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**DIRECTORY OF DOT FIRE RESEARCH
1979 EDITION**

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U.S. DEPARTMENT OF TRANSPORTATION
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
TRANSPORTATION SYSTEMS CENTER
CAMBRIDGE, MA 02142



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FINAL REPORT

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16. Abstract This document presents the results of a survey of the fire safety projects conducted by the modal administrations of the U. S. Department of Transportation. Ongoing and recently completed modal fire safety projects for the period June 1978 to December 1979 are identified and presented. This survey updates project information previously contained in the report "Assessment of Current U. S. Department of Transportation Fire Safety Efforts," July 1979.					
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PREFACE

This report presents the results of a survey of fire safety research efforts sponsored and/or conducted by the modal administrations of the U.S. Department of Transportation (DOT). It is anticipated by the Office of the Secretary of Transportation (OST) that the compilation of all DOT fire safety research into one document will facilitate the exchange of information, assist in identifying areas for further research, and encourage the initiation of jointly conducted research efforts among the modal administrations.

With the cooperation of the members of the DOT Fire Safety Coordinating Committee, each of the modal administrations provided the information contained within the individual project descriptions. On-going and recently completed projects covering the time period June 1978 to December 1979 are included. Two modal administrations, the Federal Highway Administration (FHWA) and the National Highway Traffic Safety Administration (NHTSA), have indicated that no fire safety research was conducted during that period of time. The information contained within the project descriptions updates that included in the Transportation Systems Center (TSC) report, "Assessment of Current U.S. Department of Transportation Fire Safety Efforts."*

The emphasis of the research efforts contained in this survey is directed towards the fire safety aspects of the modal transportation vehicle itself. The project descriptions are presented separately by modal administration.

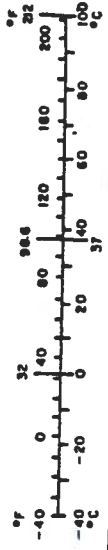
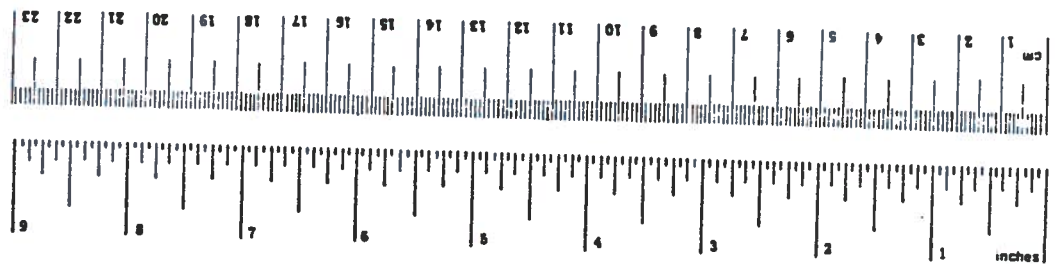
The authors, William T. Hathaway, (TSC), and Stephanie H. Markos, Raytheon Service Company, wish to acknowledge the important contributions made by the various individuals of the modal administrations who furnished the information contained in the project descriptions.

This document was prepared under the sponsorship and guidance of Charles W. McGuire, OST.

*Hathaway, W.T., I. Litant, "Assessment of Current U.S. Department of Transportation Fire Safety Efforts," Transportation Systems Center, Cambridge, MA Report No. UMTA-MA-06-0051-79-4, July, 1979.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures				Approximate Conversions from Metric Measures			
Symbol	When You Know	Multiply by	To Find	Symbol	When You Know	Multiply by	To Find
LENGTH							
in	inches	2.5	centimeters	mm	millimeters	0.04	inches
ft	feet	30	centimeters	cm	centimeters	0.4	inches
yd	yards	0.9	meters	m	meters	3.3	feet
mi	miles	1.6	kilometers	km	kilometers	1.1	yards
						0.6	miles
AREA							
sq in	square inches	6.5	square centimeters	cm ²	square centimeters	0.16	square inches
sq ft	square feet	0.09	square meters	m ²	square meters	1.2	square yards
sq yd	square yards	0.8	square meters	m ²	square meters	0.4	square miles
ac	acres	2.6	square kilometers	km ²	hectares (10,000 m ²)	2.5	acres
		0.4	hectares	ha			
MASS (weight)							
oz	ounces	28	grams	g	grams	0.035	ounces
lb	pounds	0.45	kilograms	kg	kilograms	2.2	pounds
	short tons (2000 lb)	0.9	tonnes	t	tonnes (1000 kg)	1.1	short tons
VOLUME							
tsp	teaspoons	5	milliliters	ml	milliliters	0.03	fluid ounces
Tbsp	tablespoons	15	milliliters	ml	liters	2.1	pints
fl oz	fluid ounces	30	milliliters	ml	liters	1.06	quarts
c	cups	0.24	liters	l	liters	0.26	gallons
pt	pints	0.47	liters	l	cubic meters	36	cubic feet
qt	quarts	0.95	liters	l	cubic meters	1.3	cubic yards
gal	gallons	3.8	cubic meters	m ³			
cu ft	cubic feet	0.03	cubic meters	m ³			
cu yd	cubic yards	0.76					
TEMPERATURE (exact)							
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature



*1 in = 2.54 (exact). For other exact conversions and more detailed tables, see NBS Mon. Publ. 784, Units of Weights and Measures, Price \$7.25, SD Catalog No. C.13.10.786.

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DOT TYPE SAFETY TAG

1. FEDERAL AVIATION ADMINISTRATION

DOT FIRE SAFETY R&D

TITLE: Cabin Hazards From Large Pool Fires

CONTRACT NO.: 181-521-22

FUNDING LEVEL: \$5,000

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: C.P. Sarkos

SPONSORING ORGANIZATION: FAA/AWS-120

OBJECTIVE:

To measure the flame penetration and resulting accumulation of heat and smoke inside an aircraft cabin produced by a large external fuel fire adjacent to a fuselage door opening.

DESCRIPTION OF WORK:

Tests will be performed at the airport fire test site using an available 20-foot-square fire pit. The test article will be surplus DC-7 fuselage fire hardened on the pit side with a Kaowool insulation/galvanized steel sheet cover to prevent melting of the aluminum skin. Additional doors will be cut into the fuselage. Instrumentation will consist of heat flux transducers, thermocouple trees, laser transmissometers and motion picture and still photography. Approximately 10 tests are envisioned, initially under zero wind and, subsequently, at increasing wind speeds. Location of door openings will also be varied.

EXPECTED OUTPUT:

Cabin hazard data under realistic large fuel fire conditions for validation of C-133 and modeling test results. Final report issued: "Cabin Hazards from a Large External Fuel Fire Adjacent to an Aircraft Fuselage", Federal Aviation Administration, NAFEC, Report FAA-RD-79-65, August 1979.

DOT FIRE SAFETY R&D

TITLE: Combined Hazard Index (CHI) Study

CONTRACT NO.: DOT-FA77-WA-4019

FUNDING LEVEL: \$540,000

PERFORMING ORGANIZATION: Douglas Aircraft Co.

NAME OF PRINCIPAL MONITOR: H. Spieth

SPONSORING ORGANIZATION: FAA Technical Center

OBJECTIVE: Develop a small-scale test methodology for determining a single rating index which combines the hazards of flammability, smoke and toxicity for a material under postcrash cabin fire conditions.

DESCRIPTION OF WORK:

The OSO test chamber is utilized to measure heat, smoke and toxic gas emission rates as a function of time. A mathematical enclosure fire model computes the distribution of hazards within DAC's Cabin Fire Simulator (CFS), which is their large-scale cabin fire test article. The hazards are combined by computing their contribution to the theoretical remaining escape time at some selected CFS location. It is assumed that the various hazards have an additive effect on escape time; acute escape time limits are primarily based on extrapolated data. The OSU test method data acquisition and the mathematical model are computerized. The validity of the OSU/mathematical model predictions is determined by comparison with test data obtained in the CFS.

EXPECTED OUTPUT:

A combined hazard index test methodology for interior materials, December 1980.

DOT FIRE SAFETY R&D

TITLE: Compatibility of Anti-Misting Fuel with Fuel System Components

CONTRACT NO.: 181-520-138

FUNDING LEVEL: N/A

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: E.P. Klueg

SPONSORING ORGANIZATION: FAA/ACT-310

OBJECTIVE:

To evaluate the effect of anti-misting fuel additives on the performance of engine and fuel system components, individually and as a system.

DESCRIPTION OF WORK:

Degraded and undegraded anti-misting fuel will be tested on various aircraft components individually and in combination. The performance of the components (e.g., fuel pumps, wing tanks etc.) will be compared with the performance when using neat Jet A.

EXPECTED OUTPUT:

Letter reports and final reports will be issued on the performance of the components and systems when tested with the anti-misting fuel, with recommended minor changes to the system to assure compatibility. Final report draft, June 1981.

DOT FIRE SAFETY R&D

TITLE: Conduct a Review of the Minimum CFR Service Level Criteria
at Civil Airports

CONTRACT NO.: NPD 08-472: Subprogram 081-431-180

FUNDING LEVEL: \$20,000

PERFORMING ORGANIZATION: Aircraft & Airports Safety Div., Fire Safety
Br., ACT-430, FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: G.B. Geyer

SPONSORING ORGANIZATION: FAA/ARD-420

OBJECTIVE: To identify recommended changes to the minimum CFR service requirements of FAR Part 139, for certificated airports, that would improve the current level of airport safety, or would reduce costs while maintaining an equivalent level of safety.

DESCRIPTION OF WORK:

Review the factors and criteria which led to the present level of CFR services prescribed by FAR Part 139 for airport certification. Evaluate the minimum certification requirements for Index A through E airports, in terms of the current state-of-the-art improvements in firefighting agents, equipment, and firefighting techniques. Evaluate any new candidate firefighting agents/equipment.

EXPECTED OUTPUT:

Recommended changes in the requirements for certificated airports that would result in an improved safety-cost relationship through the exploitation of current CFR technology and improved operational techniques.

DOT FIRE SAFETY R&D

TITLE: Design of an Aircraft Materials Data Bank

CONTRACT NO.: Interagency Agreement DTFA03-80-A-00178

FUNDING LEVEL: \$140,000

PERFORMING ORGANIZATION: ECON, Inc.

NAME OF PRINCIPAL MONITOR: J. Scratt

SPONSORING ORGANIZATION: FAA/NASA

OBJECTIVE: Define the capabilities and costs of reasonable options for establishing a comprehensive library data base of aircraft materials with particular emphasis on fire, smoke and toxicity characteristics.

DESCRIPTION OF WORK:

Task 1. A survey of potential users within the Government and the private sector to determine who the most likely users may be and how they would utilize such a data base. A survey of potential data suppliers to determine the availability and the form of the supplied data. Preliminary data gathering to support the theoretical operation of projected libraries.

Task 2. A survey of commercially available software packages to support the construction and operation of a library system and alternative computer hardware systems. Estimates of hardware and software support and maintenance requirements. Total cost, schedule and service of each option will be used to rank the alternative concepts.

Task 3. A detailed review of existing models that may be applicable to a total systems approach to aircraft materials research and regulatory analysis.

EXPECTED OUTPUT:

Accurate schedules and budgets for alternative library systems and detailed description of capabilities thereof, July 1980.

DOT FIRE SAFETY R&D

TITLE: Develop Fuel Specifications for Anti-Misting Fuel

CONTRACT NO.: 181-520-142

FUNDING LEVEL: N/A

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: E.P. Klueg

SPONSORING ORGANIZATION: FAA/ACT-310

OBJECTIVE:

Develop a specification for anti-misting fuel which is compatible with the operation of transport aircraft.

DESCRIPTION OF WORK:

The development of a fuel specification includes (1) characterizing anti-misting fuels on the basis of the existing aviation fuel specifications, and (2) relaxing the existing fuel specification where possible to accommodate anti-misting fuels and adding specification tests appropriate for anti-misting capability and favorable fluid flow properties.

EXPECTED OUTPUT:

A specification test procedure for anti-misting fuels. This will include a relaxed form of the ASTM aviation fuels specification as well as additional tests on flammability and compatibility properties.

Identification of key problem areas to be investigated in compatibility projects.

DOT FIRE SAFETY R&D

TITLE: Droplet Characterization of Anti-Misting Fuel

CONTRACT NO.: 181-520-112

FUNDING LEVEL: N/A

PERFORMING ORGANIZATION: NASA Jet Propulsion Laboratory

NAME OF PRINCIPAL INVESTIGATOR: U. Sarohia

SPONSORING ORGANIZATION: ACT-310/FAA Technical Center

OBJECTIVE:

Determine the droplet size, shape, distribution of anti-misting fuels during simulated and actual releases of fuel from rupture wing tanks and correlate to flammability envelopes.

DESCRIPTION OF WORK:

Small scale releases of anti-misting fuels will be conducted and examined photographically. These photographs will be enhanced to establish ignition point and propagation rates. Flame paths will be examined to relate them to the fuel physical characteristics. The small scale system will be extended to use in large and full scale tests.

EXPECTED OUTPUT:

Reports describing the droplet characteristics and the techniques for use in large and full scale releases will be printed in late FY 1982.

DOT FIRE SAFETY R&D

TITLE: Effects of an External Fuel Fire Adjacent to a Fuselage Opening
on the Cabin Environmental Conditions
CONTRACT NO.: 181-521-15

FUNDING LEVEL: \$97,000

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: C.P. Sarkos

SPONSORING ORGANIZATION: FAA AWS-120

OBJECTIVE: The primary objective is to study the relationship between the characteristics of an external fuel fire adjacent to a cabin opening, and the cabin environmental hazards related to survivability. A secondary objective is to measure the heat flux and temperature created by the fuel fire at various material locations and fuselage stations for the purpose of defining what test conditions should be used in laboratory fire tests for cabin materials. The relative importance of heat, smoke, toxic gases and oxygen depletion on occupant survivability will be shown.

DESCRIPTION OF WORK:

The C-133 fuselage will be tested with the interior configured to the shape and length of a wide-bodied transport cabin. The interior of the C-133 will be stripped of all combustible materials and covered with a noncombustible insulation. A series of tests will be conducted with the fire load consisting solely of aviation fuel. Fuel fire conditions will be parameterized (wind velocity, fuselage opening, etc.) to determine their effect on cabin environmental conditions.

EXPECTED OUTPUT:

Information that relates the characteristics of an external fuel fire adjacent to a cabin opening to the attainment of life-threatening conditions within the cabin. These data will provide a better understanding of the relative importance of the factors (heat, smoke, toxic gases, and oxygen depletion) controlling survivability during a cabin fire dominated by burning fuel. Final report issued: Hill, R.G., et. al., "Postcrash Fuel Fire Hazard Measurements in a Wide Body Aircraft Cabin, FAA/NAFEC, Report FAA-NA-79-42, December 1979.

DOT FIRE SAFETY R&D

TITLE: Evaluate the Aircraft Skin Penetrator Nozzle for Cabin Fire Protection

CONTRACT NO.: NPD 08-472; Subprogram 081-431-120

FUNDING LEVEL: \$20,000

PERFORMING ORGANIZATION: Aircraft & Airports Safety Div., Fire Safety
Br., ACT-430, FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: J. O'Neill (G. Geyer)

SPONSORING ORGANIZATION: FAA/ARD-420

OBJECTIVE: To determine the firefighting effectiveness of the U.S. Air Force Aircraft skin penetrator nozzle in extinguishing Class A and Class B cabin fires with foam-water/fog provided by the crash-fire-rescue (CFR) services from an external source of supply.

DESCRIPTION OF WORK: Fire harden the interior cabin of a DC-7 aircraft to contain a fireload of sufficient size to provide a thermally uninhabitable environment in 1/4 to 1/3 of the total volume of the cabin in approximately 90 seconds after fuel ignition. Establish the optimum nozzle configuration and the ballistic charge required to penetrate the fuselage skin of the test bed aircraft at various critical points of entry within the passenger cabin. Determine the nozzle orifice configuration required to obtain the maximum flow rate of each agent, and the optimum distribution pattern and density within the cabin interior.

EXPECTED OUTPUT: A final technical report presenting an assessment of the feasibility and procedures for employing the aircraft skin penetrator nozzle to combat interior aircraft cabin fires.

Report published. Report No. NA-79-55-LR

DOT FIRE SAFETY R&D

TITLE: Evaluate Firefighting Agents, Equipment, Systems, and Techniques

CONTRACT NO.: NPD 08-472; Subprogram 081-431-110

FUNDING LEVEL: \$100,000

PERFORMING ORGANIZATION: Aircraft & Airports Safety Div., Fire
Safety Br., ACT-430, FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: G.B. Geyer

SPONSORING ORGANIZATION: FAA/ARD-420

OBJECTIVE: To provide effective aircraft firefighting and rescue capabilities at airports.

DESCRIPTION OF WORK: Conduct laboratory and full-scale fire modeling experiments with all nationally and internationally available firefighting foams, and rank these agents according to their firefighting effectiveness. Determine the most effective firefighting techniques applicable to each of the three classes of firefighting foams i.e. Aqueous-Film-Forming-Foams (AFFF), Fluoroprotein Foam and Regular Protein Foam.

EXPECTED OUTPUT: A final technical report representing the results of laboratory and full-scale fire modeling experiments of value to airport operators, fire chiefs and research/educational organizations. Additionally, the report will provide a data base for assessing the optimum foam fire extinguishing agents, quantities and application techniques for airports.

Project completed. Final Report published. Report No. FAA-RD-79-61

DOT FIRE SAFETY R&D

TITLE: Evaluate On Board Foam/Water Sprinkler System to Extinguish Aircraft Cabin Fires from CFR Trucks

CONTRACT NO.: NPD 08-472: Subprogram 081-431-170

FUNDING LEVEL: \$20,000

PERFORMING ORGANIZATION: Aircraft & Airports Safety Div. Fire Safety Br., ACT-430, FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: G.B. Geyer

SPONSORING ORGANIZATION: FAA/ARD-420

OBJECTIVE: To determine the feasibility of extinguishing aircraft interior fires by means of a fixed on board dry-pipe foam/water sprinkler system, to be supplied with Aqueous-Film-Forming-Foam (AFFF) solution from a CFR vehicle, through quick-connecting hose couplings permanently mounted in the sides of the fuselage.

DESCRIPTION OF WORK:

Construct within the completely instrumented DC-7 aircraft fuselage a configuration of specially designed foam/water sprinkler nozzles positioned strategically in the wall, ceiling, and floor areas, so as to be capable of completely saturating any flammable Class A materials without significantly impairing passenger evacuation procedures during fire emergencies.

Full-scale fire modeling experiments will be conducted to determine the optimum foam/water nozzle locations, foam patterns, and solution flow rates and the concentrations required to obtain the most rapid control and extinguishment of a standardized Class A fire load.

A method will also be developed to utilize the on board piping/ extinguisher system to extinguish any potential in-flight fires.

An additional series of experiments will be conducted, using the established on board piping system, to determine the practicality of providing foam/water discharge nozzles at the floor level of each exit door for the purpose of protecting evacuation slides and passengers from any potential ground fuel fire hazards.

EXPECTED OUTPUT:

A determination of the feasibility of extinguishing Class A and Class B aircraft cabin fires, by means of an on board dry-pipe foam/water sprinkler system supplied with Aqueous-Film-Forming-Foam provided by a foam/water truck, as well as interim protection provided by the on board potable water supply, until the arrival of the CFR services. A benefit/cost analysis of the foam/water sprinkler system compared with other means of providing equivalent fire safety of passengers will be included.

DOT FIRE SAFETY R&D

TITLE: An Evaluation of the Firefighting Equivalency Between the Principal Ancillary Agents and the AFFF Agents Employed by the CFR Services at Airports

CONTRACT NO.: 910-003-300 NAFE Agreement No. 295

FUNDING LEVEL: \$106,000

PERFORMING ORGANIZATION: Aircraft & Airports Safety Div., Fire Safety Br., ACT-430, FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: G.B. Geyer

SPONSORING ORGANIZATION: U.S. Air Force, DET 1 Hq. ADTC/CNE, Tyndall AFB, Florida

OBJECTIVE:

To establish the firefighting effectiveness of dry chemical powders (DCP), Halon 1211, and low-temperature carbon dioxide (CO₂), both singly and in combination with Aqueous-Film-Foaming-Foam (AFFF) in simulated full-scale fire tests.

DESCRIPTION OF WORK:

Determine the fire extinguishing effectiveness of a gas (CO₂), a vaporizing liquid (Halon 1211) and three solid aerosols (PKP, Monnex, Total potassium sulfate powder) when they are discharged at equal rates by weight on standardized class A and B fires which are nominally representative of aircraft accident fire situations. Assess any increase or decrease in the firefighting effectiveness of these agents when they are discharged in combination with AFFF on the standardized fire test bed configurations.

EXPECTED OUTPUT:

The results of these experimental procedures will provide a data base upon which the relative fire extinguishing equivalency between each ancillary agent and AFFF can be derived.

DOT FIRE SAFETY R&D

TITLE: Evaluation of Flammability Test Methods

CONTRACT NO.: 181-521-14

FUNDING LEVEL: \$5,000

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: C.P. Sarkos

SPONSORING ORGANIZATION: FAA/AWS-120

OBJECTIVE: Evaluate and compare five accepted fire test methods for flammability assessment of wide-bodied jet passenger compartment interior materials. Determine the effect of variation of incident heat flux on heat release rate in OSU Rate of Heat Release Apparatus.

DESCRIPTION OF WORK:

Five widely-used laboratory fire tests will be utilized for the evaluation of twenty cabin materials representing a cross section of the physical and chemical characteristics for the more important usage categories (panels, foams, fabrics, and thermoplastics). Test methods will be compared in terms of ease of ignition, surface flame travel rate, heat evolution, repeatability, and testing time. In addition, a subjective appraisal of the difficulty in operating the equipment will be made.

EXPECTED OUTPUT:

Comparison of cabin material performance data obtained from five laboratory flammability test methods. Final report issued: Nicholas, E.B., "Evaluation of Existing Flammability Test Methods by Comparison of the Flammability Characteristics of Interior Materials," FAA/NAFEC, Report FAA-NA-79-46, March 1980.

DOT FIRE SAFETY R&D

TITLE: Fire Protection of Emergency Evacuation Slides

CONTRACT NO.: 181-521-23

FUNDING LEVEL: \$60,000

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: C.P. Sarkos

SPONSORING ORGANIZATION: FAA/AWS-120

OBJECTIVE:

To develop a laboratory test method for evacuation slide material that is relevant to full-scale postcrash fire conditions and suitable for materials qualification testing in airworthiness certification.

DESCRIPTION OF WORK:

Definition of slide thermal failure modes during a typical postcrash cabin fire emergency evacuation will be established by testing real slides subjected to a large pool fire. The laboratory test devised under the preliminary assessment will be further developed and criteria established for qualifying slide materials for a critical time-history thermal hazard. Full-scale tests of general slides will be conducted to validate the relevancy of the lab test. Full-scale tests will also assess the fire resistance of available improved candidate materials for use in the construction of slides and determine which of these materials can provide a significant improvement in fire protection. A reflective coating will be developed under a contractual effort that, if applied to conventional slides, would significantly increase the resistance to radiative heating. Practical requirements such as crease integrity, packing requirements and hot/cold cycling, will be taken into consideration.

EXPECTED OUTPUT:

Development of an optimum reflective coating for application to in-service evacuation slides. A final report defining a qualification test method and associated criteria for thermal failure modes to support potential air regulations controlling fire resistance of emergency evacuation slides. September 1980.

DOT FIRE SAFETY R&D

TITLE: Full-Scale Fire Modeling Tests of a Compact Rapid Response Foam and Dry Chemical Powder Dispensing System

CONTRACT NO.: NPD 08-472; Subprogram 081-431-160

FUNDING LEVEL: \$50,000

PERFORMING ORGANIZATION: Aircraft & Airports Safety Div., Fire Safety Branch, ACT-430 FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: G.B. Geyer

SPONSORING ORGANIZATION: FAA/ARD-420

OBJECTIVE: To develop a rapid response skid/trailer mounted firefighting system capable of dispensing dry chemical powder or foam, either singly or in combination.

DESCRIPTION OF WORK: Evaluate a twinned foam-powder dispensing system in terms of each agent alone and in combination and establish the equivalency of the agents against a dual agent discharge on full-scale Jet A fuel fires.

EXPECTED OUTPUT: A final technical report presenting data and an assessment of the firefighting equivalency of dry chemical powder in terms of Aqueous-Film-Forming-Foam (AFFF) on full-scale Jet A fuel fires and the increased/decreased advantages in using the combined foam-powder discharge over a single agent application.

Project completed. Final Report published. Report No. FAA-RD-78-105

DOT FIRE SAFETY R&D

TITLE: General Aviation Crash Resistant Fuel System

CONTRACT NO.: 184-521-3

FUNDING LEVEL: \$180,000

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: Dave Nesterok

SPONSORING ORGANIZATION: FAA Technical Center (Caesar Caiafa)

OBJECTIVE: To improve the crashworthiness of general aviation air plane fuel containment through the test demonstration of crash-resistant tank technology.

DESCRIPTION OF WORK:

Dynamic tests of an aircraft wing/fuel system assembly using different types of fuel tanks and systems.

EXPECTED OUTPUT:

Development of a crash worthy fuel system.

DOT FIRE SAFETY R&D

TITLE: Habitable Inert Atmosphere Using Carbon Tetrafluoride (Halon 1400)

CONTRACT NO.: 910-003-300 Agreement #295

FUNDING LEVEL: \$55,000

PERFORMING ORGANIZATION: Aircraft & Airports Safety Div., Fire
Safety Br., ACT-430, FAA Technical Center
NAME OF PRINCIPAL INVESTIGATOR: G. Geyer

SPONSORING ORGANIZATION: U.S. Air Force, DET 1 Hq. ADTC/ONE,
Tyndall AFB, Florida

OBJECTIVE: To establish the feasibility of replacing a potentially lethal aircraft interior environment with a cool habitable atmosphere which is nonsupporting of combustion during evacuation in fire emergencies.

DESCRIPTION OF WORK: Design and test a crash-fire-rescue (CFR) vehicle/system capable of producing a habitable atmosphere by proportioning Halon 1400 into a moving airstream. The cool inert atmosphere produced by a centrifugal fan will be discharged into the aircraft interior through suitable flexible ducts to sweep out the hot toxic atmosphere during an aircraft fire emergency.

Full-scale fire modeling experiments will be conducted in a DC-7 to establish the atmospheric flow rates required to develop and maintain a habitable fuselage environment in realistic fire test configurations.

EXPECTED OUTPUT: A final report describing a new highly specialized CFR vehicle for extinguishing aircraft cabin fires, and means of providing a cool habitable atmosphere for passengers during evacuation in fire emergencies.

Project completed. Report No. FAA-NA-79-43 ESL-TR-79-40

DOT FIRE SAFETY R&D

TITLE: Improve Operation and Extend Testing Range of NBS Smoke Chamber

CONTRACT NO.: 181-521-17

FUNDING LEVEL: \$6,000

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: C.P. Sarkos

SPONSORING ORGANIZATION: FAA/AWS-120

OBJECTIVE: Modify the NBS smoke chamber to extend the range of radiant heat flux level, monitor sample weight loss, and measure laser light transmission. Use the modified chamber to evaluate typical cabin materials, including melting and nonmelting types under both flaming and nonflaming conditions. Determine the operational characteristics of the modified chamber (calibration, ease of operation, repeatability, and general performance) to investigate more effective smoke standards.

DESCRIPTION OF WORK:

Modifications to be made to the NBS smoke chamber will be as similar as possible to those previously incorporated at the University of Utah, Lawrence Livermore Laboratory, and NBS experiments. The capability of extended heat flux up to 10 BTU/Ft²-sec will make the NAFEC-modified chamber a versatile design. Cabin materials evaluated will eventually include those tested in the C-133 aircraft, for the purpose of correlating laboratory and full-scale smoke data, as well as testing additional materials solicited from the airframe and seat manufacturers.

EXPECTED OUTPUT:

A technical report will present smoke data for common cabin materials tested under the entire range of head flux level likely in a cabin fire. Final report issued: Brown, L.J., "Smoke Emissions from Aircraft Interior Materials at Elevated Heat Flux Levels using Modified NBS Smoke Chamber", FAA/NAFEC., Report FAA-RD-79-26, July 1979.

DOT FIRE SAFETY R&D

TITLE: Improve Transport Aircraft Emergency Lighting

CONTRACT NO.: 181-521-18

FUNDING LEVEL: \$11,000

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: C.P. Sarkos

SPONSORING ORGANIZATION: FAA/AWS-120

OBJECTIVE: Determine the adequacy of existing and new concept of cabin lighting and exit markings under conditions of smoke which typify a post-crash fire.

DESCRIPTION OF WORK:

During full-scale burn tests using C-133 test facility at NAFEC evaluate performance of emergency interior cabin lighting and exit marking standards under adverse conditions, i.e., dark night and black smoke. Determine whether brighter signs and lights, addition of floor-level lighting system or other lighting/marketing concepts improves exit visibility. Perform evacuation studies at CAMI in a theatrical smoke environment to establish the improvement in evacuation time provided by advanced emergency lighting concepts as compared to conventional lighting.

EXPECTED OUTPUT:

Technical report to provide Flight Standards Service with information to support advanced regulations on cabin emergency lighting, January 1981. The following NAFEC letter reports have been issued:

1) Demaree, J.E., "The Behavior of Wide Body Aircraft Emergency Exit Signs at Elevated Air Temperatures", FAA/NAFEC, Letter Report NA-78-69-LR, December 1978.

2) Demaree, J.E., "A Preliminary Examination of Interior Aircraft Emergency Lighting Under Simulated Post Crash Fire and Smoke Conditions", FAA/NAFEC, Letter Report NA-79-46-LR, 1979.

DOT FIRE SAFETY R&D

TITLE: Inhalation Toxicity of the Irritant Gases HCL, NO₂, and SO₂.

CONTRACT NO.: AM-78-TOX36

FUNDING LEVEL: \$90,000

PERFORMING ORGANIZATION: CAMI

NAME OF PRINCIPAL INVESTIGATOR: Dr. Charles R. Crane

SPONSORING ORGANIZATION: FAA/OAM (Office of Aviation Medicine Funding)

OBJECTIVE: To determine the toxicity - in terms of the incapacitation and lethal doses for the albino rat - of each of the three irritant gases hydrogen chloride, nitrogen dioxide, and sulfur dioxide.

DESCRIPTION OF WORK: Rats will be exposed in the CAMI Inhalation Toxicity Apparatus to known concentrations of each of the subject gases and the times - to - incapacitation and the death will be determined. The exposures will be repeated a sufficient number of times, and at a sufficient number of different concentrations, to allow the statistical definition of the incapacitating dose and the lethal dose for each of these gases.

EXPECTED OUTPUT: Results of these tests are required in order that the individual contribution for each gas to the total toxicity of a mixture of combustion gases may be assessed. Such information could then be used to establish tolerance limits for each gas in a fire environment, and in this way aid in the selection of polymeric materials used in transportation vehicles to improve the potential for escape and survival in the event of a fire.

DOT FIRE SAFETY R&D

TITLE: Inhalation Toxicology of the Combustion Products of New, State-of-the-Art, Polymeric Materials.

CONTRACT NO.: AM-78-TOX38

FUNDING LEVEL: \$60,000

PERFORMING ORGANIZATION: CAMI

NAME OF PRINCIPAL INVESTIGATOR: Dr. Charles R. Crane

SPONSORING ORGANIZATION: FAA/OAM (Office of Aviation Medicine Funding)

OBJECTIVE: To evaluate the toxicity of the thermal degradation products of new, advanced technology, synthetic polymers relative to that of materials in current usage.

DESCRIPTION OF WORK: Appropriate materials will be thermally decomposed under defined thermal conditions. The toxicity of the resultant volatile products will be determined by the CAMI Combustion Toxicology protocol which is based on the measurement of time to incapacitation of albino rats exposed to the toxic atmosphere.

EXPECTED OUTPUT: Results of these tests will be used to maintain the currency of a file describing the relative merits (based on potential toxicity) of polymeric materials that are either currently used in the transportation industry or have a potential for future use. This information will provide a mechanism for the informed selection (or replacement) among several candidate materials for a specific end - use to insure that the hazard from exposure to toxic combustion products is minimized in the transportation industry.

DOT FIRE SAFETY R&D

TITLE: Involvement of Interior Materials During a Cabin Fire and Significance to Survivability

CONTRACT NO.: 181-521-16

FUNDING LEVEL: N/A

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: C.P. Sarkos

SPONSORING ORGANIZATION: FAA/AWS-120

OBJECTIVE: The determination of the involvement of interior materials during post-crash, full-scale cabin fire and their significance to occupant survivability; the determination of the relative hazards of material flammability smoke generation, and toxic gas emissions; and the significance of materials' location to the total fire hazard.

DESCRIPTION OF WORK:

The test article will be the C-133 fuselage prepared for the 181-521-15 project. A section of the fuselage around the fire-entry opening will be furnished with interior materials for a length of three seat rows, straddling the entry door. Installation of ceiling panels may be more extensive to assess flash-over effects. Instrumentation will be similar to the external fire project with the additional capability of measuring selected dominant combustion gases of the interior materials: e.g., HF, HCN, HCl, H₂S, SO₂, etc. The tests will incorporate white rats to measure the effects of systemic poisons and irritants. By comparing measured (animals) or calculated (based on gas, smoke, and temperature measurements) survival indexes for cabin fire environments with and without interior materials, the change in survivability directly attributed to combustion of interior materials will thus be determined.

EXPECTED OUTPUT:

Report to assist in defining advanced regulations of flammability, smoke, or toxic gas emission characteristics of interior materials. The determination of the relative importance of flammability, smoke, and emissions to survival is expected to support future regulations dealing with combined combustion hazards of materials. Also, an indicator of the relative importance of material location in the cabin and its involvement in fire could provide the basis of factoring this important effect into present and future materials' standards. Final report draft, January 1981.

DOT FIRE SAFETY R&D

TITLE: Laboratory Testing of Anti-Misting Fuel

CONTRACT NO.: 181-520-111

FUNDING LEVEL: N/A

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: E.P. Klueg

SPONSORING ORGANIZATION: FAA/ACT-310

OBJECTIVE:

To provide small-scale apparatus for quality control and specification testing of modified fuel candidates.

DESCRIPTION OF WORK:

The laboratory test project will be directed at:

1. Spray flammability rig.
2. Rheological tests.
3. Small-scale compatibility simulation.
4. Fuel properties.

Under Item 1 above, spray flammability rigs will be constructed for use at other laboratories. Under Item 2, a small bench scale test will be built to provide a standard rheological test for anti-misting fuel degradation. Under Item 3, tests will be performed on anti-misting fuels to determine potential for in-flight degradation. Under Item 4, viscosity apparatus will be provided for quality control of anti-misting fuels. Past experience has shown that viscosity testing must be evaluated uniformly and methodically.

EXPECTED OUTPUT:

Six spray flammability rigs.

Rheological test apparatus.

Information on anti-misting fuel viscosity and susceptibility to degradation due to in-flight use.

DOT FIRE SAFETY R&D

TITLE: Mathematical Modeling of Cabin Fire

CONTRACT NO.: FA-47 WA-3532

FUNDING LEVEL: \$320,000

PERFORMING ORGANIZATION: University of Dayton Research Institute

NAME OF PRINCIPAL MONITOR: C. D. MacArthur

SPONSORING ORGANIZATION: FAA Technical Center

OBJECTIVE: Develop a reliable mathematical postcrash cabin fire model and computer program to predict the effects of changing cabin design and interior materials on fire spread and hazard development.

DESCRIPTION OF WORK:

The Dayton Aircraft Cabin (DACFIR) Model employs a grid scheme on all the surfaces in the cabin to determine fire development. OSU chamber measurements of flame spread rates, ignition times, the heat flux at the on-set of smoldering, smoldering times, and burning times are used in this determination. Similarly, emissions of heat, smoke and toxic gases measured with the OSU chamber, are used to compute these emissions for the area of material undergoing smoldering or flaming at any time interval. The distribution of heat, smoke and toxic gases which rise to the ceiling and create a stratified cabin environment are determined through the use of a lumped parameter, one-dimensional, dynamic model (two zone assumption). Studies will be undertaken in FY-80 to upgrade or expand capabilities of the model; e.g., two-dimensional field model solution of longitudinal spread of combustion products, thermal degradation model of material burning and external pool fire penetration through a fuselage opening.

EXPECTED OUTPUT:

A mathematical model and computer program to predict hazard development inside an aircraft cabin during burning of interior materials.

Final reports issued:

1) Reeves, J.B., and Mac Arthur, C.D., "Dayton Aircraft Cabin Fire Model", Volumes I, II, and III, FAA, Report FAA-RD-76-120, June 1976.

2) MacArthur, C.D., and Meyers, J.F., Dayton Aircraft Cabin Fire Model Validation, Phase I", FAA, Report FAA-RD-78-57.

DOT FIRE SAFETY R&D

TITLE: Physical Modeling of Cabin Fire

CONTRACT NO.: 181-521-19

FUNDING LEVEL: \$190,000

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: C.P. Sarkos

SPONSORING ORGANIZATION: FAA/AWS-120

OBJECTIVE: To develop a cabin fire modeling method to (1) assess and predict the time-dependent hazardous combustion characteristics of cabin materials or materials/furnishing systems under postcrash fire conditions, and (2) evaluate cabin fire management systems under these conditions.

DESCRIPTION OF WORK:

1. Evaluate state-of-the-art of Froude and pressure modeling technology.
2. Establish facilities at NAFEC for cabin fire modeling studies and tests integrated with the C-133 materials and environmental test projects.
3. Conduct pool fire scaling studies to determine postcrash radiant heat levels for simulated fuel spill fires. Examine dependency of cabin hazard buildup on fire size, wind velocity and exit openings configuration.
4. Conduct pressure modeling studies of materials to investigate correlation of material flammability with C-133 and laboratory fire tests.
5. Conduct pressure/Froude modeling studies of cabin fire management systems to demonstrate correlation with available full-scale tests.
6. Integrate prior test results to define a cabin fire modeling methodology.
7. Conduct specific tests to demonstrate correlation between physical model and full-scale fire tests in C-133 facility.

EXPECTED OUTPUT:

A series of reports describing a cost-effective method of physical modeling of postcrash cabin fire by which the fire safety, time-dependent characteristics of a cabin design can be assessed. Comprehensive report: Cost Effective Method of Physically Modeling a Cabin Fire, December 1982. The following reports have been issued:

- 1) Eklund, T.I., "Pool Fire Radiation through a Door in a Simulated Aircraft Fuselage", FAA/NAFEC, Report FAA-RD-78-135, December 1978.
- 2) Alpert, R.L., "Pressure Modeling of Vertically Burning Aircraft Materials", FAA Contract, Report FAA-RD-78-139, January 1979.
- 3) Eklund, T.I., "Preliminary Evaluation of the Effects of Wind and Door Openings on Hazard Development Within a Model Fuselage from an External Pool Fire", FAA/NAFEC, Letter Report NA-79-1-LR, February 1979.
- 4) Eklund, T.I., "Feasibility of Froude Modeling a Pool Fire External to an Aircraft Fuselage", FAA/NAFEC, Letter Report NA-79-21-LR, July 1979.
- 5) Eklund, T.I., et. al., "Preliminary Evaluation of the Performance of Advanced and Conventional Aircraft Windows in a Model Fire Environment," FAA/NAFEC, Letter Report NA-80-17-LR, May 1980.

DOT FIRE SAFETY R&D

TITLE: Technical Support For Full Scale C-133 Fire Tests

CONTRACT NO.: 181-521-13

FUNDING LEVEL: \$170,000

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: C.P. Sarkos

SPONSORING ORGANIZATION: FAA/AFS-120

OBJECTIVE:

Design and development of gas analysis and animal toxicity systems in support of C-133 materials burn test.

DESCRIPTION OF WORK:

Develop an ion chromatographic method of analysis for fluoride and chloride. Analyze samples trapped on solid absorbents for hydrogen cyanide and other gases by gas chromatography. Complete the computerization of the laboratory and full-scale tests. Develop a functional full-scale animal test protocol. Investigate procedures for simultaneously evaluating sensory irritants and systems' toxicants. Investigate acid gas effects on carbon monoxide exposures.

EXPECTED OUTPUT:

Development and subsequent verification of those analytical and animal exposure procedures required to support full-scale 133 fire tests. Generation of report describing these procedures, January 1981. Papers:

- 1) Spurgeon, J.S., Speitel, L.C. and Feher, R.E., "Oxidative Pyrolysis of Aircraft Interior Materials", Journal of Fire and Flammability, Vol. 8, pp. 349-363, July 1977.
- 2) Spurgeon, J.C., Filipczak, R., Feher, R.E., and Sternik, S., "Procedure for Electronically Monitoring Animal Response Parameters using the Rotating Wheel", Journal of Combustion Toxicology, Vol. 6., pp. 198-207, August 1979.

DOT FIRE SAFETY R&D

TITLE: USAF Fire Protection Program

CONTRACT NO.: MIPR FY 1455-80-00605 Agreement NA-168

FUNDING LEVEL: \$123,000

PERFORMING ORGANIZATION: Aircraft & Airports Safety Division
Fire Safety Branch, ACT-350, FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: G. Chamberlain

SPONSORING ORGANIZATION: USAF Wright Patterson AFB, Ohio AFWAL/POSH

OBJECTIVE:

1. Select suitable replacement fire extinguishing agent for bromochloromethane (Halon 1011) for aircraft habitable compartment.
2. Determine feasibility of using intumescent coating for the improvement of fire resistance of self-sealing fuel lines.
3. Improvement of fire hardening, detection and control for engine compartments in high performance aircraft.

DESCRIPTION OF WORK:

1. Determination of agent concentration in fixed volumes under ventilated & non-ventilated conditions, agent decomposition products, throw range and effectiveness range for Halon 1211, 1301 and Halon Foam.
2. Evaluation of many various intumescent coatings on plain aluminum fuel lines; fire testing and gun fire testing of 2 selected intumescent coatings after application to self sealing fuel lines.
3. Testing of F-111 high performance fuselage to develop improved fire hardening, detection and control of engine fires.

EXPECTED OUTPUT:

1. Work completed. Report: Advanced Fire Extinguishing Agents for Aircraft Habitable Compartments. No: AFAPL-TR-79-2036. October, 1979.
2. Recommendation as to the feasibility of using intumescent coatings to improve fire resistance of fuel lines (Report).
3. Recommendations for the improvement of fire hardening, detection, and control for high performance aircraft (Report).

DOT FIRE SAFETY R&D

TITLE: Wing Spillage Tests of Anti-Misting Fuel

CONTRACT NO.: 181-521-151

FUNDING LEVEL: N/A

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: E.P. Klueg

SPONSORING ORGANIZATION: FAA/ACT-310

OBJECTIVE: To develop a facility of simulating and controlling fuel spillage from a ruptured wing in an airstream over a range of air velocities, fuel spillage rates, air temperatures and fuel temperatures likely to have an influence on the mist flammability envelope. The flammability envelope of candidate additives will be determined at these conditions as a function of additive concentration.

DESCRIPTION OF WORK:

To develop the following conditions for the improved wing spillage device:

Airspeed : 60-160 knots
Airstream flow : 300-600 pounds per second
Fuel spillage rate: 20-100 gallons per second
Air temperature :
0-20°F above ambient
Fuel temperature :
0-70°F above ambient (with heat exchanger)

EXPECTED OUTPUT:

A facility for simulating fuel spillage into an airstream to study the effect of various aerothermodynamic factors on mist flammability.

Flammability envelopes for candidate additives.

A better understanding of the role of rear-mounted engines on ignition of fuel mists.

Recommendations on the design of full-scale crash tests.



DOT RISK RATING

1. Title: [Illegible]

2. Contact: [Illegible]

3. Date: [Illegible]

4. Description: [Illegible]

5. Name of Principal Investigator: [Illegible]

6. Location: [Illegible]

2. FEDERAL RAILROAD ADMINISTRATION

7. Description of Work: [Illegible]

8. Summary of Findings: [Illegible]

DOT FIRE SAFETY R&D

TITLE: Fire Safety Concepts for Railroad Cars Carrying Class A Explosives

CONTRACT NO.: AR-8198

FUNDING LEVEL: \$125,000

PERFORMING ORGANIZATION: National Bureau of Standards

NAME OF PRINCIPAL INVESTIGATOR: Dave Dancer

SPONSORING ORGANIZATION: FRA

OBJECTIVE: Reduce the frequency/severity of fires in RR cars carrying Class A explosives.

DESCRIPTION OF WORK: (1) Determine the performance requirements of spark shields and fire detection/suppression systems.

EXPECTED OUTPUT: Performance specs for spark shields and fire detection/suppression systems. A test plan for full scale and/or small scale fire tests.

DOT FIRE SAFETY R&D

TITLE: Flammability of Materials Used in Rail Passenger Cars

CONTRACT NO.: AR-8179

FUNDING LEVEL: \$675,000

PERFORMING ORGANIZATION: Dept. of Army Ballistics Laboratory

NAME OF PRINCIPAL INVESTIGATOR: Ed Baicy

SPONSORING ORGANIZATION: FRA Office of Rail Safety Research

OBJECTIVE: Collect information on vehicle accidents involving interiors and evaluate flammability test methods to determine their usefulness in setting performance standards.

DESCRIPTION OF WORK:

1. Literature search of flammability test methods and accidents resulting in interior fires.
2. Evaluation and testing of various flammability test methods.
3. Full scale fire test of a rail passenger vehicle.

EXPECTED OUTPUT:

Performance specifications for interior systems used in rail passenger vehicles.

DOT FIRE SAFETY R&D

TITLE: Neutralization and Control of Spills From Railroad Tank Cars

CONTRACT NO.: P.O. 8204

FUNDING LEVEL: \$9,969

PERFORMING ORGANIZATION: Geo-Centers

NAME OF PRINCIPAL INVESTIGATOR: Dave Dancer

SPONSORING ORGANIZATION: FRA

OBJECTIVE: Mitigate the effects of RR chemical spills.

DESCRIPTION OF WORK:

1. The contractor shall review the various methods and techniques for controlling and inhibiting the flammability/explosibility/detonability and toxicity from chemical spills. These shall include, but not be limited to, cloud dispersal and initiation and the use of additives to reduce and inhibit the deflagration, detonation, and toxicity threat.
2. The contractor shall perform a preliminary analysis on cloud dissipation techniques (laser, sparks, high explosives, ultra-violet light) which could be used to dissipate, neutralize, and inhibit the threat from chemical clouds resulting from spills that present toxic dangers. Some of these dissipation techniques can be employed remotely, thus they are attractive from a safety viewpoint.
3. The contractor shall recommend laboratory and field tests that would corroborate the results obtained in Tasks 1 and 2 above.

EXPECTED OUTPUT: Techniques for the emergency response to RR chemical spills.

DOT FIRE SAFETY R&D

TITLE: Rail Hazardous Material Tank Car Torching Study and Pool Fire Test (Phase V)

CONTRACT NO.: AR-44061

FUNDING LEVEL: \$350,000

PERFORMING ORGANIZATION: U.S. Army Ballistic Research Laboratories

NAME OF PRINCIPAL MONITOR: Ed. Baicy

SPONSORING ORGANIZATION: FRA

OBJECTIVE: Develop Guidelines and/or specifications for the thermal protection of tank cars subjected to torch fires.

DESCRIPTION OF WORK:

1. Comparison testing of selected insulation systems - conduct 16 tests on 2 insulation jacket thermal shield materials to determine
 - (a) Repeatability in various torch fire facilities
 - (b) Correlation between data results obtained from different torch fire facilities
 - (c) Effect of density.
2. Conduction of 2 full scale torch fires: one tank car with no protection; one car with an insulated jacket.

EXPECTED OUTPUT:

1. Test methodology for evaluating thermal shield materials.
2. Determination of effect of density on thermal shield effectiveness.

DOT FIRE SAFETY R&D

TITLE: Rail Car Material Evaluation

CONTRACT NO.: N/A

FUNDING LEVEL: \$8,400

PERFORMING ORGANIZATION: TSC

NAME OF PRINCIPAL MONITOR: I. Litant/DTS-332

SPONSORING ORGANIZATION: FRA

OBJECTIVE:

1. Review of materials specifications and evaluation for AMTRAK
2. Test and evaluation of selected materials
3. Monitoring of ongoing and proposed studies of PCB transformer retrofill.

DESCRIPTION OF WORK:

1. Assistance is provided to FRA and AMTRAK in reviewing materials (non-metallic) used in AMTRAK vehicles.
2. Co-monitoring of contracts concerning the replacement of arochlors in transit transformers.

EXPECTED OUTPUT:

1. The review of materials is an ongoing project and is provided on an as-required basis. Information on new materials is provided to AMTRAK design personnel.
2. Recommendations will be made to FRA concerning the efficiency of retrofitting arochlor-filled transit transformers.

DOT FIRE SAFETY R&D

TITLE: Study of Fire Extinguishment of Transformer Fluids

CONTRACT NO.: 332-5657

FUNDING LEVEL: \$8600.

PERFORMING ORGANIZATION: Factory Mutual Research Corp.

NAME OF PRINCIPAL INVESTIGATOR: David Heard

SPONSORING ORGANIZATION: FRA/Research and Development

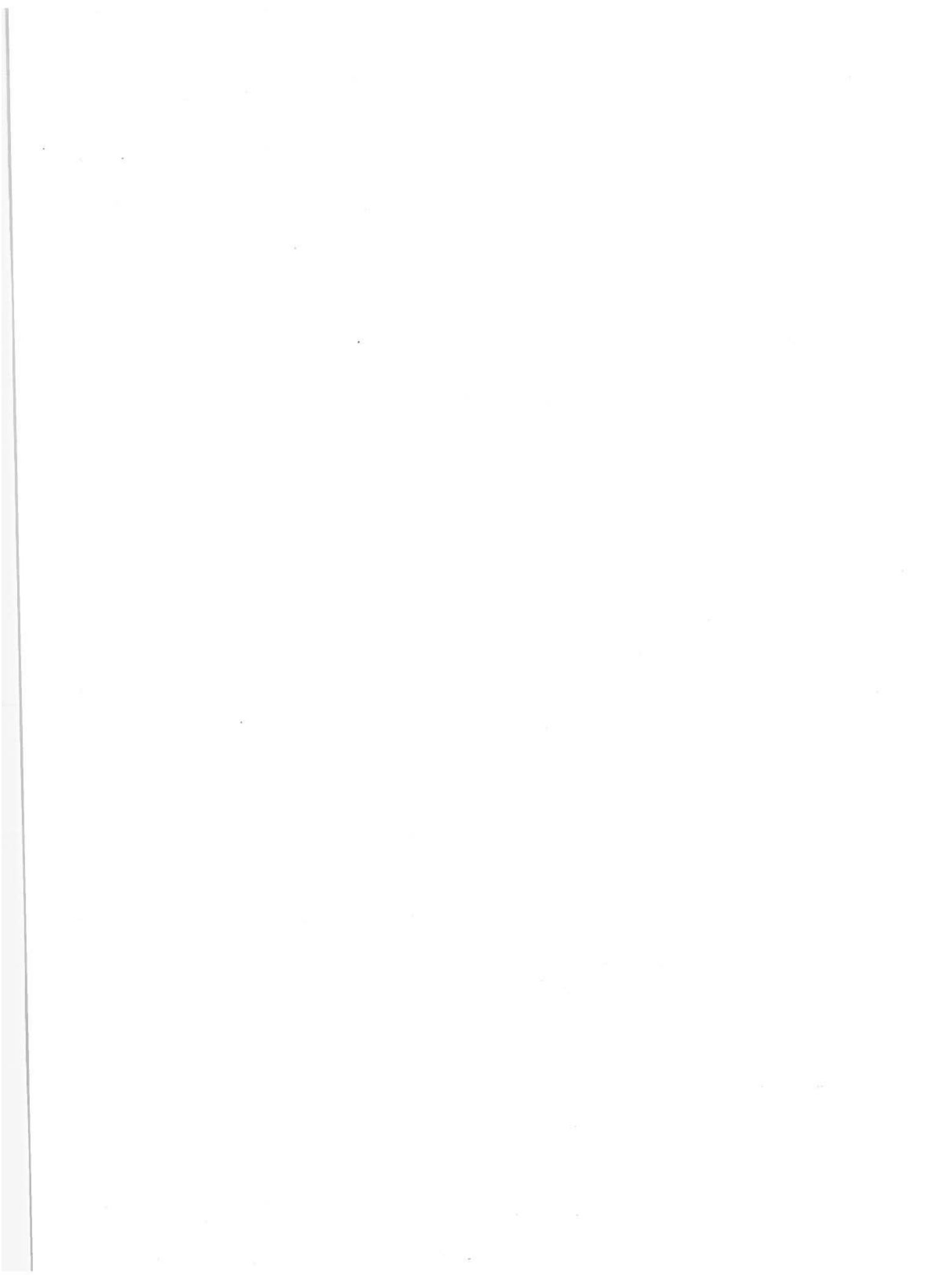
OBJECTIVE: To obtain information on means of extinguishment of fires caused by Askarel replacements in transformers.

DESCRIPTION OF WORK:

Extinguishment of pool fires in two different types of transformer fluids using three different extinguishants.

EXPECTED OUTPUT:

Guidance for FRA in establishing protective measures against pool fire origination from ruptured transformers.



OFFICE OF THE SECRETARY OF TRANSPORTATION

3. OFFICE OF THE SECRETARY OF TRANSPORTATION

DOT FIRE SAFETY R&D

Development of Protocol and Combustion/Exposure Chamber of Evaluating
TITLE: Combustion Product Toxicity and Smoke Resulting from Burning
Transportation Vehicle Interior Materials

CONTRACT NO.: DOT-OS-60174

FUNDING LEVEL: \$60,000 total - Continuing in FY 79

PERFORMING ORGANIZATION: University of Utah

NAME OF PRINCIPAL INVESTIGATOR: William A. Galster

SPONSORING ORGANIZATION: University Research Program

OBJECTIVE: The principal objective of the research is to formulate and evaluate a simplified and meaningful protocol, along with an appropriate combustion and exposure chamber, which will utilize only those parameters and physiological/behavioral effects found to be most relevant in assessing the relative toxicological hazards of burning materials.

DESCRIPTION OF WORK:

- (1) Develop exposure chamber, instrumentation and technique.
- (2) Subject fabrics to elemental analysis, infrared analysis and thermal analysis.
- (3) Conduct in-depth analysis of toxicological characteristics of a fire-retarded material used in transportation.
- (4) Evaluate and confirm the repeatability and fidelity of the test protocol.

EXPECTED OUTPUT:

- (a) A test protocol, exposure chamber and instrumentation that can be adopted as a standard procedure for toxicity assessment and measurement.
- (b) Data on toxic effects of products of combustion particularly CO, HCN, CO₂, SO₂ and H₂S.

DOT FIRE SAFETY R&D

TITLE: Transportation Fire Safety

CONTRACT NO.: PPA No. OP-037

FUNDING LEVEL: \$25,000 in FY-80

PERFORMING ORGANIZATION: Transportation Systems Center

NAME OF PRINCIPAL INVESTIGATOR: W.T. Hathaway

SPONSORING ORGANIZATION: Office of the Secretary

OBJECTIVE: To develop an integrated program plan for the improvement of fire safety in transportation.

DESCRIPTION OF WORK: The task is to evaluate the current status of fire safety in transportation and the thoroughness with which DOT programs address the fire safety problems. Areas which have multimodal interest and application will receive special attention.

EXPECTED OUTPUT: A report of the present DOT Fire Safety effort with a plan for improving the DOT fire safety program.

A report on the analytical fire models available for application to transportation.

DOT FIRE SAFETY R&D

TITLE: System Safety - An Interdisciplinary Approach to Transportation Safety

CONTRACT NO.: DOT-OS-50241

FUNDING LEVEL: \$135,000 1978-79

PERFORMING ORGANIZATION: Polytechnic Institute of New York

NAME OF PRINCIPAL INVESTIGATOR: L.J. Pignataro

SPONSORING ORGANIZATION: University Research Program

OBJECTIVE: To develop a transportation Safety Methodology, apply the methodology to transportation cases and refine the methodology.

DESCRIPTION OF WORK: Year 1 - Identification and necessary resolution of key issues, and preparation of a draft methodology for the study of transportation system safety.

Year 2 - Application of methodology as developed in year one. Selection, execution and reporting of case studies.

Year 3 - Refinement of the methodology, generalization of guidelines and further testing when necessary.

EXPECTED OUTPUT:

- (1) Transportation System Safety Methodology.
- (2) Key Issues in Transportation Safety.
- (3) Survey and Annotated Bibliography.
- (4) Case studies in air, rapid rail and highway modes.
- (5) Detailed analysis of one mode.
- (6) A National Symposium on Transportation Safety.

Completed in 1979.

UNITED STATES DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

Office of Research and Special Programs Administration

Contract No. HHS-13-80-001

Project Title: [Illegible]

[Illegible]

4. RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION

[Illegible]

[Illegible]

[Illegible]

DOT FIRE SAFETY R&D

TITLE: Classification of Oxidizers and Flammable Solids

CONTRACT NO.: DOT-AS-30042

FUNDING LEVEL: \$124,815 Started FY-73 - On-going Program

PERFORMING ORGANIZATION: Naval Ordnance Station, Indian Head, MD.

NAME OF PRINCIPAL INVESTIGATOR: Dr. Charles B. Nile

SPONSORING ORGANIZATION: OHMO (DMT-10)

OBJECTIVE: To develop test methods and related criteria for classification of oxidizing materials and flammable solids for transportation technical basis for updating Title 49 CFR.

DESCRIPTION OF WORK: The work involves validating and modifying proposed methods for determining the hazards of gaseous, liquid and solid oxidizers and flammable solids for classification and resultant packaging selection. Selected materials are tested also on an "as needed" basis. Project is ongoing.

EXPECTED OUTPUT: Standardized test methods and related classification criteria which can form the technical basis for revising the corresponding section of the DOT Hazardous Materials Regulations (Title 49 CFR). Results are also useful for emergency response purposes. Data which enable decisions on exemption petitions and provide compliance and investigation support also result.

DOT FIRE SAFETY R&D

TITLE: Classification of Spontaneously Combustible Materials

CONTRACT NO.: DOT-AS-40049

FUNDING LEVEL: \$68,100 - Started FY74 On-going Program

PERFORMING ORGANIZATION: Naval Surface Weapons Center (White Oak, MD)

NAME OF PRINCIPAL INVESTIGATOR: Mr. Harry Weaver

SPONSORING ORGANIZATION: MTB/OHMO (DMT-10)

OBJECTIVE: To develop test methods and related criteria for classification of spontaneously combustible materials (other than pyrophorics) for transportation technical basis for updating Title 49 CFR.

DESCRIPTION OF WORK: The work involves developing a calorimetric method for determining those materials which over a period of time may reach an auto ignition temperature without external ignition source in the transportation system. Selected materials are being tested to validate the method. The project is ongoing.

EXPECTED OUTPUT: A standardized test method and related classifications criteria which can form the technical basis for revising the corresponding section of the DOT HM Regulations (Title 49 CFR). Results will be useful in evaluating exemption petitions and supporting surveillance, compliance efforts and investigations.



FOR THE YEAR 1970

5. URBAN MASS TRANSPORTATION ADMINISTRATION

DOT FIRE SAFETY R&D

TITLE: Computerized Materials Information Bank

CONTRACT NO.: DOT-TSC-1534

FUNDING LEVEL: \$83,000

PERFORMING ORGANIZATION: Boeing Commercial Airplane Co.

NAME OF PRINCIPAL INVESTIGATOR: J. Peterson

SPONSORING ORGANIZATION: UMTA through TSC, PPA UM-21

OBJECTIVE: Updating and maintenance of UMTA's material data bank.

DESCRIPTION OF WORK:

1. Addition of materials categories and insertion of metric equivalents
2. Addition of new materials data and correction of old data.

EXPECTED OUTPUT: A revised and updated materials data bank for reference in specifying materials for transit systems.

DOT FIRE SAFETY R&D

TITLE: DPM Materials Support

CONTRACT NO.: UM041-OB

FUNDING LEVEL: \$17,000

PERFORMING ORGANIZATION: TSC-DTS/332

NAME OF PRINCIPAL INVESTIGATOR: I. Litant

SPONSORING ORGANIZATION: UMTA/Office of AGT Applications

OBJECTIVE: Overview of Flammability and materials requirements for DPM systems

DESCRIPTION OF WORK:

Review of Materials specifications for DPM systems and provide guidance as required to potential suppliers regarding materials flammability.

EXPECTED OUTPUT:

Response to proposed materials specifications related to flammability and smoke emission.

DOT FIRE SAFETY R&D

TITLE: Fire Safety Evaluation of Automated Guideway Transit Vehicles

CONTRACT NO.: DOT-AT-70025

FUNDING LEVEL: \$20,000

PERFORMING ORGANIZATION: Center for Fire Research, National Bureau
of Standards

NAME OF PRINCIPAL INVESTIGATOR: R.D. Peacock

SPONSORING ORGANIZATION: UMTA, UTD-50

OBJECTIVE: To explore and formulate the fire safety guidelines to be required for automated vehicles used for the movement of people in congested urban areas.

DESCRIPTION OF WORK: By the review of existing systems similar to those that are expected to be used in the "Downtown People Mover" (DPM) program, scenarios will be developed in order to establish the maximum and minimum levels of fire safety of the vehicles for several types of DPM systems. In addition to the methods and materials of construction, the interior finish materials, the means of fire detection and/or suppression, size, accessibility and operations environment will be considered when proposing fire safety guidelines.

By comparing them to the standards being used in other modes of transportation, using available test methods, the most relevant rationale for establishing guidelines will be developed.

EXPECTED OUTPUT: A final report will be prepared describing the effort and presented to the manufacturers and operators in a workshop environment.

DOT FIRE SAFETY R&D

TITLE: Fire Safety In Transit Systems

CONTRACT NO.: PPA UM-21

FUNDING LEVEL: \$350,000, FY-80

PERFORMING ORGANIZATION: TSC/DOT

NAME OF PRINCIPAL INVESTIGATOR: W.T. Hathaway

SPONSORING ORGANIZATION: UMTA

OBJECTIVE: To assess the overall fire threat in transit systems and to identify and recommend suitable remedial actions. These remedial actions shall be designed to minimize and, where possible, eliminate the fire threat in transit systems.

DESCRIPTION OF WORK: This project involves assessing the present fire safety efforts and then identifying, through the use of scenarios, the fire threat in transit systems. Having identified the fire threats, countermeasures designed to eliminate or minimize this fire threat may then be proposed. Resulting from these countermeasures will be proposed standards and prospective R&D projects to evaluate or implement the proposed standards.

EXPECTED OUTPUT: A better understanding of the fire threat in transit systems and a means for eliminating or minimizing this fire threat.
Completed work to date:

1. Report: Identification of the Fire Threat in Urban Transit Vehicles, July, 1979.
2. Development of proposed standards for flammability and smoke emission requirements for materials used in transit vehicles.
3. Analysis of costs/benefits to accrue from implementation of fire safety standards.
4. Identification of countermeasures for application to transit vehicles.

DOT FIRE SAFETY R&D

TITLE: Flammability Testing of Materials

CONTRACT NO.: RA: 76-4 Mod#1 611-0349

FUNDING LEVEL: \$36,250 (FY77-FY80)

PERFORMING ORGANIZATION: FAA Technical Center

NAME OF PRINCIPAL INVESTIGATOR: C.P. Sarkos

SPONSORING ORGANIZATION: UMTA/TSC

OBJECTIVE: Provide reliable fire-safety data on selected materials for transit systems.

DESCRIPTION OF WORK: Testing of flammability and smoke emissions of materials provided by UMTA/TSC.

EXPECTED OUTPUT: Data for inclusion in UMTA data bank.

DOT FIRE SAFETY R&D

TITLE: Study of Electrical Insulation

CONTRACT NO.: DOT-TSC-1221

FUNDING LEVEL: \$116,707

PERFORMING ORGANIZATION: Boeing Commercial Airplane Co.

NAME OF PRINCIPAL INVESTIGATOR: J. York/L. Myer

SPONSORING ORGANIZATION: UMTA/TSC

OBJECTIVE: To determine whether any of the currently used electrical insulations can provide a fire-safe environment in terms of low flame propagation, smoke and toxic gas emission.

DESCRIPTION OF WORK:

1. Review standard test method for flammability of wire and cable insulation and select most appropriate for transit system.
2. Review standard test methods for smoke emission and select one for measurement of smoke emission from wire and cable.
3. Select method for measurement of wire circuit integrity.
4. Evaluation candidate electrical insulation by selected procedures.
5. Rank insulation according to test results.

EXPECTED OUTPUT:

Reports published December, 1978.

DOT FIRE SAFETY R&D

TITLE: Study of Flammability of Electrical Insulation

CONTRACT NO.: DTRS-57-80-C-00073

FUNDING LEVEL: \$135,819

PERFORMING ORGANIZATION: Factory Mutual Research

NAME OF PRINCIPAL INVESTIGATOR: A. Tewarson

SPONSORING ORGANIZATION: UMTA/TSC

OBJECTIVE: To continue to examine the fire performance characteristics of electrical insulation materials used in rail rapid transit systems in order to provide a more fire-safe environment.

DESCRIPTION OF WORK:

Examination and testing of representative insulation materials from a wide sampling of electrical wire and cable by means of several test procedures for flammability, smoke emission and other properties.

EXPECTED OUTPUT:

A report which will rank wire and cable insulation materials according to test procedure. The ranking will provide an order of relative merit, allowing design engineers to select wire and cable which will provide a more fire-safe environment for rail rapid transit vehicles.

DOT FIRE SAFETY R&D

TITLE: Toxicity of Combustion Products of Transit Materials

CONTRACT NO.: (RA) 77-16

FUNDING LEVEL: \$50,000

PERFORMING ORGANIZATION: CAMI

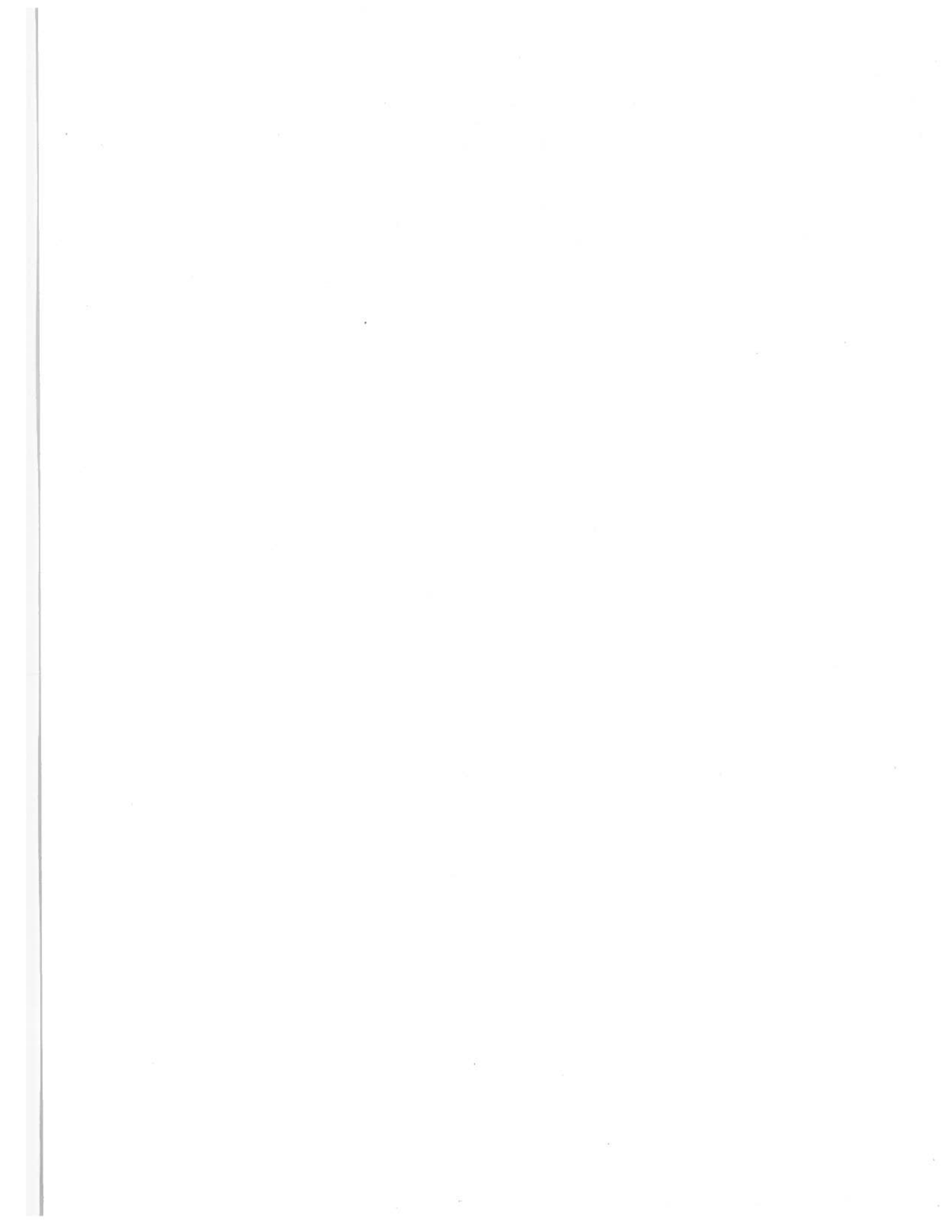
NAME OF PRINCIPAL INVESTIGATOR: Dr. Charles R. Crane

SPONSORING ORGANIZATION: UMTA/TSC

OBJECTIVE: To determine the toxicity of products of combustion of various types of materials used in urban rail systems.

DESCRIPTION OF WORK: Live animals (rats) are exposed to gases evolved from materials used in rail transit vehicles, such as electrical insulation. The time to incapacitation and times to death are determined.

EXPECTED OUTPUT: Results of these tests will be used to determine the toxicity of the products of combustion to humans. These results will be combined with results of flammability tests on electrical insulation, performed under contract by Boeing Commercial Airplane Co., to provide a total comparison of flammability properties.



THE U.S. COAST GUARD

6. U.S. COAST GUARD

DOT FIRE SAFETY R&D

TITLE: Automated Deck Foam Fire Extinguishing Systems for Tankers

CONTRACT NO.: 3308.5.5.1

FUNDING LEVEL: \$91,300

PERFORMING ORGANIZATION: U.S. Coast Guard R&D Center

NAME OF PRINCIPAL MONITOR: D. F. Sheehan

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: To determine if unmanned foam monitors can be effectively used as an alternative to manned foam monitors for combating major cargo fires aboard tankers.

DESCRIPTION OF WORK:

Several oscillating, remote controlled, and automatic monitors were tested on large spill fires on the deck of a tankship.

Maneuverability tests were conducted using remote control and automatic monitors to determine response time and ability to aim monitors as desired.

EXPECTED OUTPUT:

Automated monitors are unreliable even under test conditions. In the harsh marine environment their reliability would be unacceptable.

In some cases loss of foam was as high as 25 to 50% due to overshooting or improper aim, even when the fire location was known in advance.

Manual override is needed.

Exposure to personnel is reduced.

DOT FIRE SAFETY R&D

TITLE: Bunk Reading Light Tests

CONTRACT NO.: 793308.8.1

FUNDING LEVEL: \$1000

PERFORMING ORGANIZATION: U.S. Coast Guard R&D Center

NAME OF PRINCIPAL MONITOR: LCDR J.D. Moore

SPONSORING ORGANIZATION: U.S. Coast Guard (G-ENE)

OBJECTIVE: Determine if bunk reading lights can ignite foam pillows, feather pillows or pillow cases.

DESCRIPTION OF WORK: Twelve tests were conducted varying the distance of the lamp from the pillows, and the orientation of the pillows.

EXPECTED OUTPUT:

The foam pillows tested were found to quickly develop pungent smoke and eventual temperatures of up to 850°F.

The feather pillows with or without cases, generated light smoke for several minutes until a self-insulating char formed which stopped smoke generation and further temperature increases for 8 hours.

DOT FIRE SAFETY R&D

TITLE: Carbon Disulfide Extinguishment Test

CONTRACT NO.: 841340-A

FUNDING LEVEL: \$150,000

PERFORMING ORGANIZATION: Applied Technology Corp., Norman, OK

NAME OF PRINCIPAL MONITOR: D.F. Sheehan

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT and MHM)

OBJECTIVE: To determine the minimum flow rates for various fire extinguishing agents on carbon disulfide fires.

DESCRIPTION OF WORK: The apparatus developed in the "Chemical Cargo Fire Protection" program is to be used to evaluate common fire extinguishing agents for combating carbon disulfide fires.

EXPECTED OUTPUT:

Minimum design application rates of various fire extinguishing agents on carbon disulfide fires.

DOT FIRE SAFETY R&D

TITLE: Cargo Hold Fire Extinguishment Using High Expansion Foam

CONTRACT NO.: 3308.5.5

FUNDING LEVEL: \$75,000

PERFORMING ORGANIZATION: U.S. Coast Guard R&D Center

NAME OF PRINCIPAL MONITOR: D. F. Sheehan

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: Determine the ability of high expansion foam to extinguish advanced Class A cargo hold fires.

DESCRIPTION OF WORK: One hold of a cargo vessel will be filled with baled cardboard and ignited. After a suitable preburn to allow the fire to become deep seated, an attempt will be made to extinguish the fire with high expansion foam.

EXPECTED OUTPUT:

If successful, high expansion foam may be allowed as an alternative to the carbon dioxide systems presently required for cargo holds.

DOT FIRE SAFETY R&D

TITLE: Cargo Hold Extinguishment with CO₂

CONTRACT NO.: 3308.5.4

FUNDING LEVEL: \$119,900

PERFORMING ORGANIZATION: USCG R&D Center

NAME OF PRINCIPAL INVESTIGATOR: R.C. Richards

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: Evaluate the parameters necessary for successful extinguishment of large scale Class A fires with carbon dioxide.

DESCRIPTION OF WORK: Preliminary work has evaluated on a small scale the difficulty to extinguish fires involving various Class A materials. Large scale tests will be conducted on compressed cardboard, which the small scale tests found to be a good example of a hard-to-extinguish fire.

Parameters such as concentration, discharge rate, nozzle placement, etc. will be evaluated.

EXPECTED OUTPUT: It is expected that these tests will either verify the acceptability of existing regulations for CO₂ systems or show how regulations need to be revised.

DOT FIRE SAFETY R&D

TITLE: Cargo Hold Extinguishment with Halon 1211

CONTRACT NO.: 3308.5.7

FUNDING LEVEL: \$72,100

PERFORMING ORGANIZATION: USCG R&D Center

NAME OF PRINCIPAL INVESTIGATOR: R.C. Richards

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: Determine the ability of Halon 1211 to safely extinguish cargo hold fires.

DESCRIPTION OF WORK: Halon 1211 will be applied to large scale cargo hold fires to determine the conditions under which these fires can be extinguished.

EXPECTED OUTPUT: The viability of Halon 1211 extinguishing systems for cargo hold fires will be determined.

DOT FIRE SAFETY R&D

TITLE: Cargo Hold Extinguishment with Halon 1301

CONTRACT NO.: 3308.5.6

FUNDING LEVEL: \$85,100

PERFORMING ORGANIZATION: USCG R&D Center

NAME OF PRINCIPAL INVESTIGATOR: R.C. Richards

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: Evaluate the ability of Halon 1301 to safely extinguish large fires involving Class A material.

DESCRIPTION OF WORK: Halon 1301 is to be discharged into a cargo hold containing burning cardboard to determine the concentration and discharge time necessary to achieve extinguishment. Temperatures, gas concentrations breakdown products, etc. are to be monitored.

EXPECTED OUTPUT: Since Halon 1301 is already being used on vessels for machinery space protection, these tests will determine if the same halon supply can provide cargo protection.

DOT FIRE SAFETY R&D

TITLE: Carpet Fire Tests

CONTRACT NO.: MIPR

FUNDING LEVEL: \$25,000

PERFORMING ORGANIZATION: National Bureau of Standards

NAME OF PRINCIPAL MONITOR: W. G. Boyce

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: Evaluate laboratory fire tests of carpet to determine which, if any, correlate with large fires. Evaluate carpet fire tests requirements for shipboard use.

DESCRIPTION OF WORK: Phase I is a study of shipboard conditions to determine carpet fire test needs.

Phase II is an examination of various tests for ignition, heat release, flame spread, and smoke produced. For example, flame spread tests to be evaluated are ASTM E-84 with both floor and ceiling mounting, UL 992, Flooring Radiant Panel, and a proposed IMCO Test using the ISO apparatus.

EXPECTED OUTPUT: Recommendation of fire tests for carpet installed on ships.

DOT FIRE SAFETY R&D

TITLE: Chemical Cargo Fire Protection

CONTRACT NO.: CG-42,355

FUNDING LEVEL: \$400,000

PERFORMING ORGANIZATION: Applied Technology Corporation

NAME OF PRINCIPAL MONITOR: D. F. Sheehan/M. Query

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT) and (G-MHM)

OBJECTIVE: To provide design data for engineering fire protection systems for hazardous cargos.

DESCRIPTION OF WORK: Develop a standardized test procedure to evaluate available fire extinguishing agents on fires involving hazardous materials. Phase I is to consist of a series of several hundred tests using hexane to use as a basis of comparison.

EXPECTED OUTPUT: A matrix of agents vs. cargos providing application quantities and rates which will allow extrapolation to new cargo. A standard test method to compare new agents with existing agents. Phase I testing with hexane has been completed and a report is expected by the end of 1979.

DOT FIRE SAFETY R&D

TITLE: Class A Fire Extinguisher Tests

CONTRACT NO.: 824313

FUNDING LEVEL: \$5,000

PERFORMING ORGANIZATION: Underwriters Laboratories, NFPA

NAME OF PRINCIPAL MONITOR: Klaus Wahle

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: Determine if NFPA Classification and UL approvals of 2A fire extinguishers are equally acceptable with untrained persons.

DESCRIPTION OF WORK: Untrained operators are to be used for all tests of Class A fire extinguishers. Identical fires are to be extinguished using water, foam, dry chemical, and halon to determine the minimum amount of each agent capable of extinguishing fires with a novice operator.

The NFPA 10 committee on portable extinguishers will evaluate the results.

EXPECTED OUTPUT: Verify or revise existing rating and testing requirements for Class A portable fire extinguishers.

DOT FIRE SAFETY R&D

TITLE: Classification of Hazardous Areas

CONTRACT NO.: DOT - CG-929212-A

FUNDING LEVEL: Part I \$22,000 (other parts not yet awarded)

PERFORMING ORGANIZATION: Advanced Marine Enterprises

NAME OF PRINCIPAL MONITOR: B. A. Jackson

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: Evaluate classification of hazardous areas on vessels and drilling units.

DESCRIPTION OF WORK: Measurements and calculations are to be made to determine the classification of areas aboard vessels and drilling units. Probabilities of leakage are to be determined.

EXPECTED OUTPUT: Data on classification of specific areas on vessels.

DOT FIRE SAFETY R&D

TITLE: Commercial Vessel Safety Fire Testing Support

CONTRACT NO.: N/A

FUNDING LEVEL: \$270,000 annually

PERFORMING ORGANIZATION: CG R&D Center/Fire and Safety Test Facility

NAME OF PRINCIPAL MONITOR: D. F. Sheehan

SPONSORING ORGANIZATION: U.S.C.G. Office of Merchant Marine Safety

OBJECTIVE: To test, full scale, new materials, agents and methods for commercial vessel fire protection/prevention.

DESCRIPTION OF WORK: Tests are planned by R&D Center personnel and carried out at the Fire & Safety Test Facility, Mobile, Ala. Previous work includes tests of life saving equipment, deck monitors, compatibility of foam/dry chemicals, explosion suppression systems for tanker pumprooms. Future work includes compartment burnout series, cargo hold extinguishment series.

EXPECTED OUTPUT:

Experimental data for use by the Office of Merchant Marine Safety in preparation of regulations.

DOT FIRE SAFETY R&D

TITLE: Compartment Burnout Tests.

CONTRACT NO.: 3308.5.2

FUNDING LEVEL: \$254,300

PERFORMING ORGANIZATION:USCG R&D Center

NAME OF PRINCIPAL INVESTIGATOR: R.C. Richards

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: Evaluate the effect of changes in construction and furnishing materials on the fire performance of compartments.

DESCRIPTION OF WORK: Several furnished compartments are to be burned out. Ventilation rates are to be varied to determine their effect. Modern contents are to be compared to contents tested in similar tests approximately 30 years ago.

Modeling studies will be examined to determine if small scale models can accurately predict the performance of large scale compartments.

EXPECTED OUTPUT: The results should aid in determining the need for revising the fire resistance requirements of bulkheads and decks, the need to revise the time-temperature curve, or the need to limit the fuel load of certain materials.

DOT FIRE SAFETY R&D

TITLE: Detonation Flame Arresting Devices for Gasoline Cargo Vapor Recovery Systems

CONTRACT NO.: 74328

FUNDING LEVEL: \$300,000

PERFORMING ORGANIZATION: NASA-JET Propulsion Laboratory, Pasadena, CA

NAME OF PRINCIPAL MONITOR: A. L. Rowek

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MHM)

OBJECTIVE: To experimentally develop parametric data on the flame speed, flame acceleration, run-up distance to produce detonation, pressure build-up due to detonation, and pressure levels resulting from reflected shockwaves from combustible mixtures of gasoline and air in a 6-inch diameter piping system. To demonstrate the effectiveness of several selected flame arrester devices before and after exposure to detonations in simulated vapor recovery piping systems.

DESCRIPTION OF WORK: The study includes the following tasks.

(1) A literature review to supplement JPL data base and to gather and examine potential theoretical expressions and empirical correlations for scale-up.

(2) An experimental study to determine the parametric data described in "objective" and to determine the effectiveness of several potential detonation arrester designs. Arresters tested include:

- (a) flow direction change-pressure relief arrester;
- (b) water seal arrester;
- (c) non-irrigated vertical packed bed arrester utilizing Raschig rings, pall rings or other suitable material;
- (d) irrigated vertical packed bed arrester;
- (e) packed arrester using "Retimet" metal foam;
- (f) LINDE water seal arrester - commercial type

(3) Experimentally determine the effectiveness of several of the above arresters when a detonation wave enter the arrester through the normal exit port.

(4) Experimentally determine the effectiveness of Amal, Ltd. and Shand and Jurs Co. crimped ribbon flame arresters as detonation arresters for gasoline/air mixtures.

DOT FIRE SAFETY R&D

TITLE: Detonation Flame Arresting Devices for Gasoline Cargo Vapor Recovery Systems

CONTRACT NO.: 74328

EXPECTED OUTPUT:

A final report detailing -

- (1) experimental data on the measurement of flame speed, flame acceleration to detonation, run-up distance from ignition to detonation, detonation pressure, and detonation wave velocity for propane air and gasoline air mixtures in a nominal 6-inch diameter pipeline.
- (2) experimental data on the measured pre and post-test pressure drops, flame quenching capability, detonation dampering characteristics, structural durability, pressure build-up due to detonation and detonation flame speed for the tested detonation-flame arresters subjected to gasoline/air detonations in a simulated vapor recovery system using 6-inch piping.
- (3) Recommendations with respect to 12-inch diameter piping testing.

DOT FIRE SAFETY R&D

TITLE: Development and Evaluation of International Flame Spread Test

CONTRACT NO.: MIPR

FUNDING LEVEL: \$100,000

PERFORMING ORGANIZATION: National Bureau of Standards

NAME OF PRINCIPAL MONITOR: D. F. Sheehan

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: Evaluate flame spread test proposed by IMCO using ISO apparatus and make recommendations to improve or replace the apparatus.

DESCRIPTION OF WORK:

Tests are being conducted using the proposed flame spread apparatus. These are being compared with tests using flame spread apparatus common in the United States.

EXPECTED OUTPUT:

Several changes to improve the operation of the apparatus have been made. The output may be a single international flame spread apparatus to replace the multitude of tests now being used.

DOT FIRE SAFETY R&D

TITLE: Development of Lightweight High Capacity Transportable Fire Fighting Module

CONTRACT NO.: DOT CG 60,567

FUNDING LEVEL: \$270,000 (CG share)

PERFORMING ORGANIZATION: NASA

NAME OF PRINCIPAL MONITOR: D. G. DICKMAN

SPONSORING ORGANIZATION: U.S. Coast Guard (G-WLE) & NASA

OBJECTIVE: Develop lightweight firefighting module that can be easily transported by aircraft or utility boat to the scene of major marine fires.

DESCRIPTION OF WORK: A small, lightweight unit using a jet engine and pump has been developed and tested. Unit is being turned over to NASA for award to a port city for its operational use. Reports will be made by the city on module performance.

EXPECTED OUTPUT: Firefighting module.

DOT FIRE SAFETY R&D

TITLE: Electric Cables for Ships - Standards of Performance and Test Specifications

CONTRACT NO.: z - 70099-74285

FUNDING LEVEL: \$200,000

PERFORMING ORGANIZATION: Todd Shipyard, Seattle Div. and Underwriters Laboratory, Inc.

NAME OF PRINCIPAL MONITOR: A. Jackson

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT) and MARAD

OBJECTIVE: Develop a performance standard and test specification for electric cable on ships. Fire performance is to be a part of this specification.

DESCRIPTION OF WORK: Survey existing cable and test data. New types of cable are to be fire tested.

Develop recommendations for determining the properties of electric cable.

EXPECTED OUTPUT: Specification.

DOT FIRE SAFETY R&D

TITLE: Emergency Capabilities for Responding to Marine Hazardous Cargo
Casualties

CONTRACT NO.: Z 70099-7-75042

FUNDING LEVEL: \$80,000

PERFORMING ORGANIZATION: National Academy of Sciences

NAME OF PRINCIPAL MONITOR: W. D. Markle

SPONSORING ORGANIZATION: USCG, MARAD, U.S. Navy, U.S. Army

OBJECTIVE: Assess the capabilities of responsible government agencies and industries to limit major hazards resulting from casualties to cargo ships or barges carrying bulk quantities of hazardous materials.

DESCRIPTION OF WORK:

Identify the technological deficiencies in:

- (1) Preplanning
- (2) Response procedures
- (3) Equipment needed for fast response

EXPECTED OUTPUT:

Report highlighting both capabilities and deficiencies within the marine community to respond to and limit maritime casualties involving hazardous cargoes. Recommendations for alleviating deficiencies.

DOT FIRE SAFETY R&D

TITLE: Evaluation of Mattress Materials for Coast Guard Cutters

CONTRACT NO.: z 70099-7-74380

FUNDING LEVEL: \$16,000

PERFORMING ORGANIZATION: National Bureau of Standards

NAME OF PRINCIPAL MONITOR: T. P. Brandsma and M. Friel

SPONSORING ORGANIZATION: U.S. Coast Guard (G-CSP)

OBJECTIVE: Evaluate fire hazard of mattresses used or proposed for Coast Guard cutters.

DESCRIPTION OF WORK:

Three neoprene mattresses and one polyurethane mattress were tested in full-scale simulated bunk spaces. The spaces were instrumented for temperature, weight, heat flux, smoke, and gas concentrations. The three neoprene mattresses consisted of a used black foam mattress removed from a vessel, a new black foam mattress from a warehouse and a new buff foam mattress which had recently been developed with the intent of reducing smoke production.

Newspaper was used to ignite pillow and mattress. Test duration was 30 minutes.

EXPECTED OUTPUT:

None of the neoprene mattresses was significantly consumed before termination of test. About 50% of urethane mattress was consumed. Maximum temperatures for the used neoprene mattress and the polyurethane mattress were higher than for the other mattresses, which would not even have operated a sprinkler head.

Gas concentration from the polyurethane mattress was high. The buff neoprene mattress exhibited superior smoke reduction.

DOT FIRE SAFETY R&D

TITLE: Evaluation of Nozzles to be Used with AFFF

CONTRACT NO.: CG-D-26-77

FUNDING LEVEL: \$50,300

PERFORMING ORGANIZATION: USCG R&D Center

NAME OF PRINCIPAL INVESTIGATOR: R. C. Richards

SPONSORING ORGANIZATION: U.S. Coast Guard (G-ENE)

OBJECTIVE: To determine the optimum AFFF foam nozzle to be used with the Coast Guard in-line proportioner

DESCRIPTION OF WORK:

Evaluative, fire extinguishment and burnback tests were conducted. Commercially available water fog nozzles were compared to mechanical foam and Navy all-purpose nozzles.

EXPECTED OUTPUT:

Recommendations were made on the ranking of nozzles for foam production with existing proportioning systems on Coast Guard vessels.

DOT FIRE SAFETY R&D

TITLE: Evaluation of Smoke Detectors for Shipboard Use

CONTRACT NO.: 703308.8.9

FUNDING LEVEL: N/A

PERFORMING ORGANIZATION: Naval Ship Engineering Center,
Philadelphia

NAME OF PRINCIPAL MONITOR: R.C. Richards

SPONSORING ORGANIZATION: U.S. Navy

OBJECTIVE: To provide the Coast Guard with reliable and cost effective fire detection equipment suitable for use in machinery spaces, magazines, and living spaces.

DESCRIPTION OF WORK:

- A. A literature search, surveys of shipboard environments, full scale fire tests and detector sensitivity testing are planned in order to develop recommendations for the most effective modes of detection.
- B. After selection of detectors is completed, a detector testing system will be used to determine which is suitable for shipboard use.

EXPECTED OUTPUT:

Parameters have been set up to evaluate each of 419 detector heads and 41 systems under test. Goal is a military specification and qualified supplier list.

DOT FIRE SAFETY R&D

TITLE: Experimental Evaluation of Screen Type Flame Arresters with Fuel/
Air Mixtures under Atmospheric Flash-Back Conditions

CONTRACT NO.: N/A

FUNDING LEVEL: \$330,000

PERFORMING ORGANIZATION: NASA-Jet Propulsion Laboratory, Pasadena, CA

NAME OF PRINCIPAL MONITOR: A.L. Rowek

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MHM)

OBJECTIVE: To evaluate the effectiveness of U.S. Coast Guard approved screen type flame arresters for quenching unconfined flames propagating in the open environment.

DESCRIPTION OF WORK: An experimental study will be conducted.
The test scheme includes:

Screens -

1. single 30 x 30 mesh screen
2. dual 20 x 20 mesh screens separated by 1 inch.

Products -

acetaldehyde	gasoline
carbon disulfide	methyl alcohol
ethylene	propane
ethyl ether	toluene

Ignition locations -

1. at the vent exit just downstream of the screen
2. approximately 10-20 ft downstream of the screen

EXPECTED OUTPUT:

A final report detailing:

1. the unconfined flame propagation behavior of various cargo/air mixtures;
2. the effectiveness of Coast Guard approved flame screens for preventing passage of a flame impinging on the screen;
3. the effectiveness of Coast Guard flame screens for preventing the passage of an unconfined propagating flame.

DOT FIRE SAFETY R&D

TITLE: Experimental Study of Flame Control Devices for Cargo Venting Systems

CONTRACT NO.: 42357

FUNDING LEVEL: \$161,400

PERFORMING ORGANIZATION: Arthur D. Little, Inc., Cambridge, MA.

NAME OF PRINCIPAL MONITOR: A.L. Rowek

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MHM)

OBJECTIVE: To evaluate the effectiveness of various off-the-shelf flame arresters for stopping and quenching flames resulting from the ignition of near stoichiometric fuel/air mixtures in cargo vent lines.

DESCRIPTION OF WORK:

- (1) A theoretical investigation of how arresters must be designed to stop flames of various products.
- (2) An experimental study to verify the theoretical findings and to determine experimentally the critical arrester dimensions for quenching near stoichiometric fuel/air high speed and low speed flames.

(a) Products investigated:

acetaldehyde	carbon disulfide	hydrogen sulfide
acetylene	ethylene	methane
butane	ethylether	methyl alcohol
butadiene	gasoline	toluene

(b) Arresters tested:

single screens	steel parallel plates	crimped ribbon
perforated plates	plastic parallel plates	

- (3) An experimental study to test non-obstructive flame control devices, namely, high velocity vents and steam snuffers.

EXPECTED OUTPUT:

- (1) Critical design dimensions of passageways diameter and length to stop flames of fuel/air mixtures.
- (2) Relationship of cargo type to arrester design criteria.
- (3) Effectiveness of non-obstructive control devices in preventing flame passage.
- (4) Data on run-up distances for low and high speed flame production.
- (5) Correlation of theory with experiment towards developing a predictive technique for choosing effective flame arresters.

Three final reports are available:

1. Design Criteria for Flame Control Devices for Cargo Venting Systems, R. P. Wilson and S. Attalah, 1975, NTIS No. AD A015822.
2. Blockage of Flame Control Devices: Design and Maintenance Criteria, R. P. Wilson and P.G. Gott, 1975, NTIS No. AD A015 143.
3. Experimental Study of Flame Control Devices for Cargo Venting Systems, R. P. Wilson and D. P. Crowley, 1978, NTIS No. AD A063008.

DOT FIRE SAFETY R&D

TITLE: Fire Performance of Intermodal Shipping Containers

CONTRACT NO.: 3308.5.5.4

FUNDING LEVEL: \$59,300

PERFORMING ORGANIZATION: U.S. Coast Guard R&D Center

NAME OF PRINCIPAL INVESTIGATOR: R. Eberly

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: Examine the potential fire hazards of intermodal shipping containers.

DESCRIPTION OF WORK: Fires originating within containers were examined to determine if they could burn through the container shell.

The effects of exterior spill fires on a single level of containers and on a stack of containers were examined.

EXPECTED OUTPUT: Interior test fires self-extinguished from oxygen depletion.

Steel containers do not act as a barrier to prevent spread of fire through a container stack.

Wood floorboards do not add to the rapid spread of flame through a container stack.

Aluminum alloy frames do not provide an equivalent amount of structural integrity as steel frames during a fire.

The stacking and lashing fittings currently used provide an adequate amount of structural stability under fire conditions.

DOT FIRE SAFETY R&D

TITLE: Fire Safety Evaluation of Dual Draft Icebreaker

CONTRACT NO.: MIPR 70099-9-95830-1B

FUNDING LEVEL: \$65,000

PERFORMING ORGANIZATION: Rolf Jensen Associates

NAME OF PRINCIPAL MONITOR: Howard Chatterton

SPONSORING ORGANIZATION: U.S. Coast Guard (G-ENE)

OBJECTIVE: Evaluate preliminary icebreaker design and recommend changes to improve fire safety.

DESCRIPTION OF WORK: Review preliminary design and specifications for fire safety.

Recommend changes to be included in the final design.

Document source and methodology of recommendations.

EXPECTED OUTPUT:

Consultation during design of icebreaker. Report detailing recommendations and methodology.

DOT FIRE SAFETY R&D

TITLE: Flammability Tests of Drapes and Curtains

CONTRACT NO.: 819301

FUNDING LEVEL: \$20,000

PERFORMING ORGANIZATION: National Bureau of Standards

NAME OF PRINCIPAL INVESTIGATOR: A. F. Robertson

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: Develop international fire test for drapes and curtains

DESCRIPTION OF WORK: Tests of various nations for flammability of drapes and curtains are being evaluated. A suitable apparatus has been identified and tests are being conducted to measure reliability and reproducibility.

EXPECTED OUTPUT: A single uniform international test for flammability of drapes and curtains.

DOT FIRE SAFETY R&D

TITLE: Flammability of Solids and Liquids

CONTRACT NO.: CG-74142

FUNDING LEVEL: \$26,040

PERFORMING ORGANIZATION: U. of Oklahoma

NAME OF PRINCIPAL MONITOR: E. H. Hotard

SPONSORING ORGANIZATION: USCG Office of R&D (G-DSA-1)

OBJECTIVE: Obtain the ignition or "flash" characteristics of liquids and predict the flammable characteristics of solid materials under actual fire conditions utilizing the University of Oklahoma standardized ignition test.

DESCRIPTION OF WORK:

Develop and demonstrate a standardized test for accurately determining the ignition point of liquids and the behavior of flame spread across solids. This will involve constructing a test cabinet and using radiant heat as an ignition source. Flame spread will be measured by thermocouple strings on a test bed.

EXPECTED OUTPUT:

An evaluation of using the developed methods for determining the flash point of liquids and the flame spread characteristics of solids.

Completed in February, 1979.

DOT FIRE SAFETY R&D

TITLE: Full Scale Tests of Smoke/Gas Hazards from Fires on Ships

CONTRACT NO.: 3308.8.13

FUNDING LEVEL: \$68,400 for FY 1980

PERFORMING ORGANIZATION: USCG R&D Center

NAME OF PRINCIPAL INVESTIGATOR: R.C. Richards

SPONSORING ORGANIZATION: Canadian Coast Guard

OBJECTIVE: Determine the smoke/gas hazard from typical approved interior finishes and furnishings found on ships.

DESCRIPTION OF WORK: Small scale smoke measurements tests with candidate materials.

Full scale experiments with candidate materials where the following items will be measured:

- o smoke obscuration
- o total smoke production
- o smoke toxicity (animal model)
- o CO & O₂ concentrations in smoke

EXPECTED OUTPUT:

A ranking of candidate materials and a small scale test which may be used to rank materials in the future.

DOT FIRE SAFETY R&D

TITLE: Hazardous Materials Advisory Committee

CONTRACT NO.: DOT-CG-74248-A

FUNDING LEVEL: \$120,000

PERFORMING ORGANIZATION: National Academy of Sciences

NAME OF PRINCIPAL MONITOR: M. M. Williams

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MHM)

OBJECTIVE: Review and reevaluate the hazardous properties of materials shipped in bulk in Marine transportation.

DESCRIPTION OF WORK:

Initial review and evaluation is bulk water shipments of LNG. Later effort will be directed toward review and evaluation of hazard of other bulk cargoes. This includes emergency response procedures.

EXPECTED OUTPUT: NAS report on LNG expected by May, 1980.

DOT FIRE SAFETY R&D

TITLE: Ignition of Flammable Vapors as a Result of Metal Fractures

CONTRACT NO.: MIPR

FUNDING LEVEL: \$25,000

PERFORMING ORGANIZATION: Naval Research Labs

NAME OF PRINCIPAL MONITOR: D.F. Sheehan

SPONSORING ORGANIZATION: U.S. Coast Guard (GMMT4)

OBJECTIVE: To determine if the energy developed when metal fractures is sufficient to ignite flammable vapors.

DESCRIPTION OF WORK:

EXPECTED OUTPUT:

Final report is available from NRL. Report indicates that metal fractures do not produce sufficient energy to ignite flammable mixtures.

DOT FIRE SAFETY R&D

TITLE: Inert Gas Systems

CONTRACT NO.: DOT-CG-81349A

FUNDING LEVEL: \$66,000

PERFORMING ORGANIZATION: National Academy of Science

NAME OF PRINCIPAL MONITOR: D.F. Sheehan

SPONSORING ORGANIZATION: USCG (MMT)

OBJECTIVE: Improve maintainability and reliability of inert gas systems.

DESCRIPTION OF WORK: Examine the materials portion of inert gas systems with a view toward improving their reliability and maintainability by offering options with respect to material selection.

EXPECTED OUTPUT:

Develop a series of recommended materials for the component parts of inert gas systems. It will be recommendatory rather than regulatory.

DOT FIRE SAFETY R&D

TITLE: Investigation of Hazards Posed by Chemical Vapors Released in Marine Operations

CONTRACT NO.: DOT-CG-904571-A

FUNDING LEVEL: Phase I (Completed): \$350K. Phase II (In Progress): \$400K

PERFORMING ORGANIZATION: Southwest Research Institute, San Antonio, TX

NAME OF PRINCIPAL MONITOR: Lt. Mike Flessner G-DSA
Mike Morrisette G-MHM

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MHM)

OBJECTIVE: Determine whether flammable or toxic vapor concentrations exist on the decks of barges and ships during loading and other operations.

DESCRIPTION OF WORK:

Phase I

- (1) Background study
- (2) Mathematical modelling using plume rise and dispersion equations to predict concentrations of vapors at various locations on the vessel during loading and other operations.
- (3) Design of an experimental method (using instrumentation) which will acquire concentration versus time data during operations on tank vessels.
- (4) Full scale tests to refine the method developed in (3) and to make sure it will work under shipboard conditions.

Phase II

- (1) Full scale tests on twelve tank vessels.
- (2) Develop Hazardous Chemical Vapor Assessment Handbook.

EXPECTED OUTPUT:

Experimental data indicating the hazardous areas (both health and flammability) on the decks of tank vessels for various weather conditions, pumping rates, venting configurations, and other significant factors.

Hazardous Chemical Vapor Assessment Handbook to predict the location of these hazardous areas for a given set of conditions.

DOT FIRE SAFETY R&D

TITLE: Localized Fire Extinguishing Systems Evaluation for Shipboard Machinery Spaces

CONTRACT NO.: 3308.8.10

FUNDING LEVEL: \$8,000 for FY 1980

PERFORMING ORGANIZATION: U.S. Coast Guard R&D Center

NAME OF PRINCIPAL INVESTIGATOR: C. D. Wolverton

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: Determine the most suitable localized fixed fire extinguishing systems for high-hazard shipboard machinery space areas.

DESCRIPTION OF WORK:

- Determination of the major fire hazard areas.
- Examination of equipment available for localized extinguishing systems.
- Conduct a testing program for evaluating representative localized systems.

EXPECTED OUTPUT:

Design guidelines for localized systems.

DOT FIRE SAFETY R&D

TITLE: NAS Fire Safety Aspects of Polymers

CONTRACT NO.: 4-35856

FUNDING LEVEL: \$20,000 (Coast Guard share)

PERFORMING ORGANIZATION: National Academy of Sciences

NAME OF PRINCIPAL MONITOR: D. F. Sheehan

SPONSORING ORGANIZATION: USCG, NAS, FAA, FRA

OBJECTIVE:

Study burning characteristics of polymers to improve understanding of the fire safety of these materials.

DESCRIPTION OF WORK:

Identify existing knowledge of combustibility of polymers. Examine the nature of by-products of combustion. Determine how fire behavior of polymers may be measured and predicted.

EXPECTED OUTPUT:

Recommendations to make the use of polymeric materials safe in specific applications.

DOT FIRE SAFETY R&D

TITLE: Performance of Commercially Available Flame Arresters for Butane/Air and Gasoline/Air Mixtures.

CONTRACT NO.: 42357

FUNDING LEVEL: \$52,400

PERFORMING ORGANIZATION: Arthur D. Little, Inc.

NAME OF PRINCIPAL MONITOR: A. L. Rowek

SPONSORING ORGANIZATION: U.S. Coast Guard G-MHM

OBJECTIVE: To provide an empirical basis for evaluating the effectiveness of off-the-shelf flame arresters for use in gasoline/air vapor recovery systems.

DESCRIPTION OF WORK: Quenching of flames resulting from the ignition of near stoichiometric butane/air and gasoline/air mixtures was attempted using single screen, double screen, parallel plate, corrugated parallel plate, crimped ribbon and metal flame arresters. Tests were performed to determine the critical arrestor dimensions for arresting both low speed and high speed turbulent flames in a 6" pipeline.

EXPECTED OUTPUT:

A final report, NTIS AD. A062 948:

- (1) Comparing the effectiveness of various off-the-shelf arrestors for quenching butane/air and gasoline air mixtures.
- (2) Giving the critical dimensions of arrestors for quenching.
- (3) Giving data on high and low flame speeds for butane and gasoline.
- (4) Giving the minimum mixture efflux velocities to prevent flame passage.
- (5) Detailing the effectiveness of flame arresters after prolonged heating due to stabilization of flames on the arresters.

DOT FIRE SAFETY R&D

TITLE: Portable Extinguisher Evaluation for CG Cutters

CONTRACT NO.: 3308.5.3

FUNDING LEVEL: \$48,600

PERFORMING ORGANIZATION: U.S. Coast Guard R&D Center

NAME OF PRINCIPAL INVESTIGATOR: D. E. Beene, Jr.

SPONSORING ORGANIZATION: U.S. Coast Guard (G-ENE)

OBJECTIVE: Examine market to determine if optimum extinguishers are being used in engine rooms of Coast Guard cutters.

DESCRIPTION OF WORK:

Bilge fires, flowing fires, and spray fires were extinguished using 3 dry chemical, and 2 Halon agents. These were compared with the carbon dioxide and dry chemical fire extinguishers presently used in engine rooms of Coast Guard cutters.

EXPECTED OUTPUT:

Halon 1211 was found to be much more effective than CO₂ on a weight basis.

Dry chemical was equal to or better than Halon in all cases tested.

Technique proved to be more important than agent.

DOT FIRE SAFETY R&D

TITLE: Port Safety Fire Fighting Requirements Study for Port of Philadelphia

CONTRACT NO.: CG-42,355-A

FUNDING LEVEL: \$90,000

PERFORMING ORGANIZATION: Applied Technology Corporation

NAME OF PRINCIPAL MONITOR: D. G. Dickman

SPONSORING ORGANIZATION: USCG (G-WLE)

OBJECTIVE:

To evaluate current C.G. fire fighting capability compared to hazards present and, if necessary, provide alternative suggestions to upgrade our level of effectiveness

DESCRIPTION OF WORK:

Define available municipal, industrial and Coast Guard firefighting equipment, personnel and training and compare to maximum potential fire in area. If available resources are not sufficient to effectively combat these fires, provide suggestions to upgrade Coast Guard effectiveness.

EXPECTED OUTPUT:

A series of levels of desirable equipment which would improve CG firefighting. The program manager will be able to select the level of equipment/performance which is commensurate with CG policy.

DOT FIRE SAFETY R&D

TITLE: Propane Extinguishment Tests

CONTRACT NO.: CG-42,355

FUNDING LEVEL: \$150,000

PERFORMING ORGANIZATION: Applied Technology Corp.

NAME OF PRINCIPAL MONITOR: Dr. J. Cece

SPONSORING ORGANIZATION: DOE

OBJECTIVE: To determine the effective flow rates of fire control agents for LPG fires in order to determine the effectiveness of regulated fire protection systems.

DESCRIPTION OF WORK: Test Propane (LPG) according to a matrix of 5 fire control agents and 4 different fire sizes using the apparatus developed in the "Chemical Cargo Fire Protection" project.

EXPECTED OUTPUT:

A knowledge of the minimum flow rates necessary to control and extinguish LPG fires without hot steel or other reignition sources present.

DOT FIRE SAFETY R&D

TITLE: Protection of Tank Vessels While Moored to Shore Facilities from the Hazard of Stray Current, Phase I

CONTRACT NO.: MIPUR Z70099-9-95956-1B

FUNDING LEVEL: \$65,000

PERFORMING ORGANIZATION: Jet Propulsion Laboratory, Pasadena, CA

NAME OF PRINCIPAL MONITOR: LT Michael Flessner, G-DSA

SPONSORING ORGANIZATION: U.S. Coast Guard G-MVI

OBJECTIVE: To determine through cursory measurement and literature review whether there is need to undertake an extensive study of the hazard of Stray (electrical) Currents between the ship/shore interface of a moored tank vessel, and if so, to define the course for the required research.

DESCRIPTION OF WORK: JPL is currently developing its final proposal for the Phase I research. The research would include review of available documentation, experimental measurements at tanker facilities and mathematical modeling of the phenomenon.

EXPECTED OUTPUT: A determination of the extent of the stray current hazard. If this determination indicates a need for further extensive study, i.e. Phase II, a proposal for performing this study.

DOT FIRE SAFETY R&D

TITLE: Round Robin on Noncombustible Material Test

CONTRACT NO.: MIPR

FUNDING LEVEL: \$5,000

PERFORMING ORGANIZATION: National Bureau of Standards

NAME OF PRINCIPAL MONITOR: Klaus Wahle

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: To determine the acceptability of Underwriters Laboratories, Inc. as Coast Guard recognized testing lab for conducting the 46 CFR 164.009 fire test "Noncombustible Materials."

DESCRIPTION OF WORK: Identical samples of approved noncombustible materials were sent to UL and NBS (the only lab previously recognized for this test by USCG) for testing and comparison of results. Costs were incurred only for the work at NBS. UL, as the prospective CG recognized lab, paid for its own testing costs.

EXPECTED OUTPUT:

The results were comparable within experimental error and UL was accepted as CG recognized lab for conducting the 164.009 fire tests.

DOT FIRE SAFETY R&D

TITLE: Safety Evaluation of Distress Flares and Smokes

CONTRACT NO.: 74132

FUNDING LEVEL: \$24,897

PERFORMING ORGANIZATION: Atlantic Research Corporation

NAME OF PRINCIPAL MONITOR: D.R. Gauthier

SPONSORING ORGANIZATION: U.S. Coast Guard (G-BLC)

OBJECTIVE: Determine the safety hazards of signal devices that have been proposed for use on recreational boats.

DESCRIPTION OF WORK: Typical flares and smokes used on commercial vessels were tested.

Hand held flares and smokes and aerial flares were evaluated for safety. Reliability was also investigated.

EXPECTED OUTPUT: Hand held flares were found to present a fire hazard. Even if properly held, slag may drip from the flare and ignite wood, carpet, fuel, etc.

Some smokes were found to be toxic.

DOT FIRE SAFETY R&D

TITLE: Safety of LNG-Cargo Tanks in Fire Environment

CONTRACT NO.: 3308.8.11

FUNDING LEVEL: \$113,000 for FY 1980

PERFORMING ORGANIZATION: USSCG R&D Center

NAME OF PRINCIPAL INVESTIGATOR: Amar Datta

SPONSORING ORGANIZATION: USCG MMT-4

OBJECTIVE: To determine if Coast Guard regulations regarding capacities of safety relief valves of LNG-tanks are adequate, and, if not, to recommend revisions.

DESCRIPTION OF WORK: Commonly used insulating materials are to be tested at elevated temperatures. The mechanism of evaporation of LNG is to be studied, and the theoretical predictions are to be tested in scale-models of LNG tanks of various geometries in a fire environment.

EXPECTED OUTPUT:

Thermal conductivity, fire endurance and self-extinguishment characteristics of candidate insulating materials; computer program for predicting fire-endurance characteristics of LNG-filled tanks, including pressures developed and blow-off rates.

DOT FIRE SAFETY R&D

TITLE: Smoke Movement in Coast Guard Vessels

CONTRACT NO.: PROPOSED FOR USCG R&D CENTER

FUNDING LEVEL: Estimated \$50,000

PERFORMING ORGANIZATION: 1 ST Detachment, Mobile

NAME OF PRINCIPAL MONITOR: H. Chatterton

SPONSORING ORGANIZATION: U.S. Coast Guard (G-ENE)

OBJECTIVE: Study active control of smoke during fires.

DESCRIPTION OF WORK: Use a tracer gas aboard ships underway to verify feasibility of smoke control using installed ship ventilation systems.

EXPECTED OUTPUT:

Recommendation to change mode of ventilation control during shipboard fires to improve firefighting operations.

DOT FIRE SAFETY R&D

TITLE: Study of Smoke from Fires in Vessels

CONTRACT NO.: MIPR

FUNDING LEVEL: \$50,000

PERFORMING ORGANIZATION: National Bureau of Standards

NAME OF PRINCIPAL MONITOR: D. F. Sheehan

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE:

Examine movement of smoke in commercial vessels.

DESCRIPTION OF WORK:

Shipboard arrangements will be examined to determine smoke spreads through a vessel. Tracer gas will be used to obtain quantitative data on air movement through vessels.

EXPECTED OUTPUT:

Recommendations on controls for ventilation systems and subdivision of vessels to reduce smoke spread.

DOT FIRE SAFETY R&D

TITLE: Testing of Firefighting Foam

CONTRACT NO.: CG-827673-A

FUNDING LEVEL: \$82,000

PERFORMING ORGANIZATION: Underwriters Laboratories

NAME OF PRINCIPAL MONITOR: Klaus Wahle

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: Determine relative effectiveness of different types of commercially available foams. Evaluate various tests of firefighting foams.

DESCRIPTION OF WORK: Contractor is to test all of the different types of firefighting foams to determine which are effective on shipboard type fires. He is also to evaluate the four tests presently being used by various authorities to test foam and determine which tests, if any, evaluate the characteristics essential for fighting shipboard fires.

EXPECTED OUTPUT: Rank order of the types of firefighting foams in terms of effectiveness in fighting shipboard fires. Recommendations on an appropriate test method for evaluating foams.

DOT FIRE SAFETY R&D

TITLE: Testing Portable Extinguishers for Pleasure Craft.

CONTRACT NO.: CG-832600-A

FUNDING LEVEL: \$29,000

PERFORMING ORGANIZATION: Dynamic Science, Inc.

NAME OF PRINCIPAL MONITOR: Klaus Wahle

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT) and (G-BBT)

OBJECTIVE: Evaluate extinguishing agents on class B fires to determine equivalent amounts of different agents.

DESCRIPTION OF WORK: Simulated engine compartment and other types of fires will be extinguished with CO₂, halon, foam and all types of dry chemical extinguishers to determine equivalent amounts of different agents.

EXPECTED OUTPUT:

Verification or revision of USCG fire extinguisher rating system.

DOT FIRE SAFETY R&D

TITLE: Transitory Fire Resistance of Tanker Lifeboats

CONTRACT NO.: 3308.8.12

FUNDING LEVEL: \$39,000

PERFORMING ORGANIZATION: Coast Guard Research & Development Center
Fire and Safety Test Detachment

NAME OF PRINCIPAL MONITOR: Bob Markle

SPONSORING ORGANIZATION: U.S. Coast Guard (G-MMT)

OBJECTIVE: Determine whether steel, aluminum and fiberglass lifeboats provide adequate resistance to a transitory deck fire.

DESCRIPTION OF WORK: Nine half-hull lifeboats, three each of aluminum, steel, and fiberglass reinforced plastic will be tested one at a time over a short term fire in a test pan. The boats were constructed to Coast Guard specifications except that they were split in half at the keel and clamped to a steel bulkhead cut to expose the inside of the boat to view. At the conclusion of the first round of tests, another round will be conducted with the boat hulls protected by a water spray.

EXPECTED OUTPUT:

Aluminum lifeboats were shown to fail quickly in a fire when not protected. Fiberglass reinforced plastic (fire retardant resin) and steel boats showed adequate resistance to a short term fire. Resistance could be extended by water spray on surface of hull.

DOT FIRE SAFETY R&D

TITLE: USCG Cutter Bulkhead Panel Fire Tests

CONTRACT NO.: 3308.5.8

FUNDING LEVEL: \$69,700

PERFORMING ORGANIZATION: U.S. Coast Guard R&D Center

NAME OF PRINCIPAL INVESTIGATOR: C.D. Wolverton

SPONSORING ORGANIZATION: U.S. Coast Guard (G-ENE)

OBJECTIVE: Evaluate the performance of lightweight honeycomb wall panels in full scale burnout tests of shipboard compartments.

DESCRIPTION OF WORK: Mock-up living quarters similar to those found on Coast Guard cutters are to be constructed on a test ship. In lieu of standard noncombustible marinite panels, lightweight panels are to be used. The test will determine how long the panels can be expected to last under realistic shipboard fire conditions and to measure smoke and toxic gases that may be evolved.

EXPECTED OUTPUT:

Data on suitability of lightweight honeycomb panels for use on board Coast Guard cutters where weight is critical.

DOT FIRE SAFETY R&D

TITLE: Unconfined Vapor Cloud Explosion Study

CONTRACT NO.: MIPR-CG-34094-A, 816817

FUNDING LEVEL: \$1,560,000

PERFORMING ORGANIZATION: Naval Weapons Center, China Lake, California

NAME OF PRINCIPAL MONITOR: Dr. Alan L. Schneider

SPONSORING ORGANIZATION: U.S. Coast Guard with support from: Office of Pipeline Safety Operation, Energy Research and Development Administration, Department of Energy, National Aeronautics and Space Administration, American Gas Association, Gas Research Institute.

OBJECTIVE: To determine the hazards from spills of large quantities of flammable liquefied gases, including: pool fires on water, unconfined cloud fires, confined vapor deflagrations and detonations.

DESCRIPTION OF WORK:

1. Confined deflagrations and detonations in a shock tube with methane, propane, and ethylene oxide.
2. Low energy initiation of methane-, propane-, ethylene oxide-, ethylene-, acetylene-, and butadiene-air mixtures in 5m and 10m radius plastic hemispheres
3. High energy initiations of methane-, methane-propane-air mixtures in 5m and 10m radius plastic hemispheres.
4. LNG, LPG, and gasoline pool fires on water-up to 5.7 m³ of fuel.
5. LNG, LPG cloud fires - up to 5.7 m³ spilled on water.
6. Dispersion tests - up to 4.5 m³ spilled on water, cloud dispersion over land, test of vapor concentration measurement devices (LNG).
7. Development of mathematical model of unconfined vapor cloud detonation.
8. Calculation of deflagration and detonation properties for various gases.

EXPECTED OUTPUT:

1. An understanding of the burning rates, flame dimensions, and thermal fluxes from pool and cloud fires of LNG and LPG.
2. Boiling rates and pool spread rates of LNG and LPG on water.
3. Factors favoring detonations and overpressures during unconfined vapor cloud fires.
4. Effects of composition on vapor cloud detonability.
5. Dispersion of LNG over land.

DOT FIRE SAFETY R&D

TITLE: Ventilation of Cargo Holds

CONTRACT NO.: N/A

FUNDING LEVEL: \$100,000

PERFORMING ORGANIZATION: National Bureau of Standards

NAME OF PRINCIPAL MONITOR: Donald Kerlin

SPONSORING ORGANIZATION: Sea Land Services, Inc.

OBJECTIVE: To determine what air change rate should be applied to a container hold of a container ship when carrying dangerous goods. The results of the study were to be used for U.S. input to the IMCO Fire Protection Sub-Committee.

DESCRIPTION OF WORK: A mathematical model was developed to predict the motion of air through a container ship hold. An air extraction rate is a given and then a rate is predicted for vapour entrainment. The basic assumption is that air in the hold is stably stratified.

Following the mathematical model, a computer program was developed. The output was the rate at which vapours are removed, in grams per hour, at each specified rate of air change. An Analog Model (Scale Model) was also developed to represent the hold of an SL-7 container ship.

Also several ships were fitted with thermocouples to determine various "real-world" temperatures.

EXPECTED OUTPUT:

A report, "A Study of Ventilation of Containership Holds for Carriage of Flammable Liquids" (June 18, 1979), was presented to the CG, and they, in turn, presented it to IMCO FP S/C. The report indicated that a ventilation rate of one air change per hour was adequate. Some discussion with regards to exhaust duct location was also an output of the research effort.