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TESTING OF FIRE EXTINGUISHERS, IDENTIFIED AS MODEL PFE-101, MODEL PFE-102 AND MODEL PFE-1LR, CONDUCTED FOR CLASS 1-B, 2-B, 5-B, TYPE K, AND RESIDENTIAL TYPE K PERFORMANCE IN ACCORDANCE WITH UL 711 (6TH EDITION) / CAN/ ULC-S508 (4TH EDITION), *RATING AND TESTING OF FIRE EXTINGUISHERS (2002 EDITION)*, AND UL SUBJECT 711A, *THE FIRE TEST METHOD FOR PORTABLE HAND-HELD EXTINGUISHERS INTENDED FOR USE ON RESIDENTIAL COOKING EQUIPMENT (2005 EDITION)*

REVISED FINAL REPORT
Consisting of 12 Pages

SwRI® Project No. 01.13538.01.307[1]
Test Dates: July 28 and 29, 2009
Report Date: November 18, 2009
Revised Report Date: July 29, 2010

Prepared for:

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ABSTRACT

The objective of this program was to evaluate the effectiveness of three different fire extinguishers, identified by FireStopper Chemicals and Technologies Company, Inc. (Client), as *Model PFE-101, Model PFE-102,* and *Model PFE-1LR.* Specifically, Class 1-B, 2-B, 5-B, Type K, and Residential Type K testing was conducted in accordance with Underwriter's Laboratory (UL) Test Standard 711 (6th Edition), *Rating and Testing of Fire Extinguishers (2002 Edition),* and UL Subject 711A, *The Fire Test Method for Portable Hand-Held Extinguishers Intended for Use On Residential Cooking Equipment (2005 Edition).* The standard for the rating and testing of fire extinguishers is a common standard between UL and Underwriter's Laboratories of Canada (ULC). The ULC designation for the standard is CAN/ULC-S508 (4th Edition). The remainder of this final report refers to this common standard as UL 711, for simplicity.

This report was revised to replace references to UL Subject 605 with UL Subject 711A. UL Subject 711A is a newer document that replaced UL Subject 605. Testing was conducted in accordance with UL Subject 711A, as opposed to UL Subject 605.

Testing was conducted July 28 and 29, 2009, for FireStopper Chemicals and Technologies Company, Inc., of Palisades, California, at the Client's fire testing facility in MacClenny, Florida. Mr. Jason P. Huczek, of Southwest Research Institute's Fire Technology Department, witnessed testing onsite.

The *Model PFE-101* fire extinguisher successfully met the requirements of UL 711 (Class 1-B) and UL Subject 711A, for both the cast iron skillet and stainless steel pot test fires. The *Model PFE-102* fire extinguisher successfully met the requirements of UL 711 (Class 2-B) and UL Subject 711A, for both the cast iron skillet and stainless steel pot test fires. The *Model PFE-1LR* fire extinguisher successfully met the requirements of UL 711 (Class 5-B and Type K) and UL Subject 711A, for both the cast iron skillet and stainless steel pot test fires.

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1.0. INTRODUCTION

The objective of this program was to evaluate the effectiveness of three different fire extinguishers, identified by FireStopper Chemicals and Technologies Company, Inc. (Client), as *Model PFE-101, Model PFE-102,* and *Model PFE-1LR.* Specifically, Class 1-B, 2-B, 5-B, Type K, and Residential Type K testing was conducted in accordance with Underwriter's Laboratory (UL) Test Standard 711 (6th Edition), *Rating and Testing of Fire Extinguishers (2002 Edition),* and UL Subject 711A, *The Fire Test Method for Portable Hand-Held Extinguishers Intended for Use On Residential Cooking Equipment (2005 Edition).* The standard for the rating and testing of fire extinguishers is a common standard between UL and Underwriter's Laboratories of Canada (ULC). The ULC designation for the standard is CAN/ULC-S508 (4th Edition). The remainder of this final report refers to this common standard as UL 711, for simplicity.

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The test methods described in this report are intended to measure and describe the properties of materials or products in response to heat and flame under controlled laboratory conditions. The results should not be used alone to describe or appraise the fire hazard or the fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a complete fire hazard for fire risk assessment, which takes into account all the factors that are pertinent to an assessment of the fire hazard or risk of a particular end-use.

The results presented in this report apply specifically to the specimens tested, in the manner tested, and not to the entire production of these or similar materials, nor to the performance when used in combination with other materials.

2.0. SAMPLE DESCRIPTION

The Client supplied three models of fire extinguishers with corresponding extinguisher agent for testing. All extinguishers and extinguishing agent was inspected prior to testing by SwRI project engineer, Mr. Jason P. Huczek. Figures 1–4 provide photographs of the extinguishers, the nozzles and extinguishing agent tested. The extinguishers were identified as *0.4-L Spray Extinguisher*, *0.4-L Foam Extinguisher,* and *1.5-L Foam Extinguisher.* Details on the three extinguisher types are provided in Table 1.

Table 1. Description of Fire Extinguishers (Provided by Client).

Extinguisher ID	Extinguisher Description	Nominal Operating Pressure	Media (Extinguishing Agent)	Operating Temperature	Discharge Range
Model PFE-101	0.4-L Capacity Extinguisher with Fog/Mist Nozzle	195 psig	FireStopper PFE-FR, water thin clear liquid (pH: 7.0–7.8, Specific Gravity: 1.1–1.3)	¯100° F–108° F (Approximate)	8–10 ft (Approximate)
Model PFE-102	0.4-L Capacity Extinguisher with Spray/Naturally Aspirated Foam Nozzle				
Model PFE-1LR	1.5-L Capacity Extinguisher with Spray/ Naturally Aspirated Foam Nozzle				

Both extinguisher models consisted of a stainless steel canister with a stainless steel application nozzle. Both extinguisher models are described as modular, disposable, pre-charged cartridge units. Additional detailed information about the fire extinguishers is on file in SwRI's FTD, Listing and Labeling Section.

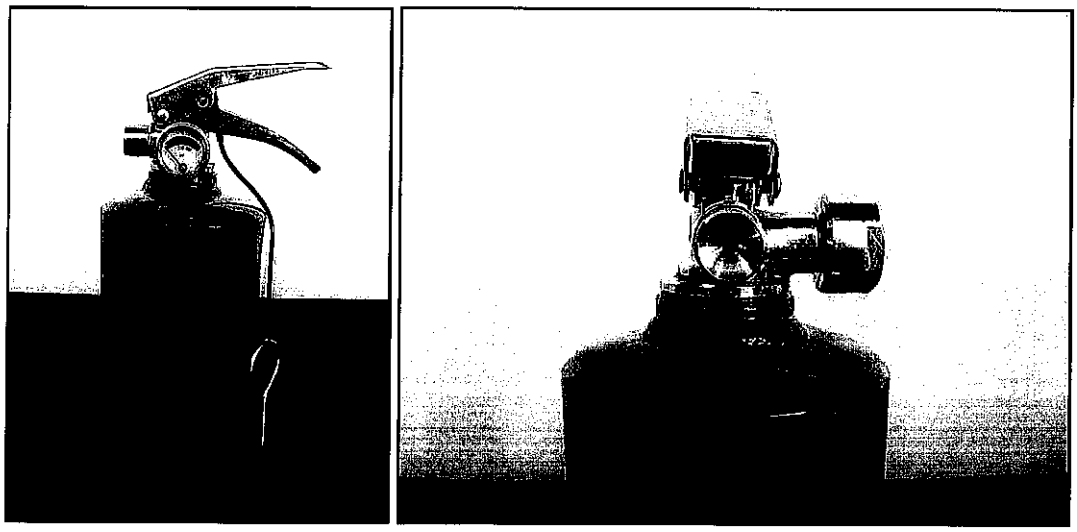

Figure 1. Client's 0.4-L *Model PFE-101* Extinguisher.

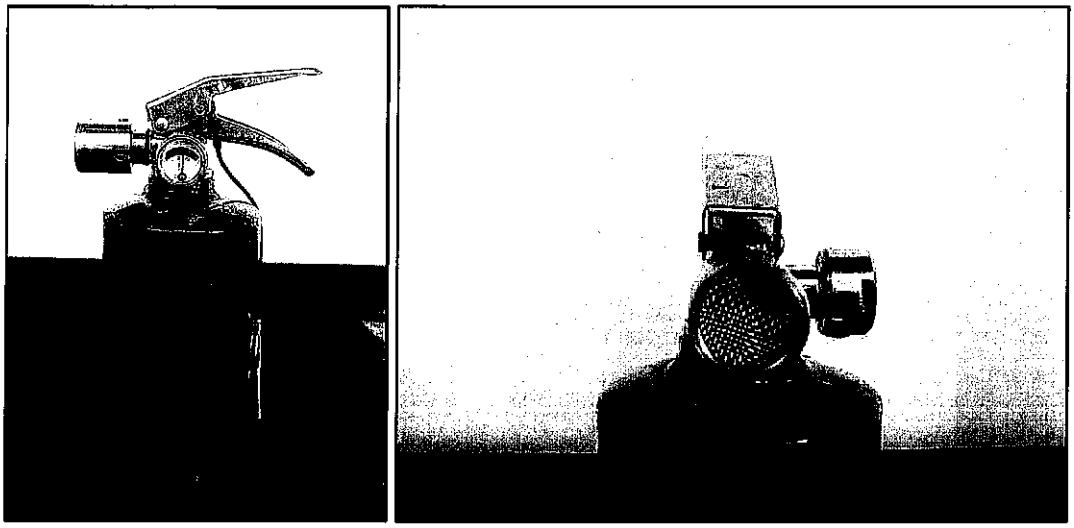

Figure 2. Client's 0.4-L *Model PFE-102* Extinguisher.

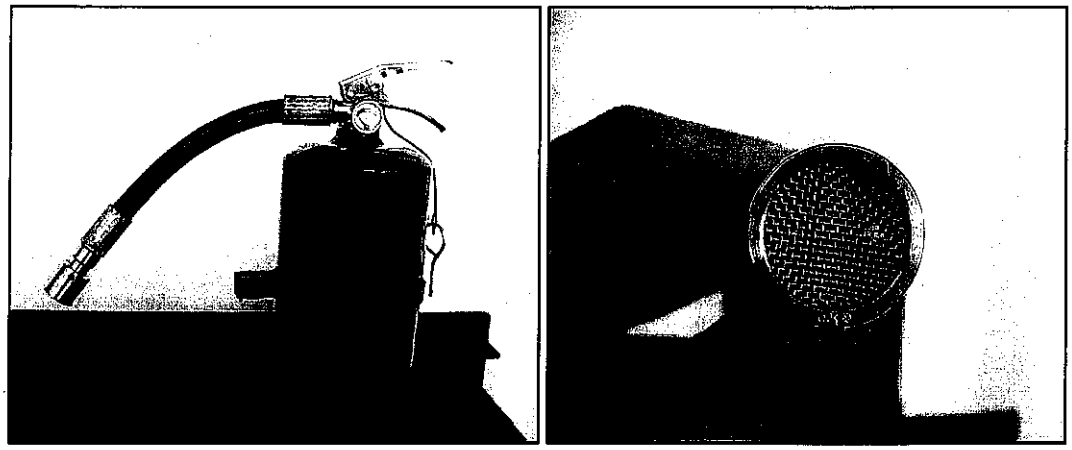

Figure 3. Client's 1.5-L *Model PFE-1LR* Extinguisher.

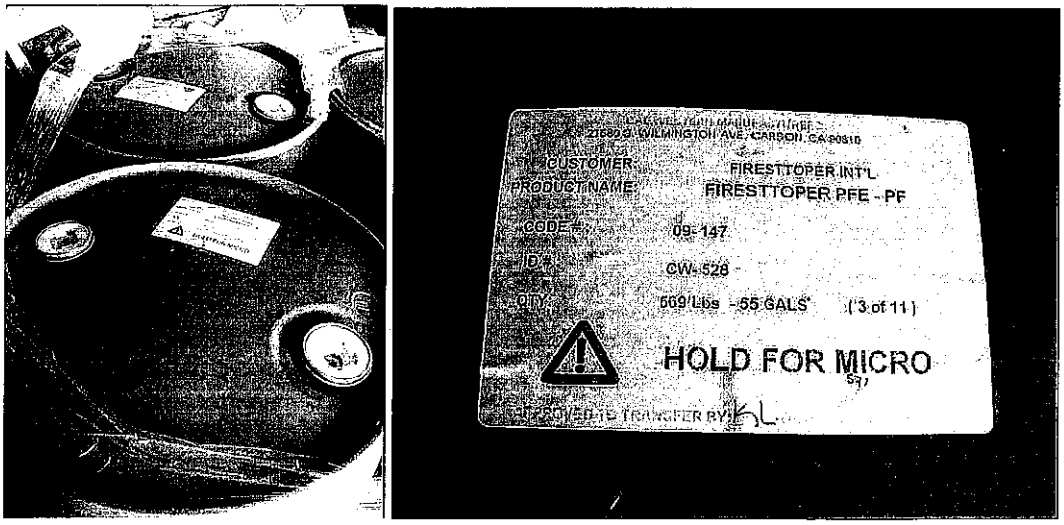

Figure 4. Client's PFE-FR Extinguishing Agent.

3.0. TEST PROCEDURES

3.1. Class B

Fire extinguishers that are "B" classified must be able to extinguish a flammable liquid (heptane) fire. The specific classification (1-B, 2-B, 5-B, *etc.*) is a function of the area of the fuel pan that is to be extinguished. The fire extinguishers in this project were tested for their ability to extinguish a 1-B, 2-B, and/or 5-B pan.

The Client provided a 1-B, 2-B and a 5-B pan constructed per Table 5 of UL 711. In each case, the pan is constructed out of ¼-in. thick steel with liquid-tight welded joints. In addition, at the top of the pan, 3/16-in. thick steel angle iron is welded to provide structural rigidity. This reinforcing angle is welded around the perimeter of the pan and forms a turned-out edge, leveled with the top edge of the pan. Figure 5 provides a photograph of the Client's 5-B pan.

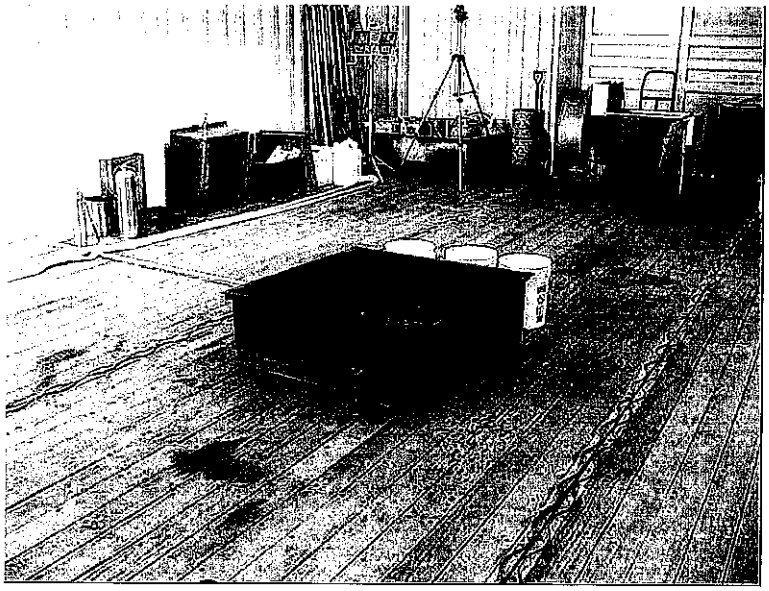

Figure 5. Client's 5-B Steel Pan.

UL 711 requires a 6-in. high freeboard (distance between top of fuel surface and top of the pan), and a minimum of 2 in. of commercial grade heptane. The Client's test pans had nominal heights of 12 in. Adding a 4-in. thick layer of water upon which the heptane floats compensates the difference in height. This provides a level fuel surface, in addition to protecting the floor of the steel pan.

After the pan is filled with water and fuel, the heptane is ignited and allowed to burn for 60 s prior to attacking the fire with the extinguisher. After 60 s, the manufacturer's instructions for use are followed, and fire extinguishment is attempted. In this particular case, the Client performed the extinguishment test, such that the instructions for use were carried through without question.

During each test, observations were recorded. Observations included: (1) application of extinguisher, (2) duration of discharge of extinguisher, and (3) time when fire in pan is extinguished.

3.2. Type K

Fire extinguishers that are "Type K" classified must be able to extinguish a vegetable oil (minimum auto-ignition temperature of 363 °C [685 °F]) fire from a commercial deep fat fryer with a nominal 36 kg (80 lb) capacity and nominal dimensions of 460 mm (18 in.) deep and 460 × 610 mm (18 × 24 in.) in surface area. The Client's propane gas-fired deep fat fryer was utilized for this testing. The fryer measured 451 mm (17¾ in.) deep and had a surface area of 444.5 × 610 mm (17½ × 24 in.). Figure 6 provides a photograph of the deep fat fryer used for testing.

Figure 6. Client's Deep Fat Fryer Utilized for UL 711 (Type K) Testing.

At the start of each test, the vegetable oil was poured into the fryer and heated to its auto-ignition temperature. Upon pouring 36 kg of vegetable oil into the fryer, the freeboard was approximately 12 in. Between the temperatures of 260 °C and 316 °C (500 °F to 600 °F), the oil is heated at a minimum rate of 6.7 °C (12 °F) per minute. This was measured with a thermocouple that was 25 mm (1 in.) below the fuel surface and not closer than 75 mm (3 in.) from the walls of the fryer.

Upon auto-ignition of the oil, the fire is allowed to pre-burn for 60 s. After 60 s, the extinguisher is discharged continuously until all of its contents have been delivered to the fire. The energy source is to remain on during the discharge. The energy source is removed after discharge is complete. As with the Class B testing, in this particular case, the Client performed the extinguishment test, such that the instructions for use were carried through without question.

In order to meet the requirements of this test method, the extinguisher must completely extinguish the fire, not permit re-ignition of the fire for a period of 20 min, or until the temperature of the vegetable oil has decreased at least 33 °C (60 °F) below the auto-ignition temperature, and not cause splashing of flaming oil outside the fryer.

3.3. Residential Type K

Kitchen fire extinguishers that meet the requirements of UL Subject 711A, *The Fire Test Method for Portable Hand-Held Extinguishers Intended for Use On Residential Cooking Equipment (2005 Edition)*, must be able to extinguish a cooking oil (minimum auto-ignition temperature of 363 °C [685 °F]) fire from both a cast iron skillet and a stainless steel pot.

The skillet has a 356 mm (14 in.) diameter (measured at the top of skillet) and is 50 mm (2 in.) deep. The stainless steel pot has a 254 mm (10 in.) diameter (measured at top of pot) and is 178 mm (7 in.) deep.

At the start of each test, oil is poured into the skillet (depth of 1 in.) and/or pot (depth of 4 in.) and heated to its auto-ignition temperature. Between the temperatures of 260 °C and 316 °C (500 °F to 600 °F), the oil is heated at a minimum rate of 6.7 °C (12 °F) per min. This was measured with a thermocouple that was placed below the fuel surface and not closer than 75 mm (3 in.) from the walls of the fryer.

A propane gas-fired burner, typically used for camping applications, was used to provide the heat exposure to the oil of this testing. Figure 7 provides a photograph of the burner used for this testing.

Upon auto-ignition of the oil, the fire is allowed to pre-burn for 60 s. After 60 s, the extinguisher is discharged continuously until all of its contents have been delivered to the fire. The energy source is to remain on during the discharge. The energy source is removed after discharge is complete. The test method stipulates that the extinguisher is discharged, initially 1.52 m (5 ft) from and at a 45° angle to the center of the test vessel (skillet or pot). As with the Class B and Type K testing, in this particular case, the Client performed the extinguishment tests, such that the instructions for use were carried through without question.

In order to meet the requirements of this test method, the extinguisher must completely extinguish the fire, not permit re-ignition of the fire for a period of 20 min, or until the temperature of the oil has decreased at least 33 °C (60 °F) below the auto-ignition temperature, and not cause splashing of flaming oil outside the fryer.

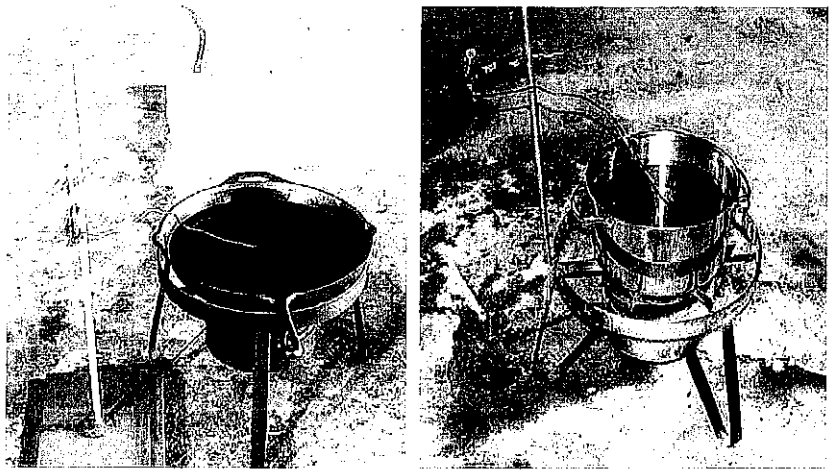

Figure 7. Propane Gas-Fire Burner for UL Subject 711A Testing; Skillet (Left), Pot (Right).

4.0. RESULTS

Testing was conducted July 28 and 29, 2009, at the Client's fire testing facility, located in MacClenny, Florida. Table 2 provides a summary of the test plan. Tables 3–8 provide test observations for each type of testing for each extinguisher. The Client documented the tests with video and this video is on file with SwRI. The photographs provided in this report were taken by SwRI representative, Mr. Jason P. Huczek.

The *Model PFE-101* fire extinguisher successfully met the requirements of UL 711 (Class 1-B) and UL Subject 711A, for both the cast iron skillet and stainless steel pot test fires. The *Model PFE-102* fire extinguisher successfully met the requirements of UL 711 (Class 2-B) and UL Subject 711A, for both the cast iron skillet and stainless steel pot test fires. The *Model PFE-1LR* fire extinguisher successfully met the requirements of UL 711 (Class 5-B and Type K) and UL Subject 711A, for both the cast iron skillet and stainless steel pot test fires.

Table 2. Summary of Test Plan.

Fire Extinguisher Tested	Number of UL 711 Test Trials (Class 1-B)	Number of UL 711 Test Trials (Class 2-B)	Number of UL 711 Test Trials (Class 5-B)	Number of UL 711 Test Trials (Type K)	Number of UL Subject 711A Test Trials (Res. Type K)
Model PFE-101	2	-	-	-	3
Model PFE-102	-	2	-	-	3
Model PFE-1LR	-	-	4	2	-

Table 3. UL 711 (Class 1-B) Test Observations for *Model PFE-101* Fire Extinguisher.

Model PFE-101 Extinguisher - UL 711 (Class 1-B) Test Observations					
	Test 1	Test 2	Test 3	Averages	Std. Dev.
Pre-Burn Time (s)	59	59	-	59.0	0.0
Duration of Discharge (s)	8	9	-	8.5	0.7
Fire in Pan Extinguished (s)	7	8	-	7.5	0.7

Table 4. UL Subject 711A (Residential Type K) Test Observations for *Model PFE-101* Fire Extinguisher.

Model PFE-101 Extinguisher - Subject 711A (Skillet) Test Observations					
	Test 1	Test 2	Test 3	Averages	Std. Dev.
Pre-Burn Time (sec)	60	-	-	60.0	0.0
Duration of Discharge (sec)	16	-	-	16.0	0.0
Fire in Pan Extinguished (sec)	3	-	-	<1	0.0
Model PFE-101 Extinguisher - Subject 711A (Pot) Test Observations					
	Test 1	Test 2	Test 3	Averages	Std. Dev.
Pre-Burn Time (sec)	60	60	-	60.0	0.0
Duration of Discharge (sec)	12	12	-	12.0	0.0
Fire in Pan Extinguished (sec)	2	2	-	2.0	0.0

Table 5. UL 711 (Class 2-B) Test Observations for *Model PFE-102* Fire Extinguisher.

Model PFE-102 Extinguisher - UL 711 (Class 2-B) Test Observations					
	Test 1	Test 2	Test 3	Averages	Std. Dev.
Pre-Burn Time (s)	60	60	-	60.0	0.0
Duration of Discharge (s)	7	6	-	6.5	0.7
Fire in Pan Extinguished (s)	14	28	-	21.0	9.9

Table 6. UL Subject 711A (Residential Type K) Test Observations for *Model PFE-102* Fire Extinguisher.

Model PFE-102 Extinguisher - Subject 711A (Skillet) Test Observations					
	Test 1	Test 2	Test 3	Averages	Std. Dev.
Pre-Burn Time (sec)	60	-	-	60.0	0.0
Duration of Discharge (sec)	26	-	-	26.0	0.0
Fire in Pan Extinguished (sec)	2	-	-	2.0	0.0

Model PFE-102 Extinguisher - Subject 711A (Pot) Test Observations					
	Test 1	Test 2	Test 3	Averages	Std. Dev.
Pre-Burn Time (sec)	60	60	-	60.0	0.0
Duration of Discharge (sec)	53	37	-	45.0	11.3
Fire in Pan Extinguished (sec)	1	1	-	1.0	0.0

Note: longer discharge times for UL Subject 711A tests due to intermittent discharge to avoid overflow of pot/pan.

Table 7. UL 711 (Class 5-B) Test Observations for *Model PFE-1LR* Fire Extinguisher.

Model PFE-1LR Extinguisher - UL 711 (Class 5-B) Test Observations						
	Test 1	Test 2	Test 3	Test 4	Averages	Std. Dev.
Pre-Burn Time (s)	60	60	60	60	60.0	0.0
Duration of Discharge (s)	22	18	22	21	20.8	1.9
Fire in Pan Extinguished (s)	N/A	N/A	22	20	21.0	1.4

N/A: not applicable (fire in pan not extinguished)

Table 8. UL 711 (Type K) Test Observations for *Model PFE-1LR* Fire Extinguisher.

Model PFE-1LR Extinguisher - UL 711 (Type K) Test Observations					
	Test 1	Test 2	Test 3	Averages	Std. Dev.
Pre-Burn Time (s)	60	60	-	60.0	0.0
Duration of Discharge (s)	18	21	-	19.5	2.1
Fire in Pan Extinguished (s)	2	1	-	1.5	0.7

Assessment of the toxicity (48h LC_{50}) of Firestopper®PFE-FR to the marine copepod *Acartia tonsa*

Final report
Study no 1577c-1

Contents

Confidentiality statement

Study director's statement

I hereby state, that this study was conducted in accordance with the OECD principles of Good Laboratory Practice (GLP) as administered by the UK Dept of Health and that the report fully and accurately reflects the raw data generated during the study.

All raw data and a copy of the final report will be archived within Opus Plus Ltd's facility, on Flotta, for a period of three and a half years from the date of issue of the final report.

(Signed)

11 November 2011

(Date)

William Scott
Study Director Ecotoxicology
Opus Plus Limited

Quality assurance statement

The conduct of this study has been subjected to inspections by Opus Plus Ltd Quality Assurance Unit. Short term studies are not inspected individually but are subject to process based inspections. The dates of inspection are given below.

Date of QA inspection	Type of inspection	Date of Report to Management
15 August 2011	Study Plan audit	N/A
31 October – 02 November 2011	Facility Inspection	07 November 2011
01 – 03 November 2011	Copepod test process inspection	07 November 2011
09 November 2011	Report audit	10 November 2011

This report has been audited by the Quality Assurance Personnel according to the appropriate Standard Operating Procedure. The report is considered to describe accurately the methods and procedures used in the study and the original data generated during the study.

(Signed)

10/November/2011

(Date)

Summary

Sponsor name	Firestopper International Limited	**Test personnel**	Mrs Brenda Hudson, Ecotox Coordinator Miss Melanie Anderson, Technician Mr William Scott, Study Director Mr William Clouston, Technician
Sponsor address	P.O Box 655 Pacific Palisades CA 90272-0655 USA	**Test facility**	Opus Plus Limited Flotta, STROMNESS Orkney, KW16 3NP **t** +44 1856 702 000 **f** +44 1856 701 473 admin@opus-results.com www.opus-results.com
Sponsor contact	Ranjit Bedi	**Test guidelines**	ISO 14669 (1999) Water Quality - Determination of acute lethal toxicity to marine copepods (*Copepoda; Crustacea*) ISO 5667-16 (1998) Water Quality Sampling – Guidance on biotesting of samples

Study number 1577c-1 was commissioned by Firestopper International Limited to determine the aquatic phase toxicity of Firestopper®PFE-FR to the marine copepod *Acartia tonsa*. A summary of all testing conducted is given below:

Test material	Firestopper®PFE-FR
Behaviour in seawater	Soluble
Preparation method	Dilution Series
Range finding test period	17 – 19 August 2011
Provisional 48h LC_{50} ($mg.l^{-1}$)	>1000
Definitive test period	31 August 2011 – 2 September 2011
24h LC_{50} ($mg.l^{-1}$)	6175
48h LC_{50} ($mg.l^{-1}$)	2040.61
48h LC_{90} ($mg.l^{-1}$)	3095.04
48h NOEC ($mg.l^{-1}$)	1000

Tests were assessed for compliance by the following guideline criteria:

36Parameter	Guideline criterion	Observed values
Salinity at 0h of dilution water	36 ± 4‰	36
pH at 0h of dilution water	8 ± 0.3	7.96
pH at 0h of the test material stocks	6 - 9	7.94 – 8.20
Temperature range	20 ± 2 °C	20.5 – 22.6*
Dissolved O2 range	≥ 80%	96 – 100
Informal reference toxicant 48h LC50 range	0.4 - 1.5 mg.l-1	0.65
Control mortality	≤ 10%	7.69

** Temperature above limits. See Interpretation.*

Section 1

Test organisms were obtained from age standardised cohorts and were 19 days old at definitive test commencement. Details of culture methods, in addition to test methods, procedures, guidelines and statistical methods are given in Appendix A. Appendix B indicates the nature of test material preparation methods and Appendix C contains the quality control data.

Characterisation of Firestopper®PFE-FR

Table 1.1 Description and characterisation (SOP 402)

Property	MSDS supplied	Observed
Form	Liquid	Liquid
Colour	Clear to slightly hazy	Clear to slightly hazy
Density	1.210 – 1.260	1.1802g/cm^3 @ 20°C
Odour	Mild	Acidic
Viscosity	Not stated	Slight
pH	Not stated	TSW=6.44, DiW=4.02 (1000 mg.l^{-1} stock)
Aqueous solubility	Soluble	Soluble at 1000 mg.l^{-1} in sea water after 1 hour stirring
Preparation method		Dilution Series
Flash point	Not flammable	
Melting point	Not stated	
Boiling point	Not applicable	
	Name, CAS No, Percentage composition	
Chemical Description	A proprietary aqueous solution, composed of organic and inorganic components	
	CAS No N/A, Percentage composition not stated	
	Liquid	

Firestopper®PFE-FR was characterised as soluble and was therefore prepared by dilution series.

Rangefinding test preparation

Table 1.2 Test material preparation (dilution series)

Diluent	Preparation volumes (ml)	Nominal concentrations (mg.l^{-1})	Weight (g) or volume (ml) added
Treated seawater	250	1	0.25ml from 1000mg/l
	250	10	2.5ml from 1000mg/l
	250	100	25ml from 1000mg/l
	1000	1000	0.498g

Rangefinding test results

Table 1.3 Mortality of *Acartia* after 48h exposure

Nominal Concentration ($mg.l^{-1}$)	Number dead/immobile at test termination	Total exposed	Proportional response 48h
1	2	5	0.40
10	2	5	0.40
100	1	5	0.20
1000	0	5	0.00

The Rangefinding test exhibited a 48h LC_{50} of greater than $1000mg.l^{-1}$ (series).

Definitive test preparation

Table 1.4 Test material preparation (dilution series)

Diluent	Preparation volumes (ml)	Nominal concentrations ($mg.l^{-1}$)	Weight (g) or volume (ml) added	Actual nominal concentration ($mg.l^{-1}$)
Treated seawater	250	100	2.5ml from 10000mg/l	100
	250	320	8ml from 10000mg/l	320
	250	1000	25ml from 10000mg/l	1000
	250	3200	80ml from 10000mg/l	3200
	500	10000	5.002g	10004

Definitive test results

Table 1.5 Mortality of *Acartia* after 24h and 48h exposure

Nominal Concentration ($mg.l^{-1}$)	Number/dead immobile at 24h		Number dead/immobile at test termination (48h)		Total exposed	Proportional response	
	Replicate a	Replicate b	Replicate a	Replicate b		24h	48h
100	0	0	2	2	20	0.00	0.20
320	1	1	2	2	18	0.11	0.22
1000	2	0	2	0	20	0.10	0.10
3200	0	2	9	8	18	0.11	0.94
10000	9	9	9	9	18	1.00	1.00

Table 1.7 Calculated LC_{50} values with 95% confidence limits, and 48h LC_{90} and NOEC values

Test material		LC_{50} ($mg.l^{-1}$)	95% Confidence limits ($mg.l^{-1}$) Lower	Upper	48h LC_{90} ($mg.l^{-1}$)	48h NOEC ($mg.l^{-1}$)
Firestopper®PFE-FR	24h	6175	5027.5	6789.32		
	48h	2040.61	1706.33	2327.69	3095.04	1000

Interpretation

The test was conducted in accordance with the study plan and met all relevant validity criteria.

Firestopper®PFE-FR exhibited a 48h LC_{50} value of 2040.61$mg.l^{-1}$ (dilution series) to the marine copepod *Acartia tonsa* in the aqueous phase.

The result is based on nominal concentrations and was calculated by Linear Interpolation within the Toxcalc suite of statistical analysis.

At 48 hours, it was found that the temperature of the test pots and some of the reference chemical pots was slightly over (≤0.6°C) the guide limit. As the increase was only very small, and no unusual effects were observed, this was determined to have had no effect on the test result.

There were no interferences in this test.

Retention and archiving of test documentation

The study plan and all data and records generated during the test are archived at Opus Plus Ltd's offices, and will be retained for a period of three and a half years from the date of the study.

References

ISO 14669 (1999) Water Quality: Determination of acute lethal toxicity to marine copepods (Copepoda;Crustacea).

ISO 5667-16 (1998) Water Quality Sampling – Guidance on biotesting of samples.

ToxCalc Version 5 Tidepool Scientific Software.

Appendix A

Test organisms

The Initial culture, CCAP 1077/5 was received from Dunstaffnage Marine Laboratory in 1995.

The test organisms were cultured in accordance with SOP 501 to provide age standardised cohorts. Organisms used for testing were between 17 and 25 days old at test commencement; stage 5 in their life cycle. The culture system was maintained with flowing 0.45 µm filtered ultra violet treated sea water, supplied by pump from Scapa Flow in Orkney. The cultures were maintained on a mixed algal diet comprising of between 2 and 4 species.

Test method and guidelines

Test methods were consistent with ISO 14669 (1999) Water Quality: Determination of acute lethal toxicity to marine adult copepods (*Copepoda; Crustacea*).

ISO 5667-16 (1998) Water Quality Sampling – Guidance on biotesting samples.

The method estimates the effect of chemicals on the mortality/immobility on adult copepods over a period of 48h at a temperature of 20±2 °C.

Test procedure

Tests were conducted in 100 ml capacity borosilicate glass crystallising dishes, each containing 50 ml of test medium covered with soda glass watch covers.

Rangefinding tests were conducted at 1000, 100, 10 and 1 $mg.l^{-1}$, plus four control vessels. Definitive test concentrations depend on the magnitude of response evident in the Rangefinding test and employ five concentrations, plus four control vessels.

In the Rangefinding tests, five animals were exposed per concentration and in definitive tests ten animals were exposed per replicate (20 per treatment). Test animals were transferred to test vessels using glass pipettes of three to five millimetres in diameter (internal) and with fire polished rims.

Measurement of water quality (dissolved oxygen, pH and temperature) are carried out in one replicate at each concentration at 0h and 48h. Observation of mortalities are carried out at 24h and 48h. An animal is regarded as immobile if after gentle stimulation no movement is visible after 10 seconds.

A salinity measurement is carried out in the control medium at 0h.

Statistical methods

Mortalities are determined in each vessel at 24 and 48h. The number of dead or immobile copepods are expressed as a proportion of the total number exposed.

Where sufficient response is observed, the 24 and 48h LC_{50}, 48h LC_{90} and 48h NOEC values are calculated using an appropriate statistical method from the ToxCalc Version 5 software.

Appendix B

Test material preparation

The test material was assessed for risk to health, and appropriate handling and containing procedures were implemented. Following this, a comparison of the reported and observed physical characteristics (eg form, colour, odour, pH and density) of the test material was carried out.

In order to determine an appropriate test preparation method, an assessment was made of the material's behaviour in seawater. A 1000 $mg.l^{-1}$ stock was prepared in filtered seawater, and the resulting mixture was stirred for one hour. If the material was observed to be soluble a dilution series was prepared, where an appropriate weight of test material was added to prepare an initial stock. Appropriate volumes were taken from this stock to prepare subsequent test concentrations which were brought to volume with culture medium. If it was poorly soluble then it was stirred again for approximately 19 hrs, then left to settle for one hour and its behaviour assessed (SOP 402). If, the material produced floating, settled or neutrally buoyant particles or films, it was classified as poorly soluble and exposures were carried out with Water Accommodated Fractions (WAFs). WAFs were prepared by the direct addition of the required nominal weights or volumes to seawater followed by gentle stirring for approximately 20 hours and a settling period of approximately one hour. After this settling period, the middle phase of the preparation is siphoned, avoiding incorporation of undissolved particles, if present.

A reference test was conducted concurrently using 3,5 Dichlorophenol at 0.10, 0.32, 1.0, 1.8 and 3.2 $mg.l^{-1}$ which were prepared from a main stock of 100 $mg.l^{-1}$. The 100 $mg.l^{-1}$ stock was stirred for a minimum of one hour, or until completely dissolved.

If, at 0h, the pH of the dilution water is out with the pH range of 8 ± 0.3 then pH will be returned to within these limits by adjustment with either 1M HCl or NaOH as is appropriate.

Natural seawater is supplied by pump from Scapa Flow, Orkney and is UV sterilised and filtered to 0.2 µm. The salinity of the seawater should be 36 ± 4 ‰.

Appendix C

Control data

Table C1 Age of test organisms at test commencement

Culture number	Date initiated	Date sampled	Age at 0h test
T 3	10 August 2011	31 August 2011	19 Days

Table C2 Test room temperature

	0h	24h	48h
Date	31 August 2011	1 September 2011	2 September 2011
Temp (°C)	20.8	19.6 – 21.5	19.7 – 21.5

Table C3 Water quality in 3,5 DCP and control vessels at end of 48h test

Nominal Concentration ($mg.l^{-1}$)	pH	Temperature (°C)	Dissolved Oxygen (%)
Control	8.13	21.4	96
0.10	8.07	22.1*	95
0.32	8.11	22.3*	95
1.0	8.09	22.2*	96
1.8	8.06	21.7	96
3.2	8.09	21.6	97

** Temperature above limits. See interpretation.*

Table C4 ***Acartia*** **mortality after 48h exposure to 3,5 DCP and control media**

Nominal Concentration ($mg.l^{-1}$)		Number dead/immobile		Total exposed	Proportional response 48h
		Replicate a	Replicate b		
Control	1	1		9	0.11
	2	1		10	0.10
	3	1		9	0.11
	4	1		9	0.11
	5	0		9	0.00
	6	0		10	0.00
	7	2		11	0.18
	8	0		11	0.00
3,5 DCP	0.10	3	0	19	0.16
	0.32	2	3	20	0.25
	1.0	7	9	19	0.84
	1.8	11	10	21	1.00
	3.2	9	10	19	1.00

Table C5 **Calculated 3,5 DCP LC_{50} ($mg.l^{-1}$) values with 95% confidence limits**

Test material	48h LC_{50}	95% confidence limits	
		lower	upper
3,5 DCP	0.65	0.51	0.77

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CHEMISTRY AND CHEMICAL ENGINEERING DIVISION
FIRE TECHNOLOGY DEPARTMENT
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September 12, 2006

NSF-ISR
QUALITY SYSTEM REGISTERED TO ISO 9001:2000

Mr. Ranjit Bedi
FireStopper Chemicals and Technologies Company, Inc.
16070 Sunset Blvd., No. 303
P.O. Box 655
Pacific Palisades, CA 90272

Subject: SwRI® Final Report No. 01.11812.01.309a

Dear Mr. Bedi:

Enclosed please find two copies of the above-referenced report, along with a CD containing photographic documentation. If you should have any questions or if I can be of further assistance, please feel free to contact me at 210-522-3632, or you can reach me by fax at 210-522-3377.

Sincerely,

Jason P. Huczek
Research Engineer
Engineering and Research Section

JH/llr
W:\fire\Rachelle McCoy\Jason\Reports\r11812-309a.doc

Enclosures: 1) 2 Copies of Final Report
2) 1 Photo CD

cc: Record Copy A (FTD) w/o Enc. 2
Record Copy B (IQS) w/o Enc. 2
Cory Machado, SwRI

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NSF-ISR
QUALITY SYSTEM REGISTERED TO ISO 9001:2000

TESTING OF FIRE EXTINGUISHERS, IDENTIFIED AS 0.8-L FR EXTINGUISHER, 0.95-L PFE EXTINGUISHER, AND 0.8-L FOG1 EXTINGUISHER, CONDUCTED FOR CLASS C PERFORMANCE IN ACCORDANCE WITH UL 711 (6TH EDITION) / CAN/ ULC-S508 (4TH EDITION), *RATING AND TESTING OF FIRE EXTINGUISHERS (2002 EDITION)*

FINAL REPORT
Consisting of 7 Pages
SwRI® Project No. 01.11812.01.309a
September 12, 2006

Prepared for:

FireStopper Chemicals and Technologies Company, Inc.
16070 Sunset Blvd., No. 303
P.O. Box 655
Pacific Palisades, CA 90272

Prepared by:

Jason P. Huczek
Research Engineer
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Approved by:

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Engineering and Research Section

ABSTRACT

The objective of the test program was to evaluate the effectiveness of three different fire extinguishers, identified by FireStopper Chemicals and Technologies Company, Inc., as 0.8-L FR Extinguisher, 0.95-L PFE Extinguisher, and 0.8-L FOG1 Extinguisher. Specifically, Class C testing was conducted in accordance with Underwriter's Laboratory (UL) Test Standard 711 (6th Edition), *Rating and Testing of Fire Extinguishers (2002 Edition).*

The standard for the rating and testing of fire extinguishers is a common standard between UL and Underwriter's Laboratories of Canada (ULC). The ULC designation for the standard is CAN/ULC-S508 (4th Edition).

Testing was conducted on August 16, 2006, at the National Electric Energy Testing, Research & Applications Center (NEETRAC), which houses the High Voltage Laboratory, located at the Georgia Institute of Technology, in Atlanta, Georgia. A representative of Southwest Research Institute's (SwRI) Fire Technology Department (FTD), Mr. Jason Huczek, witnessed the testing at NEETRAC.

Both the FR and FOG1 fire extinguishers successfully met the requirements of UL 711 (Class C) at both ambient and elevated temperatures for a separation distance of 24 in. The PFE fire extinguisher successfully met the requirements of UL 711 (Class C) at both ambient and elevated temperatures for a separation distance of 36 in.

1.0 INTRODUCTION

The objective of this program was to evaluate the effectiveness of three different fire extinguishers, identified by FireStopper Chemicals and Technologies Company, Inc. (Client) as 0.8-L FR Extinguisher, 0.95-L PFE Extinguisher, and 0.8-L FOG1 Extinguisher.

Specifically, Class C testing was conducted in accordance with Underwriter's Laboratory (UL) Test Standard 711 (6th Edition), *Rating and Testing of Fire Extinguishers (2002 Edition).* The standard for the rating and testing of fire extinguishers is a common standard between UL and Underwriter's Laboratories of Canada (ULC). The ULC designation for the standard is CAN/ULC-S508 (4th Edition). The remainder of this final report refers to this common standard as UL 711 for simplicity.

Testing was conducted on August 16, 2006, at the National Electric Energy Testing, Research & Applications Center (NEETRAC), which houses the High Voltage Laboratory, located at the Georgia Institute of Technology, in Atlanta, Georgia. A representative of Southwest Research Institute's (SwRI's) Fire Technology Department (FTD), Mr. Jason Huczek, witnessed the testing at NEETRAC.

The test methods described in this report are intended to measure and describe the properties of materials or products in response to heat and flame under controlled laboratory conditions. The results should not be used alone to describe or appraise the fire hazard or the fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a complete fire hazard for fire risk assessment, which takes into account all the factors that are pertinent to an assessment of the fire hazard or risk of a particular end-use.

The results presented in this report apply specifically to the specimens tested, in the manner tested, and not to the entire production of these or similar materials, nor to the performance when used in combination with other materials.

2.0 SAMPLE DESCRIPTION

The Client supplied three models of fire extinguishers with corresponding extinguisher agent for testing. All extinguishers were received from the Client on August 16, 2006, at NEETRAC. The extinguishers were identified as "0.8-L FR Extinguisher," "0.95-L PFE Extinguisher," and "0.8-L FOG1 Extinguisher." Details on the extinguisher types are provided below:

1. 0.8-L Capacity FR Extinguisher (Model PFE 102/FFN-100)
   - Nozzle Type: Fog/Mist
   - Operating Pressure Range: 220-250 psig (nominal operating pressure: 240 psig)

- Media (Extinguishing Agent): FireStopper FR, water thin to slightly viscous clear to hazy liquid (pH: 7.0 – 7.8, Specific Gravity: 1.1 – 1.3)
- Operating Temperature: Approximately ¯100 to 180°F
- Discharge Range: Approximately 5 - 8 ft

2. 0.95-L Capacity PFE Extinguisher (Model PFE 103/FAN-100)
   - Nozzle Type: Foam Aerated
   - Operating Pressure Range: 220-250 psig (nominal operating pressure: 240 psig)
   - Media (Extinguishing Agent): FireStopper PFE, water thin, clear liquid (pH: 7.0 - 7.6, Specific Gravity: 1.04 – 1.1)
   - Operating Temperature: Approximately ¯20 to 180°F
   - Discharge Range: Approximately 8 - 10 ft
3. 0.8-L Capacity FOG1 Extinguisher (Model FN-101)
   - Nozzle Type: Fog/Mist
   - Operating Pressure Range: 220-250 psig (nominal operating pressure: 240 psig)
   - Media (Extinguishing Agent): FireStopper FR, water thin to slightly viscous clear to hazy liquid (pH: 7.0 – 7.8, Specific Gravity: 1.1 – 1.3)
   - Operating Temperature: Approximately ¯100 to 180°F
   - Discharge Range: Approximately 5 - 8 ft

Each extinguisher model consisted of a stainless steel canister with a stainless steel application nozzle. Each extinguisher model is described as a modular, disposable, pre-charged cartridge unit. Additional detailed information about the fire extinguishers is on file in SwRI's FTD, Listing, Labeling, and Follow-Up Inspections Section.

3.0 UL 711 CLASS C TEST PROCEDURE

Fire extinguishers that are "C" classified must be able to meet the requirements of an electrical conductivity test. There are no tests for the fire-extinguishing capability of an extinguisher on an electrical fire, so there are no numerical components of Class C ratings. Rather, the Class C rating is in conjunction with a Class A, B, and/or K rating.

The electrical conductivity test consists of impressing a high-voltage (100,000 VAC) at 60 hertz, between an electrically insulated extinguisher and an electrically charged target. The current flow through the path formed by the agent during the discharge towards the target is measured and shall be no more than one milliampere. In addition, there shall be no arc observed during the discharge between the target and the extinguisher or extinguishing agent.

A schematic of the circuit design used for this test procedure can be referenced in Figure 5 of UL 711. Figures 1 and 2 of this report each show photographs of the general setup at NEETRAC for this testing.

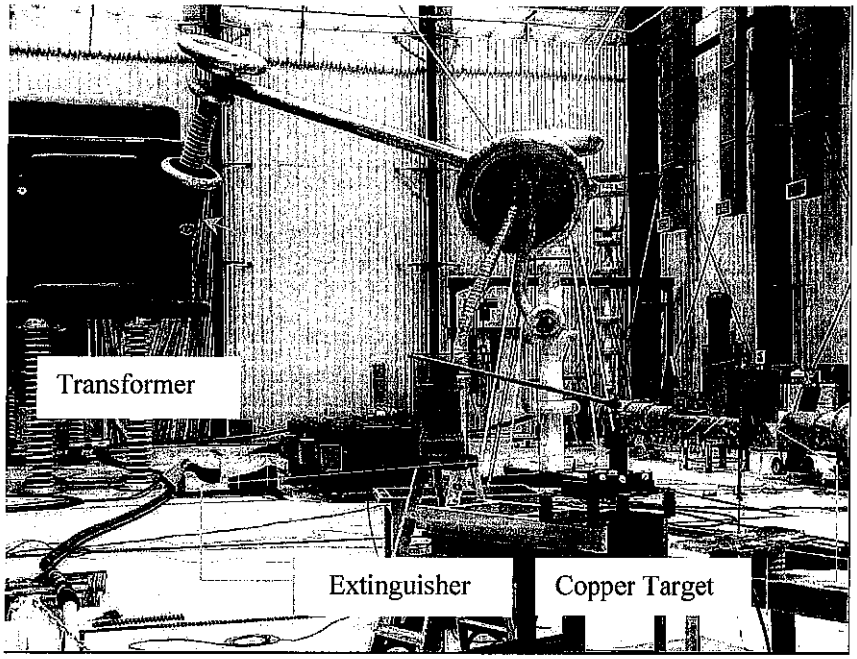

Figure 1. General Setup Illustrating Step-Up Transformer Voltage Source, Extinguisher, and Target.

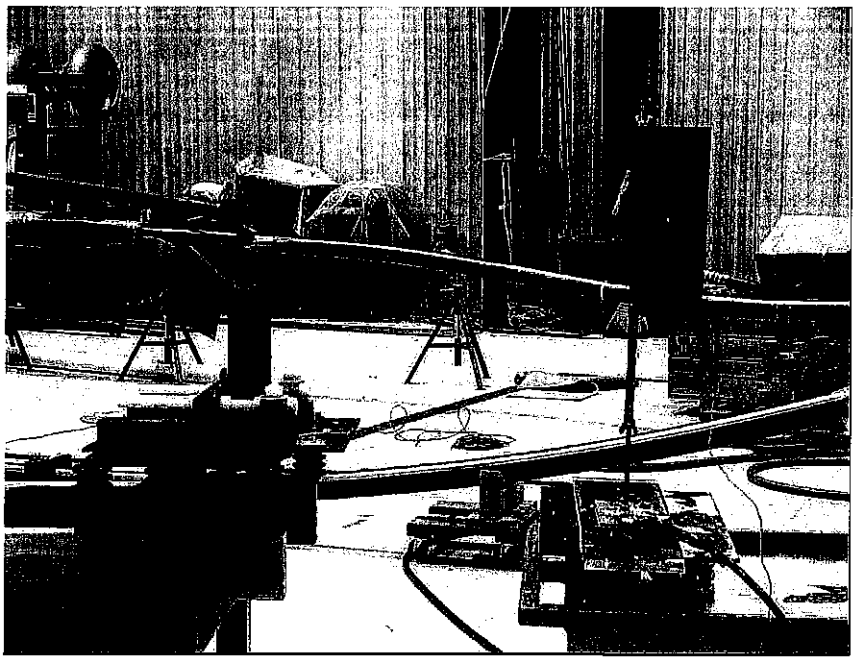

Figure 2. General Setup Illustrating Test Extinguisher and Target.

The target is placed at varying distances from the extinguisher to determine the minimum distance at which a potential of 100,000 volts is capable of being maintained without an arc or without allowing a maximum of one milliampere of current pass through the connection. Typically, the extinguisher is to be operated for 20 sec; however, since all three test extinguishers have discharge times of less than 20 sec, they were operated until the contents were fully released (12-15 sec).

This test is repeated for each extinguisher, after the target plate has been heated to an initial temperature of 370°C (700°F) prior to the discharge of the extinguisher's contents.

4.0 RESULTS

Testing was conducted on August 16, 2006, at NEETRAC's High Voltage Laboratory. A representative of SwRI's Fire Technology Department (FTD), Mr. Jason Huczek, witnessed the testing at NEETRAC. Figures 3-5 provide photographs of a successful test for the FR, PFE, and FOG1 extinguishers, respectively.

The FR and FOG1 fire extinguishers successfully met the requirements of UL 711 (Class C) at both ambient and elevated temperatures for a separation distance of 24 in. The PFE fire extinguisher successfully met the requirements of UL 711 (Class C) at both ambient and elevated temperatures for a separation distance of 36 in.

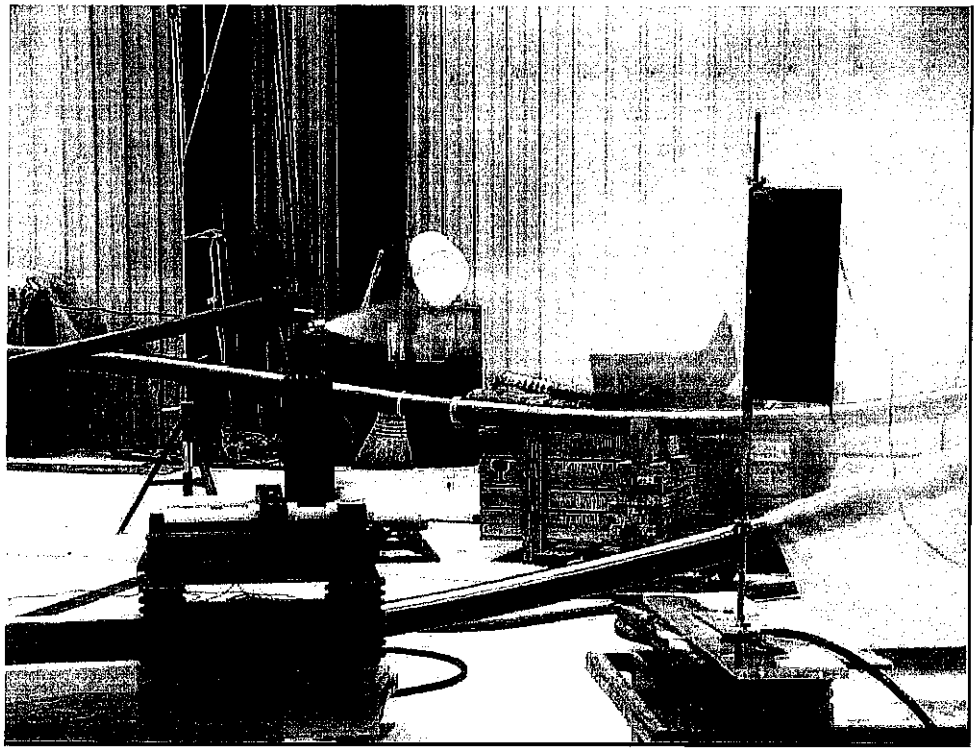

Figure 3. 0.8-L FR Extinguisher – UL 711 (Class C) – Test in Progress.

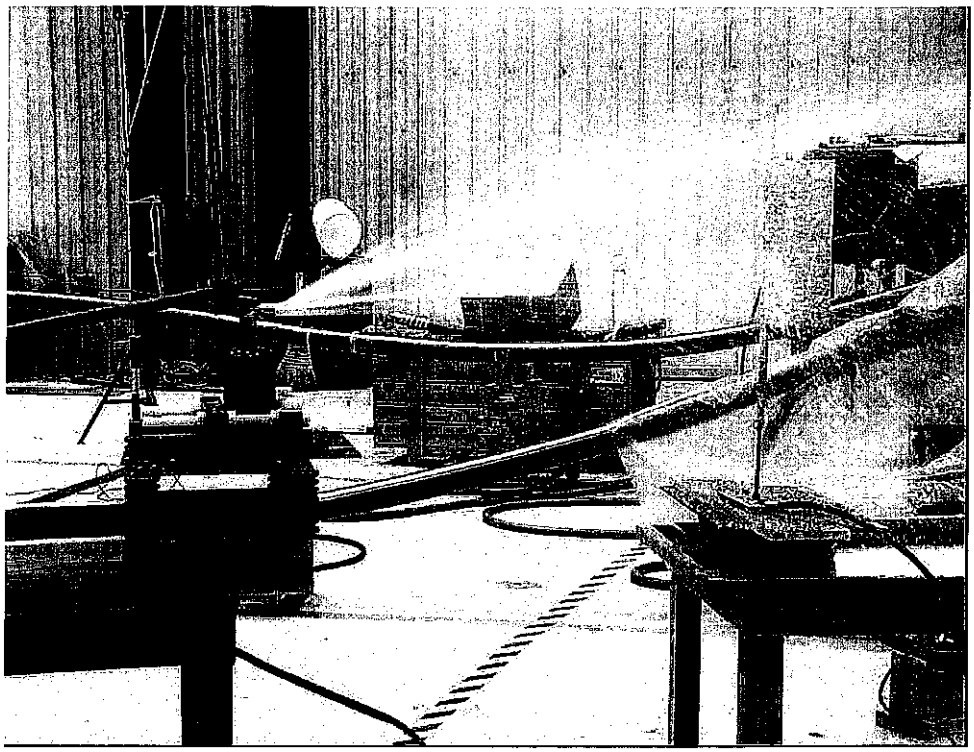

Figure 4. 0.95-L PFE Extinguisher – UL 711 (Class C) – Test in Progress.

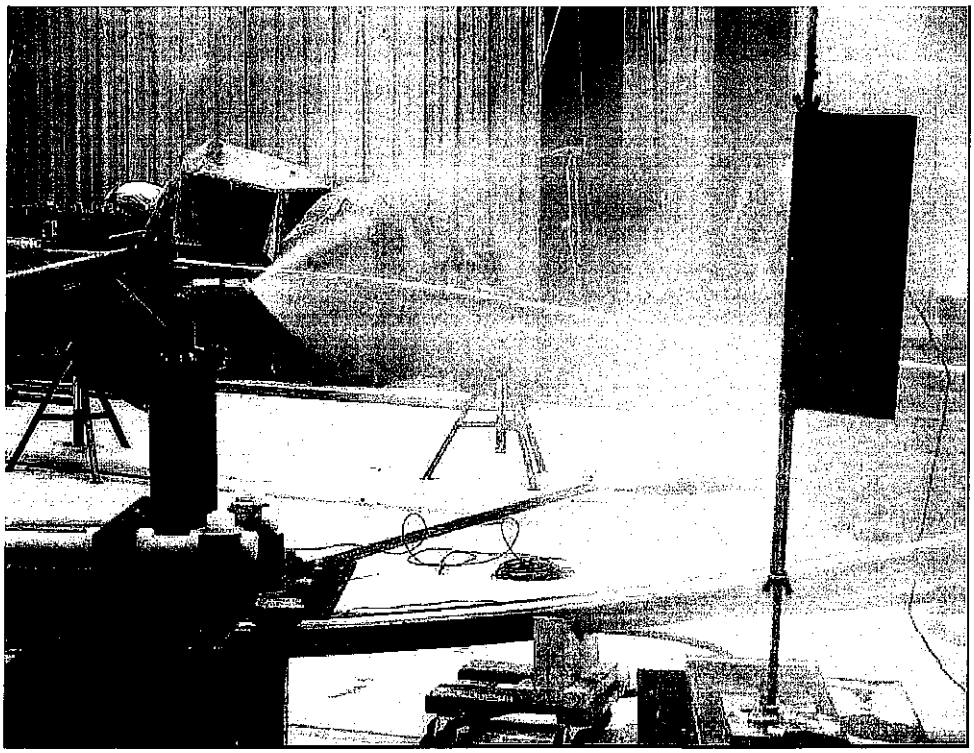

Figure 5. 0.8-L FOG1 Extinguisher – UL 711 (Class C) – Test in Progress.