EVALUATING THE NEED TO ADD A WATER BASED FIRE RETARDANT POLYMER GEL TO ORANGE COUNTY FIRE RESCUE DEPARTMENT'S ARSENAL FOR FIRE PROTECTION

EXECUTIVE ANALYSIS OF FIRE DEPARTMENT OPERATIONS IN EMERGENCY

MANAGEMENT

BY: Ken Burke
Orange County Fire Rescue Department
Winter Park, Florida

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ABSTRACT

Orange County Fire Rescue Department provides fire protection for unincorporated Orange County, Florida. A large percentage of this area is considered urban/wildland interface. In periods of drought, brush fires severely tax local firefighting resources. Currently, water based fire retardant polymer gels are available which can be applied to a structure and provide a temporary fireproof coating. These protective coatings can provide fire protection for structures using a minimal amount of water in the event that firefighters must evacuate. The problem is whether OCFRD should purchase a water based fire retardant polymer gel and the necessary delivery equipment for fire protection use.

Descriptive and evaluative research techniques were used to answer the following research questions:

1. What are water based fire retardant polymer gels and how are they used?
2. What are the characteristics of the different types of gels manufactured?
3. Do other eastern central Florida fire departments have water based fire retardant polymer gels available for use?
4. Have purchasers of fire retardant polymer gels found the decrease in fire loss to structures and vegetation to be justified by the cost?

The procedures used to complete this research included a literature review, personal interviews, an Internet search, a survey of fire departments using fire retardant gels in eastern central Florida, and a survey of purchasers of water based fire retardant polymer gels.

The results of this research indicate fire retardant gels are primarily composed of polymers, which are safe, non-toxic, and environmentally friendly. The application of these gels provides a temporary fireproof coating to vegetation or structures. The use of these gels reduces

the amount of water needed for exposure protection from fire. The primary use of these gels is a "last ditch" effort to save a structure from an impeding brush fire and crews must leave for their own safety. As a result, millions of dollars worth of property have been spared from destruction.

The recommendation of this research project is that OCFRD acquire enough fire retardant polymer gel and delivery equipment to equip at least one unit in each of the five battalions. An additional supply of the gel product should also be purchased to train all personnel engaged in firefighting operations.

TABLE OF CONTENTS

PAGE

ABSTRACT.....……... 2

TABLE OF CONTENTS.....……... 4

INTRODUCTION.....…….. 5

BACKGROUND AND SIGNIFICANCE.....……... 6

LITERATURE REVIEW.....……... 9

PROCEDURES.....……... 16

RESULTS.....……... 17

DISCUSSION.....……... 24

RECOMMENDATIONS.....……... 25

REFERENCES.....……... 27

APPENDIX.....……... 29

INTRODUCTION

Orange County Fire Rescue Department (OCFRD) provides fire protection and Emergency Medical Service to all of unincorporated Orange County, Florida. In addition, OCFRD has mutual aid and joint response agreements with most of the incorporated cities within Orange County and with adjacent counties. OCFRD also participates in the statewide disaster assistance plan.

During the 1998 Fourth of July weekend, a major firestorm roared through a Palm Coast, Florida neighborhood. The fire was moving so fast many residents had to evacuate with little warning leaving precious belongings and even a pet behind. Twenty homes were sprayed by firefighters with a new water based fire retardant polymer gel. When one of the homeowners returned, he was amazed to find his home and even the doghouse untouched by the blaze. In this particular case, the family dog had taken shelter in his doghouse and was spared as well. Of the 20 homes sprayed with the protective gel, all were spared from the firestorm (Perritano, 2000).

Several different manufacturers produce water based fire retardant polymer gels. These fire retardant polymer gels can be applied to a structure and provide a temporary fireproof coating. The problem is whether OCFRD should purchase a water based fire retardant polymer gel and the necessary delivery equipment for fire protection use. The purpose of this research paper is to evaluate if the use of water based fire retardant polymer gel is appropriate for use by OCFRD.

Descriptive research methods will be used to answer the following questions:

1. What are water based fire retardant polymer gels and how are they used?
2. What are the characteristics of the different types of gels manufactured?

3. Do other eastern central Florida fire departments have water based fire retardant polymer gels available for use?
4. Have purchasers of fire retardant polymer gels found the decrease in fire loss to structures and vegetation to be justified by the cost?

BACKGROUND AND SIGNIFICANCE

OCFRD was formed in October of 1981 by combining sixteen separate fire control districts. The department provides fire and Emergency Medical Service (EMS) to all of unincorporated Orange County, Florida. There are 33 operational stations and one flight operations hanger. Each shift staffs 33 engine companies, 24 Advance Life Support (ALS) rescues, five truck companies, two hazardous materials squads, an air and light truck, and an ALS transport helicopter. OCFRD also has six water tanker trucks and fourteen four-wheel drive brush trucks available, which are not staffed full-time, for response as needed. One-half of the 24 ALS rescues transport all patients to the hospital. The other half responds with private ambulances, which in turn transports patients to the hospital.

The town of Palm Coast, Florida was overwhelmed in 1985 by a firestorm, which swept through the community and destroyed 200 homes in its path. In 1989, Florida experienced a severe dry season. During that year, 7,291 wildfires burned over 645,000 acres of landscape (Word, 2002).

From 1990 through the present, Florida has experienced phenomenal growth in population. According to the U.S. Census Bureau, from 1990 until 2000, Florida's population has grown 23.5%. Most of the counties in central Florida have grown even faster than the overall state average. Flagler County's population has grown by 73.6%, Lake County by 38%,

and Orange County by 32.3%. In the year 2000, Orange County had 896,000 residents by the census bureau's count (U.S. Census Bureau, 2002).

From 1998 until early 2002, Florida was plagued with a long period of draught. Jim Karels, Fire Chief of the Florida Division of Forestry, said prolonged La Nina, an unusual cooling of ocean waters, brought dry conditions to Florida and active fire seasons in that four-year period (Wood, 2002).

In 1998, Central Florida experienced one of the worst brush fire seasons in history. By July 4, Flagler County had ordered all of its 35,000 residents to evacuate. Volusia and Brevard Counties had 50,000 people evacuated as well. The July 4th NASCAR race, scheduled at Daytona International Speedway, was postponed with evacuees and firefighters housed at its pavilion (Ryan, 1998). During the same brush fire season, 126 homes and 25 businesses were destroyed. An additional 211 homes and eight businesses were damaged. Almost 5,000 reported brush fires destroyed over 500,000 acres (Word, 2002).

In 1998, Orange County fire crews were in demand as well. During the Fourth of July weekend, wildfire forced the evacuation of 200 homes in the community of Christmas, Florida. Several major roads were closed, including 125 miles of Interstate 95, for 18 hours. Ash fell like snow and all of central Florida smelled of wood smoke. Between the brush fires and subsequent traffic tie-ups, all of Central Florida was affected (Tampa Tribune, 2002).

In the year 2000, brush fires raged through central Florida again. Fortunately this in this case, the fires were not as bad as those in 1998. One of the worst brush fires in central Florida was in an area known as Hunter's Creek in Orange County. That particular fire lasted for several weeks, requiring a major joint operation between the Florida Division of Forestry and OCFRD. Fortunately, no homes were destroyed (author's personal experience).

Orange County has a large percentage of area that is classified as urban/wildland interface. In periods of draught, brush fires severely tax local firefighting resources. A responsible fire department must consider new technology when responding to catastrophic events, especially when their resources can be overwhelmed.

This research relates to the United States Fire Administration *5-Year Operational Objectives* by meeting the goal "To appropriately respond in a timely manner to emergent issues." The fire service must be able to adapt and change to make use of new technology. As new technology is developed, the fire service will improve its ability to better serve the community.

This research also relates to the National Fire Academy course, Executive Analysis of Fire Service Operation in Emergency Management, as provided in the student manual. On page SM 6-4, in reference to capabilities and resources needed for Emergency Incident Management, it states:

> The shortage of particular resource critical to the outcome becomes the limiting factor in the suppression of the fire. The limiting factor must be supplemented or replaced in sufficient time to be effective at absorbing heat or the fuel is totally consumed.

When firefighting resources are overwhelmed, other measures must be taken or exposures will be consumed (EAFSOEM student manual).

LITERATURE REVIEW

What are water based fire retardant polymer gels and how are they used?

Fire retardant gels are made from super absorbent polymers. Polymers are chemical compounds that form long chains of molecules. Each link or molecule in the chain is referred to as a monomer. Polymers can occur either naturally or synthetically. Sodium polyacrylate, a super absorbent polymer, acts like a sponge soaking up to 800 times its weight in water (Pervitano, 2000).

Fire retardant polymers when mixed with water become a sticky gel through a process known as hydration. Basically, it becomes sticky water. During the hydration process, fire retardant polymers encase water droplets in a bubble-like shell. That shell is very sticky in the gel form (Peritano, 2000).

Tafreshi and Marzo (1999) in their research on comparing foam and gels as fire protection agents, indicate fire retardant polymers act as water thickeners during the gelling process. The action of fire proofing by the polymer gel is through thermal diffusion. The radiant heat is absorbed and converts the liquid water in the gel spheres to water vapor controlled by the "latent heat of vaporization". As that layer of gel is vaporized, the next layer absorbs heat and continues the protective process.

The hydrated gel sticks to almost any surface, which maybe exposed to fire. This unique thermal protection gel can be used to protect many types of structures including homes, businesses, and even fuel tanks. The gels can been used to provide firebreaks to protect almost anything. Florida Power and Light Company, one of the nation's largest power companies, credited one manufacturer of fire retardant gels, Barricade®, with saving more than 100 utility

poles in April of 1999. This hydrogel provides protection from radiant heat, flying embers, and flames (Hodgsen, 2000; Testa, 1999).

Fire retardant gels are applied by mixing a concentrate with water and then spraying on almost any object to protect it from fire spread. It is sprayed on and adheres; protecting almost any material from fire, even glass. Tests with the gel applied to glass increased the time until breakage. The gel can protect against flames for up to thirty hours. The coating of gel, however, remains active for several days depending on weather conditions. Wind, humidity, and other weather conditions affect the length of time the gel is effective (Perritano, 2000; Grand, 2000).

Water based fire retardant gels are supplied in two forms, liquid concentrate and powder. In the liquid concentrate form, the gel is applied using a special eductor, generally at the spray nozzle. The gel is applied from a concentrate mixed with water at a ratio of 2% to 6%. The gels appear to provide the best adherence to vertical surfaces at the 6% ratio, depending on the particular product used. Richard Rawls (personal communication, November 1, 2002), manufacturer representative for FireOut® Ice, states their product is produced in a powder form. It is generally batch mixed and can be sprayed from almost any size tank (Grand, 2000).

Once the threat of fire has passed, the hydrogels can simply be washed off with water. The gels are biodegradable and nontoxic. They break down into harmless substances and are safe for the environment (Perritano, 2000, Lowe, 2001).

What are the characteristics of the different types of gels manufactured?

There are several water based fire retardant gels available. They are available under the trademarked names of Barricade®, FireCape® FP47, FireOut® Ice, Nochar® E112, and Thermo-gel® 200L. The USDA Forest Service approves FireOut® Ice, FireCape® FP47, and Thermo-Gel® 200L for use. The Building and Fire Research Laboratory, an agency of the

National Institute for Standards and Technology (NIST), has conducted tests on Barricade® and Nochar® E112, resulting in positive results. Due to the differences in each brand of fire retardant polymer gels, the web site for each brand was used to obtain information about the respective product. Also, distributor representatives were contacted for costs and information not provided on the Internet sites (USDA Forest Service, 2002; Grand, 2000).

Of all of the gels listed, Barricade® is the most well known. Its primary active component is sodium polyacrylate. The idea for using sodium polyacrylate for fire protection came from a firefighter, John Bartlett, in Palm Beach County, Florida. In 1993, he noticed while extinguishing a trash fire that a soiled diaper remained unburned. As a result, he began to study the water absorbent materials in baby diapers. He found the water absorbent material in baby diapers is sodium polyacrylate. He then worked with several chemists to develop the water based fire retardant polymer gel given the product name of Barricade® (Vidreira, 1998).

Barricade® is advertised as nontoxic and environmentally friendly as it is completely biodegradable. The Material Safety Data Sheet (MSDS) indicates this gel has a pH of 6-8 at a 5 g/l concentration. The MSDS also suggests that it can be irritating to the eyes and skin, and therefore, advises gloves and eye protection use during application. However, the inventor John Bartlett routinely applies this gel to his hand and then places his hand in 3500 degree Fahrenheit flame to show the fire blocking characteristics of his product. This material is extremely slippery and caution should be used on hard surfaces, roofs, and ladders during and after the application (Barricade®, 2002).

Barricade® has been used all over America and Canada. The fire retardant gel was used at a Slave Lake paper mill in Canada. It was successfully applied to millions of dollars worth of lumber used for paper production as the fire approached saving the mill's entire inventory. The

gel was used during the summer of 1998 to save twenty homes in Flagler County and Putnam County in Florida. Large quantities of the gel were used in Montana's Bitter Root Valley wildfires in the year 2000. As a result of the extensive use of Barricade® in the western states, the three largest wildfire private contractors include fire gel technology as part of each engine's inventory (Lowe, 2001).

Barricade® can be purchased directly from the manufacturer or through a supplier. Bruce Hill (personal communication, November 1, 2002), a representative for Barricade®, states that the company sells both a homeowner and fire department application system. The gel itself sells for $150 per five gallons. The QuikAtak™ 15 gpm nozzle is sold for $499. The average home can be coated with five to ten gallons of concentrate. Excluding the nozzle, the average home can be protected for under $300. Barricade® is warranted to have a shelf-life of five years.

Stockhausen, Inc., a chemical company based in Germany, manufactures FireCape® FP47, with Fire Control and Thermo Technologies as the two of main U.S. distributors. The active ingredient in FireCape® FP47 is sodium polyacrylate. According to the MSDS the gel is environmentally safe, however, it may cause adverse long-term effects to aquatic life. The pH for FireCape® FP47 is about 7 at 27.5 g/l. Chad Nelson (personal communication, December 11, 2002), representative for Thermo Technologies, routinely drinks this gel to show his customers that FireCape® FP47 is nontoxic. Gloves and eye protection are recommended during application. As with all of the gels, FireCape®FP47 is extremely slippery (Fire Control, 2002).

FireCape® is fairly new to America and its use is not well documented. However, San Diego Fire Department has conducted tests using FireCape® FP47. Fire Chief Jeff Bowman is quoted as stating, "This product allows us to put it on a house that is near impingement, that

hasn't been ignited yet, in hopes of keeping it from igniting." (San Diego News 10 Troubleshooter, 2002)

FireCape® FP47 is sold in a gel concentrate for $319 per 5-gallon container. The various gel educting nozzles for this product range in price up to $750. FireCape® FP47 is approved for use by the US Forest Service at a two percent to water ratio (USDA Forest Service, 2002; Fire Control, 2002, Nelson, 2002).

FireOut® Ice is produced by FireOut Enterprises in Reston, Virginia. This gel is supplied to the user in a powder form and is generally batch mixed. According to company representative Rawls (2002), it can be mixed in a tank of normal firefighting apparatus and applied through standard firefighting hoses and appliances. The product is ecologically friendly and nontoxic.

FireOut® Ice's primary ingredient is potassium polyacrylate. According to the MSDS for the product, protective equipment should be used when mixing the powder with water to reduce contact with the eyes or inhaling the material. Also, when applying the gel, skin and eye protection should be used (USDA Forest Service, 2002).

FireOut® Ice was used in March 2002 by the Virginia Department of Transportation. The gel was sprayed along the Blue Ridge Parkway to establish a fire line as part of the defense to battle the Buck Mountain brush fire. The delivery equipment used was a seed spreading truck. The fire line provided protection for fifteen homes threatened by the brush fire (O'Brien, 2002).

Finn Corporation and FireOut Enterprises have combined technological efforts. The Finn Corporation builds a HydroSeeder, which is a planting machine that blows a layer of water, seed, fertilizer, and mulch over an area that requires reseeding. These two companies have invented a machine called a Fire Fin-nisher, which can be used to spray FireOut® Ice to establish a

firebreak or extinguish brush. The machine can then be reconfigured to replant the burned area (Paeth, 2002).

FireOut® Ice is sold by the pound. Rawls (2002) stated that current rate is about $160 for 24 pounds, which can treat 600 gallons of water. This concentration would be for a gel fire line or as an additive for fire extinguishments. A stronger concentration would be required for a structural protective gel. FireOut® Ice Enterprises also markets a gel delivery system and storage tank which holds 3,350 gallons of water/gel for about $60,000, plus the chassis.

Nochar®, Inc. of Indianapolis, Indiana manufactures Nochar® E112. The MSDS supplied for this gel lists it as non-corrosive and non-toxic. The gel, supplied in a liquid concentrate, can be educted at the nozzle or batch mixed in a fire apparatus supply tank. Once the gel is batch mixed, it can be applied with standard fire hose and nozzles (Nochar®, 2002).

Nochar® E112 fire protective gel's primary ingredient is listed as a trade secret. The E112 product also contains mineral oil and other additives. The MSDS recommends the use of gloves and eye protection during application. This gel is also very slippery. Clean up of the gel is accomplished with water rinsing. Water with baking soda added improves the efficiency of cleanup (Nochar®, 2002).

A published study by Omega Point Laboratories sponsored by the National Institute for Standards and Technology (NIST) reported favorable results in testing Nochar® E112 fire retardant gel. The report indicated the application of this gel extended ignition times for fire exposure by ten to fifteen times that of untreated wood siding. The test included a drying time of two hours prior to exposure to flame. The fire protective gel was also found to be effective in prolonging the period of time until windows cracked or broke (Grand, 2000).

Nochar® E112 is distributed through fire service suppliers. Christopher James (personal communication, November 1, 2002), a sales representative for Wildfire Pacific, provided sales information about Nochar® E112. Wildfire Pacific sells the gel concentrate for $137.95 per 5-gallon container. They also sell several different nozzle eductor systems for up to $750.

Hydrofire Inc. distributes the product Thermo-Gel® 200L. Thermo-Gel® 200L is also manufactured by Stockhausen. The main ingredient in this gel is potassium polyacrylate. Thermo-Gel® 200L was one of the first fire protective gels to be approved by the U.S. Forestry Service in May 1998. This gel is supplied as a powder and is batch mixed. The product is advertised as non- toxic, non-corrosive, and environmentally friendly. It cleans up with water and is broken down by ultraviolet light after it dries (Hydrofire, 2002).

Since Thermo-Gel® 200L is supplied as a powder, respiratory, eye, and skin protection should be used during mixing with water. Eye and skin protection should be used during application. It can be applied with standard firefighting hoses and nozzles in medium concentrations. Cleanup of gelled structures and equipment is accomplished simply by flushing with water (Hydrofire, 2002).

Duran McDaniel (personal communication, December 9, 2002), a representative of Hydrofire and distributor for Thermo-Gel® 200L, explained that hard water reduces the effectiveness of this gel. Clean up is accomplished using water, however, household bleach can assist in its removal. He recommends the mixture of powder to water should be 800 gallons of water to a 5-gallon container of powder. Each 5-gallon container sells for about $150. The gel can be applied through standard fire nozzles and hoses.

PROCEDURES

Descriptive and evaluative research methodology was used to obtain information on water based fire retardant polymer gels. This included their chemical configuration, history of development, analytic testing, and current use. Information was also derived as to their ecological impact and costs associated with use. Research included a literary review of trade journals, news releases, and independent laboratory testing results. Interviews were conducted with representatives from the various manufacturers of the fire retardant gels and individuals with experience using fire retardant gels. Internet web sites were also used to provide documentation and performance characteristics for each brand.

An extensive Internet search provided web sites for each marketed and manufactured fire retardant gel. Each manufacturer was contacted to obtain additional information not published or included on their web site. Information such as technical information on application, safety concerns, MSDS documentation, and costs were obtained in this manner.

A survey of fire departments in eastern central Florida was conducted to determine the use of fire retardant gels (Appendix A). The membership list from the Florida Fire Chief's Association was used to obtain contact information. The survey included Flagler, Orange, Seminole, and Volusia Counties. The local office for the Division of Forestry for Florida was surveyed as well. The list of departments surveyed is listed in Appendix C.

A second survey was taken of purchasers of fire retardant gels. The list of purchasers was developed from media releases of gel use, Internet advertisements, and the marketers of the fire retardant gels. The survey of fire departments in the eastern Central Florida using fire retardant gels also added to the list of purchases of fire retardant gels. As a result of conducting the survey via the telephone, information was developed and interviews were conducted.

Assumptions and Limitations

Due to the relatively new use of water based fire retardant polymer gels, there is limited documentation on their use, especially by urban/suburban fire departments. Independent laboratory testing of these gels is ongoing and more research is expected.

The MSDS for each gel was used to provide data on the safety and environmental impact of each product. This and other characteristic information about each brand of fire retardant gel was provided by the marketer or the manufacturer and assumed to be accurate and unbiased. The prices given for each gel product do not include shipping costs.

In the interest of time, both surveys were conducted by phone. Information developed from the survey of fire departments using fire retardant gels provided information necessary for the completion of the survey of purchasers of fire retardant gels. Most of the manufacturers and marketers of the different fire retardant gels were very reluctant to provide the names of their customers. This factor limited the number of purchasers that could be surveyed. Other manufacturers of fire retardant gels may exist but information was not developed on their existence.

RESULTS

1. What are the different water based polymer gels and how are they used?

Fire retardant gels are made from super absorbent polymers, which can absorb as much as several hundred times their weight in water. During the hydration process, the polymers encase water droplets in a bubble-like shell. The hydrated polymer turns into a sticky gel (Peritano, 2002).

Tafreshi and Marzo (1999) indicate in their research the water absorbent polymers act as water thickeners in the gelling process. The action of fire proofing by the gel, when applied to a

surface exposed to heat or flame, displays the property of thermal diffusion. Radiant heat is absorbed on the gel surface until vaporization of the gel occurs.

Fire retardant gels stick to almost anything, including glass, which allows the gels to be used to protect almost any material. They have been used to protect vegetation, homes, businesses, fuel tanks, and power poles. The hydrogel provides protection from radiant heat, flames, and flying embers (Hodgsen, 2000; Testa 1999).

Water based fire retardant gels are supplied in two forms, liquid concentrate and powder. The mixed gel is applied to an object and the protective coating can last up to thirty hours depending on the weather. The coating is active for several days and can be re-hydrated with a mist of water according to Rawls (2002). The gel concentrate is applied using an eductor at the nozzle of a water line and sprayed on the exposure. The water/concentrate can be adjusted at the nozzle. The powder form of gel can be batch mixed in almost any size tank and applied through standard fire fighting nozzles (Perritano, 2000; Grand, 2000; Lowe 2001).

Once the threat of fire has passed the fire retardant gel can be washed off with water. The gel is biodegradable and nontoxic. The gels decompose into harmless materials and are environmentally safe (Perritano, 2000; Lowe 2001).

2. <u>What are the characteristics of the different gels manufactured</u>?

Information was developed on five manufacturers of water based fire retardant gel products. They include Barricade®, FireCape® FP47, FireOut® Ice, NoChar® E112, and Thermo-Gel® 200L. The USDA Forest service has approved FireCape® FP47, FireOut® Ice and Thermo-Gel® for use on Federal land. Barricade® and NoChar® E112 have been tested at the direction of the National Institute of Standards and Technology (Grand, 2000; USDA Forest Service, 2002).

The best-known fire retardant polymer gel is Barricade®. John Bartlett, a West Palm Beach firefighter, developed this gel. Its main ingredient is sodium polyacrylate. The MSDS sheet for the product suggests using gloves and eye protection, as it can be irritating to the eyes and skin. It is advertised as nontoxic and environmentally friendly (Vidreira, 1998).

Ken Moore (personal communication, December 6, 2002), former Chief of Canaveral Space Port Fire Rescue, relayed that Barricade® was used during the 2000 drought at the Space Port. The gel was used to protect the vegetation surrounding the launch pads of rockets. A delay in rocket launches would have cost the National Aeronautical and Space Administration (NASA) millions of dollars. The U.S. Fish and Wildlife Commission approved this fire retardant gel for use on NASA property.

Barricade® has been used all over America and Canada. It was used to protect the Slave Lake Lumber Yard in Canada saving millions of dollars worth of lumber. Twenty homes were saved by its use in Flagler County during Florida's 1998 brush fires, and it is used by three of the largest private firefighting contractors in the western U.S. (Lowe, 2001).

Barricade® is a gel concentrate and can be purchased directly from the manufacturer or through a supplier. The product sells for $150 per 5-gallon container and an eductor/nozzle for $499. Excluding the nozzle, the average home can be fire-proofed for under $300 (Hill, 2002).

Stockhausen, Inc. manufactures FireCape® FP47 with Fire Control as one of its main U.S. distributors. The MSDS for the product lists it as environmentally safe but recommends the use of glove and eye protection during application. It is supplied as a gel concentrate (Fire Control, 2002)

Battalion Chief Gerry Brewster (personal communication, December 9, 2002), of the San Diego Fire Department, stated FireCape® FP47 use was one tactic that helped his strike team

save 30 to 40 homes last summer. The gel was also used to provide fire protection for fuel tanks. Facing an incredible volume of fire, he and his team were disappointed at the loss of one home, which had been sprayed with gel. Firebrands were blown under the house where there was a breach in the foundation and ignited the fire from the inside.

FireCape® FP47 is sold for $319 for a 5-gallon container and various eductor nozzles range in price up to $750. Its recommended use by the U.S. Forest Service is at a 2% ratio of gel to water (USDA Forest Service, 2002; Fire Control, 2002; Nelson, 2002).

The product FireOut® Ice is produced by FireOut Enterprises. This product is supplied in powder form and is batch mixed for application. The product is ecologically friendly, nontoxic, and can be applied with standard fire fighting hoses and nozzles. According to the MSDS for the gel, protective eye and respiratory equipment should be used during mixing, and gloves and eye protection during application (Rawls, 2002; USDA Forest Service, 2002).

FireOut® Ice was used on the Buck Mountain brush fire in March of 2002 and applied using a seed spreading truck to establish a fire line along the Blue Ridge Parkway. The fire line provided fire protection for fifteen homes threatened by the brush fire. The Finn Corporation, a builder of water/seed applicators, is teaming up with FireOut Enterprises to produce a machine that can apply fire retardant gel and reseed after the fire (Paeth, 2002; O'Brien, 2002).

FireOut® Ice sells for about $160 for 24 pounds, which is enough to treat 600 gallons of water for fire line use. A stronger concentration is necessary for structural protection. FireOut Enterprises markets a gel delivery system, which holds 3,350 gallons of gel and sells for $60,000 plus chassis (Rawls, 2002).

Nochar® E112 is another fire retardant gel that is supplied as a gel concentrate. The gel can be educted at the nozzle or batch mixed and applied through standard fire nozzles and hose. The

MSDS for this product lists it as non-corrosive and non-toxic but recommends gloves and eye protection during application. Water is used for cleanup and baking soda added to the water increases the efficiency of the process (Nochar®, 2002; Grand, 2002).

A published study, conducted for the NIST, found that this gel provided ten to fifteen times the fire resistance for a treated structure versus and untreated structure. The gel also increased the time until glass breakage when exposed to fire (Grand, 2002).

Nochar® E112 is distributed for about $140 per 5-gallon container. There are several types of application nozzles, which sell for up to $750 through different distributors (James, 2002).

Stockhausen, Inc., also produces Thermo-Gel® 200L. Thermo-Gel® 200L was one of the first fire retardant gels approved by the U.S. Forest Service. The product is advertised as non-toxic, environmentally safe, and non-corrosive. This gel is supplied as a powder, is batch mixed, and cleans up with water. The addition of household bleach to the cleanup water makes the process more efficient. Since it is supplied as a powder, respiratory and eye protection are recommended during mixing. Gloves and eye protection are needed during application (Hydrofire, 2002; McDaniel, 2002; Nelson, 2002).

This gel is supplied in 5-gallon containers of powder, which sell for about $150. The gel is applied through standard firefighting hoses and nozzles. A 5-gallon container is mixed with 800 gallons water to produce the fire retardant gel (McDaniel, 2002).

3. <u>Do other eastern central Florida fire departments have water based fire retardant polymer gels available for use</u>?

Since the survey (Appendix A) of was accomplished by phone, a 100% response level was achieved. Of the 30 departments (Appendix C) surveyed, 22 (77%) answered question 1 that they were aware of fire retardant polymer gels, while 8 (23%) had no knowledge of this

technology. As a result, only 20 (66%) of the departments had considered purchasing this technology and the other 10 (33%) had not.

Seventeen agencies responded to question 3 with reasons that a fire retardant gel was not purchased. Multiple answers were sometimes provided. The most common reason given by 11 (65%) of the 17 agencies was that their response area had insufficient urban/wildland interface. The next most common reason was expense so answered by 8 (47%) of the 17 agencies. Shelf-life and insufficient information about the product did not seem to be a factor receiving no responses. Under the Other category, five reasons for not purchasing the gel were provided. These included: Products damaged paint or siding, the products are still under consideration, the department uses Compressed Air Foam, the department does not perform brush firefighting, and finally, one individual could not recall the reason fire retardant gel was not purchased.

In response to question 4, of the 30 firefighting agencies contacted in the surveyed area, only 4 (13%) had a fire retardant gel in their department's inventory for use. The Florida Division of Forestry and three fire departments had the fire retardant gel available for use.

4. <u>Have purchasers of fire retardant polymer gels found the decrease in fire loss to structures and vegetation to be justified by the cost</u>?

The survey of Purchasers of Fire Retardant Gels (Appendix B) was completed by phone and a 100% response was achieved. Thirteen organizations (Appendix D) were contacted. These included eight fire departments (three from Central Florida), two forestry divisions, two private firefighting companies, and one electric power utility company.

In response to question 1, it was determined that Barricade® is the most commonly purchased gel by ten (77%) of 13 organizations. FireOut® Ice had been used by two (15%)organizations and FireCape® E112 was preferred by one (8%) organization.

In question 2, 11 (85%) of the responding organizations had used fire retardant gels under actual fire conditions with two (15%) having never used the gel technology. Question three addressed an estimate of structures saved by using a fire retardant gel. The totals for this question included 87 homes, 100 utility power poles, and 1 utility building. This does not include keeping at least one rocket launch by NASA on time during drought conditions at Cape Canaveral.

Question 4 asked if an organization had used fire retardant gel for fire line use. Three (23%) organizations confirmed use for fire lines. Question 5 asked why they had not used gels for fire lines. Of the ten (77%) that had never used fire retardant gel for brush fire lines or breaks, eight (80%) cited expense, one (10%) felt the use of the gel did not apply to them, and one (10%) had not had an occasion to use the gel.

Question 6 addressed the issue of any problems using fire retardant gels. Four (31%) organizations indicated that they did not have any problems using the gels. Two (15%) organizations complained that the gels were very sticky and slippery. Two (15%) fire departments had problems cleaning application equipment, commenting that it was time consuming. One (8%) respondent had problems fine-tuning the mix of water and concentrate. Another advised of problems cleaning the gel off an applied structure. One fire department had problems with the eductor, however, the manufacturer worked with them to correct the problem. Another complained of having to use a special nozzle/eductor. And finally, one felt the application to a home was too time consuming (25 to 30 minutes).

Question 7 queries if organizations that have purchased fire retardant gels would recommend their use to other agencies and all responded yes (100%). Question 8 received a 100% reply of yes when asked if the cost of the gel was justified.

DISCUSSION

Water based fire retardant polymer gels have been used by the fire service for almost five years. These fire retardant gels provide a means to apply thickened water to a structure or vegetation, reducing the required water and personnel resources. The primary use of these gels is a "last ditch" effort to save a structure from an impeding brush fire when crews must leave for their own safety. The gel absorbs radiant heat and as long as burning embers or debris do not enter the structure, it is protected as was recalled by Battalion Chief Brewster of the San Diego Fire Department (Brewster, 2002; Pervitano, 2002; Tafreshi and Marzo, 1999).

Tests with fire retardant gels have shown that the ignition time for a treated structure is delayed ten to fifteen times to that of an untreated structure. This is confirmed by the many homes that have been found standing after a catastrophic brush fire has completely surrounded them, burning everything but the home (Grand, 2000; Lowe 2001).

Tests by the U.S. Forest Service have authorized the use of three of the gels indicating a minimal impact on the environment. The MSDS for all of the fire retardant gels list them as non-toxic and safe for use. Organizations contacted that have used these gels confirm this as well. The Federal Fish and Game Commission authorized the use of a gel that was not on the U.S. Forest Service's list at Cape Canaveral. The environment did not appear to have been impacted except to preserve it from the heat from a rocket launch (U.S. Forest Service, 2002; Barricade®, 2002; Fire Control, 2002; Nochar®, 2002; Hydrofire, 2002; Moore, 2002).

Water is used primarily to clean equipment and structures after gel use or application. The greatest concern voiced by almost all interviewed and in the Manufacturer's provided information is that these gels are extremely slippery creating a problem during application and cleanup. The survey confirmed every organization using the fire retardant gels recommended

their use and felt the cost was more than justified (Barricade®, 2002; Fire Control, 2002;USDA, 2002; Rawls, 2002; Nochar®, 2002; Hydrofire, 2002).

A cost comparison between the different manufactured fire retardant gels is difficult to accomplish since three of the gels are supplied in gel concentrate and two in powder form. In addition, the recommended gel concentrate application ratio of gel concentrate to water ranges from 2% to 6%. The NIST by Grand (2002) indicated a 6% ratio was required to accomplish a temporary fireproof coating. The U.S. Forest Service indicates their required ratio of gel concentrate to water as 0.4% to 2% for the one gel concentrate product on their approval list. The U.S.Forest Service table does not indicate whether the use is for vegetation or structural protection (Barricade®, 2002; Fire Control, 2002; FireOut® Ice, 2002; Grand, 2002; Nochar®, 2002; Hydrofire, 2002; USDA Forest Service, 2002).

All of the problems and issues raised about the use of water based fire retardant polymer gels, including cost; do not appear to over-ride the benefit of their use. Millions of dollars worth of property has been protected from fire by the use of gel technology, and the overwhelming benefit is the relief and happiness a family receives when everything around them is burned yet they still have a home. The public relations benefit of these products is immeasurable.

RECOMMENDATIONS

The research shows that water based fire retardant polymer gels perform extremely well. Tests have shown outstanding results in exposure protection. These gels can be applied and left to do the job of exposure protection for 12 to 24 hours, depending on the weather, without additional attention. In situations when a site is about to be overrun by a brushfire and crews have to leave for their own safety, “gelling” a structure has proven to be very successful. The

products are environmentally safe, safe for personnel to use, and can be applied easily. The use of these gels is cost effective and the public relations benefit of saving a home is immeasurable.

This technology can also be used under other circumstances as well. When the resources of personnel and water are in short supply, these gels may be applied for exposure protection for a normal structure fire. In today's world, limits on the use of a product by fire service personnel are only limited by their imagination. With terrorism being a true threat to America, there very easily could be a situation whereby fire crews must consider abandoning firefighting operations due to a chemical, biological, or radioactive threat. Using gel technology can protect exposures when fire crews' attention is required elsewhere.

As the fire service becomes more global, fire personnel need to be aware of as much technology as possible. Central Florida continues to grow and with mutual aid agreements and as an active participant in the statewide disaster plan, personnel could be deployed almost anywhere. It is this writer's recommendation that OCFRD purchase enough fire retardant gel and the necessary delivery equipment for use on five of its units. This would provide each of the five battalions in OCFRD at least one unit that can be deployed to use gel technology. Enough of the product will need to be purchased for use as well as for training of personnel.

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APPENDIX A

Survey of Water Based Fire Retardant Polymer Gels Used by Fire Departments in the Eastern Central Florida Area

Name of Organization _____

Name of Contact_____

Phone or Means of Contact_____

1. **Is your Department familiar with the use of water based fire retardant polymer gels?**

   ☐ Yes ☐ No

2. **Has your Department ever considered the purchase of fire retardant gels and their delivery equipment?**

   ☐ Yes ☐ No

(If this question is answered no, the rest of the survey does not need to completed)

3. **If your department considered the purchase of fire retardant gels and their delivery equipment and did not buy it, explain why?**

   ☐ Expense

   ☐ Shelf life of product

   ☐ Insufficient urban/wildland interface in response area to justify use

   ☐ Not enough information available on the product

   ☐ Other/Explain_____

   _____

   _____

4. **Does your Department have a fire retardant polymer gel and its delivery equipment?**

   ☐ Yes ☐ No

(If this question is answered yes, complete survey on Purchasers of Water Based Fire Retardant Polymer Gels.)

APPENDIX B

Survey of Purchasers of Water Based Fire Retardant Polymer Gels

Name of Organization_____

Name of Representative_____

Phone or Means of Contact_____

1. **What brand of water based fire retardant gel do your organization use?**

   ☐ Barricade® ☐ Firecape® FP-47

   ☐ Fireout® Ice ☐ NoChar® E112

   ☐ Thermo-gel®200L ☐ Other

2. **Has your organization used a fire retardant gel under actual fire conditions?**

   ☐ Yes ☐ No

3. **Estimate how many structures have been saved by your use of fire retardant gel?**_____

4. **Has or would your organization ever use fire retardant gel for a fire line or break?**

   ☐Yes ☐ No

5. **If not, why?**_____

6. **Did you experience any problems with the use of the gel.**_____

   _____

   _____

7. **Would you recommend the use of water based fire retardant gels to other agencies or organizations?** ☐ Yes ☐ No

8. **Did your organizations feel the cost of the fire retardant gel and its delivery equipment justified the expense?** ☐ Yes ☐ No

APPENDIX C

List of Eastern Central Florida Fire Departments Surveyed

For the Use of Fire Retardant Gel

Flagler County

Flagler Beach Fire Department
Flagler County Emergency Services
Palm Coast Fire Rescue Department

Orange County

Apopka Fire Department
Greater Orlando Aviation Authority
Maitland Fire Department
Ocoee Fire Department
Orlando Fire Department
Reedy Creek Emergency Services
Winter Garden Fire Department
Winter Park Fire Department

Seminole County

Casselberry Fire Department
Lake Mary Fire Department
Longwood Fire Department
Orlando Sanford International Airport Fire Rescue
Oviedo Fire Rescue Department
Sanford Fire Department
Seminole County EMS Fire Rescue Department

Volusia County

Daytona Beach Fire Department
Deland Fire Department
Deltona Fire-Rescue Department
Holly Hill Public Safety-Police and Fire
New Smyrna Beach Fire Department
Orange City Fire Department
Ormond Beach Fire Department
Ponce Inlet Fire Department
Port Orange Fire Rescue Department
South Daytona Fire Rescue Department
Volusia County Fire Services

Florida Division of Forestry

Appendix D

List of Organizations Contacted as Purchasers of Fire Retardant Gels

Fire Departments

Cape Canaveral Space Port Fire Rescue – Florida
Flagler Beach Fire Department - Florida
Flagler County Emergency Services - Florida
Martin County Fire - Florida
Oviedo Fire Department - Florida
Roanoak Fire Department - Virginia
Rockerville Volunteer Fire Department – South Dakota
San Diego Fire Department – California

Private Fire Fighting Corporations

North Tree International
Bridger Fire

Forestry Departments

Florida Division of Forestry
Virginia Department of Forestry

Utility Companies

Florida Power and Light