supplementary protection in group I and II aircraft hangars.

- **High Expansion Foam System.**

These systems are designed to discharge an expanded mass of foam bubbles over the protected area to a depth of at least 3 ft. (0.9 metre) within 1 minute and flow for a minimum of 12 minutes.

GROUP I HANGAR FIRE PROTECTION DESIGN REQUIREMENTS

A Group I aircraft hangar can have an approved foam-water deluge system covering the aircraft service and storage areas. It is to be installed in accordance with NFPA 16, Standard on Deluge Foam-Water Sprinkler and Foam-Water Spray Systems with an application rate of 0.16 gpm per sq. ft. (6.5-lpm/sq. m) when standard sprinkler heads are used. If air aspirating type heads are used, the application rate is to be 0.20 gpm per sq. ft. Sprinkler spacing as projected on the floor shall be limited to 130 sq. ft. per head. (12.1 sq. m). The maximum distance between sprinklers, either on branch lines or between branch lines shall be 12 feet. (3.7 m). The maximum protected area for each

individual deluge system is to be 15,000 sq. ft. (1,395 sq. m).

Other fire protection options include:

1). A combination of automatic sprinkler protection in accordance with NFPA 13 AND an automatic Low-Level Low Expansion Foam System.

2). A combination of automatic sprinkler protection in accordance with NFPA 13 AND an automatic Low-Level High Expansion Foam System.

Individual automatic sprinkler systems in Group I hangars, shall not exceed 52,000 sq. ft. (4,831 sq. M). The application rate shall be 0.17-gpm/sq. ft. (6.9 lpm/sq. m) over the hydraulically most remote 15,000 sq. ft. (1,394 sq. m).

The quantity of foam concentrate required is to be sufficient to operate the system for 10 minutes at the actual flow rate. No reduction in run-time is permitted if the system overdischarges.

The foam concentrate requirements should be calculated to include a 15% overage for hydraulic balance.

If the foam-water sprinkler system is also used for column fire protection within the hangar in lieu of the column having a fire resistive rating of not less than 2 hours, allowances must be made for the additional foam concentrate required.

Foam concentrate reserve supplies shall comply with the following requirements:

Group I Hangars: A reserve supply of foam concentrate shall be provided in accordance with 4.3.2.5.2 of NFPA 11.

Group II Hangars: There shall be a reserve of foam concentrate of a compatible type directly connected to the system. The reserve supply shall be in the same quantity as the main supply. To prevent accidental depletion of this reserve supply, it shall be available to the system only by intentional manual operation.

Group IV Hangars: A reserve supply of foam concentrate shall be provided in accordance with 4.3.2.5.2 of NFPA 11.

If the foam concentrate is injected into the water supply by foam pumps, two pumps are to be installed. Either pump should be capable of supplying the foam concentrate at the maximum system demand flow rate.

A jockey pump should be installed where the foam concentrate piping from the foam pump(s) to the injection point is below ground or if above ground 50 ft. (15.24 m) in length or greater. The jockey pump is to keep the foam concentrate line pressurized at all times to ensure prompt injection of concentrate into the system when activated.

Where there is an aircraft with a wing area in excess of 3,000 sq. ft. (279 sq. m), that DOES NOT have drained and purged fuel tanks, an approved supplementary foam-water fire protection monitor system is to be installed.

Foam-water hand hose systems shall be installed if the aircraft **DO NOT** have drained and purged fuel tanks. If the aircraft HAS drained and purged fuel tanks, water only hand hose lines may be installed.

WATER SUPPLY

For overhead deluge systems, sufficient water supply requirements are determined by assuming that a fire at any point will operate all the systems in every draft curtained area that is wholly or partially within a 100 ft. (30.5 m) radius of that point measured horizontally.

For design purposes, the water supply should operate for a minimum of 60 minutes when all systems designed to operate simultaneously flow at their designed pressure and flow rate. If the hangar has a supplementary foam protection system, the water supply shall be sufficient to flow for a minimum duration of 45 minutes.

High Expansion Foam System

A High Expansion Foam System installed in an aircraft hangar is to be designed to cover the protected area to a depth of 3 feet (0.9 metre) with a mass of foam bubbles within 1 minute. High Expansion Systems must have sufficient foam concentrate and water to operate at the design application rate for a minimum of 12 minutes. When a high expansion system is installed inside a hangar, allowances must be made for the possibility that the foam could be affected by any discharging sprinkler system. Please refer to the section on High Expansion Foam Systems in this Engineering Manual for further information.

The generators should only be mounted at the ceiling or on exterior walls of the hangar where **outside air only** (required by NFPA 409) is used to generate the foam.

Note:
For the most part, high expansion foam generators do not project a foam “stream” as would be experienced with an oscillating monitor. The distance projected outward from the generator is relatively short and as such extreme caution should be exercised where high expansion foam generators are mounted on exterior walls. In some cases it may not be possible to achieve the desired coverage when the generators are mounted on the wall.

It is recommended that the high expansion generators be installed so that the flow of foam on the floor is directed to areas beneath aircraft wings and center sections.

GROUP II HANGAR FIRE PROTECTION REQUIREMENTS

The fire protection requirements of a Group II hangar may be one of the following.

- In accordance with the requirements for a Group I hangar.
- A combination of automatic sprinkler protection in accordance with NFPA 13 AND an automatic Low-Level Low Expansion Foam System.
- A combination of automatic sprinkler protection in accordance with NFPA 13 AND an automatic Low-Level High Expansion Foam System.

* A Closed Head Foam/Water Sprinkler System.

Individual automatic sprinkler systems in Group II hangars shall have an application rate of 0.17 gpm/sq.ft. (6.9 lpm/sq. m) over the hydraulically most remote 5,000 sq. ft. (464.5 sq. m).

The application rate for a closed head foam/water sprinkler system in a Group II hangar shall be 0.16-gpm/sq. ft.(6.5 lpm/sq. m) over the entire aircraft storage and servicing floor area.

GROUP III HANGAR FIRE PROTECTION REQUIREMENTS

- Fixed fire protection systems are not normally required.
- If any hazardous operations such as fuel transfer, welding, painting, torch cutting, etc. is performed in a Type III hangar, the hangar should be protected in accordance with the requirements of a Type II aircraft hangar.

GROUP IV HANGAR FIRE PROTECTION REQUIREMENTS

The fire protection requirements of a Group IV hangar may be defined as follows:

A). Where the hangar fire area is greater than 12,000 sq. ft. (1,115 sq. m) and the aircraft are fuelled, the fire protection shall be in accordance with one of the following:

1). A Low Expansion Low Level Foam System over the whole storage and servicing area at 0.1 gpm sq. ft. (4.1 lpm sq. m).

2). A High Expansion Foam System with an effective application rate of 3 cu. ft. min, per sq. ft. (0.9 cu. m. per sq. m).

B). Where the hangar fire area is greater than 12,000 sq. ft. (1,115 sq. m) and the aircraft are unfueled, the fire protection shall be in accordance with one of the following:

1). A Low Expansion Low Level Foam System over the whole storage and servicing area at 0.1 gpm sq. ft. (4.1 lpm sq. m).

2). A High Expansion Foam System with an effective application rate of 3 cu. ft. min, per sq. ft. (0.9 cu. m. per sq. m).

3). Automatic Sprinkler Protection that complies with the following criteria:

Closed head water sprinkler system in accordance with NFPA 13.

- Quick response sprinkler heads.
- A design density of 0.17-gpm sq. ft. (6.9 lpm sq. m) over 5,000 sq. ft. (464.5 sq. m.).

Foam System Application Summary

Overhead primary protection systems.

- Discharge duration - 10 min.
- Application Rate:
- 0.16 gpm per sq. ft. / AFFF through standard sprinkler heads.
- 0.20 gpm per sq. ft. / Protein, Fluoroprotein or AFFF through air aspirating sprinkler heads.
- If the foam concentrate is injected into the water supply by a foam pump, there are to be two pumps (one main, one reserve), either of which can supply the necessary supply of foam concentrate at the design flow rate and operating pressure.
- When using a 1% type of foam concentrate, multiply the total foam solution required by 0.01 to obtain the quantity of foam concentrate required. Multiply by 0.03 when using a 3% type concentrate and by 0.06 when using 6%.

SUPPLEMENTARY PROTECTION SYSTEMS

Each Supplementary Fixed Foam Fire Protection System is to be designed to achieve control of the protected specified floor area within 30 sec. of activation and to extinguish any fire within 60 sec. The specified floor area is the area under the wing and the wing center section of the aircraft. The different configurations of aircraft and their positioning within the hangar must be considered for effective fire protection when positioning the monitors. If more than one aircraft is located within any drainage system, it is recommended that the supplementary foam monitor system be capable of effectively covering the complete floor beneath all aircraft.

Minimum flow rates through supplementary monitor systems for the area of coverage is to be 0.10 gpm per sq. ft.(4.1 lpm/sq. m) when using AFFF and 0.16 gpm per sq. ft. (6.5 lpm/sq. m) when using Protein or Fluoroprotein foam concentrates.

It is recommended that a control valve be installed at the base of each oscillating monitor or fixed nozzle system.

Foam Hand Line Protection System

Provisions are to be made in water flow calculations for operating a minimum of two foam hand line systems. Each system must flow a minimum of 60 gpm (227 lpm) at a sufficient nozzle pressure with a discharge duration of foam solution for 20 min.

Engineering Technical Letter

The ETL (Engineering Technical Letter) contains design practices for aircraft hangars and is used by the U.S. Air Force and some other branches of the armed services, such as the Air National Guard. This document is updated periodically and the current version as of this writing is dated April 2001. The latest issue removed all types of A.F.F.F. systems for the protection of U.S. Air Force hangars and substituted High Expansion Foam. The design criteria used by the U.S. Air Force for High Expansion Foam Systems is different to that found in N.F.P.A. 409 in the following areas:

Note: The requirements for NFPA 409 are shown in parenthesis.

Run Time: 15 minutes (12 minutes)

Flooding characteristics:

Cover 90% of the aircraft silhouette within 1 minute and the whole hangar floor area to a depth of 1 metre (3.28 ft.) within 4 minutes.

Safety Factors:

The following “approximate” safety factors are applied to the design calculations. Shrinkage is the normal effect of the foam collapsing under its own weight. Sprinklers discharging water directly on to the foam bubbles will affect the foam blanket. Leakage is as a result of open windows, doors or other non-closing openings.

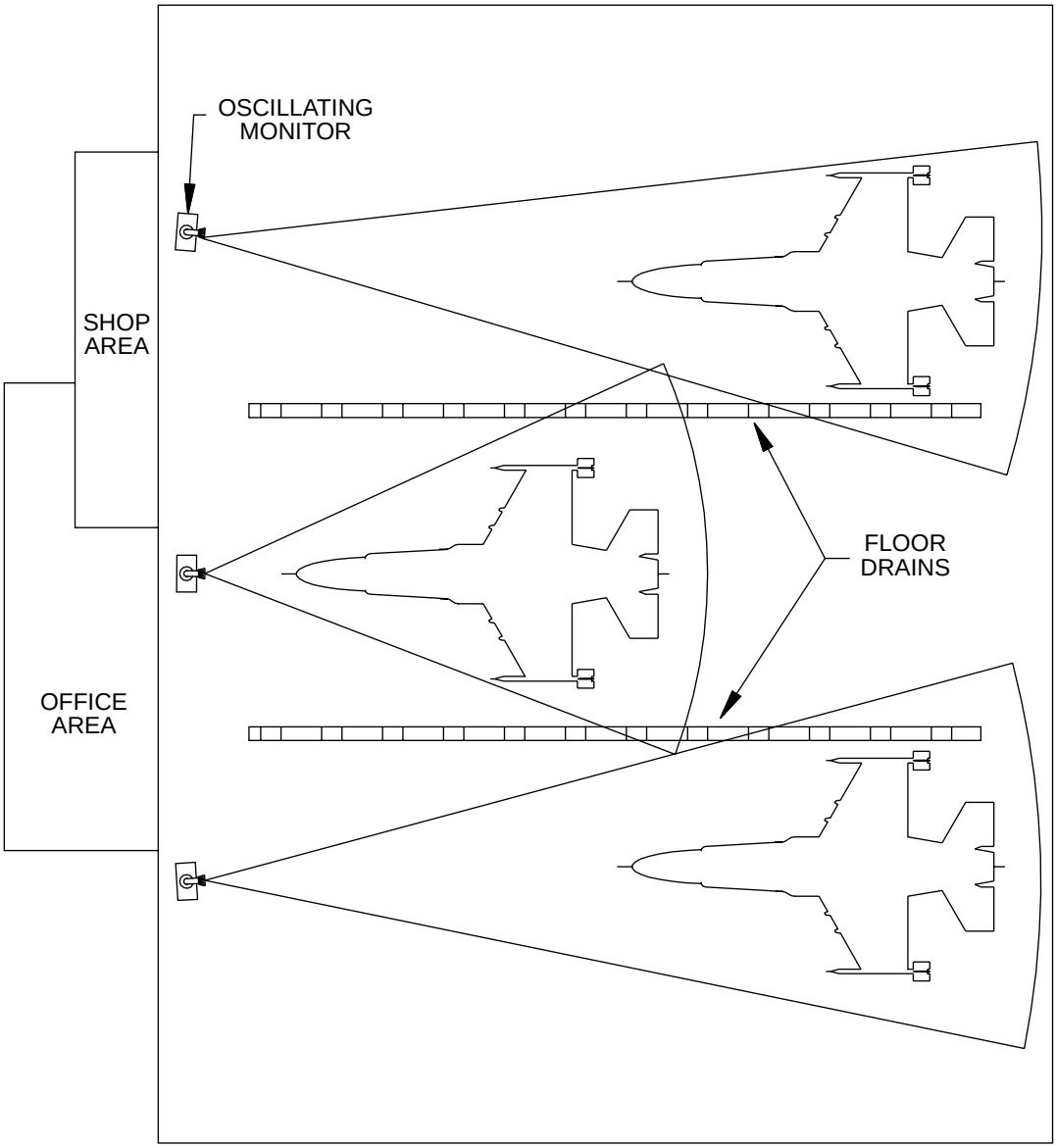
Shrinkage	1.15	(1.10)
Effect of Sprinklers	1.19	(1.10)
Leakage:	3.00	(1.15)

Additional Requirements for all Types of aircraft hangars.

Fire extinguishers must be distributed throughout the aircraft hangar per NFPA 10 Standard for Portable Fire Extinguishers.

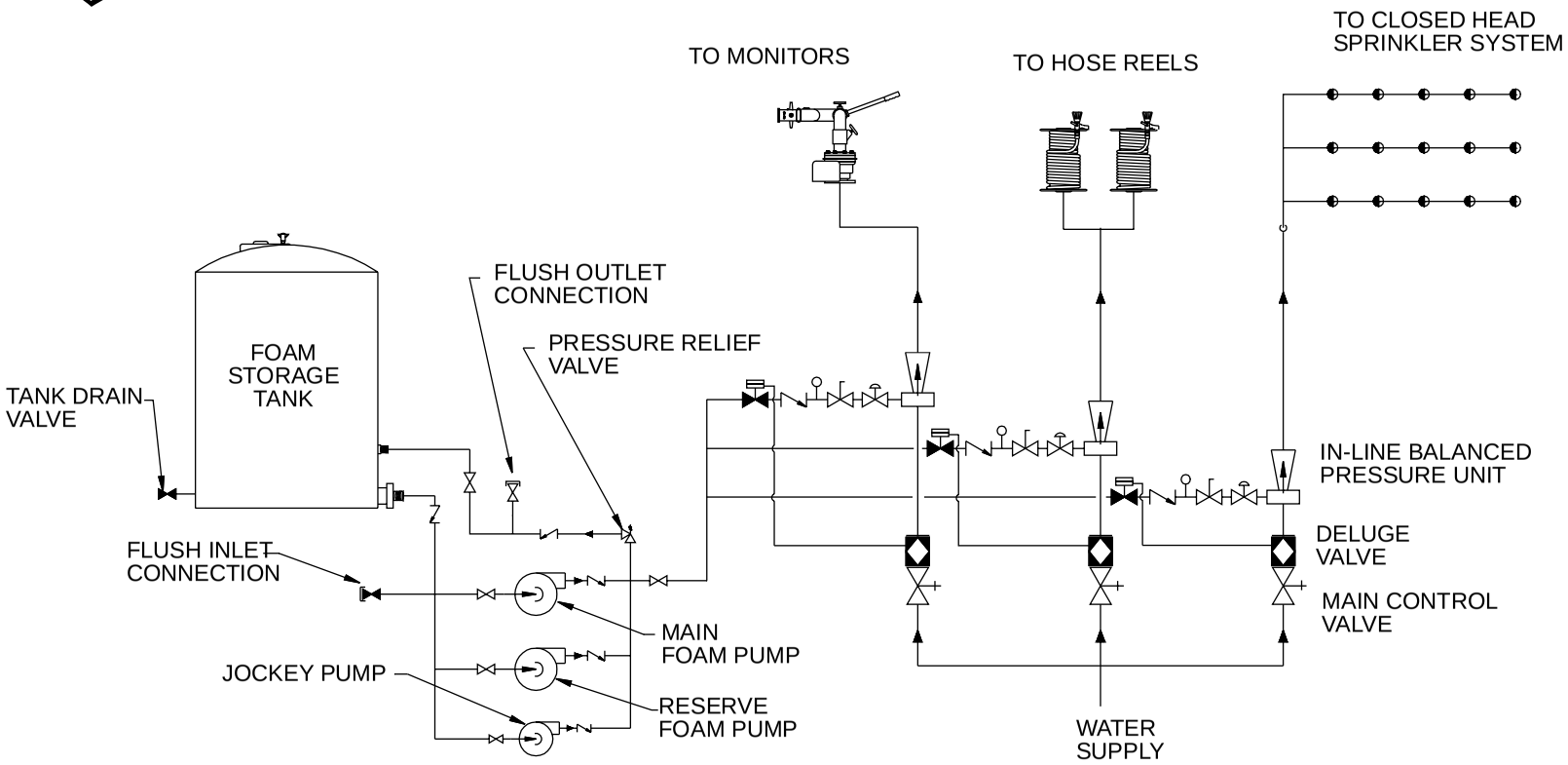
AIRCRAFT HANGARS

MONITOR LOCATIONS



AIRCRAFT HANGAR
WITH POSSIBLE LOCATIONS FOR
AUTOMATIC OSCILLATING MONITORS

BALANCED PRESSURE TYPE WITH I.L.B.P. MODULES



AIRCRAFT HANGAR
IN-LINE BALANCED PRESSURE SYSTEM with
JOCKEY, MAIN and RESERVE FOAM PUMPS