Water Enhancing Products
for
Aerial Firefighting Tactical Support

Ground Based Blender Operations

Objective: To have locally available state-of-the-art water-enhancing gel blending equipment that can be rapidly deployed to meet the logistical challenges of Helicopters and SEATs for Initial Attack, Extended Attack and Large Fire Support.

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Introduction

*"Of the millions of gallons of suppressant/retardant dropped from aircraft each year, approximately 85% is straight water dropped from water scooping aircraft and helicopters leaving only 15% as retardants. The delivery methods of water …… …… remain unchanged." **

*U.S. Forest Service Quadrennial Fire Review 2009

Aviation resources are critically important to wildland fire suppression operations because they can be deployed rapidly and can fulfill a variety of critical mission requirements, some of which are unique to aircraft. Delivery of suppressants with aircraft is an essential tool for fire managers. The rapid response that aircraft offer results in suppression actions being applied when fires are small and when suppression actions are most effective. These actions result in smaller fires and increased probability of containment during initial attack or early stages of fire spread.

Since the early 1930s, research has been directed towards improving the effectiveness of water as a forest fire extinguishing agent. Over the years, various chemical substances have been added to water to improve its effectiveness in fighting fires. The use of aircraft for the delivery of fire suppressants was a significant advancement in firefighting and the introduction of SEATs (Single Engine Airtankers) and helicopters with external buckets or fixed tanks was a major step in quick response and the direct attack tactics used for combating wildfires.

Helicopters and SEATs provide speed of delivery and capabilities in terms of firefighting capacity and flexibility that cannot be matched by ground suppression resources and they offer an exceptional ability to deliver payloads with minimal drift and evaporation losses. They excel in close-quarters tactical support of ground-based equipment and fire crews where accuracy, quick turn-around times between drops and unrestricted access to the terrain are critical. Together, they account for nearly 85% of all gallons of suppressant dropped from aircraft on wildland fires, with plain water by far being the most common payload.

The Fire Chemicals Challenge

Fire chemicals are available in three different product families that result in different effects on the water payload.

Salts contained in Long-Term Retardants (LTRs) offer a modest reduction in fire intensity, but only after the water is fully evaporated. Until then, the water contained in LTRs is the active fire modifier and the retardants do nothing different and offer no greater effectiveness than plain water.

Class A Foams reduce the surface tension of water and improve penetration properties, which makes Foams adaptable for use in very deep-seated duff fires or fires established

in large piles of dried vegetation (for instance, hay bales).

The third family of fire chemicals is Water Enhancers. They typically do one of two things; trap water in solid forms much like a sponge, or bind with water molecules creating a viscous, thickened fluid with much greater internal cohesion and external adhesion properties than plain water or foams. These properties result in greater film thicknesses in wildland vegetation, which can significantly increase the amount of suppressant held in the fuel bed or on vertical fuels, and extend the time the water enhancer remains effective due to reduced time dependent evaporation losses.

Gel and Long Term Retardant Effectiveness

Nearly all drops from helicopters and SEATs are made along or very near the fire's edge using direct attack techniques. The effect on the fire in direct attack, regardless of whether suppressants or long-term retardants are used, is from the water in the payload. The statement by the US Forest Service,

> ***"Long-term retardants are only marginally more effective than plain water in direct attack…and may be the least desirable alternative due to cost,"***

emphasizes this point. Consequently, it is very difficult to justify the use and expense of long-term retardants in any direct attack because they perform only marginally better than plain water, have steep environmental penalties and their costs are considerably higher than other payload options.

As Forest Service Chief Tom Tidwell's testimony before the Senate Energy and Natural Resources Committee stated,

> ***"The long term products have a limited utility and do not achieve the results many within the Forest Service have been lead to expect."***

The time to combustion recovery, the re-emergence of the flaming phase from the smoldering phase after knockdown, is extended by having water remaining in place throughout the fuel bed. On one hand, high viscosity (the resistance of a fluid to flow) products like long-term retardants can lack the ability to penetrate many fuels. On the other hand, low viscosity agents like foam and water, can quickly run through the fuel and be absorbed into the soil, creating little follow-on effect in maintaining moisture levels, which aid in holding down subsequent combustion recovery.

Firewall II™, a water enhancing gel, has several advantages over plain water. It can initially hold in suspension between two to four times the typical amounts of water in fuels, allowing greater success in knocking down high intensity fire perimeters. The thicker water films persist longer under heat attack or evaporation than the much thinner films created by plain water or foam. In live fuels with shiny or waxy surfaces, this film forming effect is particularly noticeable. On angled foliage, Firewall II™ forms a thick,

sticky film rather than beading up and running off.

The persistence associated with greater film thickness provides a greater time for either heat dissipation from fuel particles that ends combustion or the burnout of smoldering particles as it increases the hold down period. Firewall II™ creates a water rich environment that prevents spread and the transition back into the flaming phase.

In gauging direct attack knockdown effectiveness and flaming recovery minimization, the distance that flames advance in short timeframes is crucial. Drops that suppress active flaming stop the high-energy output from already involved fuels. Preventing the spread to un-ignited fuels, inches or feet in front of the flaming perimeter, produces a dominant negative feedback loop. Without the new energy provided by the expansion into new fuels, the heat intensity necessary to cause ignition is lost and spread thwarted. The flaming phase of the fire stops but the potential for leaving smoldering remnants that have not been fully extinguished by an initial attack still exists.

Testing has shown that Firewall II™ is initially retained on fuels at many times the rate of water or foam in direct attack. In addition to its greater film thickness playing a role in knockdown, it also provides an immediate water rich environment for an extended time. This extended water presence creates a thermal mass, or heat sink, that allows many more of the embers to extinguish through energy dissipation to either the surroundings, or burn out without reaching the flaming phase or igniting adjacent fuel particles.

Firewall II™ is not a one-size-fits-all product like LTRs, foams or water. Its liquid composition allows it to be instantly blended with any water source throughout a range of viscosities to match existing fuel characteristics, such as the need to penetrate canopies and litters, while retaining more moisture in the fuel cross section.

The Punch

The Punch is the extra amount of water that Firewall II™ can place and hold on the flaming fire perimeter and adjacent fuels. It can absorb and overcome levels of heat attack that water and foam cannot. With more than 95% of wildland fires fought in the direct attack mode, Firewall II™ offers increased certainty of knockdown from a single application and can directly take on greater fire intensities not possible with water or foam. With its capability to retain effective levels of moisture for a longer time in fuels, combined with fewer losses due to evaporation and drift, Firewall II™ can accommodate drop location error that water and foam cannot.

Figure 1, below, depicts comparison data for an independent test, using a one-hour dead fuel analog, as an example of what could be encountered under typical California wildfire conditions (99 °F, 19% RH, full afternoon sun). It is important to note two critical features when evaluating the chart data:

- Moisture of Extinction (MOE) – moisture level above which fuel will not ignite
- Product retained in the fuel during the early stages of the treatment cycle

All three Firewall II™ blending ratio compositions maintained moisture levels above MOE from the time of initial application for up to 10 minutes for 0.5% and for up to 17 minutes for 1.5%.

These are the most critical times for direct attack, when suppressants are dropped on the edge of (or slightly into) the advancing flame front. At no time did either plain water or the foam mixture exceed the MOE level. Tests under similar conditions, using other fuels, differ slightly but provide the same comparative results.

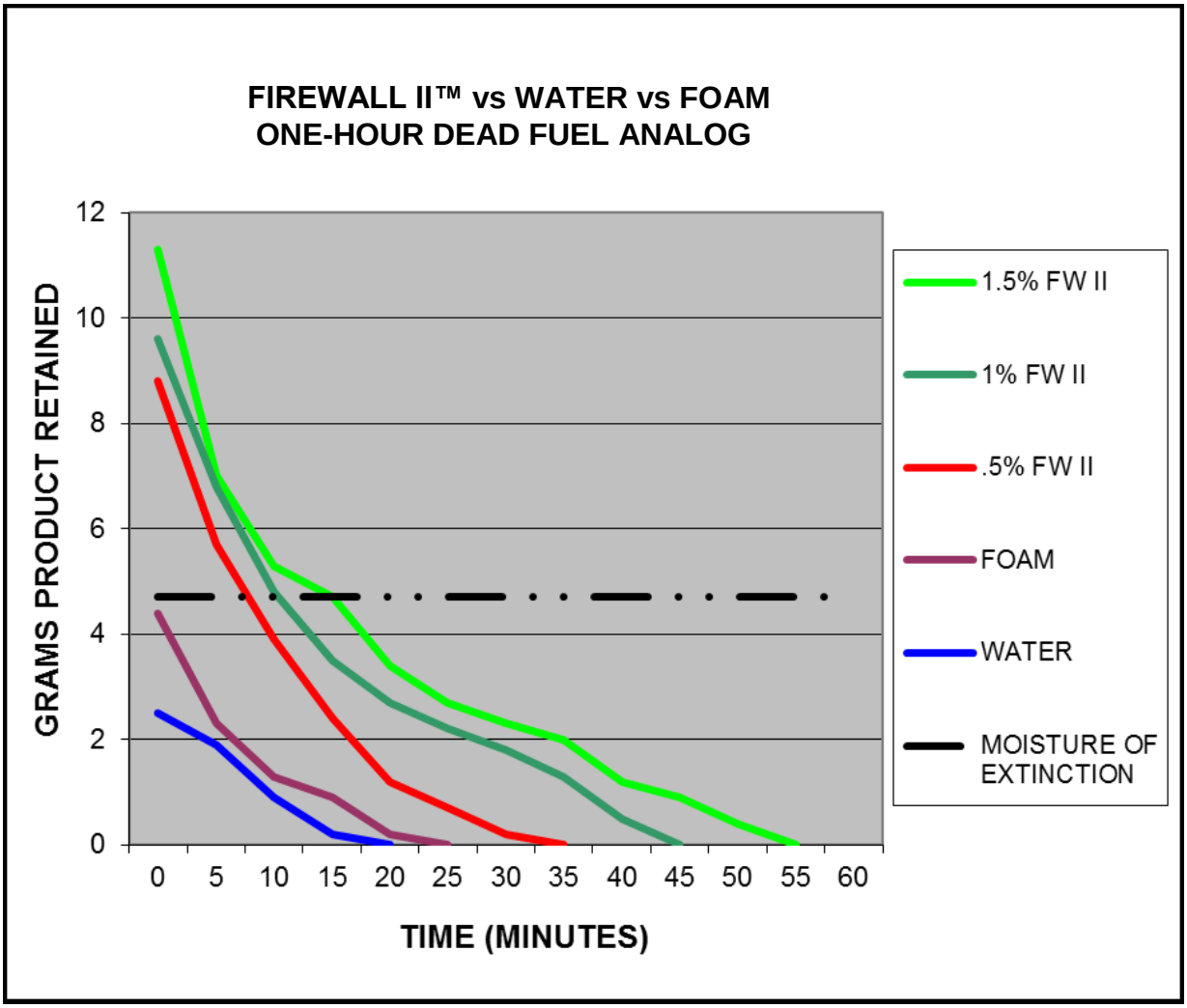

Figure 1

Blending with Hard Water

The advantage of helicopters is their ability to operate using nearby water sources to minimize flight time and turnaround times and maximize the amount of water capable of being applied in direct attack.

Until now, there has not been a product that could blend in hard waters without requiring an increase in the dosing rate (blended ratio of mixed product). In the case of

helicopters blending gels other than Firewall II™ onboard, the dosing rate must be proportionally increased as the available water becomes harder and harder. Consequently, more and more product must be consumed per aircraft drop cycle, proportionately increasing containment costs and absorbing financial resources that could be allocated to other incident command expenditures.

In contrast, Firewall II™ can blend in all waters, including sea water, regardless of the hardness. The benefits of this technology will open up previously unusable water sources to blending with Firewall II™, providing the Incident Commander a much wider choice of firefighting tools at his or her disposal.

Firewall II™ Tested by CalFire

Documented reports from experienced Air Attack Officers and ground observers have confirmed that Firewall II™ is a superior agent to water, foam or retardants under field conditions (See Appendix A, CalFire Gel Study 2005). The effect described was sudden, dramatic and often complete and well beyond what could be expected from the other agent types that are routinely used.

The field evaluations have also suggested that Coverage Levels could be decreased when compared to LTRs due to the increased knockdown capability and the resistance to the observed combustion recovery. A large reduction in the amount of mop-up needed in numerous fuel types, was also noted.

Firewall II™ Effectiveness on Whites Fire

On July 30, 2014, a lightning strike started the Whites Fire south of Yreka, CA, near Etna, in the Klamath National Forest. The nearby Log Fire and Man Fire, also started by lighting on the same day, were eventually merged with the Whites Fire and re-designated as the July Complex Fire on August 3rd. Firestorm Wildland Fire Suppression, Inc., was activated to provide Initial Attack support for helicopters, using Firewall II™ as a fire suppressant.

Two separate Firewall II™ mixing plants were set-up; one just east of Etna and one near the Idlewild Campground, along the north fork of the Salmon River. Eco Fire Solutions personnel spoke with Bruno Levi, a pilot for HeliQwest, who used Firewall II™ with a 700 gallon FAST bucket (SEI Industries, Ltd). Here is what he said:

> "……came out of the bucket really well with a very nice spread. The firefighters on the ground really liked it and kept asking for more."
>
> "…..clean-up was really easy and nice. The bucket only needed one rinse and it was clean with no residue left behind. LTRs and other gels are really dirty stuff and are difficult to clean. They contaminate the bucket, rubber and penetrate the cables. ……problematic and messy."

Not only do his comments offer strong proof to the effectiveness of Firewall II™ in direct

attack, but they also allay the misguided fears and circulating word-of-mouth misinformation that Firewall II™ contaminates aerial firefighting equipment and requires excessive cleaning and decontamination after use.

Figure 2 shows the HeliQwest K-Max helicopter on the Whites Fire using a dip tank (pumpkin) supplied with blended Firewall II™.

Figure 2

Current Aerial Firefighting Perspective

The effectiveness of helicopters and SEATS conducting tactical suppression operations can be leveraged by adopting systems that make the right fire chemical available to firefighters at the right time - when the individual properties of the fire chemicals are needed.

When LTRs are used as suppressants in direct attack, it is solely for the suppressant value of the contained water, rendering its added chemicals as an unnecessary waste. LTRs are extremely expensive compared to other suppressant options and they pose serious environmental consequences, as well.

Class A Foams are effective only in specific circumstances that are very infrequent. Plain water is also good in many applications and will likely remain the most commonly used suppressant. However, water's suppressant performance can be dramatically improved by treating it with Firewall II™.

The current suppression model for multi-engine fixed wing airtankers is almost totally committed to the singular use of LTRs (or plain water if LTRs are not available) in Direct Attack and Extended Attack operations. Water-dropping helicopters and SEATs, some with Class A Foam capability (but rarely used), may be added in late Extended Attack operations or in early major fire operations.

Tactical aircraft support with helicopters and SEATs has long been an effective resource for Incident Commanders. However, common practice has been for them to use plain water as the payload-of-choice in support of direct and parallel line building and flare-up support.

With the advanced products and equipment now available, it only makes sense to implement a program that increases the effectiveness of the water payload. Not only can firefighting costs be significantly reduced, but a corresponding increase in operational safety results because fewer flight hours are needed for containment, thereby lessening flight hour exposure and risk.

Firewall II™ Mixing Plant Advantages

The instant blending properties of Firewall II™ and the simplicity of operations for ground based blenders, provides several options and advantages to an Incident Commander:

- Dip tanks of blended Firewall II™ can support helicopters using either fixed-tanks or buckets.
- The mix ratio of Firewall II™ can be varied on site throughout the full range of US Forest Service approved mix ratios in the QPL.
- Helicopters with fixed-tanks or SEATs can be provided blended Firewall II™ directly from Eco Fire Solutions' compact mobile blending units.
- All equipment needed to blend Firewall II™ is self-contained and portable and requires very little mobilization or demobilization effort.
- A single rinse is all that is needed to clean aircraft and ground based equipment after exposure to Firewall II™.
- Increased fire suppression effectiveness and no environmental damage.
- Non-corrosive blended gel.

Appendix B depicts a *typical* flow diagram for an Eco Fire Solution (EFS) ground based blender. Specific equipment locations may vary and control units and electric circuitry are not shown.

Appendix C, US Forest Service QPL for Water Enhancers (Gels) contains this note:

> ***"Colored experimental products may be used within a controlled study to determine visibility as required by the specification."***

In order to accommodate an agency that desires to experiment with colorant, the EFS blender provides the option to add colorant (see flow diagram) as desired by a fire agency. Figure 3 shows a Type II helicopter dropping blended and colored Firewall II™ during a training exercise. Note the clean leading edge dispersal of suppressant with very little drift, in spite of strong crosswinds.

Figure 3

Appendix C also contains the following note, which applies only to fire agencies in the United States: “Forest Service policy does not allow application of water enhancers from large airtankers.” However, the note continues with an exception,

> ***“These products meet the requirements for application from multi-engine aircraft for those agencies whose policy permits this use,”***

which provides other fire agencies in the U.S., at their discretion, the opportunity to use Firewall II™ in fixed wing aircraft for direct attack on wildland fires.

Common Firewall II™ Questions and Answers

Appendix D provides more information on the effectiveness of Firewall II™, its properties and storage requirements.

If you have any questions or need more information, please contact:

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