SPILL TECHNOLOGY NEWSLETTER

An informal newsletter published bi-monthly by the Environmental Emergency Branch, Environmental Protection Service, Ottawa, Canada.

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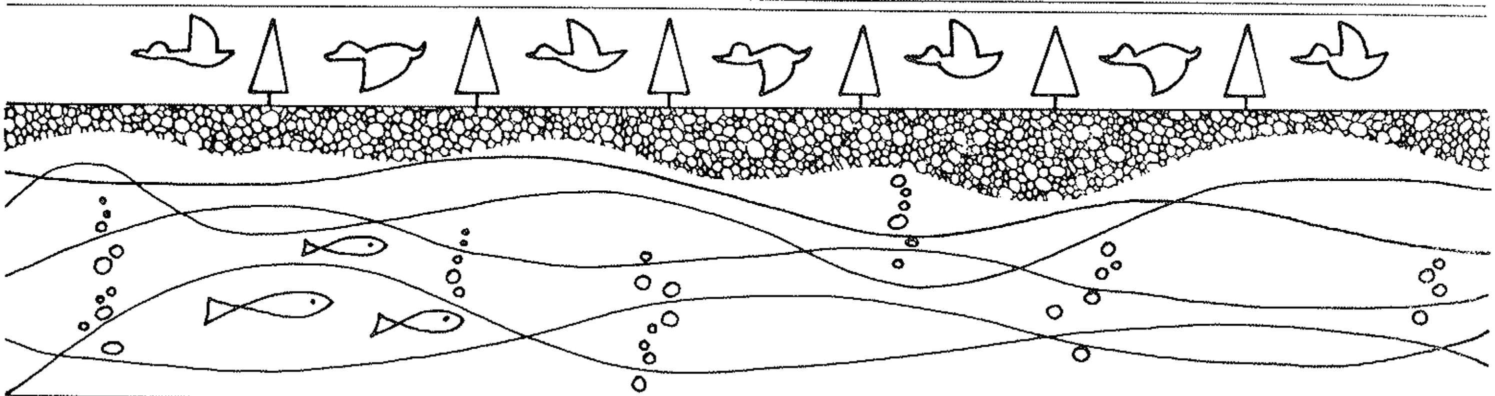

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The Spill Technology Newsletter was started with modest intentions in 1976 to provide a forum in Canada for the exchange of information on oil spill countermeasures and other related matters. The interest in it was such that we now have over 2,500 subscribers in Canada and around the world.

To broaden the scope of this newsletter, and to provide more information on industry and foreign activities in the field of oil spill control and prevention, readers are encouraged to submit articles on their work and views in this area.

INTRODUCTION

The first three articles of this Newsletter deal with oil spills. The first article, submitted by Jim Kingham, describes IMO's efforts to develop guidelines for oil spill dispersant application. The second article by Bob Schulze of ARCTEC provides a view on the problems of using lighter-than-air craft in the Arctic. The third article by Randy Belore describes a device for measuring oil slick thickness.

When the Spill Technology Newsletter began publishing in 1975, the intent was to cover the technologies related to both oil spills and spills involving other hazardous materials. Readers have no doubt noticed that coverage of the latter has been infrequent. It is the editors' opinion that part of the reason for this is the generally lower level of activity in hazardous material spill control technology. This is changing and a number of groups, including the Environmental Emergency Branch (EEB) have increased their hazardous material activities in recent years. The last article in this Newsletter describes the Environmental Emergency Branch program regarding hazardous materials spills and provides an overview of future plans. The editors invite comments or questions on any aspect of the program.

REPORTS AND PUBLICATIONS

● The Canadian Offshore Oil Spill Research Association (COOSRA), an association sponsored by the Canadian Petroleum Industry, makes available reports resulting from their research projects. These reports are available from Pallister Resource Management Ltd., 105, 4116-64th Avenue, S.E., Calgary, Alberta, T2C 2B3, phone (403) 236-2344. The following are the currently-available reports and the prices for these:

Report	Price Microfiche	Paper Copy
Fireproof Boom Development, Phase III - Prototype Construction and Testing McAllister Engineering Ltd.(Vancouver)	$12.00	$43.25
Burning of Crude Oil Under Wind Herding Conditions Energetex Engineering (Waterloo, Ontario), 1981	$18.00	$69.50
Fireproof Boom Development - Ohmsett Trials Oil Spill Research Section, Beaufort Sea Production Development Department, Dome Petroleum Limited	$6.00	$18.00
Oil and Gas under Sea Ice (Final Report), Volume 1 Oil Spill Research Section, Beaufort Sea Production Department, Dome Petroleum Limited	$36.00	$180.00
Oil and Gas Under Sea Ice(Appendices), Volume 2 Oil Spill Research Section, Beaufort Sea Production Development Department, Dome Petroleum Limited	$54.00	$309.50
The Development and Testing of a Helicopter Portable Burner Oil Spill Research Section, Beaufort Sea Production Development Department, Dome Petroleum Limited	$6.00	$11.50
Saacke Burner Operating Manual Nick Vanderkooy, Oil Spill Research Group, 1981	$12.00	$46.75

● IMO (International Maritime Organization, formerly IMCO) has available a number of new publications. These may be ordered from IMO, Publications Section, 101-104 Piccadilly, London, W1V 0AE, United Kingdom. The following is a listing of these releases:

"Emergency Procedures for Ships Carrying Dangerous Goods - Group Emergency Schedules" is now available in English. It costs £3.00 post free and the sales number is 254 82.18.E.

The 1981 "Amendments to the International Convention for the Safety of Life at Sea, 1974" are now available in English, French and Spanish. The Russian edition will be available later. The amendments were adopted in November last year and are expected to enter into force on 1 September 1984. The publication does not contain the 1978 Protocol to the SOLAS Convention, nor the amendments to the Protocol. The sales numbers and post-free prices are as follows: English edition 092 82.01.E£3.50; French edition 093 82.01.F£4.50; Spanish 095 82.01S 4.50.

Other recent publications include the "Convention on the International Maritime Organization", including the amendments which entered into force on 22 May. The English (023 82.08.E), French (024 82.08F) and Spanish (026 82.08.S) editions cost£1.50 each. Amendment 19-80 to the "International Maritime Dangerous Goods Code" is now available in English and French at a price of£11.00. The English sales number is 236 81.17.E and the French 237 81.17.F.

Three more new publications are available in English. They include the new edition of "Crude Oil Washing Systems", including amendments adopted in 1981 by Assembly Resolution A.497(XII). It costs£6.00 and the sales number is 618 82.04.E. "Guidelines on Surveys under the 1978 SOLAS Protocol" is the second. It contains Resolution A.413(XI) as amended in 1981 by Assembly Resolution A.465(XII). The sales number is 857 82.06.E and the price is£1.25. Amendment no. 3 to "Ships' Routeing" consists of loose leaves for insertion in the main volume. The sales number is 921 81.21.E and the price is£3.75.

● The Environmental Emergency Branch has recently released nine contractor's reports, the titles of which appear below. These reports are unedited and have not undergone rigorous technical review but will be distributed on a limited basis to transfer the results to people working in related fields. For copies of these reports contact: Publications Coordinator, Environmental Impact Directorate, Environmental Protection Service, Ottawa, Ontario, K1A 1C8.

"Research Needs for Spills of Opportunity - Atlantic Coast" (EE-30)

"Scientific Research to Spills of Opportunity" (EE-31)

"Oil-Water Interfacial Tensions in Chemical Dispersant Systems" (EE-32)

"A Bibliography on Hazardous Material Spills; 1974-1980" (EE-33, a,b,c, and d - Four volumes)

"Studies of Water-In-Oil Emulsions" (EE-34)

"An Exploratory Study of Sedimentation of Naturally and Chemically Dispersed Oil" (EE-35)

"Research Needs for Spills of Opportunity - Pacific Coast" (EE-36)

"Subsea Blowout Containment System Concept Analysis" (EE-37)

"Étude des Appareils Respiratoires Autonomes et des Combinaisons Entièrement Étanches aux Agents Chimiques" (EE-38)

● The following reports are available from the U.S. Department of Commerce, National Technical Information Service, Springfield, Virginia, 22161, Telephone (703) 487-4650. Most reports are also available on Microfiche at $4.00 each (U.S.A. Price). Canadian buyers add $2.50 to each paper copy and $1.50 for each microfiche report. Prices are quoted in U.S. dollars.

"Environmental Quality Research - Fate of Toxic Jet Fuel Components in Aquatic Systems." R.C. Cooper, L. Hunter, P.C. Ulrichs, and R. Okazaki. California University, Irvine. December, 1981. 61 p. AD-A109 790/6 $8.00

"Oil Spill Clean-up: An Economic and Regulatory Model." J.B. Bidwell. Massachusetts Institute of Technology, Cambridge. July, 1981. 30p. pB82-147489 $6.50

"Study of Factors Affecting the Safety of Arctic pipelines." W.T. Black, D.M. Holloway, U. Luscher, et. al. Woodward-Clyde Consultants, San Francisco, California. November 1981 114p. pB82-149030 $11.00

"Oil Spill Removal: Dispersants, Absorbants, Booms and Skimmers. 1978-January, 1982 (Citations from the Information Retrieval, Ltd. Data Base)." National Technical Information Service, Springfield, Virginia. January, 1982. 78p. pB82-859125 $28.00

"Oil Spill Removal Techniques and Equipment. 1976- November, 1981 (Citations from the NTIS Data Base)." National Technical Information Service, Springfield, Virginia. January, 1982. 165p. pB82-803172 $28.00

"Sulfuric Acid Spill Characteristics Under Maritime Accident Conditions." I.N. Tang, W.T. Wong, H.R. Munkelwitz and G.S. Smith. Brookhaven National Lab, Upton, New York. November, 1981. 111p. AD-A110 276/3 $11.00

"Toxicity of pesticides. September, 1978- December, 1981 (Citations from the NTIS Data Base)." National Technical Information Service, Springfield, Virginia. January, 1982. 347p. pB82-803040 $28.00

UPCOMING CONFERENCES

- The 7th Inland Spills Conference will be held September 27-29, 1982 at the Marriott Inn/North, Columbus, Ohio. For further information contact: Sara E. Garnes, Ohio EPA, 361E. Brond St., Columbus, Ohio, (614) 466-8820.

- The 3rd National Conference and Exhibition on "Management of Uncontrolled Hazardous Waste Sites" is scheduled for November 29-December 1, 1982, in Washington, D.C. For further information contact: Hazardous Material Control Research Institute, 9300 Columbia Boulevard, Silver Spring, Maryland, 20910, phone (301) 587-9390.

- The 1983 "Oil Spill Conference (Prevention, Behaviour, Control, Cleanup)" will be held February 28- March 3, 1983 at the San Antonio Convention Center, San Antonio, Texas. For further information contact: 1983 Oil Spill Conference, suite 700, 1629 K Street, N.W., Washington, D.C., 20006, phone (202) 296-7262.

- The "Canadian Offshore Resources Exposition" will take place September 15-17, 1982 at Ocean Terminals 31-34, Halifax, Nova Scotia. Exhibition hours are 12 noon to 6 p.m.

- The "Seventeenth International Symposium on Remote Sensing of Environment" will be held May 9-13, 1983, in Ann Arbor, Michigan. For further information call: Remote Sensing Centre, Environmental Research Institute of Michigan, P.O. Box 8618, Ann Arbor, Michigan, 48107, telephone (313) 994-1200.

BRIEF NOTES

The Environmental Emergency Branch is planning a new series of oil spill sorbent tests. Suggestions from readers as to particular sorbents to be tested are invited. A listing of sorbents tested to date appears in the EPS publications, "Selection Criteria and Laboratory Evaluation of Oil Spill Sorbents" (EPS 4-EC-76-5) and "Selection Criteria and Laboratory Evaluation of Oil Spill Sorbents: An Update "(EPS 4-EC-78-8). Suggestions may be sent to : Mr. H. Whittaker, Process Development Engineer, Environmental Emergency Branch, Environmental Protection Service, Ottawa, Ontario, K1A 1C8, phone (819) 997-3921.

DISPERSANTS - THE INTERNATIONAL PERSPECTIVE

Submitted by: Dr. J.D. Kingham*
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Two United Nations organizations approved a final text for publication. The publication is entitled "IMO/UNEP Guidelines on Oil Spill Dispersant Application and Environmental Considerations". It should soon be available from either the International Maritime Organization (IMO) or the United Nations Environment Program (UNEP).

The international community has long had serious debate on whether or not dispersants should be used, and if so, how they should be used. Certain countries, most notably the United Kingdom, have encouraged the use of dispersants in general, as soon as a spill occurs. Others, most notably the United States, have discouraged the use of dispersants even, in some cases, as a last resort.

The debate was sharpest in the Marine Environment Protection Committee (MEPC) of IMO. This Committee has been working on a comprehensive anti-pollution manual for many years, and two years ago published a booklet on Practical Information for dealing with Spillages of Oil. At about the same time as the booklet was being published UNEP held a conference in Brest, France, partly as a result of the Amoco Cadiz accident, to discuss the problems of dispersants. The conference decided that guidelines for dispersant use should be prepared.

UNEP engaged a consultant from the oil industry to prepare a first draft and, because of their earlier work, IMO soon got into the act. The subsequent collaboration resulted in the finalization of the joint IMO/UNEP publication.

The publication strives to achieve the delicate balance on this contentious issue. It acknowledges that many techniques may be required to deal with a single, large spill, and that the judicious, careful use of dispersants may be one of them.

Certain standard information appears in the publication: the fate of untreated and chemically-dispersed oil spills are discussed in two chapters; useful and current data on dispersant application are included; the physical effects of dispersed oil are described; limited information on dispersant testing is included; and, the need for monitoring and assessing those situations in which dispersants are used is emphasized.

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In a chapter entitled "Deciding on How to Deal with an Oil Slick at Sea" the publication will present a decision tree. Most Canadian readers of the Spill Technology Newsletter will find the decision tree quite logical and straightforward. It suggests that when an oil spill occurs one should first determine the oil characteristics and then ask a series of questions:

1. Can the oil be effectively removed? If "yes", then remove the oil.
2. Can the oil type and condition be dispersed?
3. Do weather conditions, sea state, etc. permit dispersion?
4. Will dispersion cause less damage overall than the oil slick will cause?

If all the answers to questions 2, 3 and 4 are "yes" and the answer to question 1 is "no" then the oil may be dispersed. If any of the answers to questions 2, 3 or 4 is "no" then dispersants should not be applied.

The distressing thing is that, from an international perspective, this decision tree could not be allowed to stand on its own. Qualifying paragraphs had to be added, to the effect that the objectives of different countries, taking into account cost-benefit and socio-economic factors or the time and expertise available to make a decision, may lead to different decisions. The decision tree shown is one which is intended to achieve the objectives of removing oil where it can effectively be removed and to minimize adverse impacts.

It is sad, but necessary, to note that some countries cannot aspire to achieve even these modest objectives. It is even sadder to note that certain other countries, who can afford to attempt to achieve these objectives choose not to. Such is the state of international affairs.

The publication refers to, and lists, twenty six references and includes seven tables and nine figures which should be of considerable value to those in the oil spill area. Readers of the Spill Technology Newsletter should contact the IMO or UNEP secretariats, whose addresses follow, with respect to the availability of this publication.

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LIGHTER-THAN-AIR CRAFT FOR USE IN THE ARCTIC

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The increase in economic activity in the far north has led various operators to look for innovative means of transportation over the rugged, roadless terrain. Air transportation is an obvious choice, and considering the requirements for high lift capability and endurance, the use of airships is also suggested. Airships have also been suggested for oil spill control work.

Airships were used successfully in the earlier days of flying and some are still around for advertising and promotional purposes. I do not think that any are being used for transportation or airlift now and the reason is that operating airships has always been fraught with problems. The question is, have the problems been solved?

Current airship enthusiasts point out that airships have not been used regularly now for about twenty years and that new aircraft designs would solve the old problems using space age technology. This may be true, but the old airship problems were those of the size of the aircraft and problems of operating in severe weather conditions. These problems are not likely to be solved easily, even with advanced technology. This observation can be best illustrated by a story, which I will share with you now.

In April of 1958 I was a naval aviator stationed at the Naval Air Station at South Weymouth, Massachusetts. I was attached to an experimental test squadron that used many different types of aircraft, including three airships. The airships the Navy used in that period were non-rigid aircraft popularly know as blimps. The Navy used blimps because most of the larger rigid airships of the 1930's were lost in various kinds of disasters.

The blimps we were using were the largest and newest available at the time. The lift was provided by 1.5 million cubic feet of helium. These ships had incredible endurance. The previous year this same squadron used one of these ships to complete a record-breaking, un-refueled flight lasting 11 days. The flight left South Weymouth, crossed the Atlantic Ocean, and made land fall at Libson, Portugal. It then continued south about half-way down the coast of Africa, headed east, and was recovered at Key West, Florida. One might suppose that this sort of performance would keep airships in the Navy forever. Instead the Navy discontinued using airships only a few years later. There were still many problems, which brings me back to the story of the incident in April in Massachusetts.

When airships are not in flight, they are secured to a large mast. In U.S. Navy practice, these masts were mobile so that the airship attached to the mast could be moved with a large tractor. This is the way they were moved to different locations and brought into the hangar. When the weather was good, they were often left out on pads where they could swing with the wind. This probably made them the world's largest wind socks.

On the day of our story, April 11, 1958, one of these giants was swinging on its mast when a flash snow storm came up. The reader might wonder why snow was not anticipated and the airship brought into the hangar before the storm reached the field. That is still another story. The fact is that on the 11th of April we were suddenly having a heavy wet snow with flakes the size of quarters blowing horizontally across the airfield. At about 8 AM that morning the duty officer checked the airship and realized we had a problem. By 8:10 the weight of the snow on the airship had blown all the tires, the hydraulic landing gear struts were completely depressed, and the airship couldn't be moved. By 8:20 the ship ripped under the weight of the snow, rolled over, and died.

I hope the reader got a sense of the swiftness of what had happened. This storm in a relatively moderate climate had quickly ended in disaster. Anyone with experience in the Arctic can imagine that storms far worse than this one may occur all year long. A heavy ice storm could do the job even more quickly.

At this point in the study the airship enthusiasts remind us that the modern airship will be heated so that snow and ice will not be a problem. Maybe, but I am skeptical. I have flown modern heavier-than-air craft with heated wings, heated tail surfaces, and heated proprellers. I have also seen these heated aircraft accumulate so much ice in 15 minutes that the pilot was forced to leave the icing conditions immediately or descend. Space age technology has solved a lot of problems, but one of them is probably not the problem of ice on aircraft at low altitudes. Evidence of this is the recent case of Air Florida Flight 90 leaving Washington National Airport only to collide with a bridge.'

I think my story of the snow storm clearly indicates that airships operating in the Arctic would have to be protected by hangars. This presents a formidable building and operating problem in remote locations. The hangars we had in South Weymouth were 250 feet high and had clam-shell hangar doors that stretched from the ground to the top of the hangar. Building and maintaining such a structure in the Arctic could be a real problem. Not only are there problems with ice and snow accumulating on the airship, there are also problems with accumulations on the hangar. After a heavy snow in South Weymouth, we typically spent a week clearing the hangar doors so that they could be opened.

Successfully hangaring the airship in a storm also depends on the wind conditions. Hangars are generally built parallel to the prevailing winds because airships can't be hangared in a strong cross wind. And strong cross winds may be the order of the day in many locations in the Arctic. By a strong cross wind, I mean more than 8 to 10 knots.

Airships have an advantage in that they could be masted to an offshore rig, but there is still the problem of high winds. I don't think airships could be masted off the coast of Labrador in winds of 40 to 70 knots, and these winds are common in this area. In high winds the airship is in danger of overriding the mast or tearing from the mast altogether. Space age technology is not likely to solve this problem either.

The U.S. Navy operated airships most successfully in warm weather locations: Bermuda, Key West, Panama, and Hawaii. They were never great in ice and snow. I am sure that modern technology could help to solve some of the problems, but many will remain. The big problems are the size of the airship and the effect ice, snow, and high winds have on such a large surface.

The modern engineer should be alert to consider all possible methods of providing suitable transport in the Arctic, but in considering airships, he should proceed cautiously. Those of us with some experience in airships would advise against committing a large investment to a project until all of the problems are really solved.

A DEVICE FOR MEASURING OIL SLICK THICKNESS

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Introduction

As part of an offshore oil spill dispersant experiment held off Newfoundland in October of 1981, a slick thickness measuring system was developed and successfully utilized. The experiment was one of a series sponsored by the government/industry group, the Canadian Offshore Aerial Applications Task Force (COAATF). It is not the intention of this paper to report on the results of the offshore trial; rather the purpose is to briefly describe the simple oil thickness measurer developed for the trial. The device is quite primitive but it does work, is relatively easy to construct and use and can be employed in a wide range of oil spill situations where slick thickness information would be valuable. The laboratory testing and the preliminary development of the device are not discussed in this brief article, but can be found in COAATF's final report on the field trial.

Basic Concept and Design

The method employs a "cookie-cutter" approach for the sample collection. An open-ended cylinder is lowered onto the slick thus trapping a known area of oil. A piece of sorbent (3-M brand sheet) held within the cylinder then soaks up and retains the isolated sample. The oil is then extracted from the sorbent by a colourless solvent (methylene chloride) and its volume determined by a simple colorimetric technique (SPEC 20 analysis).

This very simple concept was adapted for field use by the design and construction of the sampler which is depicted in Figures 1 and 2. A schematic cut-away of the apparatus is also attached to better illustrate its construction. (See Figure 3).

The sorbent is held in place by a friction fit between the coupling's pipe stop and a short length of PVC piping. A thin ring of pipe is used here to create a shallow draft which lessens the surface water disturbance when the sampler is lifted. The retaining ring's outside diameter is reduced by sanding to permit its smooth placement. The ring is then held by two brass bolts which twist into notches cut in the main coupling. A disc of plastic gutter screen is glued (by silicone cement) to the coupling's pipe stop to prevent the sorbent from being pushed out of position on deployment and to make placement of the sorbent in the sampler easier.

The two acrylic plastic discs, again held in place by silicone cement, form a protective valve above the sorbent. The holes in these discs allow the movement of air through the sampler when it is placed on the water. Any oil or water which splashes over the top of the device and enters the top hole is trapped by the diagonal acrylic disc thus preventing the contamination of the sorbent from above. Drainage of any trapped oil or water is possible through the top hole.

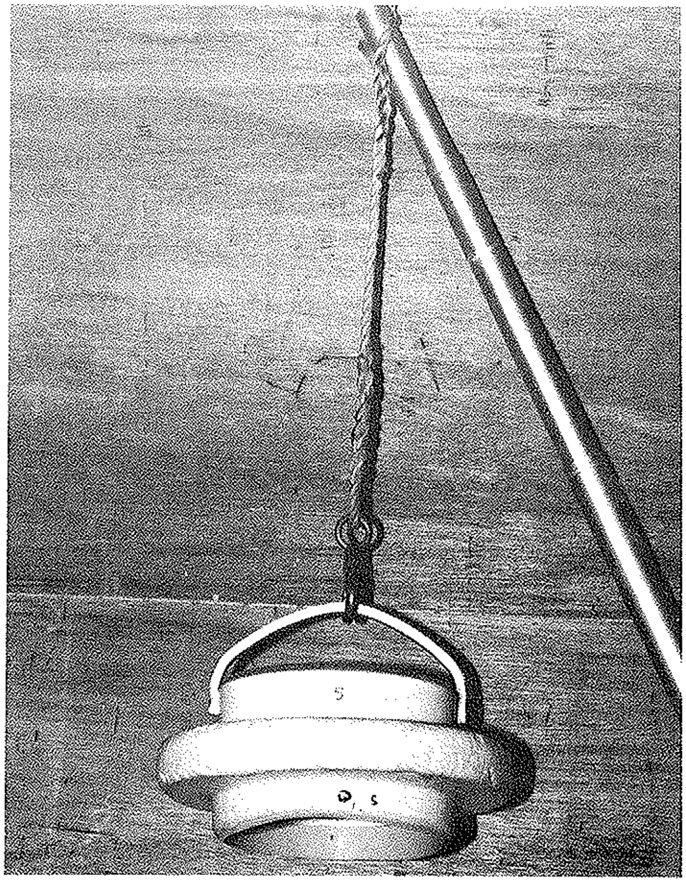

FIGURE 1 SIDE VIEW OF SAMPLER AND DEPLOYING ROD

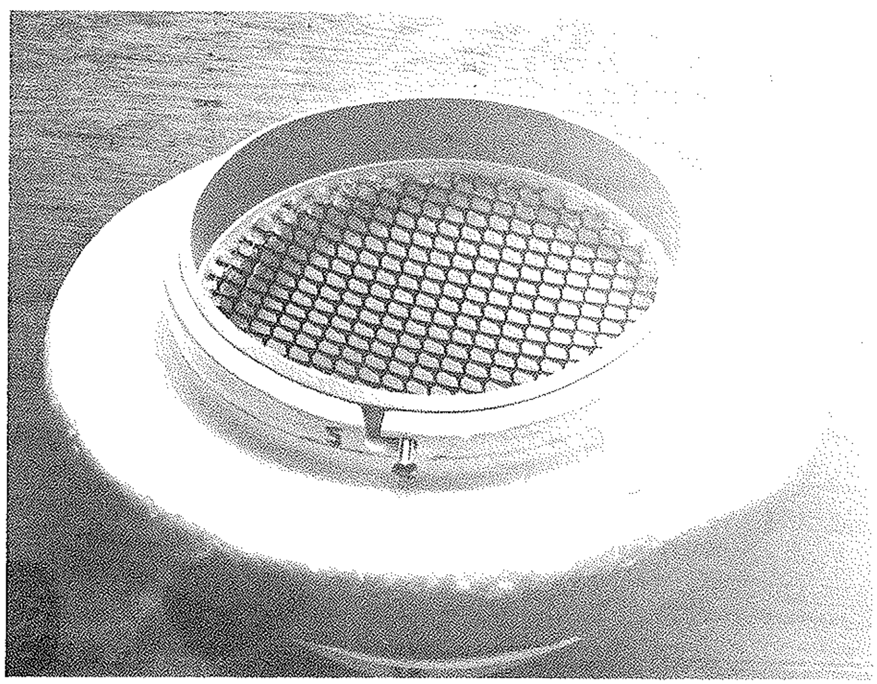

FIGURE 2 BOTTOM VIEW OF SAMPLER (sorbent not in place)

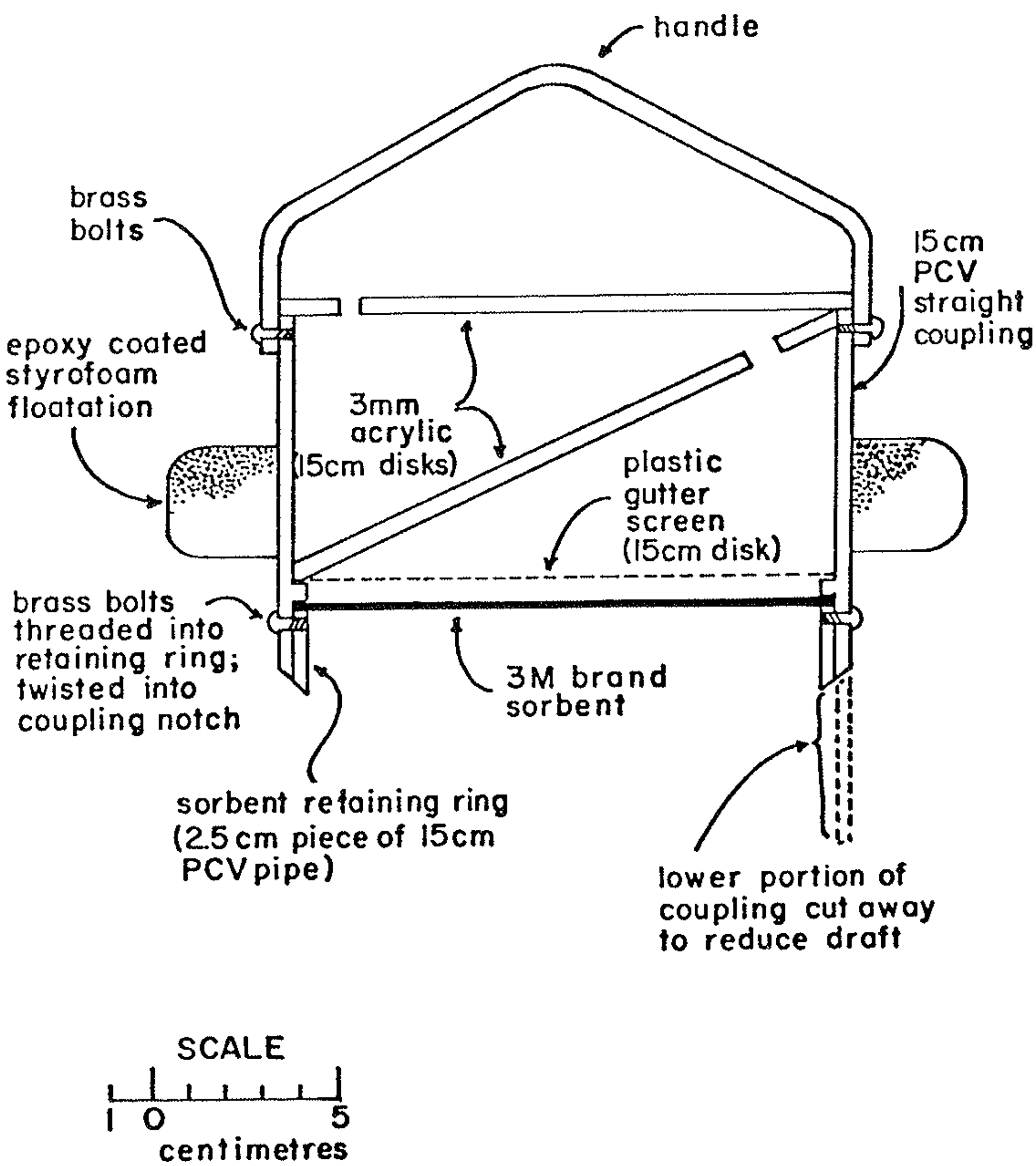

FIGURE 3 CROSS SECTIONAL VIEW OF SURFACE SLICK SAMPLER

The styrofoam floatation ring is placed such that the sorbent is just submerged when the unit is floating on the water. This assures that all of the surface oil will be absorbed by the sorbent. The styrofoam is covered by epoxy resin to prevent its damage and it is fixed in place by silicone cement to guarantee the proper sorbent positioning.

The handle's purpose is merely to provide an attachment point for the rope used in securing the device to a sampling pole. To provide flexibility and compactness an extendable boat hook was selected for the sampling rod. This allows the sampler to be deployed from a range of small boats by one person. A short piece of nylon rope attached to the end of the boat hook and fixed with a quick-clip connector ties the sampling pole to the sampler's handle (See Figure 1). A sample is gathered by extending the pole-sampler arrangement beyond the point where the sample vessel interferes with the surface slick. The sampler is dropped straight into the slick to isolate the oil sample, allowed to float freely for a few seconds, lifted and returned to the boat for the removal and replacement of the sorbent.

The use of the sampler, in the manner described above, proved to be quite acceptable under a relatively calm ocean setting, as was experienced during the field trial for which it was designed. During this field trial, oil thicknesses ranging from less than 1 micron up to about 75 microns were measured with little difficulty. The very thin slick thickness were determined by repeated applications with the same sorbent sheet.

Although the maximum thickness that the sampler can measure has not been determined, thickness in excess of 1/2 a centimetre have been accurately measured in the laboratory.

Further information regarding this simple surface oil thickness measuring device can be acquired by contacting the author.

THE HAZARDOUS MATERIAL SPILL PROGRAM OF THE ENVIRONMENTAL EMERGENCY BRANCH

Submitted by: Mervin F. Fingas
David E. Thornton
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Introduction

The Environmental Emergency Branch (EEB) was formed in 1972 with a mandate for coordinating the federal response to spills which were hazardous to the environment. In principal, this included both oil and other chemicals, but most initial effort was devoted to the oil-spill problem, since this provided the main impetus for the program formation. This focus on oil spills was particularly marked for the R&D program, since the bulk of the resources were strictly associated with the Arctic Marine Oilspill Program (AMOP).

Although a small number of early studies were undertaken, and staff were involved in the reporting and statistical analysis of all hazardous material spills, an attempt to develop a comprehensive program was not started until 1980. At that time, a number of in-house and contracted studies were performed to identify the requirements in Canada, and to review the related environmental protection activities internationally. Subsequently, a program has been developed and dubbed the Chemical Hazard Emergency Countermeasures (CHEC) Program. This article summarizes the current EEB activities which constitute this program.

National Spill Data Bases

Statistical spill data are extremely useful for setting priorities which may be used to help set the direction of projects regarding spill prevention and preparedness. This was recognized in 1972 and a data base was developed to act as a focal point for all Canadian spill data. This data base is known as NATES (National Analysis of trends in Emergencies System) and is supported by a number of federal and provincial agencies. The data are provided on a voluntary basis and certain items of information are treated as confidential. Table 1 illustrates the type of data that can be extracted from this system concerning chemical spills in Canada. The data base now contains over 16,000 events and is used by participating agencies to set priorities, analyze spill patterns and obtain information on specific events.

Another data base known as NEELS (National Emergency Equipment Locator System) was also initiated in 1972 to provide information on the location and details of equipment to deal with spills. The information headings of this system are given in the appendix in Table A1. The system is currently being reconfigured to facilitate the location of equipment specifically designed for any hazardous material, since many of the current headings are most applicable to oil-spill equipment.

TABLE 1 TYPICAL NATES DATA SUMMARY

Data base search for August, 1972 to September 1980, items spilled less frequently were eliminated to show frequent spills

CHEMICAL SUBSTANCE	NUMBER OF SPILLS	AMOUNT IN METRIC TONS
PCB's	102	10.2
Sulfuric Acid	44	4,307
Natural Gas	41	1,794
Sulfur	39	63,625
Sodium Hydroxide	35	1,717.7
Fenitrothion (Pesticide)	33	92.2
Hydrochloric Acid	32	135.6
Ammonia	26	226
Chlorine	17	191
Potassium Chloride	14	7,741
Latex	13	13,673
Hydrogen Sulfide	13	610
Matacil (Aminocarb) (Pesticide)	12	23.8
Phosphorus	11	45.6
Styrene	10	93.3
Ammonium Nitrate	8	3,232
Dimecron (Pesticide)	8	16.1
Mercury	7	2.343
Methanol	6	267.2
Cyanides (of Cu, Fe, Na, and K)	5	3.3
Benzene	4	UK
Calcium Oxide	4	158.7
Ethylene Glycol	4	119
Copper Sulfate	4	10.8
Phenol	4	4.7
Cesium Isotope 137	4	0.000003
Calcium Chloride	3	40
Pentachlorophenol	3	0.1545
Acetic Anhydride	2	UK
Xylenes	2	UK
Sodium Chloride	2	UK
Ferric Chloride	2	259
Sodium Chlorate	2	113.3
Sulfur Dioxide	2	38
Tetraethyl Lead	2	29.7
Urea	2	15.5
Sodium Hypochlorite	2	7.7
Ethanolamine	2	3.8
Vinyl Chloride	2	3.5
Methylene Chloride	2	1.8

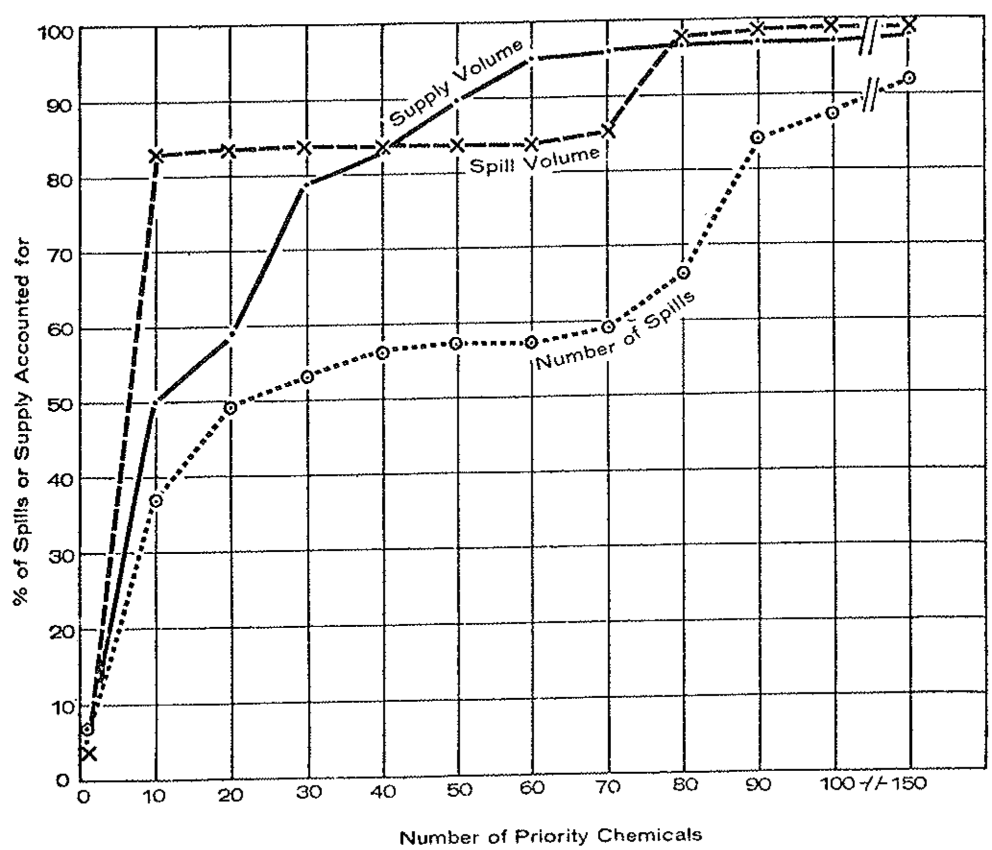
UK = Unknown

Priority List of Spilled Chemicals

In order to focus future work, one of the first CHEC projects was to develop a priority list of environmentally hazardous chemicals which are spilled most frequently on a national basis. It was recognized that many priority lists existed already, but that these do not apply directly to the spill situation. Most of the existing lists are concerned primarily with chronic environmental contamination caused by continual industrial discharge. Data on chemical spillage, production, importation, and transportation were collected. The reported spill frequencies and volumes correlated closely with the supply volume (sum of production and importation). Certain notable exceptions to this observation are items of high environmental concern, such as PCBs. The reported spillage of these items correlate well with their toxicity (aquatic and human).

A number of arithmetical approaches were tried and it was found that a simple ranking of supply volume, reported spill frequency, historical spill volumes, and toxicity (the aquatic toxicity rating or the oral LD50 to the rat, whichever is highest) and the addition of the ranks, produced a list that fully met the objective stated above. The first 10, 50 and 150 priority substances are listed in Tables A2 to A4 in the appendix. Figure 1 shows that these priority chemicals can account for a large percentage of the reported spills (by spill frequency and volumes) and top 200 items by supply volume. For example, the first 10 chemicals account for 37% of the reported spill events by number, 83% of the spill volume and 50% of the supply volume. The graph shows that increasing the number of chemicals produces an asymptotic curve. A note of caution - it may appear that one could take the first, say, 100 chemicals and ignore the remainder, because a spill of another chemical is not very probable historically. This would only hold true if the pattern of supply and spillage remains relatively constant. Also, and quite importantly, those substances which are spilled infrequently often cause more difficulty because there is less information and experience for dealing with them.

The priority list was developed in 1981 and will be re-evaluated from time to time to ensure that it reflects the highest priority chemicals.



Ability of Priority Chemicals to Account for the Maximum Amount of Spills and Chemical Supply

FIGURE 1 THE ANALYSIS OF THE TOP PRIORITY CHEMICALS

Prevention and Contingency Planning

The spill data and chemical priority list will be used to direct future risk-analysis or safety-analysis studies to identify the primary causes of more frequent spills. Also, work is planned regarding contingency planning guidelines for the highest priority chemicals.

Spill-Site Personal Protection

A survey of personal protection at spill sites was conducted, including existing training programs, equipment and regulations. One of the studies, entitled "A Survey of Self-Contained Breathing Apparatus and Totally Encapsulated Chemical Protection Suits", has been published in the Branch's technical report series.

The regional staff have a limited on-site role at certain spills to provide environmental advice and monitoring data to operational agencies. Consequently, thirty-two personnel across the nation have been trained and equipped to ensure personal protection at spill sites, and to show leadership in this important area.

Information Program

A significant portion of the early phase of the CHEC program is devoted to the development of information packages regarding environmentally-sound and safe contingency and response measures. Technical countermeasures information is often unavailable, or can be found only after an extensive library search. Such information can best be presented at a variety of levels, and table 2 illustrates the levels selected by this Branch.

TABLE 2 INFORMATION LEVELS OF SPILL RESPONSE MANUALS

Level	Content Description	Typical Length of Listing	Audience	Purpose
I	Mostly qualitative	Paragraph	First responders	Immediate response information
II	Some qualitive and Some quantitative	Page or two page	First responders and assessors	Information on materials for control and assessment
III	Comprehensive information	Entire monograph	Planners, scientists and technologists	Information for planning and countermeasures design

The first level includes the first-response manuals, which contain little or no quantitative technical information, and typically contain "standard" statements providing basic information on fire-fighting and classification of the substance by the transport designation (e.g. flammable, corrosive, etc). A number of these manuals exist. Many of these cover under 500 materials and focus only on regulated goods. No Branch work at this level is currently planned, although support may be provided in the future to more operational agencies in the preparation or updating of manuals providing basic information on the many substances which are spilled infrequently but which, because of a current lack of ready information, are difficult to deal with.

The second level includes spill-response manuals which provide quantitative information on at least twelve items. Few are currently available and most are not being updated or are priced such that the average first-responder does not acquire them. Further, none of the manuals are designed for Canada in terms of material inclusion and climatic conditions, and most lack information on environmental parameters. These facts led EEB to start the compilation of a level II manual in 1978. A version of this manual is now complete and has been released in draft form for review by specialists. It will be released to the public in January, 1983. The manual now contains listings on 220 different groupings or substances in a 2-page format - the first page provides quantitative information and the second qualitative information relating to spill control and environmental cleanup. Our plans call for updating, improving and expanding the manual in the future.

It was considered that no manuals existed at level III, therefore we have begun the development of level III manuals called "TIPS" - "Technical Information for Problem Spills". These are monographs on our 50 top-priority chemicals which contain information relevant to the behaviour, control, modelling, effects and cleanup of spills - focussing especially on environmental aspects.

Table 3 lists the types of information contained in these manuals. Recent talks with the American Association of Railroads (AAR) have resulted in cooperation on some manuals, with the result that the TIPS manuals now incorporate data collected by AAR and the manuals will be used as a baseline document by AAR to input data into a computerized data base.

At this time, several of the TIPS manuals are in draft form and have been circulated to specialists for review. Final versions of the manuals will be available from December, 1982 through July, 1983. The release of these manuals will be announced through this Newsletter, and they will be available free-of-charge. Plans call ultimately for the production of manuals on 200 to 400 top-priority chemicals and their updating periodically.

TABLE 3 CONTENTS OF THE TIPS (LEVEL III)

Chapter	Heading	Sub-inclusions
1	Summary	
2	Physical and Chemical Data	Data Variations with temperature, pressure
3	Commerce	Manufacturers and processes Production levels Major transportation routes
4	Materials handling and compatability	Containers and vessels Offloading Compatability with materials
5	Contaminant transport	Leak nomograms, dispersion Behaviour on or in water Penetration into soil
6	Environmental data	Drinking water Aquatic toxicity Effect studies Degradation
7	Human health (for responders)	Recommended exposure limits Irritation data Acute toxicity Chronic toxicity Medical considerations
8	Chemical compatability	
9	Countermeasures	Recommended handling procedure Cleanup and treatment Treatment processes Disposal Protective measures Specialized countermeasures equipment
10	Previous spill experience	
11	Analytical methods	In air, water and soil
12	References and bibliography	

Hazard-Level Monitoring

A number of spill incidents in Canada revealed the need for systems to rapidly monitor the personal-and environmental-hazard level of the spilled substance in air, water, and sometimes soil. Standard laboratory techniques and capabilities existed, but most of these could not be applied in the field or could not be applied on a very rapid basis (usually a number of days or even weeks passed before reliable measurements became available). In 1980, a world-wide review of the situation was commissioned which concluded that there did not exist an adequate range of systems directly usable for spill response.

Analytical capability for spills was divided into a number of levels based on portability, accuracy and complexity. The first three levels were considered most useful for rapid, on-site monitoring and all required immediate evaluation and/or development work. These levels are described in Table 4.

TABLE 4 EEB DESIGNATION OF ANALYTICAL LEVELS

Level	Description	Portability/Capital Cost	Typical Coverage	Status/Comment
1	Small detector system (usually colour-change indicator)	Pocket-portable approx. $3K	Up to 100 substances	A number of commercially available units
2	Detector systems with meters or other similar indicators	Person-portable approx. $30K	Possibly up to 1000 substances	Requires development
3	Computer-controlled instruments with pre-developed software packages	Vehicle-portable approx. $150K	Possibly up to 10,000 substances	Requires development
4	Mobile laboratories	Towable on good roads approx. $500K	As many as preparations are made for	Several prototypes on market, not very useful for rapid spill work in remote areas
5	Fixed Laboratories	Not portable (existing)	As 4 above	Existing and not very useful for rapid spill work

On the basis of the survey conducted in 1980 and subsequent followups, a number of instruments appeared to have potential for rapid on-site monitoring. These instruments were purchased or borrowed and assessments made of their potential. At this time, the evaluation and selection of the basic equipment is essentially complete and we are moving into a phase of final modification and calibration for the bulk of the instruments. The current systems undergoing development are illustrated in Table 5:

TABLE 5 EEB HAZARD-LEVEL MONITORING SYSTEMS/INSTRUMENTS AROUND WHICH DEVELOPMENT/EVALUATION IS TAKING PLACE

Level	Media: Air	Water	Land/sediment
1	Draeger System (assessment only)	No capability	No capability
2	HNU OVA	Hach	Hach
3	Radio Shack TRS-80 and Perkin Elmer IR and UV/Vis Spectrometers Computer controlled GC		

It was found that a number of commercial systems existed for air measurements at level 1 and several of these underwent an initial assessment. The Draeger System was selected for detailed evaluation because of its ruggedness and the large number of detector tubes available. These tubes typically measure concentrations over one order of magnitude. In laboratory tests it was found that reproducibility and accuracy of these tubes was good (about 10%), when operated at the correct pumping rate, although it was found that accuracy was dependent upon pumping rate (which was difficult to maintain at cold temperatures), and that sometimes the tubes could be defective. However, these problems can be overcome with proper operator instructions and use.

The greatest amount of development progress has been in air monitoring at level 2, where two instruments are being modified and calibrated. The HNU unit uses an ionization source (lamp) to detect chemicals. The OVA unit employs a Flame Ionization Detector (FID). The capabilities of the two detectors are essentially complementary and in combination they can be employed to detect a great variety of substances. Calibration has been taking place for approximately one year using the bulk of the gases (or vapours) that appear on the priority list of 150 substances. These data will be used to design transparencies which can be fitted onto the units, thus providing immediate and direct read-out of the levels present with an accuracy of about ± 10%. The main advantages that these units have over the Draeger system are that 3 or 4 orders of magnitude of levels can be measured directly and continuously, and that, ultimately, a much greater number of chemicals may be monitored.

For water analysis, the Hach portable laboratory was chosen as the most suitable available unit which could be modified to suit the application. The principle of the unit is to use standard colourimetric reactions to provide direct readout of the material in question. The existing tests have been evaluated for applicability to EEB priority chemicals with favourable results and a number of new tests are being added. Many of the Hach tests are also applicable to soil, if the soil is extracted with water and one is willing to accept a low accuracy. Development of a very simple procedure and apparatus for doing this is now taking place.

It was recognized early in the development process that certain substances in some media could not be detected and measured by level I and II systems. For this reason a more sophisticated system, which is vehicle portable (e.g. station wagon or van), would be required to extend spill analytical capability to some of the substances frequently spilled as well as to other potential spills. This system would have the additional advantage of increased accuracy and the ability to separate two or three compounds. The first stage of this system (the computer, IR and UV spectrometers) is functioning. The system has been loaded with 600 IR spectra and is capable of identifying these compounds in air and quantifying their levels. Work is continuing on calibration of this system for other media and other substances. The computerized chromatography system is only in the early stages of development at this time.

Development work is continuing on the level II and III systems. The schedule shown in Table 6, indicates the important target dates. It is noted that evaluation/development continues after the completion of a preliminary system at each level, primarily in order to expand the detection capability to additional compounds.

TABLE 6 SCHEDULE FOR ANALYTICAL SYSTEM DEVELOPMENT

	Level I	Level II	Level III
1980	Review of capability and recommendations	Review of capability and recommendations	Review of capability and recommendations
1981	Assessment	Assessment and development	Assessment and development
1982	Completed	Preliminary operational system	Development
1983	Completed	Further development	Installation of a prototype
1984	Assessment of new technology	Further development	Further development
1985	Completed	Updated operational system	Preliminary operational system

Countermeasures

The major portion of the R&D CHEC program funds and manpower will be designated to the improvement of countermeasures for spills of chemical substances. This activity includes the review of existing equipment, materials and techniques, their evaluation, and if necessary, their development. In 1980 a major survey, which will be published shortly, was undertaken using the categories illustrated in the appendix in Table A5. The survey reveals, not surprisingly, that a number of gaps in countermeasures capability exist. Major examples include the ability to deal with soluble products in water and with gases generally. It is the authors' opinion that the state-of-the-art in dealing with chemical spills is significantly behind that for dealing with oil spills.

After the survey was completed, the first evaluation development project was initiated on a small reverse osmosis unit. A prototype unit, the size of a small camping trailer, is being built and will be capable of processing a minimum of 1800 litres/hours (400 gallons/hour). After completion in late 1982, the prototype will be tested for the ability to process a number of chemical solutions as well as desalinating sea water for oil-spill cleanup using steam generators.

A number of projects are being planned for the future, and Newsletter readers will be provided with further information in future issues.

APPENDIX

TABLE A1 NEELS MAIN INFORMATION HEADINGS (FIELDS)

1. Province/State
2. Place Name
3. Organization
4. Latitude - Longitude
5. Facility
6. Phone Numbers
7. Booms/Fencing
8. Watercraft/Aircraft
9. Skimmers/Pumps/Fittings
10. Hoses/Connections/Portable Tanks
11. Vacuum/Pumper Trucks
12. Special Vehicles
13. Communications Equipment
14. Sorbents/Chemical Treating Agents/Application Equipment
15. Safety Equipment/Special Clothing
16. Generators/Lights
17. Earth Movers/Heavy Equipment
18. Other Equipment and Materials/Local Resources
19. Disposal Facilities
20. Comments/Control Points

TABLE A2 THE TOP TEN PRIORITY SUBSTANCES
(in alphabetical order)

Ammonia
Ammonium Nitrate
Calcium Oxide/Hydroxide
Chlorine
Methanol
Natural Gas
Potash (Potassium Chloride)
Sodium Hydroxide
Sulfur
Sulfuric Acid

TABLE A3 THE TOP FIFTY PRIORITY SUBSTANCES
(In alphabetical order)

Acetic Acid
Acetic Anhydride
Ammonia
Ammonium Nitrate
Ammonium Phosphates
Benzene
Butyraldehydes
Calcium Chloride
Calcium Oxide/Hydroxide
Carbon Dioxide
Chlorine
Cyclohexane
Ethylbenzene
Ethylene Dichloride (1,2-Dichloroethane)
Ethylene Glycol
Ethylene Oxide
Ethylene
Ferric Chloride
Formaldehyde
Hydrogen Chloride/Acid
Hydrogen Fluoride/Acid
Hydrogen Sulfide
Mercury
Methanol
Morpholine
Naphtha
Natural Gas
Nitric Acid
Phenol
Phosphoric Acid
Phosphorous
Potash (Potassium Chloride)
Propylene Oxide
Propylene
Sodium Chlorate
Sodium Chloride
Sodium Hydroxide
Sodium Hypochlorite
Sodium Sulfate
Styrene (Monomer)
Sulfur Dioxide
Sulfuric Acid (and Oleum)
Sulfur
Tetraethyl Lead
Toluene
Urea
Vinyl Chloride
Xylenes
Zinc Sulfate
2-Ethylhexanol

TABLE A4 THE TOP ONE-HUNDRED-FIFTY PRIORITY SUBSTANCES

Acetic Acid
Acetic Anhydride
Acetone
Acetylene
Acrylonitrile
Adipic Acid
Aluminum Chloride
Aluminum Hydroxide
Aluminum Sulfate
Aminocarb Pesticide (Matacil)
Ammonia
Ammonium Chloride
Ammonium Nitrate
Ammonium Phosphates
Ammonium Sulfate
Arsine
Barium Sulfate
Benzene
Benzoic Acid
Borax
Boric Acid
Butanols
Butylene
Butyraldehydes
Calcium Carbide
Calcium Carbonate
Calcium Chloride
Calcium Hypochlorite
Calcium Oxide/Hydroxide
Calcium Phosphate
Caprolactam
Carbaryl
Carbofuran Pesticides
Carbon Dioxide
Carbon Disulfide
Carbon Tetrachloride
Chlordane
Chlorine
Chloroform
Copper Sulfate
Cresols
Cyclohexane
Dicamba
Dichlorobenzene
Dimethyl Ether
Dimethyl Terephthalate
Dinoseb
Diphenylmethane-4,4'-Diisocyanate
Ethanolamine
Ethanol
Ethylbenzene
Ethylene
Ethylene Dibromide
Ethylene Dichloride (1,2-Dichloroethane)
Ethylene Glycol
Ethylene Oxide
Fenitrothion
Ferric Chloride
Fluorochloromethanes
Formaldehyde
Formic Acid
Hydrazine
Hydrogen Chloride/Acid
Hydrogen Fluoride/Acid
Hydrogen Peroxide
Hydrogen Sulfide
Hydrogen
Isopropanol
Isopropylbenzene
Latex
Lead Chromate
Lead Oxides
Magnesium Hydroxide
Malathion
Maleic Anhydride
MCPA
Mercury
Methanol
Methyl Ethyl Ketone
Methyl Isobutyl Ketone
Methyl Methacrylate
Methylamines
Methylene Chloride
Morpholine
Naphtha
Natural Gas
Nitric Acid
Nitrilotriacetic Acid
Nitroglycerine
Nonyl Phenol
n-Hexane
PCBs
Pentachlorophenol
Pentaerythritol
Perchloroethylene
Phenol
Phosphoric Acid
Phosphorous
Phthalic Anhydride
Potash (Potassium Chloride)
Potassium Hydroxide
Potassium Sulfate
Propylene
Propylene Glycols
Propylene Oxide
Sodium Aluminate
Sodium Arsenite
Sodium Borohydride
Sodium Carbonate
Sodium Chlorate
Sodium Chloride
Sodium Cyanide
Sodium Dichloroisocyanurate
Sodium Dichromate
Sodium Hydrosulfite (Dithionite)
Sodium Hydroxide
Sodium Hypochlorite
Sodium Phosphates
Sodium Silicates
Sodium Sulfate
Sodium Sulfite
Styrene (Monomer)
Sulfur
Sulfur Dioxide
Sulfuric Acid (and Oleum)
Sulfuryl Chloride
Tall Oil
Terephthalic Acid
Terphenyls
Tetraethyl Lead
Titanium Dioxide
Toluene
Triallate Pesticides
Trichlorfon Pesticides
Trifluralin Pesticides
Trinitrotoluene
Turpentine
Urea
Vinyl Acetate
Vinyl Chloride
Xylenes
Yellow Cake
Zinc Chloride
Zinc Oxide
Zinc Sulfate
1,1,1-Trichloroethylene
1,3-Butadiene
2,4-D (2,4-Dichlorophenoxyacetic Acid)
2,4-Toluene Diisocyanate
2-Ethylhexanol

TABLE A5 CATEGORIZATION OF HAZARDOUS MATERIAL SPILL COUNTERMEASURES EQUIPMENT AND MATERIALS

1. CONTAINMENT

   - 1.1 Leak plugging
   - 1.2 Land containment
   - 1.3 Containment of spills on water
   - 1.4 Containment of spills in water
   - 1.5 Vapour suppression

2. RECOVERY

   - 2.1 Recovery from land
   - 2.2 Recovery from water - floating material
   - 2.3 Recovery from water - sinking material

3. TRANSFER SYSTEM

   - 3.1 Transfer of gases
   - 3.2 Pumps for liquids
   - 3.3 Transfer hoses
   - 3.4 Transfer of multi-state materials

4. TEMPORARY STORAGE

5. HANDLING DEVICES

6. TREATMENT

   a) Systems or processes

   - 6.1 Incineration
   - 6.2 Chemical/physical modification
   - 6.3 Removal from water
   - 6.4 Removal from soil

   b) Agents

   - 6.5 Chemical/physical modification agent
   - 6.6 Sorbent
   - 6.7 Gelling agent
   - 6.8 Biological agent

   c) Applicators

   - 6.9 Treating agent applicator