High Expansion Foam Systems

High Expansion Foam Concentrate and water are mixed in the correct proportion by various methods to form a foam solution. This solution flows to the High Expansion Foam Generator (HEFG) with a water powered motor. It is then discharged through a nozzle onto a fine mesh stainless steel screen. A rotating fan (powered by the water motor) in the generator forces large volumes of air through the stainless steel screen as the foam solution is sprayed onto it. The air mixes with the foam solution to form a large discharging mass of stable bubbles at a rate of up to 940 gallons of expanded foam for each gallon of foam solution. This clean highly expanded foam mass quickly fills large areas flowing around obstacles and flooding every void smothering the fire quickly and effectively.

The output of a Chemguard High Expansion Foam Generator (HEFG) in a fixed installation depends on which generator is selected. These generators are available in a wide output range (in cubic feet per minute) at various foam solution inlet pressures. When multiple units are used an almost limitless output can be achieved. The HEFS is suitable for use for fire extinction of solid fuel or flammable liquid fires in areas where the expanded foam can be contained.

Examples:

- Ship holds
- Aircraft hangars
- Hazardous material/waste storage areas
- Flammable liquid packaging areas
- Flammable liquid drum storage
- Warehouse areas such as: Rolled paper, tire storage, in rack storage of combustible materials and boat storage

High Expansion Foam Systems have been installed as added protection for Liquid Natural Gas (LNG) facilities where it is used as a fire suppressant and for controlling vapors released from an accidental LNG spill. Blanketing spills with High Expansion Foam is an effective method for reducing and controlling fire intensity and decreasing LNG vapor generation.

METHOD OF EXTINGUISHMENT

When the High Expansion Foam is discharged into a fire compartment, three extinguishing mechanisms simultaneously occur:

1. The large mass of the discharging foam fills all voids and seals the area involved in the fire and prevents fresh air from reaching the base of the flames. The foam mass maintains an oxygen deficient area until the fire is extinguished.
2. The steam generated is a result of the radiant heat from the fire evaporating the water in the foam blanket. This conversion to steam absorbs large quantities of heat and the resulting steam-air mixture is well below the oxygen level that is required to support continued combustion.
3. The cooling effect of the Hi-Ex foam occurs as the bubbles break and release water onto any hot surfaces. The surface tension of the draining water is lowered and the cooling and wetting effect of the draining water penetrates any Class “A” type materials more rapidly than water. This cools the burning material to below its ignition temperature.

INSTALLATION

The High Expansion Foam System (HEFS) must be designed and installed in strict accordance with NFPA 11 (2002 or later) Standard for Low-, Medium-, and High Expansion Foam and any guidelines established by the "Authority Having Jurisdiction" or Insurance Provider.

Chemguard recommends a contractor having previous experience in installing fixed fire protection foam systems install the HEFS. Upon installation, the HEFS components should be located and arranged so that any recharging, inspection, testing or general maintenance will cause a minimum

disruption to the fire protection system. The HEFG may be installed in either a vertical or a horizontal position.

When mounting a generator in a fixed location, care should be taken so as not to distort the cylinder section of the generator housing as this could interfere with the rotation of the fan/motor assembly. The generator should be supported from the bottom not the top and both the front and the rear. It is imperative that the generator be firmly braced to ensure there is no flex or movement when the system is in operation.

PIPING MATERIALS

Stainless steel 304, 316, brass, galvanized and black steel pipe are suitable for use with foam solutions. The black steel pipe is only recommended for use with foam concentrates when the pipe is kept flooded at all times. Stainless steel pipe is suitable for use with foam concentrates at all times. Galvanized pipe cannot be used with foam concentrate.

It is recommended that where threaded pipe joints are in contact with the foam concentrate or the foam solution, a quality Teflon™ based pipe joining compound and a quality Teflon™ tape in accordance with MIL- T-27730 are both used to ensure leak tight screw fittings.

DESIGN INFORMATION

For Aircraft Hangars please see the red tab "AIRCRAFT HANGARS" in this manual.

TOTAL FLOODING SYSTEM is a fixed foam fire protection system consisting of the High Expansion Foam Generators, proportioning system, foam concentrate, water supply and necessary interconnecting piping. This type system is designed to discharge the expanded foam into an enclosed space or around the hazard. The total flood system is suitable for use where there is a permanent enclosure around the hazard that is capable of holding the required amount of foam for the designed duration.

For adequate protection, there should be sufficient foam concentrate to allow the system a discharge rate sufficient to cover the hazard to an effective depth before any unacceptable damage occurs.

The minimum total depth of foam is to be not less than 1.1 times the height of the highest hazard being protected but in no case can it be less than 2 ft. above that hazard. Submergence time varies with the type of building construction and if the building has a sprinkler system.

Figure 25: provides maximum submergence times in minutes for high expansion foam measured from the start of foam discharge. The chart does not include submergence times when used on water miscible/polar solvent type fuels or flammable liquids having a boiling point less than 100ºF (38ºC). These products may require higher application rates. Please check with the engineering department at Chemguard for application guidelines. When used in tire storage areas, the submergence time shown reflects the area also having sprinkler protection. When certain combustible products are stored 15 feet or higher, fire spread may still be rapid and the discharge times in the submergence chart may not be suitable. A faster submergence time may be more appropriate.

The foam discharge rate is to be sufficient to satisfy the foam depth requirements and submergence times allowing compensation for normal foam shrinkage, foam leakage and breakdown effects of any sprinkler discharge.

The factor for compensation for normal foam shrinkage is 1.15.

The compensation factor for loss of foam due to leakage around doors, windows and through unclosable openings is determined by the design engineer after proper evaluation of the structure. This factor cannot be less than 1.0. Depending on foam expansion ratio, sprinkler operation and foam depth, this factor may be as high as 1.2 for a building with all openings normally closed.

The factor (Rs) for compensation of breakdown by sprinkler discharge is determined by the following formula or by test:

R_S= S X Q where

S = Foam breakdown in cfm per gpm of sprinkler discharge. S is to be 10 cfm/gpm (0.748 cu. M/minutes/L/minutes)

Q= Estimated total discharge from maximum number of sprinklers expected to operate gpm (L/minutes)

The following is the formula for calculating the minimum rate of foam discharge or total generator capacity allowing for compensation of normal foam shrinkage, foam leakage and breakdown effects of sprinkler discharge:

Formula for Calculating

R	$(V/T + R_S) \times C_N \times C_L$ where:
R	Rate of discharge in m^3/min (ft^3 / min)
V	Submergence volume in m^3 (ft^3)
T	Submergence time in minutes
R_S	Rate of foam breakdown by sprinklers in m^3/ min (ft^3/min)
C_N	Compensation for normal foam shrinkage
C_L	Compensation for leakage

All openings such as doorways, windows, etc. below the design filling depth shall close automatically before or during foam discharge when the system is activated.

DISCHARGE DURATION: There shall be sufficient high expansion foam concentrate and water to allow continuous operation of the system at the design density for 25 minutes or to generate 4 times the submergence volume, whichever is less, but in no case less than enough for a 15 minute discharge.

Following is a typical High Expansion Foam System for a building without a sprinkler system:

Building: Light Steel, No Sprinklers

Size: 100 ft. x 30 ft. x 10 ft.

Products Stored: Low density combustibles 7 ft. in height

Cubic area to be protected: 100 x 30 x 9, 2 ft. above height of combustibles=27,000 cu. ft.

Fill Time: Per NFPA 11, 3 minutes

Formula for system without sprinklers

R = (V/T) x Cn x Cl

V = 27,000 cubic feet

T = 3 minutes

Cn = 1.15

Cl = 1.1 (slight leakage)

R = (9,000) x 1.15 x 1.1 = 11,385 cfm

11,385 cfm is required for the above building.

EQUIPMENT LIST

1 x High Expansion Foam Generator 12,000 CFM / 59 psi /170 gpm

1 x 3" Between flange style, Ratio controller, Flow range 70 – 750 gpm

1 x 50 Gallon Vertical Bladder Tank
(170 gpm x 0.02 - 3.4 gpm of 2% High-X Foam x 15 minutes = 51 gallons of foam concentrate)

55 x Gallons High-X Foam Concentrate
(51 gallons system fill, 4 gallons system test)

Plus miscellaneous swing checks and ball valves

LOCAL APPLICATION SYSTEM

This type of system consists of a fixed foam-generating device complete with the necessary piping and foam concentrate proportioning equipment. The system is designed to protect a specific piece of equipment or discharge directly onto a potential hazard area. Local application systems can be used to protect hazards located indoors, outdoors or in partly sheltered areas. When used outdoors or in partly sheltered areas, provisions should be made to compensate for the effects of wind or other climatic conditions.

FIG. 25

MAXIMUM SUBMERGENCE TIME (MINUTES) FOR HIGH EXPANSION FOAM MEASURED FROM START OF ACTUAL FOAM DISCHARGE

Hazard	Light or Unprotected Steel Construction		Heavy or Protected or Fire-Resistive Construction	
	Sprinklered	Not Sprinklered	Sprinklered	Not Sprinklered
Flammable liquids [flash points below 38ºC(100ºF)] having a vapor pressure not exceeding 276 kPa (40 psia)	3	2	5	3
Combustible liquids [flash points of 38ºC (100ºF) and above][a]	4	3	5	3
Low-density combustibles (i.e., foam rubber, foam plastics, rolled tissue, or crepe paper)	4	3[b]	6	4[b]
High-density combustibles (i.e., rolled paper kraft or coated banded)	7	5[b]	8	6[b]
High-density combustibles (i.e., rolled paper kraft or coated unbanded	5	4[b]	6	5[b]
Rubber tires	7	5[b]	8	6[b]
Combustibles in cartons, bags, fiber drums	7	5[b]	8	6[b]

[a]Polar solvents are not included in this table. Flammable liquids having boiling points less than 38ºC (100ºF) might require higher application rates. See NFPA 30.

[b]These submergence times might not be directly applicable to storage piled above 4.6m (15ft) or where fire spread through combustible contents is very rapid.