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Spills of Oil and Hazardous Materials; Canadian Research and Development-People and Priorities

Economic and Technical Review
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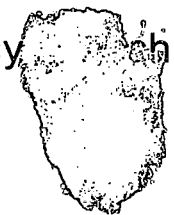

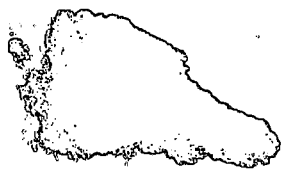

SPILLS OF OIL AND HAZARDOUS MATERIALS; CANADIAN RESEARCH AND DEVELOPMENT - PEOPLE AND PRIORITIES

Prepared by

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Prepared for: The Environmental Emergency Branch
Environmental Protection Service

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Review Notice

This report has been reviewed by the Environmental Emergency Branch, Environmental Protection Service and approved for publication. Approval does not necessarily reflect the views and policies of the Environmental Protection Service. This present publication is a background study and represents the opinion of the authors.

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Resumé

This report contains background information selected for use in the establishment of Canadian research and development programmes related to the clean up of spills of oil and other hazardous materials. It begins with a brief survey of recent spills in Canada and the United States to help identify the scope of the problem. This is followed by a list of university research groups and private companies in Canada which have been involved in spill-related work. There is a brief discussion of spill-related research programmes in the U.S., U.K. and France and, finally, some recommendations regarding the Canadian programme.

Ce rapport contient des données de base sélectionnées de façon à aider l'établissement d'un programme Canadien de recherche et développement dans le domaine de la technologie relié au nettoyage des épandages accidentels d'huile et autres matières toxiques. L'étude débute par un bref sommaire des épandages accidentels au Canada et aux Etats-Unis pour aider à identifier l'étendue du problème. Ceci est suivie par une brève revue des groupes de recherches universitaires et compagnies privées Canadiennes qui ont travaillé dans ce domaine. Une brève discussion est faite des programmes de recherches similaires aux Etats-Unis, Royaume-Uni et en France. Finalement, des recommandations sont faites sur les directions que devraient prendre le programme Canadien.

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TABLE OF CONTENTS

B.C. town on alert

Chlorine leak clears hospital

THE MONTREAL STAR, THURSDAY, JULY 13, 1972

Canadian Press

PORT ALICE, B.C. — A score of persons were given emergency first aid treatment last night when a chlorine gas leak forced the evacuation of a hospital, movie theatre and the pulp mill at which the leak originated.

Fire department units rushed oxygen tanks to the Rayonier Canada (B.C.) Ltd. mill as the 80 men on the afternoon shift evacuated the plant while the gas leaked from a hose hooked up to a railway tank car.

THE MONTREAL STAR, THURSDAY, JULY 27, 1972

Defects in pipeline blamed

Canadian Press

TORONTO — Harvey Clare, environmental co-ordinator for Imperial Oil Ltd., said yesterday that "undetectable defects" in a product pipeline at Resolute Bay, N.W.T. were the cause of two recent spills of airplane fuel.

The spills occurred at a storage terminal owned by the federal ministry of transport and operated by Imperial

SCIENCE, VOL. 177

28 JULY 1972 343

Petroleum Hydrocarbons: Uptake and Discharge by the Marine Mussel Mytilus edulis

Abstract. *The common marine mussel* Mytilus edulis *has been observed to rapidly take up mineral oil,* [^{14}C]*heptadecane, 1,2,3,4-tetrahydronaphthalene,* [^{14}C]*toluene,* [^{14}C]*naphthalene, and* [^{3}H]*3,4-benzopyrene from seawater solution.*

Shell Oil has developed a new oil-skimming barge that is articulated, permitting large components to flex with waves and currents. The barge can recover oil from water at speeds up to 2.75 feet per second with 95% efficiency. Articulation of components reduces turbulence in the oil collecting area and speeds efficient oil recovery. Shell says Shell has licensed Marine Maintenance Co., Houston, Tex., to build the barge

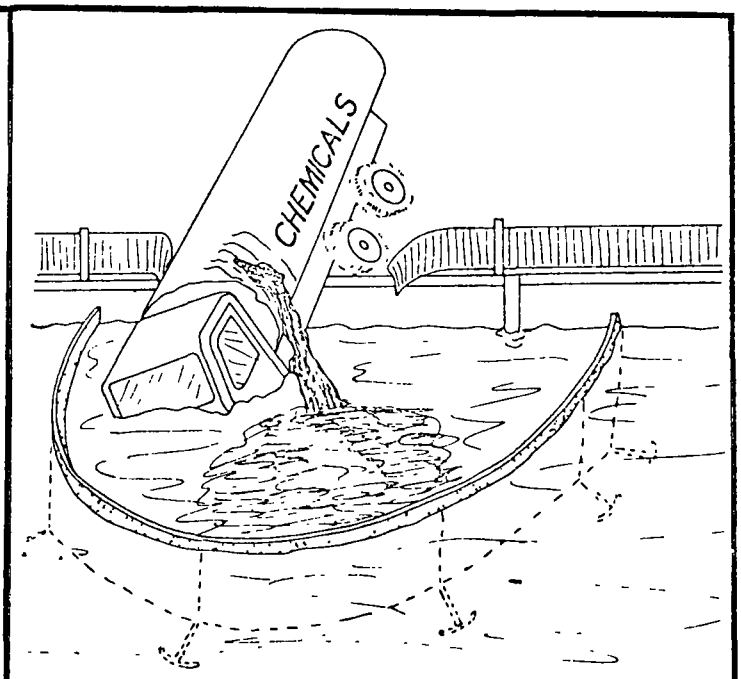
14 C&EN Sept. 4, 1972

Sept. 4, 1972 C&EN 7

An oil-absorbent polystyrene fiber of irregular cross section will be introduced next month by Teijin, Ltd., for use in cleaning up oil spills at sea. The company is set to make 150,000 square meters a month of the material, which it says can absorb 25 times its own weight of oil—more than double the capacity of materials already on the market.

August 28, 1972 C&EN 13

Environmental impact of offshore drilling for oil in the Atlantic is the goal of an "environmental inventory" of the U.S.'s Atlantic continental shelf, to be completed in September. Under a grant from the American Petroleum Institute, Dr. Saul B. Saila of the University of Rhode Island is coordinating a group of specialists who are surveying the scientific literature to find what is already known and what needs to be known about the physical and chemical oceanography, biological environment, fisheries, mammals, and birds of the Mid-Atlantic Bight, which extends from Cape Hatteras, N.C., to Nantucket, Mass.



Sealed boom for containing spilled materials in watercourses.

I. INTRODUCTION

The studies whose results are given in this report were intended to help guide the establishment of a major Canadian research effort related to spills of oil and hazardous materials. Of particular interest were information of use in establishing priorities for such a research effort and a survey of personnel and organizations in the private sector in Canada who are already engaged in spill-related research. To obtain this information, studies in several areas were undertaken. These were:

1- A survey of recent major spills in Canada and in the U.S.
2- A study of the spill-related research and development effort sponsored by the U.S. government and to a lesser extent by those of the U.K. and France.
3- A survey of spill-related research in Canadian universities.
4- A survey of Canadian companies with an interest in oil spill clean-up operations.

The results of these studies are discussed in some detail in the various sections of the report. A final section contains some recommendations concerning spill-related research in Canada.

Classification of Research Topics

It is useful in any discussion of spill-related research and development to establish a classification for the various specific areas which might be included in this general heading. A listing which was found useful in the present studies is given below:

1- Prevention

Design of equipment and procedures to minimize the chances of an accidental spill or to off-load a pollutant from a stranded vessel.

Classification of Research Topics (continued)

2- Surveillance and Detection

Methods for rapid detection of spills so that remedial action may be taken as soon as possible.

3- Identification

Methods for identifying pollutants either by means of their intrinsic properties (passive tagging) or by means of additives added specifically for this purpose (active tagging).

4- Fate and Effect

Studies of the physical, chemical and biological behaviour of the spilled material including, for example: oil slick spreading and evaporation rates, photochemical and biological degradation and toxicity.

5(A) Clean-up Methods (in water)

Nearly all of the work in this area has been focused on the removal of oil from water, although there is a growing effort in the U.S. on methods for handling spills of hazardous materials. For oil on water the principle methods employed are:

a. use of dispersants
b. sinking
c. burning
d. booms and mechanical collection devices
e. floating absorbents
f. gelling techniques

5(B) Clean-up Methods (other)

If a spill occurs over land or if a spill at sea is not controlled before it reaches a shore line, then a different sort of clean-up problem arises which often involves the need to dispose of large quantities of contaiminated sludge or semi-solid material. Clean-up of beaches has received considerable attention.

Classification of Research Topics (continued)

Because the studies described here were undertaken for the agency interested mainly in responding to spills, the areas given under items 4 and 5 were given the most attention. The fate and effect field is of interest here as it must be the basis for a rational approach to deciding the extent to which a given spill needs to be controlled.

II. A SURVEY OF RECENT SPILLS IN NORTH AMERICA

Introduction

In attempting to set priorities for a spill-related research program it is useful to know what kinds of materials are likely to be spilled and under what circumstances. Unfortunately, there is no central clearing house for data on actual spills. In the U.S., federal law now requires the offender to report any major oil spill, but there is as yet no such regulation for hazardous materials. In Canada, the federal government keeps no complete records, and among the provinces only Ontario has made an attempt to keep records for any significant length of time. Nevertheless, data from a number of sources have been employed to develop some sort of picture of the patterns established in recent accidents involving major spills of oil and hazardous materials.

To expose the general level of the spill problem in a highly industrial country, the available data for U.S. spills during the month of November 1971, as given in the March 1972 issue of the Oil Pollution Research Newsletter, have been analyzed. Table I gives the total number and volume of spills.*

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*This document also states
"In order to make valid interpretations of oil and hazardous materials pollution incidents, we are in need of more accurate, careful and voluminous reporting of spills, their causes and sources".

TABLE I

U.S. Oil and Hazardous Material Spills
November 1971

	Oil	Hazardous Material	Total
Number of spills	148	29	177
Total Volume (U.S. gal)	447,000	200,000	647,000
Percentage of volume entering surface water bodies	78	93	83

TABLE 2

Sources of U.S. Oil and Hazardous Material Spills - November 1971

Source	Percentage of Total Number of spills	Percentage of Total Volume spilled
Pipeline	32.8	48.8 *
Plants and plant outfalls	8.5	5.5
Terminals and onshore facilities	5.1	2.1
Trucks and Trailers	7.3	2.7
Railroad tank cars or engines	3.4	8.1
Vessels	16.4	14.0
Storage tanks	7.3	4.4
Wells and platforms	5.1	2.6
Holding lagoons and collection pits	2.2	2.6
Other known sources	5.1	9.2
Unknown sources	6.8	<0.1
	100.0	100.0

These figures show that pipelines, railroads and vessels account for over 70% of the volume spilled.*

*Transmission pipelines are closely regulated as public utilities in the vast majorities of cases. Included in these regulations is a requirement to report oil spills and other accidents. This type of requirement has been made mandatory for other aspects of oil handling system only recently.

Many hazardous material spills go unreported, but some major spills which were reported (1) in 1971 are listed in Table 3.

TABLE 3

Examples of Hazardous Material Spills
United States - 1971

Material	Quantity U.S. Gal	Cause of Spill
Molasses	130,000	Sunken barge
Liquid fertilizer	160,000	Capsized barge
Pesticides	1,000	Storage facility fire
Methanol	30,000	Overflowed tank
Tannery waste	1,800,000	Lagoon failure
Waste solvent	50,400	Waste treatment plant failure
Sulfuric acid	10,000	Storage tank rupture
Toluene	10,000	Railroad tank car leak
Diethyl sulfate	4,000	Overturned tank truck
Zinc cyanide (solution)	1,000	Ruptured tank truck
Liquid ammonia	23,000	Ruptured pipeline

Storage and Transporation Accidents - Ontario

Records of spills in Ontario from January 1,1971 to July 31,1972 were supplied by the Ministry of the Environment, Province of Ontario through D.P. Caplice, Director of the Industrial Wastes Branch.

For the present analysis, accidents occurring during plant operation (3), those from an unknown source (1), those of less than 100 gallons of liquid or 100 pounds of solid (23) and those of unknown amount (32) were deleted. The remaining accidents are summarized in Table 4.

TABLE 4

Total Accidents Larger than 100 gal/100 lb
January 1,1971 - July 31,1972

Source	Number	Percent
Truck	50	34
Rail	7	5
Ship/Barge	7	5
Storage/Transfer	84	56
	148	100

The "Storage/Transfer" category includes any accidental spill from a storage facility or from a transfer line during the filling or emptying of a storage facility.

There was sufficient data in the Truck and Storage/Transfer categories to warrant further analysis. In this analysis, liquid hydrocarbons were considered separately from other materials. As might be expected, the truck accident rate for liquid hydrocarbons is not uniform throughout the year with 64% of accidents occurring during the months December through March, 34% from April through July and only 10% from August through November. Table 5 lists the reported liquid hydrocarbon accidents according to the size of the spill.

TABLE 5

Liquid Hydrocarbon Spills in Ontario
Classified According to Size

Size range Imp. gallons	Avg. Size in Range Truck	Avg. Size in Range Storage/Transfer	% of spills in range Truck	% of spills in range Storage/Transfer
"Small" 100-800 gal.	340	290	40%	53%
"Medium" 800-9500 gal.	3300	2800	60%	44%
"Large" > 9500 gal.				

The high percentage of very large spills during Storage/Transfer represents just two spills. As more data accumulate, accidents of this magnitude will probably represent much less than 3% of the total. There was no tendency for spill size to vary with time of year. It should be borne in mind that these frequency distributions can change due to technological advances or safer designs. An example would be the construction of much larger trucks. The small spills average one-tenth the size of the medium spills, thus an overall average size of spill is misleading.

For spills of materials other than liquid hydrocarbons, a wide variety of materials is involved. Table 6 summarizes the Ontario data for the 18 months ending July 31, 1972. A complete list of accidents is given in Appendix A.

TABLE 6

Spills of Hazardous Materials in Ontario
January 1, 1971 - July 31, 1972

	Trucks %	Storage/Transfer %	Rail %
Ammonia and its solutions	23	8	-
Acidic solutions (inorganic)	15	36	17
Basic solutions (inorganic)	9	4	17
Organic Liquids	23	32	17
Solids	15	-	49
Other	15	20	-
	100	100	100
Number of accidents	13	25	6

Spills from Ruptured Tank Cars

The data on ruptured tank cars from 1958 to mid-1971, reported by the Association of American Railroads (2) do not include tank cars punctured or torn by mechanical impact. A rupture is classified as a hole, tear or crack originated or propogated by a combination of internal pressure and lowered tank strength. These records were analyzed by deleting the three accidents involving commodities for which rail transportation specifications were later changed. Of the 46 accidents included, 4 occurred in Canada, although there were no unusual circumstances surrounding the Canadian incidents. In 35 cases, the accident involved a derailment followed by a fire. In the typical reported accident one or two tank cars are punctured or torn by mechanical impact resulting from the derailment. A fire usually follows with several other cars rupturing due to increased internal pressure and/or heat weakened tanks. A total of 97 cars were ruptured in the 46 accidents studied, and in the case of 55 cars the amount spilled was between 30,000 and 34,000 U.S. gallons. Nearly all the other ruptured cars spilled lesser amounts of material. There were 18 cars which spilled between 10,000 and 12,000 gallons. The large number of accidents in these two classes reflects the fact that cars of these sizes transport the bulk of liquid products.

In Table 7 the data are further broken down by commodity released. It should be kept in mind that these releases generally resulted in fire and/or explosion.

TABLE 7

Ruptured Cars by Commodity

Substance	No. Cars	No. Accidents	Volume Released in U.S. Gal. Total All Cars	Average Per car	Average Per Accident
LPG	29	12	893,650	30,820	74,470
Propane	28	7	753,090	26,900	107,600
Butadiene	6	2	176,630	29,440	88,320
Vinyl chloride	4	4	135,960	33,990	33,990
Butane	4	2	132,580	33,140	66,290
Ethylene oxide	7	6	107,820	15,400	17,970
Ammonia	3	3	99,870	33,290	33,290
Alcohols	3	3	69,690	23,230	23,230
Acrylo-nitrite	2	1	41,580	20,790	20,790
Acetal-dehyde	1	1	22,000	22,000	22,000
Ethyl acetate	1	1	20,850	20,850	20,850
Isopropyl amine	1	1	20,690	20,690	20,690
Naptha	2	2	20,150	10,080	10,080
Tetraethyl lead	3	2	15,070	5,020	7,530
Propylene	1	1	11,000	11,000	11,000

In all except 2 accidents only one material was spilled. Since the volumes released were assumed to be equal to the capacity of the car, the actual releases from the cars were lower than those tabulated. However, the tabulated figures are believed to be representative of the total release from rail accidents involving flammable materials since punctured cars are not reported, and in the typical reported derailment one punctured car leads to several ruptured cars. Non-combustible materials with low vapor pressure (e.g., sulfuric acid) would be released primarily through puncture. No data for these materials are available. More than half the reported accidents involve LPG, propane and ethylene oxide.

Pipeline Accidents

Data are presented on pipeline accidents in two parts. First, statistical data are presented for operational failures of pipelines in the United States. Then, the failure history of a small liquid fuel pipeline in the subarctic is presented, as a case history of special interest to Canada.

The data for the U.S. pipeline failures were taken from references (3) and (4) and from the March 1972 issue of the Oil Pollution Research Newsletter.* The data are given separately for natural gas pipelines

*Data on liquid transmission pipelines in Canada became available after the termination of the contract and are presented here, without intensive discussion. The causes of failure of Canadian transmission pipelines show different trends than the one indicated in the U.S. mainly due to the following factors:

1 - Pipelines in the U. S. are older.

2 - The standards of construction,when most of the pipelines in the U.S. were installed, were lower than the standards applicable when the Canadian pipelines were built. The technology available at the time of the Canadian pipeline construction was superior. For example, the cathodic method to protect against corrosion had been improved and the metallurgical quality of the material used in more recent construction was superior.

FAILURES ON LIQUID PIPELINES

Regulated by the National Energy Board
1965 - 1973

Causes of Failure	Number	Barrels Escaped	% Incidents	% Escaped
Corrosion - Internal	42**	9,522	29.2	7.4
- External	38	658	26.4	0.5
Equipment Rupturing Line	12	10,805	8.3	8.4
Pipe Girth Welds	6	17,080	4.2	13.2
Longitudinal Welds	14	45,966	9.7	35.5
Rock Penetration	3	275	2.1	0.2
Rupture	2	21,000	1.4	16.2
Blasting	1	7,000	0.7	5.4
Landslide	1	5,000	0.7	3.8
Valve, Gasket, or Pump	10	5,830	6.9	4.5
Miscellaneous	15	6,164	10.4	4.8
	144	129,300 bbls.	100.0%	100.0%

**Many incidents of internal corrosion were believed to be from a single line.

and for liquid pipelines. Table 8 lists natural gas pipeline failures between January 1950 and June 1956 classified according to cause. These data cover 97% of U.S. Natural gas pipelines.

TABLE 8

Pipeline Failures - Natural Gas Pipelines in U.S.

Failure by/of	Percent
Tractor Gouges	30.0
External Corrosion	13.4
Longitudinal Seam Failures	12.0
Other External Causes	11.6
Acetylene Girth Welds	6.6
Regulation Measurements and Compressor	3.8
Electric Girth Welds	3.7
Wrinkle Bends	3.4
Internal Corrosion	1.4
Branch Connection	0.8
Miscellaneous	13.3

Accidents involving liquid pipelines for 1970 are classified according to material in Table 9.

TABLE 9

Liquid Pipeline Failures by Commodity

Material Shipped	Percentage of Accidents
Crude Oil	62.2
Gasoline	18.2
LPG	6.9
Fuel Oil	4.3
Diesel Fuel	2.9
Miscellaneous	5.5

Crude Oil and Gasoline account for over 80% of all pipeline accidents.

Causes of liquid pipeline accidents in 1968 are listed in Table 10.

TABLE 10

Causes of Failures - Liquid Pipelines in U.S.

Failure by/of	Percent
External Corrosion	43.3
Equipment Rupturing Line	19.7
Defective Pipe Seam	6.2
Internal Corrosion	3.2
Incorrect Operation by Carrier Personnel	2.8
Ruptured Gasket	2.4
Ruptured Leaking, or Malfunction of Valve	2.2
Split due to Pressure	1.8
Defective Lapweld Pipe	1.6
Rupture of Previously Damaged Pipe	1.6
Malfunction of Control or Relief Equipment	1.4
Defective Pipe (Base Metal)	1.0
Defective Coupling or Collar	0.8
Defective Pipe Girth Weld	0.8
Defective Acetylene Girth Weld	0.6
Wrinkle Bend Split	0.4
Landslides	0.4
Flood	0.4
Mechanical Seal Failure	0.4
Miscellaneous	9.0

All of these accidents involved injury, property damage or liquid loss. In November 1971 there were 58 pipeline spills for a total volume of 316,000 U.S. gallons. Of this amount 78% was spilled directly in water.

Although the categories in Tables 8 and 10 are not the same, the major causes of failure are external corrosion and externally caused ruptures of the line. The latter are particularly frequent for buried pipelines as suburban areas spread.

It is of interest here to look in detail at the experiences to date with particular installation located in the subarctic (5). This is a small military piepline which connect Haines and Fairbanks, Alaska, and runs for 300 miles through British Columbia and the Yukon Territory. This line carries fuels for military vehicles and aircraft. Data on the line itself are given in Table 11.

TABLE 11

Haines-Fairbanks Pipeline

Diameter	8 inches
Length	
Buried	148 miles
Above Ground	478 miles
Total	626 miles
Holdup of line	210,000 bbl*
Minimum flowrate	27,500 bbl/day

*1 bbl = 35 gal (Imp.) = 42 gal (U.S.)

It should be remembered, however, that these figures are based on only twelve accidents, and that they would be quite different for pipelines with relatively longer buried lengths. Buried lines cannot be damaged by bullets but they are susceptible to damage by earth moving equipment.

Oil Spills in Water - A Global View

Hydrocarbons enter the world's waters from many sources, and to obtain a balanced view of the dangers from any source it is instructive to compare it with other sources. Table 13 presents an estimate (6) of the total amount of oil entering the world's waters from all sources in 1969.

TABLE 13

Estimates of Direct Losses into the World's Waters, 1969
(Millions of metric tons)

	Loss	Percentage of Total Loss
Tankers (normal operations):		
Controlled ("load on top")	0.03	1.4
Uncontrolled	0.50	24.0
Other ships (bilges,etc)	0.50	24.0
Offshore production (normal operations)	0.10	4.8
Accidental spills :		
Ships	0.10	4.8
Nonships	0.10	4.8
Refineries	0.30	14.4
In rivers carrying industrial automobile wastes	0.45	21.6
Total	2.08	100

In the same year it is estimated that world oil production was 1820 million metric tons of which 1180 million metric tons were transported by tanker. Thus, direct oil losses were estimated to be 0.11% of total crude production. Direct maritime losses from ships are summarized in Table 14 as a percentage of the oil shipped by tanker.

Since the line was put into service in 1956 there have been 12 leaks. The causes of the leaks and the estimated loss in each incident are given in Table 12.

TABLE 12

Leaks in Haines-Fairbanks Pipeline

Date	Cause	Estimated Loss (bbl)
Spring 1956	bullet hole	unknown
Nov. 1964	corrosion	unknown
Dec. 1966	vehicle hit valve	unknown
Summer 1967	power pole auger	unknown
May 1968	corrosion	4,000
June 1968	corrosion	100
July 1968	bullet hole	200
July 1968	corrosion	50
Dec. 1968	corrosion	800
May 1969	bullet hole	unknown
June 1969	bullet hole	100
Sept. 1970	corrosion	1,800

Four of these leaks occurred in Canada, including the 4,000 bbl leak at Dezadeash Lake. Two of the bullet holes were at locations where the line ran above ground near a garbage dump. One occurred during target practice while another leak resulted from a bullet meant for a bear prowling a dump.

We note that half of the leaks resulted from corrosion and one third from bullet holes with the remainder caused by vehicles and earth moving equipment.

TABLE 14

Estimates of Direct Oil Losses from Shipping
Millions of Metric Tons

	Loss	Loss as Percentage of Crude Oil Transported by Tankers
Tankers (normal operations)		
Controlled (Load on top)	0.03	0.0025
Uncontrolled	0.50	0.042
Other ships (bilges, etc)	0.50	0.042
Accidental spills		
Ships	0.10	0.0085
	1.13	0.095

The figure for total loss as a percentage of oil transported agrees closely with the widely quoted estimate of 0.1% made by Blumer (7).

Large oil spills at sea are now occurring frequently. A list of reported spills larger than 1000 barrels, since 1957, is given in Appendix A. Data for tanker accidents up to 1970 were analyzed in the Dillingham report (8). The important conclusions of that report are listed below.

.Source	75% were associated with vessels
.Cargo	90% involved crude or residual oils
.Volume	70% of the spills were greater than 5,000 barrels, 30% greater than 80,000 barrels. The mediam spill size was about 25,000 bbl.
.Distance Offshore	80% occurred within 10 miles of the shoreline 50% within 1 mile.
.Wave height at a time of spill	50% had heights greater than 9 ft.
.Wind speed at time of spill	50% had speeds greater than 20 knots
.Extent	80% contaminated less than 20 miles of coastline
.Coastline	85% occurred off shoreline considered to be recreational.
.Distance from Port	75% were within 25 miles of the nearest port.

III. SPILL-RELATED RESEARCH IN CANADIAN UNIVERSITIES

Introduction

A reasonably exhaustive investigation revealed that there are some 26 groups in Canada currently studying phenomena directly related to spills of oil and hazardous materials. Fairly large groups involving more than 3 assisting personnel (graduate students and technicians) exist at several institutions. Table 15 shows the distribution of groups by the area being studied.

TABLE 15

Classification of University Research Groups

	Subject Area	No. of Groups
1.	Effects of Hazardous Materials (excl. pesticides)	8
2.	Effects of Pesticides	4
3.	Ageing of Oil Slicks (excl. biological degradation)	5
4.	Biological Degradation of Hydrocarbons	5
5.	Ecosystem Studies which include spills	3
6.	Literature Survey and Appraisal	1
	TOTAL	26

Details of the projects under study by each group are tabulated on the following pages. The individual projects number approximately 50.

The number of groups is not large, and nearly all the projects concern biological aspects of pollution. However, there is a wealth of technical expertise and facilities in Canadian universities which could be brought to bear on spill related problems. For example nearly every university biology department has the expertise to study the effect of oil spills on plants or animals. Thus, the number of current projects in spill-related areas is mainly a function of the support available for such research and not of latent interest and capability.

In the following tabulation of projects the subject codes are those used in Table 15.

LIST OF UNIVERSITY PROJECTS

Subject Code	University	Professional Personnel	Department	No. of Assis-tants	Financ. support	Specific Projects	Recent Publication
1	McGill	Prof.J.B.Lewis 514-392-4311	Redpath Museum	1	NRC	Effects of Oil Spills & dispersants on coral	9
1	U.B.C.	Prof.F.J.R.Taylor 604-228-4587	Oceanography	1	NRC	Effects of Pollutants on marine organisms	
1	U.of Guelph	Prof.J.B.Sprague 519-824-4120		1	NRC Imp. Oil	Effect of Venezuelan crude oil on lobster larvae	10
1	U.of Toronto	Prof.T.Hutchinson 416-928-7320	Botany	7	DIA & ND	Effect of Crude Oil spills on photo-plankton	
1	U.of Alberta	Prof.L.C.Bliss 403-432-4026	Botany	3	DIA & ND	Effect of spilled crude oil on tundra vegetation;	11
					NRC DOE EMR	Effect of spilled diesel fuel	12
1	McGill	Prof.W.C.Leggett 514-392-4311	Biology	2	NRC DOE Que. dept.of Educ.	Response of fish to changes in salinity;distribution of the homing instinct of fish entering a river.	

Subject Code	University	Professional Personnel	Department	No. of Assist-ants	Financ. Support	Specific Projects	Recent Publication
1	Alberta	Prof.F.S.Chia 403-432-3111	Zoology	2	NRC	Effect of diesel oil on marine larvae (spill @ Anacortes,Washington)	13
1	Toronto	Prof.P.M.Stokes 416-928-7441	Botany	1	NRC	Effects of oil fractions on algae	
2	Guelph	Prof.L.W.Smith 519-824-4120	Botany	1	NRC Ontario Hydro	Fate of pesticides in the environment	
2	Manitoba	Dr.G.Webster Dr.P.Cansfield 204-269-7379	Agriculture "	4	NRC CDA DOE Univ.	Analytical methods for pesticides;degradation of pesticides;biological effects of pesticides	
2	Saskatchewan	Dr.D.Cullimore Dr.Sherman Dr. K.Johnson 306-584-4111	Biology Chemistry Chemistry	6	NRC	Effect of herbicides on algal growth; pollution microbiology	14
2	Waterloo	Prof.H.B.N.Hynes 519-885-1211	Biology	1	NRC	Effects of pesticides (esp.methoxychlor) on benthic organisms in streams	
3	Toronto	Prof.C.R.Phillips 416-928-2011	Chem.Eng	3	DOE	Sorption,spreading & weathering of oil spilled on land(esp.with low temp.); characterization of oil after a spill (mass spec, uv.etc).	

Subject Code	University	Professional Personnel	Department	No. of Assist-ants	Financ. support	Specific Projects	Recent Publication
3	Nova Scotia Tech.	Prof.A.Y.McLean Prof.G.O.M.MacKay Prof.A.F.McMillan 902-429-8300	Chem.Eng Chem.Eng Chem.Eng	5		Stability of oil/sea water enulsions;evaporation of residual oils;weathering of shore-bound oil;analysis of oils;effect of uv light on weathering;solubility of hydrocarbons in sea water; development of a vortex separator.	15
3	Ottawa	Prof.B.Lu 613-231-5798	Chem.Eng	1	NRC	Solubility of hydrocarbons in water and water in hydrocarbons (0^{o}-25^{o}C).	
3	Toronto	Prof.D.MacKay Prof.M.E. Charles 416-928-2011	Chem.Eng Chem.Eng	5	DIA & ND	Effects of oil spills on land & water:ageing & environmental effects; identification of best cleanup techniques.	
3	Sherbrooke	Prof.B.Coupal 819-565-4317	Chem.Eng	1	DOE	Definition of conditions required for burning oil slicks;use of peat moss	
4	Waterloo	Prof.A.G.Kempton 519-885-1211	Biology	1	EMR	Ecological side effects associated with micro-biological methods of controlling oil pollution in cold,fresh water.	
4	Western	Prof.J.E.Zajic 519-679-2111	Eng.Sci.	3	NRC EMR	Biogradiation of bunker C; microbial emulsifiers; movement of oil between water & ice.	16
4	Waterloo	Prof.M.Moo-Young Prof.C.W.Robinson 519-885-1211	Chem.Eng Chem.Eng	3	NRC	Yeast degradation of oil; effect of surfactants on yeast degradation;methods for improving degradation rate.	17
4	Alberta	Prof.F.D.Cook 404-432-3111	Microbiology			Effect of controlled spills of oil on land; toxicity and biodegradation	

Subject Code	University	Professional Personnel	Department	No. of Assist-ants	Financ. Support	Specific Project	Recent Publication
4	Memorial	Prof.E.A.Barnsley 709-753-1200	Bio-Chem.	2	NRC	Degradation of polynuclear aromatics by marine micro-organisms;survey of marine organisms for enzymes active in detoxification.	
5	McGill	Prof.J.Spence 514-392-4311	Biology	1	DIA & ND	Ecological study of effects of James Bay Power project (incl.effects of oil spills)	
5	McGill	Prof.J.Spence Prof.W.C.Leggett Prof.J.Kalff	Biology Biology Biology	2	DOE EPA(US) Que. dept. Educ.	Long term study of Lake Memphremagog (incl.monitoring spills).	
5	Queen's	Prof.G.A.Bartlett Two civil engineers Two geographers	Geology	10	NRC, DOE EMR Prov. Govts	Monitoring water quality in the Maratimes incl: .water chemistry .degradation of pollutants .micro-organic & bacterial cycles	
6	McGill	Prof.M.Dunbar 514-392-5714	Marine Sci. Ctr.	2	Alcan	Review & evaluation of literature on effect of Pollution on the ocean.	18

IV. CANADIAN COMPANIES ACTIVE IN THE SPILL CONTROL FIELD

Introduction

Although there is some manufacturing of materials and equipment for the control of oil spills in Canada, there is very little research and development in the private sector. A number of the companies originally included in the survey turned out to be simply the Canadian sales representatives for foreign companies, and these are not included in the tabulations. The remaining 16 organizations are listed on the following pages in three categories:

Manufacturers (7)
Research and Development Companies (4)
Consultants and Consortia (6)

Very few of these organizations have any technically trained professional personnel engaged in research and development, the principle exception being the Bennett firm of Vancouver. However, there are a number of testing laboratories and engineering design and consulting firms in Canada which, although they do not have directly related experience, could undertake spill-related research and development work.

MANUFACTURERS

Imperial Oil Ltd. 2 Place Ville Marie Montreal, Quebec. 514-861-4251	Imperial manufactures at its Sarnia plant dispersants for bunker oil and for light oil. These materials were developed by Imperials' U.S. parent company.
Releasall Limited 1255 Laird Blvd., Montreal 304, Que. 514-735-4461	This company manufactures "Target" oil spill degreaser blue grade and "Target" Lilac grade bilge cleaner. The latter product is claimed to be biodegradable.
Smith-Anderson Co. Ltd., 3181 St. James St. W., Montreal, Quebec. 514-933-8472	Manufactures "Flexy" oil containment booms.
Dominion Welding and Engineering Co. Ltd., Keele St. North, Maple, Ontario. 416-889-4861	Manufactures the "slicklicker" belt system designed and patented by R.B.M. Cybernetic Limited.
Watermaster Industries Ltd., 680 Waterloo St., London, Ontario. 519-672-0330	Manufactures a floating pump which can be attached to a surface skimmer.
Industrial Plastics Canada Limited, Fort Erie, Ontario. 416-871-0412	Canadian representative of STICKBAR Inc., a U.S. company making a line of booms, skimmers, pumps and absorbents. Recently began manufacture of equipment based on STICKBAR design.

RESEARCH AND DEVELOPMENT COMPANIES

R.B.M. Cybernetics (1970) Limited, P.O. Box 4025, Postal Station A, Victoria, BC. 604-658-5713	Developed and patented the "Slicklicker" which is an oleophilic,continuous-belt skimmer whose basic design features grew out of work at the Pacific Laboratory of D.R.B.
Bennett Pollution Controls Limited, Suite 980, Gunness Tower, 1055 W. Hastings, Vancouver 1, B.C. 604-687-9601.	Develops and manufactures oil cleanup equipment including booms, skimmers and oil recovery and storage vessels. Also offers consulting services for planning and coordination related to spill emergencies. The U.S. affiliate is Harding Pollution Control Corporation of West Hempstead, N.Y.
B.C. Research, 3650 Wesbrook Crescent, Vancouver 8,B.C. 604-224-4331	Conduct research and laboratory studies of water quality and pollution problems for pulp and paper, petroleum and mining industries.
LaSalle Hydraulic Laboratory Limited, 0250 St.Patrick St., LaSalle, Quebec. 514-366-2970.	Operate a 30,000 square foot laboratory equipped with wave tank and open channel. Typical projects included model studies of Gulf of St. Lawrence and Port of Vancouver.

CONSULTANTS AND CONSORTIA

G.L. Williams Brothers Canada Limited, 3rd Floor, 640-7th Avenue S.W., Calgary, Alberta. 403-266-8601.	This company is the engineering consultant for the Northwest Project Study Group.
PenuCan Services, 320-9th Avenue S.W., Calgary, Alberta, 403-261-8710.	Engineering consultants for the Gas Arctic Northwest Project Study Group.
Templeton Engineering Co., 58 St. James St., Winnipeg, Manitoba. 204-786-5446.	Consultants to Gas Arctic Northwest Project Study Group. They administer the Environmental Protection Board.
MacKenzie Valley Pipe Line Research Limited, Room 410, 693-5th Avenue S.W., Calgary, Alberta. 403-264-3740.	This Consortium of sixteen oil and pipeline companies was formed to study the technological and economic feasibility of constructing a crude oil pipeline from the north slope of Alaska to Edmonton. At a test site near Inuvik the effects of pipeline operation on permafrost has been studied.
Gas Arctic - Northwest, Project Study Group, Suite 1270 Calgary House, 550-6th Avenue S.W., Calgary, Alberta. 403-266-6201.	This consortium was formed to study the feasibility of a natural gas pipeline to bring gas from north Alaska and northern Canada to energy markets in the south. Experimental studies are being carried out at Prudhoe Bay, Alaska;Norman Wells, N.W.T.; and Nordegg, Alberta to obtain design data for the proposed pipeline. A subsidiary activity is the support of the Environmental Protection Board, formed to examine the impact of the pipeline on the environment.
Petroleum Association for the Conservation of the Canadian Environment, Suite 400, 130 Albert St., Ottawa, Ontario.	Most major oil refineries are members of "PACE". They have expressed a desire to help in defining problem areas, but are not anxious to undertake development work for containment and recovery devices. PACE has a research committee to evaluate proposals made to them for support in developing booms, etc. They are now supporting the development of a boom for use in fast moving streams and studies of hydrocarbon toxicity in fish.

V. SPILL-RELATED RESEARCH IN THE U.K., FRANCE AND THE U.S.

Introduction

There are several reasons why it is useful, in establishing a Canadian Research program, to know how other countries have approached this problem. First, it makes it possible to avoid duplication of effort and build on the relevant results obtained in other countries. Secondly, it exposes the possibilities for co-ordinated or co-operative efforts in fields of mutual interest. Thirdly, the experience of other governments with their own programs may be of interest in devising a Canadian program.

The scope of this study did not permit the thorough study of the programs in any overseas countries, although brief visits were made to France and Britain when the project manager was in Europe to attend a scientific conference. The situation in the United States was studied more completely, and it is felt that the results of this study are of great interest in the present context.

A list of all those interviewed in connection with this aspect of the project is given in Appendix B.

Spill-Related Research in the U.K.

Great Britain is in a very vulnerable position, geographically, with regard to oil pollution at sea. The high density of traffic in the English Channel together with rapidly growing off-shore drilling activity will contribute to a growing number of oil spills which will directly affect the British coastline and biological environment. Because of its direct effect on many citizens, the prevention of contamination of beaches has been the prime concern. In this regard it is interesting to note that most of the material which ends up on British beaches as a result of oil spills has been at sea for 20 to 30 days and looks more like chocolate mousse than oil.

Spill-Related Research in the U.K. (continued)

Large scale government support of research concerning oil spills grew out of the Torrey-Canyon accident of March 1967. In response to this disaster a special committee (19) recommended research in the following areas:

1. Means for speedy transfer of the cargo from a stranded tanker.
2. Methods of firing oil in stranded tankers and on the sea surface.
3. Effects of natural factors on the movement, dispersal and destruction of oil at sea.
4. Oil sinking, scavenging and gelling agents.
5. More effective but less toxic detergents.
6. Detergent spraying and other cleansing equipment.
7. Mechanical methods of removing oil both from the sea surface and from beaches.
8. Cheap and effective booms, primarily for protecting harbours and inlets.
9. Effects of pollution on marine life, seabirds and coastal vegetation and ways of minimizing them.

All five of the government research councils support research in various pollution areas. These are:

1. Agriculatural Research Council
2. Medical Research Council
3. Natural Environment Research Council
4. Science Research Council
5. Social Sciences Research Council.

The Science Research Council has no specific responsibility in the pollution area, and it is mainly the first three of those listed above which sponsor research on pollution. In the context of the present study, it is the Natural Environment Research Council which is of most interest.

Spill-Related Research in the U.K. (continued)

The research supported by these Councils is done partly at research institutes and units operated by the Councils and partly by contracts and grants of limited duration to universities. The government does not support research in private industry. In the year 1970-71 one million pounds were spent by the research councils on direct pollution research aimed at solving specific pollution problems. It is estimated (20) that an additional 2 million pounds were spent on supporting research not initiated with a pollution problem as its prime objective. Of the 1 million pounds spent on direct pollution research, 412,000 pounds went to universities, hospitals and association laboratories as grants and contracts. Classified according to pollutant, a total of 400,000 pounds supported research directly related to oil and hazardous materials including 173,000 pounds on pesticides. A list of all current government supported research projects on pollution (21) is available from the Department of the Environment in London.

Responsibility for co-ordinating the response to emergencies rests with the Department of Trade and Industry (33). Its development work on methods for responding to spills is centered at the Warren Springs Laboratory in Stevenage, Herts. By use of its own test basin and field tests at sea this laboratory has carried out tests of boom and dispersant spreading systems. The effects of dispersants are studied in an isolated body of water at Milford Haven.

The British program of oil spill response rests mainly on the use of dispersants (23). It is felt there that the environment can handle the stress imposed by the oil. Furthermore, present mechanical removal methods are not reliable, and even if a good boom system were available it would be very costly to deploy it rapidly enough to be effective. This is not to say that the British have played no role in boom development, and the British Petroleum floating boom, which drifts with the oil, has some interesting advanced features. Sinking, which has been used by the Dutch, is also under study in Britain, and some experts believe a great deal of the oil which is spilled at sea ends up on the bottom anyway.

Spill-Related Research in the U.K. (continued)

At the Marine Biological Association Library in Plymouth there is a full-time information Scientist for Marine Pollution who maintains an index of current research on marine pollution throughout the world. He has also published a bibliography on marine and estuarine oil pollution (24).

Spill-Related Research in France

This section is based on a single day of interviews in Paris and is thus very brief. Prime responsibility for supervision of research related to marine oil pollution rests with the Département "Lutte Contre la Pollution des Mers" which is part of the Centre National pour l'Exploitation des Océans (CNEXO). The responsibility for responding to emergencies rests with other agencies, especially at the local government level, although the Marine Marchand and the Direction Generale pour la protection de la nature et de l'environment in Paris have a strong interest in available technology for clean-up of spills.

CNEXO carries out its mandate by co-ordinating the work of a number of government laboratories and by negotiating contracts with universities. In addition, some grants are made to universities for feasibility studies, and funds are advanced to industries for development work. These latter funds must be repaid when and if the company profits from the new development. CNEXO is preparing an "atlas" of marine pollutants which can be used to identify the source of many pollutants. Other current projects include toxicity studies of dispersants and the development of a vortex type oil-water separator. CNEXO also operates a research vessel for use by its contractors.

Apparently, CNEXO finds its biggest challenge in the co-ordination of the work in the many government laboratories. The contract research is much easier to control.

Spill-Related Research in the United States

In the United States, protection of the environment from spills of oil and hazardous materials is primarily the responsibility of the Coast Guard and the Environmental Protection Agency. The Coast Guard is responsible for spills at sea, and the E.P.A. looks after those which pose a threat to inland water ways and water supplies. Because of the need for air and sea craft for off-shore clean-up, the Coast Guard plays an active roll in these operations. The E.P.A., however, handles all of its inland clean-up operations by means of contracts with local private industry. For major spills, E.P.A. also contracts with private companies for detailed reports of the spill and its effects. For example the report of an oil spill resulting from offshore drilling operations near Louisiana in the spring of 1970 was the subject of a 134 page report (25) published in the spring of 1971.

The Coast Guard, through its Office of Research and Development, sponsors contract research mainly on mechanical devices for removing oil from the sea (26). Appendix C is a list of the work currently in progress as a result of Coast Guard Contracts. The Coast Guard has set as a goal for its mechanical collection equipment program the ability to collect 2000 gal/minute of oil in a sea with waves 5 feet in height and to withstand the occasional 10 foot waves. CDR Wm E. Lehr, Jr., Chief of the Pollution Control Branch, feels this goal will be reached within 2 years. Current equipment is limited to use in seas with maximum wave heights of 2 feet and maximum currents of 1-½ knots. Another major project involves the development of an "Air Deliverable Anti-Pollution Transfer System (ADAPTS)" which involves the use of aircraft to deploy special pumps and huge rubber tanks for offloading oil (or hazardous materials) from stranded ships (27). A project not involving equipment development is the development of a "Chemical Hazards Response Information System (CHRIS)". This project involves the preparation of manuals for use in the field by those directing response to spills of hazardous materials and also a central information system to provide data for route and emergency control. A study of particular interest to Canada was one of the behaviour of oil spills in the Arctic (28,29).

Spill-Related Research in the United States (continued)

The Environmental Protection Agency, through its Office of Research and Monitoring, oversees a large research and development effort, but the regulating and emergency response responsibilities rest with a separate "Operations" department in the Air and Water Office. In particular, the Division of Oil and Hazardous Materials with its two Branches looks after spill regulation and response mainly by means of contracts with private industry. The Hazardous Materials Branch has developed an "Oil and Hazardous Materials Technical Assistance Data System (OHM-TADS)" which is a computer based information depository which can provide all information necessary to respond to a spill of any one of 800 hazardous materials.

The Oil Spills Research Branch of the Office of Research and Monitoring (EPA) supports many projects, a list of which is given in Appendix D. This work is done mainly by private industry under contracts. About 15% of the R and D budget is spent on research in government laboratories, and there are currently 4 projects being supported by grants to universities. The contract officers for these projects and the major site of the Branch's own research efforts is the Edison, New Jersey laboratory of the National Environmental Research Centre with headquarters in Cincinnati. About 20 miles from Edison, the Oil Spills Research Branch is building a very remarkable test facility. It is a test basin 65 feet wide and 667 feet long with facility for generating waves up to 2 feet in height. A travelling bridge can move a speeds up to 6 knots. This basin will be finished sometime in 1973 and will be used to develop strandard tests for mechanical equipment. It will also be available for use by contractors doing projects for EPA or other government agencies.

The Oil Spills Research Branch sponsors research in the general areas of:

1. Chemical identification of hydrocarbon pollutants.
2. Fate and effect of spilled oil, particularly biological.
3. Applied technology; containment devices and skimmers for use in high currents (30).

Spill-Related Research in the United States (continued)

Some projects of interest are:

1. Development of a micro-eco system for use in toxicology studies to replace the TL-50 "dead fish" test (Mississippi State University).
2. Development of a sorbent system in which polyurethane pieces are collected, squeezed out and redeployed on the oil slick. (Shell Pipeline Co.).
3. Development of relatively non-toxic oils with various viscosities for use in field tests. (Jetco Chemicals).
4. Development of methods for identification of sources of oil spills and studies of effects of oil pollution on marine organisms (Woods Hole Oceanographic Institute).

Other areas studied include aerial detection of spills, oil gelation, pipeline leak detection and loss evaluation, restoration of shorelines and waste oil treatment. Although official policy is to avoid the use of dispersants for combatting oil spills in the U.S., dispersants have been used in every major spill to protect shorelines, and considerable effort has gone into the development and evaluation of dispersants (31).

Research on methods for fighting spills of hazardous materials is a very new field, and only in the U.S. did we find a significant effort. The Hazardous Materials Branch of the Office of Research and Monitoring (EPA) also operates out of the Edison, N.J. Laboratory, and has so far awarded 10 contracts, details of which are given in Appendix E. In preparation for the establishment of this program, EPA commissioned a study of the potential hazards and available technology in the area of spills of hazardous materials. The final report of this study (32) which was issued just two years ago concluded that adequate control, neutralization and treatment techniques for countering spills of hazardous materials were practically non-existent. An espeically interesting item in this report is a priority ranking system for water soluble materials based on the properties of the material, the quantity shipped each year and the probability of an accidental spill. The resulting list of 257 materials was intended to indicate the potential threat of each item to water quality.

Spill-Related Research in the United States (continued)

The "top 15" were:

1. Phenol
2. Methyl alcohol
3. Cyclic Rodenticides
4. Acrylonitrile
5. Chlorosulfonic acid
6. Benzene
7. Ammonia
8. Misc. cyclic insecticides
9. Phosphorous Pentasulfide
10. Styrene
11. Acetone Cyanahydrin
12. Chlorine
13. Nonyl Phenol
14. DDT
15. Isoprene

Nearly all of these materials are either manufactured or imported in Canada in significant quantities (33), but the priority ranking would probably be somewhat altered if it were based on Canadian shipping data.

Based on the recommendations of the survey study on hazardous materials (32) ten contracts for research and development studies have been issued to date. The titles are listed below, and details are given in Appendix E.

1. Methods to treat, control and monitor spilled materials.
2. Field detection and damage assessment manual.
3. Development of thin films aerator to treat spilled hazardous materials.
4. Methods for disposal of spilled and unused pesticides.
5. Rapid detection of toxic materials in water.
6. Control of hazardous chemicals spilled by physical barriers.
7. Development of a barrier to control hazardous materials spilled in watercourses.

Spill-Related Research in the United States (continued)

8. Development of mass transfer media for treatment of hazardous material spills.
9. Development of modular transportable prototype system for treating hazardous materials.
10. Method to control hazardous material spills: foamed plastic barriers for stopping spills of hazardous materials from leaking containers.

The goals of the U.S. program have been published (41) and a National Conference on Control of Hazardous Material Spills was held this year (35).

Other U.S. government agencies sponsoring research related to spills include the Navy, Department of the Interior, Maritime Administration and the National Ocean and Atmospheric Administration (Commerce Dept). The projects supported by these offices tend to be of a more specialized nature than those initiated by The Coast Guard or E.P.A. as can be seen in Appendix F.

Very little research and development is funded by the private sector. The Association of American Railways and the tank car manufacturers have just finished a major study of tank car design which was directed at reducing the potential danger from accidents involving trains containing hazardous materials (2). The American Petroleum Institute has supported studies of a general sort (36, 37) and cosponsors conferences on oil-spill cleanup (8, 38).

The Smithsonian Science Information Exchange recently completed a compilation of all pollution-related research projects currently in progress in the United States together with a detailed index (39).

VI. CONCLUSIONS AND RECOMMENDATIONS

Introduction

The goals of this study were modest ones, and involved simply the gathering of information. This information is presented in the report and its appendices, and does not require any extensive comentary. However, in the course of the work, voluminous amounts of material were digested and many hours were spent interviewing people in person and on the phone, and the information presented in the report was carefully selected in accordance with the specified goals of the work. Thus those involved in the study were left with a large residue of impressions and data covering a broad range of spill-related subjects, and the recommendations given below are based only in part on the bare bones of fact presented in the body of the report.

Keeping Abreast of Developments

New developments in the spill effect and response area are occurring very rapidly, and it is important in administering a research program to know about these. At the technical level, an important guide to the current literature is POLLUTION ABSTRACTS published by:

Pollution Abstracts, Inc.,
P.O. Box 2369,
La Jolla, California.

This periodical began publication in 1970 and the cost is $70.00 per year. It is available in the National Science Library. The CAN/SDI system of the National Science Library provides a personalized information retrieval service based on a subscriber's list of key words. As part of its Pollution Information Project (PIP), the National Science Library can also provide retrospective searches as far back as September 1968 based on the user's particular interest.

Conclusions and Recommendations (continued)

With regard to research currently in progress the Smithsonian Science Information Exchange Inc (1730 M St. N.W. - Washington, D.C., 20036) maintains a file of all research projects currently in progress in the U.S. and will make a subject search of the file for $50.00. Some of their major searches are published and this includes a recent one on environmental protection which has already been mentioned in this report (39).

For regular reports of recent spills, new contracts awarded and important research results, the Office of Research and Monitoring of E.P.A. publishes 2 newsletters; the "Oil Pollution Research Newsletter" and the "Hazardous Material Spills Research Newsletter". Both are published by:

Edison Water Quality Research Laboratory,
National Environmental Research Center,
Edison, New Jersey 08817, U.S.A.

Hazardous Materials

The lists of reported hazardous material spills in Section II as well as the priority list established in the U.S. (32) and given in Section V give some indication of the types of materials which can be troublesome. Moreover, it would be useful to have a study of Canadian production, import, and transport data to establish a Canadian priority list using a method similar to that employed to establish the U.S. list (32).

It is difficult to conceive of a single spill response procedure which would handle the tremendous variety of materials and circumstances which can be involved in hazardous material spills. The U.S. has made an attempt to develop equipment and procedures which will be applicable to sizeable classes of spills (1,34). The progress of this new program should be studied carefully in the light of a Canadian list of high rish materials before setting up a Canadian program in this area, (see Appendix E).

Conclusions and Recommendations (continued)

One clearly defined need in the control of hazardous material spills is a method for rapidly giving detailed information to field workers on the exact hazards of particular spilled materials and what precautions need to be taken in controlling them. In Canada, the Canadian Chemical Producers' Association operates a Transportation Emergency Assistance Program (TEAP) through regional teams prepared to give phone and field response. A similar but considerably more elaborate (and costly) system is the Chemical Transportation Emergency Centre (CHEMTREC) operated by the Manufacturing Chemists Association in Washington. It must be recalled, however, that these information dispensing systems set up by associations of Chemical Manufacturers are interested in "first aid" and have little vested interest in environmental protection. It was for this reason that the EPA set up its own information system (OHM-TADS, described in section V) for hazardous materials. In addition, the Coast Guard, through "CHRIS" also has an information centre for hazardous materials. However, these three U.S. information centres provide services which overlap in many ways, and it is hoped that the inefficiencies associated with this situation can be avoided in Canada.

Oil Spill Studies

There is a great amount and variety of research activity related to oil spills and it was not possible within the scope of this study to prepare a summary of it. However, several important points can be made with regard to a Canadian research program.

First, a valuable source of data on the behaviour of spilled oil is the study of actual incidents. As was discussed in Section V, detailed studies of all major U.S. spills are prepared. In Canada this is not the case. The Ministry of Transport personnel charged with supervising oil spill control operations are not responsible for maintaining complete documentation of reported spills. An exception, of course, is the Arrow disaster which was the subject of a 3-volume report (40). But no records are kept of observations made in many smaller spills. Arrangements should be made immediately to provide for on-scene observation by technically trained personnel of significant spills and for detailed reporting of these observations.

Secondly, the effect of temperature on the fate and effect of spilled oil and on the effectiveness of clean-up procedures has not been properly explored. In its study for the American Petroleum Institute (36) the Arthur D. Little Company pointed out the important effect which temperature has on the effectiveness of many treatment techniques including dispersion, sorption, combustion and biological degradation. However, laboratory studies are usually conducted at temperatures convenient to the experiment, and no systematic study of the effect of temperature on such things as dispersant effectiveness and biodegradation appear to have been made. This should have a high priority in a Canadian research program. The effect of ice is another topic of special interest in Canada, which has been studied only superficially (28, 29).

In a brief prepared for the Canadian Wildlife Service in 1969 (41) Dr. R.E. Warner, then a Professor at Memorial University, made some excellent suggestions for research topics, and a few of his ideas are thought worth repeating here. He points out, for example, the increasing likelihood of a major off-shore oil well blowout in Canada, and the governments special responsibility for contingency planning because of its

Oil Spill Studies (continued)

part ownership of Panarctic Oils Limited. One of Dr. Warner's specific recommendations is for a national survey to identify sites particularly sensitive to oil pollution for several reasons including:

1. aesthetic values (recreation areas)
2. presence of highly susceptible life forms
3. presence of rare or endangered species.

With regard to pipelines, there is no doubt, especially in view of past experience, as described in Section II, that Canada will be faced sooner or later with a major pipeline spill in the Northwest. Fate and effect studies should be made for the conditions prevailing there, and control methods developed.

Placing of Contracts

It was noted in Sections III and IV that the lists of Canadian Univeristy projects and industrial organizations currently engaged in spill related research and development are rather short. However, these lists are not good indications of the potential capacity of existing Canadian institutions to carry out such work. For example, the Université du Québec is forming a research group at its Rimouski Campus which will be able to do contract work on fate and effect studies of oil in water as well as methods for analyzing samples of polluted water to identify the pollutants. In the case of the initial contracts with groups with no previous experience directly related to spills, somewhat less may be accomplished than would be the case with an experienced group. This must be looked upon as an investment in the development of Canadian expertise, and it is an investment which EPA had to make when they awarded their first contracts. It is more important to have as contractors people with basic technical competence and ability than to have people who know all the words and phrases of the pollution control field but are neither clever nor energetic. Thus it is recommended that requests for contract proposals in specific areas be given the widest possible distribution, not just the prinicpal research officerof a university but the Chairmen of all the departments which might contain interested researchers;

Placing of contracts (continued)

not just the companies currently active in the field, but every engineering design and consulting firm in Canada.

Contracts should be carefully worded so that the goals of the work are specified in sufficient detail to eliminate uncertainity or misunderstanding. All contracts awarded by the E.P.A. contain a "best efforts" clause which, while making the contract much more palatable to a potential contractor, does severely limit the the government's recourses in the case of nonfeasance, but their experience has been good when goals were clearly stated. After all, most of the contractors have hopes of futher work and know they won't get it if they do a bad job.

Reporting of Spills

It is important to keep complete records of major spills. Unfortunately, many spills are presently unreported, and only Ontario has a law requiring the report of major spills. Thus it is recommended that Federal law require the reporting of major spills. In addition, it is recommended that the information resulting from these reports be carefully analyzed to expose trends which would be of great interest to those developing contingency plans as well as to those co-ordinating research programs.

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APPENDIX "A"

DATA ON RECENT SPILLS

TABLE A-1: Reported Spills of Hazardous Materials in Ontario from June 1,1971 to July 31,1972.

TABLE A-2: Major World Oil Spills from 1957 to the Present.

TABLE A-1

HAZARDOUS MATERIALS SPILLED IN ONTARIO

JANUARY 1,1971 - JULY 31,1972

Date	Material	Quantity	Spilled from
1/71	Nitric acid	3 tons	valve
1/71	Pickle liquor	6,000 gal	line
1/71	Edible oil	3,500 gal	truck
2/71	Latex	67,500 lb	transfer line
3/71	Brewery waste	500 gal	tank
3/71	Glycol	1,500 gal	tank
3/71	Methyl chloroform	250 gal	tank
3/71	Magnesium hydroxide	16,000 gal	rail car
3/71	Phosphoric acid	40,000 lb	tank
3/71	Diisooctyl azelate	4,300 gal	tank
4/71	Calcium phosphate	20 tons	truck
5/71	Copper concentrate	70 tons	rail car
5/71	Zinc concentrate	70 tons	rail car
5/71	Polyvinyl chloride slurry	225 lbm	tank
5/71	Ammonia solution	1,500 gal	tank
6/71	Brine with 9 ppm Hg	500 gal	tank
6/71	Ethylene dichloride	1,000 gal	tank
6/71	Ammonium nitrate sol.	51,000 lb	truck
7/71	Phosphoric acid	100 gal	truck
7/71	Hydrochloric acid	8,000 lb	truck
8/71	Pickle acid	1,600 gal	tank
9/71	Brine with 5 ppm Hg	22,000 gal	tank
10/71	Solution of NH_3,NaCl KCL & trace metals	100 gal	truck
11/71	Calcium chloride sol.	1,000 gal	tank
12/71	Diethanolimide	2,500 gal	truck
2/72	Caustic solution (5%)	1,000 gal	tank
2/72	Chromic acid	1,200 gal	tank
2/72	Copper concentrate	100 tons	rail car
3/72	Vegetable oil	200 gal	tank
3/72	Ferric chloride	3,400 gal	truck
3/72	Caustic solution	200 gal	truck
3/72	Turpolene solvent	270 gal	tank
3/72	Alcohol	900 gal	truck
4/72	Rape seed oil	3,000 gal	rail car
4/72	Acetic anhydride	7,000 gal	rail car
5/72	Sulfuric acid	93 tons	tank
5/72	Hydrochloric acid (3%)	5,000 gal	tank
5/72	Paint thinner	400 gal	tank
5/72	Ammonia (anhydrous)	400 gal	pipeline
6/72	Copper sulfate	38 bags	truck
7/72	Ammonia	1,000 gal	truck
7/72	Hydrochloric acid	2,500 gal	tank
7/72	Ammonia solution	1,000 gal	truck
7/72	Hydrochloric acid	3,000 gal	tank

TABLE A-2

Oil Spill Incidents Larger than 1000 bbl

Date	Name	Cause of Spill	Material	Volume bbl	Location
3/57	TAMPICO, tanker	grounding	diesel fuel	60,000	Baja, Calif.
7/62	ARGEA PRIMA, tanker	grounding	crude oil	28,000	Puerto Rico
?/62	Refinery loading site	hose failure	crude oil	2,000	inland river
9/62	MARTITA, tanker	collision	bunder C	4,300	Los Angeles, Calif
2/66	ANNE MILDRED BROVIG, tanker	collision	crude oil	125,000	North Sea
1/67	CHRYSSI P. GOULANDRIS, tanker	unknown	crude oil	2,600	Milford Haven, England
3/67	TORREY CANYON, tanker	grounding	crude oil	700,000	England
9/67	R.C. STONER, tanker	grounding	mixed	143,300	Wake Island
2/68	TIM, tank barge	sinking	#6 fuel oil	7,000	Philadelphia, Pa.
3/68	GENERAL COLOCOTRONIS, tanker	grounding	crude oil	30,000	Bahamas
3/68	OCEAN EAGLE, tanker	grounding	crude oil	83,400	Puerto Rico
3/68	Moron, refinery	pumping	crude oil	16,000	Venezuela
4/68	ESSO ESSEN, tanker	grounding	crude oil	30,000	Off South Africa
5/68	ANDRON, tanker	sinking	crude oil	117,000	Off Africa
6/68	WORLD GLORY, tanker	hull failure	crude oil	322,000	Off South Africa
11/68	KEO, tanker	hull failure	#4 fuel oil	210,000	Off New Jersey
11/68	KENAI PENINSULA, tanker	collision	crude oil	1,000	Delaware River, Pa
12/68	WITWATER, tanker	hull failure	mixed	15,000	Canal Zone
12/68	Humboldt Bay, refinery	hose failure	diesel fuel	1,400	Eureka, Calif.
1/69	Santa Barbara, platform	natural fault	crude oil	100,000	Santa Barbara, Cal
2/69	ALGOL, tanker	grounding	#6 fuel oil	4,000	Buzzards Bay, Mass
2/69	Dutch coast	unknown	residual oil	1,000	North Sea Coast
3/69	Ship shoal, drill rig	storm	crude oil	2,400	Gulf of Mexico
4/69	HAMILTON TRADER, tanker	collision	residual oil	5,000	Liverpool Bay. Eng.

TABLE A-2

Date	Name	Cause of Spill	Material	Volume bbl	Location
5/69	BENEDICTE, tanker	collision	crude oil	14,000	Off Sweden
9/69	FLORIDA, tank barge	grounding	#2 fuel oil	4,000	Buzzards Bay, Mass.
11/69	Seewarren, storage tank	tank failure	crude oil	200,000	New Jersey
3/72	VANLENE, freighter	grounding	bunker B	2,700	Vancouver Island
2/70	ARROW, tanker	grounding	bunker C	65,000	Nova Scotia
2/70	Breton Sound, platform	?	crude oil	15,000	Gulf of Mexico
3/70	OCEAN GRANDEUR, tanker	grounding	crude oil	20,000	Off Australia
4/70	Tarut Bay, pipeline	line break	crude oil	100,000	Saudi Arabia
5/70	POLYCOMMANDER, tanker	grounding	crude oil	70,000	Off Spain
6/70	Deception Bay, storage tank	Landslide	diesel fuel	11,000	Hudson Strait,Que.
1/71	OREGON STANDARD, tanker	collision	bunker C	20,000	San Francisco,Calif
4/71	Anacortes, refinery	loading	diesel oil	4,500	Washington
11/71	Douglas, storage tank	dike failure	slop oil	70,000	Pennsylvania
11/71	JULIANA, tanker	hull failure	crude oil	25,000	Off Japan
7/72	TAMANO, tanker	grounding	#6 fuel oil	2,500	Maine
9/72	Inuvik, storage tank	tank overflow	diesel fuel	1,000	Innvik, N.W.T.

APPENDIX "B"

PERSONS INVERVIEWED IN THE U.K., FRANCE AND THE U.S., BY J.M. DEALY IN CONNECTION WITH PROJECT ON SPILLS OF OIL AND HAZARDOUS MATERIALS

Dr. Joseph P. Lafornara,
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U.S. Environmental Protection Agency,
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Dr. C. Hugh Thompson, Chief,
Hazardous Materials Branch,
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Air and Water - Operations,
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Mr. John C. Zercher, Manager,
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Manufacturing Chemists Association,
1825 Connecticut Avenue, N.W.,
Washington, D.C. 20009, U.S.A.

Mr. R.M. Graziano, Director,
Bureau of Explosives,
American Railroads Building,
Washington, D.C. 20036, U.S.A.

Mr. David Moulder,
Information Scientist, Marine Pollution,
Marine Biological Association Library,
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Mr. J. Stephen Dorrler, Chief,
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Cdr. William E. Lehr, Jr.,
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M. Philippe le Lourd,
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75783 Paris Cedex 16,
France.

APPENDIX "C"

POLLUTION CONTROL PROJECTS SPONSORED BY THE UNITED STATES COAST GUARD AS OF 1 JULY 1972

UNITED STATES COAST GUARD
OFFICE OF RESEARCH AND DEVELOPMENT
POLLUTION CONTROL BRANCH

Work in Process

724101/006

"Feasibility and Design Study for ADAPTS Deployment" Contract DOT-CG-22,529-A with Sikorsky Aircraft Co., Stratford, Connecticut.

Conduct study to evaluate the mechanical workability, aircraft performance and aircraft flight controlability of the HH-3F helicopter when deploying ADAPTS pumping subsystem components. Design and fabricate material to reinforce the hoist of the HH-3F helicopter for equipment deployment. Scheduled completion March 1973.

714102/A/009
(Final Report in Preparation)

"Study of Sea Calming Effects of Oil Booms and Boom Breakwaters" Contract DOT-CG-03, 712-A with URS Research, Inc., Burlinghouse, California.

Model test program of various shaped booms. Determine damping characterisitics , if any, for each configuration. Study damping effects of petroleum, and develop methods to enhance damping. Scheduled completion July 1972.

714102/B/013
(Final Report in Preparation)

"Construction of Light Weight Oil Containment System" Contract No. DOT-CG-10,250-A with Johns-Manville.

Construct a light weight high seas oil containment system for field test and evaluation. This is a further development of successful concept development work (Report No. 714102/A/003 June 1970). Scheduled completion August 1972.

714102/015

"Combined Effects of Waves and Current on Oil Containment Barrier Performance" Contract DOT-CG-12,937-A with Massachusetts Institutue of Technology, Cambridge, Massachusetts.

Determine the combined effects of waves and currents on a barrier to develop evaluation methods using lab model tests and analytical predictions. Scheduled completion September 1972. Program extended 9 months due to Point Conception Tests.

724103.11/1 "Prototype Weir-Basin High Seas Oil Recovery System" Contract No. DOT-CG-22,651-A with Ocean Systems, Inc. Reston, Virginia.

Conduct advanced testing, detailed design, fabrication, and calm water testing of an air transportable high seas high capacity oil recovery system. Develop outline plans and recommendations for a high seas test program.

724103.11/2 "Prototype Disc-Drum High Seas Oil Recovery System" Contract No. DOT-CG-24,231-A with Lockheed Missiles and Space Co., Sunnyvale, California.

Conduct advanced testing, detailed design, fabrication and still water testing of an air transportable, high seas, high capability oil recovery system. Develop outline plans and recommendations for a high seas test program.

724103.8/1 "Concept Development of a Free Vortex Oil Recovery System" Contract No. DOT-CG- with Scientific Associates, San Monica, Calfornia.

Conduct research and development directed to the use of a "free vortex" device for use on the high seas with particular emphasis on slick thickness $\leq$ 1 inch and currents $\leq$ 1 knot. Design and test a model utilizing a 2' diameter impeller under varying conditions of oil properties, currents, and waves, and with varying operational modes. Develop a conceptional design for a high seas unit.

724104.3/4 "Develop a Mechanical Oil Slick Detector" Contract DOT-CG 24,670-A with URS Research Co., San Mateo, California.

Develop and test a simple, low cost mechnical oil spill detector for use on rivers and harbors. Tests will determine motor tarque vs time as a function of oil viscosity, oil thickness, rotor diameter and rotor clearance . Scheduled for completion July 1973.

724104.4 "Development of an Operational Prototype Airborne Oil Surveillance System" Contract No. DOT-CG-22,170-A with Microwave Division of Aerojet-General Corporation, El Monte, California.

Design, fabricate and flight test a multisensored day/night all weather oil spill detection system. Scheduled for completion July 1974.

724104.7/1

"Earth Resources and Technology Satellite and Skylab Spacecraft Oil Pollution Experiments" Contract DOT-CG-24,063-A with the University of Michigan, Ann Arbor, Michigan.

To investigate the feasibility of using ERTS-A and Skylab remote sensor data for oil pollution detection, monitoring and law enforcement. Scheduel completion July 1974.

724104.7/2

"The Determination of Oil Slick Thickness by Means of Multifrequency Passive Microwave Techniques" Contract MIPRZ-70099-2-21881.

To conduct aircraft borne measurements of the microwave brightness temperature of controlled oil spills at two frequencies for a wide range of oil types and slick thickness. Parallel laboratory measurements of oil films in a water task and theoretical investigations will be conducted to study the interrelationship of frequency, oil film thickness, oil type, sea state and atmospheric conditions. Scheduled for completion October 1972.

724104.7/3

"A Differential TV System for Airborne Surveillance of Oil Spills" Contract MIPRZ-70099-2-23146 with NASA/AMES Research Center, Moffett Field, California.

Design and fabricate a differential TV system for airborne surveillance of oil spills. Conduct a flight evaluation program of this system in a NASA aircraft. Scheduled for completion 1 March 1973.

714104/A/003

"Ultraviolet Laser Measurements of Oil Pollution" Contract No. Not Applicable with Department of Transportation , Transportation Research Center, Cambridge, Massachusetts.

Conduct laboratory measurements program over a wide range of oil types in order to determine the spectral character and excitation frequencies associated with fluorescence phenomena. Fabricate a bread board model of an active line scanning laser to verify laboratory data in the real world under various conditions at sea. Scheduled completion July 1971.

724105.2/1

"Evaluation of a Jet Vortex Concept for Separating Oil from Water" Contract CG-20,253-A with United Aircraft Research Laboratories.

Design build, and evaluate a laboratory size jet vortex separator; and project shipboard size, weight, and performance capability. Scheduled completion January 1973.

724105.2/2 "Evaluation of Tabular Ultra Filtration for Separating Oil from Water" Contract CG-24,286-A with Abcor, Inc.

Design build and evaluate a laboratory size tubular ultra filtration separator; and project shipboard size, weight, and performance capability. Scheduled completion January 1973.

724105.2/3 "Evaluation of a Centrifuge Coalescer for Separating Oil from Water" Contract CG-24, 287-A with Foster-Miller Inc.

Design, build, and evaluate a laboratory size centrifugal coalescer; and project shipboard size, weight, and performance capability. Scheduled completion January 1973.

724105.2/4 "Evaluation of Electrofloation for Separating Oil from Water" Contract CG-24,288-A with Lockheed Aircraft Service Co.

Design, build, and evaluate a laboratory size electrofloation cell; and project shipboard size, weight, and performance capability. Scheduled completion January 1973.

724105.2/5 "Evaluation of a Viscosity Difference Concept for Separating Oil from Water" Contract CG-24,289-A with Union Carbide Corporation.

Design, build, and evaluate a laboratory screw type separator; and project shipboard size, weight, and performance capability. Scheduled completion February 1973.

724105.2/6 "Evaluation of a Plate Coalescer Concept for Separating Oil from Water" Contract No. CG-24,290-A with the General Electric Company.

Design, build, and evaluate a laboratory size plate coalescer; and project shipboard size, weight, and performance capability. Scheduled completion January 1973.

724105.2/7 "Evaluation of Ultra Filtration Membranes for Separating Oil from Water" Contract No. CG-24,291-A with the Gulf General Atomic Company.

Formulate, test and evaluate membrane materials with promise for rapid effective separation of oil from water.

724105.2/8 "Evaluation of Vacuum Air Desorption for Separating Oil from Water" Contract No. CG-24,292-A with Mechanics Research, Inc.

Design, build, and evaluate a laboratory size vacuum assisted flotation Separator; and project shipboard size, weight, and performance capability. Scheduled completion January 1972.

724107.2/1 "Physical Process in the Spread of Oil on a Water Surface" Contract No. CG-01,381-A with the Massachusetts Institute of Technology.

This is an add on to write an appendix.

724107.3/4 "The Effects of Winds and Waves on Oil Slick Movement" Contract No. CG-12,196-A with the University of Missouri at Rolla.

This is an experimental program utilizing an open tank equipped with a wind and wave generator in an attempt to simulate oil slick movement on the open seas.

724107.6 "The Spreading and Transport of Oil Slicks on the Open Ocean in the Presence of Winds, Waves, and Currents." Contract No. CG-20,617-A with AVCO Corp.

This is a computer program to predict slick growth given a matrix of input conditions.

724108/3.1 "Oil Dissipation in the Arctic" Contract No. DOT-CG-12,438-A with Massachustts Institute of Technology, Cambridge, Massachusetts.

Study to predict how oil spreads from a large spill in an ice field and the effects of the aging oil trapped under ice. Scheduled completion April 1973.

724108/3.2 "Arctic Oil Biodegradation" Contract No. (TBD) with University of Alaska, College, Alaska.

Two year research program to determine the effects of microbial oxidation on crude oil discharged in Arctic waters. Scheduled completion date July 1974.

724109/6.1.1 "Oil Slick Sampling Device" Contract No. DOT-CG-24,827-A with Shell Pipeline Corp.

Develop a prototype thin slick surface oil sampler based on a surface active agent "pushing" an oil into a polyurethane foam sorbent. The sampler will be for purposes of oil slick identification.

724109/6.1.2 "Oil Slick Sampling Device" Contract No. DOT-CG-20, 278-A with Poseidon Scientific Corporation.

Design and construct a prototype thin slick oil sampler. The prototype will be in the configuration of a sorbent mesh net to be towed behind a small boat. The sampler will be for purposes of oil slick identification.

724109/6.1.3 "Oil Slick Sampling Device" Contract No. DOT-CG-24, 828-A with Marconsult, Inc.

Design and construct a prototype thin slick oil sampler. The sampler will consist of a stainless steel open ended cylinder with a highly efficient sorbent suspended across a right cross section. The sampler will be for purposes of oil slick identification.

724110.1/2.2 "Survey, Analysis and Test of Sorbents" Contract MIPR-Z-70099-0-00584 with the Naval Ship R&D Laboratory, Annapolis, Maryland.

Conduct standardized laboratory tests on all available sorbent materials to determine their suitability to collect oil. Initial report complete. Work continuing to develop a flow thru sampler. Completing scheduled August 1972.

724110.1/3.1 "Assessment of Biodegradation Potential for Controlling Oil Spills on the High Seas". Contract CG-20,260-A with Oklahoma State University, Stillwater, Oklahoma.

Conduct a literature survey, interview contemporary researchers, and compile a state-of-the-art-report including the problems and potential for oil spill clean up. Scheduled completion 16 October 1972.

724122.3.1 "Develop a Prototype 20-Man Shipboard Wastewater Treatment System" Contract No. DOT-CG-12,843-A with Thiokol Chemical Corp., Brigham City, Utah.

Design, develop construct and test a prototype 20-Man shipboard wastewater treatment system based on mechanical filtration, incineration, and chemical oxidation and disinfection. Contract awarded in August 1971. Scheduled completion in September 1973.

724122.3.2 "Develop a Prototype 20-Man Shipboard Wastewater Treatment System" Construct No. DOT-CG-20,733-A with Grumman Aerospace Corp., Bethpage, New York.

Design, develop, construct and test a prototype 20-man shipboard wasterwater treatment system based on centrifugal solids separation, incineration, and

ozonation for chemical oxidation and disinfection. Contract awarded August 1971. Scheduled completion September 1973.

724122.4.2 "Conduct Feasibility Study of Wet Oxidation for Shipboard Wastewater Treatment" Contract No. DOT-CG-23,034-A with Lockheed Missiles and Space Company, Sunnyvale, California.

Conduct laboratory feasibility investigation ot wet oxidation to determine its potential for application to a shipboard wastewater treatment system, determine optimum operating parameters, and prepare a preliminary prototype design. Contract awarded June 1972. Scheduled completion June 1973.

724128.4 "Develop Preliminary Certification Program for Marine Sanitation Devices" Contract No. DOT-CG-24, 724-A with Environmental Quality Systems, Inc., Washington, D. C.

Collect data on vessel wastwater characteristics, survey shipboard wastewater treatment systems commercially available and under development, and formulate certification program for marine sanitation devices. Contract awarded June 1972. Scheduled completion October 1972.

724130/2 "Shipboard Air Pollution Monitoring and Control, Problem Definition" Contract No. N.A. with DOT-Transportation Systems Center, Cambridge, Massachusetts.

Assess the impact of Coast Guard vessel and boat exhaust emission on ambient air quality consolidate standards. Define Coast Guard vessel emissions and their impact on air quality. Identify techniques for emission monitoring and control. Conduct field measurements of Coast Guard vessels.

714141/007 "The Fate of Petroleum Hydrocarbon in Beach Sand" Contract No. MIPR-Z-700991-1-1337 with Naval Biochemical Research Laboratory, University of California, Berkley, California.

Determine certain aspects of the fate of a crude petroleum product in the marine and estuarine beaches of the San Francisco Bay area after a large scale spills, and investigate the microbiological effects on the hydrocarbons.

714141/001 "Analysis of Schuylkell River Samples by Neutron Activators" Contract No. DOT-CG-13, 800-B with Gulf Radiation Technology.

Identify those environmental baseline and trends of marine chemical variables requiring investigation based upon the rate at which a variable is subject to change due to man's present and anticipated future alteration of the environment.

714151/003 "Develop Chemical Hazards Response Information System (CHRIS)" Contract No. CG-03,223-A with Arthur D. Little, Cambridge, Massachusetts.

Develop a comprehensive information system to provide pertinent information for both route and emergency control of dangerous chemical shipments. This information system to be incorporated as part of the National Pollution Response Center.

714152/002 "LNG Study" Contract No. MIPR-Z-70099-1-12395 with the Bureau of Mines, Pittsburg, Pennsylvania.

Determine the hazards involved when liquid natural gas (LNG) is spilled on water in large quantities. Continue Bureau of Mines research on spreading, vaporization rate, atmospheric and dispersion. Conduct laboratory experiments to isolate LNG-Water interaction phenomena measure overpressure associated with explosion phenomena for large-scale spills. Conduct 1000-2000 gallons LNG spill tests out-of-doors. Work completed. Final report in preparation.

724151.3 CHRIS Manual No. 1 "A Condensed Guide to Chemical Hazards"

Compile and organize information from CHRIS Manual No. 2 that will be incorporated into this manual. The information will be converted into the required form for this manual (where necessary), and a manuscript prepared for publication.

724151.4 CHRIS Manual No. 2 "Hazardous Chemical Data" (Both a detailed and field version).

Extract and record the required chemical information on 400 chemicals from published literature in accordance with the Preliminary Specifications contained in the Final Report "CHRIS Preliminary Development".

724151.6 CHRIS Manual No.4 "Hazardous Assessment Handbook".

Develop, describe and organize methods of calculating

the movement and dispersion of a released chemical. These methods will be programed for a computer and detailed graphs, charts and nomographs generated.

724151.2 "CHRIS Multi-Model User Analysis".

A reevaluation of CHRIS to expand its scope to meet the needs of all modes of transportation. The two tasks of this contract are: Task A - An evaluation of all modes of Hazardous Material Transport and emergency response, and Task B - A modification of the current CHRIS concepts to incorporate this knowledge gained in Task A.

714121/104 "Ultrafiltration 50 Man Ship Type Waste Treatment System" Contract No. DOT-CG-12,186-A with Hydronautics, Inc., Laurel, Maryland.

Investigate the feasibility of ultrafiltration and incineration for an effective 50 man ship type waste treatment system. Final report in process. Follow on work under consideration.

714121/103 "Development of a Ship Type 50 Man Waste Treatment System" Contract No. DOT-CG-04, 085-A with Lundy Electronics and Systems Inc., Glen Head, New York.

Design, develop and test prototype system consisting of centrifugal filtration for solids separation, electrical incineration for solids reduction, and chemical oxidation for soluble BOD reduction and disinfection. Scheduled completion August 1973.

APPENDIX "D"

OIL POLLUTION CONTROL RESEARCH AND DEVELOPMENT PROJECTS SPONSORED BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

(Taken from list presented at the 1971 conference on Provention and Control of Oil Spills).

OIL POLLUTION CONTROL RESEARCH AND DEVELOPMENT PROJECTS

Project Title/Description	Investigator	Remarks
Surveillance		
1. The Spreading of Oil Films	New York University Bronx, New York	Laboratory investigation of fundamental factors influencing oil slick movement. Report # PB 192 852 Source 3.
2. Investigations of Surface Films - Chesapeake Bay Entrance	Virginia Institute of Marine Science Gloucester Point, Va.	Determination of effect of wind, wave and current regimes of oil films.
3. Oil Tagging Systems Study	Melpar Inc. Falls Church, Virginia	Determine operational systems for tagging petroleum and petroleum products with chemicals and other identifying tags. Report # 15080DJO Source 1.
4. Detection, Identification and Determination of Oils, Tar and Slimes by Reflectance Spectroscopy	Univ. of Michigan Ann Arbor, Michigan	Application of the technique to analytical methods and continuous monitoring. Report # 15080 EAF Source 1.
5. Oil Pollution Source Identification	Phillips Scientific Corp. Bartlesville, Oklahoma	Development of a system for passive identification of oil pollution sources using carbon isotope ratios.
6. Oil Pollution Source Identification	Esso Research and Engineering Company Linden, New Jersey	Development of a system for passive identification of oil pollution sources by developing oil fingerprints.
7. Oil Pollution Detection by Microwave Radiometry	Microwave Sensor Systems Downey, California	Demonstration of the application of microwave radiometry to the detection and measurement of thickness of oil slicks.
8. Multi-Spectrum Scanning to Determine Oil Slick Fate	Univ. of Michigan Ann Arbor, Michigan	Determination of multispectral radiation characteristics of crude oil in the Santa Barbara Channel, February 1969. Work completed.
Control		
1. Prevention and Elimination of Oil Pollution in the Buffalo River	City of Buffalo Buffalo, New York	Cornell Aeronautical Laboratory subcontractor develop and demonstrate equipment and techniques to detect, sample, contain and collect oil entering the Buffalo River. Being reviewed.
2. Test and Evaluate Mechanical and Pneumatic Barriers to Contain Spilled Oil and Means for Removing the Contained Oil in Harbor and Adjacent Waters	Maine Port Authority Protland, Maine	Determine effectiveness and develop techniques for utilization of available containment and recovery systems. Report # 15080 DOZ Source 1.

OIL POLLUTION CONTROL RESEARCH AND DEVELOPMENT PROJECTS (Continued)

	Project Title/Description	Investigator	Remarks
3.	Collection of Spilled Oil With the Aid of Foams	City of Cleveland Cleveland, Ohio	Horizons, Inc., subcontractor oil recovery system.
4.	Oil-Water Separation System for Treatment of Oil Wastes	Garrett Corp. Los Angeles, Calif.	Oil harvesting device and high capacity (500 gpm) centrifuge.
5.	Investigation of Recovery of Large Marine Oil Spills by Use of a Vortex Assisted Air Lift System	Battelle Northwest Richland, Washington	Pilot scale demonstration. Work complete, being reviewed.
6.	Containment and Collection of Oil in Protected Waters	Massachusetts Institute of Technology Cambridge, Massachusetts	Seven individual studies directed toward development of design data containment and harvesting systems.
7.	Molecular Interactions at the Oil Water Interface and Formation of Microemulsions	Columbia University New York, New York	Study of factors influencing effectiveness of dispersants. Work completed.
8.	Effectiveness Criteria for Dispersants	EPA Edison, New Jersey	Criteria for evaluating effectiveness of oil dispersants.
9.	Microbiological Seeding to Accelerate Degradation of Hydrocarbons	Univ. of Texas Marine Science Instit. Port Aransas, Texas	Techniques including seeding with selected cultures, nutrients and other additives will be developed.
10.	A Feasibility Study for an Oil Recovery System Using Sorbent Materials	Shell Pipeline Corp. Houston, Texas	Development of a system for the deployment, harvesting and reuse/disposal of oil sorbents utilizing on-site foam generation.
11.	Design, Fabricate, Assembly, Test, and Evaluation of an Oil Absorbent Harvesting System	URS Research Company San Mateo, California	Development of a system for the deployment, harvesting and reuse/disposal of oil sorbents utilizing vessels of opportunity and straw.
12.	Oil Recovery System Using Sorbent Materials	Hydronautics, Inc. Laurel, Maryland	Development of a system for the deployment, harvesting and reuse/disposal of oil sorbents utilizing chips of a resilient fiberous matrix.
13.	Oil Recovery System Using Sorbent Materials	Meloy Laboratories Springfield, Virginia	Development of a system for the deployment, harvesting and reuse/disposal of oil sorbents utilizing spray-boom delivery of sorbent.
14.	Concept Development of a System for the Recovery of Oil from Unprotected Waters with the Aid of Polyurethane Foam Sorbents	Battelle Northwest Richland, Washington	Development of a system for the deployment, harvesting and reuse/disposal of oil sorbents utilizing a spray-jet collection assembly.
15.	Hydrocyclonic System for Separating Oil from Sea Water	American Process Equipment Corp. Culver City, Calif.	Design, construction and testing of an oil-water separator employing a cyclone concept to separate un-emulsified oil-water mixtures. Report #15080 EUU Source 1.
16.	Recovery of Floating Oil-Rotating Disk Type Skimmer	Atlantic Research Corp. Costa Mesa, Calif.	Concept development studies on a self-containing oil harvesting device employing a series of rotating disks. Report under study.

OIL POLLUTION CONTROL RESEARCH AND DEVELOPMENT PROJECTS (Continued)

	Project Title/Description	Investigator	Remarks
17.	Concept Development of a Hydraulic Skimmer System for Recovery of Floating Oil	Battelle Northwest Richland, Washington	Design fabrication and full-scale testing of an oil harvesting system employing water-jet sweeps, skimming, and primary oil-water separation. Report being reviewed.
18.	Study of Control of Spillage of Hazardous Pollution Substances	Battelle Northwest Richland, Washington	A study to evaluate the causes, effects, and existing methods of mitigating the effects of spills of hazardous polluting substances and a program to develop effective means for coping with these incidents. Report #15090 FOZ Source 1.
19.	Concept for Recovery of Floating Oil	Consultec, Inc, Rockville, Maryland	Concept development studies on a device to harvest oil slicks based upon the use of a water permeable-oil impermeable filter bag.
20.	The Development of a Submerged Hydrodynamic Oil Concentrator for the Recovery of Floating Oil	JBF Scientific Corp. Chelmsford, Mass.	The development and demonstration of a prototype scale mechanical harvesting device based upon the use of a submerged hydrodynamic oil concentrator.
21.	Testing Oil Dispersant Toxicity and Emulsion Efficiency	Univ. of Miami School of Marine and Atomospheric Sciences Miami, Florida	A study to determine reproducibility, cost and operational difficulties associated with tests developed by the EPA to measure oil dispersant toxicity and efficiency.
22.	Testing Oil Dispersant Toxicity and Emulsion Efficiency	New England Aquarium Boston, Mass.	A study to determine reproducibility, cost and operational difficulties associated with tests developed by the EPA to measure oil dispersant toxicity and efficiency.
23.	Testing Oil Dispersant Toxicity and Emulsion Efficiency	Pacific Engineering Laboratory San Francisco, Calif.	A study to determine reproducibility, cost and operational difficulties associated with tests developed by the EPA to measure oil dispersant toxicity and efficiency.
24.	Testing Oil Dispersant Toxicity and Emulsion Efficiency	Syracuse University Research Corporation Syracuse, New York	A study to determine reproducibility, cost and operational difficulties associated with tests developed by the EPA to measure oil dispersant toxicity and efficiency.
25.	Recovery of Floating Oil	New Mexico State Univ. Las Cruces, New Mexico	Development and demonstration of a 1/4 scale mechanical oil recovery device employing a combination of principles: gravity weir, preferential wetting on a rotating belt, and vacuum suction. Work complete.
26.	Comprehensive Oil Spill Control Program for New York Harbor and Immediate Waters	Fire Department City of New York New York, New York	Demonstration of a comprehensive full-scale program for coping with oil spills, including inventory and source determination, fate and movement, evaluation and analysis of control techniques and devices, procurement of equipment and development of spill response plans.

OIL POLLUTION CONTROL RESEARCH AND DEVELOPMENT PROJECTS (Continued)

	Project Title/Description	Investigator	Remarks
27.	Development of a Concept for a Belt-Type Skimming Device for Recovering Floating Oil from Water Surfaces	Rex Chainbelt, Inc. West Milwaukee, Wis.	Development of fundamental design criteria for a belt-type harvesting device including fabrication and experimental prototype testing and evaluation under simulated environmental conditions.
28.	Voraxial Oil Separation System	Reynolds Submarine Services Corp. Miami, Florida	Design, construction, and testing at pilot scale (50 gpm) of a high capacity oil-water separator device for separation of oil-water mixture collected by mechanical oil slick harvesting devices.
29.	TRW Oil/Water Separation Device	TRW Scientific Corp. Redondo Beach, Calif.	Evaluation of a surface oil harvesting device for use on the open sea through the use of model testing. Work complete.
30.	Oil Skimming Devices	EPA Edison, New Jersey	Investigation of the various collection devices presently available.
31.	Oil Containment Systems	EPA Edison, New Jersey	Investigation of various containment systems both available and under development.
32.	Chemical Treatment of Oil Slicks	EPA Edison, New Jersey	An investigation of the potential pollution of effects of chemicals and other materials used to disperse, sink, burn or otherwise dissipate oil slicks. Report # PB 185 947 Source 3.
33.	Oil Dispersing Chemicals	EPA Edison, New Jersey	An overview of the state-of-the-art of manufacturing and testing oil dispersing chemicals. Report # PB 188 207 Source 3.
Effects			
1.	Treatment of Waterfowl Trapped in Oil Polluted Waters	Univ. of California San Diego, Calif.	Determine factors contributing to death, develop methods of cleaning and managing birds in captivity. Report # 15080 EBZ Source 1.
2.	Abundance and Composition of Deep and Shallow Water Macroplankton and Littoral Fish Population in and about Santa Barbara Channel	Univ. of California Santa Barbara, Calif.	Determination of the effects of the February 1969 oil spill. Work completed.
3.	Preliminary Study of Oil Spill Damage in the Intertidal Regions of Santa Barbara and Ventura Counties, California	Univ. of California Santa Barbara, Calif.	Determination of the effects of the February 1969 oil spill. Work completed. Report # 15080 DZR Source 1.
4.	Interation Between Marine Organisms and Oil Pollution	Woods Hole Oceanographic Institute Woods, Hole, Mass.	Determination of the chronic and sublethal effects of hydrocarbon on marine organisms.
5.	Relative Toxicity Test for Dispersants and Oil Dispersant Mixtures	EPA W. Kingston, Rhode Is.	Development of standard methods for determining toxicity to aquatic organisms. Work complete.

OIL POLLUTION CONTROL RESEARCH AND DEVELOPMENT PROJECTS (Continued)

Project Title/Description	Investigator	Remarks
6. Possible Effects of Crude Oil on Aquatic Organisms	Univ. of Alaska College, Alaska	Investigate physical and physiological effects of various oils on sockeye salmon.
7. Assessment of Intertidal Animals and Plants Following Contamination by Oil	Univ. of California Bodega Marine Lab Bodega Bay, Calif.	A biological assessment of intertidal animals and plants following contamination by oil.
8. Biological Recovery Following an Oil Spill	Woods Hole Oceanographic Institute Woods Hole, Mass.	Documentation of the biological effects of a significant spill of fuel oil.
9. Documentation of the Breton Sound Pollution Incident	Alpine Geophysical Associates, Inc. Norwood, New Jersey	Documented effects of an oil spill and effectiveness of measures tried to contain and clean-up the spilled oil. Work completed.
Beach and Shore Restoration		
1. Feasibility Analysis of Incinerator Systems for Restoration of Oil-Contaminated Beaches	Aerojet General Corp. El Monte, California	Evaluation of alternative combustion systems for removing oil from sand. Report # 15080 DXE Source 1.
2. Application of Froth Flotation Separation to Beach Restoration	Melpar Incorporated Falls Church, Va.	Demonstration of 30 Ton/Hr capacity plant.
3. Evaluation of Selected Earth Moving Equipment in Beach Restoration Operations	URS Systems Corp. Burlingame, Calif.	Evaluate selected earth moving equipment, make appropriate minor modifications and develop and demonstrate operating procedures. Report # 15080 EOS Source 1.
4. A Mobile Washing System for In-Place Restoration of Beaches Contaminated by Oil	Ecological Research Corporation Hanover, New Hampshire	Design and test a pilot scale system for cleaning oil contaminated beach sand. The system includes a jet-washer and cyclones for oil-water-sand separation.
5. Demonstration of New Procedures for In-Place Beach Restoration	Sonics International, Inc.	The demonstration and evaluation of use, effectiveness and cost of a device using an ultrasonic energy concept to clean oil contaminated beach sands. Work complete.
6. Cleaning Oil Contaminated Beaches	EPA Edison, New Jersey	A study of the effects of cleaning oil contaminated beaches with chemical dispersants. Report # 189 172 Source 3.

OIL POLLUTION CONTROL RESEARCH AND DEVELOPMENT PROJECTS (Continued)

Project Title/Description	Investigator	Remarks
Other		
1. Documentation of Cleanup Experience Following the Oil Spill Disaster at Santa Barbara, California	Battelle Northwest Richland, Washington	Document causes and affects and effectiveness of measures tried to contain and clean up spilled oil. Report PB 191 712 Source 3.
2. Nontoxic Simulated Crude Oil	Jetco Chemical Co. Corsicana, Texas	The development and demonstration of a synthetic nontoxic simulated crude oil.
3. Oil Sampling Techniques	EPA Edison, New Jersey	Presentation of several basic techniques for sampling slicks with a thickness greater than 2 mm. Report # PB 190 171 Source 3.

APPENDIX "E"

DESCRIPTIONS OF PROJECTS CONCERNING HAZARDOUS MATERIAL SPILLS SPONSORED BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY.

INFORMATION SHEET

RESEARCH, DEVELOPMENT OR DEMONSTRATION PROJECT

This sheet describes briefly a contract under Section 5 Federal Water Pollution Control Act, As Amended.

PROJECT NUMBER: 15090 HGT

TITLE OF PROJECT: "Methods to Treat, Control and Monitor Spilled Hazardous Materials"

CONTRACTOR:
Cornell Aeronautical Laboratory
4455 Genesee Street
Buffalo, New York

PROJECT DIRECTOR:
Dr. Robert Ziegler

PROJECT SITE: Buffalo, New York

SPECIFIC DATA ABOUT THIS AWARD

COMPLETION DATE: March 29, 1972

FEDERAL COST: $494,424

EPA PROJECT OFFICER:
Dr. Joseph P. Lafornara
Edison Water Quality Research Division
EPA, NERC
Edison, New Jersey

DESCRIPTION OF PROJECT:
This is a comprehensive project to develop new and effective methods to prevent selected spilled hazardous materials from reaching watercourses and to treat, control, and monitor the materials in the watercourses. Materials to be investigated include anhydrous ammonia, phenol, chlorine, acrylonitrile, acetone cyanhydrin, methyl alcohol and heavy metals. The development of appropriate countermeasures will include consideration for use of neutralization, precipitation and adsorption agents; methods for introducing treatment materials; methods to detect and monitor spilled materials; development of appropriate flotation, containment and skimming methods; bioassay determinations of effects of countermeasures on the aquatic environment; and an evaluation of the logistics involved, including cost factors, safety, delivery systems, availability and storage requirements.

INFORMATION SHEET

RESEARCH, DEVELOPMENT OR DEMONSTRATION PROJECT

This sheet describes briefly a contract under Section 5 Federal Water Pollution Control Act, As Ammended.

PROJECT NUMBER: 15090 HOE

TITLE OF PROJECT: "Field Detection and Damage Assessment Manual"

CONTRACTOR:
Enviro-Control, Inc.
1250 Connecticut Ave., N.W.
Washington, D.C.

PROJECT DIRECTOR:
Dr. D. M. McArthur

PROJECT SITE: Washington, D.C.

SPECIFIC DATA ABOUT THIS AWARD

COMPLETION DATE: Final Report in Process

FEDERAL COST: $56,037

EPA PROJECT OFFICER:
Dr. C. Hugh Thompson
Division of Oil and Hazardous Materials
EPA
Washington, D.C.

DESCRIPTION OF PROJECT:
This project is designed to produce a handbook of procedures and techniques which are technically and legally defensible for assessing damages to the aquatic environment resulting from discharges of oil and hazardous materials. The handbook will serve as a model for developing State response and contingency planning programs. Standardized observations, testing and reporting will result from State and local programs adopting similar damage assessment techniques.

INFORMATION SHEET

RESEARCH, DEVELOPMENT OR DEMONSTRATION PROJECT

This sheet describes briefly a contract under Section 5 Federal Water Pollution Control Act, As Ammended.

PROJECT NUMBER: 15090 HGS

TITLE OF PROJECT: "Development of Thin Film Aerator to Treat Spilled Hazardous Materials"

CONTRACTOR:
Industrial Bio-Test Labs, Inc.
1810 Frontage Road
Northbrook, Illinois

PROJECT DIRECTOR:
Dr. Robert G. Sanders

PROJECT SITE: Northbrook, Illinois

SPECIFIC DATA ABOUT THIS AWARD

COMPLETION DATE: March 29, 1972

FEDERAL COST: $133,916

EPA PROJECT OFFICER:
Mr. Paul Minor
Industrial Pollution Control Section
EPA
Washington, D.C.

DESCRIPTION OF PROJECT:
The purpose of this project is to develop and evaluate a continuous flow-through thin film aerator to which chemicals can be added to neutralize, oxidize, precipitate, or adsorb spilled hazardous materials. A second device to remove precipitates, carbon slurries, gasses and other solids from the effluent of the aerator will also be investigated. High potential hazardous materials will be evaluated to determine the effectiveness of these devices in watercourses.

INFORMATION SHEET

RESEARCH, DEVELOPMENT OR DEMONSTRATION PROJECT

This sheet describes briefly a contract under Section 5 Federal Water Pollution Control Act, As Ammended.

PROJECT NUMBER: 15090 HGR

TITLE OF PROJECT: "Methods for Disposal of Spilled and Unused Pesticides"

CONTRACTOR:
Midwest Research Institute
425 Volker Boulevard
Kansas City, Missouri

PROJECT DIRECTOR:
Dr. E. W. Lawless

PROJECT SITE: Kansas City, Missouri

SPECIFIC DATA ABOUT THIS AWARD

COMPLETION DATE: April 29, 1972

FEDERAL COST: $60,800

EPA PROJECT OFFICER:
Dr. John E. Brugger
Edison Water Quality Research Division
EPA, NERC
Edison, New Jersey

DESCRIPTION OF PROJECT:
The purpose of this project is to develop and compile information describing safe and non-polluting methods for treating spilled and unused portions of pesticides or other agricultural chemicals in terms understandable by, and with equipment available to, informed laymen, county agents and public health officials. Information to be gathered and/or developed includes the toxicity and hazards of the materials, detoxification by conversion to innocuous products, treating of spills in general and on a layman's property, and proper decontamination of pesticide containers and equipment. The effort will result in the preparation of a manual which could be furnished to appropriate officials for distribution of information on specific pesticides.

INFORMATION SHEET

RESEARCH, DEVELOPMENT OR DEMONSTRATION PROJECT

This sheet describes briefly a contract under Section 5 Federal Water Pollution Control Act, As Ammended.

PROJECT NUMBER: 15090 GLU

TITLE OF PROJECT: "Rapid Detection of Toxic Materials in Water"

CONTRACTOR:
Midwest Research Institute
425 Volker Boulevard
Kansas City, Missouri

PROJECT DIRECTOR:
Dr. Louis H. Goodson

PROJECT SITE: Kansas City, Missouri

SPECIFIC DATA ABOUT THIS AWARD

COMPLETION DATE: Final Report in Process

FEDERAL COST: $84,180

EPA PROJECT OFFICER:
Dr. Thomas Hoover
Athens Water Quality Laboratory
Athens, Georgia

DESCRIPTION OF PROJECT:
The project incorporates the design, development, fabrication, demonstration and evaluation of an automatic water monitoring device which will provide an immediate warning signal in response to the presence of organophosphates in watercourses. Organophosphates are inhibitors of the enzyme cholinesterase, which will be used as a sensor to monitor the waste being sampled. Water suspected of containing organophosphates and a substrate will be passed over the enzyme in an electrochemical cell. In the absence of the organophosphates, the substrate will hydrolyze and produce a low potential. When the toxic material is present, the substrate will not be hydrolyzed and a high potential will activate an alarm system.

INFORMATION SHEET

RESEARCH, DEVELOPMENT OR DEMONSTRATION PROJECT

This sheet describes briefly a contract under Section 5 Federal Water Pollution Control Act, As Ammended.

PROJECT NUMBER: 15090 HGP

TITLE OF PROJECT: "Control of Hazardous Chemical Spills by Physical Barriers"

CONTRACTOR:
MSA Research Corporation
Evans City, Pennsylvania

PROJECT DIRECTOR:
Mr. Ralph Hiltz

PROJECT SITE: Evans City, Pennsylvania

SPECIFIC DATA ABOUT THIS AWARD

COMPLETION DATE: April 29, 1972

FEDERAL COST: $160,688

EPA PROJECT OFFICER:
Mr. Ira Wilder
Edison Water Quality Research Division
EPA, NERC
Edison, New Jersey

DESCRIPTION OF PROJECT:
The purpose of this project is to develop and demonstrate methods to confine spills of hazardous materials on land by use of polyurethane compounds, and low and high expansion foamed inorganics. Selected potentially high hazardous materials, including ammonia, chlorine, acrylonitrile, acetone-cyanhydrin, methyl alcohol, phenol, lindane and an organic mercury solution, will be used to select an appropriate compatable foam, structurally stable for creating dikes. The methods are to result in a portable, high capacity foaming device which can be deployed immediately following a spill, handled, for example, as a back-pack and installed and carried on a transporting vehicle.

INFORMATION SHEET

RESEARCH, DEVELOPMENT OR DEMONSTRATION PROJECT

This sheet describes briefly a contract under Section 5 Federal Water Pollution Control Act, As Ammended.

PROJECT NUMBER: 15090 HGU

TITLE OF PROJECT: "Development of a Barrier to Control Hazardous Materials Spilled in Watercourses"

CONTRACTOR:
Ocean Systems, Inc.
11440 Isaac Newton Industrial Square North
Reston, Virginia

PROJECT DIRECTOR:
Mr. Frank A. March

PROJECT SITE: Reston, Virginia

SPECIFIC DATA ABOUT THIS AWARD

COMPLETION DATE: April 30, 1972

FEDERAL COST: $128,272

EPA PROJECT OFFICER:
Mr. Paul Heitzenrater
Applied Science and Technology Branch
EPA
Washington, D.C.

DESCRIPTION OF PROJECT:
This project is to develop and test a physical barrier that can be used to contain spilled hazardous materials in watercourses to prevent dispersion to surrounding waters. Incorporated in the barrier is an air-inflated flotation collar which supports the top of the barrier, and a water-inflated seal which seals the bottom of the barrier to the bottom of the watercourse. Components necessary for deployment will be evaluated to optimize functional and operational procedures under actual field conditions in both a lake and flowing stream. The ability of the barrier to withstand currents up to three knots in a tidal situation will be determined.

INFORMATION SHEET

RESEARCH, DEVELOPMENT OR DEMONSTRATION PROJECT

This sheet describes briefly a contract under Section 5 Federal Water Pollution Control Act, As Amended.

PROJECT NUMBER: 15090 HGQ

TITLE OF PROJECT: "Development of Mass Transfer Media for Treatment of Hazardous Material Spills"

CONTRACTOR:
Pacific Northwest Laboratories
Battelle Memorial Institute
Richland, Washington

PROJECT DIRECTOR:
A. J. Shuckrow

PROJECT SITE: Richland, Washington

SPECIFIC DATA ABOUT THIS AWARD

COMPLETION DATE: April 29, 1972

FEDERAL COST: $112,690

EPA PROJECT OFFICER:
Mr. Ira Wilder
Edison Water Quality Research Division
EPA, NERC
Edison, New Jersey

DESCRIPTION OF PROJECT:
The goal of this project is to select, test, demonstrate and evaluate the production, subsurface application and surface collection of floatable mass transfer media for in situ treatment of spills in watercourses. Exchange resins and physical sorption media will be utilized to treat spills of toxic bases, acids, and organic compounds. Media will be selected that can be made floatable with a controlled rate of rise to insure optimum contact time with the contaminated watercourse. Methods will be developed to effectively deposit the media at the bottom of the watercourse under spill conditions and subsequently collect the spent media on the water surface.

INFORMATION SHEET

RESEARCH, DEVELOPMENT OR DEMONSTRATION PROJECT

This sheet describes briefly a contract under Section 5 Federal Water Pollution Control Act, As Ammended.

PROJECT NUMBER: 15090 HGV

TITLE OF PROJECT: "Development of Modular Transportable Prototype System for Treating Hazardous Materials"

CONTRACTOR:
Ecology Division
Rex Chainbelt, Inc.
P. O. Box 2022
Milwaukee, Wisconsin

PROJECT DIRECTOR:
Mr. Donald Mason

PROJECT SITE: Milwaukee, Wisconsin

SPECIFIC DATA ABOUT THIS AWARD

COMPLETION DATE: May 29, 1972

FEDERAL COST: $166,300

EPA PROJECT OFFICER:
Mr. Paul Minor
Industrial Pollution Control Section
EPA
Washington, D.C.

DESCRIPTION OF PROJECT:
To develop and fabricate a modular transportable prototype system for removing and treating spilled hazardous materials in aqueous solutions. Equipment necessary to treat most of the high potential hazardous spill materials will be mounted as modular units on a truck which can be driven to a spill site where treatment can be instituted immediately. Treatment will include neutralization, flocculation, precipitation, filtration, and carbon adsorption.

INFORMATION SHEET

RESEARCH, DEVELOPMENT OR DEMONSTRATION PROJECT

This sheet describes briefly a contract under Section 5 Federal Water Pollution Control Act, As Ammended.

PROJECT NUMBER: 15090 HGW

TITLE OF PROJECT: "Method to Control Hazardous Material Spills: Foamed Plastic Barriers for Stopping Spills of Hazardous Materials from Leaking Containers"

CONTRACTOR:
Rocketdyne Division
North American Rockwell Corp.
Canoga Park, California

PROJECT DIRECTOR:
Dr. B. L. Tuffly

PROJECT SITE: Canoga Park, California

SPECIFIC DATA ABOUT THIS AWARD

COMPLETION DATE: March 29, 1972

FEDERAL COST: $99,072

EPA PROJECT OFFICER:
Mr. Ira Wilder
Edison Water Quality Research Division
EPA, NERC
Edison, New Jersey

DESCRIPTION OF PROJECT:
The purpose of the project is to demonstrate the feasibility of a system based on the use of foam plastic barriers to plug leaks of hazardous materials from ruptured containers on land and under water. Various types of currently available plastic foams will be tested and evaluated in the presence of high potential hazard spill materials. The evaluation will include compatability of plugging material with hazardous substances, water resistance, bond strength, barrier effectiveness and setting time under simulated spill conditions.

APPENDIX "F"

OIL POLLUTION CONTROL RESEARCH AND DEVELOPMENT PROJECTS SPONSORED BY U.S. GOVERNMENT AGENCIES OTHER THAN THE U.S.C.G. AND THE E.P.A.

(Taken from list presented at the 1971 conference on Prevention and Control of Oil Spills).

OIL POLLUTION CONTROL RESEARCH AND DEVELOPMENT PROJECTS

Project Title/Description	Sponsor	Investigator	Remarks
An Engineering Investigation of Oil Pollution from Petroleum Oil Lubricant (POL) Facilities	U.S. Navy	Van Houtan and Associates New York, New York	A study of existing facilities and operational procedures with aim at developing corrective measures as well as new design criteria.
Comprehensive System and Cost Requirement Study to Prevent, Control, and Abate Water Pollution from Oil from Naval Forces Ashore and Afloat	U.S. Navy	Naval Ship Systems Command Washington, D.C.	A determination of the sources and magnitudes of existing oil pollution, a ranking of methods for processing/controlling and a summary of budget capabilities for complete abatement.
Shipboard Oil-Pollution Control Systems for Ballast and Bilge Waters	U.S. Navy	U.S. Navy Washington, D.C.	Development of systems to prevent oil pollution attributable to bilge and ballast water from naval ships.
Oil-Water Instrumentation	U.S. Maritime Administration	Illinois Institute of Technology	Development of a device to monitor oil concentration in ballast and bilge waters.
Oil-Water Separation	U.S. Maritime Administration	AMF Cuno Stamford, Conn.	Development and demonstration of a high capacity oil-water separator for bilge and ballast waters.
Oily Water Separator	U.S. Maritime Administration	AMF Incorporated Uncasville, Conn.	The development of an effective shipboard oil-water separation system for treating bilge and ballast water.
Removal of Oil from Aqueous Wastes by Flotation	Interior Dept. Office of Water Resources Research	Univ. of California Berkeley, Calif.	A theoretical and experimental study of the application of air flotation to the removal of emulsified oils from aqueous wastes.
Selection of Parallel Plate Interceptor (PPI) Oil/Water Gravity Separator for Harbor Oil Spill Clean Up	U.S. Navy	U.S. Navy Port Hueneme, Calif.	Selection based on literature review and theoretical analysis of available techniques and their ability to meet Navy requirements.
A Study of Seven Representative Sorbent Materials for Use in Cleaning Up Naval Oil Spills	U.S. Navy	U.S. Navy Port Hueneme, Calif.	Comprehensive behavioral determination were made in various liquids and liquid combinations.
Removal of Oil from Tidal Waters	U.S. Navy	U.S. Navy Port Hueneme, Calif.	The development of a system of equipment, materials, and techniques for oil removal from the surface of harbor waters under various conditions.
Detection of Oil Contamination in Sea Water	U.S. Maritime Administration	IIT Research Instit. Chicago, Illinois	Construction and testing of an instrument for continuous monitoring of oil in fresh or salt water employing infrared absorption spectrometry.
Detection and Identification of Molecular Water Pollutants by Laser Raman Spectroscopy	Interior Dept. Office of Water Resources Research	Univ. of Kentucky Lexington, Kentucky	The development of practical applications of Laser Raman spectroscopy.

OIL POLLUTION CONTROL RESEARCH AND DEVELOPMENT PROJECTS (Continued)

Project Title/Description	Sponsor	Investigator	Remarks
Microwave Radiometric Measurement of Oil and Sea Temperature	National Science Foundation - Office of Sea Grant Programs	Univ. of California Santa Barbara, Calif.	Static tests.
Chemical Determination of Source Pollutant Tars	National Science Foundation - Office of Sea Grant Programs	Univ. of California Santa Barbara, Calif.	Heavy metal concentrations in natural seeps and production crude oil.
Oil Slick Source Identification	Atomic Energy Commission	Gulf General Atomic San Diego, Calif.	Neutron activation analysis to determine characteristic trace metals.
Oil Spill Analysis	National Bureau of Standards	National Bureau of Standards	
Application of Remote Sensing to Surface Parameters of Large Water Bodies	National Aeronautical & Space Administration	Univ. of Wisconsin Madison, Wisconsin	A study of the detection and monitoring of oil and thermal pollution as well as the determination of near-shore circulation patterns.
Oil Spill Analysis	National Bureau of Standards	National Bureau of Standards	
The Effects of Salinity on the Oxidation of Hydrocarbons in Estuarine Environments	Interior Dept. Office of Water Resources Research	Mississippi State University State College, Miss.	A study of aerobic utilization, anaerobic decomposition of petroleum products and microflora predominence at various salinities.
Toxicity of Pollutants to Striped Bass	Interior Dept. Bureau of Sport Fisheries and Wildlife	State Wildlife and Fisheries Commission Baton Rouge, Louisiana	A study of the toxicity of pollutants to various sizes of striped bass, including oil well effluents.
Fishes of the Santa Barbara Kelp Forest	National Science Foundation - Office of Sea Grant Programs	Univ. of California Santa Barbara, Calif.	Ecological Study
Multiple Use of Santa Barbara Channel Marine Resources	Commerce Dept. National Ocean and Atmospheric Admin. Sea Grant Office	Univ. of California Santa Barbara, Calif.	A continuation of previously initiated program of study on the marine resources of the Santa Barbara Area.
Ecology of a Tropical Shore — Pre-Analysis for Pollution Studies	Smithsonian Instit. Tropical Resources Institute	Smithsonian Institution Balboa Heights, Canal Zone	A program for loging the basework for evaluating the biological costs of future oil spills on tropical and related ecosystems.
The Effects and Implications of Petroleum Pollutants on Resources of the Santa Barbara Channel	National Science Foundation - Office of Sea Grant Programs	Univ. of California Santa Barbara, Calif.	Ten sub-projects studying the marine resources of the Santa Barbara Area.
Population Dynamics of Intertidal Organisms	National Science Foundation - Office of Sea Grant Programs	Univ. of California Santa Barbara, Calif.	

Oil Removal Equipment for Naval Harbors	U.S. Navy	U.S. Navy Port Hueneme, Calif.	The development of portable and stationary equipment for the removal of oil spills from naval harbors.
Analysis of Methods for Removal of Oil from Harbor Wastes	U.S. Navy	Battelle Northwest Richland, Washington	Cost effectiveness study of available equipment. Work completed.
Biodegradation of Oil Slicks	U.S. Navy	Rutgers University New Brunswick, N.J.	Determination of factors influencing oil biodegradation.
Collection of Floating Oil in Harbors	U.S. Navy	U.S. Navy Port Hueneme, Calif.	Study of equipment and methods.
Fuel Oil Slagging	U.S. Navy	U.S. Naval Research Laboratory Washington, D.C.	A study of the action of demulsifying agents on sea water separation from fuel oil and the development of the importance of controlling variables.
Degradation of Petroleum and Related Compounds in the Biosphere	National Science Foundation - Div. of Biological and Medical Science	Univ. of North Carolina Raleigh, N.C.	An investigation of the microbial degradation of hydrocarbon substrates in marine environments.
Microbial Degradation of Hydrocarbons	Commerce Dept. National Ocean and Atmospheric Admin. Sea Grant Office	Univ. of North Carolina Raleigh, N.C.	The investigation of the possible use of certain types of bacteria for breaking down oil pollutants in water.
Investigations of Various Materials and Methods for Use in the Removal of Surface Layers of Oil from Water	U.S. Army	U.S. Army Vicksburg, Miss.	The investigation and evaluation of various materials and methods which are potential solutions to crude oil pollution from tanker spillage at sea.
Oil Spill Control Facility	Connecticut State Government	Essex Marine Laboratories, Inc. Essex, Connecticut	A determination of the requirements for an effective oil spill control system for the Connecticut River.