Compatibility of On-Board Apparatus Foam Systems and Foam/Wetting Agent Concentrates

Shawn Oke

Albemarle Fire Department, Albemarle, North Carolina

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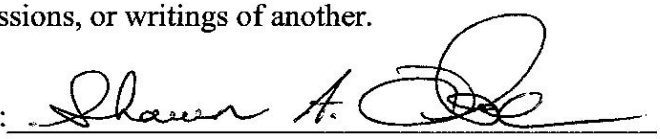
Signed: 

Abstract

The problem was compatibility data relating to on-board apparatus foam systems and foam/wetting agent concentrates in relation to viscosity and required delivery percentages wasn't readily available to the Albemarle Fire Department.

The purpose of this research was to identify and determine the compatibility of identified apparatus foam systems with identified foam concentrates in relation to viscosity and required delivery percentages.

Research was conducted utilizing the descriptive research method. The following research questions were examined: a) Is each identified on-board foam system compatible in regards to viscosity with identified foam concentrates?, b) Is each identified on-board foam system compatible in regards to delivering the manufacturer recommended percentage of concentrate for Class A fires?, and c) Is each identified on-board foam system compatible in regards to delivering the manufacturer recommended percentage of concentrate for Class B fires?

The primary research tools were the internet and a survey. Data was collected and reviewed on various foam delivery systems and foam concentrates.

Research was conducted to determine the viscosity and recommended delivery percentages for the identified foam concentrates and the maximum viscosity and delivery percentage range for the identified foam delivery systems.

Procedures included identifying foam concentrates and foam delivery systems in service throughout the fire service. Identified and verified products were researched to provide data related to the research questions.

Results determined viscosity widely varies between concentrates, several foam delivery systems weren't compatible with many of the concentrates researched, and some foam systems

are not able to deliver the recommended percentages of concentrate. The delivery systems and concentrate in the Albemarle Fire Department are compatible.

It is recommended that foam delivery systems and concentrates be researched prior to purchasing to determine compatibility. All departments with foam delivery systems in service should utilize this research to assist in determining delivery system and concentrate compatibly.

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Introduction

The problem is compatibility data about on-board apparatus foam systems and foam/wetting agent concentrates in relation to viscosity and required delivery percentages isn't readily available to the Albemarle Fire Department. This lack of easily accessible information prevents the department from identifying if available foam/wetting agent concentrates will properly perform with available on-board foam systems. Throughout this research foam concentrates, unless otherwise stated, will encompass Class A foams, wetting agents, alcohol resistant aqueous film forming foam (AR-AFFF), and aqueous film forming foam (AFFF).

The purpose of this research is to identify and determine the compatibility of identified on-board apparatus foam systems with identified foam concentrates in relation to viscosity and required delivery percentage. Research was conducted utilizing the descriptive research method. The following research questions were examined: a) Is each identified on-board foam system compatible in regards to viscosity with identified foam concentrates?, b) Is each identified on-board foam system compatible in regards to delivering the manufacturer recommended percentage of concentrate for Class A fires?, and c) Is each identified on-board foam system compatible in regards to delivering the manufacturer recommended percentage of concentrate for Class B fires?

Background and Significance

The Albemarle Fire Department purchased its first on-board apparatus foam system in 2006. The basis for the type of system purchased was the recommendation of the sales person that was working with the department to order the apparatus. During the purchase process there were no discussions regarding the type of concentrate being utilized or the required delivery

percentages of the concentrate being utilized. The system was purchased based solely on the recommendation of the sales person.

In 2011 the department purchased two additional apparatus that were equipped with on-board apparatus foam delivery systems. During the purchase process various brands of on-board foam systems were considered. The consideration of these products consisted only of a price comparison. Due to the positive experiences our department had with the manufacturer of our current on-board foam system the decision was made to remain with the same company for the new apparatus foam systems. The foam systems installed on these apparatus were installed based on the recommendation of the manufacturer of the system that was installed on the 2006 apparatus. The manufacturer did inquire about what concentrate would be utilized and the required delivery percentage of the concentrate. The manufacturer provided the department with a recommended on-board foam system based on the information provided by the department.

Due to a lack of available information and knowledge the department purchased their on-board foam systems based on recommendations by the sales person and manufacturer. There was no consideration given by the department regarding the needed delivery percentage or if the foam system would be able to deliver the concentrate through its system. There was no consideration in the purchase process of the on-board foam systems regarding what limitations regarding available concentrates existed.

The knowledge of department members regarding foam concentrates has increased since the purchase of all department on-board foam systems. This increase in knowledge has uncovered the need to know more about what concentrates can be utilized with what particular on-board foam systems.

If more care isn't given in future purchases of on-board foam systems the Albemarle Fire Department could be forced to utilize particular concentrates based on the ability of the on-board foam system and not the hazards being protected by the apparatus containing the on-board foam system and concentrate.

Determining the compatibility of on-board foam systems with available foam concentrates will assist the Albemarle Fire Department in achieving the United States Fire Administration (USFA) Operational Objectives. The results of this research will allow the department to be assured their on-board foam delivery systems will correctly operate based on the compatibility of the delivery system and concentrate. This assurance relates to the USFA Operational Objective, "Improve the fire and emergency services' capability for response to and recovery from all hazards" (United States Fire Administration, n.d.).

The research conducted relates to Unit 6, *Decisionmaking,* of the National Fire Academy Executive Leadership class. The chapter discussed the decision making process and the components of effective decision making (Executive Leadership, 2012). The research will allow the Albemarle Fire Department to make more effective and informed decisions on what on-board foam systems to purchase with future fire apparatus.

Literature Review

There is virtually no information that could be located regarding the compatibility of on-board foam systems and the various concentrates available to the fire service. A review of new apparatus deliveries in various trade journals shows a growing trend for fire departments to purchase on-board foam delivery systems, especially direct injection proportioning systems. The literature review was able to produce a small number of sources to assist fire departments on the

variables that should be considered when purchasing an apparatus with an on-board foam delivery system.

According to the International Fire Service Training Association (IFSTA) alcohol-resistant foam concentrates should not be utilized with direct injection type foam systems due to the viscosity of the concentrate (International Fire Service Training Association, 2006, p. 469). The information provided by IFSTA provides a direction for further research and examination, viscosity. The Albemarle Fire Department had not taken the viscosity of our concentrate into consideration when purchasing any of our on-board foam systems.

The National Fire Protection Association (NFPA) provides a standard for the fire service on automotive fire apparatus, NFPA 1901. In the NFPA 1901 standard an entire chapter is devoted to foam proportioning systems that are installed on fire apparatus. Included in this chapter is a section on design and performance of the concentrate delivery system.

The chapter provides guidance to assure the installed foam delivery system is capable of delivering the needed percentage of foam concentrate. The standard states the proportioning system will be certified by the manufacturer as being "accurate throughout the foam proportioning system's declared range of water flow, water pressure, foam percentage and concentrate viscosity" (National Fire Protection Association, 2009, p. 1901-76). The standard also requires the final installer to test and certify that the system "has been calibrated and tested to meet the foam equipment manufacturer's and the purchaser's performance specifications" (National Fire Protection Association, 2009, p. 1901-79).

One requirement of the chapter is that the purchaser of the foam system is required to specify the following to the manufacturer of the fire apparatus, "(1) Range of water flows and

pressures, (2) Proportioning rates, (3) Types of concentrate(s) (Class A, Class B, etc), and (4) Brand and viscosity of concentrate" (National Fire Protection Association, 2009, p. 1901-76).

The same standard provides accuracy guidance to the final installer. If the foam system is designed to produce finished foam solution at concentrate percentages lower than one percent the system has an accuracy range of -0/+40 percent. If the proportioning system is designed to produce finished foam solution at percentages of one percent or greater the system has an accuracy range of -0/+30 percent or one percent, whichever is less (National Fire Protection Association, 2009, p. 1901-79).

NFPA provides guidance in regards to the viscosity testing of certain concentrates. There are three NFPA standards providing guidance on the majority of the foam concentrates and wetting agents in use throughout the fire service. NFPA 18 provides guidance on wetting agents, NFPA 1150 provides guidance on foam chemicals for Class A fires and NFPA 11 provides guidance on low-, medium- and high- expansion foam.

NFPA 11 does not provide any guidance regarding testing or reporting of concentrate viscosity. NFPA 18 requires the concentrate to be tested for viscosity at 35^{o}F, 65^{o}F and 120^{o}F with a +/- 5^{o}F variance. There are no requirements that the results of the testing be reported (National Fire Protection Association, 2011, p. 18-8). NFPA 1150 provides similar guidance in regards to viscosity testing of a concentrate meeting the standard. There are differences in the temperatures that concentrates complying with NFPA 1150 must meet compared to NFPA 18. NFPA 1150 requires the concentrate to be tested for viscosity at 35^{o}F, 70^{o}F and 120^{o}F with a +/- 2^{o}F variance. In addition to the temperature and variance differences, as compared to NFPA 18, NFPA 1150 requires the manufacturer to report the results of the testing on their product data sheet (National Fire Protection Association, 2010, p. 1150-6).

The viscosity of a liquid is defined as its resistance to flow. The greater the viscosity of a liquid the slower the liquid will flow. It is important to note that as the temperature of the liquid increases the viscosity decreases (Brown, 1977/2003). The common unit of measure for viscosity is poise, "which equals 1 g/cm-s. Frequently viscosity is reported in centipoise (cps), which is 0.01 poise(P)" (Brown, 1977/2003).

In order to relate to the centipoise of a liquid it can be helpful to know the centipoise of common liquids. Water has a centipoise of one, cream has a centipoise of 20, vegetable oil has a centipoise of 40, SAE 10 motor oil has a centipoise of 88, tomato juice has a centipoise of 180, SAE 30 motor oil has a centipoise of 352, glycerin has a centipoise of 800, honey has a centipoise of 1,500 and glue has a centipoise of 3,000 (A Packaging Systems, 2013). The source did not note what temperature these viscosities were determined.

Foam Pro, manufacturer of on-board concentrate delivery systems has a published list of 126 foam concentrates with the viscosity of each foam concentrate listed in centipoise. The concentrates listed range in centipoise from 1.0 cps to 4,500 cps. There are eleven manufacturers listed which state to contact the manufacturer for the viscosity of their concentrate (Foam Pro, 2013).

Through the utilization of a survey the number of foam concentrates for use in this research were reduced to 30 products which are manufactured by 14 different manufacturers. Each of the identified products was researched to determine the required delivery percentage for Class A fires, Class B fires (polar and non-polar solvent) and viscosity.

Ansul manufacturers five of the identified foam concentrates, Thunderstorm 3% x 3% AR-AFFF (F-603A), Ansul-A Municipal "Class A" fire control, Jet-X, Silvex, and Silvex Plus.

Thunderstorm 3% x 3% AR-AFFF is not approved for Class A fires, is approved on all Class B fires at 3% and has a viscosity at 77°F of 2,100 ± 3,600 cps. The viscosity was measured using a Brookfield Viscometer Spindle #4, Speed 30 rpm (Ansul). Ansul-A Municipal "Class A" fire control is approved on Class A fires at 0.10% to 1%, is not approved for use on Class B fires and has a viscosity at 77°F of 1.7 ± 0.5 cps (Ansul Incorporated). Jet-X is approved by the manufacturer to be applied on Class A fires at 2%. The manufacturer states the product may be applied on Class B fires at 2% but does not state if the concentrate can be utilized on non-polar and polar solvents. The concentrate has a viscosity at 77°F of 186 ± 10 cps (Ansul Incorporated, 2009). Silvex is approved on Class A fires at 0.10% to 1%, is not approved for use on Class B fires and has a viscosity at 77°F of 18.72 ± 2.5 cps (Ansul Incorporated, 2010). Silvex Plus is approved on Class A fires at 0.10% to 1%, is not approved for use on Class B fires and has a viscosity at 77°F of 12 ± 3 cps (Ansul Incorporated, 2010)

Ansulite manufacturers four of the identified foam concentrates, 1% x 3% AR-AFFF (F-601A), 3% (AFC-3A), 3% x 3% AR-AFFF and ARC 3% x 6% AR-AFFF.

Ansulite 1% x 3% AR-AFF (F-601A) is not approved for Class A fires, is approved on non-polar solvent Class B fires at 1%, polar solvent Class B fires at 3% and has a viscosity at 77°F of 2,700 ± 500 cps. The viscosity was measured using a Brookfield Viscometer Spindle #4, Speed 30 rpm (Ansulite, 2010). Ansulite 3% (AFC-3A) is not approved for Class A fires, is approved on non-polar solvent Class B fires at 3%, not approved for polar solvent Class B fires and has a viscosity at 77°F of 2.9 ± 1 cps (Ansulite, 2011). Ansulite 3% x 3% Low Viscosity AR-AFFF is not approved for Class A fires, is approved on all Class B fires at 3% and has a viscosity at 77°F of 1,500 ± 500 cps. The viscosity was measured using a Brookfield Viscometer Spindle #4, Speed 30 rpm (Ansulite, 2007). Ansulite ARC 3% x 6% AR-AFFF is not approved

for Class A fires, is approved on non-polar solvent Class B fires at 3%, polar solvent Class B fires at 6% and has a viscosity at 77°F of 2,525± 700 cps (Ansulite, 2009).

Baum's Castorine is the manufacturer of Novacool. Novacool is an Underwriters Laboratories (UL) Classified wetting agent which meets the NFPA 18 standard. Novacool is approved on Class A fires at 0.40%, is approved for use on non-polar solvent Class B fires at 0.50% and is not approved for use on polar solvent Class B fires. The data obtained on Novacool provided three different viscosity measurements at three different temperatures. Novacool has a viscosity of 71.27 cps at 35.6°F, a viscosity of 37.52 cps at 69.8°F and a viscosity of 24.48 cps at 120.2°F (Underwriters Laboratories, 2006).

Chemguard manufacturers four different products that were examined during the research, 3% x 3% AR-AFFF (C-333), CAFS extreme foam, Class A Plus and First Class.

Chemguard 3% x 3% AR-AFF (C-333) is not approved for Class A fires, is approved on all Class B fires at 3%, and has a viscosity at 77°F of 1,500 cps. The viscosity was measured using a Brookfield Viscometer Spindle #4, Speed 30 rpm (Chemguard, 2013).

CAFS extreme foam is approved by the manufacturer to be utilized on Class A fires at a proportion rate between 0.10% and 1%, depending on the delivery system for the solution. The manufacturer states the concentrate is "suitable through medium expansion nozzles on Class “A” or contained Class “B” flammable liquids". The manufacturer does not list a recommended delivery percentage for Class B fires or state if the concentrate can be utilized on all Class B fires. The manufacturer's data sheet does not list the viscosity of the concentrate (Chemguard). The manufacturer did provide the viscosity information for this product via email. The viscosity for CAFS Extreme is 10 cps at 77°F. The viscosity was measured using a Brookfield Viscometer Spindle #1, Speed 60 rpm (R. Hendricksen, personal communication, 10/14/2013).

Class A Plus is approved by the manufacturer to be utilized on Class A fires at a proportion rate between 0.10% and 0.60%, depending on the delivery system for the solution. The manufacturer states the concentrate is "suitable through medium expansion nozzles on Class “A” or contained Class “B” flammable liquids". The manufacturer does not list a recommended delivery percentage for Class B fires or state if the concentrate can be utilized on all Class B fires. Class A Plus has a viscosity at 77°F of 20 cps (Chemguard, Class A Plus).

First Class is a UL Classified wetting agent for use on Class A fuels at 0.24%, non-polar Class B fuels at 0.50% and is not classified for use on polar Class B fuels (Oke, 2012, p. 16). The information contained in the manufacturer's data sheet does not state the percentages for use as UL has Classified the product. The manufacturer lists the proportion rate for Class A fires between 0.10% and 1%, depending on the delivery system for the solution. The manufacturer data sheet doesn't recommend a percentage for using First Class on Class B fires. Their page simply states, the concentrate is "suitable through medium expansion nozzles on Class “A” or contained Class “B” flammable liquids" (Chemguard, First Class). The viscosity for First Class could not be located online. The manufacturer provided the information via email. The viscosity for First Class is 10 cps at 77°F. The viscosity was measured using a Brookfield Viscometer Spindle #1, Speed 60 rpm (R. Hendricksen, personal communication, 10/14/2013).

Fire-Freeze Worldwide is the manufacturer of Cold Fire. Cold Fire is a UL Classified wetting agent for use on Class A fuels at 0.15%, non-polar Class B fuels at 1.50% and is not classified for use on polar Class B fuels. The viscosity of Cold Fire is listed as 15 cps. There is no temperature noted at which the centipoise was determined (Underwriter, 2009).

Hazard Control Technologies is the manufacturer of F-500. F-500 is a UL Classified wetting agent for use on Class A fuels at 0.25%, non-polar Class B fuels at 6% and is not

classified for use on polar Class B fuels (Oke, 2012, p.18). The viscosity of F-500 at 72°F is 85cps (Hct, 2013).

Fire Service Plus is the manufacturer of FireAde 2000 and FireAde 2000 AR-AFFF 3% x 3%. FireAde 2000 is a UL Classified wetting agent for use on Class A fuels at 0.25%, non-polar Class B fuels at 0.50% and is not classified for use on polar Class B fuels (Oke, 2012, p.16). The viscosity for FireAde 2000 could not be located. The manufacturer and suppliers were contacted and asked to provide the data with all requests going unanswered.

FireAde 2000 AR-AFFF 3% x 3% Class B is listed by the manufacturer as "applicable at 0.25% - 1% on Class A fires as a wetting agent". The manufacturer lists FireAde AR Class B as being able to be utilized on all Class B fires at 3.0%. The viscosity for FireAde AR Class B is listed at 900 cps. The temperature at which the viscosity was measured was not indicated by the manufacturer (Fire Service Plus).

Fire Suppression Products is the manufacturer of Fire Cap Plus. Fire Cap Plus is a UL Classified wetting agent for use on Class A fuels at 0.25%, non-polar Class B fuels at 0.30% and is not classified for use on polar Class B fuels (Oke, 2012, p.16). The viscosity for Fire Cap Plus could not be located. The manufacturer was contacted and asked to provide the data with all requests going unanswered.

ICL Performance Products, LP is the manufacturer of Phos-Chek WD-881. Phos-Chek WD-881 is a UL Classified wetting agent approved on Class A fires at 0.10%, is approved for use on non-polar solvent Class B fires at 0.50% and is not approved for use on polar solvent Class B fires (Oke, 2012, p.19). The data obtained on Phos-Chek WD-881 provided three different viscosity measurements at three different temperatures. Phos-Chek WD-881 has a

viscosity of 450 cps at 32°F, a viscosity of 150 cps at 40°F and a viscosity of 50 cps at 75°F (Phos Chek).

Verde Environmental is the manufacturer of Micro-Blaze Out. Micro-Blaze Out is a UL Classified wetting agent for use on Class A fuels at 1%, non-polar Class B fuels at 3% and is not classified for use on polar Class B fuels. The viscosity of Micro-Blaze Out at 70°F is 47.4 cps . It should be noted this viscosity was measured using a 1% solution not the concentrate (Verde Environmental).

National Foam, a division of Kidde Fire Fighting, manufacturers five different products that were examined during the research, Centurion 3% x 6% AFFF, Centurion 3% x 3% AFFF ATC, Universal 3% x 3% AR-AFFF, and Universal Gold 1% x 3% AR-AFFF.

National Foam Centurion 3% x 6% AR-AFFF is approved by the manufacturer for Class A fires as a wetting agent. The manufacturer does not provide a recommended delivery percentage for use on Class A fires. The concentrate is approved for use on non-polar solvent Class B fires at 3% and is approved for use on polar solvent Class B fires at 6%. This concentrate has a viscosity of 2,800 cps. The manufacturer does not state the temperature at which the viscosity was measured. The viscosity was measured using a Brookfield Viscometer Spindle #3, Speed 30 rpm. The manufacturer noted, " Viscosity measured under different shear conditions will be different because of pseudoplastic rheology of this non-Newtonian product" (National Foam, 2008).

National Foam Centurion 3% AR-AFFF is approved by the manufacturer for Class A fires as a wetting agent. The manufacturer does not provide a recommended delivery percentage for use on Class A fires. The concentrate is approved on all Class B fires at 3%, and has a viscosity of 2,600 cps. The manufacturer does not state the temperature at which the viscosity

was measured. The viscosity was measured using a Brookfield Viscometer Spindle #4, Speed 60 rpm. The manufacturer noted, " Viscosity measured under different shear conditions will be different because of pseudoplastic rheology of this non-Newtonian product" (National Foam, 2008).

National Foam Knockdown is a UL Classified wetting agent for use on Class A fuels at 0.30%, non-polar Class B fuels at 0.30% and is not classified for use on polar Class B fuels. The viscosity of this concentrate was presented in csks. Research conducted on the definition of csks did not provide any results. The viscosity of Knockdown at 70°F is 20 csks and at 20°F the viscosity is 32 csks (National Foam, 2001).

National Foam Universal 3% x 6% AR-AFFF is approved by the manufacturer for Class A fires as a wetting agent. The manufacturer does not provide a recommended delivery percentage for use on Class A fires. The concentrate is approved for use on non-polar solvent Class B fires at 3% and is approved for use on polar solvent Class B fires at 6%. The concentrate has a viscosity of 2,700 cps. The manufacturer does not state the temperature at which the viscosity was measured. The viscosity was measured using a Brookfield Viscometer Spindle #3, Speed 30 rpm. The manufacturer noted, " Viscosity measured under different shear conditions will be different because of pseudoplastic rheology of this non-Newtonian product" (National Foam, 2007).

National Foam Universal Gold 1% x 3% AR-AFFF is approved by the manufacturer for Class A fires as a wetting agent. The manufacturer does not provide a recommended delivery percentage for use on Class A fires. The concentrate is approved for use on non-polar solvent Class B fires at 1% and is approved for use on polar solvent Class B fires at 3%. The concentrate has a viscosity of 2,500 cps. The manufacturer does not state the temperature at

which the viscosity was measured. The viscosity was measured using a Brookfield Viscometer Spindle #4, Speed 60 rpm. The manufacturer noted, " Viscosity measured under different shear conditions will be different because of pseudoplastic rheology of this non-Newtonian product" (National Foam, 2008).

U.S. Foam Technologies is the manufacturer of First Strike Class "A" Foam concentrate. First Strike Class "A" is approved by the manufacturer for use on Class A fires at an application percentage between 0.10% and 1%. The concentrate is not approved for use on any Class B fires. The manufacturer lists the viscosity of the concentrate as 17. There is no unit of measure or temperature noted, just the number 17 beside the word viscosity (U.S. Foam).

Williams Fire and Hazard Control is the manufacturer of three concentrates that were examined during the research, Thunderstorm 1% x 3% AR-AFF (FC-301A), Thunderstorm 3% x 3% AR-AFFF (F-603B), and Thunderstorm SFF Structural Firefighting Foam.

Thunderstorm 1% x 3% AR-AFFF is not approved by the manufacturer for Class A fires. The concentrate is approved for use on non-polar solvent Class B fires at 1% and is approved for use on polar solvent Class B fires at 3%. The concentrate has a viscosity of 2,000-3,200 cps at 77°F. The viscosity was measured using a Brookfield Viscometer Spindle #4, Speed 30 rpm. The manufacturer noted their concentrate is "a non-Newtonian fluid that is both pseudoplastic and thixotropic. Because of these properties, dynamic viscosity will decrease as shear increases" (Williams Fire).

In regards to utilizing Thunderstorm 3% AR-AFFF (F-603B) on Class A fires, the manufacturer states, "its excellent wetting characteristics make it useful in combating Class A fires". The concentrate is approved for use on all Class B fires at 3%. The concentrate has a viscosity of 2,000-3,200 cps at 77°F. The viscosity was measured using a Brookfield

Viscometer Spindle #4, Speed 30 rpm. The manufacturer noted their concentrate is "a non-Newtonian fluid that is both pseudoplastic and thixotropic. Because of these properties, dynamic viscosity will decrease as shear increases" (Williams Fire).

Thunderstorm SFFF Structural Firefighting Foam is approved by the manufacturer for use on Class A fires at an application rate of 0.10% to 0.60%. The manufacturer states the product is "suitable through medium expansion nozzles on Class A or contained Class B flammable liquids." The manufacturer doesn't state if the product only works on specific types of Class B fuels or provide a required delivery percentage. The viscosity for this concentrate is 20 cps at 77°F (Williams Fire).

The number of on-board concentrate delivery systems to be researched was determined to be 22 models manufactured by nine different manufacturers.

Akron manufacturers the Akron Model 3126 on-board foam system. The system is capable of delivering concentrate at 0.25%, 0.50%, 0.75%, 1%, 3% and 6%. The system is an eduction system which must have a nozzle at the end delivering 125 gallons per minute (gpm) to be accurate. The length and size of the hose line being utilized to deliver the foam solution will also have an effect on the concentrate percentage being delivered. In regards to the maximum viscosity this system will deliver, the manufacturer representative states this system will "educt all concentrates, but you take the screen off for the thick stuff. The most viscose is 1-3 and that works fine" (R. Lewis, personal communication, October 8, 2013).

Elkhart Brass manufacturers the Elkhart 240P 125 gpm foam eduction system. This system will deliver concentrate at 0.50%, 1%, 3% and 6%. According to the manufacturer representative "we do not have the information available on the viscosity and centipoise of concentrates that the 240P will pump" (J. Melrose, personal communication, October 4, 2013).

Feecon Products a division of Kidde Fire Fighting manufacturers two systems that were researched for this project, the Feecon Model APH 1.5 Dual Liquid Around the Pump Foam System and the Feecon Model 1.5-1% Around the Pump Foam System. These systems deliver foam solution between 125 and 250 psi and they have no nozzle or hose length restrictions. The Model APH 1.5 is capable of delivering concentrate at 1%, 3% and 6%. The Model APH 1.5-1% is capable of delivering concentrate at 0.50%, 1% and 3% (Feecon, 2012). The maximum viscosity the system will pump could not be located and numerous attempts to get the information from the manufacturer were unanswered.

Foam Pro manufacturers five systems that were part of this research, Model 1600, Model 1601, Model 2001, Model 2002 and Model 3012. The Foam Pro foam systems are all injection type systems that will work with any size or length of hose line and with any type of nozzle. The Model 1600 and 1601 will deliver concentrate at percentages between 0.10% and 1%. The Model 2001, 2002 and 3012 will deliver concentrate at percentages between 0.10% and 10% (www.foampro/en-us/Products/ProportioningSystems, October 8, 2013). The manufacturer representative stated the Model 1600 and 1601 systems were designed as Class A foam delivery systems that are capable of delivering concentrate with a maximum viscosity of 1,000 cps. The Model 2001 and 2002 systems are capable of delivering concentrate with a maximum viscosity of 2,000 cps. The Model 3012 is capable of delivering concentrate with a maximum viscosity of 5,000 cps (R. Morley, personal communication, September 20, 2013).

Hale IDEX manufacturers two of the systems that were part of this research, FoamLogix 3.3 and FoamLogix 5.1. These systems are injection type systems that will work with any size or length of hose line and with any type of nozzle. The Model 3.3 has a maximum operating pressure of 400 psi while the Model 5.1 has a maximum operating pressure of 250 psi. These

two systems are capable of delivering concentrate at percentages between 0.10% and 10% (Hale, 2006). The manufacturer doesn't list any specific maximum centipoise that can be utilized by their systems. They do have a published list of approved concentrates that can be utilized with their delivery systems (Hale, 2013).

Pierce manufacturers four of the systems that were part of this research. Those four systems are the Husky 10, Husky 12, Husky 3 and Husky 30. These systems are injection type systems. There were no limitations in regards to size, length of hose or nozzle type that were discovered during the researching of these delivery systems.

The Husky 10 is an older system manufactured by Pierce. Specific delivery percentages could not be located for this delivery system. The manufacturer information does state the system can delivery concentrate between 0.50% and 6%. The manufacturer information researched on this delivery system did not provide specific viscosity limits for the system. The manufacturer does state this delivery system can "proportion foam concentrates across a wide range of viscosities, from low viscosities such as Class A or Class B AFFF, through high viscosities such as Class B AR-AFFF" (Pierce Manufacturing, n.d.).

The Husky 12 delivery system can delivery foam concentrate from 0.10% to 9.9%. The manufacturer provides an acceptable foam concentrate viscosity range. The minimum viscosity of three centistokes is required with a maximum of 6,000 cps. The manufacturer states the 6,000 cps is measured using a Brookfield #3 spindle at 30 rpm (Pierce Manufacturing, 2007). It should be noted that centistokes and centipoise are two different units of measure that are utilized when dealing with viscosity.

The Husky 3 delivery system can delivery foam concentrate from 0.10% to 3%. The manufacturer provides and acceptable foam concentrate viscosity range. The minimum viscosity

of 3 centistokes is required with a maximum of 6,000 cps. The manufacturer states the 6,000 cps is measured using a Brookfield #3 spindle at 30 rpm (Pierce Manufacturing, 2010).

The Husky 30 delivery system can deliver foam concentrate at a range of 0.50% to 6%. The manufacturer states, "The capacity of each foam-capable discharge is governed by the range of the proportioner". The manufacturer provides and acceptable foam concentrate viscosity range. The minimum viscosity of 3 centistokes is required with a maximum of 5,300 cps. The manufacturer states the 5,300 cps is measured using a Brookfield #3 spindle at 30 rpm (Pierce Manufacturing, 2008).

Rosenbauer America manufacturers the Rosenbauer EZ Foam delivery system. This delivery system utilizes venturi proportioners at the outlets. Information could not be located in regards to limitations with hose size, lengths or nozzle types. This system provides three foam percentage options per outlet at normal pressures; 0.50%, 1% and 3% (Rosenbauer America). No information could be located regarding the delivery systems limitations on viscosity.

Waterous Company manufacturers four delivery systems that were included in this research. They manufacturer the Aquis 1.5, Aquis 2.5, Advantus 3 and Advantus 6. The Waterous Company delivery systems are injection systems. The manufacturer did not state there were limitations in regards to hose size, hose length or nozzle type.

The Aquis 1.5 delivery system will provide concentrate from 0.10% to 1% and has a maximum viscosity of 2,000 cps. The Aquis 2.5 delivery system will provide concentrate from 0.10% to 1% and at 3%. This system can pump a maximum viscosity of 2,000 cps. The Advantus 3 and Advantus 6 delivery systems will provide concentrate from 0.10% to 1%, 3% and 6%. These systems will deliver concentrate with a maximum centipoise of 3,000 (G. Geske, personal communication, October 2, 2013).

Williams Fire and Hazard Control manufacturers the Williams Around the Pump (ATP) 1500V and Williams ATP 1500B. These delivery systems are water driven and work against 33% pump suction pressure (Williams Fire). According to a manufacturer representative these systems are "designed to work with a wide range of concentrates. However, it is not meant to be an extremely precise piece of proportioning equipment" (C. Spears, personal communication, November 14, 2013). The manufacturer did not provide specific viscosity measurements for either of their delivery systems. The manufacturer representative stated the systems "typically proportions our foams as well as foams with varying viscosity with acceptable accuracy" (C. Spears, personal communication, November 14, 2013).

The Williams ATP 1500V will deliver concentrate at rates of 0.25%, 0.50%, 1%, 3% and 6% (Williams Fire). The Williams ATP 1500B will deliver concentrate at rates of 1%, 3% and 6% (Williams Fire).

The literature review did not produce a large number of informational sources relating to the research questions. This lack of available information relating to compatibility of on-board foam delivery systems and foam concentrates clearly demonstrates the need for further research.

The concentrate viscosity list by FoamPro had 126 foam concentrates listed which clearly identified that moving forward with the research would require narrowing the number of concentrates to be examined. The discovery of this data greatly influenced the direction of the research project.

The information provided in NFPA 1901 provides guidance for final installers and purchasers which should prevent any foam system being installed to be utilized with a foam concentrate that isn't compatible with the needed percentage or the identified viscosity of the foam concentrate.

Procedures

It was determined early in the research process that information was needed from throughout the fire service to determine which foam concentrates and on-board foam systems would be researched. A survey was developed using www.surveymonkey.com (Appendix A). The survey link was distributed through emails and posting in various share groups throughout the internet. The purpose of the survey was to determine what brands of foam concentrates and on-board foam systems were being utilized throughout the fire service. The survey was also developed to gather data to possibly be utilized for future research dealing with foam concentrates and on-board foam systems.

The Albemarle Fire Department library was researched for any textbooks or reference material that would provide information related to the research questions. There was one resource located that provided information relevant to the research.

NFPA standards were researched for information related to the research questions. Information was located in the NFPA standards which provided data for the literature review.

The surveys were allowed to be completed for nearly two months. During this time period there were 181 surveys collected with data (Appendix B). There were nine surveys completed by twice by members of the same department which resulted in the number of surveys being reduced to 172 surveys. The surveys that indicated no on-board foam system was utilized by the department were removed which lowered the number of completed surveys to 147 surveys.

The remaining 147 surveys were examined to determine the particular on-board foam delivery system and foam concentrate. The additional information obtained in the surveys were not utilized for the purpose of this research. During the research of the completed surveys it was

determined there were numerous invalid answers for the type of on-board foam delivery system and foam concentrate.

The surveys containing invalid answers whose respondent had provided an email address were contacted via email and asked to clarify the answers to the survey in regards to the type of foam concentrate and on-board foam delivery system. The additional inquires provided clarification to numerous survey responses which increased the sample size.

Each of the identified concentrate delivery systems and foam concentrates were validated utilizing Google.com to search for the product. Once all of the provided delivery systems and foam concentrates were validated there were 22 different on-board concentrate delivery systems and 30 different foam concentrate to research.

The validated on-board concentrate delivery systems were researched through Google.com to determine the minimum and maximum concentrate percentage they would deliver as well as the maximum centipoise the system could properly proportion or pump. The validated foam concentrates were researched through Google.com to determine the needed delivery percentage for Class A fires, Class B fires (non-polar and polar liquids) and the maximum viscosity of the concentrate, expressed in centipoise.

The internet searches did not provide all of the required data on each product. Additional online searches through Google.com were conducted to gather contact information for the products requiring additional data. Emails were sent to each of the identified manufacturer representatives to gather the needed data.

Once the desired data was obtained each foam concentrate and on-board delivery system was identified in a chart which showed the necessary data to allow the department to determine if the foam concentrate and on-board delivery system were compatible.

The lack of knowledge of the respondents relating to the primary survey questions of the survey was a major limitation in the research process. The majority of the surveys returned did not provide complete and accurate answers to the necessary questions. The lack of valid answers resulted in additional follow-up questions to the respondents that had identified themselves and provided contact information. There were numerous surveys that could not be utilized due to insufficient answers.

The lack of information provided by the manufacturers was an additional limitation to the research process. There were two foam concentrate manufacturer's that did not provide their products viscosity and would not reply to email or phone messages. There were five concentrate delivery system manufacturer's that either did not know what the maximum centipoise their system could operate with or the information was not available.

The identified limitations did not prevent the research from taking place, they only limited the final results. It is important to note the lack of available information from manufacturer's should be taken into consideration when purchasing foam concentrates or on-board delivery systems.

Results

The survey conducted as part of this research discovered a large number of concentrates and on-board delivery systems. There were a large number of concentrates and delivery systems that were reported within the survey that weren't valid. Additional inquiries with respondents of the survey that left contact information identified the concentrates and on-board delivery systems that were valid. These concentrates and on-board delivery systems were researched in depth to provide answers to the research questions. The survey provided 30 valid foam concentrates and 22 valid on-board delivery systems. The large number of concentrates and on-board delivery

systems made it difficult to provide an individual concentrate to delivery system comparison. The research did provide the necessary data to create two charts which will allow departments to cross reference the identified on-board delivery system with the identified foam concentrates. The foam concentrate chart is located in Appendix C. The on-board foam delivery system chart is located in Appendix D. These charts are not inclusive to the foam concentrates and on-board foam delivery systems currently available to the fire service. These charts are simply the valid foam concentrates and on-board delivery systems in use at the Albemarle Fire Department and identified in the survey utilized during this research process.

Is each identified on-board foam system compatible in regards to viscosity with identified foam/wetting agent concentrates? Using the list of foam concentrates identified in Appendix C and on-board foam delivery systems in Appendix D a determination can be made regarding the compatibility of the concentrate with the delivery system in regards to the maximum viscosity the delivery system can operate with.

A determination on the compatibility in regards to viscosity of the Elkhart Model 240P could not be made because the manufacturer does not know the maximum viscosity their delivery system will pump.

The maximum viscosity could not be located for the Feecon Model APH 1.5-1% and APH 1.5 Dual Liquid, Rosenbauer EZ Foam, Pierce Husky 10, and Williams Fire and Hazard Control Model ATP 1500 V and Model 1500 B. Due to no maximum viscosity being located for these on-board delivery systems no determination in regards to compatibility could be made.

The Hale Company Foam Logic Models 3.3 and 5.1 didn't identify a maximum viscosity the system could operate with. The company does maintain an approved product list which

should be consulted when determining the compatibility of the concentrate being utilized (Hale, 2013).

The Akron #3126 and Foam Pro 3012 delivery systems are compatible in regards to the maximum viscosity with each of the identified concentrates with the exception of Ansul Thunderstorm 3% x 3% AR-AFFF (F-603A).

The Foam Pro Model 1600 and Model 1601 are compatible in regards to the maximum viscosity with each of the identified concentrates with the exception of Ansul Thunderstorm 3% x 3% AR-AFFF (F-603A), Ansulite 1% x 3% AR-AFFF (F-601A), Ansulite 3% x 3% Low Viscosity AR-AFFF, Ansulite ARC 3% x 6% AR-AFFF, Chemguard 3% x 3% AR-AFFF (C-333), National Foam Centurion 3% x 6% AR-AFFF, National Foam Centurion 3% AR-AFFF, National Foam Universal Plus 3% x 6% AR-AFFF, National Foam Universal Gold 1% x 3%, Williams Thunderstorm 1% x 3% AR-AFFF (F-601A), and Williams Thunderstorm 3% AR-AFFF (F-603B). Reviewing the compatible concentrates these two systems are compatible with all of the identified Class A foams and wetting agents.

The Foam Pro Model 2001 and 2002 and Waterous Aquis Models 1.5 and 2.5 are compatible in regards to the maximum viscosity with the same foam concentrates as the Foam Pro Models 1600 and 1601 with the exception of Chemguard 3% x 3% AR-AFFF (C-333). The foam concentrates not compatible with Foam Pro Models 1600, 1601, 200, 2002 and Waterous Aquis Models 1.5 and 2.5 each exceed 2,000 cps with the exception of Chemguard 3% x 3% AR-AFFF (C-333) which has a cps of 1,500.

The Pierce Manufacturing Husky Model 12 and 3 are compatible in regards to the maximum viscosity with all of the concentrates identified in Appendix C. The Pierce Manufacturing Husky Model 30 is compatible with all of the concentrates identified in Appendix

C with the exception of Ansul Thunderstorm 3% x 3% AR-AFFF (F-603A) and Ansulite 3% x 3% Low Viscosity AR-AFFF.

The Waterous Company Advantus Model 3 and 6 are compatible in regards to the maximum viscosity with each of the identified concentrates with the exception of Ansul Thunderstorm 3% x 3% AR-AFFF (F-603A), Ansulite 1% x 3% AR-AFFF (F-601A), Ansulite ARC 3% x 6% AR-AFFF, Williams Thunderstorm 1% x 3% AR-AFFF (F-601A), and Williams Thunderstorm 3% AR-AFFF (F-603B).

It should be noted the majority of the concentrate manufacturers reported their concentrates viscosity at 70°F or above. Departments operating their foam systems in temperatures below 70°F should note there may be compatibility issues due to the viscosity of concentrate being utilized greatly increasing due to the lower temperatures.

There were a multitude of concentrates that listed the viscosity of their product with a plus or minus variation. In order to assure the maximum cps of the concentrate could be utilized by the delivery system the maximum cps possible was calculated and utilized in determining the compatibility.

Is each identified on-board foam system compatible in regards to delivering the manufacturer recommended percentage of concentrate for Class A fires?

The following concentrates are not recommended by the manufacturer to be utilized for Class A fires: Ansul Thunderstorm 3% x 3% AR-AFFF (F-603A), Ansulite 3% (AFC-3A), Ansulite 1% x 3% AR-AFFF (F-601A), Ansulite 3% x 3% Low Viscosity AR-AFFF, Ansulite ARC 3% x 6% AR-AFFF, Chemguard 3% x 3% AR-AFFF (C-333), and Williams Thunderstorm 1% x 3% AR-AFFF (F-601A).

The manufacturer states the following concentrates may be utilized on Class A fires; National Foam Centurion 3% x 6% AR-AFFF, National Foam Centurion 3% AR-AFFF, National Foam Universal Plus 3% x 6% AR-AFFF, National Foam Universal Gold 1% x 3%, and Williams Thunderstorm 3% AR-AFFF (F-603B). The manufacturer does not provide and recommendations in regards to delivery percentages, only that their product may be utilized on Class A fires.

The following on-board delivery systems identified in Appendix D will proportion foam concentrates with a range of delivery percentages between 0.10% and 1%: all Foam Pro models, all Hale Foam Logic models, Pierce Manufacturing; Husky Model 3 and Model 12, and all Waterous Company models. These on-board delivery systems are compatible with each of the concentrates listed in Appendix C with a Class A delivery percentage between 0.10% and 1%.

The following on-board delivery systems detailed in Appendix D are capable of delivering the needed 2% concentration rate for Ansul Jet-X: Foam Pro Models 2001, 2002 and 3012, Hale Foam Logic Models 3.3 and 5.1 and Pierce Manufacturing Husky Models 3, 10, 12 and 30. Jet-X is the only foam concentrate identified in Appendix C with a delivery concentration of 2%.

The Akron Model 3126 and Williams Model ATP 1500 V are capable of delivering the needed concentrate percentage for the following foam concentrates that were identified in Appendix C: Hazard Control Technologies F-500 and Fire Service Plus FireAde 2000. These are the only two concentrates identified in the research as having a delivery percentage of 0.25% for Class A fires.

As identified in Appendix D, the Akron Model 3126, Elkhart Model 240P, Feecon Model APH 1.5-1% and APH 1.5, Pierce Manufacturing Husky Model 10 and 30, Rosenbauer EZ

Foam, and Williams Models ATP 1500V and 1500B are all on-board delivery systems capable of delivering Verde Environmental Micro Blaze Out. Micro Blaze Out is the only concentrate identified in Appendix C with a delivery concentration rate for Class A fires of 1%.

Is each identified on-board foam system compatible in regards to delivering the manufacturer recommended percentage of concentrate for Class B fires?

The Class B fires were divided into two categories, non-polar and polar. This division was necessary due to the varying percentages of foam concentrates depending on which type of fire is encountered. There are numerous concentrates that are not approved for one or both types of Class B fires. Ansul Silvex and Silvex-Plus, Chemguard Class A Plus and U.S. Foam First Strike Class "A" are not approved by the manufacturer for use on either type of Class B fire. In addition to these concentrates not being approved for Class B fires there were several concentrates not approved for use on polar Class B fires. A large number of these concentrates are products which meet the NFPA 18 standard for wetting agents which does not provide a test for polar Class B fires. Ansul-A Municipal "Class A" Fire Control, Ansulite 3% (AFC-3A), Baum's Castorine Novacool, Chemguard CAFS Extreme, Class A Plus and First Class, Fire-Freeze Worldwide Cold Fire, Hazard Technologies F-500, Fire Service Plus FireAde200, Fire Suppression Products FireCap Plus, ICL Performance Products Phos-Chek WD881, Verde Environmental Micro Blaze Out and National Foam Knockdown are all noted as not being approved for use on polar Class B fires.

The manufacturer of Thunderstorm SFFF Class A foam, Williams Fire and Hazard Control, states their product may be used on Class B contained fires. The manufacturer doesn't provide any concentration delivery percentages or note which type of Class B fires their concentrate can be utilized on (Williams Fire and Hazard Control).

The Akron Model 3126 and Williams Fire and Hazard Control Model ATP 1500 V are compatible with all of the foam concentrates approved for use on Class B fires with the exception of: Ansul Jet-X, Fire-Freeze Worldwide Cold Fire, Fire Suppression Products FireCap Plus, ICL Performance Products Phos-Chek WD881, and National Foam Knockdown. These concentrates are required to be delivered at concentrate percentages this model of delivery system cannot be set to deliver.

The Elkhart Model 240P is compatible with all of the foam concentrates approved for use on Class B fires with the exception of: Ansul Jet-X, Fire-Freeze Worldwide Cold Fire, Fire Suppression Products FireCap Plus, , ICL Performance Products Phos-Chek WD881, and National Foam Knockdown. These concentrates are required to be delivered at concentrate percentages this model of delivery system cannot be set to deliver.

The Feecon Model APH 1.5-1% and Rosenbauer EZ Foam are compatible with all of the foam concentrates approved for use on Class B fires with the exception of: Ansul Jet-X, Ansulite ARC 3% x 6% AR-AFFF, Fire-Freeze Worldwide Cold Fire, Hazard Control Technologies F-500, Fire Suppression Products FireCap Plus, ICL Performance Products Phos-Chek WD881, National Foam Centurion 3% x 6% AR-AFFF, National Foam Universal Plus 3% x 6% AR-AFFF, and National Foam Knockdown. These concentrates are required to be delivered at concentrate percentages this model of delivery system cannot be set to deliver.

The Feecon Model APH 1.5 and Williams Fire and Hazard Control Model ATP 1500 B are compatible with all of the foam concentrates approved for use on Class B fires with the exception of: Ansul Jet-X, Baum's Castorine Novacool, Chemguard CAFS Extreme and First Class, Fire-Freeze Worldwide Cold Fire, Fire Service Plus FireAde 2000, Fire Suppression Products FireCap Plus, ICL Performance Products Phos-Chek WD881, and National Foam

Knockdown. These concentrates are required to be delivered at concentrate percentages this model of delivery system cannot be set to deliver.

The Foam Pro Models 1600 and 1601 and Waterous Aquis 1.5 are compatible with the following concentrates which are identified in Appendix C: Baum's Castorine Novacool, Chemguard CAFS Extreme and First Class, Fire Service Plus FireAde 2000, Fire Suppression Products FireCap Plus, ICL Performance Products Phos-Chek WD881, and National Foam Knockdown. These concentrates are required to be delivered at concentrate percentages lower than 1%. All of the concentrates listed are UL Classified wetting agents with the exception of Chemguard CAFS Extreme.

The Pierce Manufacturing Husky Model 10 is compatible with every concentrate identified in Appendix C that is approved for us on Class B fires with the exception of Fire Suppression Products FireCap Plus, ICL Performance Products Phos-Chek WD881, and National Foam Knockdown. These concentrates are all UL Classified wetting agents which are approved for use on non-polar Class B fires at rates lower than 0.50% which the Husky Model 10 cannot deliver.

The Pierce Manufacturing Husky Model 3 is compatible with every concentrate identified in Appendix C that is approved for us on Class B fires with the exception of: Ansulite ARC 3% x 6% AR-AFFF, National Foam Centurion 3% x 6% AR-AFFF, and National Foam Universal Plus 3% x 6% AR-AFFF. These concentrates are required to be delivered at concentrate percentages this model of delivery system cannot be set to deliver.

The Pierce Manufacturing Husky Model 30 is compatible with all of the foam concentrates approved for use on Class B fires with the exception of: Baum's Castorine Novacool, Chemguard CAFS Extreme and First Class, Fire Service Plus FireAde 2000, Fire

Suppression Products FireCap Plus, ICL Performance Products Phos-Chek WD881, and National Foam Knockdown. These concentrates are required to be delivered at concentrate percentages this model of delivery system cannot be set to deliver.

The Waterous Aquis 2.5 is compatible with all of the foam concentrates approved for use on Class B fires with the exception of: Ansul Jet-X, Ansulite ARC 3% x 6% AR-AFFF, Fire-Freeze Worldwide Cold Fire, Hazard Control Technologies F-500, National Foam Centurion 3% x 6% AR-AFFF, and National Foam Universal Plus 3% x 6% AR-AFFF. These concentrates are required to be delivered at concentrate percentages this model of delivery system cannot be set to deliver.

The Waterous Advantus Models 3 and 6 are compatible with all of the foam concentrates approved for use on Class B fires with the exception of: Ansul Jet-X, and Fire-Freeze Worldwide Cold Fire. These concentrates are required to be delivered at concentrate percentages this model of delivery system cannot be set to deliver.

The Foam Pro Models 2001, 2002 and 3012, Hale Foam Logic 3.3 and 5.1, and Pierce Manufacturing Husky Model 12 are compatible with all of the concentrates identified in Appendix C. These models of on-board delivery systems will deliver concentrates ranging from 0.10% to 6%, several models even exceed 6% deliver capabilities.

The results of the three research questions clearly demonstrate that not all on-board foam delivery systems will work with all available concentrates. It is vital for departments with an on-board foam delivery system to research the system they have in service and be sure that system is compatible with the concentrate being utilized. In addition to departments with units in service departments considering purchasing an apparatus with an on-board delivery must research the

system they are considering to be sure it is compatible with the foam concentrate in use in the department or being considered for use in the department.

Discussion

There was a lack of information discovered during the literature review in regards to others having researched the compatibility of on-board foam delivery systems and foam concentrates. This is a concerning problem as a review of any recent apparatus delivery section of a fire service publication clearly shows the majority of fire departments ordering fire apparatus are ordering them with on-board foam delivery systems. A review of the Albemarle Fire Department's most recent apparatus order specification reveals there is no information in the specification concerning compatibility of our foam concentrate with the system we placed on our apparatus.

NFPA 1901, the fire apparatus standard, provides guidance for departments ordering compliant apparatus. In order for your apparatus to NFPA 1901 compliant this section of the standard must be followed.

A key component of NFPA 1901 that was overlooked by our department is the requirement that the final installer test and certify that the system "has been calibrated and tested to meet the foam equipment manufacturer's and the purchaser's performance specifications" (National Fire Protection Association, 2009, p. 1901-79). How many departments that have purchased NFPA 1901 compliant apparatus with on-board foam systems complied with this section of the standard? I know that our recent apparatus purchases did not comply as our department never provided the apparatus builder with any information pertaining to the concentrate we utilize.

The information the standard requires the purchaser to supply to the manufacturer includes the type of concentrate, brand of concentrate and the viscosity (National Fire Protection Association, 2009, p. 1901-76). If each department that responded to the survey included in Appendix B would have provided the required information to NFPA all of their concentrates and on-board delivery systems would be compatible.

There are numerous concentrates available to the fire service that would make it impossible to provide the required information according to NFPA 1901. In the limited number of concentrates examined for this research there were two concentrates that viscosity could not be located, Fire Service Plus FireAde 200 and Fire Suppression Products FireCap Plus. In addition to these two concentrates the foam viscosity list published by Foam Pro has eleven concentrates listed that require the manufacturer to be contacted in regards to viscosity (Foam Pro, 2013).

In addition to the concentrates that did not identify their viscosity there are conflicting viscosities being reported for several concentrates. These conflicts are present when comparing the viscosity listed on the Foam Pro reference list and the information obtained from the manufacturer or other product source. According to the Foam Pro reference list the viscosity for Ansul A is 7.0 cps (Foam Pro, 2013) the viscosity for the same product is reported by the manufacturer as being 1.7 cps (Ansul Incorporated). Williams Fire and Hazard Control reports the viscosity for Thunderstorm SFFF Class A foam as being 20 cps (Williams Fire) yet the Foam Pro reference list has the viscosity for the product listed at 7.0 cps (Foam Pro, 2013). Hazard Control Technologies F-500 is reported by the manufacturer to have a viscosity of 85 cps (Hct, 2013) yet the Foam Pro reference list has the viscosity for the product listed at 55 cps (Foam Pro, 2013). The concentrate with the greatest variance between the Foam Pro reference list and the

manufacturer is Chemguard 3% x 3% AR-AFFF (C-333). The manufacturer reports the viscosity for this product at 1,500 cps (Chemguard, 2013) while the Foam Pro reference list has the viscosity of the concentrate listed at 3,000 cps (Foam Pro, 2013).

It is clear from the research that the reliability of the viscosity being reported can be questionable. This unreliability could mean the difference in an on-board foam delivery system working and it not working. An example of how the conflicting viscosity reporting can affect the operation of a delivery system can be seen in Chemguard 3% x 3% AR-AFFF (C-333). If a department was purchasing an on-board foam system such as the Foam Pro Model 2001, the Chemguard 3% x 3% AR-AFFF (C-333) would work if the viscosity was 1,500 cps as the viscosity maximum for the Foam Pro Model 2001 is 2,000 cps (R. Morley, personal communication, September 20, 2013). If the department purchasing the on-board delivery system utilized the manufacturer data the concentrate would be acceptable for the Foam Pro Model 2001 whereas the data reported on the Foam Pro reference list would prevent the Foam Pro Model 2001 from working with the Chemguard 3% x 3% AR-AFFF (C-333) concentrate. It is very important for departments purchasing an on-board foam delivery system to search out multiple sources of data when determining the validity of the data on their concentrate.

It is important for departments utilizing on-board foam delivery systems to know what NFPA standard the concentrate they are utilizing complies with. The three major foam standards are NFPA 11, 18 and 1150. These standards provide guidance in regards to viscosity testing requirements which can aid departments in determining if their concentrate is compatible with their delivery system.

NFPA 11, the standard covering most AR-AFFF and AFFF foams, does not provide any guidance in regards to reporting the viscosity of the concentrate. NFPA 18, the standard

covering wetting agents, provides in depth viscosity testing for concentrates. This standard requires the concentrate be tested for viscosity at 35°F, 65°F and 120°F with a +/- 5°F variance. It is great the standard requires this testing although the standard does not have a requirement that the results be reported (National Fire Protection Association, 2011, p. 18-8). This lack of required reporting was obvious during the research process. Baum's Castorine Novacool and ICL Performance Products Phos-Chek WD-881 were the only two concentrates included in this research that reported three viscosity readings at varying temperatures. Novacool was the only NFPA 18 compliant concentrate in compliance with the NFPA 18 standard in regards to viscosity testing (Underwriters Laboratories, 2006). Phos-Chek WD-881 reported viscosity at three varying temperatures but those temperatures were not in compliance with the NFPA 18 standard. The viscosity for Phos-Check WD881 was reported for 32°F, 40°F and 75°F (Phos-Chek). These temperatures are not close to the temperatures required of NFPA 18 for viscosity testing (National Fire Protection Association, 2011, p. 18-8).

NFPA 1150, the standard that provides guidance on foam chemicals for Class A fires, provides similar guidance in regards to viscosity testing as NFPA 18. There are two major differences in NFPA 18 and NFPA 1150 in regards to viscosity. NFPA 1150 requires the concentrate to be tested for viscosity at 35°F, 70°F and 120°F with a +/- 2°F variance which is different than NFPA 18. A major difference in NFPA 1150 from NFPA 18 is that NFPA 1150 requires the manufacturer to report the results of the testing on their product data sheet (National Fire Protection Association, 2010, p. 1150-6).

During the research process there were no concentrates that were identified for use on Class A materials that complied with the NFPA 1150 reporting requirements for viscosity. There also were not any foam concentrates identified for use on Class A materials that stated the

concentrate was in compliance with NFPA 1150. It is clear the NFPA 1150 standard is not being met by the concentrate manufacturers that were researched during this process.

The importance of having multiple temperatures to test viscosity show in the results of Novacool and Phos-Chek, even though the Phos-Chek temperatures were not complaint temperatures. The maximum measured viscosity for Novacool was 71.27 cps which was taken at 35.6^{o}F (Underwriters Laboratories, 2006). This contrasts the maximum measured viscosity for Phos-Chek which was 450 cps at 32^{o}F (Phos-Chek). The minimum measured viscosity for Novacool was 24.48 cps which was measured at 120.2^{o}F (Underwriters Laboratories, 2006) compared to 50 cps for Phos-Chek which was measured at 75^{o}F (Phos-Chek).

The above noted differences make it very clear that temperature plays a vital role in the viscosity of foam concentrates. The increase in centipoise for Phos-Chek between 32^{o}F and 75^{o}F was a 900%. If many of the other concentrates researched for this project increase in viscosity at the same rate as Phos-Chek the majority of those concentrates would render the on-board foam delivery systems useless. If FireAde 2000 AR-AFFF 3% x 3% concentrate which has a viscosity of 900 cps (Fire Service Plus) were to increase 900 % as Phos-Chek did, the concentrate would go from the consistency of glycerin to the consistency of molasses (A Packaging Systems, 2013). There were no on-board foam delivery systems identified in the research that have the capability to utilize a concentrate as thick as molasses.

The research findings in regards to flow percentages were not surprising. The delivery percentages of the injection on-board foam delivery systems have the widest spread of delivery percentages available. The majority of the delivery systems identified in the survey and examined for this research provided a range of delivery percentages from 0.10% to 10%. It should be noted that as the percentage of concentrate needed increases the available gpm of

finished foam solution decreases. It is important when deciding on a particular on-board delivery system that you know the total gpm of finished foam solution the delivery system will need to flow. This gpm will determine the size of concentrate pump the delivery system will need to utilize.

In the case of the Foam Pro Model 2002, which is the delivery system the Albemarle Fire Department purchased on its last apparatus, the system is capable of delivering finished foam solution at 0.50% concentration at 1,000 gpm. This system is capable of pumping foam concentrate into the foam manifold at 5.0 gpm (Foam Pro). In contrast the other Foam Pro foam system in service at the Albemarle Fire Department is the Foam Pro Model 1601. This system is capable of delivering finished foam solution at 0.50% concentration at 200 gpm, a 500% reduction from the Model 2002. The Model 1601 is only capable of pumping foam concentrate into the foam manifold at 1.0 gpm (Foam Pro).

As you can see it is vital prior to purchasing an apparatus with an on-board foam delivery system that you know how many gallons per minute of foam solution you want to deliver and what concentration amount will be needed. These two variables are crucial in assuring the system placed on the apparatus meet the expectations of the department.

The eduction systems that were researched provided the least amount of flexibility in regards to delivery percentages. The majority of the eduction systems researched had set concentration percentages they could deliver which greatly limited the number of concentrates that could be utilized with those systems. These types of systems are also not very accurate in their delivery percentages which is important when utilizing many of the concentrates on the market with low delivery percentages. A manufacturer representative from Williams Fire and Hazard Control stated the Williams Around the Pump foam systems are "not meant to be an

extremely precise piece of proportioning equipment (C. Spears, personal communication, October 14, 2013). If accuracy is what you are searching for in regards to your finished foam solution than eduction systems are not the best choice.

There were requirements placed on the gpm delivered, length of hose line, size of hose and incoming hydrant pressure on some of the eduction systems researched for this project. The Akron Model 3126 required a nozzle at the end of the hose line that is flowing 125 gpm (R. Lewis, personal communication, October 8, 2013). This can prove to be a problem when the flow of the foam solution line needs to be higher or lower than 125 gpm.

The results of this research clearly show a difference in the viscosity and delivery percentage of the various on-board foam delivery systems. The thickness of the foam concentrate that can be handled from system to system can vary as much as 600%. This variance makes a big difference as the viscosity of foam concentrates can vary from a low of 2.2 cps to a high of 5,700 cps.

The research also discovered two manufacturers that didn't know what the maximum viscosity their system could handle. There were five on-board delivery systems that didn't list the maximum viscosity for the product. The research process was also unable to locate the maximum viscosity for these systems. The lack of information on viscosity for delivery systems isn't surprising as much of the fire service has no idea the impact viscosity of foam concentrates has on on-board foam delivery systems.

It was surprising that the manufacturers don't comply with NFPA 1150 and report the viscosity of their products to the end user. It was also surprising that the majority of the products provided the viscosity for their product at 77^{o}F. This temperature is not a common temperature throughout our country, especially during the winter months. Worse than reporting the

temperature of 77°F is the number of manufacturers that didn't report any temperature at which they measured the viscosity of their product.

The research showed there is virtually no accountability to the on-board delivery system or concentrate manufacturers in regards to assuring the fire service their products meet current NFPA standards. There is also no accountability that the manufacturers provide the data needed for end users to make sound decisions regarding the compatibility of the on-board delivery system and concentrate being utilized.

The purpose of this research was to identify and determine the compatibility of identified on-board apparatus foam systems with identified foam/wetting agent concentrates in relation to viscosity and required delivery percentage. This purpose was particularly important to the Albemarle Fire Department to determine if our current on-board foam delivery systems were compatible with our current concentrate in regards to viscosity and delivery percentages.

Albemarle Fire Department Engine Two utilizes the Foam Pro Model 1601. As noted in Appendix D, this model has a delivery percentage of 0.10% to 1% and will utilize a concentrate with a maximum viscosity of 1,000 cps. Our Engine One and Engine Three utilize the Foam Pro Model 2002. As noted in Appendix D, this model has a delivery percentage of 0.10% to 10% and will utilize a concentrate with a maximum viscosity of 2,000 cps.

Our department utilizes Baum's Castorine Novacool, which is a UL Classified wetting agent concentrate which is NFPA 18 compliant. The delivery percentages required to be utilized for the concentrate to remain NFPA compliant are 0.40% for Class A fuels and 0.50% for non-polar Class B fuels. The research provided three viscosity measurements for Novacool. The highest viscosity reported for Novacool was 71.27 cps. This measurement was taken at 35.6°F.

Utilizing the data in the charts presented in Appendix C and Appendix D to check the compatibility of the on-board foam delivery systems and wetting agent concentrate in use in our department, we have determined that our delivery systems and concentrate are compatible with each other in regards to viscosity and delivery percentage.

The informational charts in Appendix C and Appendix D will be utilized by the Albemarle Fire Department if changes in the concentrate being utilized by the department are considered. The data will also be utilized in purchasing decisions in regards to the type and model of on-board delivery systems installed on future apparatus.

The results of this research will assure the Albemarle Fire Department utilizes foam/wetting agent concentrates that are compatible with the installed on-board foam delivery system.

Recommendations

In reviewing the data obtained through this research process it is obvious changes in any future purchased on-board delivery systems by the Albemarle Fire Department need to include complete compliance of the NFPA 1901 standard, especially the section on foam proportioning systems. The manufacturer of any fire apparatus purchased by the Albemarle Fire Department in the future will provide the required documentation within NFPA 1901 to assure our department that our on-board foam delivery system and concentrate are compatible.

The charts that are presented in Appendix C and Appendix D will be utilized by the Albemarle Fire Department as a guide to assist in any possible changes to the foam concentrate in use by our department. The data obtained in these charts will assist our fire department in being assured the concentrate we utilize in our on-board delivery systems is compatible in regards to viscosity. The data in the charts will also assist our department in being assured the

concentrate we choose to utilize can be delivered at the concentrate percentage recommended by the manufacturer.

It is possible, due to the many options available for on-board delivery systems and foam concentrates, that future product considerations will not be represented in the charts in Appendix C and Appendix D. If the product being considered isn't represented in either chart it is recommended the product be thoroughly researched to provide the needed data to add that product to the appropriate chart.

This research will benefit the Albemarle Fire Department in the future through providing the needed data to assure the on-board foam delivery system and foam concentrate are compatible in regards to viscosity and required concentrate delivery percentages. This compliance will assure the equipment in service will remain in service and provide the needed foam solution when it is needed most.

The survey conducted as part of this research process clearly showed the majority of those responding were unfamiliar with their on-board delivery system and/or foam concentrate. It is particularly interesting to note a few of the responses from the survey that clearly demonstrate the lack of education throughout those that responded. When asked what brand foam/wetting agent concentrate they were utilizing some of the responses included, "unknown, it comes from logistics unmarked", "we buy what agents are the best price at the time not a particular brand", Class "A- doesn't matter; major brands are all the same" and finally, the "cheapest". These responses clearly show that members of the fire service are not completing adequate research when making decisions regarding on-board delivery systems and concentrate compatibility.

In addition to the survey replies noted above there were a large number of respondents that skipped questions that required specific answers. The majority of those that did answer all of the questions provided vague or incorrect answers. There were several models of on-board foam delivery systems noted in the survey that don't exist.

It is important that any member of the fire service taking the time to review this research project take the time to investigate the on-board delivery system and foam/wetting agent concentrate in use within their agency. The data in the charts located in Appendix C and Appendix D can provide readers a great resource to quickly determine if their on-board delivery system and foam/wetting agent concentrate are compatible. If the charts located in the Appendix don't contain the particular model of delivery system or concentrate in use take the time to conduct research to determine if the two are compatible. The time to discover the delivery system and concentrate are not compatible is now, not on the fireground when foam solution is needed!

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Appendix A

Blank Firefighting On-Board Foam Delivery System and Concentrate Survey

Name of Department:

Type of Department:
Paid
Volunteer
Combination

Population Served:
0-10,000
10,001-20,000
20,001-50,000
50,001-150,000
151,000-250,000
251,000-

Does your department have apparatus equipped with on-board foam/wetting agent delivery systems? If yes proceed to the next question. If no skip to question ?

Number of apparatus equipped with on-board foam/wetting agent delivery systems:
1
2
3
4
5
More than 5

Number of incidents in the last 12 months on-board foam/wetting agent was utilized:
1-5
6-10
11-15
16-20
21-50
Greater than 50

What incident types do you utilize foam/wetting agents?
All Class A incidents
Certain Class A incidents
    List Types:
All Class B incidents
Certain Class B incidents
    List Types:
Other:

Apparatus foam system specifics.

Please answer questions for each apparatus with different foam systems or concentrate utilized. If you have more than five apparatus equipped with different foam/wetting agent delivery systems please provide answers to the five newest systems. If all foam equipped units utilize the same foam system and concentrate you only need to answer for one apparatus.

Apparatus One:

Make and Model of Foam System:

Age of Foam System:

Type of Foam System: Class A Class B Class A/B CAFS

Brand of foam/wetting agent concentrate utilized with foam system:

Gallons of concentrate carried on-board:

Number of foam/wetting agent discharges:
Booster line
1 1/2"
2 1/2"
3" or larger
Deck Gun

Percent concentrate utilized for Class A fire attack:

Percent concentrate utilized for Class A overhaul:

Percent concentrate utilized for Wildland fire attack:

Percent concentrate utilized for Wildland overhaul:

Percent concentrate utilized for Class B fire attack:

Apparatus Two:

Make and Model of Foam System:

Age of Foam System:

Type of Foam System: Class A Class B Class A/B CAFS

Brand of foam/wetting agent concentrate utilized with foam system:

Gallons of concentrate carried on-board:

Number of foam/wetting agent discharges:
Booster line
1 1/2"
2 1/2"
3" or larger
Deck Gun

Percent concentrate utilized for Class A fire attack:

Percent concentrate utilized for Class A overhaul:

Percent concentrate utilized for Wildland fire attack:

Percent concentrate utilized for Wildland overhaul:

Percent concentrate utilized for Class B fire attack:

Apparatus Three:

Make and Model of Foam System:

Age of Foam System:

Type of Foam System: Class A Class B Class A/B CAFS

Brand of foam/wetting agent concentrate utilized with foam system:

Gallons of concentrate carried on-board:

Number of foam/wetting agent discharges:
Booster line
1 1/2"
2 1/2"
3" or larger
Deck Gun

Percent concentrate utilized for Class A fire attack:

Percent concentrate utilized for Class A overhaul:

Percent concentrate utilized for Wildland fire attack:

Percent concentrate utilized for Wildland overhaul:

Percent concentrate utilized for Class B fire attack:

Apparatus Four:

Make and Model of Foam System:

Age of Foam System:

Type of Foam System: Class A Class B Class A/B CAFS

Brand of foam/wetting agent concentrate utilized with foam system:

Gallons of concentrate carried on-board:

Number of foam/wetting agent discharges:

Booster line
1 1/2"
2 1/2"
3" or larger
Deck Gun

Percent concentrate utilized for Class A fire attack:

Percent concentrate utilized for Class A overhaul:

Percent concentrate utilized for Wildland fire attack:

Percent concentrate utilized for Wildland overhaul:

Percent concentrate utilized for Class B fire attack:

Apparatus Five:

Make and Model of Foam System:

Age of Foam System:

Type of Foam System: Class A Class B Class A/B CAFS

Brand of foam/wetting agent concentrate utilized with foam system:

Gallons of concentrate carried on-board:

Number of foam/wetting agent discharges:
Booster line
1 1/2"
2 1/2"
3" or larger
Deck Gun

Percent concentrate utilized for Class A fire attack:

Percent concentrate utilized for Class A overhaul:

Percent concentrate utilized for Wildland fire attack:

Percent concentrate utilized for Wildland overhaul:

Percent concentrate utilized for Class B fire attack:

Why doesn't your department utilize on-board foam/wetting agent delivery systems?
Cost of delivery system
Cost of concentrate
Complexity of delivery system
Complexity of concentrate
Other: Please Explain

Appendix B

Completed Firefighting On-Board Foam Delivery System and Concentrate Survey

1. Name of Department:

	Response Count
	172
answered question	172
skipped question	9

2. City and State:

	Response Count
	172
answered question	172
skipped question	9

3. Type of Department:

	Response Percent	Response Count
Paid	40.3%	73
Volunteer	11.0%	20
Combination	**48.6%**	**88**
Other (please specify)	0.0%	0
answered question		181
skipped question		0

4. Population Served:

	Response Percent	Response Count
1-10,000	16.0%	29
10,001-20,000	22.7%	41
20,001-50,000	**25.4%**	**46**
50,001-150,000	22.7%	41
151,000-250,000	3.9%	7
Greater than 250,000	9.4%	17
	answered question	**181**
	skipped question	**0**

5. Does your department have apparatus equipped with on-board foam/wetting agent delivery systems?

	Response Percent	Response Count
Yes	**85.1%**	**154**
No	14.9%	27
	answered question	**181**
	skipped question	**0**

6. Number of apparatus in your agency equipped with on-board foam/wetting agent delivery systems:

	Response Percent	Response Count
1	18.2%	27
2	10.1%	15
3	16.2%	24
4	10.8%	16
5 or more	**23.6%**	**35**
All pump equipped apparatus have on-board systems	20.9%	31
	answered question	**148**
	skipped question	**33**

7. Number of incidents in the last 12 months on-board foam/wetting agents were utilized:

	Response Percent	Response Count
1-5	**41.9%**	**62**
6-10	14.2%	21
11-15	8.8%	13
16-20	6.8%	10
21-50	12.8%	19
Greater than 50	15.5%	23
	answered question	**148**
	skipped question	**33**

8. What incident types does your agency utilize foam/wetting agents? (check all that apply)

	Response Percent	Response Count
All Class A incidents	39.2%	58
Certain Class A incidents	**48.0%**	**71**
All Class B incidents	33.1%	49
Certain Class B incidents	41.2%	61
answered question		**148**
skipped question		**33**

9. If you answered Question 8 as using foam/wetting agents only on certain incidents please list those types of incidents.

	Response Count
	93
answered question	**93**
skipped question	**88**

10. Make and Model of Foam System:

	Response Count
	114
answered question	**114**
skipped question	**67**

11. Age of Foam System:

	Response Percent	Response Count
1 year old	11.4%	13
2 years old	3.5%	4
3 years old	10.5%	12
4 years old	15.8%	18
5-9 years old	**35.1%**	**40**
Older than 10 years	23.7%	27
	answered question	**114**
	skipped question	**67**

12. Type of Foam System:

	Response Percent	Response Count
Class A	30.7%	35
Class B	11.4%	13
Class A & B	**57.9%**	**66**
	Other (please specify)	3
	answered question	**114**
	skipped question	**67**

13. Brand of foam/wetting agent concentrate utilized with foam system:

	Response Count
	114
answered question	**114**
skipped question	**67**

14. Size of foam concentrate tank (in gallons)

	0	5	10	15	20	25	30	40	Greater than 40	Rating Count
Class A	14.9% (17)	3.5% (4)	6.1% (7)	3.5% (4)	**25.4% (29)**	7.0% (8)	**25.4% (29)**	11.4% (13)	2.6% (3)	114
Class B	**39.5% (45)**	3.5% (4)	2.6% (3)	0.0% (0)	7.0% (8)	3.5% (4)	22.8% (26)	7.9% (9)	13.2% (15)	114
									answered question	**114**
									skipped question	**67**

15. Percent concentrate utilized for Class A fire attack:

	Response Percent	Response Count
0.10%	10.3%	11
0.20%	6.5%	7
0.30%	**25.2%**	**27**
0.40%	1.9%	2
0.50%	21.5%	23
0.60%	2.8%	3
0.70%	0.0%	0
0.80%	0.9%	1
0.90%	0.0%	0
1%	14.0%	15
Don't use for Class A fire attack	24.3%	26
	Other percent not listed (please specify)	9
	answered question	**107**
	skipped question	**74**

16. Percent concentrate utilized for Class A fire overhaul:

	Response Percent	Response Count
0.10%	22.2%	24
0.20%	5.6%	6
0.30%	20.4%	22
0.40%	2.8%	3
0.50%	**23.1%**	**25**
0.60%	1.9%	2
0.70%	0.9%	1
0.80%	0.0%	0
0.90%	0.9%	1
1%	9.3%	10
Don't use for Class A fire overhaul	16.7%	18
	Other percent not listed (please specify)	5
	answered question	**108**
	skipped question	**73**

17. Percent concentrate utilized for Wildland fire attack:

	Response Percent	Response Count
0.10%	19.4%	21
0.20%	3.7%	4
0.30%	14.8%	16
0.40%	2.8%	3
0.50%	13.9%	15
0.60%	0.0%	0
0.70%	0.0%	0
0.80%	0.9%	1
0.90%	0.0%	0
1%	4.6%	5
Don't use for wildland fire attack	**40.7%**	**44**
	Other percent not listed (please specify)	4
	answered question	**108**
	skipped question	**73**

18. Percent concentrate utilized for Wildland overhaul:

	Response Percent	Response Count
0.10%	24.1%	26
0.20%	3.7%	4
0.30%	13.0%	14
0.40%	3.7%	4
0.50%	13.9%	15
0.60%	0.9%	1
0.70%	0.0%	0
0.80%	0.0%	0
0.90%	0.0%	0
1%	6.5%	7
Don't use for wildland fire overhaul	**37.0%**	**40**
	Other percent not listed (please specify)	5
	answered question	**108**
	skipped question	**73**

19. Percent concentrate utilized for Class B fire attack:

	Response Percent	Response Count
0.10%	0.0%	0
0.20%	1.9%	2
0.30%	5.6%	6
0.40%	0.0%	0
0.50%	1.9%	2
0.60%	3.7%	4
0.70%	0.0%	0
0.80%	0.0%	0
0.90%	0.0%	0
1%	14.8%	16
3%	**50.0%**	**54**
6%	16.7%	18
Don't use for Class B fire attack	20.4%	22
	Other percent not listed (please specify)	10
	answered question	**108**
	skipped question	**73**

20. Number of Discharges Plumbed With Foam:

	0	1	2	3	4	5	6	Greater than 6	Rating Count
Less than 1 1/2" Discharge	**68.4% (78)**	23.7% (27)	2.6% (3)	0.9% (1)	2.6% (3)	0.0% (0)	0.0% (0)	1.8% (2)	114
1 1/2" Discharge	8.8% (10)	8.8% (10)	23.7% (27)	**33.3% (38)**	16.7% (19)	5.3% (6)	1.8% (2)	1.8% (2)	114
2 1/2" Discharge	**30.7% (35)**	19.3% (22)	26.3% (30)	5.3% (6)	12.3% (14)	3.5% (4)	1.8% (2)	0.9% (1)	114
LDH Discharge	**78.9% (90)**	14.9% (17)	3.5% (4)	1.8% (2)	0.9% (1)	0.0% (0)	0.0% (0)	0.0% (0)	114
Deck Gun	**62.3% (71)**	31.6% (36)	2.6% (3)	2.6% (3)	0.9% (1)	0.0% (0)	0.0% (0)	0.0% (0)	114
								answered question	**114**
								skipped question	**67**

21. Does your department have more than one type/brand of foam/wetting agent delivery system in use or utilize different types of concentrate?

		Response Percent	Response Count
Yes		38.6%	44
No		**61.4%**	**70**
		answered question	**114**
		skipped question	**67**

22. Make and Model of Foam System:

	Response Count
	38
answered question	**38**
skipped question	**143**

23. Age of Foam System:

		Response Percent	Response Count
1 year old		13.2%	5
2 years old		5.3%	2
3 years old		5.3%	2
4 years old		5.3%	2
5-9 years old		**36.8%**	**14**
Older than 10 years		34.2%	13
	answered question		**38**
	skipped question		**143**

24. Type of Foam System:

	Response Percent	Response Count
Class A	34.2%	13
Class B	26.3%	10
Class A & B	**39.5%**	**15**
Other (please specify)		1
answered question		**38**
skipped question		**143**

25. Brand of foam/wetting agent concentrate utilized with foam system:

	Response Count
	38
answered question	**38**
skipped question	**143**

26. Size of foam concentrate tank (in gallons)

	0	5	10	15	20	25	30	40	Greater than 40	Ratin Coun
Class A	**28.9% (11)**	10.5% (4)	13.2% (5)	2.6% (1)	10.5% (4)	7.9% (3)	13.2% (5)	7.9% (3)	5.3% (2)	
Class B	**47.4% (18)**	7.9% (3)	0.0% (0)	0.0% (0)	10.5% (4)	0.0% (0)	10.5% (4)	10.5% (4)	13.2% (5)	
								answered question		
								skipped question		1

27. Percent concentrate utilized for Class A fire attack:

	Response Percent	Response Count
0.10%	11.8%	4
0.20%	5.9%	2
0.30%	17.6%	6
0.40%	2.9%	1
0.50%	17.6%	6
0.60%	2.9%	1
0.70%	2.9%	1
0.80%	2.9%	1
0.90%	2.9%	1
1%	11.8%	4
Don't use for Class A fire attack	**47.1%**	**16**
	Other percent not listed (please specify)	3
	answered question	**34**
	skipped question	**147**

28. Percent concentrate utilized for Class A overhaul:

		Response Percent	Response Count
0.10%		20.0%	7
0.20%		5.7%	2
0.30%		17.1%	6
0.40%		2.9%	1
0.50%		20.0%	7
0.60%		0.0%	0
0.70%		0.0%	0
0.80%		0.0%	0
0.90%		0.0%	0
1%		14.3%	5
Don't use for Class A overhaul		**40.0%**	**14**
		Other percent not listed (please specify)	2

answered question	**35**
skipped question	**146**

29. Percent concentrate utilized for Wildland fire attack:

	Response Percent	Response Count
0.10%	14.7%	5
0.20%	5.9%	2
0.30%	14.7%	5
0.40%	5.9%	2
0.50%	14.7%	5
0.60%	0.0%	0
0.70%	0.0%	0
0.80%	0.0%	0
0.90%	0.0%	0
1%	2.9%	1
Don't use for Wildland fire attack	**47.1%**	**16**
Other percent not listed (please specify)		4
	answered question	**34**
	skipped question	**147**

30. Percent concentrate utilized for Wildland overhaul:

	Response Percent	Response Count
0.10%	17.6%	6
0.20%	5.9%	2
0.30%	14.7%	5
0.40%	2.9%	1
0.50%	17.6%	6
0.60%	2.9%	1
0.70%	0.0%	0
0.80%	0.0%	0
0.90%	0.0%	0
1%	5.9%	2
Don't use for Wildland overhaul	**44.1%**	**15**
Other percent not listed (please specify)		4
answered question		**34**
skipped question		**147**

31. Percent concentrate utilized for Class B fire attack:

	Response Percent	Response Count
0.10%	3.0%	1
0.20%	3.0%	1
0.30%	3.0%	1
0.40%	0.0%	0
0.50%	0.0%	0
0.60%	0.0%	0
0.70%	0.0%	0
0.80%	0.0%	0
0.90%	0.0%	0
1%	6.1%	2
3%	**48.5%**	**16**
6%	27.3%	9
Don't use for Class B fire attack	36.4%	12
	Other (please specify)	5
	answered question	**33**
	skipped question	**148**

32. Number of Discharges Plumbed With Foam:

	0	1	2	3	4	5	6	Greater than 6	Rating Count
Less than 1 1/2" Discharge	**71.1% (27)**	13.2% (5)	13.2% (5)	2.6% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	38
1 1/2" Discharge	18.4% (7)	**34.2% (13)**	10.5% (4)	18.4% (7)	15.8% (6)	2.6% (1)	0.0% (0)	0.0% (0)	38
2 1/2" Discharge	**50.0% (19)**	23.7% (9)	13.2% (5)	2.6% (1)	7.9% (3)	2.6% (1)	0.0% (0)	0.0% (0)	38
LDH Discharge	**94.7% (36)**	2.6% (1)	2.6% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	38
Deck Gun	**81.6% (31)**	15.8% (6)	2.6% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	38
								answered question	**38**
								skipped question	**143**

33. Would you like a copy of my completed research?

		Response Percent	Response Count
Yes		**54.3%**	**70**
No		45.7%	59
	If Yes, please provide your email address:		66
		answered question	**129**
		skipped question	**52**

Page 3, Q9. If you answered Question 8 as using foam/wetting agents only on certain incidents please list those types of incidents.		
1	It's up to the engineer if foam is used or not. No set SOG stating when foam will and has to be used.	Aug 16, 2013 8:21 AM
2	Not all class b incidents were handled with foam, more than likely because of the small size in nature.	Aug 7, 2013 7:30 AM
3	It is up to the discretion of the company officer. Not used very often at all.	Aug 3, 2013 4:39 PM
4	For both Class A and B incidents, It is dependant on the Engine Officer and/or IC's size up of the situation to determine what will be the best extinguishment method and/or agent.	Jul 30, 2013 3:44 PM
5	Incidents where there is small involvement or small spills <5 gals or small brush/grass fires we do not use foam. We do use foam for structure fires, large/piled class a fires, significant spills of class B >10 gals where there is a perceived threat of ignition.	Jul 30, 2013 2:20 PM
6	On equipped engines we use it for structural firefighting, automotive fires, really any incident that there is a potential for loss or a rekindle with negative consequences.	Jul 29, 2013 10:35 AM
7	Depends on the size and if the materials are smoldering.	Jul 27, 2013 6:18 AM
8	As needed based on the situation.	Jul 25, 2013 1:59 PM
9	Most of our Class A usage is done on grass/woods fires where deeper penetration is needed. We layer the area with a blanket of foam and allow it to soak in while dissipating.	Jul 25, 2013 4:50 AM
10	Our foam truck is only used on large Class B incidents. Our engines carry 2 five gallon containers of foam with eductor and foam pipe for small class B incidents.	Jul 23, 2013 11:51 AM
11	Small Class B fire or spill that we can get a quick knock down with the foam concentrate we carry on the apparatus.	Jul 23, 2013 10:50 AM
12	Flammable liquids incidents, spills, fire, etc.	Jul 23, 2013 5:37 AM
13	Brush/Grass Depending on the engine or crew, Structure fires and car fires	Jul 22, 2013 8:03 PM
14	CAFS and foam/water only is available for everything except offensive interior firefighting.	Jul 22, 2013 4:24 PM
15	Ethonal spill	Jul 22, 2013 2:16 PM
16	As deemed neccesary by the IC	Jul 22, 2013 12:39 PM
17	Certain incidents based on which engine is first due. If an engine that's only equipped with water is first due, we don't utilize the CAFS system on those incidents.	Jul 22, 2013 12:37 PM
18	We use Class A foam for structurl fire attack. We use Class B foam for Class B fires, not on spills.	Jul 22, 2013 11:36 AM

Page 3, Q9. If you answered Question 8 as using foam/wetting agents only on certain incidents please list those types of incidents.		
19	It is somewhat dependent on the fire officer who is working the incident. We do not have a specific policy that mandates the use of our CAFS system for specific ordinary combustible or flammable liquid fire scenarios.	Jul 22, 2013 10:10 AM
20	Large piles of wood, stubborn fires that do not go out easily with just water.	Jul 22, 2013 8:45 AM
21	Class B incidents that warrant immediate exinguishment, not all.	Jul 21, 2013 12:34 PM
22	IC direction	Jul 21, 2013 7:05 AM
23	Class A - wildfire Class B - flammable liquid incidents	Jul 20, 2013 3:20 PM
24	Working Structure Fires, Hay/Straw incidents, Motor Vehicle Fires	Jul 20, 2013 2:02 PM
25	As directed by the Company officer	Jul 20, 2013 8:06 AM
26	We use class A for all structure fires and any brush/grass fires	Jul 20, 2013 6:36 AM
27	currently just on overhaul, we are beginning the process of considering CAFS for all fires	Jul 20, 2013 6:35 AM
28	Building, automobile, rubbish, and wildland fires.	Jul 19, 2013 3:52 PM
29	Structure fires and hydrocarbon fires.	Jul 19, 2013 3:11 PM
30	At the direction/discretion of the incident commander	Jul 19, 2013 2:08 PM
31	Deep seated class A fires fires or hydro carbon spills.	Jul 19, 2013 1:44 PM
32	If the fuel tank is compromised during a car fire we will use class B foam. When we have a working fire we will use class a foam after the fire is knocked down to prevent re kindles.	Jul 19, 2013 1:08 PM
33	Class A incidents where the material is stored in a manner that prevents easy water absorption such as hay bales, cloth bales, etc. We also use it on substantial Class B fires/spills.	Jul 19, 2013 12:50 PM
34	certain flammable liquids	Jul 19, 2013 12:49 PM
35	Structural Fires and Oil based or vehicle fires	Jul 19, 2013 12:28 PM
36	Structure fires, vehicle fires	Jul 19, 2013 11:21 AM
37	Sturcture Fires Rubbish Fires Woods Fires	Jul 19, 2013 11:18 AM
38	We use a class A/B foam on most class A incidents. Exceptions would be any 'hopeless' burning where there is little to no chance of saving any property (therefore conserving expensive foam). We use class B foam on incidents that warrant a foam application.	Jul 19, 2013 11:17 AM
39	Wildland Fires and occassionally structure fires	Jul 19, 2013 10:52 AM
40	spills or Class B fires	Jul 19, 2013 10:22 AM

Page 3, Q9. If you answered Question 8 as using foam/wetting agents only on certain incidents please list those types of incidents.		
41	We do not use Class A foam all the time. Used during situational requirement	Jul 19, 2013 10:22 AM
42	Structure fires and flammable liquid fires	Jul 19, 2013 10:11 AM
43	Structures, and other fires having difficulty extinguishing such as large brush piles.	Jul 19, 2013 10:08 AM
44	We use them on vehicle fires. We use it during overhaul on structure fires	Jul 19, 2013 9:47 AM
45	Hard to reach incidents (Class A) Overhaul situations (Class A) Chemical Spills or Potential Spills (Class B)	Jul 19, 2013 9:43 AM
46	Use Class A on overhaul mainly not in initial extinguishment.	Jul 19, 2013 9:40 AM
47	Officers discretion for small outdoor Class A fires: mulch, leaves, small brush pile, etc	Jul 19, 2013 9:38 AM
48	Large spill.	Jul 19, 2013 9:36 AM
49	Our response area is very large (2000 square miles) with over 70 miles of US interstate 80; we don't use our CAFS on passenger vehicle fires if they are more than 10 miles from the fire station, or are already a total loss on arrival.	Jul 19, 2013 9:32 AM
50	Attic fires with cellulose insulation.	Jul 19, 2013 9:30 AM
51	structure fires, vegetation fires etc.	Jul 19, 2013 9:26 AM
52	Any incident that would not have an environmental impact. EG- would not use any foam around a fish bearing waterway as per Federal/Provincial requirements.	Jul 19, 2013 9:26 AM
53	Structure Fires, vehicle fires as wetting agent. On brush fires to aid in penetration into deep seated fires.	Jul 19, 2013 9:25 AM
54	Depends on size of fire, ability to extinguish and materials burning	Jul 19, 2013 9:23 AM
55	Structure fires and some vehicle fires	Jul 19, 2013 9:23 AM
56	Only apply class b foam when appropriate given the nature of the fire and/or involvement of certain chemicals.	Jul 19, 2013 9:20 AM
57	defined by spill type, potential for ignition, type of fire for class A, and where we are in extinguishing the fire	Jul 19, 2013 9:18 AM
58	HazMat Aviation Fuel	Jul 19, 2013 9:15 AM
59	Class b fires or large spills	Jul 19, 2013 9:13 AM
60	discretion on the type of event class B - new engine on order WITHOUT B - waste of money; ultimate low usage	Jul 19, 2013 9:11 AM
61	Class A incidents as determined by IC. We do not have a specific list. We do not use Class A foam for wildland.	Jul 19, 2013 9:07 AM

Page 3, Q9. If you answered Question 8 as using foam/wetting agents only on certain incidents please list those types of incidents.		
62	Vehicle fires involving fuel.	Jul 19, 2013 8:23 AM
63	Vehicle fires or if flammable liquids are suspected as a fuel	Jul 19, 2013 6:58 AM
64	Structure and vehicle fires.	Jul 19, 2013 6:53 AM
65	No set SOP for that, generally Captain or District Chief's call.	Jul 19, 2013 6:08 AM
66	Larger class A incidents	Jul 19, 2013 6:06 AM
67	We are an ARFF dept. so we would use them on aircraft and fuel storage incidents	Jul 19, 2013 5:35 AM
68	Any incident where other extinguishment methods are not effective.	Jul 19, 2013 5:08 AM
69	Companies stationed near the interstate highway use foam on vehicle fires even when class "A" only.	Jul 19, 2013 4:39 AM
70	Large or ongoing fuel spills.	Jul 19, 2013 4:20 AM
71	Structure fire on initial attack and on mop up. At times on woods fire issues when conditions call for it.	Jul 19, 2013 3:40 AM
72	fuel spills depending on spill size	Jul 18, 2013 9:48 PM
73	Potential Haz mat	Jul 18, 2013 6:28 PM
74	Some companies might choose to use class B foam on class A materials as a wetting agent, even though it is not specifically called for. CFD really does not limit the use of foam.	Jul 18, 2013 6:22 PM
75	Bulk organic storage piles	Jul 18, 2013 4:35 PM
76	Foam is used on Class B incidents as needed. Need is determined by the Company officer.	Jul 18, 2013 4:27 PM
77	As needed depending on fire type and fire load	Jul 18, 2013 4:05 PM
78	Vapor suppression on fuel spills. Rinsing of roadways of oils and fluids.	Jul 18, 2013 3:43 PM
79	We utilize compressed air foam systems, and class A foam systems without compressed air for overhaul fire operations. We use AFFF Class B foam systems for some class B fuel spill events with or without ignition. Because sometimes depending on the size of the spill it may be better to just protect exposures and let the fuel burn itself up until gone. We are in the process of trying to find the right answers for foam use for our department. Not sure if CAFS or just a normal Class A or B foam system is the answer. Looking for which one fits the best.	Jul 18, 2013 3:28 PM
80	Mainly for Class B fires only. We do not use Class A as we have few wildland areas and fire incidents. And water is free.	Jul 18, 2013 2:46 PM
81	Class A only when a wetting agent is called for.	Jul 18, 2013 2:09 PM

Page 3, Q9. If you answered Question 8 as using foam/wetting agents only on certain incidents please list those types of incidents.		
82	During Overhaul of Structure fire Small grass and vegitation fires	Jul 18, 2013 2:08 PM
83	that's up to the captain to decide per incident. It's not prescribed at which incident we shall use foam	Jul 18, 2013 2:07 PM
84	Structure fires and hydrocarbon fires	Jul 18, 2013 2:05 PM
85	Any response to hostile fire by policy, foam is utilized. Additionally all apparatus is CAFS.	Jul 18, 2013 2:05 PM
86	Brush , overhaul on structures . Vehical fires	Jul 18, 2013 2:01 PM
87	Structure Fire Dumpster Fire Vehicle Fire Outdoor Fire	Jul 18, 2013 1:54 PM
88	Structure fires, and some brush or dumpster fires when the apparatus pumping has that capability.	Jul 18, 2013 1:50 PM
89	Structure, liquid spills (gas)	Jul 18, 2013 1:49 PM
90	Deep seated fires and overhaul Nothing on structure fires	Jul 18, 2013 1:44 PM
91	Only extreme vehicle fires.	Jul 18, 2013 1:40 PM
92	Larger scale incidents, deep seated fires, officer discretion	Jul 18, 2013 1:39 PM
93	CAFS units use foam when practical. Foam is also used on grass fires when appropriate.	Jul 18, 2013 1:30 PM

Page 5, Q10. Make and Model of Foam System:		
1	Husky	Aug 16, 2013 8:24 AM
2	Husky by Pierce	Aug 7, 2013 7:36 AM
3	Husky Foam Pro	Aug 3, 2013 4:41 PM
4	All of our apparatus that we have purchased from 1992 on have pre-plumbed class A foam systems and also carry Class B foam and an eductor. We have 101 Fire Stations in our system.	Jul 30, 2013 3:50 PM
5	ATP system, not sure of make or model.	Jul 30, 2013 2:34 PM
6	Husky	Jul 29, 2013 10:39 AM
7	Husky 10 and 12	Jul 29, 2013 9:04 AM
8	Husky 10	Jul 27, 2013 6:21 AM
9	Husky Foam System	Jul 25, 2013 4:56 AM
10	Husky 12 GPM Foam System	Jul 24, 2013 11:11 AM
11	National Servo Command Proportioning System	Jul 24, 2013 4:31 AM
12	2005 Danko	Jul 23, 2013 11:58 AM
13	Feecon A.P.H 1.5 Dual Liquid	Jul 23, 2013 10:55 AM
14	Onboard CAFS system from Darley	Jul 23, 2013 8:51 AM
15	Waterous	Jul 23, 2013 8:11 AM
16	Akron 125gpm, not sure of model#	Jul 23, 2013 6:01 AM
17	Pierce engines	Jul 22, 2013 4:27 PM
18	Pieace Dash on board system	Jul 22, 2013 2:18 PM
19	Foampro, 3012	Jul 22, 2013 2:14 PM
20	Waterous	Jul 22, 2013 12:40 PM
21	Husky 12 CAFS System	Jul 22, 2013 12:39 PM
22	FoamPro system for Class A foam on Engine 3. National system for Class B foam on Engine 1.	Jul 22, 2013 11:43 AM
23	hale foam pro	Jul 22, 2013 8:50 AM
24	Husky 12	Jul 21, 2013 9:37 PM
25	FoamPro, two different models	Jul 21, 2013 12:37 PM
26	Husky 12	Jul 21, 2013 9:01 AM

Page 5, Q10. Make and Model of Foam System:		
27	foam pro	Jul 21, 2013 7:07 AM
28	FoamPro 2000	Jul 21, 2013 5:55 AM
29	Fecom	Jul 20, 2013 2:06 PM
30	Foam Pro on-board adductor	Jul 20, 2013 8:07 AM
31	Foampro 3212	Jul 20, 2013 7:01 AM
32	FoamLogix 3.3	Jul 20, 2013 6:44 AM
33	Waterous pump, not sure of anything else	Jul 20, 2013 6:37 AM
34	varies	Jul 20, 2013 5:02 AM
35	Foam Pro	Jul 19, 2013 7:50 PM
36	Foam Pro and Williams	Jul 19, 2013 4:46 PM
37	Hercules CAFS 140CFM	Jul 19, 2013 4:18 PM
38	Waterous Eclipse 200 CFM	Jul 19, 2013 4:03 PM
39	2001 Foam Pro	Jul 19, 2013 3:19 PM
40	FoamPro	Jul 19, 2013 2:10 PM
41	Compressed Air Foam System	Jul 19, 2013 2:09 PM
42	Husky & Pneumax	Jul 19, 2013 2:01 PM
43	FECON and Akron	Jul 19, 2013 1:46 PM
44	Husky 10 (Pierce)	Jul 19, 2013 1:22 PM
45	unknown	Jul 19, 2013 12:52 PM
46	Husky Foam System - 12 GPM	Jul 19, 2013 12:45 PM
47	Watrous injected Class A x 3 CAFS x 1	Jul 19, 2013 12:42 PM
48	AFFF	Jul 19, 2013 12:40 PM
49	Hurcules CAFS on Engines	Jul 19, 2013 12:35 PM
50	Husky 10	Jul 19, 2013 11:25 AM
51	Foam Pro 1600	Jul 19, 2013 11:20 AM
52	Foam Pro (various models - 2003 truck through one currently on order)	Jul 19, 2013 11:19 AM
53	Foam Pro 2002	Jul 19, 2013 11:05 AM

Page 5, Q10. Make and Model of Foam System:		
54	Foam Pro	Jul 19, 2013 11:00 AM
55	Husky Foam System	Jul 19, 2013 10:50 AM
56	Williams ATP1500 Pierce Husky with CAFS	Jul 19, 2013 10:32 AM
57	Elkhart 240P 125gpm	Jul 19, 2013 10:26 AM
58	Husky 12	Jul 19, 2013 10:14 AM
59	Foam Pro 2001	Jul 19, 2013 10:09 AM
60	Husky 12	Jul 19, 2013 9:53 AM
61	Husky Foam Systems with Hercules CAFS	Jul 19, 2013 9:50 AM
62	Williams Around the Pump Foam system	Jul 19, 2013 9:48 AM
63	Williams Foam Pro	Jul 19, 2013 9:44 AM
64	Several	Jul 19, 2013 9:42 AM
65	Foam Logix	Jul 19, 2013 9:40 AM
66	Foam Pro 2002	Jul 19, 2013 9:40 AM
67	Rapid CAFS	Jul 19, 2013 9:37 AM
68	Foam Pro 2002	Jul 19, 2013 9:36 AM
69	Foam Pro	Jul 19, 2013 9:34 AM
70	FoamPro All front line apparatus equipped- ages 1-9 years Engines have 40 gal tank, Truck has 20 gal.	Jul 19, 2013 9:34 AM
71	Robwen	Jul 19, 2013 9:34 AM
72	Foam Pro 2001	Jul 19, 2013 9:31 AM
73	Husky Foam Pro system	Jul 19, 2013 9:29 AM
74	Foam pro , various models depending upon capacity	Jul 19, 2013 9:28 AM
75	Pierce Husky	Jul 19, 2013 9:24 AM
76	Husky 12 by Pierce Mfg	Jul 19, 2013 9:22 AM
77	Pierce Husky	Jul 19, 2013 9:19 AM
78	Husky	Jul 19, 2013 9:17 AM
79	Varies, Foam Pro and Pierce Husky	Jul 19, 2013 9:14 AM
80	Foam Pro Don't have model info Age depends on apparatus 20 years to 3	Jul 19, 2013 9:14 AM

Page 5, Q10. Make and Model of Foam System:		
	years old	
81	Hale	Jul 19, 2013 9:13 AM
82	Foam Pro Pierce Husky 10 & 12	Jul 19, 2013 9:13 AM
83	FoamPro 2002	Jul 19, 2013 9:09 AM
84	Akron	Jul 19, 2013 8:25 AM
85	FoamPro	Jul 19, 2013 6:59 AM
86	Foam Pro	Jul 19, 2013 6:54 AM
87	Pro/Pak UL 502	Jul 19, 2013 6:17 AM
88	Foam pro E-One	Jul 19, 2013 6:12 AM
89	Foam Pro - Various Models	Jul 19, 2013 5:31 AM
90	Ansul around the pump proportioner.	Jul 19, 2013 5:12 AM
91	AFFF 3%	Jul 19, 2013 4:48 AM
92	Akron	Jul 19, 2013 4:22 AM
93	Foam Pro	Jul 19, 2013 3:47 AM
94	Pierce Husky	Jul 18, 2013 9:50 PM
95	Pierce Husky on 7 engines ?? on the remainder-I will find out tomorrow	Jul 18, 2013 8:07 PM
96	FoamPro	Jul 18, 2013 6:30 PM
97	Williams ATP 1400 gpm at 1% on all pumping units. these systems have been the standard for more than 15 years	Jul 18, 2013 6:27 PM
98	Hale Foam Logic 5.1	Jul 18, 2013 4:38 PM
99	Most class A systems are FoamPro. We use eductors for Class B.	Jul 18, 2013 4:33 PM
100	Rosenbauer fix mix with water CAFS system (200cfm) using ICS valve controllers.	Jul 18, 2013 3:47 PM
101	Foam Pro	Jul 18, 2013 2:47 PM
102	Hale foam logics	Jul 18, 2013 2:20 PM
103	Husky 30 Husky 10	Jul 18, 2013 2:18 PM
104	Foam Pro 2002 with compressed air system	Jul 18, 2013 2:15 PM
105	Firedos system it's high pressure water with a 3% foam added	Jul 18, 2013 2:10 PM

Page 5, Q10. Make and Model of Foam System:		
106	Foam pro 1600	Jul 18, 2013 2:08 PM
107	Foam Pro 2002	Jul 18, 2013 1:58 PM
108	Foam Pro	Jul 18, 2013 1:54 PM
109	elkhart	Jul 18, 2013 1:53 PM
110	unknown	Jul 18, 2013 1:52 PM
111	Foam Pro	Jul 18, 2013 1:45 PM
112	Fire Apparatus (Engines Companies)	Jul 18, 2013 1:43 PM
113	Husky	Jul 18, 2013 1:42 PM
114	Hale CAFS System	Jul 18, 2013 1:34 PM

Page 5, Q12. Type of Foam System:		
1	AFFF AR	Aug 16, 2013 8:24 AM
2	System on our apparatus can use either but we only use Class A	Jul 20, 2013 6:44 AM
3	Both, Class A only and Class A&B	Jul 19, 2013 9:42 AM

Page 5, Q13. Brand of foam/wetting agent concentrate utilized with foam system:		
1	Buckeye	Aug 16, 2013 8:24 AM
2	Cold Fire fire suppressing agent	Aug 7, 2013 7:36 AM
3	Unknown, it comes from logistics unmarked	Aug 3, 2013 4:41 PM
4	Phoscheck Class A foam concentrate. Ansul Class B foam concentrate (3X3 ACT/AFFF)	Jul 30, 2013 3:50 PM
5	F-500, Ansul 3%	Jul 30, 2013 2:34 PM
6	Chemguard First Class	Jul 29, 2013 10:39 AM
7	Silvex - Plus	Jul 29, 2013 9:04 AM
8	Thuderstorm 3/66	Jul 27, 2013 6:21 AM
9	Phos-Chek	Jul 25, 2013 4:56 AM
10	Fire-Ade 2000	Jul 24, 2013 11:11 AM
11	Chemguard AT-AFFF 3%	Jul 24, 2013 4:31 AM
12	Class A	Jul 23, 2013 11:58 AM
13	AFFF	Jul 23, 2013 10:55 AM
14	AFFF	Jul 23, 2013 8:51 AM
15	Fire Ade	Jul 23, 2013 8:11 AM
16	National Foam, Universal Gold	Jul 23, 2013 6:01 AM
17	Sylvex	Jul 22, 2013 4:27 PM
18	No idea	Jul 22, 2013 2:18 PM
19	National knockdown	Jul 22, 2013 2:14 PM
20	Unknown	Jul 22, 2013 12:40 PM
21	Buckeye	Jul 22, 2013 12:39 PM
22	National	Jul 22, 2013 11:43 AM
23	3m	Jul 22, 2013 8:50 AM
24	Phoschek	Jul 21, 2013 9:37 PM
25	Chemguard FirstClass "A"	Jul 21, 2013 12:37 PM
26	Phos-Chek (Class A)	Jul 21, 2013 9:01 AM
27	3m	Jul 21, 2013 7:07 AM

Page 5, Q13. Brand of foam/wetting agent concentrate utilized with foam system:		
28	Universal Gold	Jul 21, 2013 5:55 AM
29	AFFF	Jul 20, 2013 2:06 PM
30	Phos-Chek	Jul 20, 2013 8:07 AM
31	A- National Knockdown B- National 1 to 3 % AR AFFF	Jul 20, 2013 7:01 AM
32	Tyco/Williams	Jul 20, 2013 6:44 AM
33	Unsure	Jul 20, 2013 6:37 AM
34	3m others	Jul 20, 2013 5:02 AM
35	Fire Aid	Jul 19, 2013 7:50 PM
36	Buckeye AR AFFF	Jul 19, 2013 4:46 PM
37	U.S. First Strike Class A	Jul 19, 2013 4:18 PM
38	Phos Chek	Jul 19, 2013 4:03 PM
39	Angus class a&b	Jul 19, 2013 3:19 PM
40	FireCap Plus	Jul 19, 2013 2:10 PM
41	Unsure	Jul 19, 2013 2:09 PM
42	Chemguard	Jul 19, 2013 2:01 PM
43	Varies	Jul 19, 2013 1:46 PM
44	National Foam Knockdown	Jul 19, 2013 1:22 PM
45	unknown	Jul 19, 2013 12:52 PM
46	National Foam - Knockdown	Jul 19, 2013 12:45 PM
47	Chemguard	Jul 19, 2013 12:42 PM
48	Chem Guard	Jul 19, 2013 12:40 PM
49	FosCheck	Jul 19, 2013 12:35 PM
50	Phoscheck	Jul 19, 2013 11:25 AM
51	National Foam ATC AFFF 3%/6% National Foam GOLD Class A	Jul 19, 2013 11:20 AM
52	Fireade 2000	Jul 19, 2013 11:19 AM
53	We buy what agents are the best price at the time not a particular brand	Jul 19, 2013 11:05 AM
54	Micro Blaze Out	Jul 19, 2013 11:00 AM

Page 5, Q13. Brand of foam/wetting agent concentrate utilized with foam system:		
55	F-500	Jul 19, 2013 10:50 AM
56	National gold 3x3 AFFF ATC Chemguard A+	Jul 19, 2013 10:32 AM
57	3M AFFF ATC	Jul 19, 2013 10:26 AM
58	Ansul 3x3	Jul 19, 2013 10:14 AM
59	Jet - X Labels states for use of A and B fires AR-AFFF 15 - 5 gallon buckets stored on appar.	Jul 19, 2013 10:09 AM
60	Fire Aide 2000	Jul 19, 2013 9:53 AM
61	Ansulite, 3M	Jul 19, 2013 9:50 AM
62	Class A - National Foam Class B- Ansul/Thunderstorm 1x3	Jul 19, 2013 9:48 AM
63	MSA	Jul 19, 2013 9:44 AM
64	Varies	Jul 19, 2013 9:42 AM
65	National Gold	Jul 19, 2013 9:40 AM
66	ICL Performance Products LP - Class A Ansulite AR-AFFF	Jul 19, 2013 9:40 AM
67	Silvex - Class-A	Jul 19, 2013 9:37 AM
68	A- Tstorm SFFF B- Ansulite 3%	Jul 19, 2013 9:36 AM
69	Phos-Check	Jul 19, 2013 9:34 AM
70	National Foam Responder National Foam Knockdown	Jul 19, 2013 9:34 AM
71	First Strike / US Foam	Jul 19, 2013 9:34 AM
72	Chemguard Class A plus	Jul 19, 2013 9:31 AM
73	I am unsure the brand	Jul 19, 2013 9:29 AM
74	Fire ade 2000	Jul 19, 2013 9:28 AM
75	Kidde Knockdown Class A	Jul 19, 2013 9:24 AM
76	Silvex for class A 3x3 for clas B	Jul 19, 2013 9:22 AM
77	A - doesn't matter; major brands are all the same B - National Universal Gold for 1 and 3% usage	Jul 19, 2013 9:19 AM
78	3M	Jul 19, 2013 9:17 AM
79	varies	Jul 19, 2013 9:14 AM
80	???	Jul 19, 2013 9:14 AM

Page 5, Q13. Brand of foam/wetting agent concentrate utilized with foam system:		
81	National	Jul 19, 2013 9:13 AM
82	Ansul Class A Fire Aide	Jul 19, 2013 9:13 AM
83	Ansul 1x3 AR-AFFF	Jul 19, 2013 9:09 AM
84	Chemgaurd 333	Jul 19, 2013 8:25 AM
85	Cheapest	Jul 19, 2013 6:59 AM
86	F-500	Jul 19, 2013 6:54 AM
87	3M AFFF	Jul 19, 2013 6:17 AM
88	National	Jul 19, 2013 6:12 AM
89	National	Jul 19, 2013 5:31 AM
90	Chem-guard	Jul 19, 2013 5:12 AM
91	National	Jul 19, 2013 4:48 AM
92	Pro Gold AFFF	Jul 19, 2013 4:22 AM
93	NC State Forest service brand at time of purchase	Jul 19, 2013 3:47 AM
94	3M	Jul 18, 2013 9:50 PM
95	Fire Aid 2000 Universal Gold?	Jul 18, 2013 8:07 PM
96	Black Cow	Jul 18, 2013 6:30 PM
97	Williams Thunderstorm 3x3 ATC AFFF	Jul 18, 2013 6:27 PM
98	3M	Jul 18, 2013 4:38 PM
99	Class A is Silvex	Jul 18, 2013 4:33 PM
100	Chemguard CAFS extreme foam, wd881, Fireade	Jul 18, 2013 3:47 PM
101	No Preference. We use many.	Jul 18, 2013 2:47 PM
102	Fireade	Jul 18, 2013 2:20 PM
103	Thunderstorm Class B to be compatible with NC Haz-Mat Response Teams. Thunderstorm Class A	Jul 18, 2013 2:18 PM
104	Class A usually purchased from local NC Forestry Dept	Jul 18, 2013 2:15 PM
105	??	Jul 18, 2013 2:10 PM
106	Can't remember	Jul 18, 2013 2:08 PM
107	Unknown but the brand works on class "A" and "B"	Jul 18, 2013 1:58 PM

Page 5, Q13. Brand of foam/wetting agent concentrate utilized with foam system:		
108	National	Jul 18, 2013 1:54 PM
109	fireaid class b alcohol resistent	Jul 18, 2013 1:53 PM
110	unknown	Jul 18, 2013 1:52 PM
111	Thunder Storm 3%	Jul 18, 2013 1:45 PM
112	AFFF	Jul 18, 2013 1:43 PM
113	National	Jul 18, 2013 1:42 PM
114	National foam	Jul 18, 2013 1:34 PM

Page 5, Q15. Percent concentrate utilized for Class A fire attack:		
1	We pre-set at 0.4% but adjust from there depending on the situation	Jul 30, 2013 3:50 PM
2	Rarely used for fire attack	Jul 23, 2013 8:51 AM
3	range from .2 to .5% operator variances, no set std	Jul 19, 2013 1:22 PM
4	CAFS Automatic adjutment	Jul 19, 2013 12:35 PM
5	.25%	Jul 19, 2013 9:36 AM
6	.05 to start, may go up from there	Jul 19, 2013 9:13 AM
7	Varies	Jul 19, 2013 6:17 AM
8	.30 used due to CAFS. without air, .50	Jul 18, 2013 2:15 PM
9	3%	Jul 18, 2013 2:10 PM

Page 5, Q16. Percent concentrate utilized for Class A fire overhaul:		
1	.1 - 1% based on operator / incident	Aug 7, 2013 7:36 AM
2	.25%	Jul 19, 2013 9:36 AM
3	.05 to start, may go up from there	Jul 19, 2013 9:13 AM
4	not specified	Jul 18, 2013 6:27 PM
5	3%	Jul 18, 2013 2:10 PM

Page 5, Q17. Percent concentrate utilized for Wildland fire attack:		
1	0.1 - 0.5 %	Jul 30, 2013 2:34 PM
2	.25	Jul 19, 2013 9:36 AM
3	.05 to start, may go up from there	Jul 19, 2013 9:13 AM
4	N/A	Jul 18, 2013 1:43 PM

Page 5, Q18. Percent concentrate utilized for Wildland overhaul:		
1	0.1 - 0.5 % as needed	Jul 30, 2013 2:34 PM
2	Just for smoldering stumps	Jul 19, 2013 9:42 AM
3	.25	Jul 19, 2013 9:36 AM
4	.05 to start, may go up from there	Jul 19, 2013 9:13 AM
5	N/A	Jul 18, 2013 1:43 PM

Page 5, Q19. Percent concentrate utilized for Class B fire attack:		
1	We use a 3X3 ATC/AFFF	Jul 30, 2013 3:50 PM
2	Depends upon nature of involved liquid, depth of liquid, and whether or not alcohol is mixed with product	Jul 29, 2013 10:39 AM
3	Use 3% for Class B polar solvents attack	Jul 23, 2013 8:11 AM
4	n/a	Jul 21, 2013 12:37 PM
5	Whatever is needed to put the fire out or take care of the problem.	Jul 19, 2013 2:01 PM
6	1% for Hydrocarbon and 3% for Polar Solvent	Jul 19, 2013 12:45 PM
7	When required	Jul 19, 2013 9:42 AM
8	We do not have any class B foam capability	Jul 19, 2013 9:34 AM
9	dependent on product - alcohol resistant	Jul 19, 2013 9:19 AM
10	normally do not carry adequate class B on engine for spill coverage. Class A has beem used as a stop gap measure.	Jul 18, 2013 2:15 PM

Page 7, Q22. Make and Model of Foam System:		
1	Elkhardt- Out of Service- Gummed up	Aug 16, 2013 8:26 AM
2	Foam Pro 2001	Aug 7, 2013 7:38 AM
3	older husky model	Jul 29, 2013 10:40 AM
4	Scotty around the pump proportioners on all type -6 engines	Jul 29, 2013 9:06 AM
5	Hale V-Series	Jul 25, 2013 4:59 AM
6	foam eductor	Jul 23, 2013 1:06 PM
7	Blizzard Wizzard Foam Maker	Jul 23, 2013 11:00 AM
8	Brush Truck Class A foam system	Jul 23, 2013 8:12 AM
9	National	Jul 22, 2013 11:44 AM
10	Husky 30	Jul 21, 2013 9:02 AM
11	Huskey 10	Jul 19, 2013 5:00 PM
12	2006 foam pro	Jul 19, 2013 3:20 PM
13	Akron	Jul 19, 2013 1:47 PM
14	Akron 95gpm truck system	Jul 19, 2013 1:26 PM
15	Watrous CAFS	Jul 19, 2013 12:43 PM
16	foam pro 2100 Snuffie CAFS	Jul 19, 2013 11:22 AM
17	UPF balanced pressure industrial foam trailer	Jul 19, 2013 10:34 AM
18	Elkhart portable equipment	Jul 19, 2013 10:29 AM
19	Foam Pro Hercules CAFS (2 units) Foam Pro Proportioning (2 units - 1 light rescue; 1 brush truck)	Jul 19, 2013 10:19 AM
20	Foampro 3012	Jul 19, 2013 9:56 AM
21	separate in line eductor	Jul 19, 2013 9:41 AM
22	Husky 3	Jul 19, 2013 9:37 AM
23	FoamPro	Jul 19, 2013 9:35 AM
24	Scotty	Jul 19, 2013 9:32 AM
25	Foam Pro	Jul 19, 2013 9:25 AM
26	Odin	Jul 19, 2013 9:18 AM
27	Pierce Husky	Jul 19, 2013 9:15 AM

Page 7, Q22. Make and Model of Foam System:		
28	Total	Jul 19, 2013 8:27 AM
29	Unsure	Jul 19, 2013 6:18 AM
30	One system	Jul 19, 2013 4:51 AM
31	??	Jul 18, 2013 8:09 PM
32	Foam Pro	Jul 18, 2013 4:40 PM
33	Foam pro 1500	Jul 18, 2013 3:48 PM
34	3 Foam pro pak, hand held tank it is used on 2 other engines and a brush truck	Jul 18, 2013 2:09 PM
35	elkhart	Jul 18, 2013 1:57 PM
36	unknown	Jul 18, 2013 1:53 PM
37	EZ Foam	Jul 18, 2013 1:51 PM
38	Foam eductor	Jul 18, 2013 1:45 PM

Page 7, Q24. Type of Foam System:		
1	one system	Jul 19, 2013 4:51 AM

Page 7, Q25. Brand of foam/wetting agent concentrate utilized with foam system:		
1	Unknown	Aug 16, 2013 8:26 AM
2	3M	Aug 7, 2013 7:38 AM
3	chemguard	Jul 29, 2013 10:40 AM
4	Silvex-plus	Jul 29, 2013 9:06 AM
5	Phos-Chek	Jul 25, 2013 4:59 AM
6	AFFF	Jul 23, 2013 1:06 PM
7	National Gold	Jul 23, 2013 11:00 AM
8	Fire Ade	Jul 23, 2013 8:12 AM
9	National	Jul 22, 2013 11:44 AM
10	Chem-Guard Ultra Gold 1%-3%	Jul 21, 2013 9:02 AM
11	U.S. First Strike Class A	Jul 19, 2013 5:00 PM
12	Angus	Jul 19, 2013 3:20 PM
13	Varies	Jul 19, 2013 1:47 PM
14	National Universal Gold 3%	Jul 19, 2013 1:26 PM
15	Chemguard	Jul 19, 2013 12:43 PM
16	National Foam	Jul 19, 2013 11:22 AM
17	National gold AFFF ATC	Jul 19, 2013 10:34 AM
18	3M AFFF ATC	Jul 19, 2013 10:29 AM
19	Silvex - Class-A Ansulite 3/3 Class-B	Jul 19, 2013 10:19 AM
20	Fire Aide 2000	Jul 19, 2013 9:56 AM
21	National Gold	Jul 19, 2013 9:41 AM
22	A- Tstorm B- Ansulite 3	Jul 19, 2013 9:37 AM
23	First Strike / US Foam	Jul 19, 2013 9:35 AM
24	FireQuench	Jul 19, 2013 9:32 AM
25	Kidde Knockdown	Jul 19, 2013 9:25 AM
26	3M	Jul 19, 2013 9:18 AM
27	varied	Jul 19, 2013 9:15 AM

Page 7, Q25. Brand of foam/wetting agent concentrate utilized with foam system:		
28	Chemgaurd 333	Jul 19, 2013 8:27 AM
29	3M AFFF	Jul 19, 2013 6:18 AM
30	one system	Jul 19, 2013 4:51 AM
31	3M ARC/ATC AFFF 1/3/6	Jul 18, 2013 8:09 PM
32	3M	Jul 18, 2013 4:40 PM
33	Wd881	Jul 18, 2013 3:48 PM
34	Unable to remember	Jul 18, 2013 2:09 PM
35	fireaide class b alcohol resistent	Jul 18, 2013 1:57 PM
36	unknown	Jul 18, 2013 1:53 PM
37	Thunder Storm 3%	Jul 18, 2013 1:51 PM
38	AFFF	Jul 18, 2013 1:45 PM

Page 7, Q27. Percent concentrate utilized for Class A fire attack:		
1	.25	Jul 19, 2013 9:37 AM
2	Varies	Jul 19, 2013 6:18 AM
3	0	Jul 19, 2013 4:51 AM

Page 7, Q28. Percent concentrate utilized for Class A overhaul:		
1	.25	Jul 19, 2013 9:37 AM
2	0	Jul 19, 2013 4:51 AM

Page 7, Q29. Percent concentrate utilized for Wildland fire attack:		
1	na	Jul 23, 2013 1:06 PM
2	.25	Jul 19, 2013 9:37 AM
3	0	Jul 19, 2013 4:51 AM
4	N/A	Jul 18, 2013 1:45 PM

Page 7, Q30. Percent concentrate utilized for Wildland overhaul:		
1	na	Jul 23, 2013 1:06 PM
2	.25	Jul 19, 2013 9:37 AM
3	0	Jul 19, 2013 4:51 AM
4	N/A	Jul 18, 2013 1:45 PM

Page 7, Q31. Percent concentrate utilized for Class B fire attack:		
1	depends upon nature of chemical, depth of chemical, and presence or absence of alcohol	Jul 29, 2013 10:40 AM
2	na	Jul 23, 2013 1:06 PM
3	Depends on fire and amount of foam to suppress fire and vapors.	Jul 21, 2013 9:02 AM
4	External eductors and pails of concentrate	Jul 19, 2013 8:27 AM
5	0	Jul 19, 2013 4:51 AM

Appendix C

Foam Concentrate Data Sheet

Concentrate	Class A	Class B		
	%	Non-Polar %	Polar %	Viscosity
Ansul - **Thunderstorm 3% x 3% AR-AFFF (F-603A)**	Not Approved	3.00%	3.00%	77F= 2100 ± 3600 cps*
Ansul - **Ansul-A Municipal "Class A" Fire Control**	0.10%-1%	Not Approved	Not Approved	77F=1.7 ± 0.5 cps
Ansul- **Jet - X**	2%	2%	Not Noted	77F= 186 ± 10 cps
Ansul - **Silvex**	0.10% - 1%	Not Approved	Not Approved	77F= 18.72 ± 2.5 cps
Ansul - **Silvex-Plus**	0.10% - 1%	Not Approved	Not Approved	77F= 12 ± 3 cps
Ansulite - **1% x 3% AR-AFFF (F-601A)**	Not Approved	1%	3%	77F= 2700 ± 500 cps*
Ansulite - **3% AFFF (AFC-3A)**	Not Approved	3%	Not Approved	77°F = 2.9 ± 1 cps
Ansulite - **3% x 3% Low Viscosity AR-AFFF**	Not Approved	3%	3%	77°F= 1500 ± 500 cps*
Ansulite - **ARC 3% x 6% AR-AFFF**	Not Approved	3%	6%	77°F= 2525 ± 700 cps
Baums Castorine - **Novacool**	0.40%	0.50%	Not Approved	69.8°F=37.52 cps
Chemguard - **3% x 3% AR-AFFF (C-333)**	Not Approved	3%	3%	1500 cps*
Chemguard - **CAFS Extreme**	0.10%-1%	0.50%	Not Approved	10 cps
Chemguard - **Class A Plus**	0.10% - .6%	Not Approved	Not Approved	20 cps
Chemguard - **First Class**	0.24%	0.50%	Not Approved	10 cps
Fire-Freeze Worldwide - **Cold Fire**	0.15%	1.50%	Not Approved	15 cps
Hazard Control Technologies - **F-500**	0.25%	6%	Not Approved	85 cps
Fire Service Plus - **FireAde 2000**	0.25%	0.50%	Not Approved	Unable to locate
Fire Service Plus - **FireAde 2000 AR-AFFF 3% x 3%**	.25%-1%	3%	3%	900 cps
Fire Suppression Products - **FireCap Plus**	0.25%	0.30%	Not Approved	Unable to locate
ICL Performance Products - **Phos-Chek WD881**	0.10%	0.25%	Not Approved	75°F= 50 cps
Verde Environmental - **Micro Blaze Out**	1%	3%	Not Approved	47.4 cps****
National Foam - **Centurion 3% x 6% AR-AFFF**	*****	3%	6%	2,800 cps**
National Foam - **Centurion 3% AR-AFFF**	*****	3%	3%	2,600 cps***
National Foam- **Knockdown**	0.30%	0.30%	Not Approved	21 cps
National Foam - **Universal Plus 3 % x 6 % AR-AFFF**	*****	3%	6%	2,700 cps**
National Foam - **Universal Gold 1% x 3%**	*****	1%	3%	2500 cps***
U.S. Foam - **First Strike "Class A"**	0.10% - 1%	Not Approved	Not Approved	17 cps
Williams - **Thunderstorm 1% x 3% AR-AFFF (FC-601A)**	Not Approved	1%	3%	77°F=2000-3200 cps*
Williams - **Thunderstorm 3% AR-AFFF (F-603B)**	*****	3%	3%	77°F=2000-3200 cps*
Williams -**Thunderstorm SFFF Class A Foam**	.10% - .6%	******	******	20 cps

* Brookfield Viscometer Spindle #4, Speed 30 rpm

** Brookfield Viscometer Spindle #3, Speed 30 rpm

*** Brookfield Viscometer Spindle #4, Speed 60 rpm

**** 1% Solution Viscosity @ 70 F

***** Manufacturer states product can be utilized on Class A fires

****** Manfacturer states product can be utilized on Class B contained fires

Appendix D

On-Board Foam Delivery System Data Sheet

Foam System	*Min Concentrate %*	*Max Concentrate %*	*Max Centipose*
Akron #3126 *	*	*	4,000 cps
Elkhart 240P 125gpm	**	**	They don't know
Feecon Model APH 1.5-1%	***	***	Couldn't locate
Feecon A.P.H 1.5 Dual Liquid	****	****	Couldn't locate
FoamPro 1600	0.10%	1%	1,000 cps
FoamPro 1601	0.10%	1%	1,000 cps
FoamPro 2001	0.10%	10%	2,000 cps
FoamPro 2002	0.10%	10%	2,000 cps
FoamPro 3012	0.10%	10%	5,000 cps
Hale Foam Logic 3.3	0.10%	10%	********
Hale Foam Logic 5.1	0.10%	10%	********
Husky 10	0.50%	6%	No Specifics
Husky 12	0.10%	9.90%	6,000 cps
Husky 3	0.10%	3%	6,000 cps
Husky 30	1%	6%	3,200 cps
Rosenbauer EZ Foam	***	***	Couldn't locate
Waterous Aquis 1.5	0.10%	1%	2,000 cps
Waterous Aquis 2.5	0.10%	******	2,000 cps
Waterous Advantus 3	0.10%	*******	3,000 cps
Waterous Advantus 6	0.10%	******	3,000 cps
Williams ATP 1500V A/B Dual Agent	*********	*********	Couldn't locate
Williams ATP1500	****	****	Couldn't locate

* The max percentage deliverable is dependent on the size of the line and length of the line. This eductor must have a nozzle flowing 125 gpm. The system delivers solution at 0.25%, 0.50%, 0.75%, 1%, 3% and 6%.

** The system will deliver solution at 0.50%, 1% , 3% and 6%

*** The system will deliver solution at 0.50%, 1% and 3%

**** The system will deliver solution at 1%, 3% and 6%

***** The system will deliver solution at 0.10% increments from 0.10% to 1%, and 3%

****** The system will deliver solution at 0.10% increments from 0.10% to 1%, 3% and 6%

******** See the manufacturers proportioning system foam concentrate compatibility bulletin

********* The system will deliver solution at 0.25%, 0.50%, 1%, 3% and 6%