Tests of the General Fire Suppression Concentrate Pyrocap B-136

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August 1990

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16. Abstract

Fire extinguishing effectiveness of the general fire suppression concentrate identified as Pyrocap B-136 was determined by laboratory experiments and large-scale fire tests. This agent demonstrated strong emulsifying properties toward Jet A, kerosene fuel; JP-4, kerosene and gasoline fuel blend; and avgas, aviation gasoline fuel. At 6 percent concentration, Pyrocap B-136 extinguished large Jet A fuel fires when applied at the rate of 0.052 gallon per minute per square foot. At 30 percent concentration, the agent was effective in extinguishing magnesium aircraft wheel fires at a low application rate.

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PREFACE

This Technical Note was prepared at the Federal Aviation Administration (FAA) Technical Center, Atlantic City International Airport, New Jersey 08405, under FAA Project T1702F and under Project Order No. F84-80, for the Air Force Engineering and Services Center, Engineering and Services Laboratory (HQ AFESC/RDCF), Tyndall Air Force Base, Florida 32403-6001.

The report summarizes the evaluation of the general fire suppression concentrate identified as Pyrocap B-136 and manufactured by Pyrocap, Incorporated, 6551 Loisdale Court, Suite 400, Springfield, Virginia 22155-1845. This evaluation was part of an investigation of state-of-the-art and new agents for use at commercial or general aviation airports and heliports.

The Pyrocap concentrate was brought to the attention of the Department of Transportation (DOT) and the FAA by Representative Curt Weldon, Chairman of the Congressional Fire Services Caucus.

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INTRODUCTION

PURPOSE.

The principal objectives of this investigation were to evaluate the Pyrocap B-136 as a fire extinguishing and emulsifying agent for aviation fuels and as an extinguishing agent for magnesium metal (Class D) fires.

BACKGROUND.

The heavy duty surface active agents have been known and employed in the petrochemical industry for many years for cleaning the holds of petroleum tanker ships and barges whenever cargos are changed. More recently, large oil spills from leaking tankers have claimed the attention of oil companies to develop economical and ecologically safe methods for minimizing these potential environmental hazards. This technology is currently being exploited in the development of a potentially new class of auxiliary firefighting agents for the control and extinguishment of fuel spill fires and magnesium wheel fires at airports.

DISCUSSION

EMULSIFICATION PROCESS.

There are four classes of surface active agents available for modifying the surface activity of water that are dependent upon the active moiety in the surfactant molecule. The classes are identified as anionic, cationic, nonionic, and amphoteric. Within each class, the molecular structure can be varied widely; and by proper blending, the resulting product can be tailored to meet specific chemical and physical requirements.

The preparation of an oil in water dispersion requires the input of mechanical energy into a simple mixture of oil and water. In general, the higher the shearing stress applied to the system, the smaller the oil droplets become. Regardless of their size, however, the oil droplets will rise rapidly to the water surface and coalesce to reform a homogeneous layer. Therefore, to produce stable emulsions, it is necessary to add a suitable surface active or emulsifying agent to the water phase prior to dispersing the oil. By this means, the interfacial tension between the oil and water phases is reduced to a level which permits a film of surfactant solution to form around each oil droplet, thereby retarding the coalescence of the oil droplets and subsequent vaporization of the oil or fuels, such as Jet A, JP-4, and avgas (Jet A, kerosene fuel; JP-4, kerosene and gasoline fuel blend; avgas, aviation gasoline fuel).

PHYSIOCHEMICAL PROPERTIES OF PYROCAP B-136.

The physical and chemical properties employed to identify the Pyrocap B-136 agent were the specific gravity, viscosity, and hydrogen ion concentration (pH). These values for Pyrocap B-136, Batch No. 45 VA 299-910, are provided in table 1.

TABLE 1. PROPERTIES OF PYROCAP B-136

AGENT	SPECIFIC GRAVITY	VISCOSITY CENTIPOISE at 68 °F	CONCENTRATE pH
Pyrocap B-136	1.03	573	8.15

The variations of the hydrogen ion concentration with the solution concentration are presented in appendix A.

The degree to which the Pyrocap B-136 agent modified the physical properties of water was measured in terms of the surface tension (ST) and interfacial tension (IT) between Jet A, JP-4, and avgas fuels at various solution concentrations. The spreading coefficients (SC) calculated from these values are plotted in figure 1 as a function of solution concentration.

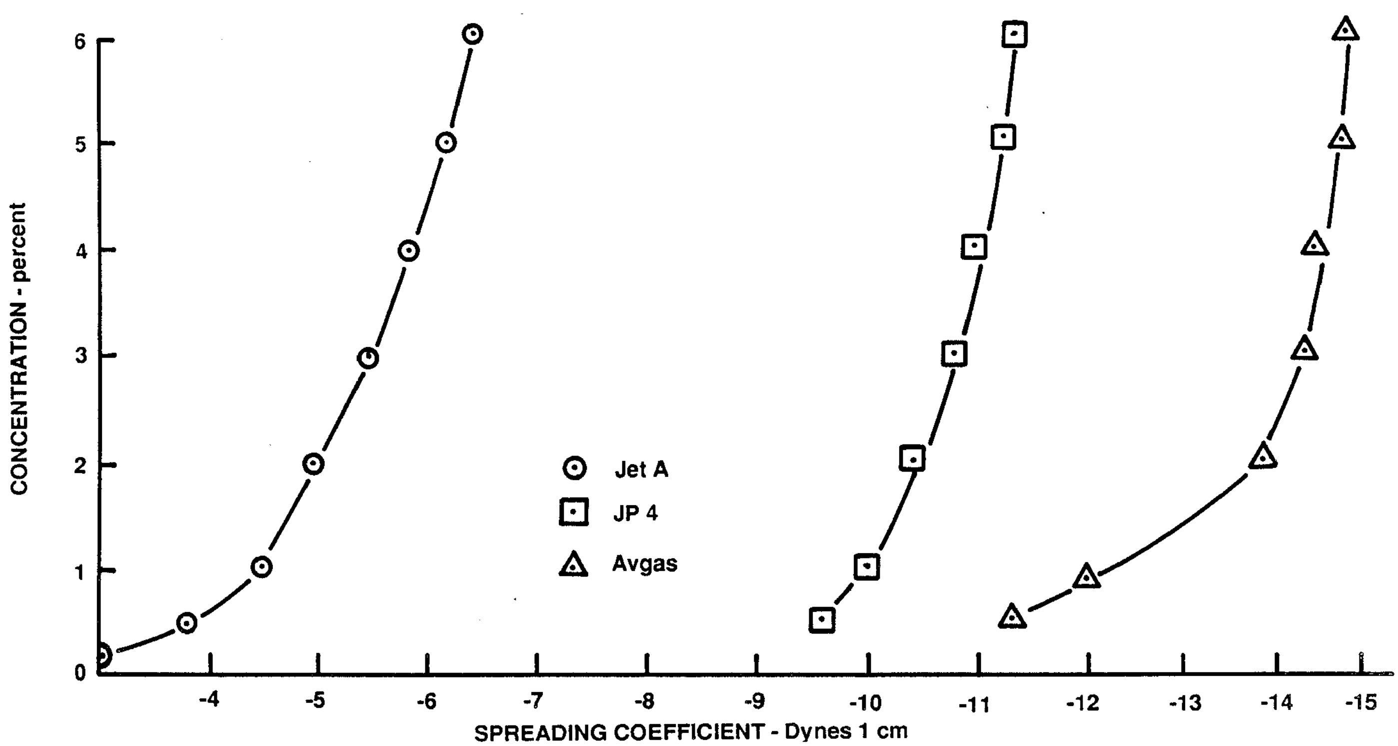


FIGURE 1. VARIANCE OF THE SPREADING COEFFICIENT WITH SOLUTION CONCENTRATION FOR PYROCAP B-136 AGAINST Jet A, JP4 AND AVGAS

According to classical theory concerning the spontaneous spreading of insoluble films on liquids, if the spreading coefficient has a value greater than zero (i.e., positive), the aqueous phase can spread spontaneously upon or "wet" the fuel. A coefficient below zero (i.e., negative) indicates that it cannot spread spontaneously. When the spreading coefficient is zero, the liquids are miscible.

All solution concentrations of Pyrocap B-136 had negative spreading coefficients against Jet A, JP-4, and avgas fuels, with avgas demonstrating the greater negativity.

EMULSIFICATION CHARACTERISTIC OF PYROCAP B-136.

The emulsifying capability of Pyrocap B-136 was visually assessed by blending premixed water solutions (20 milliliters, ml) of selected concentrations from 0.5 to 6 percent and at 30 percent by volume with 60 ml of Jet A, JP-4, and avgas fuels and vigorously shaking each mixture. Photographs showing the quality of the initial emulsion obtained with each fuel and the degree of phase separation with time, are presented in appendix B for Jet A (figure B-1), JP-4 (figure B-2), and avgas (figure B-3).

EMULSIFICATION OF JET A FUEL. Appendix B, figure B-1 (a) shows various solution concentrations of Pyrocap B-136 below the Jet A fuel prior to agitation. Figure B-1 (b) shows the degree of emulsification obtained 10 seconds after agitation. The photograph indicates that only a very small quantity of fuel in solution (water) emulsion appeared on the surface of the Jet A fuel at concentrations from 0.5 to 3 percent and that some floc was present at the interface between the fuel and solution. At a solution concentration of 4 percent, a visible fuel in solution emulsion developed on the fuel surface and a uniform distribution of light floc appeared throughout the fuel phase. When the concentration of surface active agent was further increased to 5 and 6 percent, the visible fuel in solution emulsion increased to 5.7 and 7.6 millimeters, respectively. Figure B-1 (c) shows the fuel and solution phase separation after 5 minutes. At surfactant concentrations from 0.5 to 3 percent, the fuel in solution emulsion was negligible. The emulsions formed at concentrations from 4 to 6 percent remained stable and increased in depth with agent concentration.

At 30 percent concentration, approximately 25 percent of the aqueous phase remained at the cylinder bottom, while the remainder appeared to be evenly distributed throughout the Jet A fuel. The mixture of Jet A fuel and water showed no tendency to form a stable emulsion.

Based upon these experiments, the 6 percent solution of Pyrocap B-136 was selected for the Jet A pool fire tests.

EMULSIFICATION OF JP-4 FUEL. Appendix B, figure B-2 (a) shows various solution concentrations of Pyrocap B-136 beneath the JP-4 fuel layer before agitation. Figure B-2 (b) shows the degree of emulsification obtained 10 seconds after agitation. Approximately 3.8 millimeters of emulsion was formed on the surface of the JP-4 fuel at Pyrocap B-136 concentrations from 0.5 to 4 percent and various quantities of white floc remained suspended within the fuel phase. The emulsions produced at solution concentration of 5 and 6 percent increased to approximately 11.4 and 22.8 millimeters, respectively, and the white floc produced remained evenly distributed within the fuel phase. The 30 percent solution of Pyrocap B-136 was distributed within the fuel phase with a large quantity of the agent settling to the bottom of the cylinder.

Figure B-2 (c) shows the phase separation after 5 minutes. Solution concentrations from 0.5 to 3 percent show well-defined emulsion layers of approximately 3.8 to 5.7 millimeters floating on the surface of the JP-4 fuel. The emulsions produced at agent concentrations of 5 and 6 percent remained stable.

At 30 percent concentration, the distribution of the Pyrocap B-136 within the fuel mixture did not appear to have changed with time. The mixture of JP-4 fuel and water showed no tendency to form a stable emulsion.

No fire tests were performed with JP-4 fuel since it was not available in the quantity required at the test site.

EMULSIFICATION OF AVIATION GASOLINE. Appendix B, figure B-3 (a) shows various solution concentrations of Pyrocap B-136 below the avgas phase before agitation. Figure B-3 (b) shows the degree of emulsification obtained 10 seconds after agitation. The quantity of emulsion produced by agent concentrations from 0.5 to 5 percent is shown as a thin white band approximately 2 to 3 millimeters thick floating on the surface of the avgas fuel. As the agent concentration was increased to 6 and 7 percent, the emulsion band increased to 5 and 6 millimeters in depth. It is also apparent that all of the aqueous agent phase between 1 and 7 percent is temporarily contained in the white floc. At 30 percent concentration, the Pyrocap B-136 agent produced a floc that was evenly distributed throughout the avgas phase.

Figure B-3 (c) shows the rapid settling of the floc at solution concentrations from 1 to 7 percent; however, at the higher concentrations the aqueous solution phase was more firmly bound into the floc during formation.

At a concentration of 30 percent, the floc was starting to show phase separation at the surface of the avgas. The mixture of avgas and water showed no tendency to form a stable emulsion when agitated.

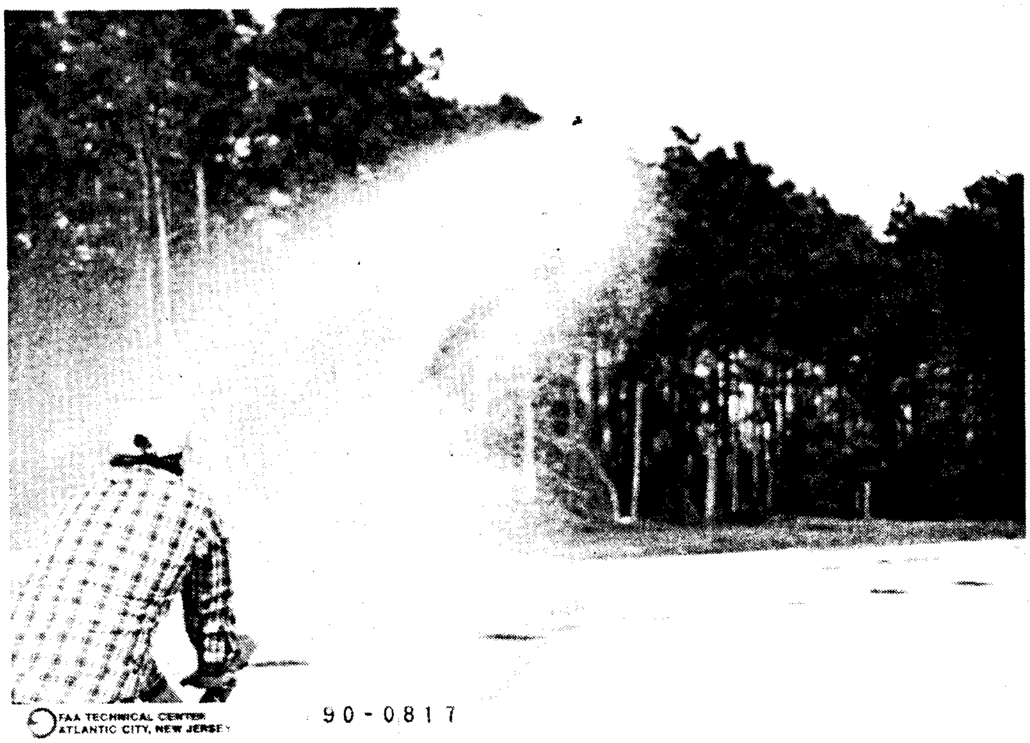
Based upon these experiments, the 6 percent solution of Pyrocap B-136 was selected for the avgas pool fire tests.

FIRE TEST PROCEDURES.

THROW RANGE OF PYROCAP B-136. To establish the most effective firefighting techniques to be employed during the large-scale fire tests, it was expedient to know the effective throw range and ground area covered by the discharge. These parameters would, in part, be employed to establish the nozzle elevation and rate of traverse that the firefighter would employ during the fire control and extinguishing operations.

To establish stable fuel-in-water emulsions, the nozzle stream must be plunged directly into the fuel surface at the base of the fire plume. This procedure is in direct contrast with that required in firefighting operations employing mechanical foam agents, such as aqueous film forming foams (AFFF).

The fluid ground patterns produced by Pyrocap B-136 discharged at 100 and 230 pounds per square inch (psi) are shown in figure 2. In these experiments, the throw ranges varied from 45 to 72 feet and widths from 11 to 22 feet.



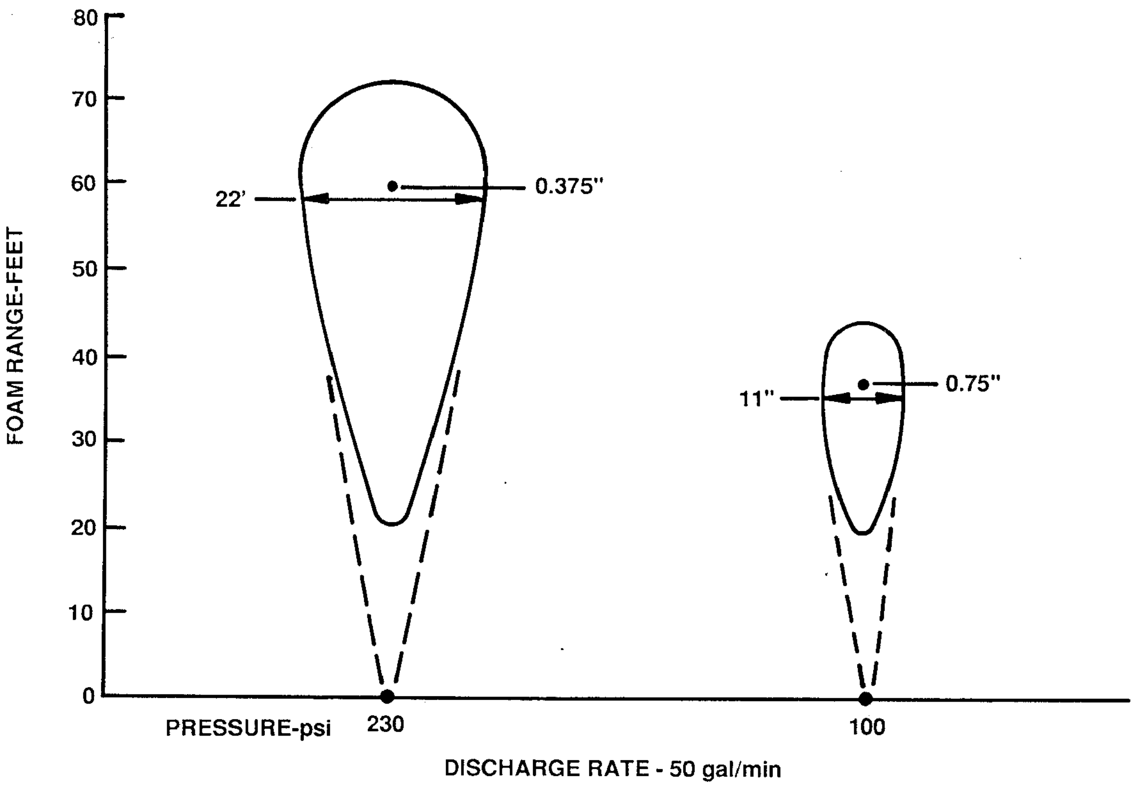


FIGURE 2. AVERAGE DIMENSIONS OF THE GROUND PATTERNS PRODUCED BY PYROCAP B-136

POOL FIRES. The first test bed was a 35-foot-diameter fire pit which contained sufficient water to provide a smooth water base upon which the Jet A fuel (335 gallons) was floated. A preburn period of 45 seconds was allowed after complete involvement of the fuel surface was obtained.

The fire was approached from the upwind side by an experienced firefighter committed to extinguishing the fire as rapidly as possible. The extinguishing fluid was applied as a 6 percent premixed solution from a 50-gallon-per-minute solid stream, air-aspirating nozzle under nitrogen pressure at 230 pounds per square inch.

Prior to conducting experiments with the emulsifying agent, a series of tests was performed using a 3 percent type aqueous film forming foam (AFFF) agent conforming with the requirements of MIL-F-24385C to establish the baseline characteristics of the procedure.

After each fire test employing the fuel-in-water emulsifying agent, the residual fuel was completely burned off the surface of the fire pit and the water was pumped out in preparation for a fresh charge of water and fuel.

SIMULATED FUEL SPILL FIRES. For the second test a Jet A fuel spill fire was simulated in a 20-foot-square bunded area containing 750 gallons of fuel. The fuel was preburned for 45 seconds after full involvement of the pit was obtained. A 6 percent premixed solution of Pyrocap B-136 was plunged into the fuel surface at the rate of 50 gallons per minute and 230 pounds-per-square-inch nozzle pressure.

FIRE TEST RESULTS.

POOL FIRES. The 6 percent premixed solution of Pyrocap B-136 controlled and extinguished the 962-square-foot Jet A pool fire in 18 seconds and 32 seconds, respectively. The estimated depth of the Jet A emulsion layer was 1/8 inch. In this experiment, some of the emulsifying water may have been derived from the aqueous substrate beneath the fuel layer. The burnback test required 160 seconds to break the emulsion and completely involve the fuel surface. The photographs presented in appendix C show four critical phases during the fire control and extinguishing process using the Pyrocap B-136 agent.

At the conclusion of the burnback test, a second attempt was made to extinguish the fire, and control and extinguishment were accomplished in 17 seconds and 30 seconds, respectively. No burnback time was recorded for this experiment. The results of these tests are summarized in table 2.

SPILL FIRES. The 6 percent premixed solution of Pyrocap B-136 applied at 0.125 gallons per minute per square foot controlled and extinguished the 400-square-foot fire in 28 seconds and 57 seconds, respectively. The fire burnback time was 184 seconds.

At the conclusion of the burnback period, a second attempt was made to control and extinguish the fire. This was accomplished in 28 seconds and 52 seconds, respectively, followed by a burnback period of 103 seconds.

An approximation of the depth of the Jet A fuel-in-water emulsion that was formed during the fire extinguishing process was 1/8 inch for the circular pool

TABLE 2. SUMMARY OF FIRE TEST RESULTS

Agents	Solution Conc. %	Fire Area ft2	Solution Rate gpm	Application Density gpm/ft2	Control Time sec.	Extinguishing Time sec.	Burnback Time sec.	Fuel
POOL FIRES								
Pyrocap B-136	6	962	50	0.052	18	32	160	Jet A
Pyrocap B-136	6	962	50	0.052	17	30	---	Jet A
SPILL FIRES								
Pyrocap B-136	6	400	50	0.125	28	57	184	Jet A
Pyrocap B-136	6	400	50	0.125	28	52	103	Jet A
Pyrocap B-136	6	400	50	0.125	none	none	---	AVGAS
*AFFF	3	962	50	0.052	9	12	MIL-F-24385C	

*For comparison only

fire with the water substrate and 3/16 inch for the simulated fuel spill fire without the water substrate. The larger quantity of Pyrocap B-136 solution used per square foot of fire surface in the fuel spill simulation test was required to provide an adequate depth of the fuel-in-water emulsion to secure the fuel surface from vapor penetration.

In a third simulated spill fire, 500 gallons of avgas was employed in the 400-square-foot bunded pit. The 6 percent premixed Pyrocap B-136 solution discharged at 50 gallons per minute and 230 pounds per square inch nozzle pressure was not able to emulsify the avgas. The solution discharge stream was varied from direct plunging to a gentle application without success, and the fuel continued to burn with undiminished intensity until it was all consumed. The results of the simulated spill fire tests are summarized in table 2.

The failure of the JP-4 fuel to produce stable fuel-in-water emulsions with Pyrocap B-136 under the established fire test conditions is attributable in part to the high volatility of the fuel. All aviation fuels are blends of many individual hydrocarbons, each of which has its own vapor pressure and boiling range. The kerosene-type fuels (Jet A) are comprised principally of the higher boiling range fractions and the gasoline types (avgas), the lower boiling range fractions. Since the military fuel (JP-4) is a blend of both the kerosene and gasoline types, the distillation curve lies somewhere between these two extremes.

An analysis of the distillation profiles for the three aviation fuels (figure 3) shows that the starting vaporization temperatures are 154 °C, 65.65 °C and 48.55 °C for Jet A, JP-4, and avgas, respectively. Since the difference in the initial distillation temperature between JP-4 and avgas is only 17.1 °C, it is speculated that the effectiveness of Pyrocap B-136 would be significantly lower against JP-4 fuel fires than Jet A fuel fires under the established fire test conditions.

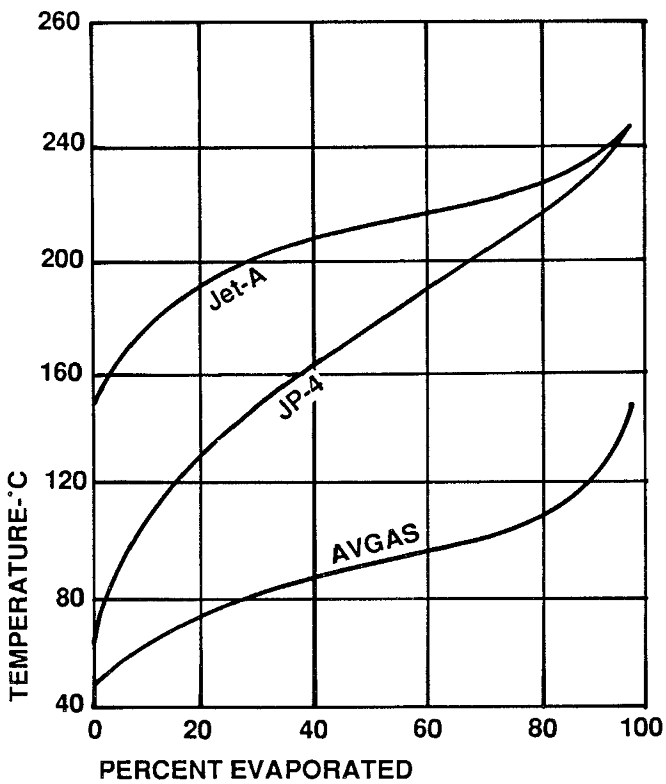


FIGURE 3. TYPICAL DISTILLATION CURVES OF AVIATION FUELS

MAGNESIUM FIRE EXTINGUISHING EXPERIMENTS.

In addition to the aircraft fuel emulsifying properties exhibited by Pyrocap B-136, the manufacturer claimed that a 30 percent concentrate of the agent was also effective in extinguishing magnesium metal fires.

Accordingly, experiments were performed using two segments of a C-130 aircraft nose wheel assembly. The 30 percent premixed Pyrocap agent was dispensed at the rate of 2.5 gallons per minute from a 2.5-gallon portable water fire extinguisher pressurized to 90 pounds per square inch by means of an external carbon dioxide cartridge.

The results of these experiments are summarized in table 3, tests 1 and 2. Photographs showing critical phases in the extinguishment of the magnesium wheel fires are presented in appendix D.

TABLE 3. MAGNESIUM FIRE EXTINGUISHING EXPERIMENTS

TEST 1

Test Article: One-half of a C-130 magnesium nose wheel.
Weight: 18.5 pounds
Height: 18.5 inches
Width: 6 inches

Fire Extinguisher: Badger 2.5 gallon water extinguisher pressurized to 90 pounds per square inch with an external carbon dioxide cartridge. Discharge rate 2.5 gallons per minute.

Extinguishing Agent: Pyrocap B-136
Solution concentration: 30 percent by volume

Log of Events

Time (min:sec)	Event
0:00	Heat applied to wheel with acetylene torch.
4:25	Magnesium ignited at bottom of wheel.
15:37	Large area of lower wheel burning.
20:00	Initial application of Pyrocap B-136 to the burning metal caused a large flareup and a shower of sparks. Continued application of fluid, in short bursts on and around the burning metal, controlled the fire. A large quantity of molten magnesium & slag (thermo- pile) continued to burn on the ground under the wheel, which was secured by the agent.
23:15	First extinguisher emptied; no burning magnesium visible. The thermopile was glowing red in the center under the wheel.
25:00	No signs of magnesium burning, but smoke (MgO) emanated from the glowing thermopile.
32:00	Thermopile flared when probed and increased in intensity.
32:57	Second 2.5 gallon extinguisher applied on thermopile.
36:00	Second extinguisher emptied; wheel fire extinguished; some low heat emanated from the thermopile.

Quantity of agent used: 5 gallons of 30 percent Pyrocap B-136.

TABLE 3. MAGNESIUM FIRE EXTINGUISHING EXPERIMENTS

TEST 2

Test Article: One-half of a C-130 magnesium nose wheel.
Weight: 18.5 pounds
Height: 18.5 inches
Width: 6 inches

Fire Extinguisher: Badger 2.5 gallon water extinguisher pressurized to 90 pounds per square inch with an external carbon dioxide cartridge. Discharge rate 2.5 gallons per minute.

Extinguishing Agent: Pyrocap B-136 concentration premixed to 30 percent by volume.

Log of Events

Time (min:sec)	Event
0:00	Heat applied to wheel with acetylene torch.
4:00	Surface burning of magnesium appeared on wheel.
5:20	Major burning of wheel started.
8:10	Approximately 25 percent of wheel involved.
11:50	External heat application stopped.
12:20	Application of Pyrocap B-136 agent; started using gentle application.
14:30	Gentle application was effective in cooling non-burning magnesium metal.
14:45	Pyrocap agent coated the metal surface and boiling occurred over the thermopile, which was glowing red.
17:00	Entire rim covered with Pyrocap agent and boiling continued over the thermopile.
17:10	First 2.5 gallon extinguisher exhausted.
21:38	Second extinguisher brought into play.
26:00	Pyrocap agent covered the wheel, but the thermopile continued to boil and glow.
29:00	Second extinguisher exhausted; all burning under control.

TABLE 3. MAGNESIUM FIRE EXTINGUISHING EXPERIMENTS

TEST 2 (CONTINUED)

Log of Events

Time (min:sec)	Event
34:00	Small emission of magnesium oxide from thermopile; no other visible burning.
45:30	Minor burning of interior of the thermopile when the slag was probed.
45:45	Third extinguisher activated.
47:00	Small emanation of magnesium oxide from thermopile.
58:00	Application of Pyrocap agent stopped; complete extinguishment.

Quantity of agent used: 6.5 gallons of 30 percent Pyrocap B-136.

SUMMARY OF RESULTS

The results obtained from laboratory experiments and large-scale fire tests employing the general fire suppression concentrate identified as Pyrocap B-136 are:

1. Aqueous solutions of Pyrocap B-136 show negative spreading coefficients when measured against Jet A, JP-4, and Avgas aviation fuels.

2. The relatively high viscosity (573 centipoise at 68 °F) of Pyrocap B-136 may require modification of some field dispensing equipment to obtain proper proportioning of the agent.

3. Pyrocap B-136 is a strong emulsifying agent toward Jet A, JP-4, and Avgas aviation fuels at ambient environmental temperatures.

4. A solution concentration of 6 percent by volume of Pyrocap B-136 controlled and extinguished a 962-square-foot Jet A pool fire at the low solution application rate of 0.052 gallons per minute per square foot.

5. Six percent concentration of Pyrocap B-136 produced stable Jet A fuel in water emulsions which resisted rapid burnback of the emulsified fuel in large-scale fire tests.

6. The 6 percent solution of Pyrocap B-136 required approximately one and one-half times longer to achieve fire control and extinguishment of the 400-square-foot simulated Jet A fuel spill fire than it did the 962-square-foot pool fire at the same discharge rate (50 gallons per minute).

7. Pyrocap B-136 was not effective in extinguishing highly volatile hydrocarbon fuel fires such as avgas.

8. Thirty percent aqueous solutions of Pyrocap B-136 demonstrated progressive control and extinguishment of aircraft magnesium wheel rim fires.

CONCLUSIONS

Based upon the results of preliminary laboratory and large-scale fire test data, it is concluded that the general fire suppression concentrate identified as Pyrocap B-136 is worthy of continued testing and evaluation as a candidate auxiliary agent for use at airports.

APPENDIX A

VARIATION OF HYDROGEN ION CONCENTRATION (pH) WITH SOLUTION CONCENTRATION OF PYROCAP B-136

Manufacturer: Pyrocap, Inc.
6551 Loisdale Court
Suite 400
Springfield, Virginia 22155-1854

General Fire Suppression Concentrate
Batch No. 45 VA 299-910
FAA Contract Order No. DTFA03-90-P-00479

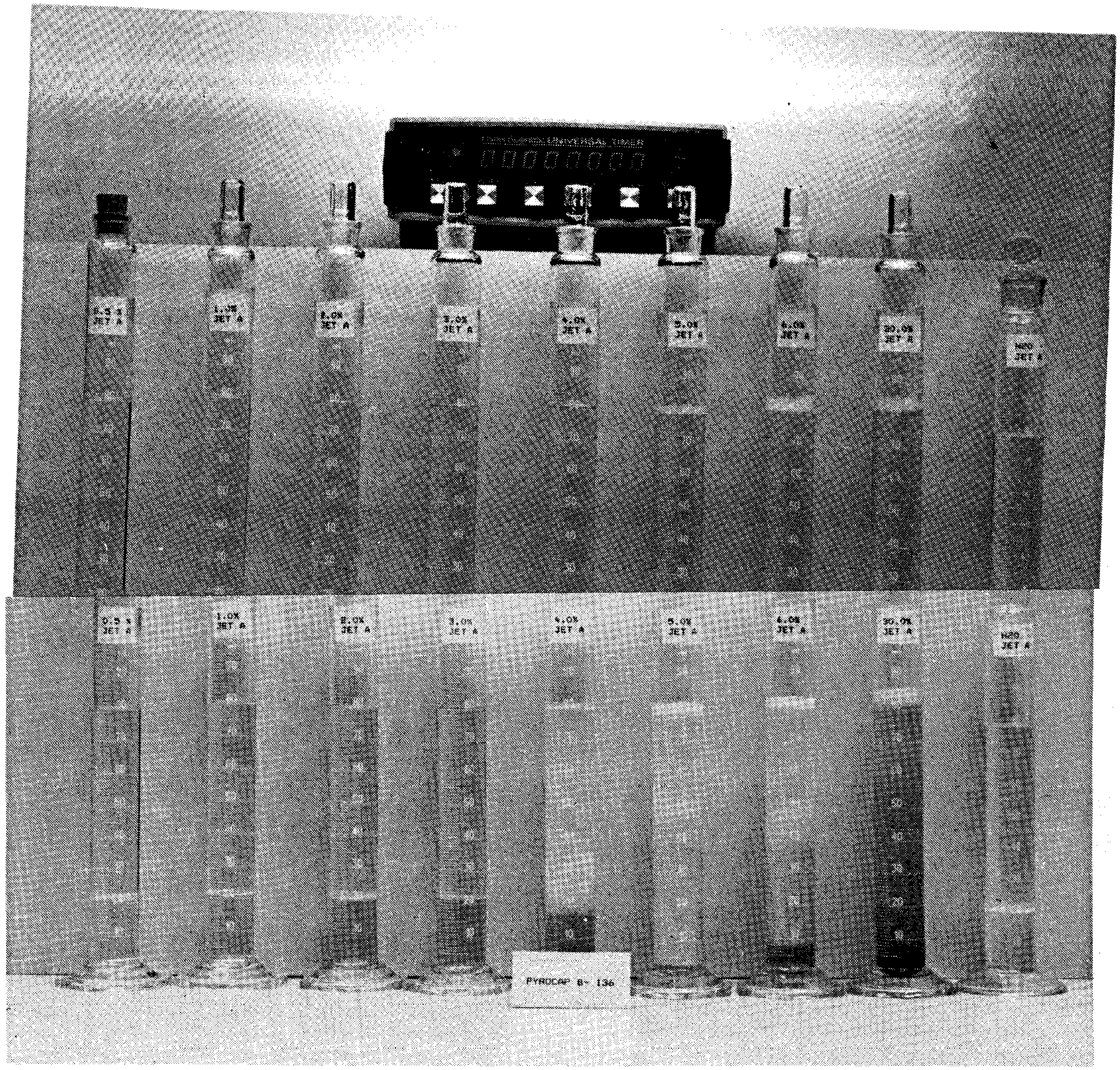
LAB TEST RESULTS

Pyrocap pH Level Concentration	Test 1	Test 2	Test 3	Average
0.2%	7.05	7.05	7.05	7.05
0.5%	7.40	7.35	7.35	7.36
1.0%	7.45	7.45	7.50	7.46
2.0%	7.75	7.75	7.72	7.74
3.0%	7.70	7.70	7.70	7.70
4.0%	7.75	7.75	7.75	7.75
5.0%	7.75	7.75	7.75	7.75
6.0%	7.75	7.70	7.70	7.71
30.0%	7.85	7.85	7.90	7.86
100.0%	8.10	8.15	8.20	8.15

Equipment Used: Beckman
Zeromatic II pH Meter
86-R pH Electrodes

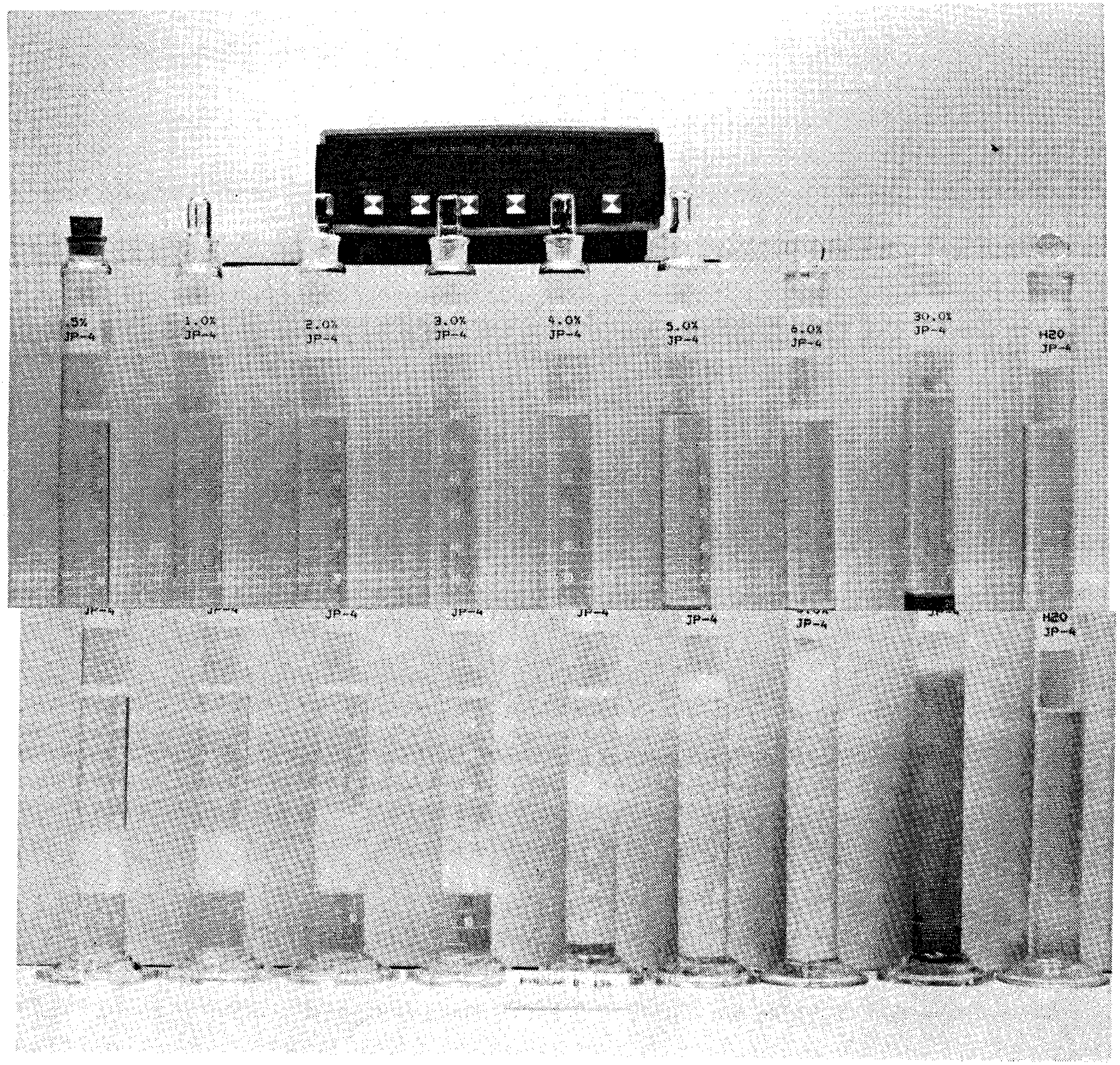
APPENDIX B

EMULSIFICATION CHARACTERISTICS
OF PYROCAP B-136



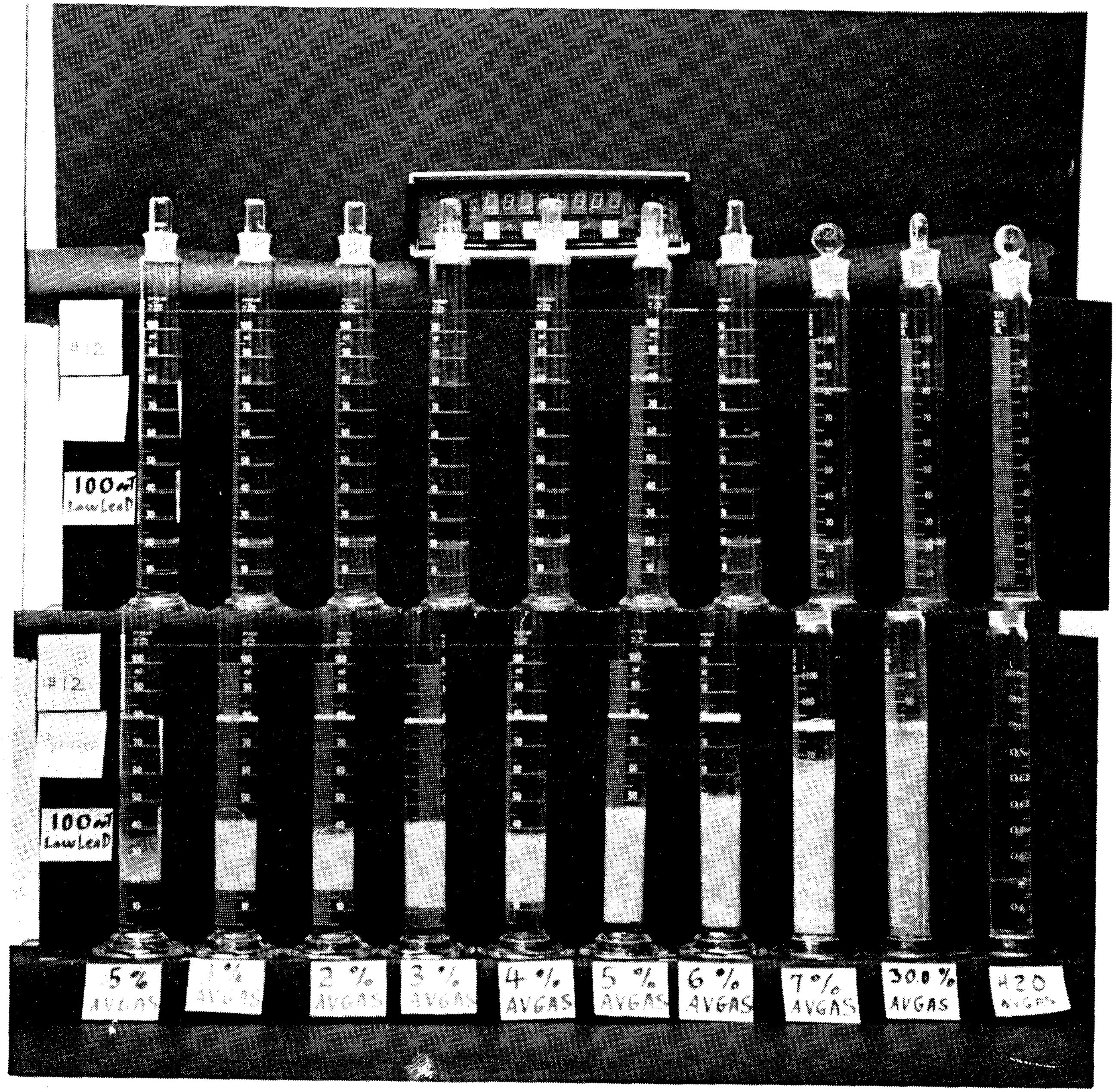
(c) Jet A and Pyrocap B-136 Solutions 5 Minutes After Agitation

FIGURE B-1. EMULSIFICATION OF JET A WITH PYROCAP B-136 SOLUTIONS



(c) JP-4 and Pyrocap B-136 Solutions 5 Minutes After Agitation

FIGURE B-2. EMULSIFICATION OF JP-4 WITH PYROCAP B-136 SOLUTIONS

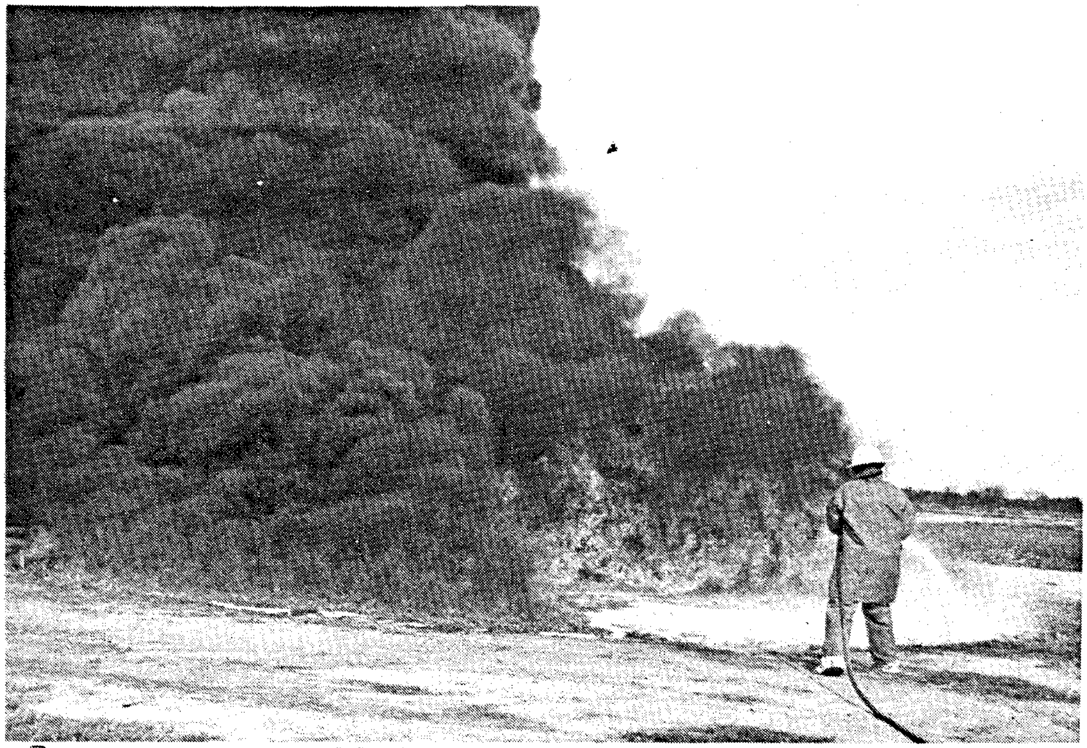


(c) Avgas and Pyrocap B-136 Solutions 5 Minutes After Agiation

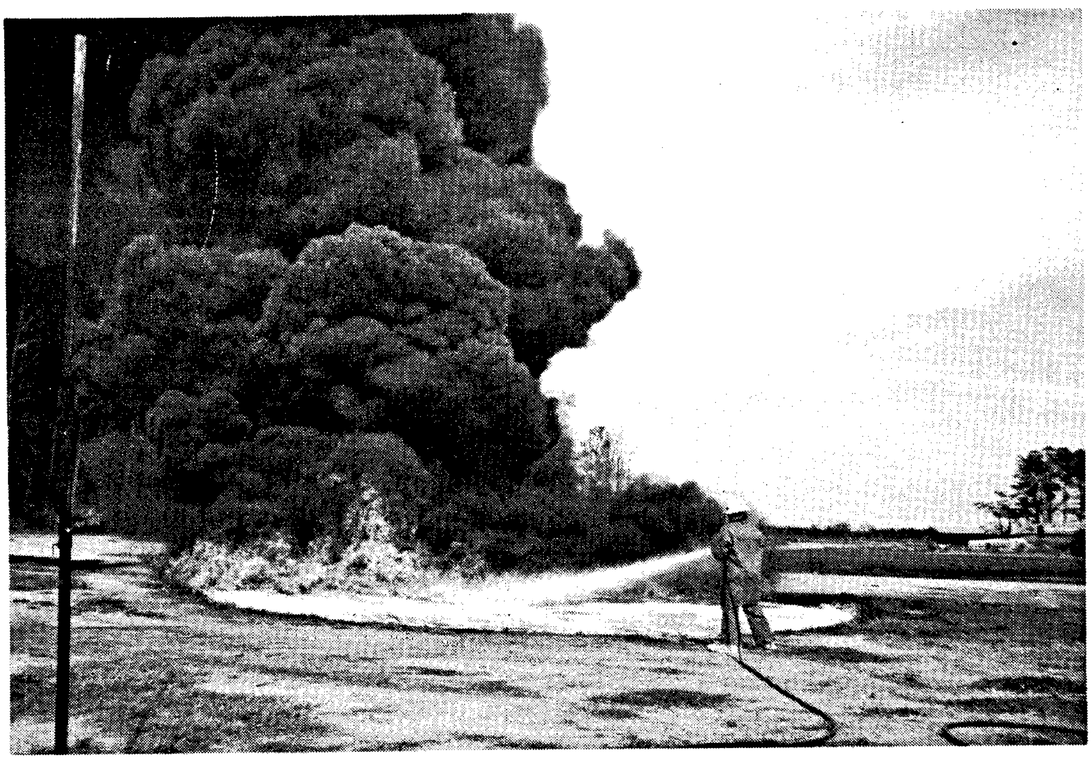
FIGURE B-3. EMULSIFICATION OF AVGAS WITH PYROCAP B-136 SOLUTIONS

APPENDIX C

EXTINGUISHMENT OF JET A POOL FIRES WITH PYROCAP B-136

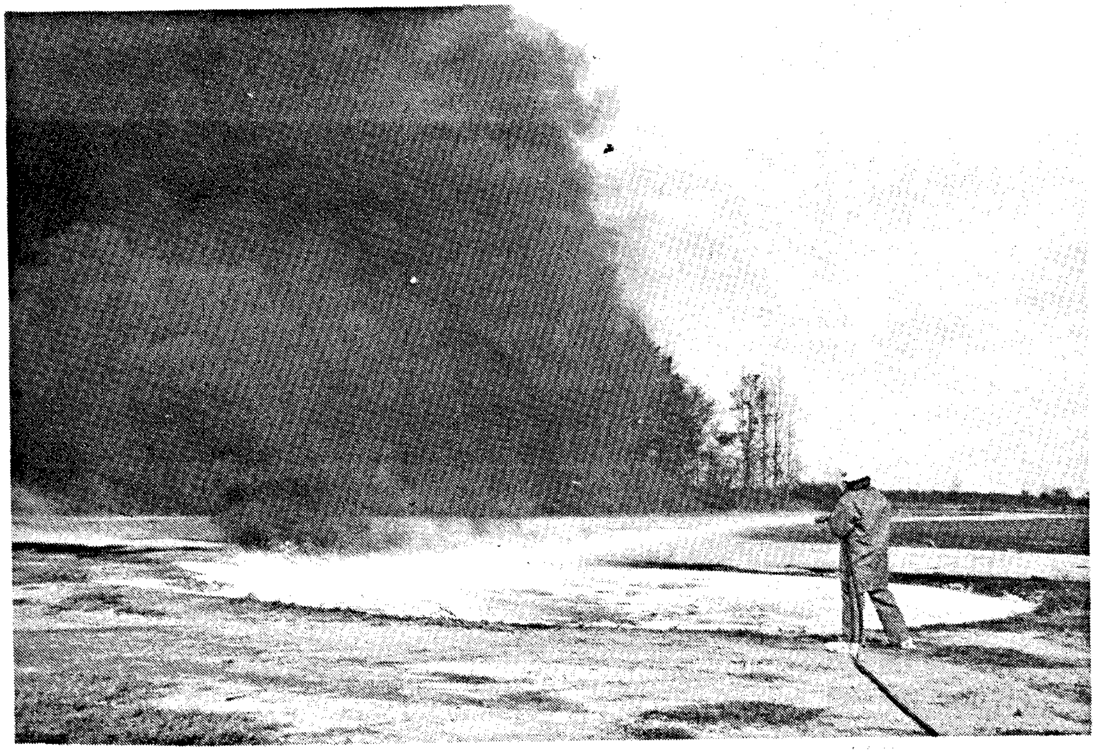


(a) Time of Discharge 6 Seconds



(b) Time of Discharge 10 Seconds

FIGURE C-1. FIRE EXTINGUISHING SEQUENCE (4 PHOTOGRAPHS) SHOWING THE DISCHARGE OF PYROCAP B-136 ON THE 35-FOOT DIAMETER JET A POOL FIRE (1 of 2)



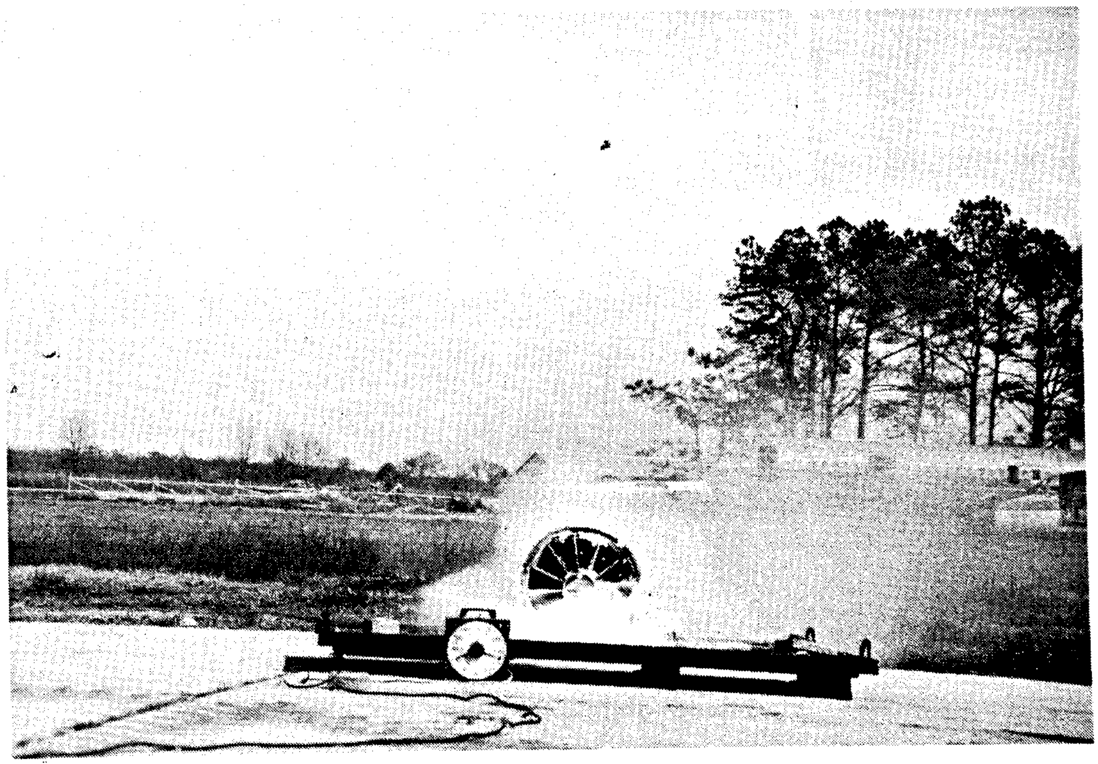
(c) Time of Discharge 18 Seconds Controlled

(d) Time of Discharge 32 Seconds Extinguished

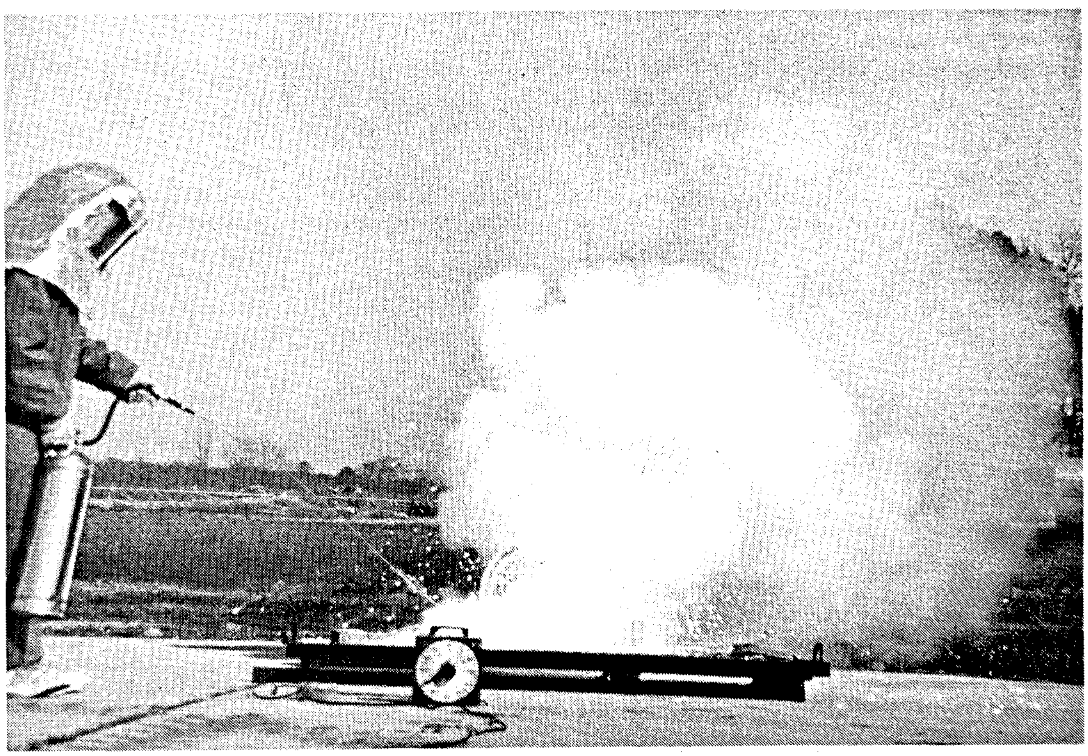
FIGURE C-1. FIRE EXTINGUISHING SEQUENCE (4 PHOTOGRAPHS) SHOWING THE DISCHARGE OF PYROCAP B-136 ON THE 35-FOOT DIAMETER JET A POOL FIRE (2 of 2)

APPENDIX D

EXTINGUISHMENT OF MAGNESIUM WHEEL
FIRES WITH PYROCAP B-136

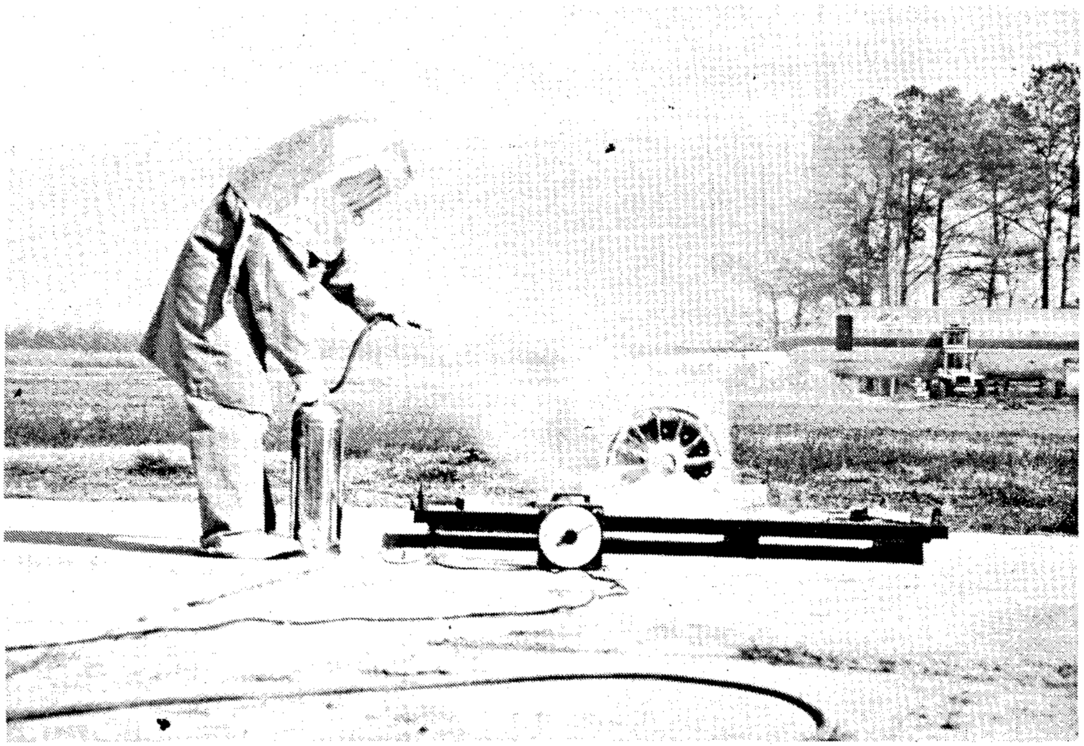


(a) Sustained Magnesium Burning

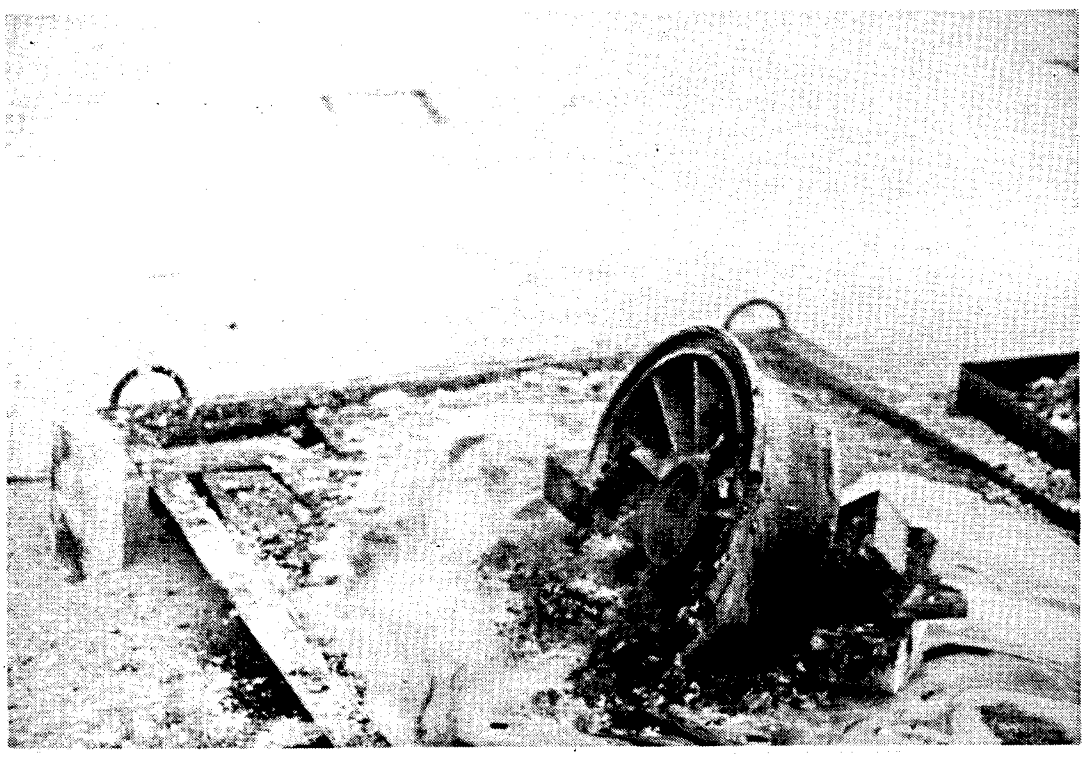


(b) Initial Spattering of Molted Magnesium

FIGURE D-1. FIRE EXTINGUISHING SEQUENCE (4 PHOTOGRAPHS) SHOWING THE DISCHARGE OF PYROCAP B-136 ON THE BURNING MAGNESIUM WHEEL (1 of 2)



(c) Fire Brought Under Control With the Pyrocap B-136 Agent



(d) Magnesium Fire Secured With Slag and the Pyrocap B-136 Agent

FIGURE D-1. FIRE EXTINGUISHING SEQUENCE (4 PHOTOGRAPHS) SHOWING THE DISCHARGE OF PYROCAP B-136 ON THE BURNING MAGNESIUM WHEEL (2 of 2)