COLD FIRE® FIRE SUPPRESSING AGENT: A HALON ALTERNATIVE

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The purpose of this paper is to introduce and illustrate the unique firefighting and life-saving characteristics of Cold Fire, and to outline why Cold Fire should be evaluated further, as a safe and effective "solution" to halon in both total-flooding and streaming applications.

Cold Fire, a UL Listed Wetting Agent, is considered to be an acceptable alternative to halon under the Environmental Protection Agency's Significant New Alternatives Policy Program (SNAP). All possible replacement and/or alternative agents to halon, need to comply with existing requirements such as environmental standards, toxicity. corrosion, storage, penetration capability, and system compatibility, to name a few. Cold Fire satisfies these requirements and offers additional advantages.

INTRODUCTION

What is Cold Fire?

Cold Fire is a UL listed Wetting Agent for Class A and B fires [1]. Cold Fire was tested in accordance with UL 162, UL 711 and NFPA 18 requirements for Wetting Agents. Cold Fire is unique; however, in comparison to most wetting agents, as it has the capability to extinguish Class B [1] and D fires [2]. This environmentally friendly agent is plant- and water-based and has been approved by the Environmental Protection Agency under their Significant New Alternatives Policy Program (SNAP) *[3]* as an acceptable substitute for Halon 1211 and Halon 1301. The agent is nontoxic, noncorrosive, and offers an unprecedented cooling effect.

How Does Cold Fire Work on Extinguishing a Fire?

Cold Fire works by ceasing the chain propagation of the free radical reaction of fire. It does this by removing the heat from the fire triangle and immediately bringing the fire below its flash point. Simultaneously, Cold Fire works to encapsulate the fuel source. When properly applied, this cooling and encapsulation process prevents the possibility of reignition.

Several criteria must be considered when assessing various replacement agents for aircraft fire suppression. The following defines the compliance of Cold Fire with these criteria.

CRITERIA

Environmental Considerations

Cold Fire is considered to be environmentally friendly and nontoxic. The agent has successfully completed extensive toxicity, corrosivity, and biodegradability testing with the following EPA

recognized Iahoratories: SGS US Testing (Fairfield, NJ) and Consumer Product Testing, (Fairfield, NJ). All tests were conducted in accordance with procedures outlined in the Environmental Protection Agency *Health Effects Test Guidelines*, EPA 560/6-82-00 I; and *Pesticide Assessment Guidelines*, EPA 540/9-82-025, Office of Pesticides and Toxic Substances.

Toxicity

Cold Fire poses no health risk to workers, crew members. and/or passengers. It has received an HMIS rating: 0 Reactivity, 0 Flammability, 0 Health Hazard.
Dermal toxicity — When tested, Cold Fire was not considered to be a dermal irritant. Cold Fire was not acutely toxic following dermal administration at *5.0* g/kg.
Ocular toxicity — When tested, Cold Fire was not considered to cause eye irritation.
Oral toxicity — Cold Fire did not induce any mortality in laboratory animals following oral administration at *5.0* g/kg. Cold Fire was considered to have an acute oral LD_{50} value greater than *5.0* g/kg.
Skin sensitization — When tested, Cold Fire was not considercd to be a skin sensitizing agent.
Acute inhalation toxicity — Whcn tested, Cold Fire was not toxic to the test animals following a 4 hr exposure at a nominal concentration of *35.3* mg/L (actual concentration was 16.9 mg/L). The LC_{50} was estimated to he greater than 35.3 mg/L (actual concentration was 16.9 mg/L). Asphyxiation and toxicity are. therefore, riot considered to be of concern if using Cold Fire as a total-flooding and/or streaming agent.

Limited Water Damage

When considering a replacement or alternative to halon for aircraft fire suppression. the issue of possible excess water damage and cleanup is of concern. Although Cold Fire is approximately 94% water, it penetrates a surface and/or area 6 times faster than water alone [1]. This penetration factor results in the use of less water to cxtinguish the fire and in minimal, if any, consequent water damage. Less cleanup is *also* required.

Indefinite Shelflife

Cold fire is 100% soluble in water. The agent will not separate or gel. and it is freeze-thaw stable. The shelf life of the agent is indefinite, as long as it is kept in a closed container or system. If left open, normal evaporation of the water over time will occur [I].

Increased Visibility

Aside from fire. heat and smoke can cause serious health hazards that, in some cases. can prove fatal to crew members and passengers. When a fire occurs on-board an aircraft. smoke becomes a significant factor. Smoke consumes the body of the aircraft in a matter of minutes. if not seconds. Once consumed. visibility to reach an exit is minimized it' not eliminated. Cold Fire works to extinguish the fire, cool the area, and encapsulate the hydroenrhons in the smoke. Cold Fire transforms the smoke from black to white. This transformation happens almost immediately. thereby increasing visibility and enhancing rescue. After a few minutes, most if not all the black hydrocarbon smoke is eliminated. As Cold Fire cools and absorbs the hydrocarbon smoke, the likelihood of smoke inhalation and steam burn are reduced.

Minimal Cleanup

Cold Fire is a nonhazardous material and requires minimal cleanup. The agent is non-staining, leaves no residue, and is not a slipping hazard.

Corrosion

Cold Fire is noncorrosive. The results of the DOT corrosion testing completed by SGS US Testing on aluminum and steel are shown in Table 1 [4].

TABLE 1. TEST RESULTS.

	Corrosion Rate	
	mm/year	in/year
Aluminum 7075 T-6 Bare	0.07–0.08	0.003–0.003
Steel	0.23–0.27	0.009–0.011

Comments: Per 49 CFR 173.130 (A) (2) a liquid is considered to have a severe corrosion rate if its corrosion rate exceeds 6.25 mm (0.0246 in) a year on steel (SAE 1020) or aluminum (non-clad 7075 T-6) at a test temperature of 55 °C (131 °F) [4].

ADVANTAGES IN USING COLD FIRE

When water is applied to a fire and/or heated surface, it converts to heated steam resulting in possible superheated steam inhalation and/or steam bum. Although, water is an excellent fire-fighting median, it lacks the enhanced cooling and penetration capability, which are inherent characteristics of Cold Fire.

Cooling Effect

Cold Fire works to destroy the molecular structure of heat. Unlike water or air, Cold Fire's extraordinary penetration capability allows the agent to he *rapidly* absorbed into a heated surface, destroying the molecular structure of heat on contact. This destruction allows the heat to be instantaneously released and dispersed into the atmosphere at ambient temperature.

Cooling *tests* conducted by Intertek Testing Services on various materials show that [5] Cold Fire has the ability to cool down a surface an average of 10 times faster than water alone. Tests were conducted on the following materials: copper (Figure 1), sheet metal (Figure 2), steel (Figure 3) and glass (Figure 4).

Penetration

According to our UL test results, Cold Fire is considered to be 6 times more penetrable than water [1]. The result is faster knockdown. rapid extinguishment, and rapid cooling. This enhanced penetration capability also allows Cold Fire to attack deep-seated and hidden fires successfully. Cold Fire viscosity is low (15 centipoise), allowing it to be absorbed much more quickly than water alone.

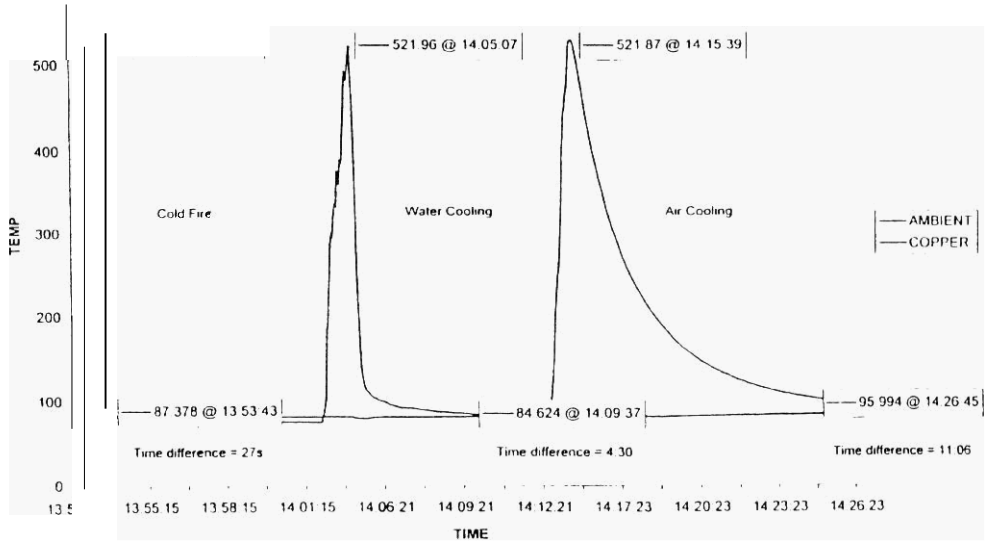

Figure 1. Cold fire cooling on copper.

Results Summary: The copper was heated to 500 "F and sprayed for 29.89 sec. It took 27 sec for Cold Fire to cool the copper to 87.378 "**F.** It took water 4 min, 30 sec to cool the copper to 84.624 "F. It **took** air 11 min, 6 sec to cool the copper to 95.994 "F.

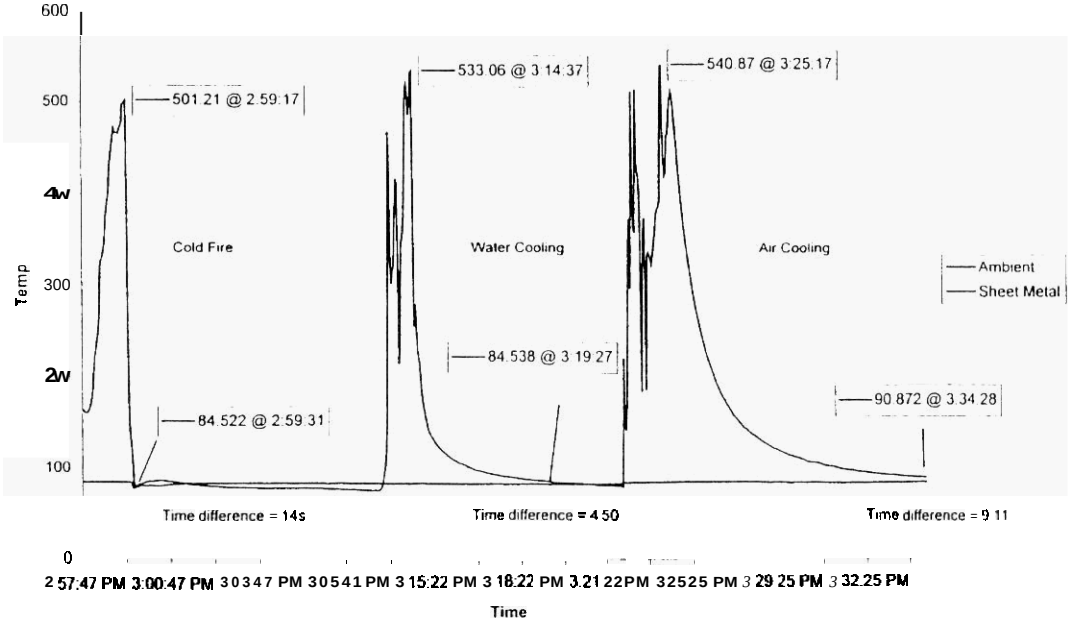

Figure 2. Cold firc cooling on sheet metal

Results Summary: The sheet metal was heated to 500 "F and sprayed for 15.69 sec. It took 14 sec for Cold Fire to cool the sheet metal to reach 84.522 "F. It took water 4 min, *50* sec to cool the sheet metal to 84.538 "F. It took air 9 min, 11 sec to cool the sheet metal to 90.872 "F.

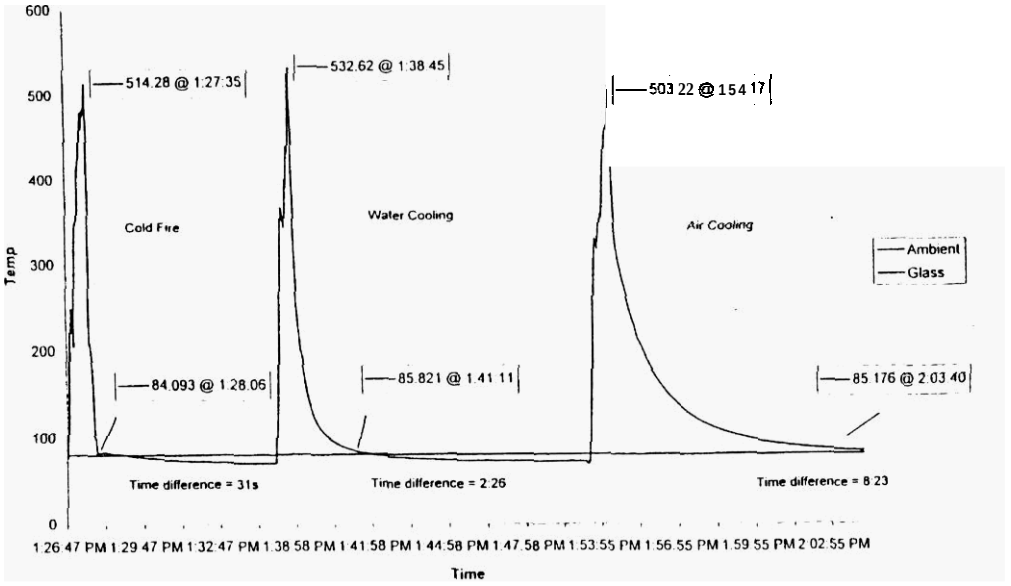

Figure 3. Cold fire cooling on glass.

Results Summary: The glass was heated to 500 "F and sprayed for 23.47 sec. It took 31 sec for Cold Fire to cool the glass to reach 84.093 °F. It took water 2 min, 26 sec to cool the glass to 85.821 "F. It took air 8 min, 23 sec to cool the glass to 85.176 °F.

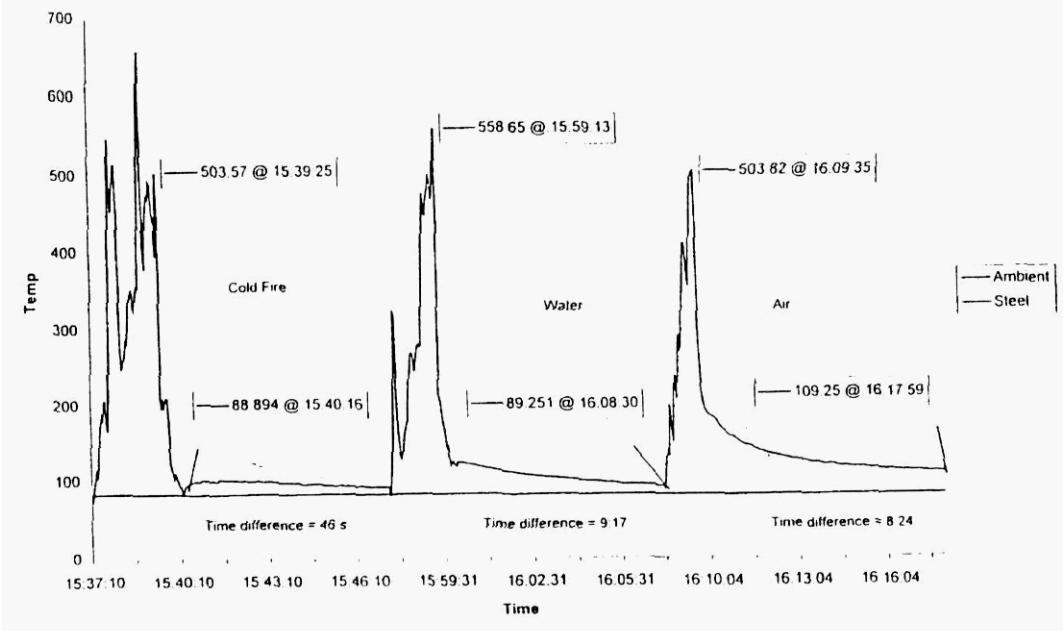

Figure 4. Cold fire cooling on steel.

Results Summary: The steel was heated to 500 °F and sprayed for 48.23 sec. It took 46 sec for Cold Fire to cool the steel to reach 88.894 "F. It took water 9 min, 17 sec to cool the steel to 89.251 "F. It took air 8 min, 24 sec to cool the glass to 109.25 "F.

Cooling and Penetration Comparison to Water

Example 1: imagine a fully involved car fire. It would normally take a fire truck with a 1.5 in hose line and a straight stream nozzle to extinguish such a fire in approximately 5 min, using anywhere between 150-500 gal of water. Cold Fire can extinguish such a fire with just two. 2.5 gal water extinguishers (5 gal of material at a 10% mix) within approximately 1 min. Within a few minutes after extinguishment, the metal of the vehicle is cool enough to touch.

Example 2: Cold Fire was used on brush fires in Mexico during the summer of 1998. Forest firefighters only needed to conduct one helicopter air drop using a bambi bucket containing 400 gal of water mixed with a 1% Cold Fire solution. Cold Fire was used to extinguish an area 100 m wide by 550 m long. In comparison. it took 5 to 8 drops with Class A foam to extinguish the same size area.

COLD FIRE'S ABILITY TO EXTINGUISH CLASS D FIRES

Many parts of an aircraft are made of titanium and magnesium components. To date, the idea of applying water or a water-bascd agent on such a fire would be inconceivable. When water is thrown on a metal fire, a chain reaction occurs in which the water creates explosions and sparks. This is due to the breaking of the water molecules into radical gaseous components that actually reinforce the metal fire. Cold Fire's unique formulation breaks this chain reaction. thereby stopping the explosions from occurring and allowing the water to cool the fire down and act as a blanket between the metal and the oxygen.

Cold Fire recently completed its preliminary UL Class D testing on molten magnesium. Testing was conducted at TIMET (Titanium Metals Corporation, Henderson, NV). The preliminary tests conducted were based, in part, on the Liquid State Fire Tests contained in the Standard for Rating and Fire Testing of Fire Extinguishers and Class D Extinguishing Media, CAN/ULC-S508-M90. 2.5 gal water extinguishers were used to conduct the tests, each containing a 30% mixture of Cold Fire. The following is a synopsis of the results [3].

Liquid—State Magnesium Spill Fire Test

A three-sided steel pan approximately 3 ft wide by 5 ft long, and with the two widths and one length having sides with a height of 6 in. was used for this test.

Approximately 16 lbs of molten magnesium. at a temperature of 718 "C, was poured into the center of the pan providing a varied depth spill of molten material covering approximately 3/4 of the pan. The initial discharge of the extinguisher occurred 1 min after the magnesium was placed in the pan. Flaming of the material and some spurting of burning magnesium was noted. A second extinguisher was applied and then a third extinguisher was used (3:40 from initial application). At 4:40 from the initial application no flaming of the magnesium was noted, only some smoking. The extinguishant was applied intermittently until exhausted. At 8:50 from initial application, a fourth extinguisher was intermittently used until exhausted at 16:30. The temperature of the magnesium was recorded 20 min after initial application. An average temperature of 80 °C was observed. Approximately 25% of the initial mass of magnesium was remaining in solid form in the steel pan [3].

APPLICATIONS USING COLD FIRE

Cold Fire can be delivered through fixed systems, handlines, and portable extinguishers. Cold Fire is presently used by the motorized racing industry in closed-loop systems for automobiles. Halon was once the agent of choice; however, as a result of environmental concerns and the banning of halon under provisions of the Montreal protocol, as well as possible asphyxiation due to use of the agent, halon is no longer used. The racing industry prefers Cold Fire for its ability to cool, its rapid extinguishment, prevention of reignition, minimal cleanup, as well as its nontoxic and noncorrosive nature.

Water-Mist System

Water-mist systems are designed to allow the use of a fine water spray application to provide fire protection with reduced water requirements and reduced consequent damage. New alternative technologies continue to be considered as options to halon use in such systems.

Cold Fire's extraordinary penetration, cooling effect, and ability to use less water would make it an excellent alternative within water-mist systems. Coupled with Cold Fire, such a system would enhance fire protection and safety, use less water, and reduce consequent water damage, all without compromise to those involved.

Cold Fire to Water Use Comparison

Cold Fire is recommended to be evaluated further for use in a water-mist system for on-board aircraft fire suppression (Table 2). Due to the agent's solubility in water and its low viscosity, it flows freely through any fixed system, and there is no fear of the agent clogging the orifices of nozzles.

TABLE 2. COLD FIRE AND WATER USE COMPARISON.

Water	Cold Fire
Limited penetration	Enhanced penetration
Minimal cooling	Rapid cooling
	Encapsulates fuel vapors
Possible reignition	Prevention of reignition
Consequent damage likely	Consequent damage greatly reduced
Not very effective on Class B fires	Very effective on Class B fires
Does not extinguish Class D	Extinguishes Class D fires
Risk of possible steam inhalation and steam burn	Immediate cooling-alleviating possible Steam inhalation and steam bum
Extreme amounts of water needed	Approximately 6 times **less** water **is** needed
Significant dollar loss to aircraft	Reduced dollar loss to aircraft
Lack of visibility	Enhanced visibility
	Direct cooling of surfaces and fuel source
	Enhances safety for a safer egress

Extinguishers

Cold Fire has completed preliminary testing with regard to British Standards for its 1.5 and 2.5 gal extinguishers. Testing was conducted by Loss Prevention Council (Hertfordshire, England) under protocol BS EN 3-1 1996. The results are shown in Table 3.

TABLE 3. UNIT SIZE AND RATING TEST RESULTS.

Unit Size	Class Rating
9 liter (2.5 gal. unit)	21A
6 liter (1.5 gal. unit)	55B

Complete tcsting. including 1- and 2-kilo unit sizes, as well as *Class* C and D ratings arc presently underway. Firefreeze Worldwide, Inc.. will bring an extinguisher to the market in the near future. which will he rated for all four classes offire.

Prevention Application

Cold Firc also works to cool down hcatcd surfaces and encapsulate fuel. rendering it inactivc. Due to this unique quality, the product can be used to pre-spray arcas where fear of fire may occur. Such areas would include engine compartments where a fire may originate due to the combination of heat generation and possible leakage of hydraulic fuel, oil, etc.

Today, this prevention application is used in the trade and automobile industry. Cold Fire is used to pre-spray an area or surface prior to using a torch to help prevent a possible hidden fire. Many plumbers, welders, roofers, and mechanics use Cold Fire for added safety prior to brazing and soldering and/or whcn working with hot surfaces. The penetration capability of Cold Fire allows it to safeguard a surface from heat damage and possible fire.

CONCLUSION

Cold Fire rapidly extinguishes and cools down a fire. uses less water to achieve enhanced firc protection, and reduces hydrocarbon smoke. thereby increasing visibility and allowing for a safe exit. Thesc are just some of the unique fire suppression and life saving capabilities of Cola Fire.

The quest continues to determine the suitability of various agents for aircraft fire suppression with the obligation of finding alternative and/or replacement options for Halon. Cold Fire, a very **safe.** effective and compatible agent, can fulfill this need.

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