MATERIAL AND EQUIPMENT STANDARD

FOR

FLC-FOAM PROPORTIONERS-GENERATORS

AND TWIN AGENTS

ORIGINAL EDITION

MAR. 1996

This standard specification is reviewed and updated by the relevant technical committee on Feb. 2001. The approved modifications are included in the present issue of IPS.

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APPENDICES

0. INTRODUCTION

Depending on concentration of foam liquid, foam generators and proportioners are usually designed to mix certain concentrated liquid foam with water and then mixed with air to produce the finished foam.

There are four methods of applying foam into fire:

a) Non-aspirated 0-2 expansion ratio

b) Low expansion 2-20 " "

c) Medium expansion 20-200 " "

d) High expansion 201 and greater expansion ratio

Finished foam is a mixture of foam liquid concentrate with water and air or foam is an aggregation of air-filled bubbles of lower specific gravity than flammable liquid or water.

Low Expansion Foam extinguishes fires by resisting flame and heat attack in the process of falling from an overhead application and where it is formed initially, to a burning flammable or combustible liquid surface, where it flows freely, progressively and removing heat, forming an air-excluding continuous blanket or film over the fuel, thus sealing volatile combustible vapor from access to the air . The foam produced by these systems possess qualities of lower expansion, higher fluidity, and more rapid foam solution drainage than foams generated in other foam systems.

Medium and high expansion foam may be used on solid fuel and liquid fuel fires but in depth coverage. High expansion foam is an agent for control and extinguishment of Class A and Class B fires and particularly suited as flooding agent in confined spaces.

1. SCOPE

This Standard specifies the minimum requirements for performance of foam liquid concentrate, proper testing and generating equipment including material specifications for purchasing of foam liquid concentrate and equipment used, methods of application of low, medium and high expansion foam systems. Application and material specification for twin agent "foam/dry chemical extinguisher" is also covered in this Standard.

The Standard is prepared in three parts as follows:

PART I	"Operational Methods-Foam Liquid and Proportioners"
PART II	"Materials Specification"
PART III	"Twin Agent Foam/Dry Powder Extinguisher"

Note:

This standard specification is reviewed and updated by the relevant technical committee on Feb. 2001. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No 139 on Feb. 2001. These modifications are included in the present issue of IPS.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-SF-140	"Foam Generation and Proportioning Systems"
IPS-E-SF-120	“Engineering Standard for Offshore Installation Fire Fighting and Fire Protection”

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO/DIS 7203 (1994)	"Fire Extinguishing Media Foam Concentrate"
Part 1	"Specification for Low Expansion Foam Concentrate for Application to Water-Immiscible Liquids"
Part 2	"Specification for Medium and High Expansion Foam Concentrate"
Part 3	"Specification for Low Expansion Foam Concentrate for Top Application to Water Miscible Liquids"

ASME (AMERICAN SOCIETY MECHANICAL ENG.)

Section VIII	"Boiler and Pressure Vessels Code"

NFPA (NATIONAL FIRE PROTECTION ASSOCIATION)

NFPA 11	“Low Expansions Foam/Combined Agent Systems”

UL (UNDERWRITER LABORATORIES)

UL	162

	UL	199
ANSI	**(AMERICAN NATIONAL STANDARDS INSTITUTION)**	
	ANSI	1474
BS	**(BRITISH STANDARDS)**	
	BS	336

3. DEFINITIONS AND TERMINOLOGY

3.1 Foam

A fire fighting agent made by mechanically mixing air with a solution consisting of fresh or salt water to which a foam liquid concentrate has been added.

3.2 Foam Concentrate

The liquid foaming agent as received from the manufacturer and used for mixing with the recommended amount of water and air to produce foam. This term as used in this Standard includes concentrates of the following types and film forming fluoroprotein (FFFP).:

Protein Foam, Fluoroprotein Foam, Aqueous Film Forming Foam (AFFF, and other Synthetic Foams).

3.3 Shear Stress N/m2

Regular 3% and 6% -12 -13.

3.4 Surface Tension

See Clause 6.1.2.7.

3.5 Shelf Life

See Clause 6.1.2.11(e).

3.6 Concentration

The percent of foam concentrate contained in a foam solution. The type of foam concentrate being used determines the percentage of concentration required. A 3 percent foam concentrate is mixed in a ratio of 97 parts water to 3 parts foam concentrate to make foam solution. A 6 percent concentrate is mixed with 94 parts water to 6 parts foam concentrate.

3.7 Foam Solution

A mixture of a proportioned of premixed foam liquid concentrate dissolved in either fresh or salt water.

3.8 Aqueous Film Forming Foam (AFFF)

The characteristic of a foam or foam solution forming an aqueous film on some hydrocarbon liquids.

3.9 Protein foam (P)

A liquid concentrate that has a hydrolyzed protein base plus stabilizing additive.

3.10 Fluoroprotein (FP)

A liquid concentrate that is similar to protein, but with one or more fluorinated surfactant additive.

3.11 Film Forming Fluoroprotein (FFFP)

A liquid concentrate that has both a hydrolyzed protein in fluorinated surfactant base plus stabilizing additive.

3.12 Synthetic (S)

A liquid concentrate that has a base other than fluorinated surfactant or hydrolyzed protein.

3.13 Polar Solvent Type Liquid Concentrate

A protein or synthetic based, low expansion liquid used in production of foam and intended to extinguish hydrocarbon and polar solvent (water miscible) fuel fire.

3.14 Aspirated Foam

Foam produced by the mixing of air and foam solution within the equipment.

3.15 Non-Aspirated Foam

Foam produced by the mixing of air and spray of foam solution, out-side the equipment.

3.16 Drainage Time

The time for defined percentage of the liquid content of a foam to drain out under specified conditions.

3.17 Expansion Ratio

The ratio of the volume of foam to the volume of foam solution from which it was made.

3.18 Induction

Methods that uses the venturi principle to introduce a proportionate quantity of foam concentrate into a water stream. Induction methods are:

a) Pressure Induction

This method employs the water supply to pressurize the foam concentrate storage tank. At the same time, water flowing through an adjacent venture or orifice creates a pressure differential. The difference between the water supply pressure and this lower pressure area forces the foam concentrate to flow through a fixed or metering orifice into the water stream.

b) Vacuum Induction

This method utilizes the negative pressure created by water passing through a venture to draw the liquid concentrate from the storage tank or container through a pick-up tube and mix it with the water stream.

c) Pump-and-Motor Induction

By means of an auxiliary pump,foam compound is injected into the water stream passing through an inductor.

The resulting foam solution is then delivered to a foam maker. The proportioner may be inserted in the line at any point between the water source and foam maker.

3.19 Foam Concentrate Proportioner

A means for controlling the ratio of foam concentrate to the quantity of water.

3.20 Discharge Device

Fixed, semifixed or portable devices, such as foam chamber, fixed foammakers, monitors nozzles, spray nozzles and sprinklers that direct the flow to the fire or flammable liquid surface.

3.21 In-Line Inductor

A venturi eductor, located in the water supply line to the foam maker to create a reduced pressure in piping that leads from a supply of concentrate so that the concentrate is automatically mixed with water in the required proportion. It is precalibrated and it may be adjustable.

3.22 Sub-Surface Injection

Discharge of foam into a storage tank below the liquid surface near the tank bottom.

3.23 Topside Application

A method of foam discharge wherein the foam is applied onto the top of a burning fuel surface.

3.24 Premix Solution

A foam solution made by mixing foam concentrate and water in proper proportion and stored ready for use.

4. UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

PART I

5. OPERATIONAL METHODS

5.1 Foam Liquid Concentrate (FLC)

5.1.1 Induction methods

A liquid concentrate shall be formulated so that it may be introduced into water flowing under pressure in pipe lines, by pressure induction, vacuum induction, or pump and motor (combined with balancing valves) induction methods.

5.1.2 Ranges of application

Foams are arbitrarily subdivided into three ranges of expansion:

Low expansion foam (LX) expansion 2 to 20

Medium expansion (MX) expansion from 21 to 200

High expansion (HX) expansion from 201 to greater expansion ratio.

5.1.3 Application of low expansion foam

Foam system shall include provision to minimize the danger when foam is applied to the liquids above 100°C, energized electrical equipment or reactive materials. Since all foams are aqueous solutions, where liquid fuel temperatures exceed 100°C they may be ineffective and, particularly where the fuel depth is considerable (e.g. tanks) may be dangerous in use. The foam and drainage of the water from the foam can cool the flammable liquid but boiling of this water may cause frothing or slop-over of the burning liquid particularly crude oil. Boil-Over, which may occur even where foam is not applied, is a more severe and hazardous event. Large scale expulsion of the burning contents of a tank is caused by the sudden and rapid boiling of water in the base of the tank or suspended in the fuel. It is caused by the eventual contact of the upper layer of liquid fuel in the tank, heated to above 100°C by the fire, with the water layer.

Particular care should be taken when applying foam to high viscosity liquids, such as burning asphalt or heavy oil, above 100°C.

Because foams are made from aqueous solutions they may be dangerous to use on materials which react violently with water, such as sodium or potassium, and should not be used where they are present.

A similar danger is presented by some other metals, such as zirconium or magnesium, only when they are burning.

Low expansion foam is a conductor and should not be used on energized electrical equipment, in this situations it would be a danger to personnel.

5.1.4 Compatibility with other extinguishing media

The foam produced by the system shall be compatible with any extinguishing media provided for application at or about the same time.

Certain wetting agents and some extinguishing powders may be incompatible with foams, causing a rapid breakdown of the latter. Only media that are substantially compatible with a particular foam should be used in conjunction with it.

Use of water jets or sprays may adversely affect a foam blanket. They should not be used in conjunction with foam unless account is taken of any such effects.

5.1.5 Compatibility of foam concentrates

Foam concentrate (or solution) added or put into a system shall be suitable for use and compatible with any concentrate (or solution) already present, in the system. Foam concentrates or foam solutions, even of the same class, are not necessarily compatible, and it is essential that compatibility be checked before mixing two concentrates or premixed solutions.

5.1.6 Uses

Low expansion foam systems are suitable for extinguishing fires on a generally horizontal flammable liquid surface.

Extinction is achieved by the formation of a blanket of foam over the surface of the burning liquid. This provides a barrier between the fuel and air, reducing the rate of emission of flammable vapors to the combustion zone, and cooling the liquid.

Low expansion foam is not generally suitable for the extinction of running fuel fires, e.g. fuel running from a leaking container or from damaged pipework or pipe joints. However, low expansion foam can control any pool fire beneath the running fire which may then be extinguished by other means.

Low expansion foam is not suitable for use on fires involving gases or liquefiable gases with boiling points below 0°C.

5.1.7 Medium high expansion and alcohol resistant foam liquid

5.1.7.1 Medium expansion foam (expansion ratio 21 to 200) are generally used for protection against fires in:

a) flammable liquid as spills of average depth not more than 25 mm; or

b) flammable liquids in defined areas such as bunds and heat treatment baths; or

c) combustible solids where up to about 3 m foam build-up is necessary to cover the hazard, e.g. engine test cells and generating sets.

5.1.7.2 High expansion foam (expansion ratio 201 to greater expansion).This liquid concentrate is applicable in total flooding systems, local application system, portable and mobile systems. High expansion foam is generally used in total flooding of warehouses, aircraft hangers, furniture stores and other similar premises. High expansion foam can also be used in situations where it would be hazardous to send personnel into in underground enclosures where smoke logging could occur and in consequence exit routes will be difficult to find. In local application smaller enclosures within larger areas such as pits, basements, etc., are places where filling the space is an effective means of dealing with an inaccessible fires. This system can be used both indoors and outdoors provided there is a means of shielding the foam from the effects of wind.

5.1.7.3 Alcohol resistant

Alcohol Resistant (AR) foam concentrates are formulated for use on foam destructive liquids, the foams produced are more resistant than ordinary foams to breakdown by the liquid.

They may be of any of the classes given in definition Item 4 of IPS-E-SF-120 and may be used on fires of hydrocarbon liquids with a fire performance generally corresponding to that of the parent type. Film-Forming foams do not form films on water miscible liquids. Alcohol resistant foam concentrates are generally used at 6% concentration on water miscible fuels.

5.2 Foam Liquid Proportioners and Generators

5.2.1 Low expansion foam liquid proportioners

For low expansion foam liquid, proportioning and mixing with water may be achieved by one or more of the following methods:

5.2.2 Air foam nozzle with built-in eductor

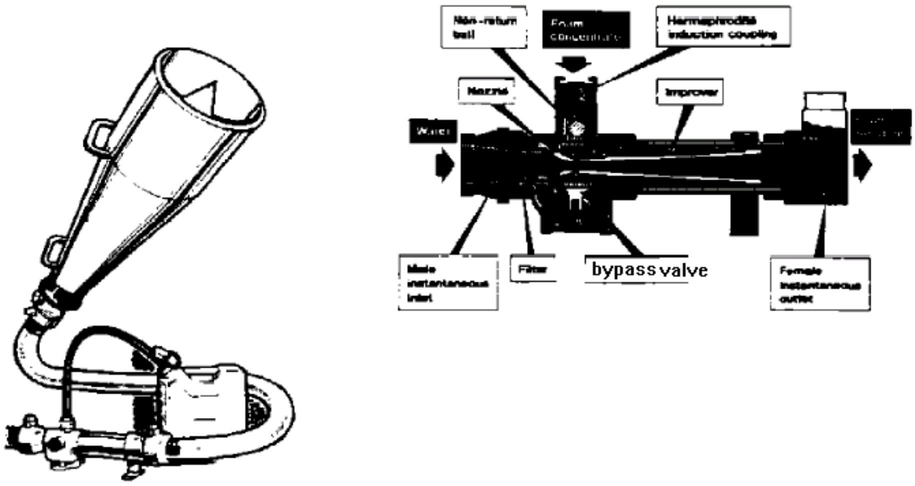
In this type of proportioner the jet in the foam maker is utilized to draft the foam liquid. The length and size of pick-up tube and foam liquid container and the foam maker shall conform to the recommendation of the manufacturers and the bottom of the foam liquid container should not be more than 1.8 meters below the foam nozzle.

5.2.3 In line inductor (Fig. 1)

This unit is used to introduce foam concentrate into the water supply to produce a solution by way of venture system.

This inductor is for installation in a hose line usually some distance from the foam maker. It must be designed for the flow rate of particular foam maker with which it is to be used. The device is very sensitive to down stream pressure and is accordingly designed for use with specified length of hose and pipe between inductor and the foam maker.

The pressure drop of approximately 35% (not more than 40%) and the rate of the induction can be varied from 2 to 6%. A mobile unit consisting of hose, fixed inductor, branch pipe and FLC (Foam Liquid Concentrate) tank is also used. The FLC container can be refilled during fire fighting operations.

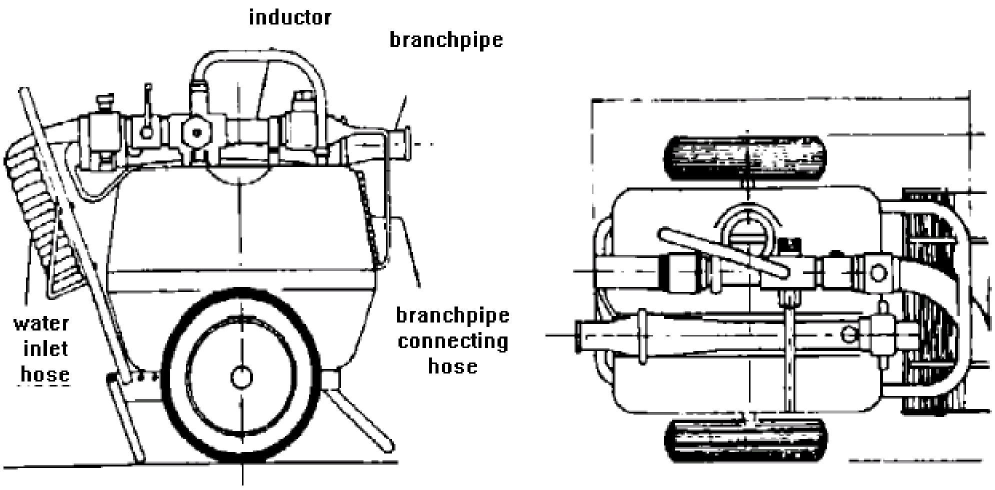


IN-LINE INDUCTOR (PORTABLE UNIT)

Fig. 1

5.2.4 Mobile unit (Fig. 2)

The Mobile unit consists of a fiberglass foam storage tank, in-line inductor, inlet and outlet hose connected to this foam making branch pipe. The unit can be used by one or two persons.



MOBILE UNIT

Fig. 2

5.2.5 Primary-Secondary eduction method

This method of introducing air foam concentrate into the water stream en route to a fixed foam maker is illustrated in Fig. 3.

The unit consists of two eductor designated as the primary eductor and the secondary eductor. The primary eductor is located outside the firewall enclosure and is installed in a bypass line connected to and in parallel with the main water supply line to the foam maker. A portion of the water flows through the primary eductor and draws the concentrate from a container by means of pickup tube.

The main water line discharges through the jet of a secondary eductor located at the foam maker proper, the mixture of water and concentrate from the primary eductor being delivered to the suction side of the secondary eductor.

Limitations

1) The primary eductor may be installed as much as 150 m from the secondary eductor. The size of piping used, both in the water and the solution lines, should be as specified by the manufacturer.

2) The elevation of the bottom of the concentrate container should not be more than 1.8 m below the primary eductor.

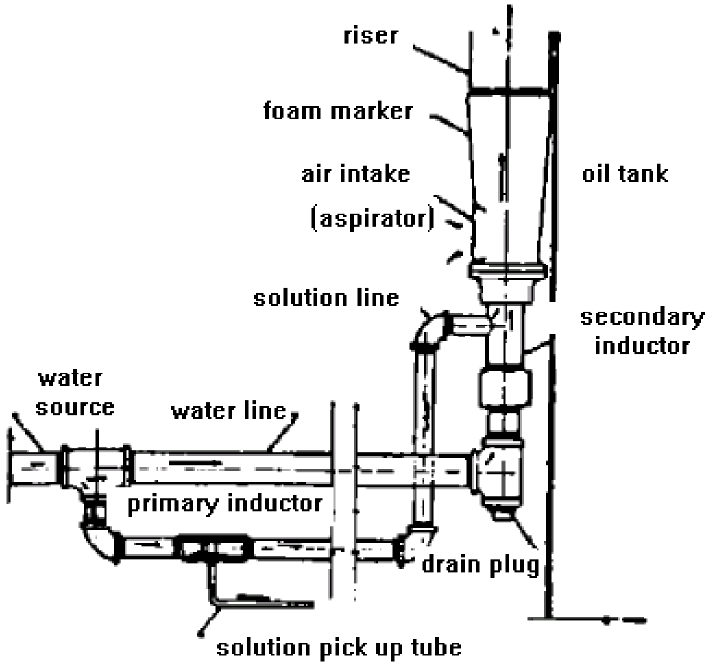


Fig. 3

5.2.6 Mechanical foam generator (Fig. 4)

This method involves foam liquid pick-up, aeration and foam generation in one unit. It is mostly used by portable equipment where "rope" jet is required.

There is a considerable pressure loss across the generator and for this reason, the pressure at the water head on the inlet side should not be less than 10 bar.

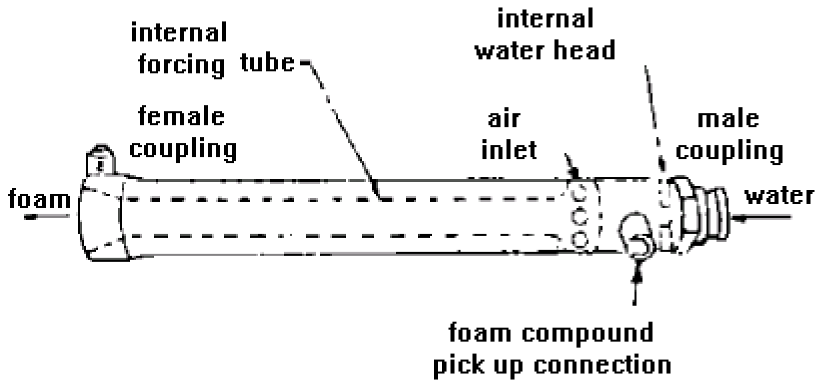
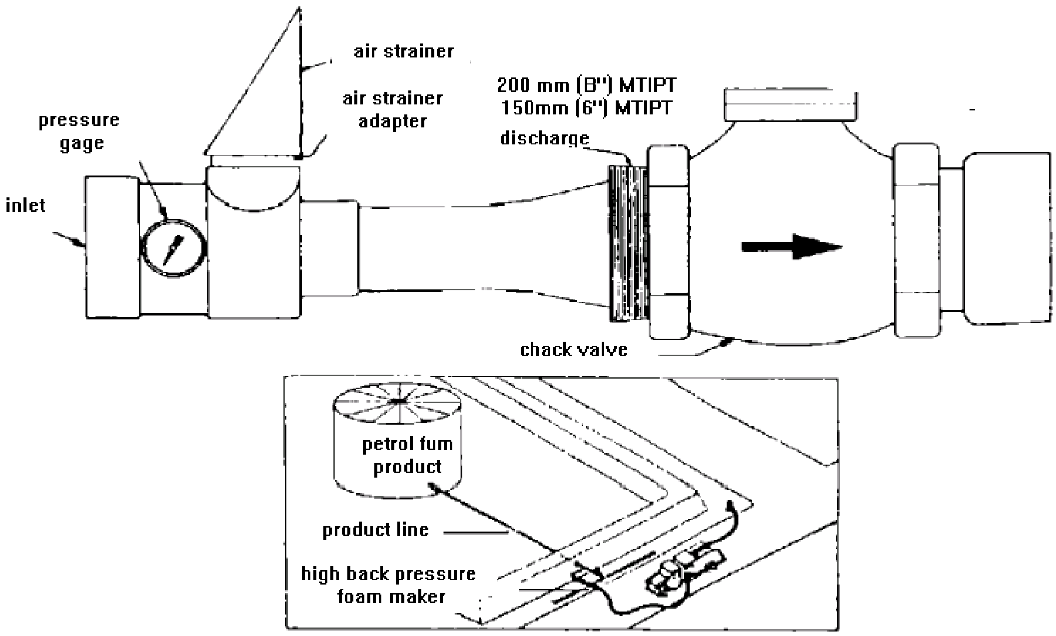


Fig. 4

5.2.7 High back pressure foam generator (Fig. 5)

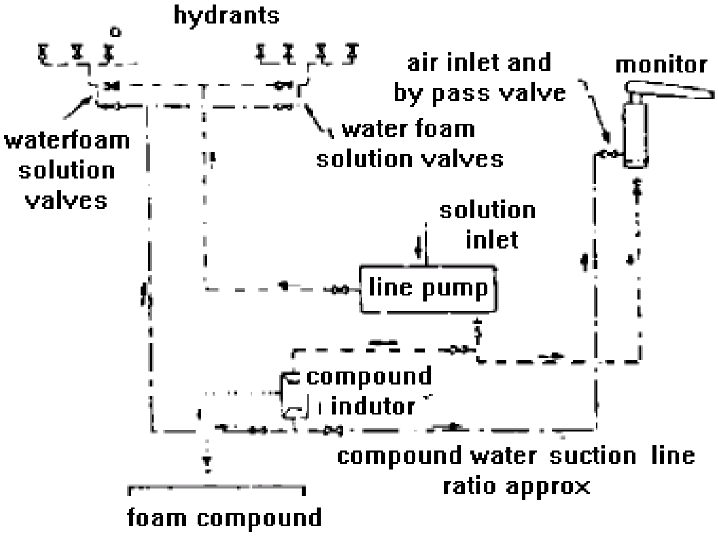
The use of high back pressure foam generators is required for semisubsurface injection of fixed roof oil tank fires. When using a water pressure of 10 bar to the foam generators, the typical system will function in tank with the height of up to 18 meters. Water supply pressure should be determined for each individual installation or tank grouping and will depend on the requirements of the foam generators, injection devices and the tank heights.



FIXED HIGH BACK-PRESSURE FOAM MAKER FOR FIXED SYSTEMS Fig. 5

5.2.8 By-Pass variable inductor (Fig. 6)

This is a preferred method for fire boats or tugs as it gives flexibility of use of foam and water from a single pump. It is also used in conjunction with certain large model foam/water monitors or deck hydrants. A small quantity of water, is by-passed through a venture which induces the foam compound at approximately the same rate. The resultant 50/50 foam compound/water solution is conveyed at low pressure 1.5 bar to the base of the monitor or headers which are fitted with manually operated water/foam valves and special induction orifice. When these valves are in the foam positions, a negative pressure condition exists on the outlet side of the valve which induces the solution into the water stream. Quantity of foam liquid can be adjusted by a lever from 0-360 LPM or more.



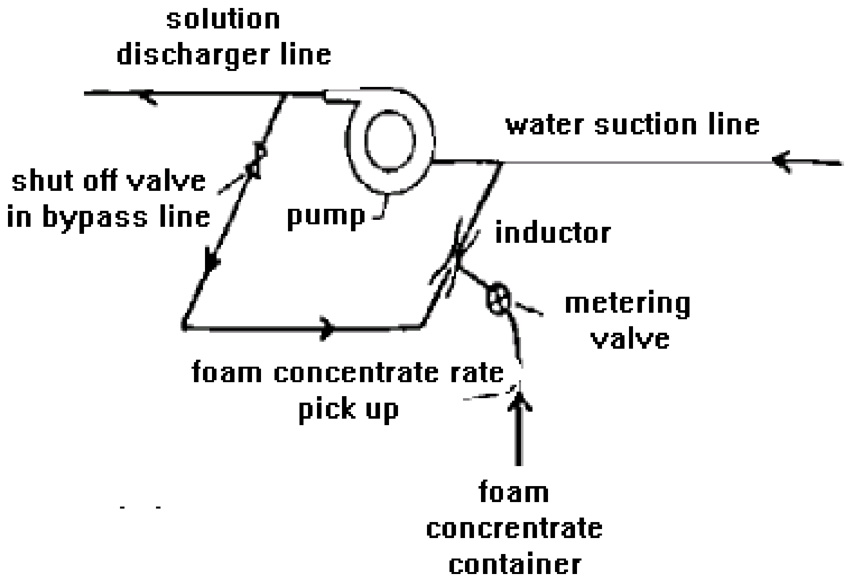
BY-PASS INDUCTION
Fig. 6

5.2.9 Round-The pump proportioner (Fig. 7)

This proportioner may be applied with either fixed or variable inductor. The system may be used with advantage on fire tugs and boats fitted with large foam/water monitors which are not suitable for use with by-pass induction method. It may also be used for fixed equipment where water/foam compound solution is pumped through pipelines. This system also can be installed on fire trucks with water tank or where water from a hydrant is available to fill the water tank.

Foam/water are mixed by the fire truck pump. A portable type with foam concentrate tank or a pick-up tube called (M-JInductor) can be supplied.

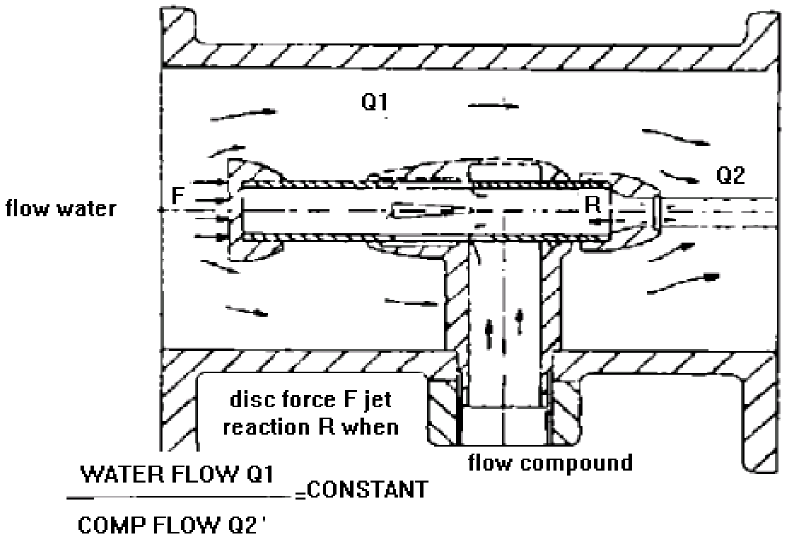
The system by-passes a small quantity of water from the delivery side of the pump. This induces foam liquid concentrate via a fixed or variable inductor and return the foam liquid/water solution to the low pressure side (suction) of the pump. The solution is then discharged from the pump deliveries. A disadvantage with this system is lack of flexibility, in as much that water and foam cannot be used at the same time from single pump.



AROUND -THE -PUMP PROPORTIONING SYSTEM TYPICAL ARRANGEMENT Fig. 7

5.2.10 Automatic foam proportioner (Fig. 8)

There are several methods, adopted, one of which can be employed in mobile fire trucks. The system automatically proportions the correct percentage of foam liquid irrespective of water pressure and volume to the full pump capacity. The injector is attached to the water inlet of the pump. Operation of this method is by balancing hydraulic forces which act on the moving member which in turn controls several parts in the compound supply stream. One force is derived from the kinetic energy of the water stream striking a disk attached to the upstream end of the moving member and the opposing force from the jet reaction of the foam compound issuing from a nozzle attached to the downstream end. The forces are arranged to balance when the flow ratio of both liquids meet the required concentration.



AUTOMATIC FOAM PROPORTIONER

Fig. 8

5.2.11 Pressure proportioning tank (Figs. 9A and 9B)

This method employs water pressure as the source of power. With this device, the water supply pressurizes the foam concentrate storage tank. At the same time, water flowing through an adjacent venture or orifice creates a pressure differential .

The low-pressure area of the venturi is connected to the foam concentrate tank, so that the difference between the water supply pressure and this low-pressure area forces the foam concentrate through a metering orifice and into the venturi. Also, the differential across the venturi varies in proportion to the flow, so one venturi will proportion properly over a wide flow range. The pressure drop through this unit is relatively low.

The system may be designed of twin tanks one tank may be replenished while the second tank is in operation. A special test procedure is available to permit the use of a minimum amount of concentrate when testing the pressure proportioner system.

Limitations

1) Foam concentrate with specific gravities similar to water may create a problem by mixing.

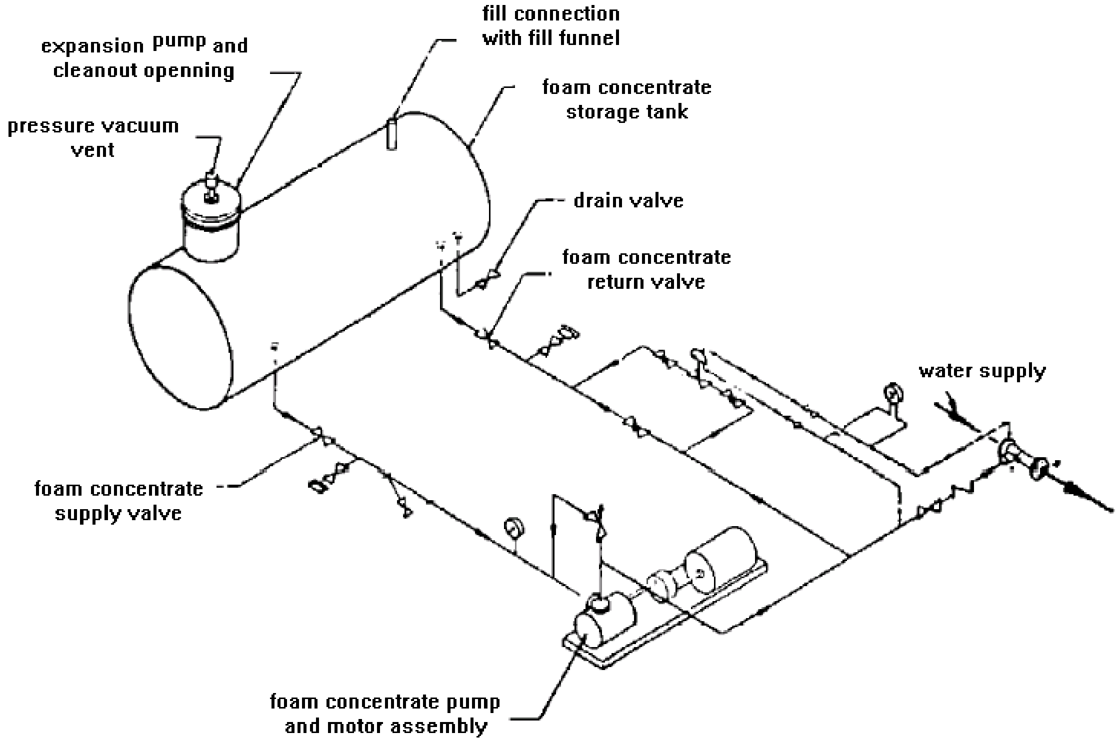
2) The capacity of these proportioners may be varied from approximately 50 to 200 percent of the rated capacity of the device.

3) The pressure drop across the propotioner ranges from (1/3 to 2 bar) depending on the volume of water flowing within the capacity limits given above.

4) When the concentrate is exhausted, the system must be turned off, and the tank drained of water and refilled with foam concentrate.

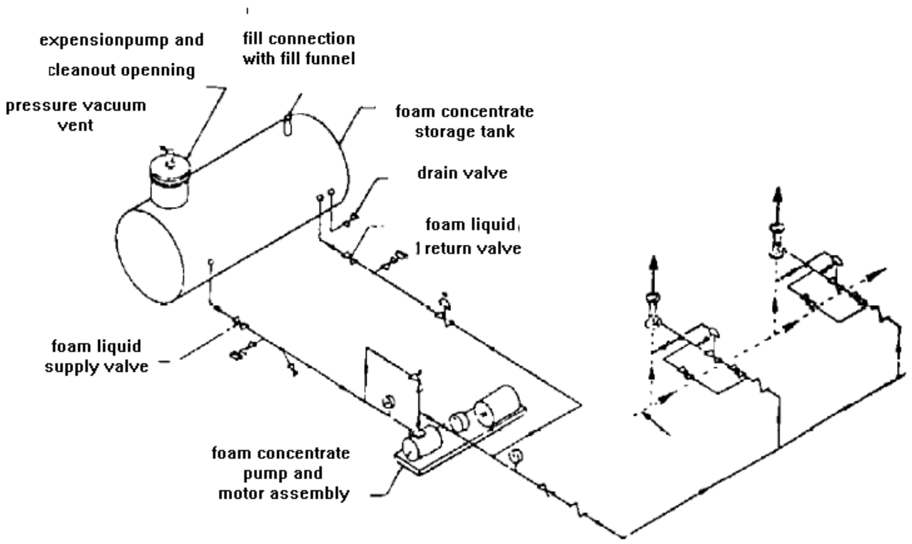
5) Since water enters the tank as the foam concentrate is discharged, the concentrate supply cannot be replenished during operation, as with other methods.

6) This system will proportion at a significantly reduced percentage at low flow rates and should not be used below minimum design flow.



PRESSURE PROPORTIONING TANK

Fig. 9A (HORIZONTAL)



BALANCED PRESSURE PROPORTIONING WITH MULTIPLE INJECTION POINTS (METERED PROPORTIONING) Fig. 9B (VERTICAL)

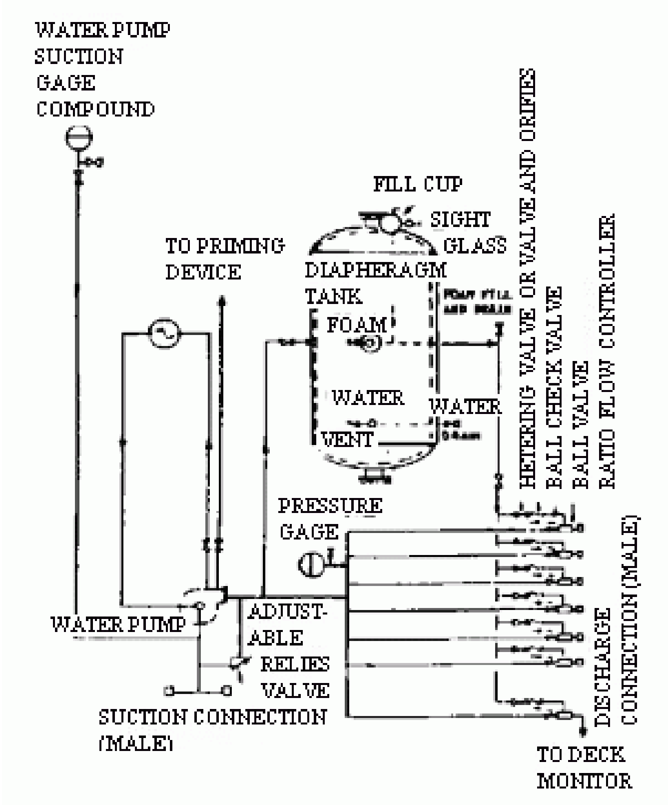
5.2.12 Diaphragm (bladder) pressure proportioning tank (Figs. 10A and 10B)

This method also uses water pressure as a source of power. This device incorporates all the advantages of the pressure proportioning tank with the added advantage of a collapsible diaphragm that physically separates the foam concentrate from the water supply. Diaphragm pressure proportioning tanks operate through a similar range of water flows and according to the same principles as pressure proportioning tanks. The added design feature is a reinforced elastomeric diaphragm (bladder) that can be used with all concentrates listed for use with that particular diaphragm (bladder) material.

The proportioner is a modified venturi device with a foam concentrate feed line from the diaphragm tank connected to the low-pressure area of the venturi. Water under pressure passes through the controller and part of this flow is diverted into the water feed line to the diaphragm tank. This water pressurizes the tank, forcing the diaphragm filled with foam concentrate to slowly collapse. This forces the foam concentrate out through the foam concentrate feed line and into the low-pressure area of the proportioner controller. The concentrate is metered by use of an orifice or metering valve and joins in the proper proportion with the main water supply, sending the correct foam solution to the foam makers downstream.

Limitations

Limitations are the same as those listed under Pressure Proportioning Tank, except the system can be used for all types f concentrates.



PRESSURE PROPORTIONING DIAPHRAGM TANK METHOD

Fig. 10A

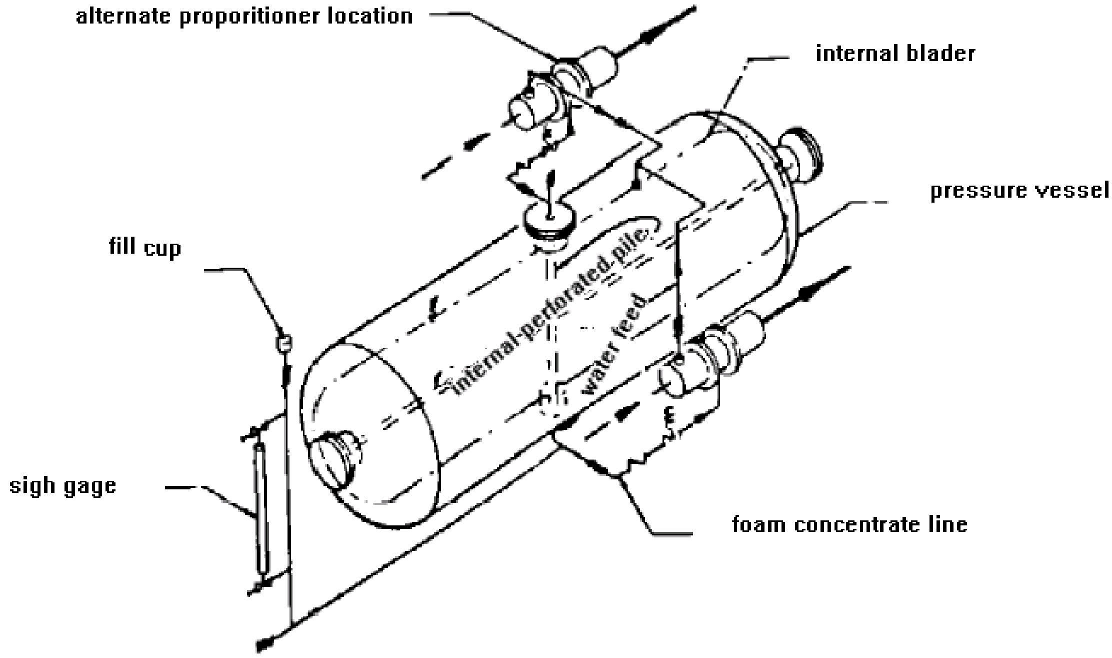


Fig. 10B

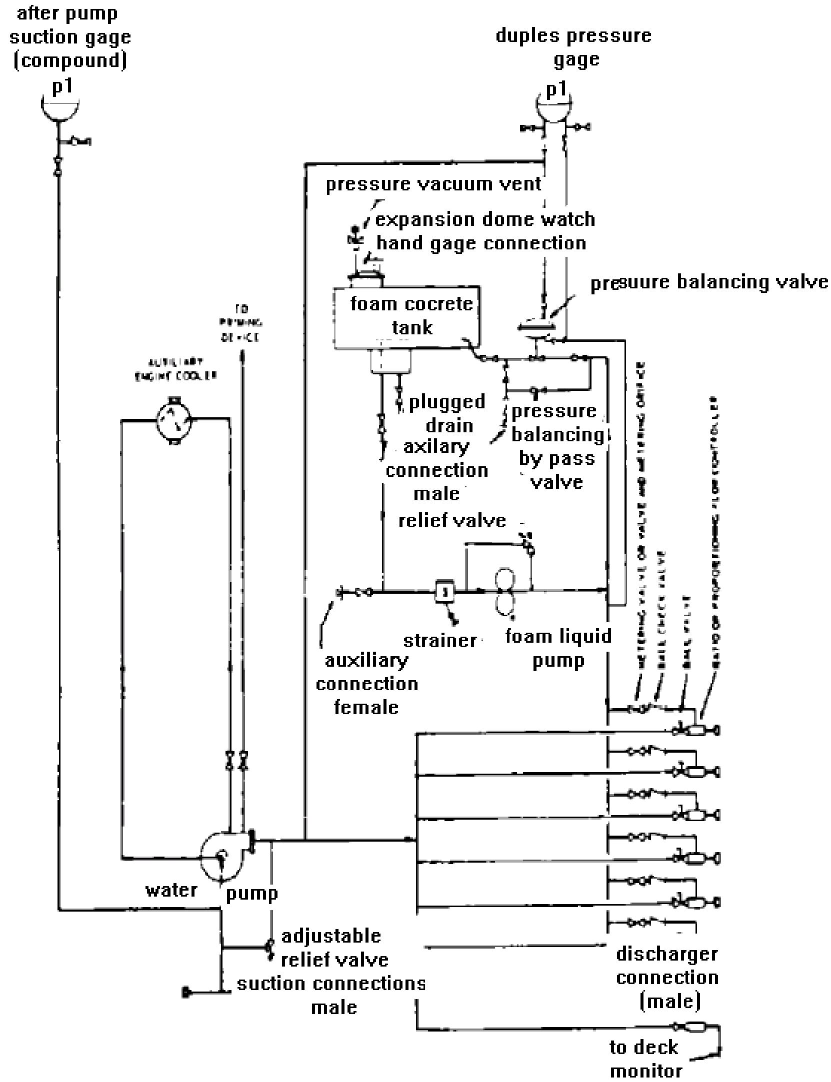
5.2.13 Wheeled diaphragm proportioner

The unit consists of a foam tank, venturi type proportioner with integral 1 to 6% foam concentrate metering orifice with ength of fire hose and foam branch nozzle. The fixed type of this units is provided with a hose reel mounted on the ank. This unit is suitable for refinery area, offshore platforms, truck loading racks and industrial process area.

5.2.14 Typical balanced pressure proportioning system (Fig. 11)

In-line balanced proportioning system utilizing a foam concentrate pump discharging through a pressure regulating balancing alve and a metering orifice into a proportioning controller. A pressure regulating valve placed in the pump return line maintains constant pressure in the foam concentrate supply line at all design flow rates.

This constant pressure must be greater than the maximum water pressure under all conditions. This type of design is suitable when using multiple proportioning controllers located away from the central foam concentrate supply. A common foam concentrate supply line carries concentrate to each proportioning controller.



TYPICAL BALANCED PRESSURE PROPORTIONING SYSTEM
Fig. 11

5.3 Medium and High Expansion Foam Generators

5.3.1 General descriptions

5.3.1.1 Medium and high expansion foams are aggregations of bubbles mechanically generated by the passage of air or other gases through a net, screen, or other porous medium that is wetted by an aqueous solution of surface active foaming agents. Under proper conditions, fire fighting foams of expansions from 20:1 to greater expansion can be generated.
Such foams provide a unique agent for transporting water to inaccessible places; for total flooding of confined spaces; and for volumetric displacement of vapor, heat, and smoke.

Tests have shown that, under certain circumstances, high expansion foam, when used in conjunction with water sprinklers, will provide more positive control and extinguishment than either extinguishment system by itself. High-piled storage of rolled paper stock is an example. Optimum efficiency in any one type of hazard is dependent to some extent on the rate of application and also the foam expansion and stability.

Medium and high expansion foams, which are generally made from the same type of concentrate, differ mainly in their expansion characteristics.

Medium expansion foam may be used on solid fuel and liquid fuel fires where some degree of in-depth coverage is necessary, e.g., for the total flooding of small enclosed or partially enclosed volumes such as engine test cells, transformer rooms, etc. It can provide quick and effective coverage of flammable liquid spill fires or some toxic liquid spills where rapid vapor suppression is essential. It is effective both indoors and outdoors.

High expansion foam may also be used on solid and liquid fuel fires but in-depth coverage it can give greater than for medium expansion foam. It is therefore most suitable for filling volumes in which fires exist at various levels. For example, experiments have shown that high expansion foam can be used effectively against high rack storage fires provided that the foam application is started early and the depth of foam is rapidly increased. It can also be used for the extinction of fires in enclosures where it may be dangerous to send personnel, e.g., in basement and underground passages.

It may be used to control fires involving liquefied natural gases and LPG and to provide vapor dispersion control for LNG and ammonia spills.

High expansion foam is particularly suited for indoor fires in confined spaces. Its use in outdoors may be limited because of the effects of wind and lack of confinement. Medium and high expansion foam have several effects on fires:

a) When generated in sufficient volume, they can prevent free movement of air, necessary for continued combustion.

b) When forced into the heat of a fire, the water in the foam is converted to steam, reducing the oxygen concentration by dilution of the air.

c) The conversion of the water to steam absorbs heat from the burning fuel. Any hot object exposed to the foam will continue the process of breaking the foam, converting the water to steam, and of being cooled.

d) Because of their relatively low surface tension, solution from the foams that is not converted to steam will tend to penetrate Class A materials. However, deep seated fires may require overhaul.

e) When accumulated in depth, medium and high expansion foam can provide an insulating barrier for protection of exposed materials or structures not involved in a fire and can thus prevent fire spread.

f) For liquefied natural gas (LNG) fires, high expansion foam will not normally extinguish a fire but it reduces the fire intensity by blocking radiation feed back to the fuel.

g) Class A fires are controlled when the foam completely covers the fire and burning material. If the foam is sufficiently wet and is maintained long enough, the fire may be extinguished.

h) Class B fires involving high flash point liquids can be extinguished when the surface is cooled below the flash point. Class B fires involving low flash point liquids can be extinguished when a foam blanket of sufficient depth is established over the liquid surface.

5.3.1.2 Mechanisms of extinguishment

Medium and high expansion foam extinguishes fire by reducing the concentration of oxygen at the seat of the fire, by cooling, by halting convection and radiation, by excluding additional air, and by retarding flammable vapor release.

5.3.1.3 Use and limitations

While medium and high expansion foams are finding application for a broad range of fire fighting problems, each type of hazard shall be specifically evaluated to verify the applicability of medium or high expansion foam as a fire control agent. Some important types of hazards that medium and high expansion foam systems may satisfactorily protect include:

a) Ordinary combustibles

b) Flammable and combustible liquids

c) Combinations of a) and b)

d) Liquefied natural gas (high expansion foam only).

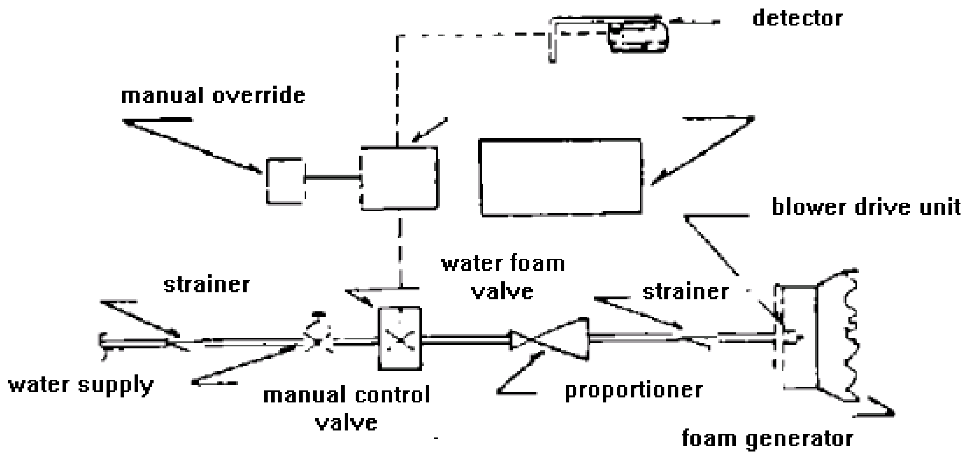
5.3.2 Operating devices

A block diagram of a typical automatic medium or high expansion foam system is shown in Figure 12.

5.3.2.1 Foam generators

At the present time, foam generators for medium and high expansion foam are of two types depending on the means for introducing air, namely, by aspirator or blower. In either case, the properly proportioned foam solution is made to impinge at appropriate velocity on a screen or porous or perforated membrane or series of screens in a moving air stream.

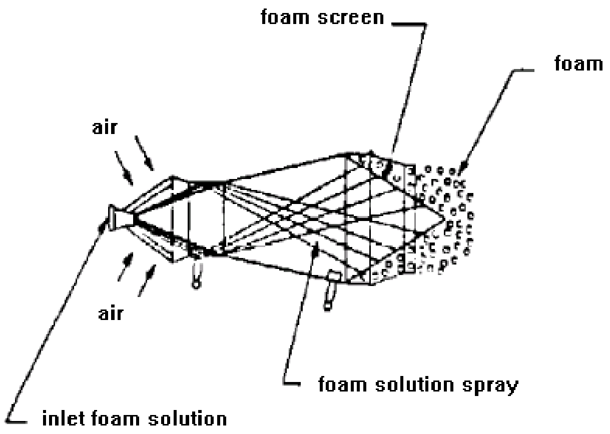
The liquid films formed on the screen are distended by the moving air stream to form a mass of bubbles or medium or high expansion foam. The foam volume varies from about 20 to 1,000 times the liquid volume depending on the design of the generator. The capacity of foam generators is generally determined by the time required to fill an enclosure of known volume by top application within 1 to 5 minutes.



BLOCK DIAGRAM OF AUTOMATIC MEDIUM-OR HIGH-EXPANSION FOAM SYSTEM Fig. 12

5.3.2.2 Foam generators aspirator type (Fig. 13)

These may be fixed or portable. Jet streams of foam solution aspirate sufficient amounts of air that is then entrained on the screens to produce foam. These usually produce foam with expansion ratios not over 250:1.

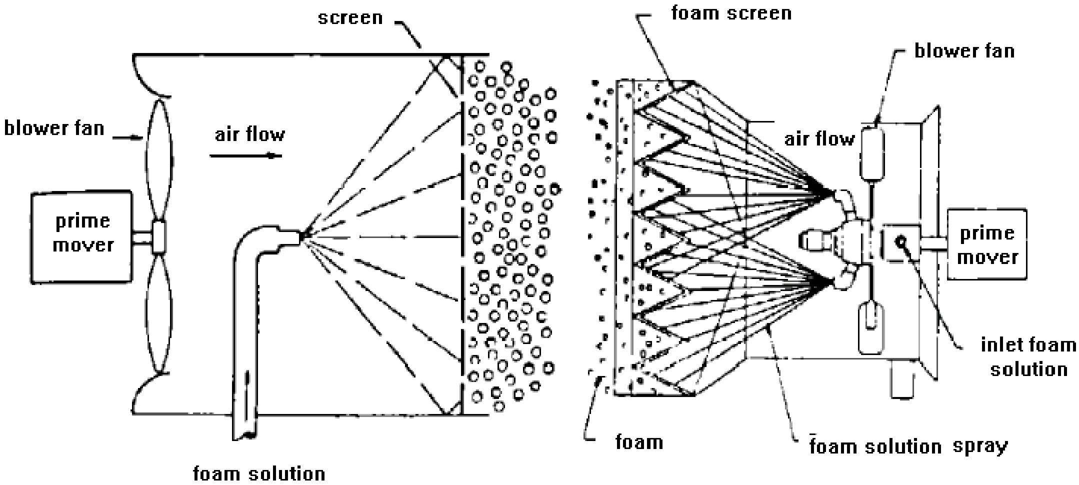


ASPIRATING-TYPE FOAM GENERATOR

Fig. 13

5.3.2.3 Foam generators blower type (Fig. 14)

These may be fixed or portable . The foam solution is discharged as a spray onto screens through which an air stream developed by a fan or blower is passing. The blower may be powered by electric motors, internal combustion engines, air, gas or hydraulic motors or water motors. The water motors are usually powered by foam solution.



BLOWER-TYPE FOAM GENERATORS

Fig. 14

PART II

6. MATERIAL SPECIFICATIONS (SEE ALSO DATA SHEET IN APPENDIX "A")

6.1 Foam Liquid Concentrate

6.1.1 General

Foams has for many years been recognized as an effective medium for extinction of flammable liquid fires.

Foam concentrates are classified by its' composition as given herein:

Protein (old type compound) (P)

Fluoro Protein (FP)

Film Forming Fluoro Protein (FFFP)

Synthetic (S)

Aqueous Film Forming (AFFF)

Alcohol Resistant or Universal (AR)

Because foams are made from aqueous solutions, they are dangerous to be used on materials which react violently with water such as sodium or potassium (see IPS-E-SF-140).

This Section specifies the requirements of foam liquid types that has expansion rates depending on its range of application that are used for fire extinguishment of liquid hydrocarbon and special foam concentrates for Alcohol Resistant (AR) Fires.

The requirements for medium and high expansion foam concentrates is also included.

6.1.2 Low expansion foam liquid

6.1.2.1 Grades

The foam concentrate shall be graded for:

a) Extinguishing performance as grade I, II, III.

b) Burnback resistance as level A, B, C and D.

Typical anticipated extinguishing performance grades and burnback levels are as given in Table 1 and shall be tested in accordance with ISO 7203-1.

TABLE 1 - EXTINGUISHING PERFORMANCE AND BURNBACK RESISTANCE ANNEX G

TYPE	EXTIN. PERFORMANCE	BURNBACK RESISTANCE	TYPE	EXTIN. PERFORMANCE	BURNBACK RESISTANCE
AFFF	1	A	FP (AR)	II	A
AFFF (AR)	1	A	P	III	B
FFFP	1	A	P (AR)	III	B
FFFP (AR)	1	A	S	III	D
FP	11	A/B	S (AR)	III	C

Note:

For extinguishing performance Class I is the highest class and Class III is the lowest class for burnback resistance level, A, is the highest level and level "D" is the lowest class.

6.1.2.2 Use with sea water

If a foam concentrate is marked as suitable for use with sea water the concentration for use with fresh water and sea water shall be identical.

6.1.2.3 Tolerance of the foam concentrate to freezing and thawing

The foam concentrate shall be tested and graded with this requirement.

6.1.2.4 Sediment in the foam concentrate

Percentage volume of sediment shall not be more than 0.25% by volume as received (before aging) and not more than 1.0% after aging when tested.

6.1.2.5 Comparative fluidity

The flow rate of the concentrate shall not be less than kinetic viscosity of 200 mm I/S when tested before and after temperature conditioning in accordance with Annex D ISO 7203-1.

6.1.2.6 PH

The PH of the foam concentrate before and after temperature conditioning shall not be less than 6.0 and not more than 9.5 at 20° (±2)°C. If there is a difference of more than 0.5 PH unit between the two values the foam concentrate shall be designated temperature sensitive.

6.1.2.7 Surface tension of the foam solution, interfacial tension between the foam solution and cyclohexane and spreading coefficient of foam solution on cyclohexane shall be tested and its temperature sensibility determined in accordance with Clause 9-10 and 11 of ISO 7203-1.

6.1.2.8 Expansion and drainage of foam

a) Expansion

The foam produced from the foam concentrate with potable water shall have the expansion within either ±20% of the characteristic value or ±1.0 of the characteristic value, whichever is greater when tested in accordance with annex H.1 of ISO 7203-1. If any values for expansion obtained after temperature conditioning is less than 0.85 times or more than 1.15 times, the corresponding value obtained before temperature conditioning the foam concentrate shall be designated temperature sensitive.

b) Drainage

The foam produced from the foam concentrate with potable water and if appropriate with the synthetic sea water shall have a 25% drainage time within ±20% of the characteristic value when tested in accordance with F2 of ISO 7203-1. If any of the value for 25% drainage time obtained after temperature conditioning is less than 0.8 times or more than 1.2 times, the corresponding value obtained before temperature conditioning, the foam concentrate shall be designated temperature sensitive.

Note:

For sampling and temperature conditioning see Appendix A and Annex B of ISO 7203-1.

6.1.2.9 Compatibility

The foam concentrate shall be of compatible with dry chemical extinguishing powder when used simultaneously or successively and the user shall be ensured by manufacturer that any unfavorable interaction does not cause an unacceptable loss of efficiency. Foam concentrate of different manufacture, grade or class are frequently incompatible and should not be mixed unless it has first been established that an unacceptable loss of efficiency does not result.

6.1.2.10 Performance and quality assurance

The manufacturer shall ensure the purchaser that the foam liquid concentrate have been sample tested in accordance with ISO 7203-1 for low expansion and ISO 7203-2 for medium and high expansion.

6.1.2.11 Marking

The following information shall be marked on shipping containers of low expansion:

a) The designation (identifying name) of concentrate and the word "Low Expansion Foam Concentrate".

b) The grade (I, II or III) and level (A, B, C or D) and if complies the word "Film Forming".

c) Recommended usage concentration (most commonly 1%, 3% or 6%).

d) Any tendency of foam concentrate to cause harmful physiological effects. The methods needed to avoid them and the first aid treatment if they should occur.

e) Recommended storage temperature and shelf life.

f) The nominal quantity in container.

g) The supplier’s name and address.

h) The batch number.

i) Suitable or not suitable with salt water.

j) Any corrosiveness of the concentrate, both in storage and in use with sea water, as appropriate.

Notes :

1) It is extremely important that the foam concentrate, after dilution with water to the recommended concentration should not, in normal usage, present a significant toxic hazard to life in relation to the environment.

2) The packaging of the foam concentrate should ensure that the essential characteristics of the concentrate are preserved when stored and handled in accordance with supplier’s recommendations.

3) Marking on shipping containers should be permanent and legible.

4) Foam concentrate of "medium and high expansion" shall also bear the identification marks

6.1.2.12 The supplier shall provide a list of the characteristic data sheet at quotation stage (see Appendix A).

6.1.2.13 Containers (metal and plastic) shall be tested in accordance with Clause 26 (drop test) and Clause 27 (nonmetallic container test) UL 162.

6.1.3 Medium and high expansion foam concentrate

6.1.3.1 Classification

The foam concentrate shall be classified as medium and/or high expansion and shall comply with the specification given on 6.1.2 for the following:

a) use with sea water,

b) tolerance of foam concentrate to freezing and thawing,

c) sediment in the foam concentrate,

d) comparative fluidity,

e) PH of foam concentrate,

f) surface tension,

g) interfacial tension between the foam solution and cyclohexane,

h) spreading coefficient of the foam solution and cyclohexane.

6.1.3.2 Expansion and drainage

a) The foam produced from the foam concentrate with potable water shall have an expansion of not less than 50 and 25%-50% drainage time within 20% of the characteristic value for medium expansion and have an expansion of not less than 201 and a 50% drainage time of not less than 10 min., for high expansion when tested.

b) If the foam concentrate is marked as suitable for use with sea water, the foam produced from the foam concentrate with synthetic sea water shall have expansion as:

1) For medium expansion, the foam shall have expansion value not less than 0.9 times and not more than 1.1 times the expansion value obtained from the same sample of foam concentrate tested with potable water.

2) For high expansion, the foam shall have an expansion not less than 0.0 times and not more than 1.1 times the expansion value obtained from the same sample of foam concentrate tested with potable water.

c) Temperature sensitivity

1) Medium expansion

If the value for expansion and/or 25% or 50% drainage times obtained after temperature conditioning is less than 0.8 times or more than 1.2 times the corresponding value obtained before temperature conditioning the foam concentrate shall be designated temperature sensitive.

2) High expansion

If the value for expansion, and/or 50% drainage time obtained by using temperature conditioned foam concentrate and found it is less than 0.8 times or more than 1.2 times the corresponding value obtained by using foam concentrate not temperature conditioned, the foam concentrate shall be designated temperature sensitive.

6.1.3.3 Procedures for measuring expansion and drainage rates of foams

Foam sampling

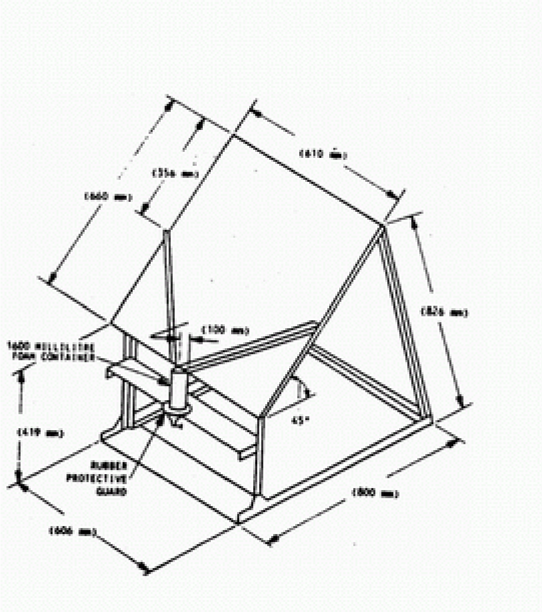
The object of foam sampling is to obtain a sample of foam typical of that to be applied to the burning surface under anticipated fire conditions. Inasmuch as foam properties are readily susceptible to modification through the use of improper techniques, it is extremely important that the prescribed procedures be followed.

A collector (slider) has been designed to facilitate the rapid collection of foam from low-density patterns; it is also used for all sampling except where pressure-produced foam samples are being drawn from a line tap. A backboard is inclined at a 45 degree angle suitable for use with vertical streams falling from overhead applicators as well as horizontally directed streams (see Fig. 15).

The standard container is 20 cm deep and 10 cm inside diameter (1600 mL) preferably made of 1.6 mm thick aluminum or brass. The bottom is sloped to the center where a 6.4 mm drain fitted with a valve is provided to draw off the foam solution (see Fig. 16).

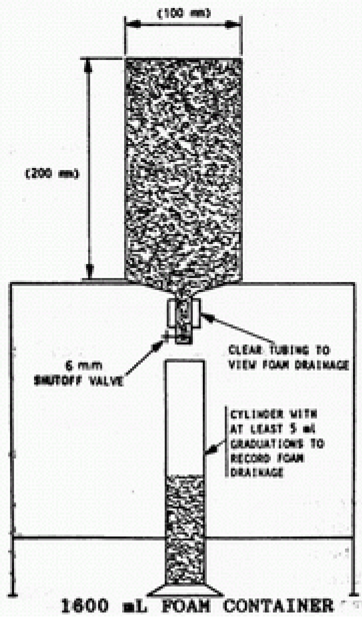
It is important that the foam samples taken for analysis represent as nearly as possible the foam reaching the burning surface in a normal fire fighting procedure. With adjustable stream devices, it is usually desirable to sample both from the straight stream position, and the fully dispersed position, and possibly other intermediate positions.

The collector should be placed at the proper distance from the nozzle so as to be the center of the ground pattern. The nozzle should be placed in operation while it is directed off to one side of the collector. After the pressure and operation have become stabilized, the stream is swung over to center on the collector. When a sufficient foam volume has accumulated to fill the sample containers, usually in a matter of only a few seconds, a stopwatch is started for each of the two samples in order to provide the "zero" time for the drainage test described later. Immediately, the nozzle is turned away from the collector, the sample containers are removed, and the top struck off with a straight edge. After all foam has been wiped off from the outside of the container, the sample is ready for analysis.



TYPICAL FOAM SLIDER

Fig. 15



1600 mL FOAM CONTAINER

Fig. 16

Note:

For subsurface injection equipment, the foam sample is to be obtained from a valved test connection on the discharge side of the foam maker.

6.1.3.4 Method of determination

Expansion

The expansion is calculated from the equation

$$E = \frac{V}{W2 - W1}$$

Where:

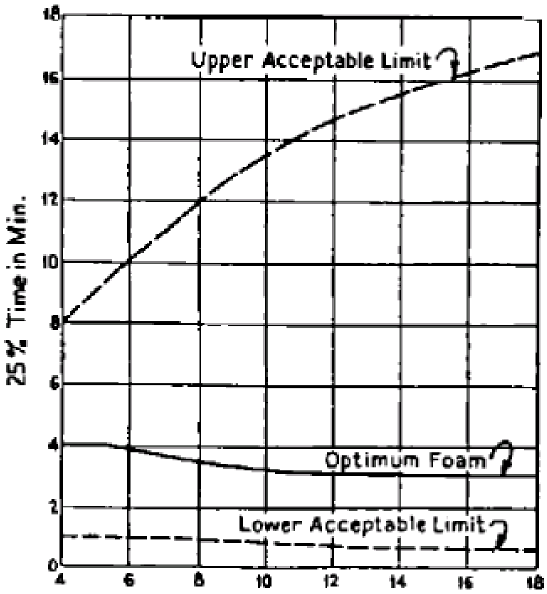
E is expansion

V is the vessel volume in milliliters 1600 mL

W1 is the mass of the empty vessel in grams

W2 is the mass of the full vessel in grams

25-50% Drainage It is the time in minutes that it takes for 25% or 50% of the total solution contained in the foam in the sample container to drain.



FOAM EXPANSION

6.1.3.5 Film forming

In this test a quantity of foam is placed on the surface of cyclohexane. The foam is swept from the surface by insertion of a conical screen and the exposed fuel surface is tested for the presence of an aqueous film by probing with a flame. If the film is present, the fuel will not sustain ignition. In the absence of film, sustain ignition will occur.

6.1.4 Fire performance test

If the foam produced from the foam concentrate before and designated temperature sensitive after temperature conditioning and tested with potable water and if found appropriate with synthetic sea water in accordance with Annex "G"

ISO 7203-2 shall have an extinction time not more than the value given in Table 2 and burnback time not less than medium expansion as stated in the Table.

TABLE 2 - FIRE PERFORMANCE TEST

TIME	MEDIUM EXPANSION	MEDIUM EXPANSION
Extinction time	Not more than 120s	Not more than 150s
1% burnback time	Not less than 30s	Not applicable

6.1.5 Foam quality laboratory testing procedure

6.1.5.1 General

With the greatly expanding use of foam in hydrocarbon liquid fire fighting, there has arisen the need for standardized laboratory procedure for analyzing and expressing the significant physical properties of the mechanical foam as related to fire fighting capabilities. The numerical value obtained by tests generally enable a characterization of the foam. Only by describing results obtained on standardized basis it will be possible to describe the optimum foam for the various operating conditions.

Considering the amount of foam liquid used and stored in numerical conditions in the Iranian Oil, Gas and Petrochemical Industries a central laboratory testing equipment should be available to test the foam liquid concentrates and to advise that the foam liquid purchased or stored in unfavorable conditions for a long period of time is acceptable.

The equipment and procedure for testing shall be in accordance with ISO 7203 Part (1) for low expansion and Part (2) for medium and high expansion foam concentrate (Annex A to J).

6.1.5.2 Inspection of storage and simple quality control testing procedure

6.1.5.2.1 Inspection of storage

To determine the condition of foam liquid, at least annual inspection shall be made of foam concentrate tanks or storage containers for evidence of excessive sludging or deterioration. Sample of concentrates shall be either referred to qualified central laboratory for quality condition testing or at least conduct a quality control test (see Clause 6.1.3.4).

6.1.5.3 Foam quality control test

a) A foam system will extinguish a flammable liquid fire if operated within the proper ranges of solution pressure and concentration and at sufficient discharge density per sq ft of protected surface. The acceptance test of a foam system should ascertain:

- **1)** All foam-producing devices are operating at "system design" pressure and at "system design" foam solution concentration.
- **2)** The laboratory-type tests have been conducted, where necessary, to determine that water quality and foam liquid are compatible.

b) The following data are considered essential to the evaluation of foam system performance:

- **1)** Static water pressure.
- **2)** Stabilized flowing water pressure at both the control valve and a remote reference point in the system.
- **3)** Rate of consumption of foam concentrate.

The concentration of foam solution should be determined. The rate of solution discharge may be computed from hydraulic calculations utilizing recorded inlet or end-of-system operating pressure or both. The foam liquid concentrate consumption rate may be calculated by timing a given displacement from the storage tank or by refractometric means.

The calculated concentration and the foam solution pressure should be within the operating limit recommended by the manufacturer.

6.1.5.3.1 Test certificate

The manufacturer shall certify that all the tests mentioned in this Standard have been carried out.

6.1.6 Marking and packaging

The following information shall be marked on the shipping containers by the supplier.

a) The designation (identifying name) of concentrate and as appropriate the word "medium" or "high" expansion.

b) If complies the word "film forming"

Note:

For other marking Clause 6.1.2.10 items c, d, e, f, g, h, i, j and for list of characteristic value Clause 6.1.2.11 and for containers Clause 6.1.2.12 shall be applied.

7. MATERIALS SPECIFICATION

7.1 Foam Proportioning and Generating System

7.1.1 The system shall be designed for low expansion foam system utilizing 3 to 6% of foam liquid concentrate.

7.1.2 Equipment shall be made of corrosion resistance suitable for the type of foam and operation with salt water.

Material used for construction of equipment shall resist galvanic corrosion and corrosion caused by atmospheric condition as determined by mercurous nitrate and salt spray tests.

7.1.3 All component parts such as check, flow control, by-pass drain, flash valves etc. and pressure gages shall be made in accordance with relevant standards.

7.1.4 Depending on the system design, the equipment shall be suitable for water pressure of upto 15 bar.

7.1.5 Before raising a purchase request, all informations related to the foam equipment and type of FLC shall be correspondent to manufacturer or vendor for obtaining relevant data sheets attached to the quotation .

7.1.6 Hose couplings used shall be of instantaneous male for inlets and female for outlets (BS 336).

7.1.7 Any-gasket "O" rings and non metallic components shall meet the requirement of ANSI 1474-UL199 standards.

7.1.8 An internal operating part whose removal may become necessary during anticipated maintenance or repair shall be accessible, removable and replaceable without damage to the equipment.

7.1.9 A tank that may be subjected to air, gas, or water pressure, or to combination thereof shall be designed, constructed, tested, inspected and marked in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code.

7.2 Portable Foam Generators or Proportioners

7.2.1 Portable foam proprtioners shall be designed and calibrated for the type of FLC, foam making and aspirating units required to be used.

7.2.2 Portable proportioners and branch pipes shall be made of brass or anodized aluminum alloy.

7.2.3 Pick-Up tubes shall be made of synthetic rubber tested to 20 bar with threaded or quick release couplings.

7.2.4 Where back pressure may cause contamination of FLC and water a check valve shall be used.

7.2.5 Mobile self contained units shall be so designed and constructed to make it convenient to be carried by one man and used for rapid intervention. The foam tank shall be constructed of high strength chemical resistance suitable for tropical climate.

7.2.6 A flow regulator shall be provided for mobile proportioners to regulate proportion of foam liquid injection into water stream from 1 to 10%.

7.2.7 The material of construction and parts shall be so chosen to minimize maintenance requirement.

7.3 Fixed Proportioners

7.3.1 All control valves used shall be of a type that open and close smoothly and readily under all rated pressure, shall effectively shut off the position of the system they control and shall be sized to compensate the maximum flow and pressure required by the position of the system they control.

7.3.2 The function and operation of controls, operating devices, gages and drains shall be clearly identified and shall be accessible.

7.3.3 The diaphragm or bladder shall be made of material that will resist corrosion, breakdown, or loss of flexibility under condition of prolonged contact with the foam concentrate.

7.4 Test and Quality Inspection

7.4.1 Manufacturer shall certify in writing that the appropriate tests and quality inspection have been carried-out in accordance with UL 162 for foam equipment.

7.4.2 It is the responsibility of vendor to make sure that all component of foam generators and proportioners have been tested.

7.5 Test Types

7.5.1 Accuracy of proportioning

The foam system shall proportion foam concentrate into water within ±10 percent of the recommended concentration range of design flows. There are two acceptable testing methods:

a) With the foam system in operation at a given flow, a solution sample is collected from each outlet and the concentration measured by refractometer as described in NFPA 11, (Standard for low expansion foam and combined agent systems.)

b) With the foam system in operation at a given flow, using water as a substitute for foam concentrate, the water is drawn from a calibrated tank instead of foam concentrate. The volume of water drawn from the calibrated tank indicates the percentage of foam concentrate used by the system.

8. FINISHING PAINTS

Purchaser shall specify the finishing paint for the type of equipment ordered.

9. PREPARATION FOR SHIPMENT

Each package unit or equipment shall be properly prepared for shipment to prevent damage by handling, and shipping and shall be labeled to insure that they are not lost in transit. In addition the following measures shall be taken:

a) All external connections shall be protected.

b) Package list to be included inside every package and one attached to the package.

c) Shipping supports shall be provided if deemed necessary.

10. GUARANTEES

The manufacturer shall guarantee by letter of acceptance the satisfactory performance of the equipment and materials and replace without charge any or all parts defective or faulty materials, design and poor workmanship for a period of 16 months after the date of shipment. Any alterations necessary to meet tests or pass inspections shall be made at manufacturers expense.

PART III

11. TWIN AGENT DRY CHEMICAL POWDER AND FOAM SYSTEM

11.1 General

11.1.1 Application

In this system foam is applied to a hazard simultaneously or sequentially with dry chemical powder. Systems of this type combine the rapid fire extinguishing capabilities of dry chemical powders (as well as their ability to extinguish three-dimensional fires) with the sealing and securing capabilities of foam, and are of particular importance for protection of flammable liquid hydrocarbon hazards.

11.1.2 Definition

Twin agent system

These systems may be self-contained, and the application of each agent is separately controlled so that the agents may be used individually, simultaneously, or sequentially as the situation requires.

11.1.3 Limitations

The manufacturers of the dry chemical and foam concentrate supplying the system shall confirm that their products are mutually compatible and satisfactory for this purpose.

Limitations imposed on either of the agents used in the system for the use of that agent alone shall also be applied to the twin agent system.

11.1.4 Application rates

Minimum delivery rates for protection of a hazard, based on the assumption that all of the agent reaches the protected area, shall be as follows:

a) AFFF solution shall be delivered at a rate of 4.1 (L/min)/m2 (0.10 GPM/Sq. Ft.) of area to be protected.

b) The ratio of dry chemical discharge rate to premix AFFF discharge rate (kg dry chemical and kg AFFF solution

per second) shall be in the range of 0.6:1 to 5:1.

11.1.5 This type of extinguisher is designed to cover the risk of the area to be protected and the size and specification of the equipment shall meet the requirements of the user. The unit may be skid, trailer or fire truck mounted, and all appropriate component parts shall comply with NFPA Standard Section 11 Chapter 4 combined agent system.

11.1.6 A data sheet covering all relevant informations shall be attached to purchasing order (see Appendix A).

11.1.7 Any exception to this specification shall be stated in writing for the attention of the manufacturers to include them in their quotations.

11.2 Extinguisher

11.2.1 Twin agent

The twin-agent unit shall contain dry chemical and premixed aqueous film forming (AFFF) or (FFFP) tanks. Both agent shall discharge independly through a twined hose reels terminated to manually triggered discharge nozzles for both agents.

11.2.2 Nitrogen gas

Compressed nitrogen gas regulated to pressure of about 15 bar shall be utilized for pressurization of storage containers and for the controlled discharge of agents from the pressurized storage containers separately or together through hose reels or/and paralleled fixed piping system, if provided.

11.2.3 Dry chemical containers

Dry chemical container shall have the following specifications.

11.2.3.1 The container shall be either of spherical or cylinderical shape and shall have necessary gasious provisions to issue complete fluidization of dry chemical powder in the container at its maximum compact state and to maintain a uniform dry chemical discharge rate throughout, not less than 95% of the specified discharged time period. The nitrogen gas shall be used as the driving force.

11.2.3.2 Each storage container shall have the specified capacity of dry chemical with 15 bar (approximately working pressure.)

11.2.3.3 Containers shall be designed and fabricated in accordance with the requirements of ASME section VIII boiler and pressure vessel code. The tank shall be welded steel construction.

11.2.3.4 Each tank shall be equipped with level indication and pressure indicator.

11.2.3.5 A manual means for depressurization of partially depleted dry chemical container shall be provided. Containers shall also be provided with manual provision for completely drainage and flushing of the container assembly.

11.2.3.6 Each container shall be provided with one fill cap. The fillcap shall consist of cast aluminum body equipped with two handles extending from opposite sides of the cap to permit hand tightening so that it is free from leakage under normal operating pressure without the use of tools. A safety vent hole shall be located in the fill cap.

11.2.3.7 A pressure relief valve shall be furnished to prevent the pressure in the tank from exceeding by 10% the maximum working pressure of the tank.

11.2.4 Foam solution tank

11.2.4.1 The premixed foam solution tank shall be either of spherical or cylinderical shape and shall have the necessary provisions for pressurization and expulsion of all the stored solution using a gaseous nitrogen source as driving energy.

11.2.4.2 Each tank shall have the specified capacity of 600 to 800 liters with 15 bar pressure (approximately) working pressure.

11.2.4.3 The tank shall be designed and fabricated in accordance with the requirements of ASME VIII boiler and pressure vessel code for the specified working pressure. The tank shall be of stainless-steel welded construction.

11.2.4.4 Clauses 11.2.3.4, 11.2.3.5 and 11.2.3.6 as outlined above for dry-chemical containers shall also be considered for foam solution tanks.

11.2.5 Nitrogen cylinders

11.2.5.1 Nitrogen gas system shall be integral part of twin agent unit with related nitrogen storage cylinders.

11.2.5.2 Standard nitrogen cylinders with adequate capacity and 197 bar design pressure shall be provided as driving force for both agents. The quantity of nitrogen gas shall be adequate to expel the whole foam solution and dry chemical as well as the flush-out of the system.

11.2.5.3 The nitrogen cylinders shall be securely placed in a horizontal or vertical position. The method of placement shall be in such a way to permit easy access for operation and replacement of the cylinders.

11.2.5.4 The nitrogen cylinders shall be manifolded and connected to the agent tank. Each cylinder shall have a minimumof one regulator for dry chemical nitrogen supply each regulator shall be designed for an inlet pressure of 197 bar and shall be set to deliver nitrogen at reduced pressure of about 15 bar. Each set of regulators shall be equipped with a spring loaded pressure relief valve and shall be connected to the nitrogen cylinders.

11.2.5.5 Each valve shall be provided at the end of nitrogen supply line to each agent.

11.2.5.6 The system shall be designed in a manner that the agents can be delivered individually or together.

11.2.6 Hose and hose reels

11.2.6.1 Single length twinned hose mounted on a suitable location shall be provided.

11.2.6.2 Hose material shall be non-kink rubber type suitable for working pressure of at least 17 bar. The hose diameters shall be of 25 mm, diameter and shall be used for foam and 20 mm diameter, minimum shall be used for dry chemical.

11.2.6.3 Metal hose reels with manual rewind and straight through internal fittings designed for minimum pressure drop shall be provided.

11.2.7 Nozzles

11.2.7.1 Manually triggered (pistol grip type) physically linked, liquid agent and dry chemical discharge nozzle for use by single operator should be supplied.

11.2.7.2 Nozzle shall be provided with minimum effective stream ranges and discharge rate in accordance with technical data given in Appendix C.

11.2.7.3 Nozzles shall be provided with an integral shut-off valve.

11.3 Type of Agent

11.3.1 Aqueous film forming or film forming fluoro protein of foam concentrate known as AFFF (or FFFP) shall be used with 3 to 6 percent concentration.

11.3.1.1 The manufacturer shall supply the quantity of foam required if so stated in purchasing order. In addition if so stated, the manufacturer shall indicate the quantity of reserve supply and the ways and conditions required for storage of foam.

11.3.2 Dry chemical powder

11.3.2.1 While dry powder of potassium bicarbonate, or Monnex is preferred, any of sodium bicarbonate or potassium sulphate base compatible with AFFF foam and suitable for class "B" and "C" if specified by purchaser could be used.

The dry chemical supplied shall be guaranteed not to accelerate the break down or interact with the foam supplied under this specification.

11.4 System Operation and Control

11.4.1 Actuation

System shall be actuated manually by pull box at local and remote (hose reel station) by hand manual. The valving and piping shall be installed so that for normal operation the nitrogen from the cylinders passes through the regulator, manifolds and piping into agent tank to adequately fluidize and pressurize the tank. The flow of the agent from the tank into the hose shall be controlled by ball type valve.

The action system shall be designed so that both agents can be discharged simultaneously by the operator.

11.4.2 Operating devices

Operating devices shall include nitrogen pressure regulator discharge control with quick opening ball valves, shut-down equipment, actuation valves, hose reel and manual over rides and agents nozzles with shut-off valves. All operation devices considered as integral parts of the system and shall function with system operation .

11.4.3 Alarms

A visual and an audible alarm should be provided if desired by the purchaser to summon the aid.

11.5 Paint and Finishing

Paint and finishes shall be desirable on manufacturer’s standards and shall adequately protect all pieces from their environment.

However corrosive, humid and chemical conditions shall be considered and the equipment should be painted with proper corrosion resistant primer and final coating for hot, humid, corrosive and unshaded condition. The company’s color codes shall be used.

11.6 Marking

11.6.1 Each twin agent extinguishing system shall be identified with permanently attached corrosion resistant nameplate.

The nameplate shall be located where it can be easely visible after installation .

11.6.2 The nameplate shall contain the following informations:

- **a)** Manufacturers name or private labeler or its identifying symbol;
- **b)** Purchase order, item number and tag number;
- **c)** Capacity of each agent’s tank and operating pressure;
- **d)** Nitrogen cylinders capacity and pressure;

e) A marking plate shall be permanently attached to the most suitable location easily visible to show "how to operate the extinguisher".

11.7 Items to be Furnished by Manufacturer

The following items shall be furnished by the manufacturer as a minimum requirements:

11.7.1 Units including foam solution tank, dry chemical tank, nitrogen propellant system, manual actuation devices, extinguishing agents (if specified by purchaser) and regulators.

11.7.2 Two 20 meters twinned hoselines with related hose reels, one for unit and one for extra hose reel station if specified.

11.7.3 Both agents discharge nozzles or twin discharge nozzles as specified.

11.7.4 Fabrication drawing including piping lay-out supports, installation details and wiring diagram (if any).

11.7.5 All operating devices which are necessary to match with alarms, if the system include alarm.

11.7.6 All connections which are necessary to connect the system as a unit.

11.7.7 Operation, maintenance instructions and spare parts lists.

11.7.8 System test procedures, initial and periodic, including special tools for this purpose.

11.7.9 Bolts, nuts, washers, clamps, gaskets etc., required for assembling and mounting. The supplied materials shall be suitable for the environment conditions stated in the specification.

11.8 Testing

11.8.1 The manufacturer shall quote all the normal tests required as well as hydrostatic and simulation tests as specified below.

11.8.2 All pressure containing parts of twin agent fire extinguisher system shall be subject to hydrostatic test at a pressure of not less than 1½ times the design pressure of that part.

11.8.3 The system shall be given prior to shipment an operational test giving actual design operating conditions as closely as possible, with extinguishing discharge. Manufacturer shall conduct such test in present of purchaser representative unless a written waiver is given.

11.8.4 Purchaser shall have in hand from manufacturer notification of test 30 days prior to test date:

a) Defective parts, if present, shall be replaced with new parts and system retested, until completely reliable and accepted.

b) Manufacturer shall furnish all equipment, materials and man power required for the test.

11.8.5 The manufacturer shall issue instruction for the proper initial and periodical testing of installed system without loss of extinguishing agent and shall provide any special equipment required for calibration and testing during operation of the system.

11.8.6 Test informations and result as specified below shall be provided in a letter certifying that the system was tested and met all requirements specified.

It shall include:

a) Date of test;

b) purchase order, item number, tag number;

c) shipping destination;

d) equipment serial number;

e) test procedure(s);

f) officially certified summary of test observation results and conclusions, any mulfunctioning and, or system connections shall be reported. In addition photographs of the system shall be furnished.

11.9 Inspections

11.9.1 If so desired the purchaser's representative shall be offered the opportunity to witness the mulfunctioning, testing, assembly or any part of the manufacturer's work which concerns the system ordered.

11.9.2 The manufacturer shall agree, by his acceptance of the purchase order, to carry any inspection and rejection stipulations in accordance with standard practices and codes specified herein .

11.9.3 Any inspection and testing in no way relieve the manufacturer of any responsibility for the system meeting all requirements of this specification and applicable codes.

11.9.4 The manufacturer shall issue instructions for the proper inspection of the system, according to acceptable international and NFPA Standards

11.10 Informations to be Furnished by Manufacturer

11.10.1 At quotation stage

The manufacturer shall furnish with his quotation at least the following information:

a) Manufacture names and model numbers;

b) comprehensive catalogs, technical data and descriptive literature of the equipment offered;

c) an explicit statement of any deviation from this specification;

d) list of spare parts for commissioning and two years operation with prices;

e) preliminary dimensional drawing and description of operation;

f) list of all necessary tests with price including those specified herein

g) list of recommended special tools for installation and future maintenance and their price.

11.10.2 At ordering stage

The manufacturer shall furnish the purchaser within 6 weeks after receipt of purchasing order, the following informations:

a) Five sets of drawing of the system and its components. The fabrication shall not start until after manufacturer receipt of approved drawings. Vendor shall supply one set of corrected drawings within weeks after receipt of drawings which have been approved or marked (approved).

b) Manufacturer shall furnish purchaser the following information prior to the shipment:

1) Ten copies of test certification. This will be prerequisite for final acceptance and invoice approval;

2) five sets of recommended spare parts list for commissioning, two years operation and list of special tools for stock;

3) five sets of installation, maintenance and operating instruction including comprehensive trouble shooting instructions;

4) five copies of certified outline drawing;

11.11 Shipment

Each package unit and related equipment shall be properly prepared for transit to prevent damage from handling, warehousing or shipping and shall be labeled to insure that it is not lost in transit. In addition the following measures shall be taken:

a) All external connections shall be protected by temporary closures to exclude dirt and other foreign matter;

b) one packing list to be included inside every package and one packing list to be in metal enclosure attached to the package;

c) adequate shipping supports and packing shall be provided in order to prevent internal damage during transit.

For ocean transport, the equipment shall be crated in heavy duty container sealed with strong tape or metal bands. Also provision shall be taken to protect the equipment from possible marine exposure.

11.12 Guarantee

Manufacturer shall guarantee by letter of acceptance the satisfactory performance of the system in accordance with this specification. Manufacturer shall also guarantee to replace without charge any or all parts defective due to faulty material, design or poor workmanship for a period of 12 months after installation or 24 months after the date of shipment.

Any alterations necessary to meet test or pass inspection shall be made at manufacturers expense.

APPENDICES

APPENDIX A

1. MANUFACTURER CHARACTERISTIC DATA TYPE -------------------

PHYSICAL		CHARACTERISTIC VALUE	PHYSICAL PROPERTIES		CHARACTERISTIC VALUE
1	Appearance		12	Premixable salt water b Potable water b	
2	Specific gravity 20°C		13	25% b Drain time (minute) 50% b	
3	Ph 20°C		14	Continuous storage temperature	
4	Viscosity 20°C		15	Concentration	
5	Viscosity 0°C		16	Compatibility ext. powder	
6	Freezing point		17	Compatibility other foam	
7	Minimum usable temperature		18	Subsurface injection	
8	Expansion		19	Standard used for tests	
9	Sediment as received % V/V		20	Performance grade	
10	" after aging %V/V		21	Comparative fluidity	
11	Freeze/thaw effect		22	Biodegradability ratio	
Containers					
Suitable materials for solution and bulk containers					
Supplier's: address					
					Signed ....

2. PURCHASER'S INFORMATION

Type of foam liquid concentrate	concentration
Site storage temperature min. max.	humidity
Sea water if used specific gravity	if used for premix Yes b No b
If used for subsurface Yes b No b	
Purchaser	
	Signed.......................

Notes:

1) This specification data sheet will be originally prepared by the user filling Part 2 and sent to manufacturers to complete at quotation stage.

2) For (AR) foam liquid, fuel and application rates technical information sheet shall be attached by manufacturer.

APPENDIX B

PURCHASING INFORMATION FORM

Twin agent dry powder and foam extinguishers

1) Brief description of the risk and the site of operation	
2) The type of dry powder	Supplied not supplied
3) Type of foam liquid concentration	Supplied not supplied
4) Twin station hose reels	Required not required
5) Alarm	Required not required

6) Automatic actuation or manual ....

7) Specific gravity of sea water if used for premix foam solution

8) Atmospheric condition = temperature min. ....max. ....

Wind velocity .... dust --- $\frac{\text{Yes}}{\text{No}}$ Sulfurous $\frac{\text{Yes}}{\text{No}}$

gaseous $\frac{\text{Yes}}{\text{No}}$ humidity ....

APPENDIX C

TECHNICAL DATA

Extinguishant capacity Dry chemical: Foam solution:	 100 kg 100 L.	 250 kg 250 L.	 500 kg 500 L.	 750 kg 800 L.
Handline(s)	1 hose reel with 20 mtrs. twinned hose	1 hose reel with 25 mtrs./ 30 mtrs. twinned hose	2 hose reel each with 25 mtrs./30 mtrs. twinned hose	2 hose reels each with 25 mtrs./30 mtrs. twinned hose
Total weight appr.	450 kg	1200 kg	2300 kg	3000 kg
Discharge rates (appr.) Dry chemical: Foam solution:	 2 kg/sec. 80 LPM.	 2 kg/sec. 200 LPM.	 2 × 3 kg/sec. 2 × 200 LPM.	 2 × 3 kg/sec. 2 × 200 LPM.
Discharge range (calm conditions) appr. Dry chemical: Foam solution:	 8 mtrs. 12 mtrs.	 10 mtrs. 20 mtrs.	 10 mtrs. 20 mtrs.	 10 mtrs. 20 mtrs.
Expellent gas System Dry chemical: Foam solution:	N2 cylinder 10 L/150 bar 1 1	N2 cylinder 20 L/150 bar 1 1	N2 cylinder 50 L/150 bar 1 1	N2 cylinder 50 L/150 bar 2 2