DEVELOPMENT OF A CLASS B FOAM STANDARD OPERATING GUIDELINE

Executive Leadership

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An applied research project submitted to the National Fire Academy as part of the Executive Fire Officer Program.

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ABSTRACT

The problem identified with this research was that policies and procedures for utilizing Class B foam by the Rice Lake Fire Department (RLFD) were non-existent which resulted in uncoordinated, non-standardized Class B foam applications during fireground operations.

The purpose of this research was to develop policies and procedures, within the RLFD, for effective utilization of Class B foam.

Action research was employed to develop a Class B foam utilization policy and procedure document for the RLFD.

Four questions were identified as the foundation for this research:

1. What situations warrant the application of Class B foam?
2. Based upon the specific fire condition, at what rate should Class B foam be applied?
3. Is any special application equipment required for the utilization of Class B foam?
4. Is any special training required for the utilization of Class B foam?

The author researched national standards, nationally recognized training manuals, trade journals, and on-line sources. The author also conducted a survey of Wisconsin fire service organizations and conducted two personal interviews to gain information regarding Class B foam utilization.

The results of this research indicated that the utilization of Class B foam by the RLFD would be of benefit during a varying degree of fire and hazardous material situations by:
1. Increasing fire fighter safety.
2. Increase fire and vapor suppression capabilities.
3. Reduction in property damage.

Based upon the research, the following recommendations were created for implementation within the RLFD:

1. Implement the policy developed as a result of this research.
2. Equip existing and all new pumping apparatus with on-board Class B foam systems.
3. Initiate formal Class B foam training for RLFD members.
4. Explore Class B foam concentrate options.
5. Incorporate the policy into the Hazardous Materials Response Team (HMRT) out-reach program.
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INTRODUCTION

The Rice Lake Fire Department (RLFD) responds to between 300 and 400 requests for emergency assistance including fire, emergency medical, rescue, and hazardous material annually. In 2001, the RLFD responded to 364 emergency incidents with a total estimated fire loss of $1 million. The majority of the fire loss involved residential property and an incident involving a recreational vehicle.

Even though the RLFD has had Class B foam concentrate and delivery capabilities for several years, RLFD personnel were not familiar with the principles of Class B foam, its proper utilization, its limitations, and its application on the fireground. Prior to 2000, the primary method of Class B foam application was by portable in-line eductor. In March 2000, the RLFD accepted delivery of a General Safety Equipment, Incorporated pumper/tanker apparatus that included an on-board Class B foam eduction system. This system, supplied by a 30 gallon tank, supplies two 1-3/4” attack lines via two 125 gallon per minute (gpm) in-line eductors.

The problem identified with this applied research project was that policies and procedures for utilizing Class B foam were non-existent resulting in uncoordinated and non-standardized use as well as potential misuse of Class B foam during fireground operations.

The purpose of this research was to develop policies and procedures for the effective application of Class B foam by the RLFD.

Action research was accomplished with the development of a policy regarding the use of Class B foam.

Four questions were identified as the foundation for this research:
1. What situations warrant the application of Class B foam?
2. Based upon the specific fire condition, at what rate should Class B foam be applied?
3. Is any special application equipment required for the utilization of Class B foam?
4. Is any special training required for the utilization of Class B foam?

**BACKGROUND & SIGNIFICANCE**

The city of Rice Lake is a small community located in northwest Wisconsin approximately 100 miles northeast of Minneapolis-Saint Paul, Minnesota, 100 miles south of Duluth, Minnesota, and 55 miles north of Eau Claire, Wisconsin. It covers approximately 9.5 square miles with a resident population 8,170 (City of Rice Lake Fiscal Year 2002 Budget, 2001, p. 6). The population increases by an estimated 35% to 45% during the summer months. Tourism and recreation are the main causes for this increase.

The community supports a diverse composition of manufacturing, wood industry, retail, commercial, residential, and recreational areas. As the city has grown in both population and complexity, potential risks to the community as well as actual demands for service have increased.

The RLFD is a combination fire department with an authorized force of 16 sworn career personnel, 18 Paid-On-Call (POC) fire fighters, and one civilian. Operations personnel are assigned to two platoons with the fire chief, captain-fire prevention, and administrative assistant on a 40 hour work week. The RLFD currently operates three
engine companies, one aerial apparatus, one medium rescue unit, two tanker units, one wild-land unit, one boat unit, three support units, two hazardous material response units, and one special operations response unit (confined space and high-angle rescue). All apparatus, with the exception of one tanker that is based in the Town of Cedar Lake, operate out of one fire station. There is a minimum on-duty staffing of three career personnel with off-duty career and POC fire fighters available to augment the on-duty fire fighting force by a pager recall system.

Through contractual agreements, the RLFD provides fire suppression, rescue, and inspection enforcement for three townships: (1) Town of Rice Lake, (2) Town of Oak Grove, and (3) Town of Cedar Lake. Including the contracted townships, the RLFD provides services for an area of approximately 115 square miles, with a population of 13,000. Approximately 100 square miles of the total coverage area are not served by a water distribution system. Included within this area are the Rice Lake Regional Air Center, three major transportation corridors, and rail lines.

The RLFD also serves as the State of Wisconsin Hazardous Materials Response Team (HMRT) for Barron County, a 900 square mile area. The HMRT is comprised of 16 career members trained to the Hazardous Materials Technician Level and 10 POC members trained to the Hazardous Materials First Responder Operational Level.

This research was prompted by the lack of written policies and procedures for Class B foam use. Class B foam use by the RLFD was accomplished with minimal guidance. RLFD personnel had insufficient knowledge of Class B foam, application scenarios, and application rates.
This research is a requirement for the National Fire Academy (NFA) Executive Fire Officer Program (EFOP) Executive Leadership course. This research relates to the Developing Decision Making Skills unit of the above-mentioned course by identifying recommendations that will hopefully provide a direction to maximize the human and physical resources of the RLFD.

The results of this research are anticipated to have a significant, positive impact within the RLFD as well as for the remainder of the volunteer fire departments in Barron County. The research indicates that implementation of the draft policy and procedure will provide standardized operational guidance for the use of Class B foam, clarify application rates, improve fire fighter safety, increase the capability to suppress fires involving flammable and combustible liquids in a variety of situations, and act as a vapor suppressing agent in certain hazardous material incidents.

**LITERATURE REVIEW**

The research process began with a literature review conducted at the Learning Resource Center (LRC) on the NFA campus in March 2002. Further literature reviews were conducted between March 2002 and June 2002, at the Rice Lake Public Library, RLFD reference library, on-line resources, from a survey of Wisconsin fire service organizations, from policies and procedures from an Illinois and Wisconsin fire service organization, and from personal interviews.

The International Fire Service Training Association (IFSTA) (1996) states: Incidents that involve ignited flammable and combustible liquids tend to be very spectacular and worthy of much media and emergency responder attention.
However, emergency response personnel are more likely to encounter incidents involving unignited spilled fuels. Although the appearance of an incident involving unignited fuels is not nearly as spectacular as that of a fire incident, an unignited spill has the potential to be extremely dangerous (p. 149).

The National Fire Protection Association (NFPA) (1997a) states: “The use of fire-fighting foams is essential for the control of flammable liquid fire threats. The ability of foam to rapidly extinguish flammable liquid fires has contributed to life safety and property conservation” (p. 6-363).

Angus Fire (2002) states:

When applying finished foam on to a fire there is a critical application rate which represents the absolute minimum amount of foam that is required to achieve extinction. If the application rate, which is calculated on solution quantities, falls below the critical rate the fire is unlikely to be extinguished. Past the critical application rate is an optimum area of application which is usually two or three times that of critical rate often termed as the minimum application rate. Above this you may move into the overkill area which is self-explanatory. Minimum rates of application will vary depending upon the type and size of the risk, the fuel, the type of foam to be applied, and the method of application.

Bowen (1995) states: “One of the most common errors made in attempting to extinguish a flammable liquid fire with foam is to initiate the attack before sufficient foam concentrate is on hand to complete extinguishment against flashback” (p.170).

To calculate the amount of Class B foam required, Bowen (1995) states: “First, three facts must be at hand: the minimum recommended application rate for the
particular foam, the proper percentage at which it is to be applied, and the surface area of the fire” (p.171).

Bowen (1995) stipulates: “A seemingly endless array of foam generation systems is available to today's firefighters. These run the gamut from simple booster tank and draft basin premixed solutions to complex around-the-pump proportioning systems. Like specific extinguishing agents, each foam generation system also has its unique advantages and disadvantages” (p. 167). Bowen continues with: “No single method of AFFF application yields optimal results for all factors. It is a matter of optimizing one characteristic and sacrificing another” (p. 172).

IFSTA (1996) contends: “In general, the type of proportioning system used ... is not important; however, it must operate properly. The main piece of equipment that may vary ... is the nozzle” (p.157).

IFSTA (1996) states: “Because Class B fires are not common in most jurisdictions, most departments are not well trained or experienced in combating sizeable Class B fires” (p.165).

The United States Fire Administration (USFA) (2000) stipulates: “Personnel using foam should be trained in accordance with NFPA 11” (p. 96).

The literature review supports the theory that Class B foam is a valuable, but often times misunderstood and under utilized, fire fighting tool. The literature review also supports the philosophy that in order for Class B foam to be effective, standard operating procedures, training, and proper equipment are required.
PROCEDURES

Methodology

Research involved a review of literature from the RLFD reference library, the NFA LRC, on-line resources, from a survey of Wisconsin fire service organizations, and from a policy from an Illinois and Wisconsin fire service organization. The literature was then reviewed with material relevant to this project, summarized, and grouped based upon the corresponding research questions. The project was then formatted following the parameters of the *Publication Manual of the American Psychological Association* (Fourth Edition) and the *Executive Fire Officer Program Operational Policies and Procedures Applied Research Guidelines* (October 1, 2001).

The author conducted two personal interviews with fire service representatives that have practical experience with Class B foam. Mr. Dave Schreier, fire chief of the Lake Johanna (Minnesota) Fire Department, and Mr. Jeff Anderson, deputy chief of the Oakdale (Minnesota) Fire Department were interviewed on May 28, 2002 regarding the use and application of Class B foam.

Limitations and Assumptions

The primary restriction was the inability of the RLFD to conduct realistic Class B foam training, including live hydrocarbon fire evolutions, due to the lack of a suitable Environmental Protection Agency (EPA) approved hydrocarbon fuel training facility within a reasonable geographic region. Wisconsin Department of Natural Resource (WI DNR) restrictions currently restrict the use of Class B foam except for emergency conditions.
Although there are several different types of Class B foams available, the author has elected to conduct research and develop a policy and procedure specific to that of Aqueous Film Forming Foam (AFFF). For the purposes of this research, the term “Class B foam” is specific to that of AFFF.

**Selected Terms and Definitions**

The following list of selected terms is provided to assist non-fire service readers a better comprehension of uncommon terminology used within the context of this applied research project:

**Aeration:** “The act of binding together substances of unlike compositions” (IFSTA, 1996, p. 263).

**Application Rate:** “The minimum amount of foam solution that must be applied to a fire, per minute, per square foot (square meter) of fire” (IFSTA, 1996, p. 263).

**Batch-Mixing:** “The making of foam solution by pouring an appropriate amount of foam concentrate into a water tank” (IFSTA, 1996, p. 263).

**Class A fire:** “Fires involving ordinary combustibles such as wood, paper, cloth, and so on.” (IFSTA, 1996, p. 263).

**Class A foam:** “Foam specially designed for use on Class A combustibles” (IFSTA, 1996, p. 264).

**Class B fire:** “Fires of flammable and combustible liquids and gases such as gasoline, kerosene, and propane” (IFSTA, 1996, p. 264).

**Combustible Liquid:** “Liquid having a flash point at or above 100°F (37.8°C) and below 200°F (93.3°C)” (IFSTA, 1996, p. 264).
**Eductor**: “Portable proportioning device that injects a liquid, such as foam concentrate, into the water flowing through a hoseline” (IFSTA, 1996, p. 265).

**Flammable Liquid**: “Liquid having a flash point at or below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psi absolute (276 kPa)” (IFSTA, 1996, p. 265).

**Foam**: “Extinguishing agent formed by mixing a foam concentrate with water and aerating the solution for expansion” (IFSTA, 1996, p. 265).

**Foam Concentrate**: “The raw liquid as it rests in its storage container prior to the introduction of water and air” (IFSTA, 1996, p. 266).

**Foam Proportioner**: “Device that injects the correct amount of foam concentrate into the water stream to make the foam solution” (IFSTA, 1996, p. 266).

**Foam Solution**: “Mixture of foam concentrate and water after it leaves the proportioner but before it is discharged from the nozzle and air is added to it” (IFSTA, 1996, p. 266).

**Hazardous Materials Response Team**: “An organized group of trained response personnel operating under an emergency response plan and appropriate standard operating procedures who handle and control actual or potential leaks or spills of hazardous materials requiring possible close approach to the material” (NFPA, 1997b, p. 472-5).

**Hazardous Material Technician Level**: “Are those persons who respond to releases or potential releases of hazardous materials for the purpose of controlling the release….are expected to utilize specialized chemical protective clothing and specialized control equipment” (NFPA, 1997b, p. 472-13).

**Hazardous Material First Responder Operational Level:**
Are those persons who respond to releases or potential releases of hazardous materials as part of the initial response to the incident for the purpose of protecting nearby persons, the environment, or property from the effects of the release….are expected to respond in a defensive fashion to control the release from a safe distance and keep it from spreading (NFPA, 1997b, p. 472-9).

**Paid-On-Call (POC) Fire Fighters:** Individuals trained to a state-specified level, pager equipped, but not a career member. POC’s are paid a wage for attending training sessions and for responding to emergency incidents.

**Polar Solvent:** “Flammable liquids that have an attraction for water, much like a positive magnetic pole attracts a negative pole; examples include alcohols, ketones, and lacquers” (IFSTA, 1996, p. 267).

**Vapor Suppression:** “The action taken to reduce the emission of vapors at a fuel spill” (IFSTA, 1996, p. 269).

**RESULTS**

The results of the survey instrument outlined in the table below indicate that 18 or 100% of the organizations surveyed utilize a form of AFFF as the primary Class B foam; 14 or 78% are utilizing AFFF, and four or 22% are utilizing Alcohol Resistive (AR)-AFFF. Three or 6% of the organizations are conducting hydrocarbon live fire training. One of the organizations surveyed had a written Class B foam policy and procedure.

Demographic information of those fire service organizations that returned the survey instrument is included in this research as Appendix B.

**Table 1**
Class B Foam Survey Results

<table>
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<tr>
<th></th>
<th>Total</th>
<th>Percentage</th>
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<tr>
<td>Number of Organizations Surveyed</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Number of Surveys Returned</td>
<td>18</td>
<td>82%</td>
</tr>
<tr>
<td>Organizations currently using AFFF</td>
<td>14</td>
<td>78%</td>
</tr>
<tr>
<td>Organizations currently using AR-AFFF</td>
<td>4</td>
<td>22%</td>
</tr>
<tr>
<td>Organizations using other than AFFF</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Organization conducting live fire training</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>Organizations with a Class B foam policy</td>
<td>1</td>
<td>5%</td>
</tr>
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The results of the survey instrument outlined in the table below indicate that of the ten departments currently utilizing Class B foam, 12 or 60% indicated the most effective use Class B foam was on vehicle fires.

Table 2

<table>
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<tr>
<th>Incident Type</th>
<th>Total</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Vehicle Fire</td>
<td>12</td>
<td>68%</td>
</tr>
<tr>
<td>Non-Pooled Fuel Spill (&lt; 1” in depth)</td>
<td>3</td>
<td>17%</td>
</tr>
<tr>
<td>Pooled Fuel Spill (&gt; 1” in depth)</td>
<td>1</td>
<td>5%</td>
</tr>
<tr>
<td>Vapor Suppressant</td>
<td>1</td>
<td>5%</td>
</tr>
<tr>
<td>Aircraft Rescue and Fire Fighting (ARFF)</td>
<td>1</td>
<td>5%</td>
</tr>
</tbody>
</table>

The results of the survey instrument outlined in the table below indicate that of the 18 departments, ten or 56% indicated that portable in-line eductors were the primary delivery method for Class B foam.

Fourteen or 78% of the departments surveyed indicated that automatic nozzles were the primary device for Class B foam application.

Table 3

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Total</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>(1) Portable In-Line Eductor</td>
<td>10</td>
<td>56%</td>
</tr>
<tr>
<td>(2) On-Board in-line Eductor</td>
<td>5</td>
<td>28%</td>
</tr>
<tr>
<td>(3) Automatic Proportioning</td>
<td>2</td>
<td>11%</td>
</tr>
</tbody>
</table>
What situations warrant the application of Class B foam?

NFPA’s *Fire Protection Handbook* (1997a), states:

Low expansion foam is used principally to extinguish burning flammable or combustible liquid spill or tank fires by application to develop a cooling, coherent blanket. Foam is the only permanent extinguishing agent used for fires of this type. Its application allows fire fighters to extinguish fires progressively (p. 6-349).

However, the NFPA (1997a) emphasizes that: “Three-dimensional (falling fuel) or pressure fires cannot be extinguished by foam unless the hazard has a relatively high flashpoint and can be cooled to extinguishment by the water in the foam” (p. 6-350).

The Countryside Fire Protection District (Illinois) operates under the following premise when utilizing Class B foam:

The use of fire fighting foam (ATC/AFFF) is not limited to simple liquid fires. The use of fire fighting foam in encouraged in fires which may have the potential of the spill or leaking flammable liquids. These may be car fires, truck fires, fires or spills and leaks involving stored flammable or combustible liquids (Countryside Fire Protection District – Standard Operating Guideline Foam Usage – Class A & B, 2001, p. 1).

The Manitowoc Fire Department (Wisconsin) stipulates: “It shall be the policy of

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<table>
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<th>(4) Other Method</th>
<th>1</th>
<th>5%</th>
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<tr>
<td>(5) Automatic Nozzle</td>
<td>14</td>
<td>78%</td>
</tr>
<tr>
<td>(6) Automatic w/Aspirating Attachment</td>
<td>2</td>
<td>11%</td>
</tr>
<tr>
<td>(7) Other Nozzle</td>
<td>2</td>
<td>11%</td>
</tr>
</tbody>
</table>
the Manitowoc Fire Department to properly apply Class B firefighting foam in situations which require vapor control or fire suppression” (Manitowoc Fire Department – Foam Production Operations, 2002, p.1).

Dominic J. Colletti (1998), a renowned fire service foam expert, provides the following regarding the general application of Class B foams by stating:

Fire departments use Class B foam in a variety of situations such as:

- On diked and non-diked flammable liquid spills for vapor suppression to prevent ignition or extinguish fire.
- On burning vehicles ranging from automobiles to bulk flammable liquid transport trucks for extinguishment.
- In and around flammable liquid storage facilities which include bulk storage tanks, loading racks for tanker trucks and rail cars.
- In refineries and chemical manufacturing and processing plants.
- Manufacturing facilities where flammable liquids are utilized in the production of textiles, pharmaceuticals, and other products.
- To support fixed on-site industrial foam suppression equipment such as foam/water sprinkler systems (p. 39).

Colletti (1998) provides the general limitations of Class B foams by stating:

Foams are generally not suitable for extinguishing fires involving:

- Gases, liquefied petroleum gases (such as butane and propane), or cryogenic liquids (such as liquefied natural gas).
- Three dimensional fires where fuels are flowing (such as tank or piping leaks).
- Fires involving energized electrical equipment.
• Fires involving combustible metals (p. 56).

Bill Stewart (2002) states: “By far the most effective firefighting tool on jet fuel fires is … AFFF. AFFF knocks down a fuel fire while smothering and suppressing vapors” (p.37).

(2) Based on the specific fire condition, at what rate should Class B foam be applied?

IFSTA (1996) contends: “To control any type of incident (fire or fuel spill), it is crucial that an adequate flow of foam concentrate be discharged onto the fuel” (p.157). IFSTA continues by stating: “Suggested minimum application rates are established by NFPA 11 and the foam concentrate manufacturer’s recommendation” (p. 157).

Specifically, IFSTA (1996) states:

NFPA 11 recommends the following minimum flow rates on spills of hydrocarbon fuels in nondiked areas:

AFFF: 0.10 gpm/ft²

These flow rates should be maintained for at least 15 minutes (p. 157). Continuing, IFSTA (1996) states:

To determine the amount of foam concentrate required to make an NFPA 11-specified application, responders need to know the following factors:

• Size of spill;
• Type of foam concentrate, its proportioning ratio, and its recommended application rate;
• Recommended discharge duration (15 minutes for spills) (p.157).

Bowen (1995) states:
Use the following formula to calculate the minimum amount of foam, the proper percentage at which it is to be applied, and the surface area of the fire. Then use the following formula to calculate the minimum amount of foam solution needed for extinguishment:

\[
\text{foam solution needed, gal/min} = (\text{surface area, ft}^2) \times (\text{minimum recommended, application rate, gpm/ft}^2).
\]

Then calculate the amount of concentrate needed:

\[
\text{Foam concentrate needed, gpm} = (\text{foam percentage}) \times (\text{foam solution needed, gpm})
\]

(p. 171).

Scott Cox (2002) elaborates by stating:

Planning for Class-B applications takes a little more math, starting with: how big a spill do (or can) we have? For example, if there is containment or dike designed to contain or containing the spill, measure it, calculate the square footage, and there you have it: You need enough foam to tackle a spill that size (p. 53).

Continuing, Cox (2002) states:

For situations without containment, determine how many gallons could be spilled and divide by 7.5…to get the number of cubic feet of the product that could be spilled. Then multiply that number by 12 to get the square footage of a one-inch deep puddle of the product (p. 53).

Concluding, Cox (2002) states:

In general, the rules of thumb for foam flows are:

- Use 15-minute flows per NFPA 11;
• For non-film forming foams, flow 0.16 gpm per square foot;
• For film-forming foam, flow 0.10 gpm per square foot; and
• Multiply the gpm rating of an in-line eductor by 10 for hydrocarbon spills and by five for polar solvents to determine how many square feet it’ll handle (p.53).

Bowen (1995) emphasizes: “Experience has shown that increasing the foam application rate up to three-fold greater than the minimum recommended rate can be beneficial in shortening extinguishing time. Any further increase is likely to just to waste foam, though” (p. 171).

(3) Is any special application equipment required for the utilization of Class B foam?

Bowen (1995) states:

AFFF manufacturers and NFPA publications favor the use of air-aspirating nozzles for AFFF applications. These sources do recognize the fact that this is not absolutely necessary, but nevertheless AA-AFFF is said to be a higher-quality foam than NA-AFFF. There can be little doubt about the accuracy of this conclusion. Responders should drill with each application technique and then make a judgment (p. 173).

Goldwater (2000) states:

For Class B foam, you should always use a foam nozzle, especially with blended gasoline. You need to expand your foam for it to work at its best. It will work with a fog nozzle on regular hydrocarbons, but vapor suppression and post fire
security are sacrificed when a standard fog nozzle is used. Remember, you want to make a thick “foam blanket”, not dish washing soap (p. 2).

IFSTA (1996) stipulates:

Fog nozzles should be used on all low-energy foam system handlines. The turbulence created by the nozzle helps aerate the foam after it is discharged. Some fog nozzles are equipped with special clamp-on aspirating nozzles that improve the amount of aeration that takes place (p. 142).

Colletti (1998) concurs by stating: “Fog nozzles aspirate foam solution because their streams draw in air after leaving the nozzle. Depending upon nozzle design and stream pattern, these nozzles produce low-expansion, sloppy foams with expansion ratios of about 2:1 to 4:1” (p. 93).

Regardless of the nozzle type, Bowen (1995) emphasizes: “It is essential with most foam systems that the nozzle be fully opened at all times while foam is flowing from it” (p. 173).

(4) **Is any special training required for the utilization of Class B foam?**

The USFA (2000) states:

Effective implementation of SOPs often requires that personnel be trained in the new procedure. Depending upon the situation, instruction may be formal or informal, conducted in the classroom or on the job. As with any type of training, program design should follow accepted principles of adult education, taking into consideration four general components: motivation, transfer of information, opportunities to practice new skills, and demonstration of competence (p. 53).
Colletti (2000) emphasizes that: “The benefit of any new firefighting concept is directly proportionate to the knowledge of the user. It is important that the entire department become involved in the education and training process”.

The NFPA (1999) states:

Because of the diversity of applications, the solution and foam need to be varied over a range of characteristics. Those who use foam need to become knowledgeable of and proficient in the conditions of preparation and application that are most suitable to each fire situation (p. 23).

Colletti (1998) emphasizes: “Classroom and hands-on training are required to understand eductor limitations, firefighting suitability, and performance characteristics” (p. 144).

Based upon the answers to the four research questions, information gained from the personal interviews, and the RLFD’s limited experience with Class B foam, action research resulted in a new policy on Class B foam use by the RLFD (Appendix C). The policy defines the role of Class B foam within the RLFD, provides specific application guidelines, outlines training requirements, and establishes procedures for storage and handling.

DISCUSSION

The author concurs with IFSTA (1996) who states: “The majority of fires faced by most firefighters are those that involve Class A fuels” (p. 121). IFSTA continues by providing: “The most common type of Class B fires that firefighters encounter are fires involving automobiles and light-duty trucks and vans” (p. 182).
RLFD response data supports this statement. The frequency of responses that warrant the use of Class B foam are much lower than that of Class A foam and/or water applications. Conversely, the potential for having to utilize Class B foam exists due to increases over the past five years in the of number general aviation aircraft movements, medical flight helicopter movements, and the transportation of hazardous materials, including flammable and combustible liquids.

The author again concurs with IFSTA (1996) who states:

Many of the principles associated with Class B fire attack are quite different from those used by the more common Class A fires. Therefore, all firefighters must be familiar with the principles of Class B fire attacks and the equipment available to them. This knowledge will help them make an effective attack on Class B fires (p. 165).

Chief Dave Schreier of the Lake Johanna (Minnesota) Fire Department, stated: “In my 25 years of service, we have used Class B foam three times. There were two times when we probably should not have used it and on the third application, it was not done correctly” (Schreier, personal communication, May 28, 2002).

In Class A fire scenarios, it is the tradition of the fire service to take an aggressive approach to fire attack. The members of the RLFD are no different regarding this aspect than any other fire fighter. In Class B fire scenarios, municipal fire service organizations, officers and fire fighters must curtail the aggressive approach and analyze the situation prior to initiating the attack to maximize available resources. The exception would be in those cases involving a passenger vehicle or general aviation
aircraft incident where an immediate and viable life hazard would dictate an immediate attack for rescue purposes.

To provide for effective fire suppression operations using Class A foam, Colletti (2000) recommends that:

A systematic training program should be formulated and placed into action upon system delivery. This should include but not be limited to:

- Classroom instruction on Class A foam methodology and implementation.
- Pump Operator training in the operation and maintenance of the foam equipment.
- Procedures for handling Class A foam concentrate to protect personnel, equipment, and the environment.
- A standard operating procedure to designate when and how Class A foam will be used.
- Hands-on training before actual fire responses.
- Training on new foam application techniques if new nozzles or CAFS will be utilized.

Again, referring to Class A foam, Colletti (1998) stipulates that a fire service organization should:

Provide Standard Operating Guidelines on product handling and discharge to all department members. They should contain definitions of minimum and maximum proportioning ratio(s) to be put to use. Also define the fire response situations where Class A foam will, and won’t be used. Determine specific
proportioning ratio guidelines for various fire suppression applications (p. 116).

The author believes the same applies for Class B foam and from all indications more so. This is emphasized by the errors noted in portable eductor set-up and operation, nozzle attachment selection, and nozzle use.

The author’s observations and opinion is supported by Deputy Fire Chief Jeff Anderson of the Oakdale (Minnesota) Fire Department who states:

Class B foam in general is probably one of the most misunderstood tools that we have in the fire service. This includes the product itself, when to use it, how to use it, and the equipment that is used to apply it. It’s a problem all the way around (Anderson, personal correspondence, May 28, 2002).

Bowen (1995) concurs by stating: “Yet, the applications and limitations of these extinguishing agents are also widely misunderstood. The latter problem is doubtlessly attributable, at least in part, to the fact that most municipal firefighters have had limited hands-on experience with foams under fire-ground conditions” (p. 164).

Chief Schreier states:

The lack of frequent use by fire department personnel is compounded by setup time for portable eductors, misunderstanding of the mathematics required for proper eductor operation, and lack of understanding of application rates. The inclusion of on-board eduction or automatic proportioning systems has eliminated some of the issues therefore increasing the chances that Class B foam will be used effectively (Schreier, personal correspondence, May 28. 2002).

The RLFD’s most recent uses of Class B foam were on vehicle accidents; one incident involving a two-vehicle motor vehicle crash with both vehicles on fire and three
critical burn patients. The second incident involved a recreational vehicle and a tow vehicle. This incident included a three-dimensional fuel and a pressurized flammable gas (propane) fire with subsequent cylinder failure. It is the opinion of the author that Class B foam would not have been utilized on either incident except that the first-due apparatus was equipped with the on-board Class B foam system. The primary reason, from the author’s perspective, is the time required to properly establish a Class B foam system using a portable in-line eductor and the somewhat temperamental nature of portable in-lineeducors.

Continuing, Chief Schreier states: “One of the biggest problems in using Class B foam is the relatively high pressures required for proper foam production. Thus, fire fighters tend to close the nozzle to reduce the pressure. With this, foam production is reduced, if not curtailed. (Schreier, personal correspondence, May 28, 2002).

This situation is emphasized by Bowen (1995) who states: “It is essential with most foam systems that the nozzle be fully opened at all times while foam is flowing from it” (p. 173). The author agrees with this. From personal experience and use of Class B foams during actual fire situations, the most common error observed is that of the nozzle bale not in the full open position effectively reducing foam production.

The lack of Class B foam policies, as indicated by the survey instrument, at first glance seems to be discouraging. Upon investigating further, the thought process that most fire service organizations using Class B foam appear to operate under is the premise that since the rate for Class B foam use is low, time and resources have not been allocated to develop a Class B foam policy. Compounding this is the readily accessible lack of Environmental Protection Agency (EPA) approved hydrocarbon
training facilities within Wisconsin to effectively train and evaluate Class B foam application techniques. The drawback to this is that Class B foam and associated equipment is not understood. Thus, the use of Class B foam may be over utilized, resulting in increased operational costs; misused, resulting in less than satisfactory results, and environmental concerns; or not used, causing fire fighter safety concerns.

While Class B foam, specifically AFFF has been available to municipal fire fighters since the 1970’s, the conceptual thought of routine use by the RLFD has been precluded by tradition, funding constraints, misunderstanding of application, and lack of equipment and foam concentrate. However, over the past seven years, the RLFD has introduced technology, and acquired funding for equipment and training. These factors have had a positive influence regarding service delivery capabilities.

Prior to the arrival of the author in February 1993, the Class B foam delivery capability of the RLFD was marginal with a total of 35 gallons of 6% AFFF concentrate and two, 95 gpm portable in-line eductors. Over the past nine years, the RLFD has expanded its Class B foam delivery capabilities but has seriously neglected to provide guidance and instruction on Class B foam.

The RLFD currently utilizes Angus 3%-6% Tridol AR-AFFF concentrate as the primary Class B foam concentrate. Each engine company, with the exclusion of one, carries a standard ten gallons of concentrate and one Angus Hi-Combat™ 125 gpm portable in-line eductor. The remaining engine company is equipped with an on-board dual in-line eductor system supplied from a 30 gallon tank with a reserve on-board supply of 30 gallons.
In addition, the RLFD within its apparatus inventory, has a response trailer stocked with materials and equipment for response to hydrocarbon incidents. Included, is 100 gallons of 3%-6% AR-AFFF concentrate and one Angus Hi-Combat™ 250 gpm portable in-line eductor. This will augment the RLFD’s Class B foam delivery within its own jurisdiction and supplement the somewhat limited resources of the volunteer fire departments within Barron County.

The RLFD has standardized its complete nozzle inventory with TFT® automatic nozzles. To augment the capabilities of the TFT® nozzle, each engine company is equipped with two styles of TFT® air aspirating attachments. The air aspirating attachments have proven to be fully compatible with Class A and Class B foams.

Based upon the research and limited use, the RLFD is well equipped to deliver Class B foam. Existing TFT® automatic nozzles, TFT® air aspirating attachments, 1-¾” Angus Hi-Combat™ attack lines, and Angus Hi-Combat™ portable in-line eductors permit adequate application rates for known hazards. The inclusion of Class B foam eduction systems on new apparatus will substantially increase the Class B foam delivery capability of the RLFD in a wide variety of fire and hazardous material situations.

Conversely, the RLFD has seriously neglected to provide adequate academic and practical Class B foam training, ranging from its technological aspects to applications in fire situations. To ensure that Class B foam is utilized effectively, the training of personnel is a priority issue to accomplish. The author intends to contact petroleum storage facilities located within the Minneapolis-Saint Paul (Minnesota)
metropolitan area to explore the feasibility of utilizing industry facilities and personnel to provide practical Class B foam training to RLFD personnel.

It is also the intent of the author to explore the cost effectiveness and operational feasibility of converting from the current 3%-6% AR-AFFF concentrate to a 3%-3% AR-AFFF for two reasons. First, this concentrate would double the flow delivery time of foam solution for an incident involving polar solvents and second, the Motor Pump Operator (MPO) would select the 3% setting on the on-board and/or portable in-line eductors. This effectively eliminates the unknown as to whether the product involved is or is not a polar solvent.

It is vital, with the perils of today’s society facing emergency responders, that technological advances be utilized to maximize human resources to accomplish the mission of the organization.

**Implications**

The implications surrounding this research are positive for the RLFD. The development of a Class B foam policy is a progressive step for the organization, as a whole, by clarifying the use of Class B foam and by providing guidance on proper application rates for various fire situations. Proper application rates and guidance should also increase the cost effectiveness of Class B foam use. The success of the policy depends upon two factors: (1) commitment from the city of Rice Lake Common Council to provide the necessary funds to implement Class B foam utilization throughout the fleet of apparatus, and (2) commitment from RLFD officers and fire fighters surrounding these issues:

- Proper application rates.
• Proper attachment selection (where applicable).
• Adherence to manufacturer’s maintenance instructions; and
• Acceptance that Class B foam will enhance the operations of the organization, thus providing a benefit to the community.

**RECOMMENDATIONS**

Based upon the results of the research, the following are the recommendations offered as a plan of action:

1. Implement the policy developed as a result of this research (Appendix C).
2. Equip existing engine apparatus, with a service life-span exceeding five years, with an on-board Class B foam eduction system.
3. Equip all new pumping apparatus with on-board Class B foam eduction systems.
4. Provide academic training for company officers and fire fighters in the technological aspects, capabilities, and limitations of Class B foam.
5. Provide practical training for company officers and fire fighters in Class B foam application techniques by conducting live fire training evolutions at a Minneapolis-Saint Paul (Minnesota) petroleum refinery facility.
6. Explore the viability of converting from the current 3%-6% AR-AFFF to 3%-3% AR-AFFF to increase flow rate duration and to standardize eductor settings at 3% for all fire fighting and hazardous material incidents.
7. Incorporate the policy developed as a result of this research into the HMRT out-reach program.
REFERENCES

Angus Fire. (2002). *Foam Basics* [Online]. Available from:
http://www.angusinfo.co.uk/foamconc/basics.htm


Appendix A

June 6, 2002

Dear Chief Fire Officer:

As part of the National Fire Academy (NFA) Executive Fire Officer Program (EFOP), an Applied Research Project (ARP) is required for completion of the EFOP.

Enclosed, please find a survey that is applicable to my ARP for the Executive Leadership (EL) course. I would appreciate you taking the time to complete the survey and return it in the enclosed envelope NLT June 24, 2002. The purpose for the ARP is to develop recommendations that will form the foundation for a policy regarding the use of Class B foam by the Rice Lake Fire Department.

Once again, your cooperation is greatly appreciated. Should you have any questions regarding the survey, please feel free to contact me at (715) 234-6641.

Respectfully,

James C. Resac
Fire Chief

Enclosures
EXECUTIVE FIRE OFFICER PROGRAM SURVEY

Name of department: __________________________________________________________

1. Indicate the type of fire department you are associated with:
(Circle the best answer)
   A. Paid/Career
   B. Combination
   C. Volunteer

2. If a career department, how many uniformed members are in your department?
   A. 10-49
   B. 50-99
   C. 100-299
   D. Over 300

3. If a combination department, how many career/volunteer members are in your department?
   A. 10-49
   B. 50-99
   C. 100-299
   D. Over 300

4. If a volunteer department, how many volunteer members are in your department?
   A. 10-49
   B. 50-99
   C. 100-299
   D. Over 300

5. What is the population of your city or jurisdiction?

6. How many square miles does your department immediately provide protection for?
   A. 0-4
   B. 5-14
   C. 15-29
   D. 30-44
   E. Over 45

7. What type(s) of Class B foam are you currently using?
8. What is the primary type of Class B foam systems are in use on fire apparatus within your department?

- [ ] automatic proportioning
- [ ] portable in-line eductors
- [ ] on-board in-line eductors
- [ ] batch-mixing
- [ ] other (explain) ________________

9. What is the primary type of fire-fighting nozzle utilized with Class B foam?

- [ ] automatic
- [ ] automatic with aspirating attachment(s)
- [ ] special foam nozzle
- [ ] penetrating nozzle
- [ ] other (please specify) ________________________________

10. What types of firefighting situations has your organization had the best results with Class B foam (please number in the order of most successful to least successful)?

- [ ] non-pooled fuel spill (<1” in depth)
- [ ] pooled fuel spill (>1” depth)
- [ ] Aircraft Rescue and Firefighting (ARFF)
- [ ] vehicle fire
- [ ] vapor suppressant (other than hydrocarbon)
- [ ] three dimensional fuel fire
- [ ] other (explain) ________________________________
11. Does your organization conduct specialized and/or live training using Class B foam?
   _____ yes (please explain) ________________________________
   _____ no

12. Has your department incurred any maintenance difficulties with the use of Class B foam?
   _____ yes (please explain) ________________________________
   _____ no

13. Does your department have a policy and procedure pertaining to the use of Class B foam?
   _____ yes
   _____ no

14. Please attach a copy of your SOG regarding the use of Class B foam.

Please return completed survey to: James C. Resac
Rice Lake Fire Department
34 South Wilson Avenue
Rice Lake, Wisconsin 54868
FAX: (715) 234-6366
## Appendix B

Demographic Information Regarding Fire Service Organizations Responding to the Survey

<table>
<thead>
<tr>
<th>Organization</th>
<th>CLASS B FOAM IN USE</th>
<th>TYPE OF CLASS B FOAM IN USE</th>
<th>Formal Policy</th>
<th>Population Served</th>
<th>Organization Type</th>
</tr>
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<tbody>
<tr>
<td>Antigo</td>
<td>Yes</td>
<td>AFFF</td>
<td>No</td>
<td>8,700</td>
<td>Combination</td>
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<tr>
<td>Ashland</td>
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<td>AFFF</td>
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<td>Beaver Dam</td>
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<tr>
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<td>AFFF</td>
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<tr>
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<td>28,400</td>
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<td>Neenah</td>
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<td>AFFF</td>
<td>No</td>
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<td>AFFF</td>
<td>No</td>
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<td>8,000</td>
<td>Paid</td>
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<td>Saint Francis</td>
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<td>AR-AFFF</td>
<td>No</td>
<td>9,450</td>
<td>Combination</td>
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<td>Two Rivers</td>
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<td>20,000</td>
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Appendix C
Policy and Procedure

Chapter: INCIDENT OPERATIONS
Subject: CLASS B FOAM
Code: 400.002
Date: August 26, 2002

Approved By:

1.00 **PURPOSE:** To establish a policy and procedure to promote and provide for standardized and uniform procedures for use, re-supply and storage of Class B foam.

2.00 **SCOPE:** This policy covers all career and Paid-On-Call (POC) members of the Rice Lake Fire Department (RLFD).

3.00 **RESPONSIBILITY:** All career and POC RLFD members shall be responsible for ensuring that the provisions of this Standard Operating Guideline (SOG) are adhered. The Incident Commander (IC) has ultimate responsibility for the implementation of this SOG at an incident. Each Captain-Operations shall be responsible for maintaining the adequate level of proficiency in these procedures for assigned personnel.

4.00 **POLICY:** Class B foam shall be used in any situation requiring vapor control or fire suppression involving flammable and combustible liquids.

5.00 **STRATEGY AND TACTICS:** Class B foam application differs significantly from that of Class A foam. Ample Class B foam concentrate must be available prior to the application of Class B foam solution (water and foam concentrate). Application of Class B foam without ample resources is a waste of foam concentrate.

A. Class B foam has been proven to be highly effective in and may be used in following situations:

1. On diked and non-diked flammable liquid spills for vapor suppression to prevent ignition or extinguish fire.
2. Vehicle fires ranging from automobiles to bulk flammable liquid transport trucks for extinguishment.
3. Aircraft incidents involving un-ignited fuel or ignited fuel.

4. Manufacturing facilities where flammable liquids are utilized in the production of textiles, pharmaceuticals, and other products.

B. Class B foam is not effective for extinguishing fires involving:

1. Gases, liquefied petroleum gases (such as butane and propane), or cryogenic liquids (such as liquefied natural gas).

2. Three-dimensional fires where fuels are flowing (such as tank or piping leaks).
   a. The use of dry chemical fire extinguishing agent in combination with Class B foam is an acceptable attack strategy.

3. Fires involving energized electrical equipment.

4. Fires involving combustible metals.
   a. The use of dry powder extinguishing agent or isolation and containment without extinguishment is an acceptable strategy.

C. Water quality may affect bubble production so local conditions must be taken into consideration during foam production. If the system is not producing foam that meets your needs, increase or decrease the percentage as necessary.

6.00 FOAM DELIVERY EQUIPMENT: All RLFD engine apparatus shall be capable of delivering Class B foam. The following shall be the distribution of such equipment:

A. Engine apparatus not equipped with an on-board foam eduction system shall be equipped with one Angus Hi-Combat™ 125 gallon per minute (gpm) portable in-line eductor.

B. Engine companies not equipped with an on-board Class B foam eduction system shall carry 10 gallons of Angus Tridol 3%-6% foam concentrate.

C. Engine apparatus shall be equipped with the following nozzle appliances adaptable to the Task Force Tip® (TFT®) Dual Force® automatic nozzles:

1. One each TFT® FJ-LX-HM air aspirating attachment.  
   Exception: Engine 4 shall be equipped with two.
2. One each TFT® FJ-HMX air aspirating attachment. 
   
   **Exception:** Engine 4 shall be equipped with two.

D. HazMat 2 shall be equipped with 20, five gallon containers of Angus Tridol 3%-6% foam concentrate and one Angus Hi-Combat™ 250 gpm portable in-line eductor.

### 7.00 PROCEDURES:

The RLFD shall utilize Class B foam to increase the effectiveness of human and physical resources and to enhance fire fighter safety. The following general procedures should be adhered to:

A. General considerations:

1. Class B foam concentrate is not to be added to fixed water systems such as tanks, standpipes, or sprinkler systems. This may cause contamination of potable water supplies and/or corrode the components of these systems.

2. **Class A and Class B foam concentrates shall never be mixed.**
   - Class A foam concentrate containers/tanks are identified by a red tag.
   - Class B foam concentrate containers/tanks are identified by a yellow tag.

B. Operational considerations:

1. Pump discharge pressures: Failure to provide an adequate inlet pressure to on-board and portable in-line eductors will not allow proper eductor operation. Based upon the manufacturers recommendations and field testing, the following pressures have been established:
   
   a. Inlet pressure for Angus Hi-Combat™ portable in-line eductors shall be 175 psi to 200 psi.
   
   b. Pump discharge pressure for Engine 4 shall be 225 psi to 250 psi with a maximum flow rate of 125 gpm based upon the ClassOne™ gauge reading.

2. Eductor guidelines:

   a. Maximum distance from pump panel to Angus Hi-Combat™ portable in-line eductor shall be 200 feet (assuming Angus Hi-Combat™ 1-¾" hose).
b. Maximum distance from Angus Hi-Combat™ portable in-line eductor to the nozzle shall be 200 feet (assuming Angus Hi-Combat™ 1-¾” hose).

c. Maximum distance from pump discharge on Engine 4 to nozzle is 200 feet (assuming Angus Hi-Combat™ 1-¾” hose).

3. Nozzle and aspirating attachments:

a. Nozzle bales must be in the full open position for proper eductor operation. Failure to do so will result in significantly reduced or no Class B foam production.

b. TFT® automatic nozzles operated with air aspirating attachments must be operated in the straight stream position.

c. For non-fire situations, such as Class B foam application on non-ignited fuel, air-aspirating tips are recommended.

d. For initial fire attack, air-aspirating tips may not provide adequate reach capabilities. In these situations, application techniques shall utilize a narrow, straight stream, followed by a narrow fog pattern. Personnel shall utilize a “rain-down” or “bank-down” technique for these situations.


C. Deployment:

1. As a general rule of thumb, RLFD members shall use the following to assist in determining the amount of foam concentrate required to mitigate an incident:

a. Hydrocarbon Fire (Non-Polar Solvent):
   - Area in square feet/20 = number of gallons of foam concentrate

b. Polar Solvent or Blended Hydrocarbons:
   - Area in square feet/five = number of gallons of foam concentrate

c. Non-Ignited Spills/Vapor Control:
1) Pure Hydrocarbons:
   - Five gallons foam concentrate per 300 square feet
2) Polar Solvents:
   - Five gallons foam concentrate per 125 square feet

Sample Scenario

A fully involved, damaged gasoline tanker with a spill area covering an estimated 50’ x 50’ area would require a total foam concentrate of 112.5 gallons.

Area involved x Critical Application Rate of 0.1 x Foam Concentration of .03 x 15 minute Flow Duration.

\[ 2500 \times 0.1 \times 0.03 \times 15 \]

2. Foam delivery duration:

   a. Engine 4, with a 30 gallon Class B foam tank, will produce the following estimated foam delivery duration rates assuming a 125 gpm delivery rate per 1-¾” attack line:
      
      1) 3% solution:
         - one 1-3/4” speedlay - eight minutes  
         - two 1-3/4” speedlays - four minutes  
      2) 6% solution:
         - one 1-3/4” speedlay – four minutes  
         - two 1-3/4” speedlays – two minutes

   b. Five gallon AFFF containers:
      
      - 3% @ 125 gpm = approximately 60 seconds  
      - 6% @ 125 gpm = approximately 30 seconds

D. Foam replenishment:

   1. Emergency Re-supply: In case of a prolonged or large-scale incident, which will require emergency re-supply of foam, the initial IC shall request additional foam. Command and control shall use the following options to provide emergency foam to the incident:

      a. Tanker 7 is equipped with 30 gallons of foam concentrate and will be used as the primary re-supply point.
b. HazMat 2 is equipped with 100 gallons of foam concentrate.

E. Storage:

1. The RLFD currently specifies Angus Tridol 3%-6% AR-AFFF concentrate. One complete refill of Class B foam concentrate, corresponding to the tank

2. Class B foam concentrate has a shelf life in excess of ten years. However, personnel shall ensure that Class B foam concentrate is rotated to ensure that the use of outdated concentrate is eliminated.

3. All personnel are to review Material Safety Data Sheets (MSDS) for Angus Tridol 3%-6% concentrate to acquaint themselves with storage and handling instructions. The MSDS is located in the MSDS binder located on the apparatus floor or on-line at http://www.angusfire.com/Angus/Foam/How%20to%20Bu20foam.htm

8.00 MAINTENANCE: Class B foam systems, in-line portable eductors and appliances shall be maintained in accordance with (IAW) the applicable manufacture instructions. Class B foam systems and portable in-line eductors shall be operated on a quarterly basis as dictated in applicable apparatus inspection schedules.

9.00 TRAINING: RLFD members shall receive training annually or whenever new equipment is received. The following areas of instruction are recommended:

A. Classroom instruction on Class B foam methodology and implementation.

B. Practical training prior to actual fire responses.

C. Live fire training.

D. A review of standard operating procedure(s) of when and how Class B foam will be used.

E. Driver/Operator training in the operation and maintenance of the foam equipment.

F. Procedures for handling Class B foam concentrate to protect personnel, equipment, and the environment.

10.00 DOCUMENTATION: Officers shall ensure that the use of Class B foam is recorded by completing the applicable section of the FireHouse National Incident Fire Reporting System (NIFRS). In the event that an excess of ten gallons of class B foam concentrate is expended, the IC shall ensure that the Barron County Department of
Emergency Management Coordinator and the Wisconsin Department of Natural Resources (WI DNR) warden are notified.