DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

DEC 31 2001

FROM: HQ AFCESA/CES
139 Barnes Drive, Suite 1
Tyndall AFB, FL 32403-5319

SUBJECT: **Engineering Technical Letter (ETL) 01-4: Fire Protection Engineering Criteria – Protective Aircraft Shelters (PAS)**

**1. Purpose.** This ETL provides fire protection criteria for protective aircraft shelters (PAS). PASs include hardened aircraft shelters (HAS); semi-hardened aircraft shelters (HAS); and other structures built to provide aircraft a degree of battle damage protection from conventional air- and ground-delivered munitions. These criteria provide for protection in the event of a fuel-spill fire. Human intervention/activation is required to minimize damage to the aircraft.

**2. Application.** Compliance with this ETL is mandatory for projects that have not completed the project definition (PD) phase, and projects beyond the PD phase but not in active design status. Compliance with this ETL should be considered for projects in active design beyond PD. Applying these criteria will result in reduced original construction and life-cycle maintenance costs, and increased overall reliability of the fire protection system.

**2.1.** New Construction. Compliance with this ETL is mandatory for the design and construction of all new PASs on Air Force installations or housing Air Force aircraft.

**2.2.** Existing Facilities. Compliance with this ETL is mandatory for the design and construction of fire protection features for all existing PASs without installed fire suppression systems. Renovation, modification, or alteration of existing PASs without an installed fire suppression system must comply with the criteria contained in this ETL.

**2.3.** Occupancy Changes. Compliance with this ETL is mandatory during a major occupancy change, such as converting a former PAS currently being used as a warehouse back to an operational PAS. A change of aircraft does not constitute a change of occupancy; however, beddown of a new mission is not recommended in an existing PAS without a fire suppression system.

**2.4.** Sortie Generation Operations (SGO) Facilities. The criteria within this ETL apply to SGO facilities (formally called Integrated Combat Turn [ICT] facilities) and meet the requirements of Technical Order (T.O.) 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*, for the conduct of SGO without fire department standby; however, compliance with this ETL alone is not authorization to conduct SGO. SGO locations and operations must be specifically evaluated and approved through the

System Safety Engineering Program (Air Force Instruction [AFI] 91-202, *The US Air Force Mishap Prevention Program*).

**2.5.** Excluded Facilities. PASs with two or fewer sides (including partial walls) are not addressed in this ETL; those shelters will be treated as open ramps.

**2.6.** Authority: AFI 32-1023, *Design and Construction Standards and Execution of Facility Construction Projects*.

**2.7.** Effective Date: Immediately.

**2.8.** Recipients: Major command (MAJCOM) civil engineering offices.

**2.9.** Coordination: Headquarters Office of the Civil Engineer, Engineering Division (HQ AF/ILEC), MAJCOM fire protection engineers (FPE), Headquarters Naval Facilities Engineering Command (HQ NAVFACENGCOM), and U.S. Army Corps of Engineers, Directorate of Civil Works, Division of Engineering and Construction (USACE/CECW-E).

**Note:** Criteria in this ETL assume fire department capabilities consistent with AFI 32-2001, *The Fire Protection Operations and Fire Prevention Program*. The use of these criteria at other locations is not recommended without a complete risk analysis prepared by the base (or the project architect-engineer [A-E] for new construction) and accepted by the MAJCOM FPE and the MAJCOM Fire Department Operations (FDO) Group.

## 3. References.

**3.1.** Air Force:

- AFI 32-1023, *Design and Construction Standards and Execution of Facility Construction Projects*
- AFI 32-1066, *Plumbing Systems*
- AFI 32-2001, *The Fire Protection Operations and Fire Prevention Program*
- Air Force Manual (AFM) 91-201, *Explosives Safety Standards*
- AFI 91-202, *The US Air Force Mishap Prevention Program*
- Air Force Handbook (AFH) 32-1163, *Engineering Weather Data*
- T.O. 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding*
- *Aircraft Hangar Fire Protection Systems – Standard Design Elements*

**3.2.** Department of Defense (DOD):

- Military Handbook (MIL-HDBK)-1008, *Fire Protection for Facilities Engineering Design and Construction*
- MIL-F-24385, *Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF) Liquid Concentrate, for Fresh and Sea Water*

**3.3.** National Fire Protection Association (NFPA) (the latest edition applies):

- NFPA 11, *Standard for Low-Expansion Foam*
- NFPA 30, *Flammable and Combustible Liquids Code*
- NFPA 31, *Standard for the Installation of Oil-Burning Equipment*
- NFPA 54, *National Fuel Gas Code*
- NFPA 70, *National Electrical Code®* (*NEC®*)
- NFPA 72, *National Fire Alarm Code®*
- NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*

**3.4.** American Society for Testing and Materials (ASTM):

- ASTM A53/A53M-01, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*
- ASTM A795-00, *Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use*
- ASTM D2996-01, *Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe*

**3.5.** American Society of Mechanical Engineers/American National Standards Institute (ASME/ANSI):

- ASME/ANSI A13.1-1996, *Scheme for the Identification of Piping Systems*
- ASME/ANSI B31.3-1996, *Process Piping*

**3.6.** International Conference of Building Officials (ICBO):

- *1997 Uniform Building Code®*

**3.7.** Underwriters Laboratories (UL):

- UL 1449, *Transient Voltage Surge Suppressors* (Second Edition)
- UL 1283, *Electromagnetic Interference Filters* (latest edition)

## 4. Acronyms and Terms.

| | |
|---|---|
| AC | - alternating current |
| A-E | - architect-engineer |
| AFCCC | - Air Force Combat Climatology Center |
| AFFF | - aqueous film-forming foam |
| AFH | - Air Force Handbook |
| AFI | - Air Force Instruction |
| AGE | - aerospace ground equipment |
| ANSI | - American National Standards Institute |
| ASME | - American Society of Mechanical Engineers |
| ASTM | - American Society for Testing and Materials |
| CEV | - Civil Engineer Environmental |
| DOD | - Department of Defense |
| ETL | - Engineering Technical Letter |
| FDO | - fire department operations |

| | |
|---|---|
| FPE | - fire protection engineer |
| FSCP | - foam system control panel |
| GS/GM | - General Schedule/General Merit |
| HAS | - hardened/semi-hardened aircraft shelter |
| HQ AFCESA/CESM | - Headquarters Air Force Civil Engineer Support Agency, Mechanical/Electrical Engineering Division |
| HQ USAF/ILEC | - Headquarters Office of the Civil Engineer, Engineering Division |
| HQ USAF/ILEV | - Headquarters Office of the Civil Engineer, Environmental Division |
| HVAC | - heating, ventilation and air conditioning |
| ICBO | - International Conference of Building Officials |
| ICT | - integrated combat turn |
| MAJCOM | - major command |
| MILCON | - military construction |
| MIL-HDBK | - Military Handbook |
| NAVFACENGCOM | - Naval Facilities Engineering Command |
| NCEES | - National Council of Examiners for Engineering and Surveying |
| NEC | - National Electrical Code |
| NFPA | - National Fire Protection Association |
| OSHA | - Occupational Safety & Health Administration |
| PAS | - protective aircraft shelter |
| PD | - project definition |
| PE | - Professional Engineer |
| SGO | - sortie generation operations |
| SIOH | - supervision, inspection, & overhead |
| SSEA | - System Safety Engineering Analysis |
| T.O. | - Technical Order |
| TVSS | - transient volt surge suppression |
| UBC | - Uniform Building Code |
| UL | - Underwriters Laboratories |
| USACE | - U.S. Army Corps of Engineers |
| USACE/CECW-E | - U.S. Army Corps of Engineers, Directorate of Civil Works, Division of Engineering and Construction |
| VAC | - volts alternating current |

**5. Specific Requirements.** This ETL, in accordance with Military Handbook (MIL-HDBK)-1008, *Fire Protection for Facilities Engineering Design and Construction*, paragraph 1.3.4, takes precedence over MIL-HDBK-1008, section 4.16. Attachment 1 provides criteria and technical guidance.

**5.1.** All design and construction packages will use the *Aircraft Hangar Fire Protection Systems – Standard Design Elements* (available from AFCESA on CD-ROM) as a reference for system components.

**5.2.** U.S. Army Corps of Engineers (USACE) Center of Expertise for Aircraft Hangar Fire Protection.

**Note:** Center of Expertise services are provided on a cost-reimbursable basis between the USACE District designing and constructing the project and the Center of Expertise. This service is expected to be covered in the standard supervision, inspection, & overhead (SIOH) paid on the project. This service should not result in additional costs or fees to the project.

**5.2.1.** For all hangar military construction (MILCON) projects on which the USACE is the design agent, the Center of Expertise will review all project designs to ensure compliance with this ETL.

**5.2.2.** For all hangar MILCON projects on which the USACE is the construction agent, the Center of Expertise will review all contractor shop submittals to ensure compliance with this ETL. All review comments issued by the Center of Expertise will be implemented by the USACE contracting officer to the satisfaction of the Air Force. An FPE in the Center of Expertise will perform the final acceptance testing of all hangar fire protection systems. The MILCON project will not be accepted by the USACE contracting officer until the Center of Expertise has accepted the fire protection system.

**5.3.** NAVFACENGCOM Division FPE.

**5.3.1.** For all hangar MILCON projects on which NAVFACENGCOM is the design agent, the division FPE will review all project designs to ensure compliance with this ETL. This review is mandatory at all design review stages, and all formal review comments issued will be implemented to the satisfaction of the Air Force.

**5.3.2.** For all hangar MILCON projects, the division FPE will review all contractor shop submittals to ensure compliance with this ETL. The contracting officer will implement all review comments to the satisfaction of the Air Force. An FPE will perform the final acceptance testing of all hangar fire protection systems.

**6. Point of Contact.** Fire protection criteria for aircraft facilities must evolve concurrently with technical developments in fire science, data generated in fire testing programs, and the availability of new fire protection equipment or methodologies. Recommendations for improvements to this ETL are encouraged and should be furnished to HQ AFCESA/CESM, 139 Barnes Drive, Suite 1, Tyndall AFB, FL 32408-5319, Attention: Mr. Fred Walker, DSN 523-6315, commercial (850) 283-6315, FAX DSN 523-6219, Internet: fred.walker@afcesa.af.mil.

MICHAEL J. COOK, Colonel USAF
Director of Technical Support

2 Atchs
1. Technical Criteria for Aircraft Hangar Fire Protection
2. Distribution List

## TECHNICAL CRITERIA FOR AIRCRAFT HANGAR FIRE PROTECTION

### A1.1. Construction Requirements.

**A1.1.1.** Structural Requirements. The structural requirements for a PAS are unique to the location of operations and the degree of protection required to support mission requirements. In most cases, the construction will be similar to or exceed traditional Type I construction.

**A1.1.1.1.** Internal Fire-rated Separations. Typically, there are no internal separations within a PAS.

**A1.1.1.2.** Allowable Floor Area. Typically, a PAS is designed to house and launch a single fighter or reconnaissance aircraft (possibly two or three aircraft under combat situations if System Safety Engineering Analysis [SSEA]-approved); therefore, floor area limits do not apply. Larger facilities would require special evaluation and this criteria cannot be applied; however, protection is required. Contact Headquarters Air Force Civil Engineer Support Agency, Mechanical/Electrical Engineering Division (HQ AFCESA/CESM) for guidance and special evaluation assistance (paragraph 6).

**A1.1.1.3.** Siting/Separation. The PAS will be sited and separated in accordance with munitions safety quantity/distance criteria (Air Force Manual [AFM] 91-201, *Explosives Safety Standards*). No minimum fire safety separation is required between any combination of PAS and Type I or Type II construction hangar protected by approved fire suppression systems.

**A1.1.1.3.1.** Separation Between PAS and Hangars of Other Construction Types. The minimum separation distance between adjacent hangars is 12 meters (40 feet). This may be reduced to 7.5 meters (25 feet) if the hangar has a one-hour exposure wall and protected three-quarter-hour openings (e.g., windows and doors), or if the hangar has an approved fire suppression system. This may be further reduced to 3 meters (10 feet) if the hangar has one-hour exposure walls, protected three-quarter-hour openings, and an approved fire suppression system.

**A1.1.1.3.2.** Separation Between PAS and Other Buildings. The minimum separation between a PAS and other buildings is 12 meters unless munitions safety quantity/distance criteria requires greater separation. Reductions in this distance must conform to the International Conference of Building Officials (ICBO) *1997 Uniform Building Code*® and applicable quantity/distance criteria.

**A1.1.1.3.3.** Separation Between PAS and Tension Fabric Structures. The minimum separation between a PAS and tension fabric structures will be 15 meters (50 feet) immediately adjacent to the tension fabric structure. This zone cannot be used for storage and must be clear of vegetation (a maintained lawn is permitted). The clear zone may be used as a street or driveway, but not for vehicle parking.

**A1.1.1.4.** Hangar Doors. PAS doors must be configured for manual operation under emergency conditions without special tools or disassembly. In manual operation, it may be necessary to use a vehicle to tow the main doors open.

**A1.1.1.4.1.** If emergency standby power is provided for the PAS it may also be used for door operations.

**A1.1.1.4.2.** Use door track heaters in areas subject to freezing to prevent accumulated snow and ice from impeding the operation of hangar doors. Track heaters must be installed in a manner that allows their replacement without destructive removal of the track or adjacent concrete.

**A1.1.2.** Utility Systems.

**A1.1.2.1.** Ramp Drainage. Aprons and the approach into the PAS must be sloped away from the hangar with a grade of not less than one-half of one percent (0.3:60 meters [1:200 feet]) to preclude a ramp fuel spill from entering the hangar. If the required grade cannot be achieved, provide an appropriately sized trench drain across the entire apron side of the hangar with a discharge to a safe location remote from the hangar.

**A1.1.2.2.** Heating, Ventilation and Air Conditioning (HVAC) Systems.

**A1.1.2.2.1.** Install heating equipment in accordance with National Fire Protection Agency (NFPA) 90A*, Standard for the Installation of Air Conditioning and Ventilating Systems*; NFPA 31, *Standard for the Installation of Oil-Burning Equipment*; or NFPA 54, *National Fuel Gas Code*.

**A1.1.2.2.2.** Heating devices with a flame or glowing element open to the atmosphere in the PAS are not permitted.

**A1.1.2.2.3.** Install only overhead radiant tube systems when radiant heating is used. Combustion air must be drawn from outside the PAS and combustion products must be discharged outside the PAS.

**A1.1.2.2.4.** Forced- or re-circulated-air HVAC systems must not draw air from the aircraft servicing area below 457 millimeters (18 inches).

**A1.1.2.2.5.** Exhaust systems discharging to the facility's exterior may draw air at any level.

**A1.1.2.3.** Electrical Systems.

**A1.1.2.3.1.** Install all electrical equipment in PAS in accordance with NFPA 70, *National Electrical Code*® (*NEC*®), Article 501 and 505 for Class I Division 2 areas or Class I Zone 2 areas. In overseas areas, electrical equipment may be installed in accordance

with local codes with equivalent hazardous location requirements. For example, in Europe equipment must be suitable for Zone 2 areas.

**A1.1.2.3.2.** Personnel shelters, offices, and other structures in the PAS must be suitable for installation in Class I Division 2 areas or Class I Zone 2 areas.

**A1.1.2.4.** Foam-Water Retention Systems.

**A1.1.2.4.1.** Exceptions. Retention systems are not required for facilities/systems designed and constructed in accordance with this ETL. Foam-water retention is not required in the following cases:

**A1.1.2.4.1.1.** Testing discharges of systems discussed in this ETL. Test headers/connections are required on all new foam-water systems allowing controlled discharge into a tank or other portable collection device, so no fixed permanent retention capability is required. In geographic regions where there is little or no open water, streams, or wetlands, and no high-ground water table, solar evaporation is an appropriate disposal method.

**A1.1.2.4.1.2.** Manual low-level low expansion foam-water nozzle systems, properly installed and maintained (these systems do not have discharges). An unplanned accidental discharge is not a “most probable worst-case” event. Accidental activations are an indication of a technical problem with the system which must be identified and corrected.

**A1.1.2.4.1.3.** Catastrophic events, such as actual fires. Foam discharge associated with a fire is not a “most probable worst-case” event. A fire in a hangar is a catastrophic event. Designing a containment system for a catastrophic event is impractical due to the number of associated variables and the mass of fire debris generated.

**A1.1.2.4.2.** Unplanned Accidental Events. Current environmental guidance for managing accidental aqueous film-forming foam (AFFF) discharges is:

- A formally documented response plan by the installation spill team and/or off-base contractors to contain, collect, and dispose of discharged AFFF.
- Direct release to a government-operated sanitary or industrial waste treatment facility, if the foam-water solution is less than 50 parts per million of the plant influent.
- In geographic regions where there is little or no open water, streams, or wetlands, and no high-ground water table, solar evaporation is an appropriate disposal method.

**A1.1.2.4.3.** Other Retention Issues. For additional guidance or information on AFFF retention and management, consult with Headquarters Office of the Civil Engineer, Environmental Division (HQ AF/ILEV) and/or the MAJCOM Civil Engineer Environmental (CEV) offices.

**A1.2. Fire Suppression System.**

**A1.2.1.** General Requirements. Protect the PAS with a manual low-level low expansion foam-water nozzle system. When there is a conflict between this ETL and any provisions of an NFPA standard or code, this ETL will take precedence.

**A1.2.1.2.** Manual Foam-Water/Water Fire Hose Stations. Do not provide interior or exterior hose stations or fire hose connections.

**A1.2.1.3.** Fire Department Connections. Do not provide fire department connections on PAS systems.

**A1.2.1.4.** Piping Systems.

**A1.2.1.4.1.** For foam-water systems, use one of the following:

- Standard weight pipe conforming to American Society for Testing and Materials (ASTM) A795-00, *Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use* (exception: do not use galvanized pipe), or ASTM A53/A53M-01, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*
- Filament-wound fiberglass pipe conforming to ASTM D2996-01, *Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe,* designation code "RTRP-11 FF-3121"

  **Note:** Filament-wound fiberglass pipe must be installed in accordance with American Society of Mechanical Engineers/American National Standards Institute (ASME/ANSI) B31.3-1996, *Process Piping.*

**A1.2.1.4.2.** Do not paint exposed interior fire protection piping.

**A1.2.1.4.3.** Mark all exposed interior piping, at 8-meter (26-foot) intervals, with plastic wraparound-type pipe labels conforming to ASME/ANSI A13.1-1996, *Scheme for the Identification of Piping Systems*, indicating the type of fluid carried and direction of flow. The following label is required on lines supplying low-level foam-water nozzles: "FOAM NOZZLE."

**A1.2.2**. Low-Level Low Expansion Foam-Water Nozzle Systems.

**A1.2.2.1.** Flow Rate. Limit individual foam-water nozzle flow rates to less than 1900 liters per minute (500 gallons per minute).

**A1.2.2.2.** Application Rate. The foam-water application rate from foam-water nozzle systems is 4 liters per minute per square meter (0.1 gallon per minute per square foot).

**A1.2.2.3.** Application Area. The foam-water application area must cover the entire floor area up to 3 meters from the walls or other physical obstruction which limits the aircraft

parking area. The foam is most effective in suppressing fuel-spill fires when it flows across the floor into the area directly under the aircraft. The area under the aircraft (single aircraft parking position) must be covered in solution in one minute or less.

**A1.2.2.4.** Foam-Water Nozzle Location. Use fixed non-aspirating nozzles. Select foam-water nozzle size and locations to provide maximum efficiency in covering the floor area without distributing foam onto any aircraft surface. Locate foam-water nozzles along the wall at least 2 meters (6.5 feet) and not more than 3 meters above the floor to permit storing aerospace ground equipment (AGE), tools, and aircraft components below the foam-water nozzles. Install piping to foam-water nozzles attached to the wall with earthquake bracing.

**Note:** This requirement provides the maximum usable floor space and minimizes the area which must be kept clear in front of the nozzles to prevent blocking delivery of the foam.

**A1.2.2.4.1.** It is not necessary for the foam-water nozzle discharge pattern (throw) to cover the entire floor area; the foam is more effective in suppressing fuel spill fires when it flows across the floor. See Figure A1.1 for a plan view example of a discharge if the manufacturer indicates a nozzle will discharge to a distance of 40 feet.

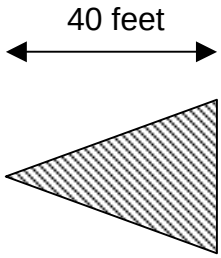


**Figure A1.1. Fixed Nozzle Discharge**

**A1.2.2.4.2.** Fixed foam-water nozzle coverage will be based on twice the throw distance (*d)* by the width at the widest point ($2d \tan \theta/2$). See Figure A1.2 for a plan view example if the manufacturer indicates a nozzle has a 45° pattern and will discharge to a distance of 40 feet (d=40 and $\theta$=45).

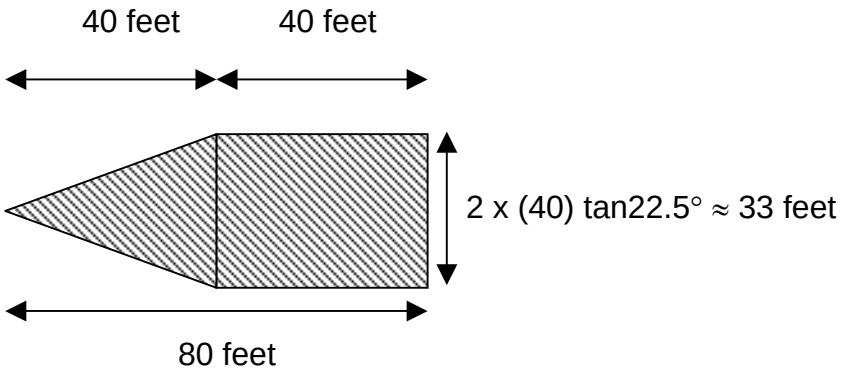


**Figure A1.2. Fixed Nozzle Discharge and Foam Push**

**A1.2.2.4.3.** Align foam-water nozzle elevations to push the foam across the floor with minimal agitation of the pool fire. It is critical that foam-water nozzles be located and positioned so as not to spray foam-water solution onto any aircraft surface, especially inside aircraft engines, doors, or hatches.

**A1.2.2.4.4.** Locate foam-water nozzles to avoid obstructions (structural components, aircraft components) interfering with the discharge pattern.

**A1.2.2.5.** Activation. The foam-water nozzle systems will be activated by manual foam activation stations located at the main exit, the wall opposite the exit, and the rear wall of the PAS.

**A1.2.3.** Foam and Water Systems.

**A1.2.3.1.** Listing. All components and assemblies used in this fire protection subsystem must be specifically listed/approved for their intended use by a nationally recognized testing organization whose listing/approval process includes follow-up factory inspections to ensure that products comply with the listing/approval conditions.

**A1.2.3.2.** Concentrate. Use only AFFF concentrates complying with the current military specification MIL-F-24385, *Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF) Liquid Concentrate, for Fresh and Sea Water*.

**A1.2.3.3.** Supply Systems. Two systems types are approved for use in a PAS: pre-mixed and post-mixed.

**A1.2.3.3.1.** A pre-mixed system consists of a pressure tank filled with a pre-mixed 3% AFFF/water solution providing sufficient agent to maintain the application rate for at least 4 minutes. The AFFF/water solution will be discharged by a nitrogen (or other stored gas) pressure reservoir/tank capable of discharging the entire liquid solution in the pressure tank.

**A1.2.3.3.2.** A post-mixed system consists of a pressure tank that provides enough water to maintain the application rate for at least 4 minutes. The water will be discharged by a nitrogen (or other stored gas) pressure reservoir/tank capable of discharging all the water in the pressure tank. AFFF concentrate will be contained in an atmospheric tank and inducted into the water stream discharging from the pressure tank. Use self-inducting in-line proportioners for all low-level nozzle systems. The AFFF concentrate must be capable of supporting the complete pressure tank discharge.

**A1.2.3.3.3.** Regardless of system type, provide freeze protection for the water and/or AFFF/water by using approved anti-freeze solutions in the water when the 99.6% dry bulb temperature is less than 0.5 °Celsius (33 °Fahrenheit) (Air Force Handbook [AFH] 32-1163, *Engineering Weather Data,* Design Criteria Data). The data is maintained by the Air Force Combat Climatology Center (AFCCC) on the Web at https://www2.afccc.af.mil/prodloc_mil/index.html. To access this data:

- In the **Product** pull-down window, select *Engineering Weather Data (EWD)*.
- In the **Station Name** window, type in the installation name (e.g., "Minot" to retrieve Minot Air Force Base data).
- Press **SUBMIT**.
- On the **Available Products matching your search criteria** page, click on the installation name (e.g., *MINOT AFB*).
- On the **Engineering Weather Data (EWD)** page, click on the file under **Standard EWD Package**.
- The information will be displayed in the **Design Criteria Data** table.

Protect concentrate, if stored separately, by using freeze-protected concentrate suitable for use to -29 °Celsius (-20 °Fahrenheit).

**Note:** Electric heaters are not recommended. Power may not be available in combat situations; if a non-antifreeze-protected solution is discharged through cold piping it may freeze and block the pipe.

**A1.2.3.4.** Location.

**A1.2.3.4.1.** For a first- and second-generation PAS, the system foam supply must be located outside but adjacent to the PAS. The supply must be mounted on a concrete surface and provided with small-arms ballistic and splinter protection.

**A1.2.3.4.2.** For a third-generation and similarly sized PAS, the system foam supply may be located inside or outside but adjacent to the PAS. The inside systems will be located on the floor to minimize the operational space occupied. Inside systems will not be mounted above the floor to the roof or wall structure. The outside supply must be mounted on a concrete surface and provided with small-arms ballistic and splinter protection.

**A1.2.3.4.2.1.** The foam equipment room will be large enough to accommodate all required equipment. All equipment will be fully accessible for inspection, testing,

maintenance, and removal/replacement without requiring the removal of any other equipment.

**A1.2.3.4.2.2.** If equipment and/or valves requiring access for maintenance, periodic testing, or re-servicing are located more than 2.4 meters (8 feet) above the floor, provide an open steel grate mezzanine with a permanent ladder at that equipment level. All platforms and ladders must be in compliance with Occupational Safety & Health Administration (OSHA) requirements.

**A1.2.3.5.** Control Valve. Provide water-powered ball valves as foam concentrate control valves. The valve must be operated by connection to the alarm line of the automatic water control valve or alarm valve. Provide a retard chamber in the line to the water-powered ball valve on wet-pipe foam-water systems.

**A1.2.3.6.** Application Time. The foam concentrate supply must be sized for not less than a single 4-minute application of foam, based on the actual system flow.

**A1.2.3.7.** Concentrate Storage.

**A1.2.3.7.1.** Atmospheric foam storage tanks must be either metal or fiberglass construction and listed/approved for storing foam concentrate. Pressure tanks for bladder tank systems must be steel and listed/approved for storing foam concentrate.

**A1.2.3.7.2.** Do not provide back-up supply of foam concentrate in the facility, either as a connected reserve or bulk reserve.

**A1.2.3.8.** Foam Concentrate Pipe. Foam concentrate pipe must satisfy the following criteria:

- Grooved, welded, or flanged stainless steel.
- Filament-wound fiberglass meeting not less than ASTM D2996-01, designation code “RTRP-11 FF-3121,” installed in accordance with ASME/ANSI B31.3-1996.

**A1.2.4.** Foam System Controls. Design all foam system controls in accordance with NFPA 72, *National Fire Alarm Code*®, and the following criteria.

**A1.2.4.1.** Foam System Control Panel (FSCP).

**A1.2.4.1.1.** Locate all FSCPs in the PAS. The FSCP must be suitable for locations with temperature ranges between -29 to 49 °Celsius (-20 to 120 °Fahrenheit) and humidity between 5% and 100%.

**A1.2.4.1.2.** FSCPs must have not less than a 24-hour secondary power supply.
**A1.2.4.1.3.** Transient Voltage Surge Suppression (TVSS).

**A1.2.4.1.3.1.** All FSCPs must have TVSS on all circuits entering and leaving the facility, including, but not limited to, the power supply circuits to the FSCP and circuits interfacing with the fire alarm receiving station (such as communication circuits or antenna systems).

**A1.2.4.1.3.2.** Alternating Current (AC) Power TVSS Devices. These devices will be tested in accordance with Underwriters Laboratories (UL) 1449, *Transient Voltage Surge Suppressors* (Second Edition), and UL 1283, *Electromagnetic Interference Filters* (latest edition), by a nationally recognized testing laboratory. The TVSS devices must provide normal sine wave tracking, with Category A1 ring wave suppression (2000 volts, 67 amperes, 180 degrees) of less than 50 volts for nominal 120-volts alternating current (VAC) legs. The TVSS will provide independent, distinct, and dedicated circuitry for each possible protection mode (i.e., line-to-line, line-to-neutral, line-to-ground, neutral-to-ground). TVSS device circuitry must be fully encapsulated for circuitry protection and to provide longer life expectancy.

**A1.2.4.1.3.3.** Data, Signal, and Control Wire TVSS Devices. TVSS device circuitry must be fully encapsulated for circuitry protection and to provide longer life expectancy. The TVSS device must be designed by the same manufacturer as the AC power TVSS devices to ensure overall compatibility and system reliability. The TVSS will be provided in accordance with the manufacturer's recommendation, based on evaluation of individual system parameters, including:

- Conductor size and length
- Number of conductors
- Shield type
- Peak current and voltage
- Signal type
- Signal baud rate
- Frequency bandwidth
- Maximum attenuation
- Maximum standing-wave ratio
- Maximum reflection coefficient

**A1.2.4.1.4.** The FSCP must be fully compatible with the base fire alarm receiving system without field modifications to any system hardware or software.

**A1.2.4.1.4.1.** The FSCP must transmit a separate and distinctive fire signal to the fire department upon activation of any portion of the foam-water system. Separate fire alarm transmitters/receivers will be permitted when they are fully compatible with the FSCP and the base fire alarm receiving system without field modifications to the FSCP.

**A1.2.4.1.4.2.** The specific number of alarm signals (e.g., fire, supervisory, tamper) to be transmitted must be defined in the system matrix (Figure A1.3).

| | SYSTEM INPUTS | ANNUNCIATION AT LOCAL PANELS | | | | FIRE SUPPRESSION SYSTEM FUNCTIONS | | | | | TRANSMIT SIGNALS TO FIRE DEPARTMENT | | | | | | AUXILIARY FUNCTIONS | | EVACUATION SIGNALS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FIRE ALARMS | Audio-Visual Fire Alarm Indication by Zone | Audio-Visual Trouble Indication by Zone/Middle | Audio-Visual Common Trouble Indication | Audio-Visual Alarm Indication by Device | Transmit Pump Start Signal to Pumphouse | Open Pre-Action Sprinkler Valves | Open Low Level Spill Fire Suppression System | Divert Drain Flow from Separators to | Activate Nitrogen Pressurization | Common Trouble Signal Per Building | Common Supervisory Signal Per Building | Common Fire Alarm Per General Area | Sprinkler Water Flow Per General Area | UV/IR Flame Detectors Per General Area | Foam Discharge Per General Area | Shut Down All Supply & Recirculating Fans | Release Magnetically Held Smoke Doors | Facility Fire Evacuation Audio-Visual Signal | Foam System Signal Blue Strobe/Beacon |
| | | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S |
| 1 | Manual Fire Alarm Stations | | | | | | | | | | | | | | | | | | | |
| 2 | Spot-Type Smoke Detectors | | | | | | | | | | | | | | | | | | | |
| 3 | Fixed Temp & Rate-of-Rise Type Heat Detectors | | | | | | | | | | | | | | | | | | | |
| 4 | In-Duct Smoke Detectors | | | | | | | | | | | | | | | | | | | |
| 5 | Rate-Compensated Type Heat Detectors on Hangar Ceiling | | | | | | | | | | | | | | | | | | | |
| 6 | Water Flow Switches - Wet or Dry-Pipe Sprinkler Systems | | | | | | | | | | | | | | | | | | | |
| 7 | Water Flow Switches - Pre-Action Foam-Water Sprinkler Systems | | | | | | | | | | | | | | | | | | | |
| 8 | Water Switches - Low Level System | | | | | | | | | | | | | | | | | | | |
| 9 | Manual Foam Discharge Station for Low Level | | | | | | | | | | | | | | | | | | | |
| 10 | Low Level Optical Fire Detector | | | | | | | | | X | | | X | | | | | | | X |
| | SUPERVISORY SIGNALS | | | | | | | | | | | | | | | | | | | |
| 11 | Valve Supervisory Switch - Wet or Dry-Pipe Sprinklers | | | | | | | | | | | | | | | | | | | |
| 12 | Valve Supervisory Switches -Foam-Water Sprinklers | | | | | | | | | | | | | | | | | | | |
| 13 | Valve Supervisory Switches - Underwing Foam-Water Nozzles | | | | | | | | | | | | | | | | | | | |
| 14 | Valve Supervisory Switches - Water Supply Entrance | | | | | | | | | | | | | | | | | | | |
| 15 | Hi-Lo Pressure Switches - Dry-Pipe Sprinklers | | | | | | | | | | | | | | | | | | | |
| 16 | Temperature Monitoring System | | | | | | | | | | | | | | | | | | | |
| 17 | UV/IR Flame Detector Trouble | | | | | | | | | | | | | | | | | | | |
| 18 | Control Component Common Trouble Condition | | | | | | | | | | | | | | | | | | | |
| 19 | Low Level System Auto Disable Switch | | | | | | | | | | | | | | | | | | | |
| 20 | Low Nitrogen Presure | | X | | | | | | | | | X | | | | | | | | |
| | TROUBLE CONDITIONS | | | | | | | | | | | | | | | | | | | |
| 21 | Low Battery Voltage | | | X | | | | | | | X | | | | | | | | | |
| 22 | Circuit Fault | | X | X | | | | | | | X | | | | | | | | | |
| 23 | Supervised Component Failure | | | X | | | | | | | X | | | | | | | | | |
| 24 | AC Power Failure | | | X | | | | | | | X | | | | | | | | | |

NOTES:

1. Fire alarm signals and supervisory alarm signals shall be clearly differentiated at the fire alarm control panel(s).
2 General area means the specific bay, dock, mezzanine, office area, or mechanical area. System zoning shall be sufficient to direct responding firefighters directly to the fire area.
3, This sample matrix shows the basic requirements and is expected to be tailored to each individual project.

**Figure A1.3. Sample PAS FSCP Controls Matrix**

**A1.2.4.2.** Manual Foam Discharge Stations for Low-Level Fuel-Spill Fire Suppression Systems.

**A1.2.4.2.1.** Provide manual foam discharge stations inside the PAS at the exit, on the wall opposite the exit, and the rear to actuate the low-level fuel-spill fire suppression systems.

**A1.2.4.2.2.** Manual foam discharge stations must be yellow, distinctively different from the manual fire alarm stations, and have distinctive signage at each device stating "Start FOAM System" in red lettering not less than 76 millimeters (3 inches) high on a yellow/lime-yellow background. Sign materials, including covering and lettering, must be weather- and chemical-resistant (i.e., petroleum products) and of suitable strength for mounting the manual foam discharge station and tamper cover.

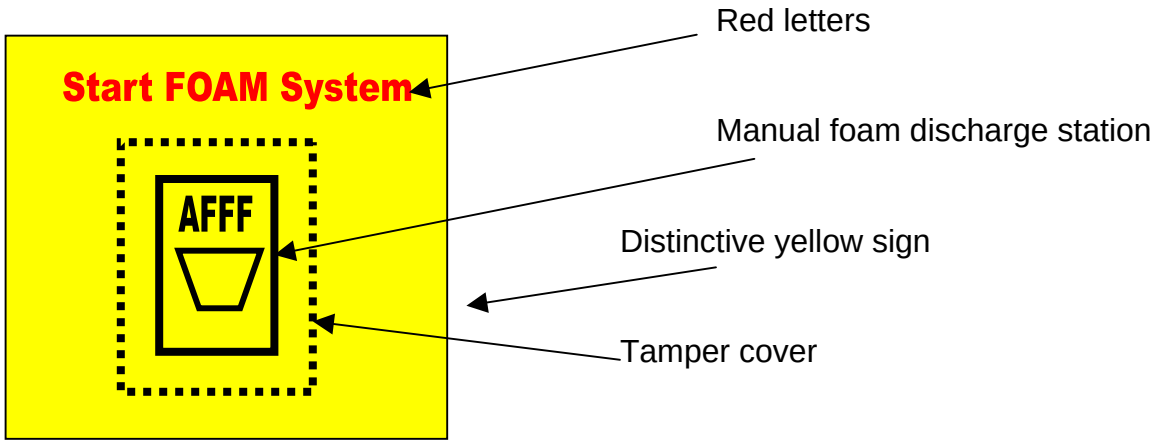


**Figure A1.4. Manual Foam Discharge Station, Tamper Cover, and Signage**

**A1.2.4.2.3.** Manual foam discharge stations must be housed within a clear plastic tamper cover that must be lifted before actuating the station. Colored portions of the tamper covers must be yellow and lettering on the cover must be "AFFF" or "FOAM"; the words "fire" or "fire alarm" must not appear on the cover.

**A1.2.4.2.4.** Actuation of any manual foam discharge station will cause the FSCP to:

- Activate foam discharge through either low-level low expansion nozzles or low-level high expansion generators.
- Activate the facility fire evacuation alarm and the foam system annunciation signal.
- Transmit a fire alarm signal to the fire department. The number and type of signals transmitted to the fire department will be locally determined based on the current fire alarm receiving equipment.

**A1.2.4.3.** Foam System Signals. Provide blue visual alarm signals (strobe or rotating beacons) within the aircraft servicing area to indicate foam system activation. The audio signal must be distinctly different from door movement audio signals or fire

evacuation audio signals. When the base has adopted a standard audio-visual signal for foam system activation, the signals in this facility will comply fully with the base standard.

**A1.3. Fire Protection System Water Supply.** Potable or non-potable distribution mains are not required to support these systems. Water to recharge the system pressure tanks may be supplied from tanker trucks or from a distribution system.

**A1.4. Design and Construction Management.**

**A1.4.1.** A-E Qualifications.

**A1.4.1.1.** It is mandatory that the design organization (whether the design is accomplished by the design agent in-house or through an outside A-E firm) use a qualified FPE, experienced in the design of aircraft hangars, for the design of fire protection systems in all Air Force projects covered by this ETL.

**A1.4.1.2.** "Qualified FPE" does not have a universal definition and is defined differently among various government agencies. For this ETL, one of the following credentials is required to meet the criteria for "qualified FPE":

- Bachelor of Science or Master of Science degree in fire protection engineering from an accredited university, plus at least 5 years' work experience in fire protection engineering.
- Professional Engineer (PE) registration by examination, National Council of Examiners for Engineering and Surveying (NCEES) fire protection engineering written examination.
- Qualification as a General Schedule/General Merit (GS/GM) 804-series fire protection engineer.
- PE registration in a related discipline with at least 5 years' work experience in fire protection engineering.

**A1.4.2.** System Testing and Acceptance.

**A1.4.2.1.** Preliminary Testing.

**A1.4.2.1.1.** Testing each newly installed fire protection system is critical. The entire fire protection system must be tested in accordance with the specification to ensure that all equipment, components, and subsystems function as intended. In addition to establishing written confirmation of all test results, all preliminary tests will be videotaped to record the methods and equipment employed to conduct the tests.

**A1.4.2.1.2.** A copy of the videotape must be submitted with a copy of the proposed test plan to the USACE Center of Expertise or NAVFACENGCOM FPE before the request for a final acceptance test is made. All preliminary tests must be completed before scheduling the final acceptance test.

**A1.4.2.2.** Final Acceptance Test. The final test will be a repeat of all preliminary tests, except that flushing and hydrostatic tests will not be repeated. The USACE Center of Expertise or NAVFACENGCOM FPE must witness the tests. All system failures or other deficiencies identified during the testing must be corrected and retested in the presence of the Center of Expertise or NAVFACENGCOM FPE.

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