

KLM Technology Group Project Engineering Standard	 www.klmtechgroup.com	Page : 1 of 47
		Rev: 01
		June 2011
KLM Technology Group #03-12 Block Aronia, Jalan Sri Perkasa 2 Taman Tampoi Utama 81200 Johor Bahru Malaysia	MATERIAL AND EQUIPMENT STANDARD FOR FIRE FIGHTING FOAM GENERATORS (PROJECT STANDARDS AND SPECIFICATIONS)	

TABLE OF CONTENT

SCOPE	3
REFERENCES	3
DEFINITIONS AND TERMINOLOGY	4
UNITS	6
OPERATIONAL METHODS	6
Foam Liquid Concentrate (FLC)	6
Foam Liquid Proportioners and Generators	9
Medium and High Expansion Foam Generators	22
MATERIAL SPECIFICATIONS	26
Foam Liquid Concentrate	26
MATERIALS SPECIFICATION	36
Foam Proportioning and Generating System	36
Portable Foam Generators or Proportioners	37
Fixed Proportioners	37
Test and Quality Inspection	37
Test Types	38
FINISHING PAINTS	38
PREPARATION FOR SHIPMENT	38
GUARANTEES	38

KLM Technology Group Project Engineering Standard	MATERIAL AND EQUIPMENT STANDARD FOR FIRE FIGHTING FOAM GENERATORS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 2 of 47
		Rev: 01
		June 2011

TWIN AGENT DRY CHEMICAL POWDER AND FOAM SYSTEM	39
General	39
Extinguisher	40
Type of Agent	42
System Operation and Control	42
Paint and Finishing	43
Marking	43
Items to be Furnished by Manufacturer	44
Testing	44
Inspections	45
Informations to be Furnished by Manufacturer	46
Shipment	46
Guarantee	47
APPENDIX A	48
APPENDIX B	49

KLM Technology Group Project Engineering Standard	MATERIAL AND EQUIPMENT STANDARD FOR FIRE FIGHTING FOAM GENERATORS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 3 of 47
		Rev: 01
		June 2011

SCOPE

This Project Standard and Specification 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 Project Standard and Specification.

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.

1. 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"
2. ASME (American Society Mechanical Eng.)
 - Section VIII "Boiler and Pressure Vessels Code"
3. NFPA (National Fire Protection Association)
 - NFPA 11 "Low Expansions Foam/Combined Agent Systems"
4. UL (Underwriter Laboratories)
 - UL 162
 - UL 199
5. ANSI (American National Standards Institution)
 - ANSI 1474

KLM Technology Group Project Engineering Standard	MATERIAL AND EQUIPMENT STANDARD FOR FIRE FIGHTING FOAM GENERATORS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 4 of 47
		Rev: 01
		June 2011

6. BS (British Standards)
 BS 336

DEFINITIONS AND TERMINOLOGY

Aqueous Film Forming Foam (AFFF) - The characteristic of a foam or foam solution forming an aqueous film on some hydrocarbon liquids.

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

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.

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

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

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

Film Forming Fluoroprotein (FFFP) - A liquid concentrate that has both a hydrolyzed protein in fluorinated surfactant base plus stabilizing additive.

Fluoroprotein (FP) - A liquid concentrate that is similar to protein, but with one or more fluorinated surfactant additive.

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.

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

KLM Technology Group Project Engineering Standard	MATERIAL AND EQUIPMENT STANDARD FOR FIRE FIGHTING FOAM GENERATORS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 5 of 47
		Rev: 01
		June 2011

the following types and film forming fluoroprotein (FFFP): Protein Foam, Fluoroprotein Foam, Aqueous Film Forming Foam (AFFF, and other Synthetic Foams).

Foam Concentrate Proportioner - A means for controlling the ratio of foam concentrate to the quantity of water.

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

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

- 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.
- 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.
- 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.

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.

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

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.

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

KLM Technology Group Project Engineering Standard	MATERIAL AND EQUIPMENT STANDARD FOR FIRE FIGHTING FOAM GENERATORS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 6 of 47
		Rev: 01
		June 2011

Protein foam (P) - A liquid concentrate that has a hydrolyzed protein base plus stabilizing additive.

Shear Stress N/m² - Regular 3% and 6% -12 -13.

Synthetic (S) - A liquid concentrate that has a base other than fluorinated surfactant or hydrolyzed protein.

Sub-Surface Injection - Discharge of foam into a storage tank below the liquid surface near the tank bottom.

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

UNITS

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

OPERATIONAL METHODS

Foam Liquid Concentrate (FLC)

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.

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.

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

KLM Technology Group Project Engineering Standard	MATERIAL AND EQUIPMENT STANDARD FOR FIRE FIGHTING FOAM GENERATORS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 7 of 47
		Rev: 01
		June 2011

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.

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. 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.

6. Uses

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

KLM Technology Group Project Engineering Standard	MATERIAL AND EQUIPMENT STANDARD FOR FIRE FIGHTING FOAM GENERATORS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 8 of 47
		Rev: 01
		June 2011

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.

7. Medium high expansion and alcohol resistant foam liquid

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

- flammable liquid as spills of average depth not more than 25 mm; or
- flammable liquids in defined areas such as bunds and heat treatment baths; or
- 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.

b. 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.

c. 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 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.

KLM Technology Group Project Engineering Standard	MATERIAL AND EQUIPMENT STANDARD FOR FIRE FIGHTING FOAM GENERATORS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 9 of 47
		Rev: 01
		June 2011

Foam Liquid Proportioners and Generators

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.

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.

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.

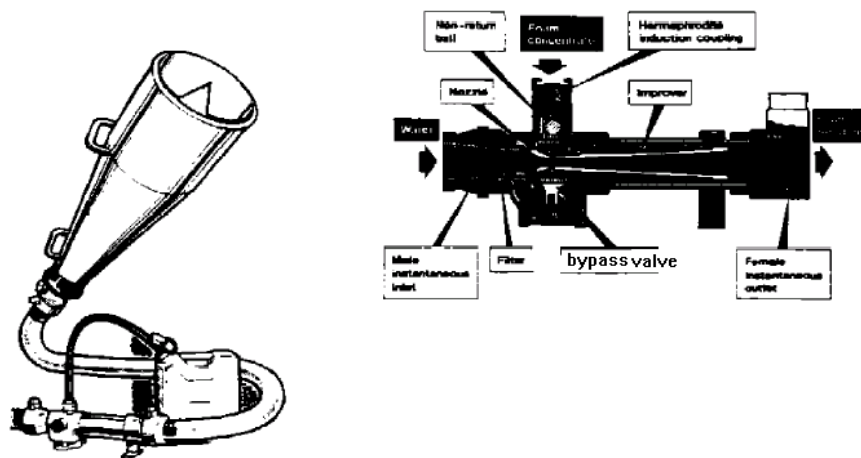


Fig. 1 In-Line Inductor (Portable Unit)

KLM Technology Group Project Engineering Standard	MATERIAL AND EQUIPMENT STANDARD FOR FIRE FIGHTING FOAM GENERATORS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 10 of 47
		Rev: 01
		June 2011

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.

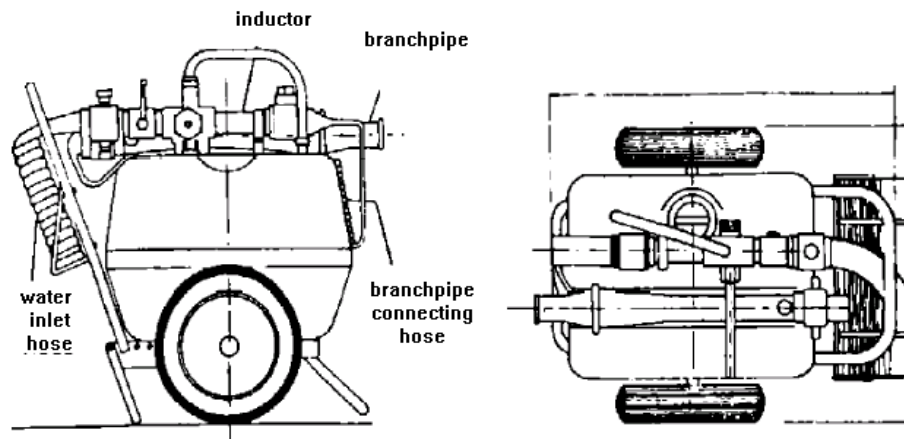


Fig. 2 Mobile Unit

5. Primary-Secondary education 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

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

KLM Technology Group Project Engineering Standard	MATERIAL AND EQUIPMENT STANDARD FOR FIRE FIGHTING FOAM GENERATORS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 11 of 47
		Rev: 01
		June 2011

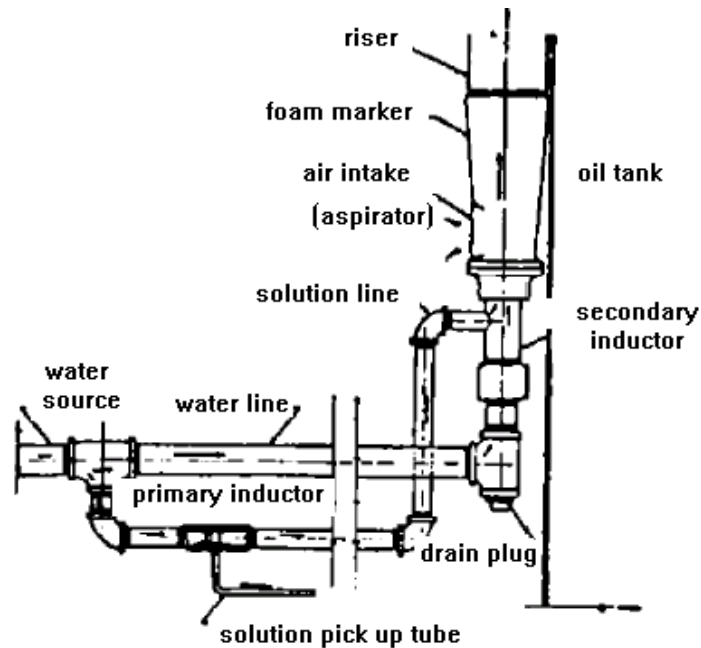


Fig. 3

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.

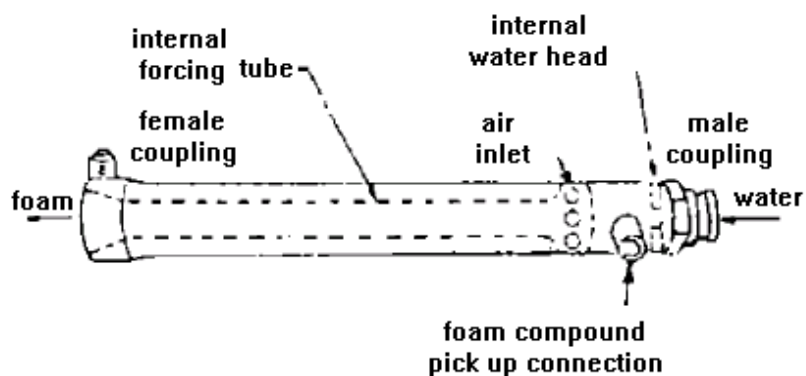


Fig. 4

7. High back pressure foam generator (Fig. 5)

KLM Technology Group Project Engineering Standard	MATERIAL AND EQUIPMENT STANDARD FOR FIRE FIGHTING FOAM GENERATORS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 12 of 47
		Rev: 01
		June 2011

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.

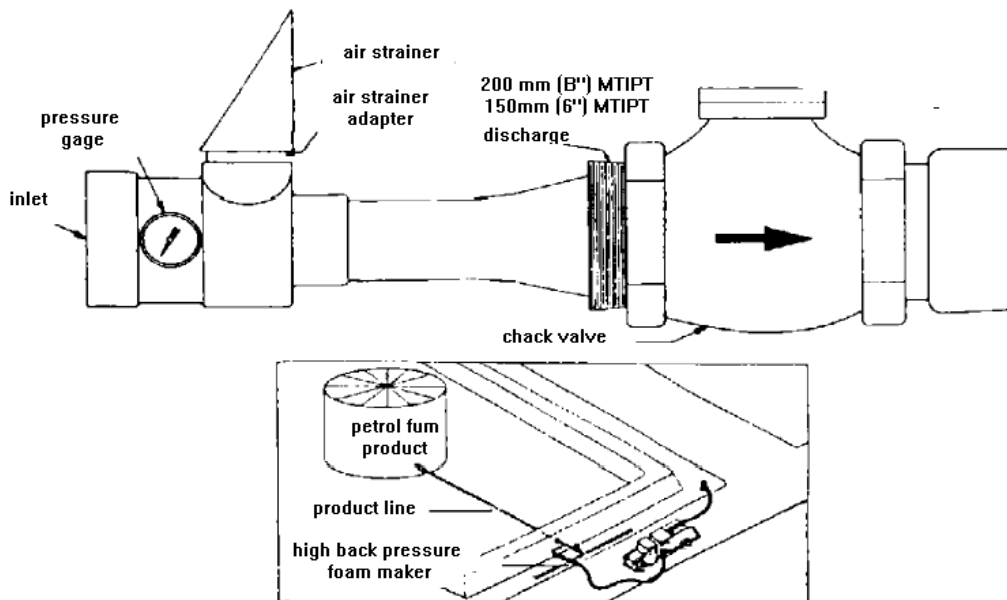


Fig. 5 Fixed High Back-Pressure Foam Maker for Fixed Systems

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.