

# **SECTION 1**

## **BASICS TO FOAM**



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# SECTION 1

## BASICS TO FOAM

### GENERAL OVERVIEW

#### WHY SHOULD YOU CONSIDER NF FOAM CONCENTRATES?

All foam systems, regardless of size, consist of a foam concentrate supply, proportioning device, water supply, and foam maker(s). While all the components must function properly to ensure system performance, the foam concentrate is the most vital component of the system.

Throughout the fire fighting industry, different terms express foam concentrates. In some cases, the terms “Foam”, “Foam Liquid”, “Foam Concentrate”, “Liquid” and “Concentrate” all mean the same thing.

In this NF section, the following definitions clarify these differences:

#### **Foam Concentrate -**

Foam concentrate is concentrated liquid foaming agent as supplied from the manufacturer.

#### **Foam Solution -**

A homogenous mixture of water and foam concentrate in proper proportions.

#### **Foam -**

Fire fighting foam is a stable aggregation of small bubbles of lower density than oil or water that exhibits a tenacity for covering horizontal surfaces. It flows freely over a burning liquid surface and forms a tough, air-excluding, continuous blanket that seals volatile vapors from access to air. It resists disruption from wind and draft or heat and flame attack and is capable of resealing in case of mechanical rupture.

National Foam, Inc. (NF) has been a pioneer in the development of mechanical foam concentrates and a world leader in fire fighting foam technology for over 75 years. NF’s foam products successfully fought flammable and combustible liquid fires, as well as hazardous fires such as storage tanks, process areas, marine tankers, loading facilities and spills that result from aircraft and automotive crashes.

Today, NF performance records continue to set the standard in the fire fighting industry. In every corner of the world, NF foam concentrates and equipment

provide reliable, durable flammable liquid fire protection.

With over 1000 different flammable liquid materials being manufactured and consumed, and with many different fire fighting foam concentrates available for their protection, it may seem difficult at first to pick the most suitable concentrate for your hazard needs. However, it becomes much easier when dealing with a manufacturer who produces a wide variety of foam concentrates and related products.

NF manufactures the largest and most comprehensive line of fire fighting foams available to the industry. Whether the hazard is a small manufacturing installation or a sophisticated storage and process facility, NF’s diverse product line simplifies selection of the best, most cost-effective foam concentrate.

#### PROPER STORAGE AND HANDLING OF FOAM CONCENTRATES

All NF foam concentrates are designed and tested to provide long shelf life stability. However, storage conditions will have a significant bearing on foam concentrate shelf life. Consult NF for specific recommendations regarding storage conditions and shelf life.

Storage in shipping containers is acceptable. Foam concentrates are typically shipped in approved plastic pails, drums or totes. Properly constructed large capacity tanks can offer near optimum conditions for prolonged storage.

Whether mounted on mobile equipment or part of an integral fixed system, foam concentrate storage tanks provide immediate access to large volumes of foam concentrate. A foam concentrate storage tank, whether fixed or mobile, should be constructed with an expansion dome capacity of at least 2% of the tank volume. The tank should be closed to the atmosphere except for a pressure-vacuum vent mounted on the expansion dome. The foam

concentrate level in the tank should be kept at a point halfway within the expansion dome to reduce the mixing of air and foam.

Consult the relevant paragraphs within this section, individual product data sheets and NF Technical Bulletins for acceptable tank construction materials and recommended ambient storage temperatures. Section 3 provides details on foam concentrate storage tanks manufactured by NF. Consult the NF Engineering Department for specific details concerning internal tank coating applications.

Molded polyethylene storage tanks do not normally have expansion domes. In these cases NF recommends NF Foam Seal on the foam concentrate surface. NF Foam Seal is a highly refined grade of white mineral oil. It provides a sealing barrier between the foam and air and reduces the effects of evaporation and foam deterioration. Use a 1/2-in (13 mm) layer on top of protein, fluoroprotein, AFFF and AR-AFFF type foam concentrates. Foam Seal is only recommended for stationary polyethylene storage tanks. It should not be used in mobile truck or trailer foam tanks that slosh and agitate or in storage tanks made from materials other than polyethylene or fiberglass.

**Note:** Do not exceed maximum recommended storage temperatures. An excessive temperature may cause deterioration in any foam concentrate. The minimum usable temperature of a foam concentrate is not its freezing point. This minimum temperature is the point at which the concentrate will proportion properly through venturi-type pickup devices such as line proportioners and pickup type nozzles.

Quality foam concentrates are not adversely affected by excessively low temperatures, but they may become too viscous to proportion properly. (Freeze-thaw cycling is generally not detrimental to NF products. Of course, some products are more sensitive than others. Refer to specific product data sheets or consult with the NF Engineering Department).

The following summary provides recommendations for maintaining and monitoring foam concentrate integrity:

1. Keep the foam concentrate tank filled halfway within the expansion dome.

2. Provide a pressure-vacuum vent. A pressure-vacuum vent reduces condensation and evaporation that are harmful to the foam concentrate. This vent requires periodic inspection and cleaning.
3. Avoid storage above the maximum recommended temperatures.
4. Never mix different brands or types of foam concentrates for long-term storage.
5. Avoid the dilution of foam concentrate with water.
6. Avoid contamination with foreign ingredients, chemicals or oils. Agitation, intermixing and improper application of Foam Seal may contaminate the foam concentrate. Contact NF for specific recommendations.
7. Valves, couplings or piping in continual contact with the foam concentrate should not be constructed of dissimilar metals. Dissimilar metals may cause rust, or galvanic corrosion.
8. Contact NF's Technical Service Department for periodic analysis of your foam concentrate supplies.

#### **FOAM CONCENTRATE INGREDIENTS**

The many types of foam concentrates comprise a complex mixture of ingredients. Protein based foams are primarily a combination of hydrolyzed protein, freezing point depressants, organic and inorganic stabilizers. Synthetic foams are combinations of foamers, stabilizers, freezing point depressants and fluorinated surfactant.

#### **ECOLOGICAL EFFECTS OF FOAM CONCENTRATES**

NF concentrates are generally biodegradable. They possess a low order of toxicity and cause minimal environmental impact. Differing state and local regulations may govern disposal options; however, dilution of foam solutions prior to waste water treatment is a generally accepted method of disposal. This process includes the treatment of the organics contained in the product. Foam solution and, more importantly, foam concentrate should be properly diluted and metered to the treatment facility to prevent Biological Oxygen Demand (BOD) overloading, or excessive foaming.

As a service to our customers, National Foam has approvals in place with disposal facilities throughout the U.S. for waste water treatment and solidification and landfill of our foam liquid concentrates and foam solutions. If required, National Foam can also

provide information on the disposal of drums used for shipping our concentrates. Please contact National Foam's Risk Management Administrator at (610) 363-1400 for additional information.

### **TOXICOLOGICAL EFFECTS OF FOAM CONCENTRATES**

Based on testing done on our foam concentrates, there should be no negative effects when the foams are used in a diluted solution form.

However, prolonged skin contact with foam concentrate or solution may cause dryness. In case of contact with skin or eyes, flush thoroughly with water and consult a physician.

**Note:** See specific Material Safety Data Sheets for further information on a specific foam concentrate.

National Foam, Inc. also complies with OSHA Hazard Communication Standard 29CFR 1910.1200

### **TESTS AND APPROVALS**

#### **INTRODUCTION**

All NF products undergo extensive testing from their conception in the research laboratory through rigid quality control standards prior to reaching the market. NF's foam concentrate products are approved and listed by independent testing agencies such as Underwriters Laboratories and Factory Mutual. Also, certain concentrates are approved by the US Coast Guard, U.S. Naval Research Laboratories, USDA and other agencies. These approvals are the customer's assurance that NF has demonstrated through extensive fire testing and evaluations that the product complies with the rigid requirements and specifications of the testing authority. Furthermore, any deviation from these standards can lead to revocation of these listings or approvals.

In special cases, fire tests are conducted to determine foam effectiveness on a particular flammable liquid and to determine the minimal application rates the hazard requires. NFPA Standards 11, 16 and 409 among others provide guidelines for application rates. Application rates for polar solvent or alcohol-type fuels are determined by the foam concentrate manufacturer through actual fire testing. The approvals for each particular foam concentrate are provided in their respective data

sheets.

### **FOAM CONCENTRATE EVALUATION**

Periodic testing of foam concentrate supplies through a good maintenance program can help sustain the integrity of the foam concentrate. NF's Technical Service Program offers analytical evaluations of foam concentrates to ensure the integrity of the foam concentrate. The Technical Service Report includes the results of at least four laboratory tests.

### **TECHNICAL SERVICE LABORATORY TESTS**

1. pH - determine if a pH value of the foam concentrate lies within its original specified limits.
2. Specific Gravity - determines if the foam concentrate is diluted, or if it is concentrated due to evaporation.
3. Sediment - measures the undissolved solids or particles in a foam concentrate. Problems with dispersion occur with sediments in excess of 0.5% **Note:** Ensure that the foam sample represents the overall foam supply.
4. Foam Quality - the quality of a good foam is the sum total of its expansion, its 25% drainage time, and ultimately, its fire performance. Procedures for these tests are outlined in NFPA Standard 11.

**Note:** Synthetic foam concentrates may require additional tests to evaluate surface tension, viscosity and the effectiveness of the aqueous film or polymeric membrane.

If the Technical Service Report for your foam concentrate sample reveals results consistent with its original specifications, it is considered satisfactory and suitable for fire service. Significant deviation from the original specifications in any of the test results may indicate one of the following problems:

1. Contamination
2. Improper storage conditions
3. Chemical change
4. Any combination of the above

At this point, fire tests are recommended.

## **FIRE TESTS**

Fire tests on foam samples are conducted within specially designed fire modeling equipment using a protocol developed to simulate full scale UL Standard (UL 162, 6th Edition) fires. Hydrocarbon and/or polar fuels are used as appropriate.

A satisfactory fire performance is achieved if a working strength solution of the sample extinguishes the fire within specified times. Then, after adding a flame source, the foam blanket must be able to prevent fuel Reignition.

## **HOW TO COLLECT FOAM CONCENTRATE SAMPLES**

### **THE IMPORTANCE OF COLLECTION FOAM CONCENTRATE SAMPLES**

If samples of foam concentrate are sent to NF's Technical Service Department on a regular basis, problems involving storage conditions can usually be detected and corrective measures recommended before the foam concentrate is irreversibly damaged. Periodic sampling of foam concentrate ensures its ready status in a fire emergency. In general, collect foam concentrate samples at least once a year.

### **SAMPLE COLLECTION**

Proper foam concentrate sampling is crucial. The foam concentrate sample submitted must represent the product in storage, whether in tanks or drums. Depending on your maintenance program, foam concentrate may consist of the following samples:

1. One sample - bottom only
2. Two samples - one top and one bottom
3. Three samples - one each from top, bottom and middle
4. One sample - composite after recirculating contents. This is the preferred method.

Submit all samples in a clean one-pint (500 ml) plastic bottle. If fire testing is recommended, a larger sample will be requested. "Request for Analysis" forms are available from your local representative or from NF world headquarters in Exton, PA.

### **BOTTOM SAMPLING**

Since the bottom of the tank may collect sediment such as rust, scale, or degradation products, it is important that these excessive contaminants be separated when drawing a sample.

A suggested procedure follows below:

1. Open the lowest drain valve and flush out one or two gallons of concentrate into a large clean bucket.
2. Fill at least one pint (500 ml) into a clean plastic bottle. Submit this sample for analysis.
3. Return the initial flushings to the top of the tank with the fill funnel. A strainer removes the excess sediment.

## **COMPOSITE SAMPLING**

Composite sampling is a good technique if many samples are collected. However, the contents of a storage tank must not be recirculated where dilution is known or suspected. Many fire protection engineers use a periodic start-up of their pumps and recirculation of the foam concentrate as part of their required maintenance program. Treat contents collected from the drain valve as bottom samples.

## **HOW TO CHOOSE A FOAM CONCENTRATE**

When selecting the proper foam concentrate, the flammable liquid or fuel will determine which one to use.

Basically, there are two general classes of flammable liquids; hydrocarbons and polar solvents.

Hydrocarbons are non-water miscible products such as crude oil, gasoline, hexane, naphtha, diesel oil, etc. Polar solvents are generally water miscible products such as alcohols, esters, ketones, etc. Moreover, some industrial solvents are a mixture of both classes.

Consider the following information to properly choose the most suitable foam concentrate:

1. Principal flammable liquids requiring protection (actual chemical name).
2. Foam solution application rates (may vary depending on concentrate selected).
3. Type of application. **Note:** Subsurface applications are **not** to be used on polar solvent hazards.
4. Foam concentrate cost.
5. System components and field piping cost.
6. Projected cost of foam system maintenance.

Remember, a little money invested in NF foam concentrates can save more money in field piping and maintenance expenses. Conversely, protection systems normally designed around a costly foam concentrate can now use a less expensive foam that also provides complete protection.

## **PROTEIN FOAM CONCENTRATES**

### **INTRODUCTION**

Regular Protein foams are intended for use on hydrocarbon fuels only. They produce a homogeneous, stable foam blanket that has excellent heat resistance, burnback, and drainage characteristics. Regular Protein foams have slow knockdown characteristics; however, they provide superior post fire security at very economical cost. Regular protein foams may be used with fresh or seawater. They **MUST** be properly aspirated and should not be used with non-aspirating structural fog nozzles.

Proteins foams were the first types of mechanical foam to be marketed extensively and have been used since World War II. These foams are produced by the hydrolysis of granulized keratin protein (protein hydrolysate) such as hoof and horn meal, chicken feathers, etc. In addition, stabilizing additives and inhibitors are included to prevent corrosion, resist bacterial decomposition and to control viscosity.

Protein foam concentrates work with all types of proportioning equipment manufactures by NF. They include line proportioners, standard pressure proportioners, bladder tank proportioners, standard balanced pressure proportioners, and in-line balanced pressure proportioners. See Section III of the NF Engineers Manual for specific details.

These regular type foams are not suitable for subsurface injection or protection of polar solvents and are generally not compatible with dry chemicals. However, they are compatible with all of the generally recognized construction materials for storage tanks and distribution systems with the exception of welded stainless steel tanks or aluminum tanks. Do not use galvanized pipe & fittings in foam concentrate service.

## **FLUOROPROTEIN FOAM CONCENTRATES**

Fluoroprotein foams have fluorochemical surfactants which greatly enhance performance with fast knockdown, improved resistance to fuel pick-up, and dry chemical compatibility. They are intended for use on Hydrocarbon fuels and select oxygenated fuel additives. As with Protein, they have excellent heat resistance, burnback, and post fire security. Fluoroprotein foams may be used with fresh or seawater. They **MUST** be properly aspirated and should not be used with non-aspirating structural fog nozzles.

Fluoroprotein foams are made by the addition of special fluorochemical surfactants to protein foam. This enhances the properties of protein foam by increasing foam fluidity and improves the properties of regular protein foam by providing faster knockdown and excellent fuel tolerance.

Fluoroprotein foams are designed for use on hydrocarbon-type flammable liquids fires through NFPA Type II devices and air-aspirating foam nozzles. However, these type concentrates are not used for non-aspirating equipment. Available in both 3% and 6% concentrations, XL Fluoroprotein Concentrates work with fresh or seawater. "Cold foams" are available for frigid climates or when heated storage is not available.

Fluoroprotein foam concentrates work with all of the proportioning equipment manufactures by NF. They include line proportioners, standard pressure proportioners, bladder tank proportioners, standard balanced pressure proportioners, and in-line balanced pressure proportioners. See Section III of the NF Engineering Manual for specific details.

They are compatible with all of the generally recognized construction materials for storage tanks and distribution systems with the exception of welded stainless steel tanks & aluminum storage tanks. Do not use galvanized pipe & fittings in pure concentrate service.

## **SYNTHETIC FOAM CONCENTRATES**

### **INTRODUCTION**

Synthetic concentrates date back to the first half of the century during the introduction of mechanical foams. The fluorine containing synthetic concentrates can generally be traced to development work carried out by the US Navy in the mid-1960's. These synthetic concentrates were called Aqueous

Film Forming Foams (AFFF's). Synthetic foam concentrates were divided into two groups: Conventional AFFF's and Alcohol Resistant AFFF's (AR-AFFF). In the early 1970's, NF invented and patented the AR-AFFF technology by introducing Universal. AR-AFFF is a synthetic product that was developed for **both** hydrocarbon and polar-solvent materials. Since then, NF introduced a variety of the AR-AFFF type concentrates. Although high expansion concentrates fall into the synthetic type, they are treated as a separate, distinct class of concentrates.

### **CONVENTIONAL AFFF FOAM CONCENTRATES**

AFFF's are designed to drain foam solution quickly from the foam bubble to produce optimum filming for rapid fire extinguishment.

These concentrates are a combination of fluorocarbon surfactants and synthetic foaming agents that add a new dimension to fire fighting - the aqueous film. This film is a thin layer of foam solution that spreads rapidly across the surface of most hydrocarbon fuels and causes dramatic fire "knockdown", an important factor in crash rescue fire fighting.

The aqueous film is produced by the action of the fluorocarbon surfactant reducing the surface tension of the foam solution to a point where the solution can actually be supported by the surface tension of the hydrocarbon fuel. Therefore, the effectiveness and durability of the aqueous film can be influenced by the surface tension of the hydrocarbon.

AFFF's are more effective on fuels with higher surface tension values such as kerosene, diesel oil, and jet fuels but less effective on fuels with low surface tension coefficients like hexane and high octane gasolines. However, long-term sealability and burnback resistance are sacrificed by this rapid drainage.

By design, AFFF's require a very low energy input to produce a good quality foam and a relatively long lasting blanket. AFFF's typically demonstrate sufficient foam-making ability that they will produce foam from non-aspirating equipment which has an impinging stream action to help draw in air. When used through air-

aspirating discharge devices, the foam extinguishes faster and offers better burnback resistance.

Of even greater significance, Aer-O-Water and Aer-O-Lite produce foam from standard type water sprinkler heads. The foam produces a sufficient quality to meet the requirements of Underwriters Laboratories for AFFF. Aer-O-Water and Aer-O-Lite will also produce adequately expanded foam through many directional and spray nozzles used in special hazard systems. Existing water deluge systems are readily converted to foam systems merely by adding the appropriate proportioning equipment.

Use NF's conventional AFFF's with fresh or sea water. "Cold Foam" versions are available upon request. All NF conventional AFFF's may be sparingly used as excellent wetting agents. They are compatible with dry chemical agents.

Conventional AFFF concentrates work with all types of proportioning equipment manufactured by NF except standard pressure proportioners. The specific gravity of these agents is so near the specific gravity of water that an adequate separation cannot be achieved and maintained. See Section III of the NF Engineering Manual for specific details.

### **ALCOHOL RESISTANT-AFFF FOAM CONCENTRATES**

#### **INTRODUCTION**

Certain flammable and combustible liquids known as polar solvents are destructive to conventional fire fighting foams. Polar solvents extract the water contained in the foam and rapidly destroy the foam blanket. Therefore, these fuels require alcohol or polar solvent resistant foam. Alcohol resistant concentrates include a polymer that protects the foam blanket from the water miscible fuel.

NF invented and patented present day AFFF based Alcohol Resistant (AR-AFFF) Foam technology. Today, NF's AR-AFFF concentrates are unquestionable the most effective and versatile foam concentrates available when a variety of fuels must be protected.

NF's AR-AFFF brand foam concentrates combine totally synthetic stabilizers, foamers, fluorocarbons and polymers. These polymers remain in the foam until it contacts the polar solvent. As the polar solvent extracts the water from the foam blanket,

this tough polymeric membrane prevents further destruction of the foam blanket. AR-AFFF can be used through NFPA Type II application devices as well as portable and monitor mounted air-aspirating nozzles.

NF offers a family of AR-AFFF brand foam concentrates to use on polar solvent hazards. Recent advances now incorporate the best features of all previous foams of this type into AR-AFFF brand concentrates that are highly effective on nearly all flammable liquids.

The fluorosurfactants in AR-AFFF effectively combat hydrocarbon fires and give them true AFFF film-forming capabilities. AR-AFFF concentrates use either fresh or sea water. Generally no special proportioning or foam making equipment is required; however, some standard proportioners reveal narrower proportioning ranges when using AR-AFFF type concentrates.

With the exception of standard pressure proportioners, all of the proportioners manufactured by NF work with AR-AFFF concentrates. See Section III of the NF Engineering Manual for specific details.

NF AR-AFFF concentrates are suitable for subsurface injection into hydrocarbon fuels; however, they are not suitable for subsurface injection into polar solvent fuels.

Consult individual Data Sheets or system design sections for recommended application rates and proportioning requirements.

## **HIGH EXPANSION FOAM CONCENTRATES**

### **INTRODUCTION**

NF's High Expansion, or Synthetic Detergent foam concentrate is designed for use through air-aspirating or forced air devices producing foam expansions from 100 to one up to 1000 to one. These very high expansion ratios produce large quantities of finished foam from relatively small amounts of water and foam concentrate. 1-1/2% proportioning is recommended for most medium to high expansion foam generators.

High expansion foam applies primarily on Class A fires in confined areas such as basements, mine

shafts, attics and other places inaccessible to the fire fighter. By placing a high expansion foam generator at an opening into a confined space and providing proper ventilation at a point opposite the generator, a fire can be brought under control without personnel entering a potentially hazardous space. High expansion foam control fires by cooling, smothering and reducing oxygen content by steam dilution. Exercise care in positioning the foam generator so that combustible products are not drawn into the air inlet. Ventilation must be planned carefully to allow foam to reach all areas of the confined space.

## **CLASS A FOAM CONCENTRATES**

### **INTRODUCTION**

Class A foam concentrates are a mixture of foaming and wetting agents in a non-flammable solvent. These products are generally non-hazardous, non-corrosive and non-flammable.

Class A foam is typically used at very low concentrations. Proportioning percentages range from 0.1% to 1% by volume of water. In addition to the methods of proportioning discussed in this guide, premixing provides an inexpensive and uncomplicated method for use. Unlike Class B foams, proportioning accuracy and application rates are not as critical to the performance of the foam.

Class A foam extinguishes by isolating the fuel, reducing the fuel temperature and separating the supply of oxygen. The most common method of extinguishment is the use of water for cooling and heat absorption. Water is relatively abundant, easy to use and able to absorb great amounts of heat as it turns to a vapor. In order for water to absorb the maximum amount of heat, it is necessary that each drop of water turns to vapor.

- Spreads water over the Class A fuel
- Slowly releases its water
- Adheres to itself
- Penetrates the fuels