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NFPA 298
Foam Chemicals for Wildland Fire Control
1989 Edition

NFPA

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

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There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NFPA 298

Standard on
Foam Chemicals for Wildland Fire Control

1989 Edition

This edition of NFPA 298, *Standard on Foam Chemicals for Wildland Fire Control*, was prepared by the Technical Committee on Forest and Rural Fire Protection and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 15-18, 1989 in Washington, DC. It was issued by the Standards Council on July 14, 1989, with an effective date of August 7, 1989.

The 1989 edition of this document has been approved by the American National Standards Institute.

Origin and Development of NFPA 298

This is the first edition of NFPA 298. The Technical Committee on Forest and Rural Fire Protection developed the document in response to a perceived need for a performance standard dealing with foam chemicals used in control of wildland fires.

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Contents

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Standard on

Foam Chemicals for Wildland Fire Control

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.

Information on referenced publications can be found in Chapter 4.

Chapter 1 Introduction

1-1 Scope. This standard specifies requirements and test procedures for foam chemicals used in wildland fire fighting.

1-2 Purpose.

1-2.1 The standard specifies requirements for foam chemicals that are applied to vegetation to help control wildland fires.

1-2.2 Tests are used to indicate compliance with the requirements of this standard and shall not be deemed as establishing performance levels in actual fire fighting situations.

1-3* Wildland Fire Suppressant Foam. Wildland fire suppressant foam within the scope of this standard is a relatively stable aggregation of small bubbles having a lower density than water. The foam bubble and its draining solution attaches to and penetrates Class A fuels due to its ability to reduce the surface tension of water. It excludes the air from the fuel, envelopes the volatile combustible vapors and the fuel interface when applied in adequate quantities, and resists disruption due to wind, heat, and flame attack. Use levels for these wildland fire suppressant foams generally fall within the area of 0.1 percent to 1.0 percent as opposed to conventional Class B foam, which generally has use levels of 3.0 percent or 6.0 percent.

1-4 Definitions.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

Biodegradability. The decomposition of organic matter through the action of microorganisms, which results in the evolution of carbon dioxide.

Expansion. The ratio of the volume of the foam in its aerated state to the original volume of the nonaerated foam solution.

Foam. Foam is the aerated solution created by forcing or entraining air into a water solution containing a foam concentrate by means of suitably designed equipment or by cascading it through the air at a high velocity.

Foam Concentrate. The concentrated foaming agent as received from the manufacturer and approved for use in wildland fire situations by the authority having jurisdiction.

Foam Solutions. A homogeneous mixture of water and foam concentrate in the proportions required to meet the needs of the user.

Foam Drain Time. Drainage time is the time in minutes that it takes for a specified percent of the total solution contained in the foam to revert to liquid and to drain out of the bubble structure.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

LC_{50}. The concentration (mg/kg) in water at which 50 percent of the test organisms die.

LD_{50}. The dosage (mg/kg of body weight) at which 50 percent of the test animals die.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.

Surface Tension. In any liquid, surface tension results from the high molecular concentration of the liquid compared to the low molecular concentration of the gas. The attractive force exerted by the molecules below the surface upon those at the surface/air interface creates an inward pull of internal pressure that tends to restrain the liquid from flowing. Its strength varies with the nature of the liquid.

Shall. Indicates a mandatory requirement.

Should. Indicates a recommendation or that which is advised but not required.

Use Level. The proportion of foam concentrate in the foam solution, expressed as a percentage.

Chapter 2 Requirements for Foam Chemicals

2-1 Corrosion.

2-1.1* Uniform Corrosion. The foam concentrate and foam solution over the range of recommended use levels shall not exhibit values exceeding those given in Table 2-1.1 when tested in accordance with Section 3-1.

2-1.2 Intergranular Corrosion. The magnesium and aluminum coupons used in Table 2-1.1 shall exhibit no intergranular corrosion when examined in accordance with 3-1.1.

2-1.3 Manufacturer shall indicate materials and treatments suitable for construction of tanks for storage of foam concentrate and foam solutions.

2-2 Health and Safety.

2-2.1* Toxicity. The foam concentrate and the foam solution at recommended use level shall meet toxicity requirements when tested in accordance with Section 3-2 and rating scales defined in Table 2-2.1 by an independent biological testing laboratory.

2-2.1.1 A summary of the toxicity testing results and a material safety data sheet shall be provided by the manufacturer upon request.

2-2.2* Flammability. The foam concentrate shall be tested according to Section 3-3. If it exhibits a closed cup flash point below 142 °F (61 °C), it shall show no fire when tested by ASTM 3119.

2-3 Environment.

2-3.1* Biodegradability. The foam concentrate shall be tested in accordance with Section 3-4. Test samples shall show at least 50 percent ultimate biodegradation in 28 days.

2-3.2 Fish Toxicity. The foam concentrate shall be tested in accordance with Section 3-5. The LC_{50} shall be greater than 10 mg/liter when measured after 96 hours of exposure.

Table 2-1.1 Corrosion Requirements for Wildland Fire Foams[1]

	2024-T3 Aluminum				4130 Steel				Yellow Brass				Az-31-B Magnesium			
	Total 70°	Immersion 120°	Partial 70°	Immersion 120°	Total 70°	Immersion 120°	Partial 70°	Immersion 120°	Total 70°	Immersion 120°	Partial 70°	Immersion 120°	Total 70°	Immersion 120°	Partial 70°	Immersion 120°
	mils-per-year															
Premix Components																
Liquid concentrates	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	10.0[2]	10.0[2]	10.0[2]	10.0[2]
Mixed Solutions																
Fixed wing	2.0[4]	2.0[4]	2.0[4]	2.0[4]	2.0	2.0	5.0	5.0	2.0	2.0	5.0	5.0	–[3]	–[3]	–[3]	–[3]
Helicopter with internal or fixed tank	2.0[4]	2.0[4]	2.0[4]	2.0[4]	2.0	2.0	5.0	5.0	2.0	2.0	5.0	5.0	2.0[4]	4.0[4]	2.0[4]	4.0[4]
Ground application or helicopter with bucket	2.0	2.0	2.0	2.0	2.0	2.0	5.0	5.0	2.0	2.0	5.0	5.0	–[3]	–[3]	–[3]	–[3]

[1] All corrosion rates are determined by 90-day weight loss. All uniform corrosion rates are the maximum allowable average of at least 2 replicates. In addition, the standard error of the mean of the results of the replicates shall not exceed 0.5 for total immersion or 1.0 partial immersion. (The number of replications may be increased to decrease the standard error if all values are retained to calculate the average and the standard error.)

$$s_m = \sqrt{\frac{\Sigma_{x_i}{}^2 - n\bar{x}^2}{n^2}}$$

s_m = Standard error of the mean, x_i = Individual corrosion rate value,
$\bar{x}$ = Average corrosion rate value, n = Number of observations.

[2] If submitted for "helicopter with internal or fixed tank"; for all other types, refer to footnote 3.
[3] Test shall be conducted for performance information.
[4] Intergranular corrosion tests shall be performed; no intergranular corrosion is allowed.

Table 2-2.1 Toxicity Tests

FORMULA ________ **MIX LEVEL** ________ **MANUFACTURER** ________ **INDEP. LAB** ________ **DATE** ________

	Acute Oral Toxicity	*Acute Dermal Toxicity*	*Primary Dermal Irritation*	*Primary Eye Irritation*	
				Unwashed	*Washed*
Requirements Foam concentrate	$LD_{50} > 500$ mg/kg If $LD_{50} \geqslant 50$ but < 500 demonstrate protective gear/handling procedures. No $LD_{50} \leqslant 50$ are acceptable.[1]	$LD_{50} > 2000$ mg/kg If $LD_{50} > 200$ but < 2000 demonstrate protective gear/handling procedures. No $LD_{50} \leqslant 200$ are acceptable.[1]	Primary irritation score: < 5.0 If more irritating, demonstrate protective gear/handling procedures.	Mildly irritating. If more irritating demonstrate protective gear/handling procedures.	Mildly irritating. If more irritating demonstrate protective gear/handling procedures.
Requirements Foam solution	$LD_{50} > 5000$ mg/kg	$LD_{50} > 2000$ mg/kg	Primary irritation score: < 5.0	Mildly irritating	Mildly irritating
Performance Test Protocol Federal Register Vol. 43, No 163	Series 81-1 If $LD_{50} \leqslant 500$ mg/kg Acute Inhalation Protocol 81-3 Stillmeadows, Inc. Protocol S9 - F66	Series 81-2 If $LD_{50} \leqslant 1000$ mg/kg Acute Inhalation Protocol 81-3 Stillmeadows, Inc.	Series 81-5	Series 81-4	Series 81-4

[1] Acute inhalation toxicity. inhalation $LC_{50} > 2.0$ gm/L if oral LD_{50} is $\leqslant 500$ mg/kg or dermal $LD_{50} \leqslant 1000$ mg/kg.

2-4 Foam Characteristics.

2-4.1 Foam expansion and drain time shall be determined at a 0.3 percent use level when tested in accordance with Section 3-6. The values for fresh water and synthetic salt water shall be determined.

2-4.1.1 Freeze Test. Concentrate sample that has been frozen to a solid state and then returned to 70 °F ± 5 °F for 24 hours shall be tested in accordance with 2-4.1. Values obtained for expansion shall be within ± 15 percent and drain time within ± 2 minutes of the values obtained for concentrate that was not previously frozen and was tested according to 2-4.1.

2-4.2* Foam concentrate shall be tested in accordance with Section 3-7. Foam concentrate shall not stratify, crystallize, or otherwise separate at the end of the tests.

2-5 Packaging and Labeling.

2-5.1 Packaging. Packaging of foam concentrates shall conform with regulations governing ground and air transport of materials. Containers shall meet U.S. Department of Transportation or Canadian Transport Commission 34 Regulations.

2-5.2 Labeling. Manufacturer shall permanently label each container with the following information in addition to information required by government agencies:

(a) Manufacturer's name and address

(b) Lot number and date of manufacture

(c) 25 percent drain time for fresh and salt water, as determined in 2-4.1

(d) Expansion ratio for fresh and salt water, as determined in 2-4.1

(e)* Manufacturer recommended use level for various uses

(f) Emergency and first aid instructions

(g) Total weight of product and container

(h) Volume of concentrate in container in U.S. gallons and liters

(i) Statement that the product meets all requirements of NFPA 298-1989.

Chapter 3 Procedure for Cleaning Corrosion Coupons and Testing

3-1 Corrosion Test. Each coupon, 1 in. × 4 in. × ⅛ in., shall be marked (by vibrating engraver) with a unique identification code, drilled in the upper center to insert the braided dacron string with which to suspend it, and then measured to the nearest 0.001 cm in each dimension (length, width, and thickness). Just prior to use, each coupon shall be degreased using an all-purpose liquid cleaner and rinsed in tap water. The coupons shall then be cleaned chemically as described in Table 3-1, rinsed in distilled water, wiped to remove most of the water film, and dried at about 130 °F for 15 to 30 minutes. After the coupons are cooled to room temperature, they shall be weighed to 0.1 mg and either used immediately or stored in a desiccator. After cleaning, coupons shall be suspended by a length of braided dacron fishing line in a 1-quart glass jar in such a way that the coupon will not touch the sides or bottom of the jar. Each jar shall contain 800 ml of solution for total immersion tests or 400 ml of solution for partial immersion tests. The coupon shall be suspended so that one-half its length is immersed in the liquid and one-half is exposed to the vapor for partial immersion tests. The coupon shall be completely covered with liquid for total immersion tests. Each jar shall be closed with a screw cap, labeled with coupon identification and starting date, and put in an incubator at 70 °F or 120 °F.

Jars containing the test solution (three at each exposure and temperature) shall stand undisturbed for 90 days.

At the end of the 90-day test period, the coupons shall be removed from the liquid and rinsed under running water to remove loosely attached corrosion products. If necessary, the coupons shall be lightly scrubbed with a toothbrush or other nonmetallic brush to aid in removal of scale. The coupons shall then be cleaned chemically using the same procedures that were used initially in Table 3-1. A clean, unused coupon shall be cleaned in the same manner to act as a control for weight lost during the cleaning process. After rinsing in distilled water, oven-drying, and cooling as before, the final weight of each coupon shall be determined to 0.1 mg.

The corrosion weight (Cr) in mils-per-year (MPY) shall be calculated for each sample by:

$$Cr = 534 \frac{Wt_I - Wt_F - Wt_C}{A\ t\ p}$$

where:

Wt_I = initial coupon weight, mg

Wt_F = final coupon weight, mg

Wt_C = weight loss of the control, mg

A = area of the coupon, in.^{2}

t = exposure, hr

p = density of the alloy, g/cm^3

i.e., for 2024-T3 aluminum = 2.77 g/cm^3
4130 steel = 7.86 g/cm^3
yellow brass = 8.53 g/cm^3
Az-31-B magnesium = 1.77 g/cm^3

Results of replicate test shall be averaged.

Corrosion rates of all coupons of the same alloy and test conditions shall be averaged and the standard error of the mean (s_m) calculated as follows:

$$s_m = \sqrt{\frac{\Sigma_{x_i}{}^2 - n\bar{x}^2}{n^2}}$$

Where:

x_i = single corrosion rate value

x = average corrosion rate value

n = number of values

If the corrosion rate exceeds the allowable value, or the standard error of the mean exceeds 0.5 for total immersion or 1.0 for partial immersion, additional tests shall be run and new values of the mean and standard error of mean shall be obtained. All values obtained shall be retained and included in the final calculation.

3-1.1 Intergranular Corrosion Test. The mixed solution shall be tested for intergranular corrosion as required by 2-1.2 by the following procedure:

At least one coupon for each exposure and temperature from 90-day weight loss tests on the specified alloys shall be sliced as shown in Figure 3-1.1, mounted, polished to 0.3 micron alumina finish, etched with Keller's reagent using standard metallurgical techniques, and examined microscopically up to a magnification of 600X.

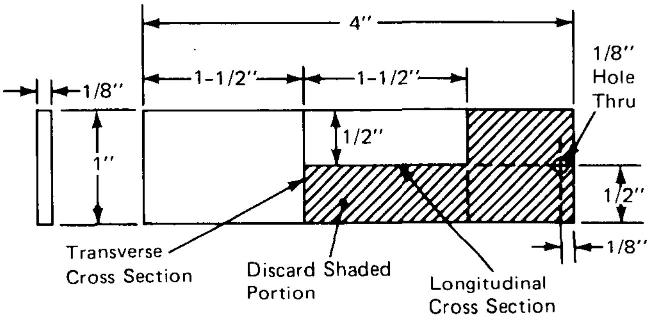

Figure 3-1.1 Intergranular corrosion test.

3-2 Toxicity. Foam concentrate and foam solution samples shall be tested in accordance with "Pesticide Assessment Guidelines, Subdivision F, Hazard Evaluation: Human and Domestic Animals," U.S. Environmental Protection Agency, Washington, D.C., as found in Federal Register, Volume 43, Number 163.

3-3* Flash Point Testing. Samples of foam concentrate shall be tested to ASTM D56-79, *Flash Point by Tag Closed Tester*, or ASTM D93-80, *Flash Point by Pensky-Martens Closed Tester*, as applicable. If the concentrate exhibits a flash point below 142 °F (61 °C), it shall be tested in accordance with

Table 3-1 Procedure for Cleaning Corrosion Coupons

Alloy	Chemical	Time	Temperature	Remarks
Aluminum	70% HNO_3	2-3 min.	Room	Follow with light scrub using nonmetallic brush[1]
Aluminum	2% CrO_3 5% H_3PO_4 Soln	10 min.	175°-185°F	Use when film resists HNO_3 — alternate 2 treatments as needed
Brass	15-20% HCl	2-3 min.	Room	Follow with light scrub using nonmetallic brush[1]
Steel	50g SnCl + 20 g $SbCl_3$ in 1 liter conc. HCl	3-5 min.	Cold	Follow with light scrub using nonmetallic brush[1]
Magnesium	15% CrO_3 + 1% $AgCrO_4$ in distilled H_2O	15 min.	Boiling	Follow with light scrub using nonmetallic brush[1]

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[1] A rubber stopper, Scotch Brite™ (or equal, nonmetallic scourer or scrubber) can be used to scrub coupons with a hard or severe coating.

ASTM 3119-75, *Mist Spray Flammability of Hydraulic Fluids*, when the sample is at 70 °F (22 °C).

3-4* Biodegradability Test.

3-4.1 796-3100 Aerobic Aquatic Biodegradation.

3-4.1.1 Introduction-Purpose. This test is designed to develop data on the rate and extent of aerobic biodegradation that might occur when chemical substances are released to aquatic environments. A high biodegradability result in this test provides evidence that the test substance shall be biodegradable in natural aerobic freshwater environments. On the contrary, a low biodegradation result may have other causes than poor biodegradability of the test substance. Inhibition of the microbial inoculum by the test substance at the test concentration may be observed. In such cases, further work is needed to assess the aerobic aquatic biodegradability and to determine the concentrations at which toxic effects are evident. An estimate of the expected environmental concentration shall help to put toxic effects into perspective.

3-4.2 Definitions.

Adaption. The process by which a substance induces the synthesis of any degradative enzymes necessary to catalyze the transformation of that substance.

Ultimate Biodegradability. The breakdown of an organic compound to CO_2, water, the oxides or mineral salts of other elements, and/or to products associated with normal metabolic processes of microorganisms.

Ready Biodegradability. An expression used to describe those substances that, in certain biodegradation test procedures, produce positive results that are unequivocal and that lead to the reasonable assumption that the substance will undergo rapid and ultimate biodegradation in aerobic aquatic environments.

3-4.3 This test method is based on the method described by William Gledhill (1975). The method consists of a 2-week inoculum build-up period during which soil and sewage microorganisms are provided the opportunity to adapt to the test compound. This inoculum is added to a specially equipped Erlenmeyer flask containing a defined medium with test substance. A reservoir holding barium hydroxide solution is suspended in the test flask. After inoculation, the test flasks are purged with CO_2-free air, sealed, and incubated with shaking in the dark. Periodically samples of the test mixture containing water-soluble test substances are analyzed for dissolved organic carbon (DOC) and the $Ba(OH)_2$ from the reservoirs is titrated to measure the amount of CO_2 evolved. Differences in the extent of DOC disappearance and CO_2 evolution between control flasks containing no test substance and flasks containing test substance are used to estimate the degree of ultimate biodegradation.

3-4.4 Prerequisites. The total organic carbon (TOC) content of the test substance shall be calculated or, if this is not possible, analyzed to enable the percent of theoretical yield of carbon dioxide and percent of DOC loss to be calculated.

3-4.5 Test Information.

3-4.5.1 Information on the relative proportions of the major components of the test substance will be useful in interpreting the results obtained, particularly in those cases where the result lies close to a "pass level."

3-4.5.2 Information on the toxicity of the chemical may be useful in the interpretation of low results and in the selection of appropriate test concentrations.

3-4.6 Reference Substances. Where investigating a chemical substance, reference compounds may be useful and an inventory of suitable reference compounds shall be identified. In order to check the activity of the inoculum the use of a reference compound is desirable. Aniline, sodium citrate, dextrose, phthalic acid, and trimellitic acid will exhibit ultimate biodegradation under the conditions of this test guideline method. These reference substances shall yield 60 percent of theoretical maximum CO_2 and show a removal of 70 percent DOC within 28 days. Otherwise the test is regarded as invalid and shall be repeated using an inoculum from a different source.

3-4.7 Reproducibility. The reproducibility of the method has not yet been determined; however it is believed to be appropriate for a screening test that has solely an acceptance but no rejective function.

3-4.8 Sensitivity. The sensitivity of the method is determined by the ability to measure the endogenous CO_2 production of the inoculum in the blank flask and by the sensitivity limit of the dissolved organic carbon analysis. If the test is adapted to handle ^{14}C-labeled test substances, test substance concentration can be much lower.

3-4.9 Possibility of Standardization. This possibility exists. The major difficulty is to standardize the inoculum in such a way that interlaboratory reproducibility is ensured.

3-4.10 Possibility of Automation. None at present, although parts of the analyses may be automated.

3-4.11 Test Procedures.

3-4.11.1 Apparatus. The shake flask apparatus in Figure 3-4.11.1 shall consist of an open reservoir containing 10 ml of 0.2 N $Ba(OH)_2$ suspended over 1 liter of culture medium in a 2-liter Erlenmeyer flask.

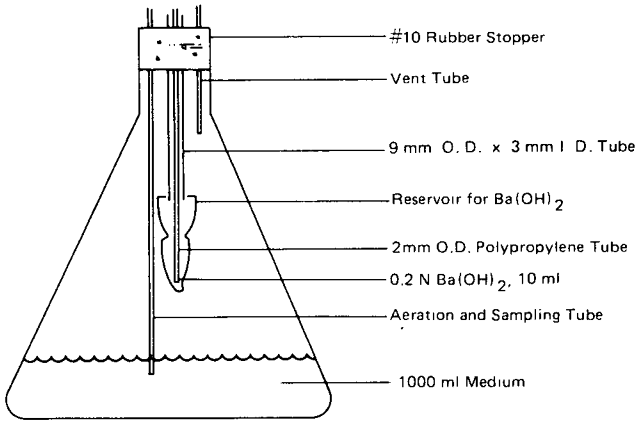

Figure 3-4.11.1 Shake-flask system for carbon dioxide evolution.

The $Ba(OH)_2$ container shall be made by placing a constriction just above the 10 ml mark of a 50 ml heavy-duty centrifuge tube and attaching the centrifuge tube to a 2 mm I.D. × 9 mm O.D. glass tube by means of 3 glass support rods. The centrifuge tube opening shall be large enough to permit CO_2 to diffuse into the $Ba(OH)_2$, while the constriction permits transferal of the flask to and from the shaker without $Ba(OH)_2$ spillage into the medium. For periodic removal and addition of base from the center well, a polypropylene capillary tube, attached at one end to a 10 ml disposable syringe, shall be inserted through the 9 mm O.D. glass tube into the $Ba(OH)_2$ reservoir. The reservoir access port shall be sealed during incubation with a serum bottle stopper. Two glass tubes shall be added for purging, venting, and medium sampling. The tops of these tubes shall be connected with a short section of flexible tubing during incubation.

3-4.11.2 Reagents and Stock Solutions.

- Stock solutions, I, II, and III in Table 3-4.11.2.
- Yeast extract.
- Vitamin-free casamino acids.
- 70 percent O_2 in nitrogen or CO_2-free air.
- 0.2 N $Ba(OH)_2$.
- 0.1 N HCl.
- 20 percent H_2SO_4.
- Phenolphthalein.
- Dilution water — distilled, deionized water (DIW).

3-4.11.3 Soil Inoculum. A fresh sample of an organically rich soil shall be used as the inoculum in the ultimate biodegradation test. Soil shall be collected, prepared, and stored according to the recommendations of Pramer and Bartha (1972). The soil surface shall be cleared of litter and a soil sample is obtained to 20 cm below the surface. The sample shall be screened through a sieve with 2 to 5 mm openings and stored in a polyethylene bag at 2 to 4 °C for not more than 30 days prior to use. The soil shall never be allowed to air-dry, and shall not be frozen during storage.

Table 3-4.11.2 Medium Employed for Assay of CO_2 Evolution

Solution[1]	Compound	Stock Solution Conc. (g/L)
I	NH_4Cl	35
	KNO_3	15
	K_2HPO_4-$3H_2O$	75
	NaH_2PO_4-H_2O	25
II[2]	KCl	10
	$MgSO_4$	20
	$FeSO_4$-$7H_2O$	1
III	$CaCl_2$	5
	$ZnCl_2$	0.05
	$MnCl_2$-$4H_2O$	0.5
	$CuCl_2$	0.05
	$CoCl_2$	0.001
	H_3BO_3	0.001
	MoO_3	0.0004

[1] Each liter of test medium contains 1 ml of each solution

[2] Final pH is adjusted to 3.0 with 0.10 N HCl

3-4.11.4 Acclimation Medium. Acclimation medium shall be prepared by adding for each liter of distilled, deionized water (DIW): 1 ml each of solutions I, II, and III in Table 3-4.11.2, 1.0 gm of soil inoculum, 2.0 ml of aerated mixed liquor (obtained from an activated sludge treatment plant not more than 2 days prior to commencing the acclimation phase, and stored in the interim at 4 °C) and 50 ml raw domestic influent sewage. This medium shall be mixed for 15 minutes and filtered through a glass wool plug in a glass funnel. The filtrate shall be permitted to stand for 1 hour, refiltered through glass wool, and supplemented with 25 mg/L each of Difco vitamin-free casamino acids and yeast extract. Appropriate volumes shall be added to 2-liter Erlenmeyer flasks. Test compounds shall be added incrementally during the acclimation period at concentrations equivalent to 4 and 8 mg/L carbon on days 0.7 and 11, respectively. On day 14, the medium shall be refiltered through glass wool prior to use in the test. For evaluating the biodegradability of a series of functionally or structurally related chemicals, media from all inoculum flasks shall be combined before final filtration.

3-4.12 Procedures.

3-4.12.1 Inoculum (100 ml of acclimation medium) shall be added to 900 ml DIW containing 1 ml each of solutions I, II, and III in Table 3-4.11.2 in a 2-liter Erlenmeyer flask. Test compound equivalent to 10 mg/liter carbon shall be added to each of the replicate flasks containing the test medium. Ten ml of 0.2 N $Ba(OH)_2$ shall be added to the suspended reservoir in each flask and duplicate 10 ml samples of $Ba(OH)_2$ shall also be saved as titration blanks for analysis with test samples. Flasks shall be purged with CO_2-free air (for volatile test materials, purging is done prior to addition of the chemical), sealed, and placed on a gyrotary shaker (approximately 125 rpm) at 20 to 25 °C in the dark. For each set of experiments, each test, reference, inhibited, and control system shall be analyzed at time zero and at a minimum of four other times from time zero through day 28. Sampling shall be made with sufficient frequency to allow for a smooth plot of biodegradation with time. Sampling times shall be varied by the investigator as deemed appropriate to match the rate of degradation of the test substance. Tests shall be terminated when biodegradation reaches a plateau and is consistent (±10 percent) over 3 consecutive days or on day 28, whichever occurs first. For chemicals that are water soluble at the test concentration, an adequate volume (5 to 10 ml) of medium shall be removed for DOC analysis. Each sample for DOC analysis shall be filtered through a membrane filter of 0.45 micrometer pore diameter before DOC analysis. For all test and reference compounds, $Ba(OH)_2$ from the center well shall be removed for analysis. The center well shall be rinsed with 10 ml CO_2-free DIW and shall be refilled with fresh base. Rinse water shall be combined with the $Ba(OH)_2$ sample to be analyzed. Flasks shall be resealed and placed on the shaker. On the day prior to terminating the test, 3 ml of 20 percent H_2SO_4 shall be added to the medium to release carbonate bound CO_2.

3-4.12.2 For each set of experiments, each test substance shall be tested in triplicate.

3-4.12.3 For each set of experiments, one or two reference compounds shall be included to assess the microbial activity of the test medium. Duplicate reference flasks shall be prepared by adding reference compound equivalent to 10 mg/liter carbon to each of two flasks containing the test medium. Reference compounds that are positive for ultimate biodegradability include: sodium citrate, dextrose, phthalic acid, trimellitic acid, and aniline.

3-4.12.4 For each test set, triplicate controls receiving inoculated medium and no test compound, plus all test and reference flasks, shall be analyzed for CO_2 evolution and DOC removal. Results from analyis of the control flasks (DOC, CO_2 evolution, etc.) shall be subtracted from corresponding experimental flasks containing test compound in order to arrive at the net effect due to the test compound.

3-4.12.5 A test system containing a growth inhibitor shall be established as a control for each substance tested for biodegradation by this method. That inhibited system shall contain the same amount of water, mineral nutrients, inoculum, and test substance used in the uninhibited test systems, plus 50 mg/liter mercuric chloride ($HgCl_2$) to inhibit microbial activity.

3-4.12.6 Flasks shall be incubated in the dark to minimize both photochemical reactions and algal growth. Appropriate sterile controls or controls containing a metabolic inhibitor, such as 50 mg/liter $HgCl_2$, are needed to correct for interferences due to nonbiological degradation. With volatile organic materials, purging with CO_2-free air shall be performed only once just prior to addition of the test chemical. Analyses for CO_2 evolution and DOC removal shall be conducted within 2 to 3 hours of sampling to minimize interferences that may occur in storage. All glassware shall be free of organic carbon contaminants.

3-4.13 Analytical Measurements. The quantity of CO_2 evolved shall be measured by titration of the entire $Ba(OH)_2$ sample [10 ml $Ba(OH)_2$ + 10 ml rinse water with 0.1 N HCl] to the phenolphthalein end point. $Ba(OH)_2$ blanks shall also be supplemented with 10 ml CO_2-free DIW and titrated in a similar manner. Samples (5 ml) for DOC shall be centrifuged and/or filtered and supernatant or filtrate analyzed by a suitable total organic carbon method.

3-4.14 Data and Reporting; Treatment of Results.

3-4.14.1 Test compound (10 mg carbon) is theoretically converted to 0.833 mmol CO_2. Absorbed CO_2 precipitates as $BaCO_2$ from $Ba(OH)_2$, causing a reduction in alkalinity by the equivalent of 16.67 ml of 0.1 N HCl for complete conversion of the test compound carbon to CO_2. Therefore, the percent theoretical CO_2 evolved from the test compound shall be calculated at any sampling time from the formula:

$$\text{Percent } CO_2 \text{ evolution } = [(TF - CF)/16.67]\ 100 \text{ (for 10 mg/L test compound carbon)}$$

where:

TF = ml 0.1 N HCl required to titrate $Ba(OH)_2$ samples from the test flask.

CF = ml 0.1 N HCl required to titrate $Ba(OH)_2$ samples from the control flask.

3-4.14.2 The cumulative percent CO_2 evolution at any sample time shall be calculated as the summation of the percent CO_2 evolved at all sample points of the test.

3-4.14.3 The percent DOC disappearance from the test compound shall be calculated from the following equation:

$$\text{Percent DOC Removal } = [1 - (DTF_x - DCF_x)/DTF_0 - DCF_0)]\ 100$$

where:

DTF = Dissolved organic carbon from test flask

DCF = Dissolved organic carbon from control flask

0 = Day zero measurements

x = Day of measurements during test.

3-4.14.4 The difference between the amount of 0.1 N HCl used for the $Ba(OH)_2$ titration blank samples and the $Ba(OH)_2$ samples from the control units (no test compound) shall be an indication of the activity of the microorganisms in the test system. In general, this difference shall be approximately 1 to 3 ml of 0.1 N HCl at each sampling time. A finding of no difference in the titration volumes between these two samples indicates a poor inoculum. In this case, the validity of the test set shall be rerun beginning with the acclimation phase.

3-4.14.5 CO_2 evolution in the reference flasks shall also be indicative of the activity of the microbial test system. The suggested reference compounds shall all yield final CO_2 evolution values in the range 80 to 100 percent of theoretical CO_2. If, for any test set, the percent theoretical CO_2 evolution value for the reference flasks is outside this range, the test results are considered invalid and the test shall be rerun.

3-4.14.6 Inhibition by the test compound shall be indicated by lower CO_2 evolution in the test flasks than in the control flasks. If inhibition is noted, the study for this compound shall be rerun beginning with the acclimation phase. During the test phase for inhibitory compounds, the test chemical shall be added incrementally according to the schedule: Day 0 — 0.5 mg/liter as organic carbon. Day 2 — 1 mg/liter C; Day 4 — 1.5 mg/liter C; Day 7 — 2 mg/liter C; Day 10 — 5 mg/liter C. For this case, the $Ba(OH)_2$ shall be sampled on Day 10, and weekly thereafter. The total test duration remains 28 days.

3-4.14.7 The use of ^{14}C-labeled chemicals is not required. If appropriately labeled test substance is readily available and if the investigator chooses to use this procedure with labeled test substance, this is an acceptable alternative. If this option is chosen, the investigator shall use lower test substance concentrations if those concentrations are more representative of environmental levels.

3-4.15 Test Report. For each test and reference compound, the following data shall be reported.

3-4.15.1 Information on the inoculum, including source, collection date, handling, storage, and adaptation possibilities (i.e., that the inoculum might have been exposed to the test substance either before or after collection and prior to use in the test).

3-4.15.2 Results from each test, reference, inhibited (with $HgCl_2$), and control system at each sampling time, including an average test result for the triplicate test substance systems and the standard deviation for that average.

3-4.15.3 Average cumulative percent theoretical CO_2 evolution over the test duration.

3-4.15.4 Dissolved organic carbon due to test compound at each sampling time (DTF-DCF).

3-4.15.5 Average percent DOC removal at each sampling time.

3-4.15.6 Twenty-eight day standard deviation for percent CO_2 evolution and DOC removal.

3-5* Fish Toxicity. Foam concentrate samples shall be tested, using Salmo Gairdneri (rainbow trout), in accordance with "Procedures for Measuring Acute Lethal Toxicity of Liquid Effluent to Fish," Bioassay Task Force of British Columbia (1982), or equivalent test procedures recognized by the authority having jurisdiction where the foam concentrate will be used.

3-6 Foam Expansion and Drain Time.

3-6.1 Foam sampling shall be accomplished using the following:

(a) Foam generating blender.[1]

(b) Sample of manufacturers foam concentrate.

(c) Standard (1600 ml) container.

(d) Scale balance with 2610 gram capacity that measures to the nearest one gram.

(e) Stopwatch.

(f) Thermometer.

(g) Work sheet.

(h) Synthetic seawater. Synthetic seawater shall be used in place of natural seawater and it shall be prepared as follows:

	% by mass
magnesium chloride ($MgCl_2\text{-}6H_2O$)	1.10
calcium chloride ($CaCl_2\text{-}2H_2O$)	0.16
anhydrous sodium sulfate (Na_2SO_4)	0.40
sodium chloride C.P. (NaCl)	2.50
fresh water (from CGSB 28-GP-74M)	95.84

and testing shall be done at water temperature 70 °F (21 °C) ± 5 °F (± 3 °C)

(i) Fresh water. Potable water with a hardness no greater than 200 ppm at a temperature of 70 °F (21 °C) ± 5 °F (± 3 °C).

3-6.2 Procedure for Measuring Expansion and Drainage Rates of Foam.

3-6.2.1 Foam generating procedures using apparatus described in 3-6.1:

(a) Prepare 300 ml foam solution from manufacturer's product at 0.3 percent use level.

(b) Maintain solution, mixing containers and measuring containers between 68 °F (20 °C) and 72 °F (22 °C).

(c) Pour solution into blender and run blender at 15,500 rpm for 20 seconds to generate foam.

(d) Immediately transfer generated foam into the 1600 ml standard container. Start stopwatch in order to provide "zero" time for the drainage test described later. Excess foam shall be struck off the top of the 1600 ml standard container with a straight edge and also wiped off the outside of the container immediately after filling. If the standard container is not full, then the actual volume for analysis shall be recorded. The sample is now ready for analysis.

3-6.2.2 Foam Testing Procedure.

3-6.2.2.1 Foam Testing. The foam samples, as obtained in the above described procedures, shall be analyzed for expansion and 25 percent drainage time. Duplicate samples shall be obtained whenever possible and the results averaged for the final value.

3-6.2.2.2 Procedure. Prior to the testing, the empty standard container fitted with a drain hose and clamp shall be weighed to obtain the tare weight. (All containers shall be adjusted to the same tare weight to eliminate confusion in handling.) Each foam sample shall be weighed to the nearest gram and the expansion calculated from the following equation:

$$\frac{\text{Volume of Foam}}{\text{full weight} - \text{empty weight}} = \text{expansion}$$

(All weights to be expressed in grams)

3-6.2.2.3 Foam 25 Percent Drainage Time Determination. The rate at which the foam solution drops out from the foam mass is called the drainage rate. A single value shall be used to express the relative drainage rates of different foams in the "25 percent drainage time." It is the time in minutes that it takes for 25 percent of the total solution contained in the foam in the sample containers to drain.

Apparatus Required

1 — Stopwatch
1 — Sample stand
4 — 100 ml-capacity plastic graduates

3-6.2.2.4 Procedure. This test shall be performed on the same sample as used in the expansion determination. Dividing the net weight of the foam sample by 4 will give the 25 percent volume, in ml, of solution contained in the foam. To find the time required for this volume to drain out, the sample container shall be placed on a stand, as indicated, and at regular suitable intervals, the accumulated solution in the bottom of the container shall be drawn off into a graduate. The time intervals at which the accumulated solution is drawn off are dependent on the foam expansion. For foams of expansion 4 to 10, 30-second intervals shall be used, and for foams of expansion 10 and above, 4-minute intervals shall be used because of the slower drainage rate of foams of this type. In this way, a time-drainage volume relationship is obtained and after the 25 percent volume has been exceeded, the 25 percent drain-

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[1] Waring Model CB-6, one gallon mixing capacity has proven satisfactory.

age time is interpolated from the data. The following example shows how this is done.

The net weight of the foam sample has been found to be 180 grams. Since 1 gram of foam solution occupies a volume of essentially 1 ml, the total volume of foam solution contained in the given sample is 180 ml.

$$\text{Expansion} = \frac{1600}{180} = 8.9$$

$$25\%\text{ by Volume} = \frac{180}{4} = 45\text{ ml}$$

Then if the time-solution volume data has been recorded as follows:

Time (min.)	Drained Solution Volume (ml)
0	0
0.5	10
1.0	20
1.5	30
2.0	40
2.5	50
3.0	60

It is seen that the 25 percent volume of 45 ml lies within the 2.0- and 2.5-minute period. The proper increment to add to the lower value of 2.0 minutes is determined by interpolation of the data:

$$\frac{45\text{ ml (the }25\%\text{ vol.)} - 40\text{ ml (the 2.0 min. vol.)}}{50\text{ ml (the 2.5 min. vol.)} - 40\text{ ml (the 2.0 min. vol.)}}$$

$$= \frac{5}{10} = \frac{1}{2}$$

This means it is halfway between 2.0 and 2.5 minutes, or 2.25 minutes, which is rounded off to 2.3 minutes.

NOTE: When handling fast-draining foams, remember that they lose their solution rapidly and the expansion determination should be carried out with speed and dispatch in order not to miss the 25 percent drainage volume. The stopwatch should be started at the time the foam container is filled and should continue to run during the time the sample is being weighed. It is recommended that expansion weighing be deferred until after the drainage curve data has been received.

3-7 Stability of Concentrate Test.

3-7.1 Three samples shall be stored of 5 gal (19 L) of concentrate from the same production lot in a sealed container of the type used by the manufacturer for shipping and storage in the following sequence.

3-7.1.1 Sample #1 and #2 shall be stored in an environment of 105 °F ± 5 °F (41 °C ± 3 °C) for 30 continuous days. Sample #1 shall be removed and held in an environment of 70 °F ± 4 °F (21 °C ± 2 °C) for 7 days (168 hrs) then opened and inspected in accordance with 3-7.2. Sample #2 shall be placed in a cold chamber where temperature is 28 °F ± 2 °F (− 2 °C ± 1 °C) within 12 hours after removal from the heat chamber.

3-7.1.2 Sample #2 and #3 shall be stored in an environment of 28 °F ± 2 °F (− 2 °C ± 1 °C) for 30 continuous days, removed and held in an environment of 70 °F ± 4 °F (21 °C ± 2 °C) for 7 days, then opened and inspected in accordance with 3-7.2.

3-7.1.3 Samples shall not be agitated at any time during the entire storage period.

3-7.2 At the end of the storage schedule in 3-7.1, invert sealed test container four times within a one minute period. Open the sealed container and pour contents into an open pail. Let contents of pail rest for 10 minutes to allow bubbles to rise to the surface, then visually examine fluid for separation, stratification, or crystallization. Visually examine empty containers for sediment and crystallization. Where the concentrate is stored in tanks a test sample shall be drawn from the bottom of the tank annually.

Chapter 4 Referenced Publications

4-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

4-1.1 ASTM Publications. American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D56-79, *Flash Point by Tag Closed Tester*

ASTM D93-80, *Flash Point by Pensky-Martins Closed Tester*

ASTM 3119-75, *Mist Spray Flammability Hydraulic Fluids.*

4-1.2 Stillmeadow, Inc., *Biological Testing Laboratory Protocols*: S9-F14, S9-F24, S9-F34, S9-F66.

4-1.3 United States Forest Service. *Pesticide Assessment Guidelines, Subdivision F, Hazard Evaluation: Human and Domestic Animals*, U.S. Environmental Protection Agency, Washington, D.C., as found in Federal Register, Volume 43, Number 163.

Appendix A

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

A-1-3 Types of systems for producing wildland fire suppressant foam:

(a) *Compressed Air Foam System or Water Expansion Pumping System.* The compressed air foam system (CAFS) is a wildland fire fighting system that expands water from 1 to 30 times its original volume and is designed for foam application on wildland fuels and exposure protection.

Compressed air foam systems are capable of producing a smaller bubble size foam at a given expansion ratio than air aspirated nozzles. This results in a higher viscosity foam, particularly at the lower expansion ratios (10:1), which, in turn, results in more water in the vertical fuel compared to foams formed by air aspiration.

The system incorporates an apparatus mounted air and water pumping system. The foam concentrate is either metered into the hose systems or is put directly into the water tank and drawn as a premixed solution.

The foam is mechanically generated when the air and solution are merged and "pushed" through the hose. Flow at the outlet is controlled by a ball valve nozzle, which should be completely open for best results. Closure may rupture some of the bubbles and may even cause them to return to solution. Hose friction, length of hose lay, and hose configuration affect foam stability.

The pneumatics and hydraulics of CAFS foam are not well understood, but indications are that bubbles can be pumped to higher elevations and as far horizontally as water. Commercial foam concentrates are normally mixed at 0.1 to 0.3 percent by volume with this system.

(b) *Nozzle Aspirated Foam System.* Foam concentrate is mixed with water and the solution is pumped to the aspirating nozzle where foam is generated. The concentrate is usually mixed at 0.3 to 1.0 percent by volume with this method and is expanded to about 11:1.

(c) *Fixed-Wing Aerial Platforms.* Solutions mixed at 0.3 to 1.0 percent by volume dropped from about 140 ft (45 m) above the forest cover have produced water expansion up to 15:1 (depending on drop speed, aircraft height, and mix ratio).

(d) *Rotorwing Aerial Platforms.* Foam solutions are dropped from fixed tanks and water buckets to produce expansion rates of up to 10:1.

A-2-1.1 Corrosion of Metals. Generally, foam solutions have a definite cleaning action and will remove loose grease, oil, scale, and paint from metal surfaces, which normally protect metal from the corrosive attack of water.

For continuous storage, the use of such materials as cast iron, aluminum, zinc, galvanized iron, lead or lead-coated iron, die cast alloys (such as white metal, zinc, alloy, etc.), or "air-dried" types of coatings (which may include plastics, oil paint, lacquers, and asphalt) should be avoided unless investigated and listed for such use. Foam solutions, though often noncorrosive, exhibit a tendency to accelerate corrosion due to the cleaning and penetrating action of their components and will penetrate and loosen unbonded coatings that are not of the "baked on" type.

Foam concentrate or foam solutions may cause pitting-type corrosion of some metal surfaces. Storage of foam solutions or concentrates for long periods of time in metal tanks should be avoided unless the container is fabricated of corrosion-resistant materials.

Solutions containing foaming agents that do interact with and remove galvanizing or similar coatings should not be knowingly used where contact with such coatings is likely.

Points of Inspection. All joints, seams, or connections that may conceivably be subject to leakage should be carefully examined because the foam solution is capable of passing through openings too small for water. These would include valve packing, retainers, bushings, threaded joints, screw unions, etc.

A-2-2.1 Personnel Protection. All personnel involved in handling, mixing, and applying foam concentrate and solutions should be trained in the proper procedure with respect to occupational safety and health and environmental impact. All personnel should follow manufacturer's recommendations on the product label and in the material safety data sheet.

Generally, all personnel coming in contact with liquid concentrate for wildland fire fighting should wear:

- Goggles
- Rubber gloves
- Coveralls
- Rubber boots.

Foam Solution Handling. All personnel should follow manufacturer's recommendations on product label and in material safety data sheet.

Clothing wetted with concentrate should be changed and washed regularly and often. Soiled clothes should be cleaned on a daily basis, and continued (8 hours) contact with concentrate should be avoided. Showering is necessary as soon as possible after prolonged contact with concentrate.

Generally, those personnel handling foam solutions should wear eye protection and avoid ingesting solution. Individuals ingesting concentrate should be examined by a doctor as soon as possible. Skin or eyes coming in contact with concentrate should be rinsed and washed immediately. Eyes should be washed for 20 minutes. Fresh water should be available on site for this purpose.

User Agency Responsibility. Users should ensure that:

1. Every container present in the workplace that contains foam concentrate is and remains labeled in the prescribed manner.

2. Labels and material safety data sheets are available in English and such other language or languages as may be prescribed by the authority having jurisdiction.

3. Foam concentrate is not used at a workplace unless a label is present and material safety data sheet and worker instruction and training have been complied with.

4. Material safety data sheet is made available in the workplace in such a manner as to allow examination by the workers.

5. Prescribed safe handling equipment is present, in proper repair, and in use at the workplace.

A-2-2.2 Limitation, Electrical. Use of foam on electrical cables equipment should be avoided.

A-2-3.1 Recommended Operational Procedures.

Water Source Protection. The following procedures should be followed when mixing and applying wildland fire suppressant foams:

(a) *Filling Water Tenders.* All pumps used to fill water tenders using foam should have a check valve on the suction side, an internal check valve, or a check valve next to the pump on the discharge side to avoid water source contamination and siphoning of the tank. Tanks should not leak and operators should avoid overflow spills and discharge hose spills.

(b) *Filling Helicopter Buckets.* A closed portable concentrate container with a long spout, on board injection system, or similar device should be provided to prevent splashes and concentrate spills caused by rotor down wash.

Portable tanks or sumps used to premix solution or fill buckets should be located at least 100 ft (30 m) from fish bearing streams or streams flowing into fish bearing waters, and they should be situated on forest soils as opposed to gravel floodplains. Spills from portable tanks or sumps should be prevented from entering fish bearing habitat or water that flows into fish inhabited water.

(c) *Filling Land Based Fixed Wing Aircraft and Helicopters with Attached Tanks.* Mixing operations should be set up and executed to avoid spilling concentrate or solution. Spillage should not drain into drainage systems that empty into fish habitat or waterways that flow into fish inhabited water.

Air drops should be more than 100 ft from fish bearing streams or streams flowing into fish bearing systems.

(d) *Filling Water Skimming Aircraft and Mixing Solution.* Water skimming aircraft should have internal concentrate tanks and a metering device for making solutions.

Leaks in tank(s), piping, and concentrate loading apparatus should be repaired when first detected.

Skimming and refilling should not cause foam to exude from the tank overfill vents in any appreciable quantities.

Air drops should be more than 100 ft from fish bearing streams or streams flowing into fish bearing streams.

A-2-4.2 Foam Concentrate Compatability. Compatability between all products may not exist. Intermixing of different products may cause lumping or reduce effectiveness. Users should flush and rinse out concentrate holding containers before adding another brand of foam concentrate.

Request advice from manufacturer before mixing different agents.

A-2-5.2(e) Use Level. The appropriate use level (ratio of liquid concentrate to water) for each fire/fuel situation shall be recommended by the manufacturer (based on technical information and performance data collected by the manufacturer). The use levels recommended will be used in determining the mix ratios at which performance/requirement testing will be conducted. Qualification and/or approval will be over the appropriate range of use levels tested. The foam solution use level varies with the characteristic of the concentrate, the type of fire, the type of fuels, and the application method. Wildland foam concentrates can be mixed as low as 0.05 percent by volume to obtain a wet water effect (0.5 gal/1000 gal).

A-3-3 Liquids having viscosities more than 5.5 cSt at 104 °F (40 °C), or 9.5 cSt or more at 77 °F (25 °C), and containing suspended solids or having a tendency to form a surface film while under test, should be tested in accordance with Method D93. (ASTM D56-79, 1.2)

Liquids having viscosities less than 5.5 cSt at 104 °F (40 °C), not containing suspended solids or not having a tendency to form a surface film while under test should be tested in accordance with Method D56. (ASTM D93-80, 1.2)

A-3-4 References. For additional background information on this test guideline, the following references should be consulted:

(1) Gledhill, W.E. "Screening Test for Assessment of Ultimate Biodegradability: Linear Alkyl Benzene Sulfonate," Applied Microbiology, 30:922-929(1975).

(2) Pramer, D., Bartha, R. "Preparation and Processing of Soil Samples for Biodegradation Testing," Environmental Letters, 2:217-224 (1972).

A-3-5 Protocol guidelines may be obtained from BC Ministry of Environmental Parks, 810 Blanchard St, Victoria, B.C. V8V 1X5.

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SUBMITTING PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Contact NFPA Standards Administration for final date for receipt of proposals on a specific document.

INSTRUCTIONS

Please use the forms which follow for submitting proposed amendments.
Use a separate form for each proposal.

1. For each document on which you are proposing amendment indicate:
   (a) The number and title of the document
   (b) The specific section or paragraph.

2. Check the box indicating whether or not this proposal recommends new text, revised text, or to delete text.

3. In the space identified as "Proposal" include the wording you propose as new or revised text, or indicate if you wish to delete text.

4. In the space titled "Statement of Problem and Substantiation for Proposal" state the problem which will be resolved by your recommendation and give the specific reason for your proposal including copies of tests, research papers, fire experience, etc. If a statement is more than 200 words in length, the technical committee is authorized to abstract it for the Technical Committee Report.

5. Check the box indicating whether or not this proposal is original material, and if it is not, indicate source.

6. If supplementary material (photographs, diagrams, reports, etc.) is included, you may be required to submit sufficient copies for all members and alternates of the technical committee.

NOTE: The NFPA Regulations Governing Committee Projects in Paragraph 10-10 state: Each proposal shall be submitted to the Council Secretary and shall include:

(a) identification of the submitter and his affiliation (Committee, organization, company) where appropriate, and
(b) identification of the document, paragraph of the document to which the proposal is directed, and
(c) a statement of the problem and substantiation for the proposal, and
(d) proposed text of proposal, including the wording to be added, revised (and how revised), or deleted.

FORM FOR PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Mail to: Secretary, Standards Council
National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269

Date 5/18/85 **Name** John B. Smith **Tel. No.** 617-555-1212

Address 9 Seattle St., Seattle, WA 02255

Representing (Please indicate organization, company or self) Fire Marshals Assn. of North America

1. a) **Document Title:** Protective Signaling Systems **NFPA No. & Year** NFPA 72D

   b) **Section/Paragraph:** 2-7.1 (Exception)

2. **Proposal recommends: (Check one)** ☐ new text
   ☐ revised text
   ☒ deleted text.

3. **Proposal (include proposed new or revised wording, or identification of wording to be deleted):**

   Delete exception.

4. **Statement of Problem and Substantiation for Proposal:**

   A properly installed and maintained system should be free of ground faults. The occurrence of one or more ground faults should be required to cause a "trouble" signal because it indicates a condition that could contribute to future malfunction of the system. Ground fault protection has been widely available on these systems for years and its cost is negligible. Requiring it on all systems will promote better installations, maintenance and reliability.

5. ☒ **This Proposal is original material.**
   ☐ **This Proposal is not original material; its source (if known) is as follows:**

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John B. Smith

Signature

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