Environmental Impacts of Firefighting Foams

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Executive Summary

Firefighting foams have been effectively used in fire protection for over half a century. In this time, the technologies used in formulating and discharging foam have evolved and increased in their effectiveness. As public awareness and environmental regulations have increased, concerns have been raised about the impact firefighting foams have on the environment. Foam manufacturers have attempted to address this by providing new formulations, and stressing the improved environmental benefit of these formulations. In some cases, small environmental benefits have been gained. However, all firefighting foams are regulated at some point during their lifecycle, and all have the potential to impact the environment.

Firefighting foams have several intrinsic properties that cause environmental impacts, including: foaming, oxygen demand, aquatic toxicity, biodegradability, and oil emulsification. Because of these properties, firefighting foams will impact surface water and groundwater if release into the environment. If sent to a wastewater treatment plant, they can cause disruption of the plant, preventing sewage from being treated, and forcing the plant to discharge raw sewage.

The reason that all firefighting foams have these properties is because they consist of ingredients that exhibit these properties. The main ingredients in firefighting foams are water, surfactants, solvents, and other ingredients used to make the foam work in a particular system or under specified conditions. Some of these ingredients are specifically listed in environmental laws because of their environmental impacts (e.g., Butyl Carbitol, Dipropylene Glycol Methyl Ether, Ethylene Glycol, etc.). Although it is easier to highlight these as being regulated since they are specifically named, almost all of the ingredients in firefighting foams are regulated due to their properties.

The properties and ingredients of firefighting foams make them subject to U.S. Federal Environmental Laws that regulate their manufacture, storage, use, release, clean-up, remediation, and disposal. These laws include the Clean Water Act (CWA), Clean Air Act (CAA/CAAA-90), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund); The Superfund Amendments and Reauthorization Act (SARA); The Emergency Planning & Community Right-To-Know Act (EPCRA), The Resource Conservation and Recovery Act (RCRA); The Hazardous and Solid Waste Amendments of 1984 (HSWA), The Safe Drinking Water Act (SDWA), The Toxic Substances Control Act (TSCA), and The Uniform National Discharge Standard (UNDS). These laws cover the entire lifecycle of firefighting foams from manufacture to final disposition.

Whether used in fixed facility systems or on crash fire-rescue vehicles, mitigating the environmental impacts created by firefighting foams is best accomplished through careful planning and management. This may include engineered systems for capture and containment, temporary containment equipment, improved standard operating procedures, and other measures. Simple substitution of one 'environmentally friendly' foam for another will not eliminate environmental impacts. In order to make the final decision to use any type of system for fire protection, it is essential to fully review the fire and environmental risks and benefits of using fire suppression chemicals and their associated systems. The review must involve both fire protection and environmental professionals to ensure a balanced approach that ensures maximum fire protection and environmental protection at the same time.

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Introduction

Firefighting foams are highly effective in preventing, suppressing and extinguishing fuel pool fires. When used in well-designed systems with the proper equipment, they can be the most effective method for doing so, and can be used in an environmentally responsible way. Since all firefighting foams (actually all firefighting systems) have some degree of environmental impacts and liabilities, an essential step in the design and planning for the use of firefighting foams must take into account the protection of the environment.

Marketing claims have been made about certain firefighting foams, stating that they are more environmentally friendly than others. The claim is usually that environmental laws do not regulate the solvent or the surfactant used in the 'environmentally friendly' foam. However, all firefighting foams are regulated at one point or another during their life, especially when they are used in training or for a fire event, regardless of the particular solvent or surfactant used in the foam. These firefighting foams are regulated because they have ingredients directly listed in environmental laws, or have properties; including foaming itself, that can cause an environmental impact or liability during storage, use, and discharge into the environment. Substituting one foam for another may make small improvements in environmental protection; however, the best method of ensuring protection of the environment is to design the system properly, with the correct amount of foam and water, conduct required system maintenance, prevent accidental discharges, and provide a method of capture and control for any foam discharges.

Firefighting Foams and Systems

There are several types of firefighting foams available, including: Aqueous Film Forming Foam (AFFF); Alcohol-resistant AFFF; Protein Foams, Alcohol Resistant Protein Foams, Fluoroprotein Foams, Class A Foams, Medium and High Expansion Foams, Wetting Agents, Training Foams, and others. Each of these firefighting foams is used for different purposes or because of standards and specifications that require their use in specific systems. Firefighting foams usually come in a concentrate that is diluted with water and agitated to form a foam solution.

Firefighting foams are normally used for fixed-facility systems or on crash fire-rescue trucks in locations where fuel-pool fires are expected. When used in fixed-facility systems, the design should incorporate a diversion and/or containment structure that will collect or treat the foam prior to removal or release. This will prevent the foam from entering the environment, and the subsequent environmental impact or liability. When used on crash fire-rescue trucks, standard procedures should be set in place that capture and contain the foam flow.

These procedures and systems are important when foam is used in training, during accidental discharges, system checks, and during actual fire events. Although safety and fire suppression/extinguishment is paramount during a fire event, the properly designed system and standard procedures will protect the environment as well.

Firefighting Foam Ingredients and Properties

Firefighting Foam Ingredients

In general, firefighting foam concentrates consist of water, solvents, surfactants and other ingredients to 'fine-tune' the properties of the foam, including corrosion inhibitors, preservatives, dyes, and others. Within these ingredient types, only a small handful of chemicals have been found that perform well in a fire event. A survey of the Material Safety Data Sheets and Technical Data Sheets from leading foam manufacturers reveals the use of the ingredients found in Table 1. The average proportions of each are shown in Charts 1 and 2.

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Table 1 –Firefighting Foam Ingredients

Diluents		
Water		
Solvents		
(2-Methoxymethylethoxy) Propanol	1,2 Propanediol	1H-Benzotriazole
2-Butoxyethanol	Butyl Carbitol	Ethanol
Glycol s	Hexylene Glycol	Hydrocarbons
Isopropanol	Lauryl alcohol	Methyl-1H-Benzotriazole
Propylene Glycol t-Butyl Ether	N-Propanol	Tert-Butyl Alcohol
Tetraethylene Glycol Dimethyl Ether	Triethanolamine	Ethylene Glycol
Surfactants		
Alkyl dimethylamine oxides	Alkyl Polyglycoside	Octylphenoxypolyethoxyethanol
N-Lauryl beta iminoproprionate	Magnesium sulfate	Fluoroalkyl Surfactant
Octanol sodium sulfate	Benzotriazole	Protein Hydrolysate
Salt of C-Isodecyl ester	Fluorosurfactants	Synthetic Detergent Mixture
Salts of C10-16-alkyl ethers		
Others		
Acetic Acid	Biocide	Dichlorophene
EDTA	Ferrous Sulfate	Nonylphenol Ethoxylate
Polysacchaaride Gum	Sodium Chloride	Zinc oxide
2-Biphenylol Sodium Salt	Corrosion Inhibitors	

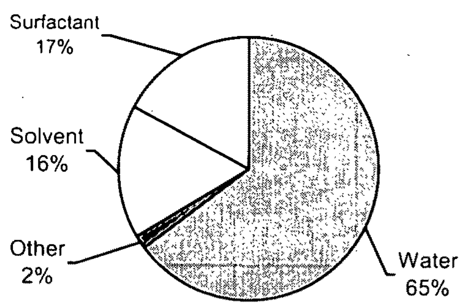

Chart 1 - Average Concentration of Ingredients in Firefighting Foam Concentrates

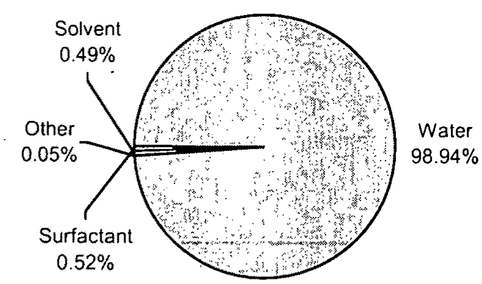

Chart 2 - Average Concentration of Ingredients in Firefighting Foam Solutions

(Assumes a mixture of 3% concentrate, 97% water)

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Foam Environmental Properties

Firefighting foams have many properties that are regulated by environmental laws. These properties include foaming, toxicity, oxygen demand, biodegradability, and oil emulsification. Each of these properties has short-term effects on the local environment, including the following.

1. Contaminating surface water, making it temporarily uninhabitable for wildlife.
2. Contaminating groundwater, setting the need for treatment prior to drinking.
3. Disrupting a wastewater treatment plant, causing untreated sewage to be discharged, and heavily contaminating surface water.

Long-term effects are still being explored, although some research has shown that some firefighting foams leave long-term residual breakdown products in soil.

Foaming

Firefighting foams contain surfactants having a chemical base of fluorocarbons, synthetic hydrocarbons, or proteins. Since the foam concentrate or solution foams when agitated, this in itself can cause an environmental impact. The surfactants in some firefighting foams are extremely stable, so that the foam will remain intact long after being agitated. The environmental impacts of foaming are generally indirect. When firefighting foams enter a sanitary or storm sewer system, they can disrupt wastewater treatment plants, pump stations, and infrastructure, causing discharge or back up of raw sewage. Foaming can also disrupt the habitat of waterfowl.

Aquatic Toxicity

Toxicity analysis focuses on the plants or animals most likely affected, and the route of entry that will cause the worst effects. In the case of firefighting foams, plant and animals in water are the ones that are most likely to be affected by exposure, and the exposure will generally be through ingestion or respiration. This type of toxicity is known as aquatic toxicity. Aquatic toxicity is an indicator of the relative toxicity of a chemical or compound in water. It is determined by using a series of tests for acute (short term) or chronic (long term) toxicity, expressed as EC50 (Effective Concentration 50), LC50 (Lethal Concentration 50), or other several other parameters.

The toxicity is compared to a standard toxicity reference to determine their potential impact, and evaluated based on use-specific conditions. Several scales are available; one example, the Fish and Wildlife Service (FWS) scale provided in Table 2 (this scale is highly situation-specific and should not be used as a planning tool or guidance for relative toxicity without consulting a qualified toxicologist).

Table 2 - Acute Toxicity Rating Scales

Relative Toxicity	Aquatic EC50 or LC50 (mg/l)
Super Toxic	<0.01
Extremely Toxic	0.01-0.1
Highly Toxic	0.1-1
Moderately Toxic	1-10
Slightly Toxic	10-100
Practically Nontoxic	100-1000
Relatively Harmless	>1000

Toxicity parameters are counterintuitive – the higher the number, the less toxic the material. In concentrate form, many firefighting foams range from Practically Nontoxic to Slightly Toxic. When diluted to the fire extinguishing solution, it is typically categorized as relatively harmless. Aquatic toxicity is often determined for the foam solution, foam concentrate and the individual ingredients. Several examples of aquatic toxicity of foam are shown in Charts 3 and 4 and of the ingredients in Chart 5.

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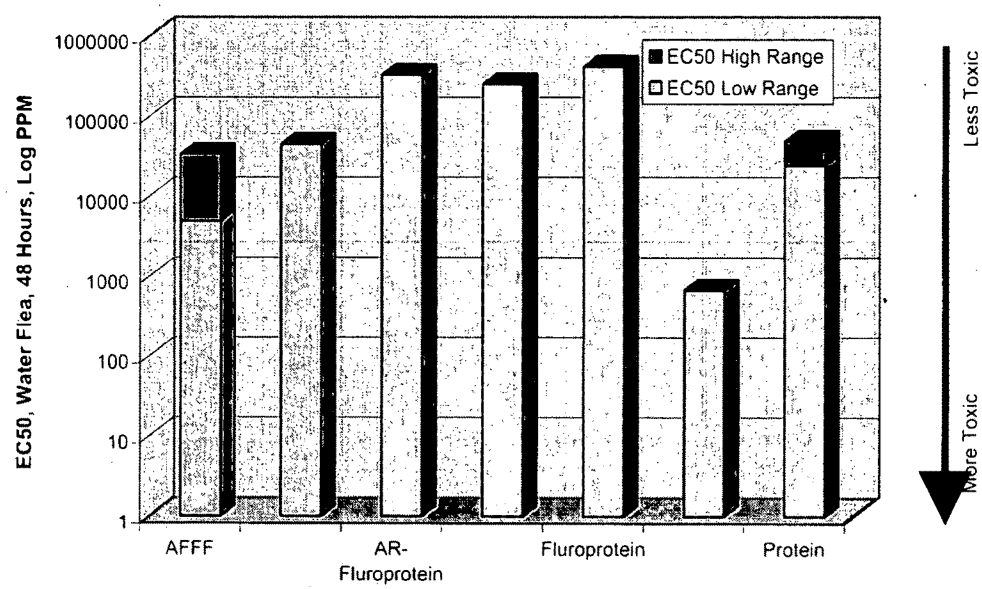

Chart 3 - Aquatic Toxicity of Firefighting Foam Solutions

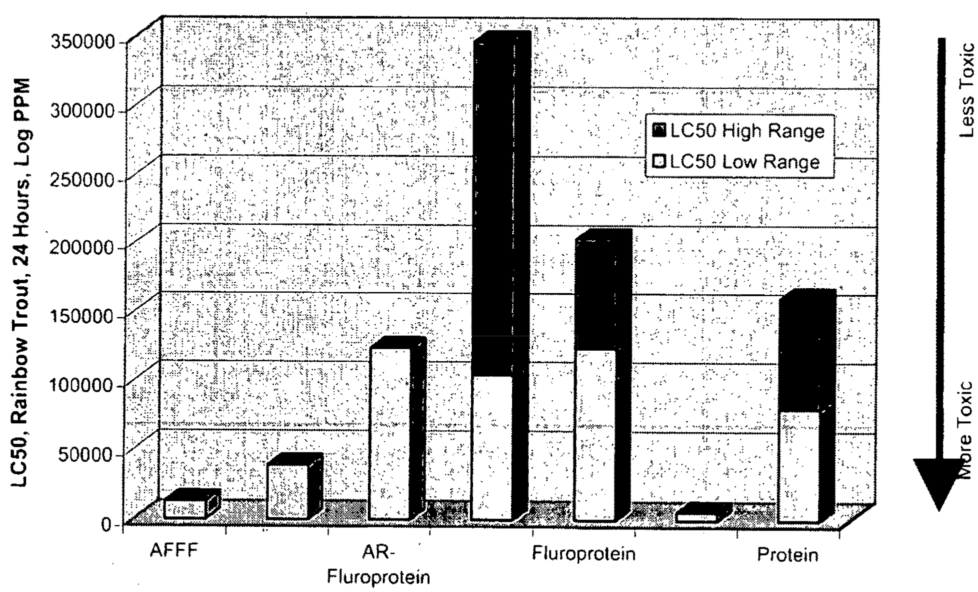

Chart 4 - Aquatic Toxicity of Firefighting Foam Solutions

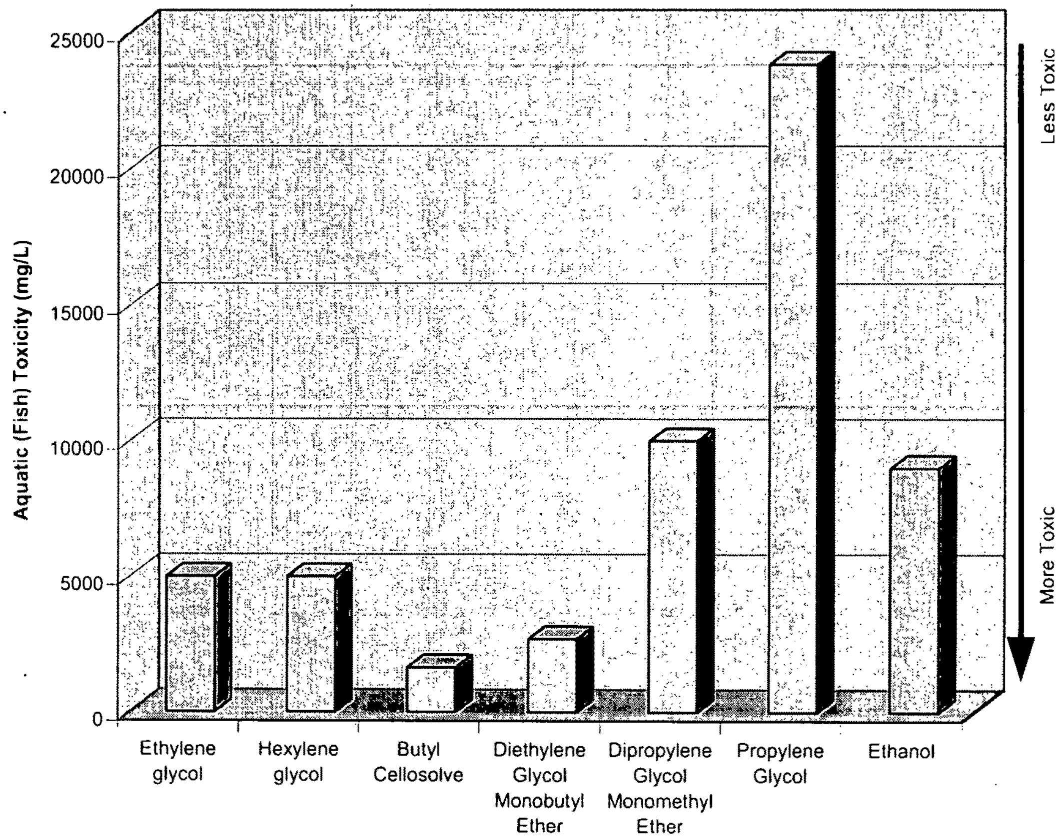

Chart 5 - Aquatic Toxicity of Firefighting Foam Ingredients

Oxygen Demand and Biodegradation

The amount of oxygen necessary to stabilize organic compounds biologically (biochemical oxygen demand - BOD) and chemically (chemical oxygen demand - COD), is used to determine the strength of a wastewater and to design a treatment plant for proper treatment capacity. The 20-day BOD is also known as the ultimate BOD, since most wastewater will have exerted its entire BOD by 20 days. However, in the case of firefighting foams, the BOD goes beyond 20 days, and can be as long as 28-30 days [i]. Both the COD and BOD of firefighting foam solutions are considered extremely high when compared to common wastewater.

When the high oxygen demand in foam solution is exerted directly on surface water, it can remove all of the oxygen from the water, and cause fish and plant kills, causing a 'red-tide' effect. This effect is in addition to the effects of aquatic toxicity. Charts 6, 7, and 8 give examples of the COD and BOD of common ingredients and firefighting foams.

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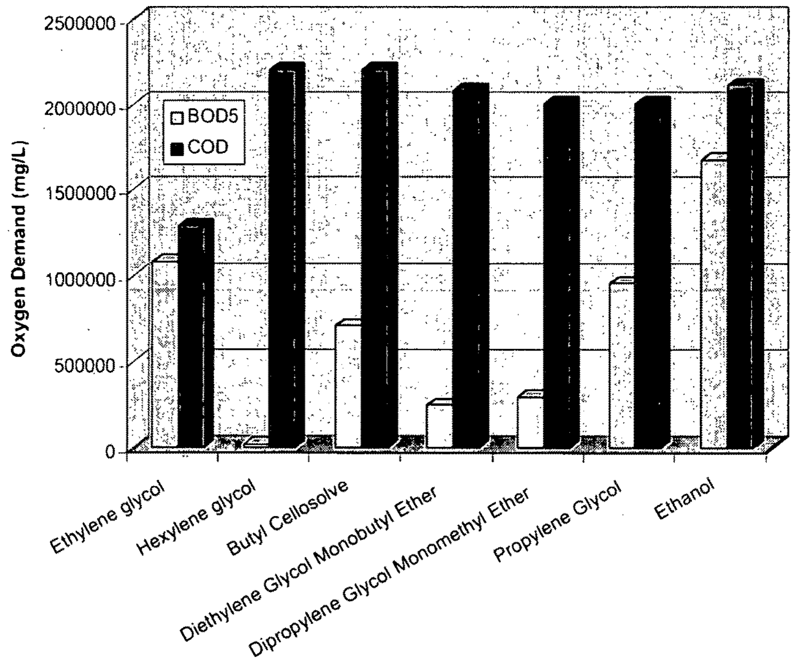

Chart 6 - BOD and COD of Firefighting Foam Ingredients

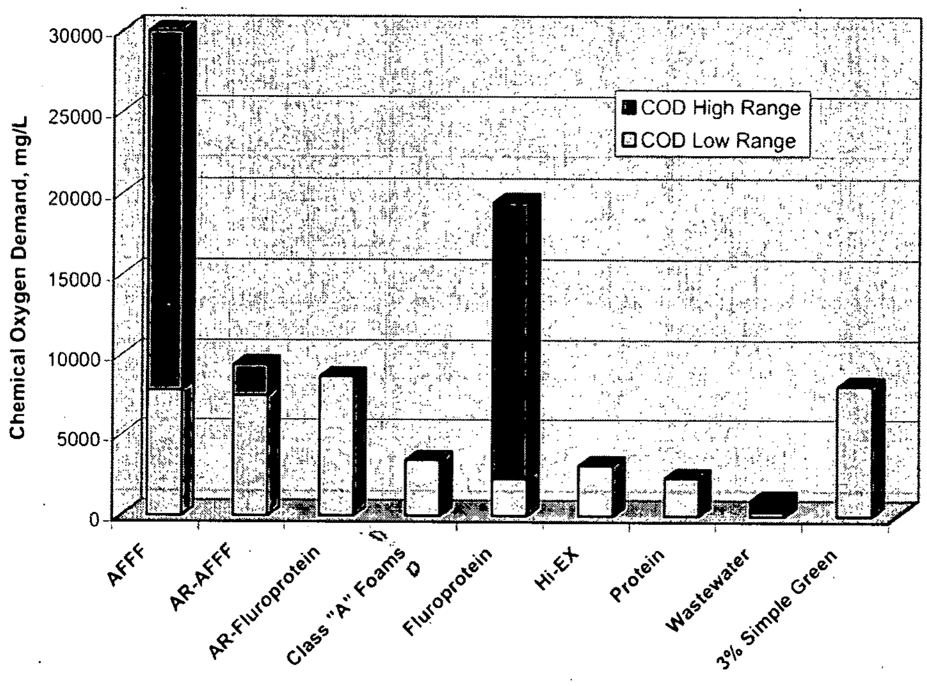

Chart 7 - COD of Common Firefighting Foam Solutions

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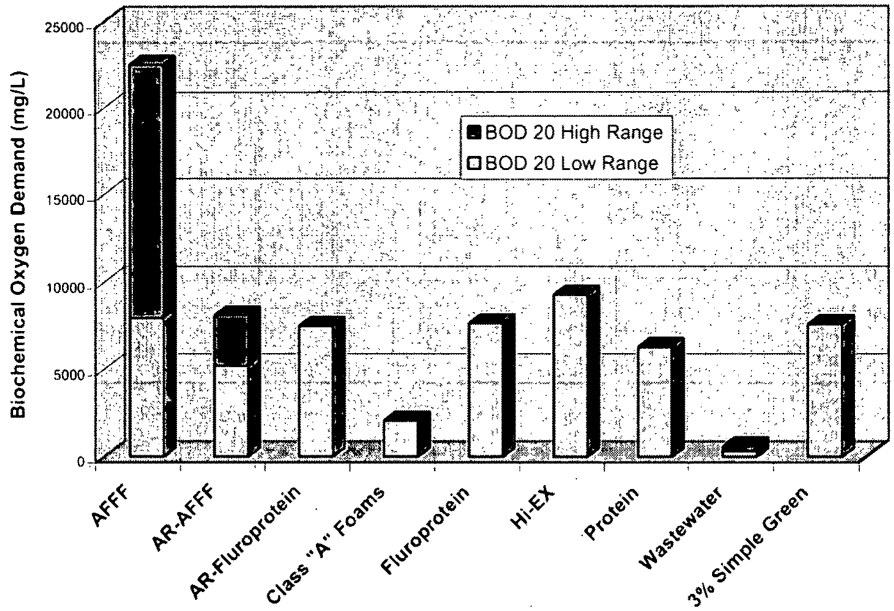

Chart 8 - 20 Day BOD of Common Firefighting Foam Solutions

Biodegradation is the capability of a chemical to be decomposed by biological means. There are several methods for measuring the biodegradation. Some are focused on industrial chemicals that degrade in water; other methods are used to determine the biodegradability of plastics and other materials. The United Nations Organization for Economic Cooperation and Development (OECD) established one method for measuring biodegradability of industrial chemicals in water – the ratio of BOD 20 to COD [ii]. This method is a quick screen to give an initial measure of biodegradability. The closer the ratio is to one, the greater the biodegradability of the material. Although this ratio describes how much a chemical biodegrades, it does not describe how rapidly biodegradation occurs, or how high the oxygen demand is for the chemical. In some cases (as in most foams) the oxygen demand is very high, and some of the ingredients degrade rapidly. Fast degradation and high oxygen demand can have a greater short-term impact on the environment. So in some cases, even though biodegradable materials are desirable, a highly biodegradable material may have a detrimental short-term effect on the environment. Chart 9 gives examples of the biodegradation ratios of firefighting foams.

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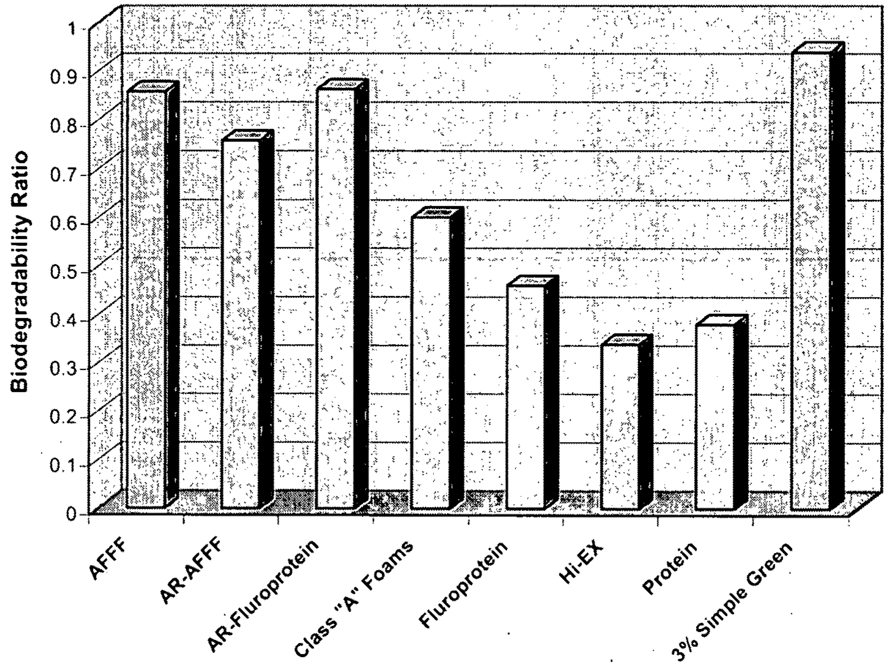

Chart 9 - Biodegradability Ratios of common Firefighting Foam Concentrates

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Bioaccumulation

Bioaccumulation Potential measures the absorption and concentration of a chemical in living organisms. Traditional measures of bioaccumulation focus on the storage of chemicals in the fatty tissues of organisms. Bioaccumulation potential is calculated based upon available data, in the following order of precedence: 1) Bioconcentration Factor (BCF) data, 2) the octanol / water partition coefficient (Log Kow), or 3) Water solubility data.

The bioaccumulation potential for firefighting foams is dependant on the constituents and their breakdown products in the environment. Firefighting foams that contain fluorosurfactants may have bioaccumulation concerns. The degradation products of some of these fluorosurfactants have been found to bioaccumulate in humans and animals in the liver and blood. The EPA model for bioaccumulation does not predict this, since it is based on storage in fatty tissues. This issue is currently being studied more closely by the EPA, however "the presence of organic fluorochemicals in the blood of the general population ... has been published dating back to the 1970's [iii]." A 3M epidemiological study of its own workers indicates no adverse effects related to the presence of these chemicals [ii].

Oil Emulsification

Firefighting foams will emulsify hydrocarbon fuels and some polar fuels that are slightly soluble in water. They will mix with water-soluble polar fuels. The formation of these emulsions causes the fuels to wash through oil/water separators, sending them to treatment plants, or wherever the separator may discharge [iv].

The fuels can cause disruption at the treatment plants or the direct discharge of oils into the environment. Firefighting foams can also emulsify oil on waterfowl, causing the birds to lose their insulation and buoyancy in water, and may result in the death of the birds.

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Environmental Laws

The purpose of U.S. Federal Environmental Laws are to protect human health and the environment by 1) ensuring that chemicals are properly manufactured, stored, used, cleaned-up, and disposed of, 2) preventing and controlling air pollution, 3) preventing and controlling water pollution and 4) protecting drinking water. These laws regulate chemicals and chemical mixtures by specific chemical listings and by the properties of the chemical or ingredients. These properties can include foaming, toxicity, oxygen demand, biodegradability, bioaccumulation, persistence, oil emulsification, and others. Each law focuses on the disposition of a substance when it is released into the environment. This could be the air, surface water, groundwater, soil, or any combination of these.

Firefighting foams are regulated by these laws from the time when the raw chemicals are manufactured to when they are stored and used to when they are disposed of as shown in Figure 1. Firefighting foams typically go through the lifecycle shown in Figure 1 and can have the environmental discharges shown. Some ingredients are specifically called out in regulations, as shown on Table 3.

In general, Federal Environmental Laws are broad-based laws. Some of them are guidelines or minimum standards that the States use to develop their own State Laws or State Implementation Plans. State Laws are customized to the local environment, climate, and business community, and in many cases are more stringent than the Federal Laws.

Table 3: Ingredients listed in Environmental Regulations

Ingredient	Clean Air Act Hazardous Air Pollutant	Clean Water Act Hazardous Substances	CERCLA	TSCA
Methyl-1h-Benzotriazole				X
1h-Benzotriazole				X
2-Butoxyethanol	X		X	X
Acetic Acid		X	X	
Benzotriazole				X
Dichlorophene				X
Dipropylene Glycol Methyl Ether				X
2-(2-Butoxyethoxy)-Ethanol (Butyl Carbitol)	X			
2,2',2"-Nitrilotri-Ethanol (Triethanolamine)				X
Ethylene Glycol	X		X	
Iron (II) Sulfate (1:1) (Ferrous Sulfate)		X	X	
Isopropyl Alcohol				X
Octylphenoxypolyethoxyethanol				X
Propylene Glycol T-Butyl Ether				X
Tert-Butyl Alcohol, Tert-Butanol				X

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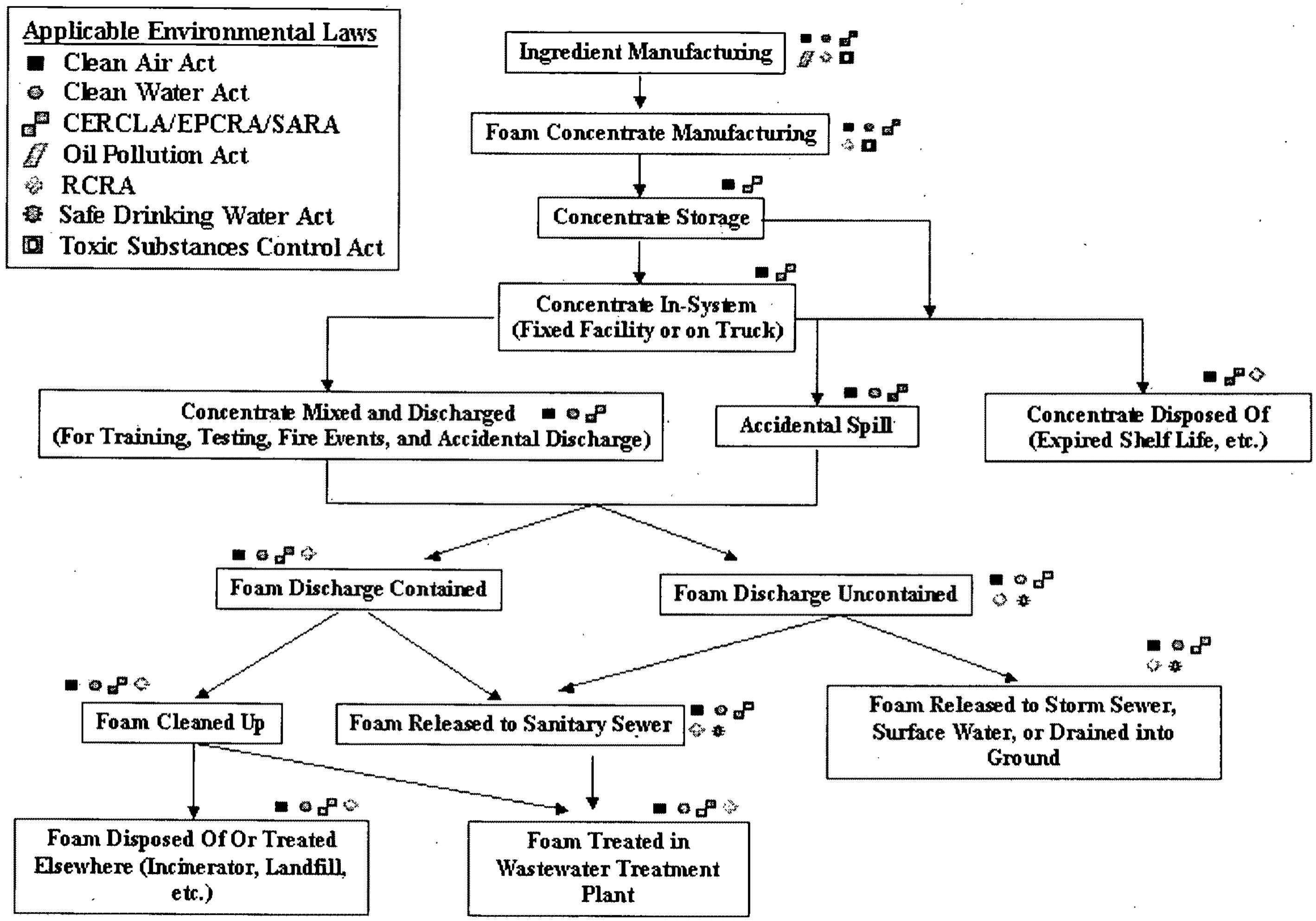

Figure 1 – Applicability of Environmental Laws in the Lifecycle of Firefighting Foams

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The Clean Water Act [v]

Applies to:

The Clean Water Act applies to facilities that might discharge any pollutants into the ground, stormwater, or sewer system.

Regulates:

The Clean Water Act (CWA) regulates discharging pollutants into "Waters of the United States." Under this law, the Environmental Protection Agency (EPA) has set effluent discharge standards for industry, sets water quality standards for all contaminants in surface waters, and approves and oversees State programs for permitting, administration and enforcement. The two main sections of the CWA that affect the use of firefighting foams are the National Pollution Discharge Elimination System (NPDES) and the National Pretreatment Standard (NPS).

The National Pollution Discharge Elimination System

The NPDES program requires permits that limits or prohibits the discharge of "pollutants" from any "point source" into "Waters of the United States." Point sources include both storm water and treated wastewater being discharged by a 'discrete conveyance,' (i.e., channel, ditch, pipe, etc.) into a body of water. Over time and through interpretation, this has come to mean releases of virtually anything but pure stormwater to anywhere (including flat fields) is considered a discharge to Waters of the US, and is regulated under the CWA.

Through NPDES permitting, the CWA limits or prohibits the discharge of water that contains hazardous substances, toxic pollutants, or 'conventional pollutants.' The hazardous substances are listed in 40 CFR 116.4. Toxic pollutants are listed in 40 CFR 401.15. The conventional pollutants are actually properties of the water, including biochemical oxygen demand (BOD), total suspended solids (nonfilterable) (TSS), pH, fecal coliform, and oil and grease content.

When a NPDES permit is applied for, the discharge must be tested for BOD, COD, TOC, and surfactants, in addition to other listed chemicals. The NPDES sets a minimum standard that all States must follow. States may have more stringent standards if the EPA approves them.

The National Pretreatment Standards

The National Pretreatment Standards prohibit the introduction of pollutants into wastewater treatment plants that will interfere with the operation of the plant. Pollutants with a high oxygen demand (i.e., BOD or COD) released in a discharge at a flow rate and/or pollutant concentration that will cause interference with the plant are specifically prohibited. This is a subjective requirement since the level of BOD that causes interference in a treatment plant depends on the capacity of the treatment plant to handle the BOD. For plants with a total design flow greater than 5 million gallons per day (or less, if the EPA so decides) receiving wastewater from industrial users, or otherwise subject to pretreatment standards, are required to develop a pretreatment program. This program must include a requirement for Significant Industrial Users to develop a plan for slug discharges. Although foam systems at an installation may not be considered a Significant Industrial Users as defined by the EPA, the installation as a whole may be, and as such will have to include the fixed facilities in its pretreatment plan. In addition, the authority to decide what the prohibitions and limits for discharge into a local treatment plant is delegated to the State or local sanitation authority.

Regulates by:

The CWA Regulates both listed chemicals and certain properties in untreated and treated wastewaters.

Applicability to Firefighting Foams:

The CWA regulates ALL foams as 'conventional pollutants' due to their high BOD and COD and because they foam. The CWA regulates some foams because they have high aquatic toxicities. As a result, foam cannot be discharged into a storm sewer or untreated from a wastewater treatment plant without a permit. This permit would not be granted unless the water was treated in some way to remove the BOD, COD, aquatic toxicity and foaming. As a result, foam cannot be discharged into a storm sewer that will wind up in a body of water without treatment.

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In general, the CWA does not regulate foams or their ingredients as either hazardous substances or as toxic pollutants. In the survey, two firefighting foams were found that contained hazardous substances - iron sulfate, acetic acid, however, these ingredients are not found in most firefighting foams.

The National Pretreatment Standards prohibit undiluted and untreated firefighting foams to be discharged directly to a wastewater treatment plant. Firefighting foams will interfere with a wastewater treatment plant's operation due to the oxygen demand pollutants, aquatic toxicity and surfactants, which will cause foaming and sludge bulking at almost any size plant. Thus, if the foam is released to a plant, it must be treated so that it will not adversely affect the plant. Treatments may include dilution, anti-foaming agents, reverse osmosis, carbon adsorption, or chemical/biological stabilization of the oxygen demand.

The Clean Air Act (CAA) [vi]

Applies to:

The CAA applies to area, stationary, and mobile sources of air emissions.

Regulates:

The CAA and Clean Air Act Amendments of 1990 is the comprehensive Federal law that regulates air emissions from area, stationary, and mobile sources. The law establishes National Ambient Air Quality Standards and addresses acid rain (SO_x, NO_x), ground-level ozone (Volatile Organic Carbons - VOCs), stratospheric ozone depletion (Ozone Depleting Substances - ODSs), and air toxics (Hazardous Air Pollutants - HAPs). These standards can require pollution control technologies, such as electrostatic precipitators or catalytic converters, set maximum emissions allowed for certain processes, and require permitting.

Regulates by:

The CAA regulates acid rain and ozone precursors by their properties (SOx, NOx, and VOCs). The CAA also regulates specifically listed HAPs, and ODS. Any chemical that evaporates has the potential to emit three main types of air pollutants, ground level ozone precursors (NOx and VOCs), stratospheric ozone depleting substances (ODSs), and HAPs. There is no standard list of VOCs. They are defined by their organic (carbon-based) chemical structure, their ability to evaporate, and their ability to create ground-level ozone. However, ODSs and HAPs are listed. There is overlap between all three types. For example, carbon tetrachloride is a HAP, ODS, and VOC. However, certain HAPs are inorganic, metal-based compounds, such as all beryllium compounds and are not VOCs. The reverse is true as well; many VOCs are not considered HAPs, such as propane. Finally, most ODS are neither VOCs nor HAPs.

Applicability to Firefighting Foams:

1. Firefighting foams and their ingredients do not contribute to acid rain. They are not a source of NOx or SOx.
2. Some firefighting foams contain VOCs and can contribute to ground-level ozone, however they are not regulated under the CAA.
3. There are no ODS in firefighting foams. In fact, the Significant New Alternatives Policy Program lists one foam, AFFF, as an alternative to Halon 1211 as a streaming agent
4. There are ingredients in many firefighting foams that are considered Hazardous Air Pollutants, and are regulated under several National Emissions Standards for Hazardous Air Pollutants (NESHAPs). These ingredients are listed in Table 3.

Ground-Level Ozone Precursors – VOCs

VOCs are ozone precursors. Strong sunlight and hot weather cause VOCs to form ground-level ozone in harmful concentrations in the air (smog). The CAA requires EPA, States, regions, and cities to implement programs to further reduce emissions of ozone precursors from sources such as vehicles, fuels, industrial facilities, power plants, and consumer/commercial products in designated Ozone Non-Attainment Areas. Any facilities that are required to file for an air permit and use firefighting foams that are in Non-Attainment areas may need to account for the use of firefighting foams in their application.

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Air Toxics - HAPS

HAPs listed by the EPA are regulated by a published list of source categories, which are listed as National Emission Standards for Hazardous Air Pollutants (NESHAP). There is no source category that directly covers the use of firefighting foams for firefighting. However, there are two cases where the HAPs in firefighting foams may be regulated: 1) during their manufacture, and 2) during their treatment at a wastewater treatment plant.

Section 112b of the CAA lists Glycol Ethers and Ethylene Glycol as HAPs. As mentioned previously, Ethylene Glycol is not in every AFFF Formulation. "Glycol Ethers that are HAPs (as defined by the EPA) include Mono- and di- ethers of ethylene glycol, diethylene glycol, and triethylene glycol with the structure:

$R\text{-}(OCH_2CH_2)_n\text{-}OR'$

where
R = alkyl C7 or less; or
R = phenyl or alkyl substituted phenyl;
R' = H or alkyl C7 or less; or
OR' consisting of carboxylic acid ester, sulfate, phosphate, nitrate, or sulfonate." [vii]

The structure for butyl carbitol is $H\text{-}OCH_2CH_2\text{-}O\text{-}CH_2CH_2\text{-}O\text{-}C_4H_9$. Using the EPA's definition, the formula is $C_4H_9\text{-}(OCH_2CH_2)_2\text{-}OH$, making it a HAP according to the CAA.

NESHAPs only regulate HAPs on installations that are considered a 'Major Source' of HAPs. A 'Major Source,' as defined by the EPA, is any stationary source or group of stationary sources located within a contiguous area and under common control that emits or has the potential to emit considering controls, in the aggregate, 10 tons per year or more of any HAP or 25 tons per year or more of any combination of HAPs. Many installations that have activities requiring the use of AFFF are Major Sources.

Glycol Ethers are listed in Section 112b of the Clean Air Act as Hazardous Air Pollutants, which automatically make them hazardous substances under CERCLA (see below).

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund); The Superfund Amendments and Reauthorization Act (SARA); and The Emergency Planning & Community Right-To-Know Act (EPCRA); [viii]

Citations:

42 U.S.C. s/s 9601 et seq. (1980)
42 U.S.C. 9601 et seq. (1986)
42 U.S.C. 11011 et seq. (1986)
40 CFR 300-399

Applies to:

CERCLA, EPCRA, and SARA apply to facilities that produce, store, use, dispose, or clean-up chemicals.

Regulates:

CERCLA, EPCRA, and SARA are laws that require responsible storage, use, and clean up of chemicals. Congress enacted CERCLA, also known as the 'Superfund,' on December 11, 1980. CERCLA mandated the revision of the National Contingency Plan (NCP), which provides the guidelines and procedures needed to respond to releases and threatened releases of hazardous substances, pollutants, or contaminants. CERCLA also regulates closed, uncontrolled and abandoned hazardous waste sites, provides for liability of persons responsible for releases of hazardous waste at these sites; and establishes a trust fund (the Superfund) with money collected from chemical manufacturers to provide for cleanup when no responsible party could be identified.

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SARA added additional funds into the superfund and created EPCRA (SARA Title III). EPCRA is intended to improve community access to information regarding chemical hazards and facilitate the development of chemical emergency response plans by State and Local governments. It establishes four types of reporting requirements for facilities that produce, use, or store hazardous chemicals.

1. Emergency Planning (EPCRA §302)
2. Emergency Release Notification (EPCRA §304)
3. Community Right-to-Know (EPCRA §§311/312)
4. Toxic Release Inventory (EPCRA §313)

Regulates by:

CERCLA, EPCRA, and SARA regulate a specific list of chemicals, and set minimum threshold quantities for triggering their applicability.

Applicability to Firefighting Foams:

EPCRA and CERCLA consider glycol ethers and other firefighting foam ingredients as meeting the definition of hazardous substances because they are HAPs pursuant to 112(b) of the Clean Air Act. The Clean Air Act Amendments of 1990 (CAAA90) added the category of glycol ethers to its list of HAPs. Because any newly identified hazardous substances automatically received a reportable quantity (RQ) of one pound, all glycol ethers received this one-pound RQ. This triggered reporting from almost any use of AFFF, and overwhelmed the National Response Center with reports of spills. On June 12, 1995, EPA published a final rule, which removed the one-pound RQ for glycol ethers. As a result, CERCLA 103 and EPCRA 304 notification requirements no longer apply to releases of AFFF containing Butyl Carbitol, unless the AFFF released contains another listed CERCLA hazardous substance found at 40 CFR 302.4 or extremely hazardous substance found at 40 CFR Part 355 Appendix A. In the June 12, 1995, Federal Register, EPA decided not to assign reportable quantities to the additional five broad categories, but rather to identify, designate, and assign reportable quantities to certain specific substances within the categories at a later date. As a result, releases of Firefighting Foams containing only chemicals within the glycol ethers category no longer require reporting to the National Response Center pursuant to CERCLA 103(a) or the State Emergency Response Commission and Local Emergency Planning Committee pursuant to EPCRA 304. Owner/operators can still be held liable under CERCLA for clean-up costs or damages caused by a release of AFFF containing a glycol ether, even though the release itself is not reportable [ix, x]. However, if the foams contain other ingredients listed under CERCLA, the release may still need to be reported.

Although most ingredients in foams are highly biodegradable and will most likely not cause any long-term damage to the environment, it is not recommended that any ingredients in firefighting foams be discharged into the environment uncontrolled.

<u>The Resource Conservation and Recovery Act (RCRA); and The Hazardous and Solid Waste Amendments of 1984 (HSWA)</u> [xi]

Applies to:

Generators and transporters of Hazardous and Non-Hazardous Wastes and owners of Underground Storage Tanks

Regulates:

RCRA provides the EPA with the authority to do the following.

1) Control hazardous waste generation, transportation, treatment, storage, and disposal,
2) Manage non-hazardous wastes.
3) Address environmental problems resulting from storing hazardous substances in underground tanks.

RCRA focuses only on active and future facilities and does not address abandoned or historical sites.

Regulates by:

RCRA defines hazardous wastes as wastes that either have a characteristic of flammability, corrosivity, reactivity, or toxicity, or are specifically listed by the EPA. The EPA has generated several lists of hazardous waste, including specific chemical wastes, specific process wastes, and general process wastes.

Applicability to Firefighting Foams:

The EPA does not consider firefighting foams or any of their constituents as hazardous wastes. They do not exhibit the characteristics of Flammability, Corrosivity, Reactivity, or Toxicity, as defined in 40 CFR 261.10, and are not listed on the 40 CFR 261, Subpart D lists. However, residue from using a foam on an actual fire event needs to be tested to ensure that it is not hazardous. Although firefighting foams are not considered hazardous wastes, many states and local municipalities require special handling and disposal of firefighting foams because of their properties of foaming, oxygen, and aquatic toxicity.

Any underground storage tanks (UST) used for positive control, or as part of the drainage collection system would not be regulated under RCRA. The UST regulation does not apply to any emergency spill or overflow containment UST system that is expeditiously emptied after use, or to any stormwater or wastewater collection system.

The Safe Drinking Water Act (SDWA) [xii]

Applies to:

The SDWA applies to public drinking water treatment facilities and delivery systems.

Regulates:

The Safe Drinking Water Act was established to protect the quality of drinking water in the U.S. This law focuses on all waters actually or potentially designed for drinking use, whether from above ground or underground sources. Through this law, the EPA established primary and secondary drinking water regulations ensuring the purity of treated drinking. The primary regulations focus on the health-related properties of drinking water. The secondary standards focus on the aesthetic properties, such as color and taste, and are written as guidelines for State regulations only, not as federally enforceable standards.

Regulates by:

The primary drinking water regulations cover a specific list of chemicals and microbes, as well as the physical characteristics of the supply system, including the pipes and soldering materials. The secondary regulations list specific chemical materials, such as aluminum, copper, chloride, and sulfate, and properties, such as pH, odor, and foaming.

Applicability to Firefighting Foams:

The primary drinking water regulations do not cover firefighting foams, their constituents, or their properties. The secondary regulations recommend a maximum contaminant level of 0.5 mg/L of foaming agents in treated drinking water. This means that the surfactants found in firefighting foams should not exceed 0.5 mg/L after the water leaves the treatment plant. It does not directly affect the amount of foam that can be in the source water for the treatment plant; however, not all treatment plants are set up to remove surfactants easily.

The Toxic Substances Control Act (TSCA) [xiii]

Applies to:

TSCA applies to manufactures, processors, and importers of industrial chemicals and mixtures.

Regulates:

TSCA gives the EPA the authority to regulate companies that import and manufacture chemicals as necessary to protect human health and the environment. The EPA can require these companies to provide data on the toxicity, environmental characteristics, and other factors contributing to the environmental risk posed by the use, manufacture, or import of these chemicals.

Regulates by:

TSCA lists specific materials that it applies to. It also gives specific conditions that cause a chemical to be added to the list, such as the production of a new chemical over certain amounts (a significant new use rule (SNUR)).

Applicability to Firefighting Foams:

TSCA lists several of the constituents of firefighting foams, including dipropylene glycol methyl ether, propylene glycol tert-butyl ether, butyl carbitol and triethanolamine. TSCA applies to manufacturers of chemicals, and can result in chemicals being 'banned' from production. If some of those chemicals are banned, then some formulations of firefighting foams may no longer be produced.

The Uniform National Discharge Standard for Vessels of the Armed Forces (UNDS) [xiv]

Applies to:

The UNDS applies to Armed Forces vessels (ships and boats) during normal operations when they are in navigable Waters of the United States, or in Waters of the contiguous no-discharge zones that are established by the EPA and the States.

Regulates:

The UNDS prohibits or requires treatment of materials prior to their discharge from vessels into the surrounding waters.

Regulates by:

The UNDS lists specific materials that can be discharged with or without controls, and when these materials are altogether prohibited from discharge.

Applicability to Firefighting Foams:

The UNDS requires AFFF discharges from Armed Forces ships and boats during normal operation to be controlled by the use of a Marine Pollution Control Device (MPCD). In this case, an MPCD is any equipment or management practice installed or used on an Armed Forces vessel that is designed to receive, retain, treat, control, or discharge an effluent incidental to the normal operation of a vessel.

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Environmental Regulation Summary

Environmental laws regulate all firefighting foams at some point during their lifecycle. The laws can regulate both the properties of the foam and ingredients in the foam. The solvents in all firefighting foams, including butyl carbitol and propylene glycols have high oxygen demand and many have a high aquatic toxicity, and can cause fish kills when released into surface water. The surfactants cause foaming that can disrupt a wastewater treatment plant and sewer infrastructure, and can kill waterfowl by removing protective oils from their feathers. The Clean Water Act regulates all of these properties, even though neither firefighting foams nor most of their ingredients are specifically listed in the Act. Other regulations, such as the CAA, CERCLA, and TSCA list ingredients such as propylene glycols, butyl carbitol, and ethylene glycol, and regulate them specifically.

Proper planning, care and management can mitigate or eliminate environmental impacts caused by the use of firefighting foams. Foams and foam systems must be selected with careful review of ingredients, properties, water requirements, and potential environmental impact. Ensuring that foam capture and control are part of contingency plans for accidental and emergency events is essential to protecting the environment. Fire protection and environmental professionals should be involved in the design and use of any firefighting foam system to ensure environmental impacts and liabilities are minimized or prevented while ensuring the system provides the maximum fire protection necessary.

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